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AIRBORNE MEASUREMENTS OF OPTICAL ATMOSPHERIC PROPERTIES IN SOUTHERN GERMANY

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ABSTRACT

This report presents atmospheric optical data collected in the daytime in Germany chiefly with airborne instruments during a field expedition in the spring of 1970. Results from six flights are presented. The data include irradiance, directional reflectance of terrain, total volume scattering coefficients, atmospheric beam transmittance, path radiance, and directional path reflectance. Data for sunlight and overcast conditions were derived for downward-looking paths of sight inclined at seven zenith angles (93, 95, 97, 100, 120, 150, and 180 degrees) from maximum altitudes of 2400 to 5100 meters AGL and lower in four spectral regions, as follows: two narrow band optical filters with mean wavelengths of 478 and 664 nanometers; and two broad band sensitivities, one representing the S-20 multiplier phototube incorporating an ultraviolet rejection filter with a mean wavelength of 532 nanometers, the other representing the photopic response with a mean wavelength of 557 nanometers.

SUMMARY

This report describing portions of the Project HAVEN VIEW effort was prepared under AFCRL contract F19628-70-C-0054. The principal project task was to take atmospheric optical measurements in Germany during Project HAVEN VIEW, and from these measurements, to determine optical properties for various downward-inclined paths of sight. These properties include atmospheric beam transmittance, path reflectance, terrain reflectance, irradiance, total volume scattering coefficient, and path radiance.

The field trip was made to Germany during May and June of 1970. Data were recorded near Memmingen over heavily cultivated, rolling pastureland. Occasional large patches of dark forest interrupted the typically green terrain patterns.

The instrumentation developed at the Visibility Laboratory and mounted in Air Force C-130A, aircraft No. 50022, consisted of a total scattering meter (or integrating nephelometer) for determining the total scattering coefficient, two sky scanning radiometers for recording upper and lower sky radiances, a dual irradiometer for recording alternately the downwelling and upwelling irradiances, an equilibrium radiance telephotometer, and a variable direction path function meter. The meteorological instrumentation included a Royco particle counter, pressure transducers, a dewpoint hygrometer, and an AN/AMQ-17 aerograph for measuring ambient temperature and humidity.

Each optical instrument was fitted with five optical filters causing it to measure at three narrow band wavelengths of the spectrum and two broad pass bands. The measurements were made using two of the narrow band filters at mean wavelengths of 478 and 664 nanometers, a broad band sensitivity of a mean wavelength of 532 nanometers, representing the S-20 multiplier phototube with ultraviolet rejection, and a filter representing the photopic response with a mean wavelength of 557 nanometers.

All but the Royco data were recorded on magnetic tape in the aircraft by means of a 42-channel magnetic tape data logger. The data tapes were returned to the Visibility Laboratory to be processed using the computer facilities at the University of California, San Diego.

A ground-based station near Memmingen contained effectively duplicate instrumentation for obtaining optical data. The ground-based nephelometer data measured simultaneously with the airborne data are reported herein.

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GLOSSARY AND NOTATION

The notation used in reports and journal articles produced by the Visibility Laboratory staff follow, in general, the rules set forth in pages 499 and 500, Duntley *et al* (1957). These rules are:

Each optical property is indicated by a basic (parent) symbol.

A presubscript may be used with the parent symbol as an identifier, e.g., b indicates background while t denotes an object.

A postsubscript may be used to indicate the length of a path of sight, e.g., r denotes an *apparent* property as measured at the end of a path of sight of length r, while o denotes an *inherent* property based on the hypothetical concept of a photometer located at zero distance from an object.

A postsuperscript *, or a postsubscript$_*$, is employed as a mnemonic symbol signifying that the radiometric quantity has been generated by the scattering of ambient light reaching the path from all directions.

The parenthetical attachments to the parent symbol denote altitude and direction. The letter z indicates altitude in general; z_t is used to specify the altitude of an object. The direction of a path of sight is specified by the zenith angle θ and the azimuth ϕ. In the case of irradiances, the downwelling irradiance is designated by d, the upwelling by u.

The glossary for meteorological symbols was presented in Section 6 and is not repeated here.

A(z)	Albedo at altitude z, defined by the equation $A(z) \equiv H(z,u)/H(z,d)$. (*Scalar Albedo*, at altitude z, is the ratio $h(z,u)/h(z,d)$.)
AGL	Above ground level.

$C_o(z_t,\theta,\phi)$ Inherent universal contrast determined for a path of sight of zero length at altitude of the object z_t in the direction of zenith angle θ and azimuth ϕ. This property is defined by the equation

$$C_o(z_t,\theta,\phi) \equiv \frac{{}_tN_o(z_t,\theta,\phi) - {}_bN_o(z_t,\theta,\phi)}{{}_bN_o(z_t,\theta,\phi)} .$$

$C_r(z,\theta,\phi)$ Apparent universal contrast as determined at altitude z from the end of path of sight of length r in the direction of the zenith angle θ and azimuth ϕ. This property is defined by the equation

$$C_r(z,\theta,\phi) \equiv \frac{{}_tN_r(z,\theta,\phi) - {}_bN_r(z,\theta,\phi)}{{}_bN_r(z,\theta,\phi)} .$$

g Acceleration of gravity.

$H(z)$ Scale height at altitude z, the height of a homogeneous atmosphere having the density of the layer at altitude z.

$H(z,d)$ Irradiance produced by downwelling flux as determined on a horizontal flat plate at altitude z. In this report d is used in place of the minus sign in the notation $H(z_t,-)$ which appears in Duntley (1969). This property may be defined by the equation

$$H(z,d) \equiv \int_{2\pi} N(z,\theta',\phi')\cos\theta' \, d\Omega .$$

$H(z,u)$ Irradiance produced by upwelling flux as determined on a horizontal flat plate at altitude z. Here u is substituted for the plus sign formerly used in the notation $H(z,+)$.

$h(z)$ Scalar irradiance. This may be defined as the radiant flux arriving at a point, from all directions about that point, at altitude z (Tyler and Preisendorfer, 1962):

$$h(z) \equiv h(z,d) + h(z,u) .$$

$h(z,d)$ Scalar irradiance produced by downwelling flux. This may be defined as the radiant flux from the upper hemisphere arriving at a point at altitude z.

${}_kh(z,d)$ Scalar irradiance defined as the radiant flux from the upper hemisphere sky (flux from the sun is not included) arriving at a point at altitude z.

${}_sh(z)$ Scalar irradiance defined as the radiant flux from the sun arriving at a point at altitude z.

$h(z,u)$ Scalar irradiance produced by upwelling flux. This may be defined as the radiant flux from the lower hemisphere arriving at a point at altitude z.

$L(z)$ Attenuation length at altitude z. This property is the reciprocal of the attenuation coefficient, that is,

$$L(z) \equiv \alpha(z)^{-1} .$$

$\bar{L}(z)$ Equivalent attenuation length is defined as

$$\bar{L}(z) = \frac{-z}{\ln T_z(0,0)} .$$

$m_\infty(z,\theta) / m_\infty(z,0)$ Relative optical airmass.

$N(z,\theta,\phi)$ Radiance as determined from altitude z in the direction specified by zenith angle θ and azimuth ϕ.

${}_bN_o(z_t,\theta,\phi)$ Inherent background radiance as determined at altitude of the photometer z_t at zenith angle θ and azimuth ϕ.

${}_bN_r(z,\theta,\phi)$ Apparent background radiance as determined at altitude z from the end of a path of sight of length r at zenith angle θ and azimuth ϕ. This property may be defined by the equation

$${}_bN_r(z,\theta,\phi) \equiv {}_bN_o(z_t,\theta,\phi)\, T_r(z,\theta) + N_r^*(z,\theta,\phi) .$$

${}_tN_o(z_t,\theta,\phi)$ Inherent radiance of an object as determined at altitude of the photometer z_t at zenith angle θ and azimuth ϕ.

${}_tN_r(z,\theta,\phi)$ Apparent radiance of an object as determined at altitude z from the end of a path of sight of length r at zenith angle θ and azimuth ϕ. This property may be defined by the equation

$${}_tN_r(z,\theta,\phi) \equiv {}_tN_o(z_t,\theta,\phi)\, T_r(z,\theta) + N_r^*(z,\theta,\phi) .$$

$N_q(z,\theta,\phi)$ Equilibrium radiance at altitude z with the direction of the path of sight specified by zenith angle θ and azimuth ϕ. This property is a point function of position and direction.

$N_*(z,\theta,\phi)$ Path function at altitude z with the direction of the path of sight specified by zenith angle θ and azimuth ϕ. This property is defined by the equation

$$N_*(z,\theta,\phi) \equiv \int_{4\pi} \sigma(z,\beta')\, N(z,\theta',\phi')\, d\Omega .$$

This property also is a point function of position and direction.

$N^*_r(z,\theta,\phi)$ — Path radiance as determined at altitude z at the end of a path of sight of length r in the direction specified by zenith angle θ and azimuth ϕ.

$n(z)$ — Index of refraction at altitude z.

$P(z)$ — Pressure at altitude z.

psia — Pressure, absolute, pounds per square inch.

psid — Pressure, differential, pounds per square inch.

${}_bR_o(z_t,\theta,\phi)$ — Inherent background reflectance as determined at the altitude of an object z_t and viewed at zenith angle θ and azimuth ϕ.

$R^*_r(z,\theta,\phi)$ — Directional path reflectance as determined at altitude z at the end of a path of sight of length r in the direction specified by zenith angle θ and azimuth ϕ.

$R_q(z,\theta,\phi)$ — Equilibrium reflectance is defined as $R_q(z,\theta,\phi) = N_q(z,\theta,\phi)\,\pi / H(z,d)$.

$R/M(0)$ — Universal gas constant.

$\overline{S_\lambda T_\lambda}$ — Standardized relative spectral response of filter/cathode combination where S_λ is spectral sensitivity of the multiplier phototube cathode and T_λ is spectral transmittance of optical filter.

$s(z)$ — Total volume scattering coefficient as determined at altitude z. This property may be defined by the equation

$$s(z) \equiv \int_{4\pi} \sigma(z,\beta)\, d\Omega \quad .$$

In the absence of atmospheric absorption, the total volume scattering coefficient is numerically equal to the attenuation coefficient.

${}_Ms(z)$ — Total volume scattering coefficient for Mie scattering at altitude z.

${}_Rs(z)$ — Total volume scattering coefficient for Rayleigh scattering at altitude z.

$T(z)$ — Temperature in degrees Kelvin at altitude z.

$T_r(z,\theta)$ — Beam transmittance as determined at altitude z for a path of sight of length r at zenith angle θ. This property is independent of azimuth in atmospheres having horizontal uniformity. It is always the same for the designated path of sight or its reciprocal.

${}_b\tau_r(z,\theta,\phi)$ — Contrast transmittance as determined at altitude z at the end of a path of sight of length r and specified by zenith angle θ and azimuth ϕ. This property is *not* independent of azimuth and is *not* the same for the designated path of sight and its reciprocal.

W_λ Spectral emittance (power/unit of area) of electromagnetic flux from a plane surface.

$\bar{y}$ Symbol for visual efficiency function.

ZSV Zero scale value. The zero point on the linear scale when the radiometric or photometric quantity x is equal to a reference radiometric or photometric quantity x_o as shown in equation

$$\log [x_o / x] = 0 .$$

z Altitude, usually used as above ground level.

z_t Altitude of an object.

$\alpha(z)$ Volume attenuation coefficient as determined at altitude z. In the absence of atmospheric absorption, the attenuation coefficient is numerically equal to the volume scattering coefficient.

β Symbol for scattering angle of flux from a light source. It is equal to the angle between the line from the source to the observer and the path of sight.

β' Symbol for scattering angle of flux from a discrete part of the sky. It is equal to the angle between the direction specified by θ' and ϕ' and the path of sight.

Δ Symbol to indicate incremental quantity and used with r and z to indicate small, discrete increments in path length r and altitude z.

δ_λ Response area is defined as $\delta_\lambda = \Sigma(\overline{S_\lambda T_\lambda})\, \Delta\lambda$.

ϵ_λ Spectral emissivity of tungsten filament.

ζ Symbol for radius of the earth in Eq. 2-11 and 2-13 and Figure 2-2.

θ Symbol for zenith angle. This symbol is usually used as one of two coordinates to specify the direction of a path of sight.

θ' Symbol for zenith angle usually used as one of two coordinates to specify the direction of a discrete portion of the sky.

λ Symbol for wavelength.

$\bar{\lambda}$ Mean wavelength is defined as $\bar{\lambda} = \Sigma\lambda\, (\overline{S_\lambda T_\lambda})\, \Delta\lambda / \delta\lambda$.

$\rho(z)$ Density at altitude z.

σ Symbol for volume scattering function. Parenthetical symbols may be added; for example, β may be used to designate the scattering angle from a source. In Gordon (1969) the parenthetical symbols are z and β for altitude and scattering angle.

$\sigma(z,\beta)/s(z)$ Proportional directional volume scattering function. This may be defined by the equation

$$\int_{4\pi} [\sigma(z,\beta)/s(z)] \equiv 1 .$$

ϕ Symbol for azimuth. The azimuth is the angle in the horizontal plane of the observer between a fixed point and the path of sight. The fixed point may be, for example, true north, the bearing of the sun, or the bearing of the moon. This symbol is usually used as one of two coordinates to specify the direction of a path of sight.

ϕ' This symbol for azimuth is usually used as one of two coordinates to specify the direction of a discrete portion of the sky.

Ω Symbol for solid angle. For a hemisphere

$$\Omega = 2\pi \text{ steradians;}$$

for a sphere $\Omega = 4\pi$ steradians.

1. INTRODUCTION

The field measurement program described in this report was organized under the project title HAVEN VIEW. The overall operation of this project was coordinated as a part of Air Force Cambridge Research Laboratory's Project 7621 and specified in AFCRL OPLAN3.

The HAVEN VIEW mission was conducted during April, May, and June 1970. Data acquisition flights were made in southern Germany, northern Spain, and eastern Morocco. Typical flight track locations are illustrated in Figure 1-1.

This report has been prepared under Contract No. F19628-70-C-0054. It contains the optical properties of various downward-inclined paths of sight based on daytime atmospheric optical measurements made near Memmingen, Germany (see Figure 1-2). These properties include irradiance, directional background reflectance, total volume scattering coefficient, beam transmittance, path radiance, and path reflectance.

The methods used in the derivation of these optical properties are discussed in detail in Section 2. There are four principal modifications from the methods outlined in Duntley *et al* (1970). First, extrapolations of total volume scattering coefficient are made according to the density ratios of the U. S. Standard Atmosphere (1962). Second, the refraction effect has been added to the effect of earth curvature for the computation of the incremental path length for the near horizontal slant paths. Third, the selection of the shape of the volume scattering function from the Barteneva (1960) catalog is now based upon the *in situ* measurements of the volume scattering function at 30 and 150 degrees. Finally, when the sky near the sun is unclouded, the apparent sun radiance value is based upon the theoretical value of the sun radiance out-of-the-atmosphere and the beam transmittance from out of the atmosphere to the altitude of measurement (based on an extrapolation of beam transmittance from the highest flight altitude).

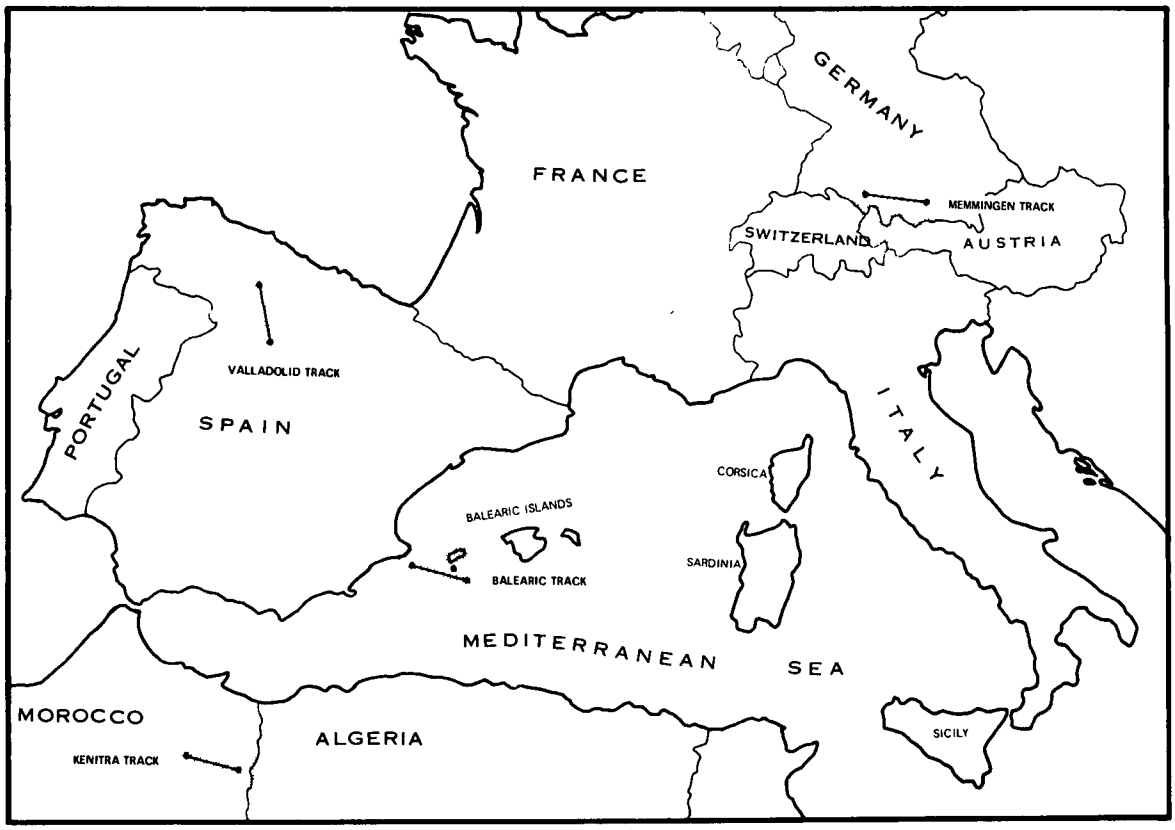

Fig. 1-1. Typical HAVEN VIEW Data Sites.

The optical instrumentation, developed at the Visibility Laboratory and installed in Air Force C-130A aircraft No. 50022, is reported in detail in Duntley *et al.* (1970). The instrumentation which generated the raw data upon which the reported properties are based consisted of an integrating nephelometer for determining the total scattering coefficient and two sky scanning radiometers for recording upper and lower sky radiances. A ground-based integrating nephelometer similar to the airborne instrument provided the ground level value of the total volume scattering coefficient.

The basic characteristics of the instrumentation are reviewed in Section 3 of this report. All significant modifications and updates accomplished subsequent to the issuance of AFCRL-70-0137, Duntley *et al.* (1970), are included wherever appropriate within this report. The major revisions to the hardware were initiated in order to convert their operating characteristics to permit daytime as well as nighttime data gathering. Two general modifications were required. First, all optical filter changers were altered to permit the automatic insertion of neutral density filters into the optical paths of each radiometer system, and secondly, a revised air inlet was devised for the airborne integrating nephelometer. The radiometer spectral responses were standardized for this deployment and are illustrated in Figure 1-3 and discussed in Section 3.5.

Data collection methods are similar to those reported by Duntley *et al.* (1970). The major revision was to insert a new flight profile which covers all altitudes between ground level and 20 000 feet (6100 meters)

above ground level. See Figure 4-1. As inferred in the previous paragraph, data collection can now be accomplished under both daytime and nighttime illumination levels. Only one flight was made at night over the Memmingen track. That was Flight C-135 on 26 May 1970. Data for this night flight are not included in this report.

The computer techniques used for processing the data included in this report are summarized in Section 5. They are, in general, similar to the techniques reported by Duntley *et al.* (1970). Several adjustments and improvements to the routines have been added to speed up the overall processing and diagnostic sequences, as well as to expand the display options. See Figure 5-1. The most obvious update is the addition of graphic displays to supplement data tables. Automatic processing and validating of the pre- and post-deployment calibration data is probably the most significant technical improvement to the data processing technique.

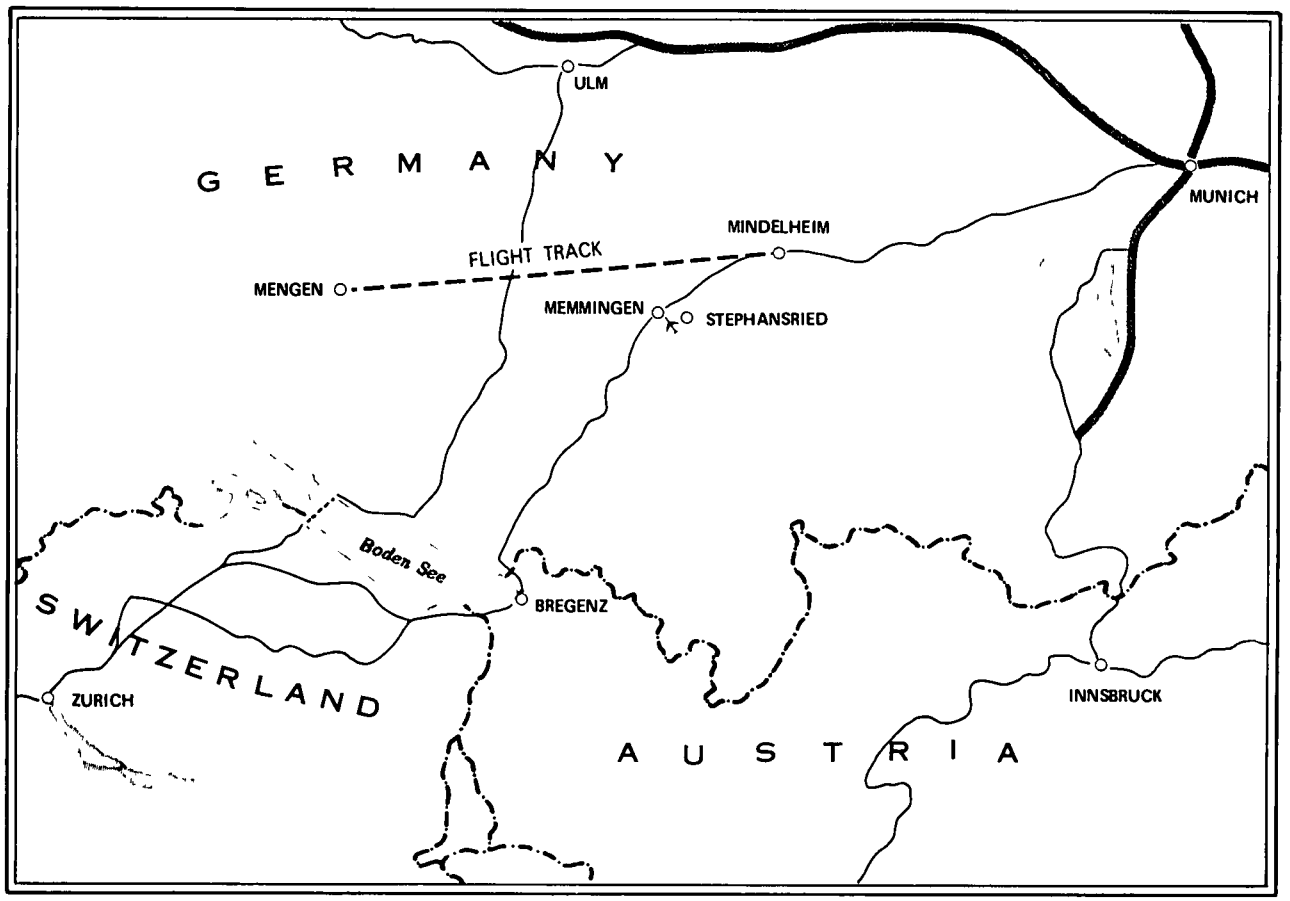

Fig. 1-2. Project HAVEN VIEW Memmingen Flight Track, 48.0° N 9.9° E, Mean Ground Elevation 629 Meters.

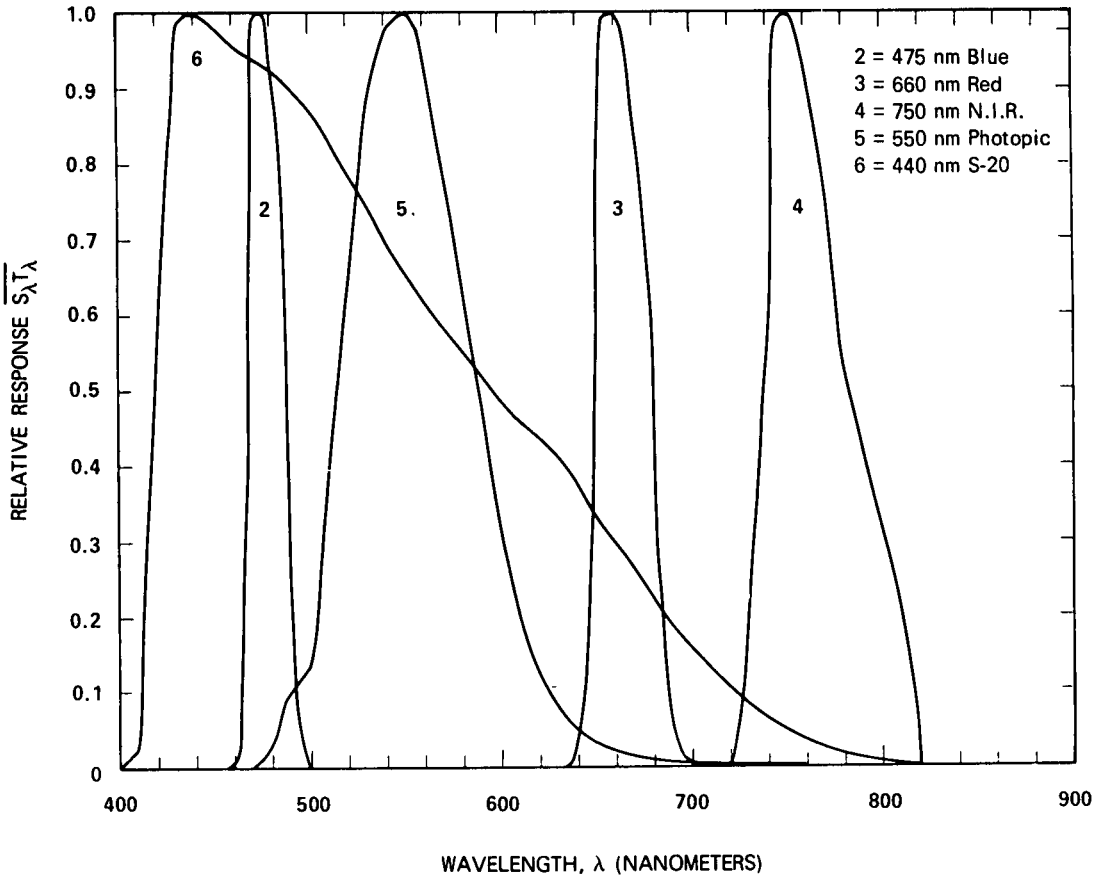

Fig. 1-3. Standard Spectral Responses for Project HAVEN VIEW.

A general discussion of the weather patterns that predominated in the Memmingen area during the data collection is presented in Section 6. This section, in conjunction with the typical flight track photographs shown in Figures 7-1 and 7-2, is intended as an aid to the data-user's interpretation and evaluation.

Presentation of the radiometric data representing the six flights covered in this report is in Section 7. The presentation format is similar to that used in AFCRL-70-0137, Duntley *et al.* (1970). The most significant update is the inclusion of graphical representations as a supplement to the basic tabular format. The graphical presentations are redundant in that they contain no new data, but their inclusion is intended to facilitate a user's rapid and generalized evaluation of data type and quality.

The ground data logger did not function properly during the HAVEN VIEW deployment. As a result, only manually retrieved data from a dump of the magnetic tape contents could be processed. The recovery of ground-based data by this method is time-consuming and costly, and has been restricted to the scattering coefficient data. These selected ground measurements are summarized in Section 8.

2. THEORY

2.1 CONTRAST TRANSMITTANCE

Contrast transmittance ${}_b\tau_r(z,\theta,\phi)$ is defined as the ratio of the apparent contrast $C_r(z,\theta,\phi)$ to the inherent contrast $C_o(z_t,\theta,\phi)$:

$$ {}_b\tau_r(z,\theta,\phi) \equiv C_r(z,\theta,\phi) / C_o(z_t,\theta,\phi) . \tag{2.1} $$

The parenthetical modifiers indicate the altitude z of the sensor and the zenith angle θ and azimuth ϕ of the path of sight. In this report, ϕ will always be in terms of azimuth from light source (sun or moon). The path length r in the direction of the path of sight is between the altitude of the target z_t and the sensor altitude z. For the inherent contrast the path length is zero. The presubscript b on the contrast transmittance ${}_b\tau_r(z,\theta,\phi)$ indicates background. The contrast transmittance is a function of the inherent background radiance ${}_bN_o(z_t,\theta,\phi)$, the atmospheric beam transmittance $T_r(z,\theta)$, and the path radiance $N_r^*(z,\theta,\phi)$ of the path of sight as shown in Eq. 2-2 (Duntley (1964) Eq. 2.4):

$$ {}_b\tau_r(z,\theta,\phi) = [1 + N_r^*(z,\theta,\phi) / {}_bN_o(z_t,\theta,\phi)\, T_r(z,\theta)]^{-1} . \tag{2.2} $$

2.2 DIRECTIONAL PATH REFLECTANCE

The concept of directional path reflectance (Duntley (1969) p. 3) is utilized in an alternate form of Eq. 2-2,

$$ {}_b\tau_r(z,\theta,\phi) = [1 + R_r^*(z,\theta,\phi) / {}_bR_o(z_t,\theta,\phi)]^{-1} , \tag{2.3} $$

where ${}_bR_o(z_t,\theta,\phi)$ is the directional background reflectance. By definition, the directional path reflectance is

$$R_r^*(z,\theta,\phi) = \pi N_r^*(z,\theta,\phi)/[H(z_t,d)\, T_r(z,\theta)]\,, \tag{2.4}$$

where $H(z_t,d)$ is the downwelling irradiance. We have chosen to present the atmospheric data in the form of directional path reflectance since, in this form, it can be easily utilized with the directional reflectance of a variety of backgrounds smaller in extent but different from the heterogeneous background which contributed to the path radiance and downwelling irradiance. The directional path reflectance is also the most convenient form of presenting the atmospheric data for easy use to obtain contrast transmittance.

2.3 BACKGROUND REFLECTANCE

The inherent background reflectance is defined as

$${}_bR_o(z_t,\theta,\phi) = \pi_b N_o(z_t,\theta,\phi)/H(z_t,d)\,, \tag{2.5}$$

where $H(z_t,d)$ is the downwelling irradiance at the target altitude (Gordon (1964) p. 558 or Boileau and Gordon (1966) p. 805). The inherent background reflectance may be obtained from either (1) a measurement by a ground-based telephotometer† or (2) measurements by an airborne telephotometer. In this report airborne telephotometer data from the lowest altitude of flight not interpolated to ground level were used to obtain the terrain reflectances reported here for each flight.

2.4 DOWNWELLING IRRADIANCE

The irradiance used to compute the directional path reflectance $R_r^*(z,\theta,\phi)$ and the airborne terrain reflectance is computed from data at the lowest altitude of flight by the equation

$$H(z,d) = \int_{2\pi} N(z,\theta',\phi')\cos\theta'\, d\Omega\,, \tag{2.6}$$

where $N(z,\theta',\phi')$ is the sky or sun radiance at direction θ',ϕ'. When $\theta' = \theta_s$ and $\phi' = 0$, $N(z,\theta_s,0)$ is the sun or moon radiance.

Using Eq. 2.6, the upwelling irradiance $H(z,u)$ is computed by replacing the sky radiances with apparent terrain radiances from the lower hemisphere scanner. The θ' would then be the nadir angle so that $\cos\theta'$ is positive. The albedo $A(z)$ is the ratio of the upwelling to downwelling irradiance $H(z,u)/H(z,d)$.

† Although the measurements are radiometric as opposed to photometric, the instrument used to perform these measurements is referred to herein as a "telephotometer" in lieu of the more precise term "teleradiometer". This is in keeping with the practice established in previous publications.

A second type of irradiance is the scalar or nondirectional irradiance:

$$h(z,d) = \int_{2\pi} N(z,\theta',\phi')\, d\Omega \,. \tag{2.7}$$

The scalar irradiance is not weighted by the cosine. The upwelling irradiance from zenith angles between 90 and 180 degrees is designated by $h(z,u)$ and computed by using Eq. 2.7 also. The total scalar irradiance is the sum of the upwelling and downwelling scalar irradiances $h(z) = h(z,u) + h(z,d)$. The scalar albedo is defined as the ratio of upwelling to downwelling scalar irradiance, $h(z,u)/h(z,d)$. For a full discussion of scalar irradiances and scalar albedo uses refer to Gordon (1969).

2.5 BEAM TRANSMITTANCE

The beam transmittance $T_r(z,\theta)$ is obtained directly from the total scattering coefficient $s(z)$ by means of Eq. 2.8. (Refer also to Boileau (1964) p. 570). When there is no significant atmospheric absorption in the pass bands of the measurements, e.g., from smoke, dust, or smog, the attenuation coefficient $\alpha(z)$ is equivalent to the scattering coefficient $s(z)$. Therefore,

$$T_r(z,\theta) = \exp\left[-\sum_{i=1}^{n} \alpha(z_i)\Delta r\right] = \exp\left[-\sum_{i=1}^{n} s(z_i)\Delta r\right] . \tag{2.8}$$

The incremental path length Δr used is 30 meters (98.4 feet). The measured total scattering coefficient data are extrapolated to ground level when no ground-based measurements are available. The extrapolation assumes that the scattering particles are the same at all altitudes, but decrease or increase according to the density at each altitude $\rho(z)$:

$$s(o) = \frac{s(z)\rho(o)}{\rho(z)} \,. \tag{2.9}$$

Similarly, upward extrapolations are made to the highest observer altitude above ground level (6 kilometers maximum) when the highest flight altitude is less. Extrapolation in this case is based on the scattering coefficient measured at highest flight altitude. The densities used for the extrapolations are for the U. S. Standard Atmosphere (1962). The density at each altitude is obtained by truncated Chebyshev expansion using the coefficients for the atmosphere 0 to 80 kilometers (U. S. Standard Atmosphere Supplements (1966) p. 69).

All altitudes reported are between ground level and 6 kilometers. For all paths of sight at zenith angles greater than 95 degrees, Δr equals $\Delta z \sec\theta$ for these altitudes. The Δr is always nonnegative

since Δz is defined as $z_1 - z_2$ (the subscripts increase with the flux direction). See Fig. 2-1. For zenith angles greater than 95 degrees, the beam transmittance can also be expressed as a function of the vertical beam transmittance $T_r(z,180)$ as follows:

$$T_r(z,\theta) = T_r(z,180)^{|\sec\theta|} . \tag{2.10}$$

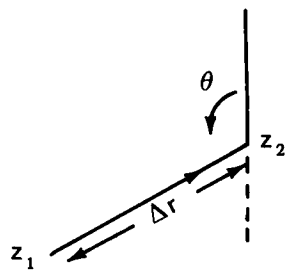

Fig. 2-1. Path Length Geometry

2.6 EARTH CURVATURE AND REFRACTION

For the paths of sight at 93 and 95 degree zenith angles, the Δr for $\Delta z = 30$ meters (98.4 feet) is significantly longer at ground level than at 6 kilometers due to the curvature of the earth. Therefore, for these paths of sight, the incremental path length Δr_1 is computed from

$$\Delta r_1 = \left\{ 1 - \left[\frac{n(z)}{n(z_1)} \frac{(\zeta + z)}{(\zeta + z_1)} \sin\theta \right]^2 \right\}^{-1/2} \Delta z . \tag{2.11}$$

This is the classical equation for computing incremental path length at paths of sight affected by earth curvature and refraction. The $n(z)$ is the refractive index, z is the sensor or observer altitude, ζ is the radius of the earth. Equation 2.11 was derived as follows. The Δr_1 due to earth curvature is a function of the angle θ'' which is the angle of the flux path at altitude z_1 (see Figure 2-2 for the relationship of θ and θ'' for the downward path of sight):

$$\Delta r_1 = \sec\theta'' \, \Delta z = (1 - \sin^2\theta'')^{-1/2} \, \Delta z . \tag{2.12}$$

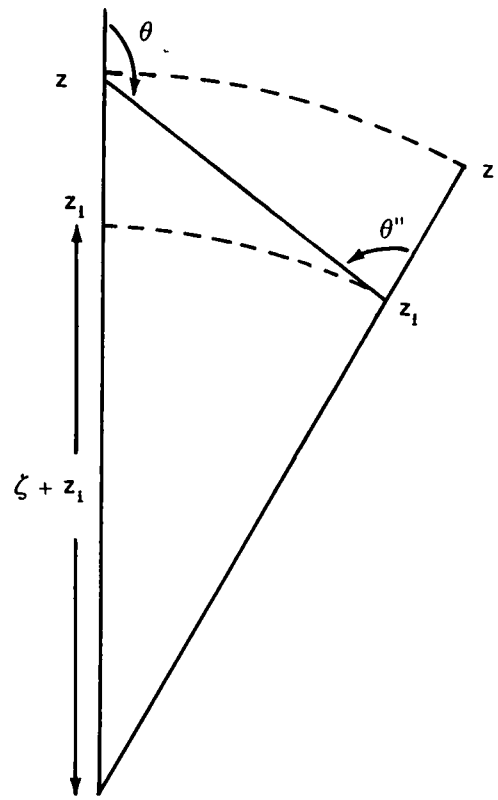

Fig. 2-2. The path of sight θ is for a sensor at altitude z. Zenith angle θ'' is the flux direction of the same path at altitude z. The angle θ'' is not equal to $180^\circ - \theta$ due to the curvature of the earth and refraction.

Since $\sin x = \sin(180^\circ - x)$, the law of sines can be used to express Δr as a function of the path of sight θ:

$$\sin\theta'' = \frac{\zeta + z}{\zeta + z_i} \sin\theta \, . \tag{2.13}$$

The refraction effect is added by recourse to Snell's law, thus resulting in Eq. 2.11.

The square of the refractive index ratio is given in an alternate form by Kasten (1965) as

$$\left[\frac{n(z)}{n(z_i)}\right]^2 = 1 + 2\,[n(z) - 1]\,[1 - \rho(z_i)/\rho(z)] \, . \tag{2.14}$$

This can be rewritten in terms of the refractive index at ground level $z = o$ as follows:

$$\left[\frac{n(z)}{n(z_i)}\right]^2 = 1 + 2\,[n(o) - 1]\left[\frac{\rho(z)}{\rho(o)} - \frac{\rho(z_i)}{\rho(o)}\right] . \qquad (2.15)$$

The density values for computing the refraction effect are, as before, based on the U. S. Standard Atmosphere (1962). The refractive index used for ground level was 1.000276, appropriate to a wavelength of 700 nanometers at 15°C. The maximum error in using the Δr based on 700 nanometers for wavelengths of 478 to 770 nanometers is 0.2 percent.

2.7 PATH RADIANCE

Path radiance $N_r^*(z,\theta,\phi)$ for the downward-looking path of sight is the integration or summation of the path function $N_*(z,\theta,\phi)$ weighted by the beam transmittance $T_{ri}(z,\theta)$. Path length ri is from the incremental path Δr to the sensor at z:

$$N_r^*(z,\theta,\phi) = \sum_{i=1}^{m} N_*(z_i,\theta,\phi)\, T_{ri}(z,\theta)\, \Delta r . \qquad (2.16)$$

(Refer to Duntley, *et al.* (1957) Eq. 17 on p. 502). The path function $N_*(z_i,\theta,\phi)$ is the product of the equilibrium radiance $N_q(z_i\theta,\phi)$ and total scattering coefficient $s(z_i)$ [Duntley, *et al.* (1957) Eq. 11 on p. 502 since $s(z) = 1/L(z)$]:

$$N_*(z_i,\theta,\phi) = N_q(z_i,\theta,\phi)\, s(z_i) . \qquad (2.17)$$

2.8 EQUILIBRIUM RADIANCE

The equilibrium radiance (Duntley, *et al.* (1957) p. 502, and Gordon (1969) p. 15) is first computed from the measurements made at each of the altitudes of level flight and then interpolated and extrapolated to obtain values at each 30 meter (98.4 foot) interval z_i. To compute the equilibrium radiance the following equation is used (refer to Gordon (1969), Eq. 16* on p. 16):

$$N_q(z,\theta,\phi) = \int_{4\pi} N(z,\theta',\phi') \frac{\sigma(z,\beta')}{s(z)}\, d\Omega , \qquad (2.18)$$

* Since the sun or moon radiance was included in the sky measurements, the separate term for the scalar irradiance of the sun (or full moon) h_s (the first term of the right member of Eq. 16) reduces to zero. Equation 16 applies equally well to real and model atmospheres.

where $N(z,\theta',\phi')$ is the apparent radiance of the sky, sun or moon, or ground for direction θ' and ϕ'. The ratio $\sigma(z,\beta')/s(z)$ is the proportional directional scattering coefficient at angle β' and altitude z. The β' is the angle between the path of sight at θ,ϕ and the radiance θ',ϕ'. It is found by

$$\cos\beta' = \sin\theta \sin\phi \sin\theta' \sin\phi' + \sin\theta \cos\phi \sin\theta' \cos\phi' + \cos\theta \cos\phi' . \qquad (2.19)$$

It is the scalar irradiance which designates the flux that enters into the computations of equilibrium radiance and path function when the directional radiances are not known or used. It is the directionality of that flux combined with the directionality of the volume scattering function which produces the unique equilibrium radiance associated with each path of sight.

2.9 PROPORTIONAL DIRECTIONAL SCATTERING COEFFICIENT

The proportional directional scattering function is found by combining the Rayleigh scattering component and the Mie scattering component:

$$\sigma(z,\beta')/s(z) = \left\{ {}_R s(z) \; {}_R\left[\frac{\sigma(z,\beta')}{s(z)}\right] + {}_M s(z) \; {}_M\left[\frac{\sigma(z,\beta')}{s(z)}\right] \right\} / s(z) . \qquad (2.20)$$

The Rayleigh scattering coefficient ${}_R s(z)$ for each pass band is based upon monochromatic values of Rayleigh volume scattering coefficient computed using the Penndorf (1957) Eq. 14 for 15°C sea level pressure. The Rayleigh scattering coefficient is corrected to ambient temperature and pressure by the ideal gas law equation. Since the Rayleigh scattering is a direct function of density,

$${}_R s(z) = {}_R s(0) P(z) / [T(z)\ 3.516E3] , \qquad (2.21)$$

where $P(z)$ is pressure in dynes cm^{-2}, $T(z)$ is temperature in degrees Kelvin, and 3.516E3* has units of dynes $cm^{-2}\,°K^{-1}$ and is the density at standard sea level pressure and 15°C temperature times the universal gas constant. The proportional directional scattering function for Rayleigh scattering ${}_R[\sigma(\beta)/s]$ is not a function of altitude so the parenthetical modifier is not used; it is found by

$${}_R[\sigma(\beta)/s] = (1 + \cos^2\beta)3 / (16\pi) . \qquad (2.22)$$

The Mie scattering coefficient at measurement altitude z is the measured scattering coefficient minus the Rayleigh coefficient computed from Eq. 2.21 above:

* The form of 3.516E3 is an alternate format for 3.516×10^3. This computer form is used throughout this report.

$$ {}_{M}s(z) = s(z) - {}_{R}s(z) . \tag{2.23} $$

The Mie volume scattering function ${}_{M}[\sigma(z,\beta)/s(z)]$ is taken from a catalog of values derived from data on photopic volume scattering functions published by Barteneva (1960) for a range of total scattering coefficients from near Rayleigh atmosphere to heavy fog. The Barteneva volume scattering functions show a good correlation with the ratio of directional scattering coefficients at scattering angles $\beta = 30°$ and 150°: $({}_{M}[\sigma(z,30)/\sigma(z,150)])$. The Mie volume scattering functions at 30 and 150 degrees are obtained from the measured volume scattering function at 30 and 150 degrees by subtracting the Rayleigh component, as follows:

$$ {}_{M}\sigma(\beta) = \sigma(\beta) - {}_{R}s(z)\ {}_{R}[\sigma(\beta)/s] . \tag{2.24} $$

2.10 APPARENT SUN RADIANCE

The sky radiances used to compute the irradiance and the equilibrium radiance include the sun radiance but the values often are beyond the calibrated span of the instrument. To compensate for this, an apparent sun radiance value is substituted when there is no cloud cover. This apparent sun radiance is based upon the inherent sun irradiance ${}_{s}H_{o}(\infty,d)$ for the appropriate broad band filter, the beam transmittance from out of the atmosphere to altitude z, $T_{\infty}(z,\theta_{s})$, and the appropriate $\Delta\Omega^{*}$ used for the numerical integration indicated in Eq. 2.6, 2.7, and 2.18:

$$ {}_{s}N_{\infty}(z,\theta_{s},0) = {}_{s}H_{o}(\infty,d)\ T_{\infty}(z,\theta_{s})/\Delta\Omega . \tag{2.25} $$

The inherent sun irradiance values are computed from spectral sun irradiances from Johnson (1954).

The transmittance from out of the atmosphere to the highest flight altitude is computed by using the concept of the scale height H(z). The scale height is the height of a homogeneous atmosphere having the density of the layer at altitude z:

$$ H(z) = \frac{T(z)\,R}{g\,M(o)} , \tag{2.26} $$

where T(z) is the temperature in degrees Kelvin at altitude z. The universal gas constant R/M(o) is 2.8705E2 $m^{2}sec^{-2}{}^{\circ}K^{-1}$. The acceleration of gravity g(z,1) is a function of altitude z and latitude 1.

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*The $\Delta\Omega$ equals $2\pi \sin\theta\,\Delta\theta/60$, where $\Delta\theta = 0.08727$ rad (5°). The θ is the scanner zenith angle in the grid 2.5° → 87.5°, $\Delta\theta = 5°$.

The value for 45°32'40'' at z = 0 is 9.80665 m sec^{-2}. The error in considering it as a constant for z 0 to 6 kilometers and for all latitudes is less than 1/2 percent. The transmittance from out of the atmosphere to altitude z is

$$T_{\infty}(z,o) = e^{-H(z)s(z)} . \tag{2.27}$$

The transmittance for the lower flight altitudes is the product of the transmittance from out of the atmosphere to the highest altitude $T_{\infty}(z_m,o)$ and the transmittance between the two flight altitudes $T_r(z,o)$ as obtained by Eq. 2.8:

$$T_{\infty}(z,o) = T_{\infty}(z_m,o)\, T_r(z,o) . \tag{2.28}$$

The conversion from vertical transmittance to transmittance at the zenith angle of the sun is made using the relative airmass $m_{\infty}(z,\theta_s)/m_{\infty}(z,o)$:

$$T_{\infty}(z,\theta_s) = T_{\infty}(z,o)^{m_{\infty}(z,\theta_s)/m_{\infty}(z,o)} . \tag{2.29}$$

The relative airmass equals secθ for $\theta_s \leq 70°$ to an accuracy of 1 percent. Also the relative airmass at altitudes up to 6 kilometers equals the relative airmass at sea level, $m_{\infty}(6,\theta_s)/m_{\infty}(6,0) = m_{\infty}(o,\theta_s)/m_{\infty}(o,o)$, to an accuracy of 1 percent for $\theta_s \leq 86°$. Sea level relative airmass values from Kasten (1965) are used for θ_s 70 → 86°.

3. INSTRUMENTATION

The scientific instrumentation utilized for the HAVEN VIEW task was basically the same as that reported in AFCRL-70-0137, Duntley *et al.* (1970). Several hardware modifications were required, however, to convert system sensitivities from nighttime to daytime operating levels. These modifications are described more fully in the appropriate subsections which follow.

For convenience of the reader, all significant instrument systems assigned during the HAVEN VIEW exercise are tabulated in Table 3-1 and depicted in Figures 3-1 and 3-2.

Table 3-1. Project HAVEN VIEW Instrumentation

I. Radiometric
   - A. Multiplier Phototube Assembly
   - B. Temperature Control Housing Assembly
   - C. Optical Filter Assembly
   - D. Radiometer Measuring Circuit Assembly
   - E. Optical Collector Assembly
     1. Automatic 2π Scanner Assembly
     2. Integrating Nephelometer Mode Selector Head Subassembly
     3. Dual Irradiometer Assembly
     4. Large Aperture Telescope Assembly
     5. Variable Path Function Meter Assembly

II. Meteorological

A. Royco Model 220 Particle Counter

B. Cambridge Model 137-C3 Aircraft Hygrometer System

C. AN/AMQ-17 Aerograph Set

D. Bourns Model 430/530 Absolute Pressure Transducer

E. Bourns Model 509 Differential Pressure Transducer

F. Bendix Model 566 Aspirated Hygrometer

G. Science Associates Windspeed and Direction Set

H. Taylor Model SMT-5-51 Aneroid Barometer

III. Control and Communication

A. 2π Scanner Control Console

B. Photometer Temperature Control Panel

C. Optical Filter Control Panel

D. Ten Slide Photometer Module

E. Camera Control Panel

F. Flight Dynamics Display Panel

G. 42 Channel Data Logger

H. 20 Channel Data Logger

3.1 RADIOMETRIC SYSTEMS

A standardized radiometer, typical of those used during this data collection interval, consists of five major assemblies as listed below.

1. Multiplier Phototube Assembly
2. Temperature Control Housing Assembly
3. Optical Filter Assembly
4. Radiometer Measuring Circuit Assembly
5. Optical Collector Assembly

These assemblies are generally interchangeable between different radiometer systems, allowing easy field cannibalization in the event of a catastrophic failure of any assembly within a key system. All assemblies mate in pressure seals which allows each section to be purged with dry nitrogen and maintained at approximately 5 pounds per square inch positive pressure.

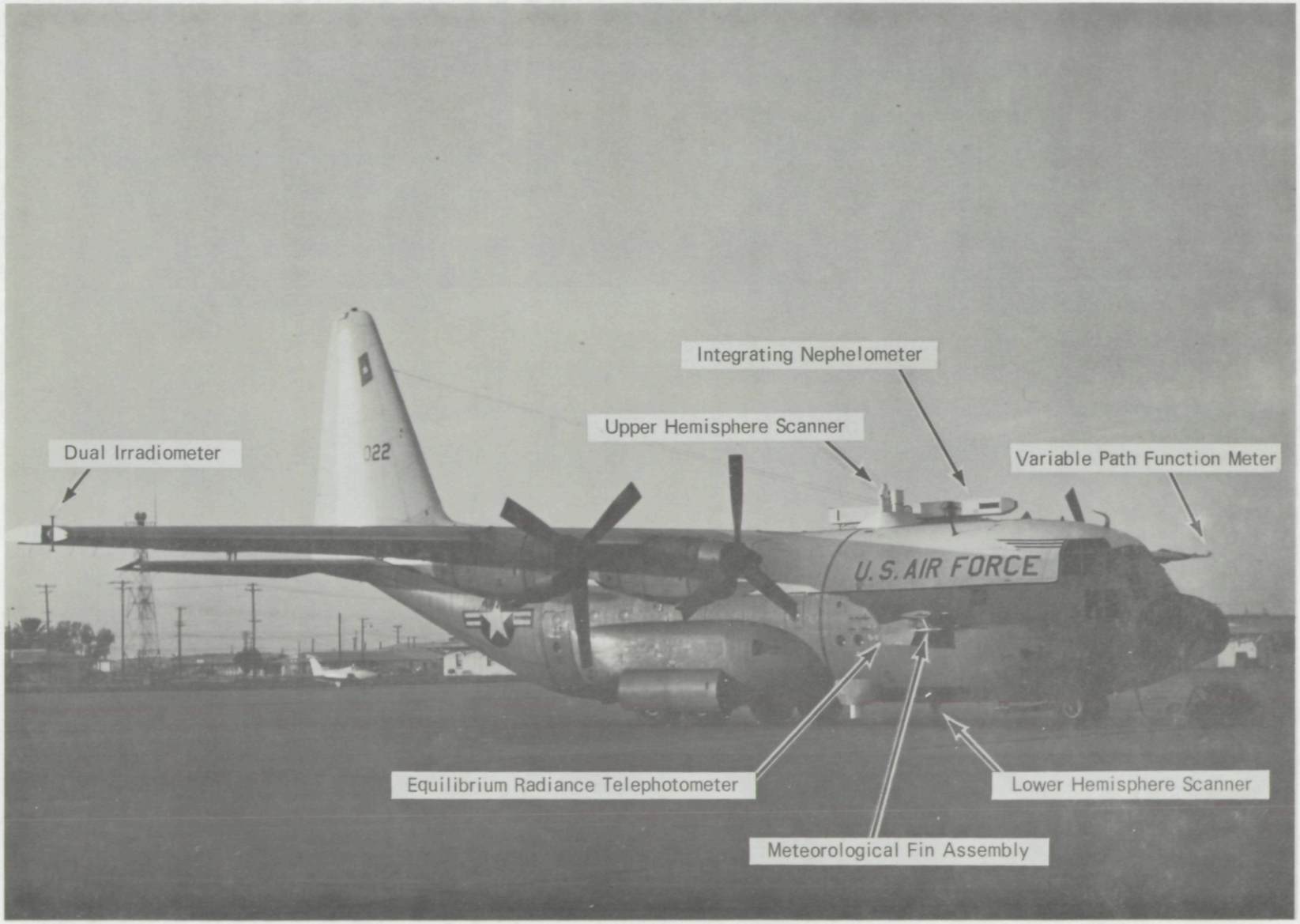


Fig. 3-1. C-130 Airborne Instrument System.

Fig. 3-2. Ground-Based Data Station.

MULTIPLIER PHOTOTUBE ASSEMBLY

The basic detector in all these systems is an EMR 541E fourteen stage, end on multiplier phototube. This series tube has an S-20 spectral response with typical cathode quantum efficiencies of 25 percent at 420 nanometers and 6.5 percent at 630 nanometers. The multiplier phototube assembly is automatically maintained at either 25°C ± 0.5°C or 10°C ± 0.5°C by the temperature control housing.

Isolite photometric reference sources are also mounted within this assembly in order to ensure their temperature stability.

For use in Project HAVEN VIEW, the multiplier phototube assemblies are unchanged from their previously reported configuration.

TEMPERATURE CONTROL HOUSING ASSEMBLY

The temperature control housing mechanically surrounds the multiplier phototube assembly and provides the heat pumping necessary for maintaining internal temperature stability. The active elements are Cambion model 3951 thermoelectric junctions.

For use in Project HAVEN VIEW, the temperature control housing assemblies are unchanged from their previously reported configuration.

OPTICAL FILTER ASSEMBLY

The optical filter assemblies are mechanisms designed to mechanically and optically interface with all temperature control housings and optical collector assemblies. Each of these mechanisms is an electrically independent device which can, upon electrical command, interpose any two of six optical filter holders into the optical path. The capability for inserting two filters simultaneously is a major revision from the previously reported configuration for this device.

For use in Project HAVEN VIEW, each of these filter changers contained two Baird-Atomic type B-3 visible spectrum interference filters, two laminated Kodak Wratten gelatin filters, one Optics Technology, Inc. nickel neutral density filter, and one memory reference system mirror.

The electrical control circuit for the filter holder carrying the memory system mirror is the electrical inverse of those circuits controlling the optical filters. Thus, whenever filter control power is off, the memory mirror automatically drops into place. This mirror completes the optical path between the Isolite standard source and the multiplier phototube cathode, providing a constant flux storage and standby condition.

The neutral density filter can be stacked in series with any one of the four color filters. It is the insertion or retraction of this density 6.0 neutral filter that allows the radiometer to function satisfactorily at either daytime or nighttime flux levels. The insertion and/or retraction of this neutral filter is accomplished upon electrical command by the system operator and can be accomplished independently from the control of the four color filters.

RADIOMETER MEASURING CIRCUIT ASSEMBLY

A standardized radiometer measuring circuit has been utilized with all systems described in this section. It is a solid state package designed for use on the 28 volt dc aircraft power. It consists of three basic subassemblies: a multiplier phototube and emitter/follower stage, a high voltage and readout section, and a general purpose power supply. In the operational mode, all three subassemblies are linked in a closed loop feedback circuit which servos the high voltage applied to the multiplier phototube. The feedback loop maintains a constant anode current by inversely varying the high voltage with the flux incident at the photocathode. A typical electrical schematic of the Visibility Laboratory model 5 photometer circuit is illustrated in Figure 3-3.

For packaging convenience, nine high voltage and readout systems plus a single shared power supply are grouped into a single module. This composite assembly is referred to in the Control and Communications Section as the ten slide photometer module.

For use in Project HAVEN VIEW, the radiometer measuring circuits and the ten slide photometer modules are unchanged from their previously reported configuration.

OPTICAL COLLECTOR ASSEMBLY

Five basic collector assemblies were used in combination with the basic detector configurations described in the preceding sections. The only major differences between the various radiometer systems

described in this report are the differences in these five collector assemblies. The basic assemblies tabulated in Table 3-1 are listed below for convenience.

1. Automatic 2π Scanner Assembly
2. Integrating Nephelometer Mode Selector Head Subassembly
3. Dual Irradiometer Assembly
4. Large Aperture Telescope Assembly
5. Variable Path Function Meter Assembly.

These typical assemblies are described briefly below.

Automatic 2π Scanner Assembly. (See Figure 3-1.) This collector assembly is essentially a small telescope that can be directed to optically scan any point within a 2π steradian field of view. The telescope itself has only a 5 degree field of view with an objective lens 9.5 millimeters in diameter.

The telescope subassembly is integrally mounted in an azimuth and elevation drive subassembly which is remotely controlled by servo transmitter/follower circuits. The sweep pattern for the field of view is determined by a solid state logic circuit contained in the 2π scanner control console. For the HAVEN VIEW mission, the airborne scanners were directed to rotate in the azimuth at a constant rate of 72 degrees per second. The elevation drive simultaneously followed a variable rate ramp function. The resultant sweep pattern covered a full 2π steradian in 160 seconds. An alternate scan rate was available for selection at the discretion of the system operator. This alternate scan covered the 2π steradian field in 32 seconds.

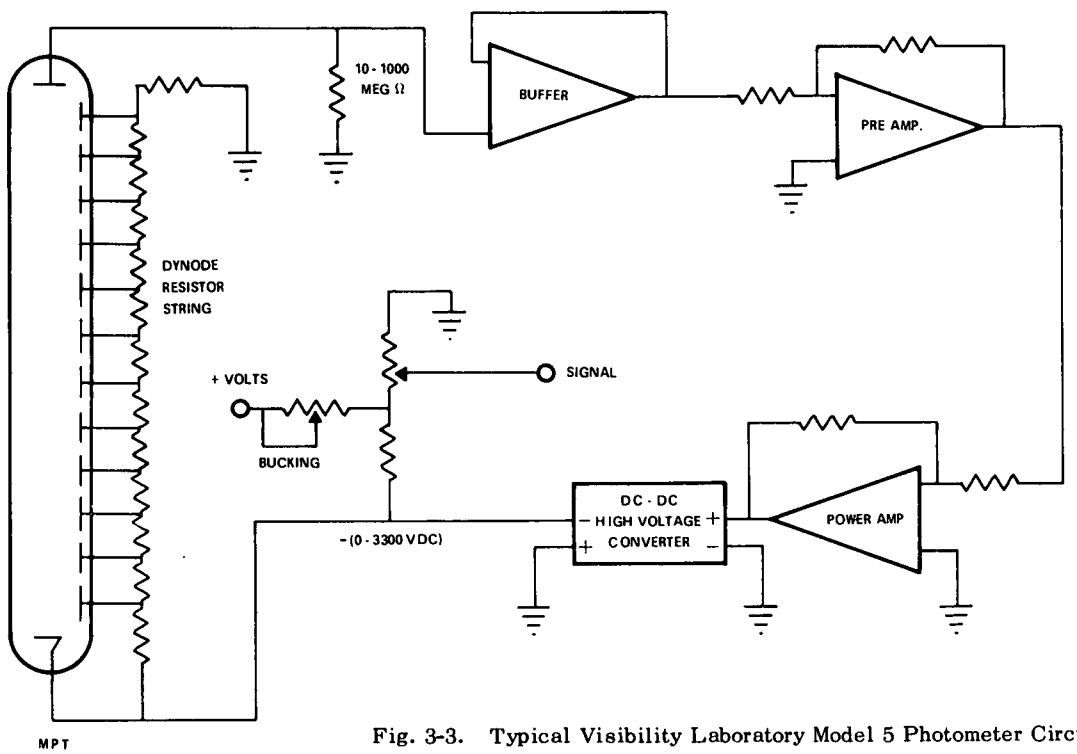


Fig. 3-3. Typical Visibility Laboratory Model 5 Photometer Circuit.

Since the 2π scanner azimuth and elevation drive subassembly is a slaved unit, it may also be driven by manually controlled servo transmitters. This enables the system operator to manually direct the pointing of the telescope line of sight at his discretion. This option is also accomplished at the 2π scanner control console.

Four telescope and azimuth and elevation drive subassemblies were provided for this project mission. They are reasonably identical and can be readily interchanged in the field. They interface mechanically and optically with any of the optical filter assemblies discussed previously.

Two of these 2π scanner assemblies are normally mounted on the project aircraft. One is located on the top of the fuselage for scanning the upper hemisphere radiance distributions and the other is located on the bottom of the fuselage for scanning the lower hemisphere radiance distributions.

The two remaining automatic 2π scanners are normally assigned to the project ground station. (See Figure 3-2 for ground station instrument setups). In this application, they may be oriented to scan either upper hemisphere radiances or inherent terrain radiances at the discretion of the system operator.

Integrating Nephelometer Mode Selector Head Subassembly. (See Figure 3-1.) In order to measure and evaluate the total scattering coefficient of typical real aerosols, the Visibility Laboratory has devised and built an instrument referred to as an integrating nephelometer. This device measures the radiant flux scattered from the well-defined flux beam of a high-intensity projector. The scattered flux is collected simultaneously through three different optical channels, sorted, and routed to the detector assembly for measurement.

The mode selector head is the subassembly which collects, sorts, and identifies this flux prior to its arrival at the detector.

The mode selector head contains three optical input channels but only one optical output. A rotating prism subassembly allows the system operator to select any one input channel for optical coupling with the output channel, while simultaneously occulting the remaining two. The resultant time-sharing of a single detector assembly yields a device optimized for ratio type measurements.

The two outermost input channels of the mode selector head are simple telescope subassemblies, while the centrally located third is an irradiometer subassembly. The complete three channel collector is oriented adjacent to the flux beam of the projector as illustrated in Figure 3-4. In this orientation, one telescope collects flux scattered from the beam at the forwardscattering angle of 30 degrees, while the other collects flux from the beam at the backscattering angle of 150 degrees. The collection apertures are 4.79 centimeters in diameter and the telescope has a 2 degree field of view. The irradiometer, which is mechanically corrected to yield a nearly cosine acceptance, collects flux scattered from the beam at all scattering angles between 5 and 170 degrees.

From properly calibrated measurements of the scattered flux made through the two telescope channels, one may derive a value for the directional scattering coefficient of the aerosol within the scattering volume.

In a similar manner, properly calibrated measurements of the scattered flux made through the irradiometer channel yield values for the total scattering coefficient of the sample aerosol.

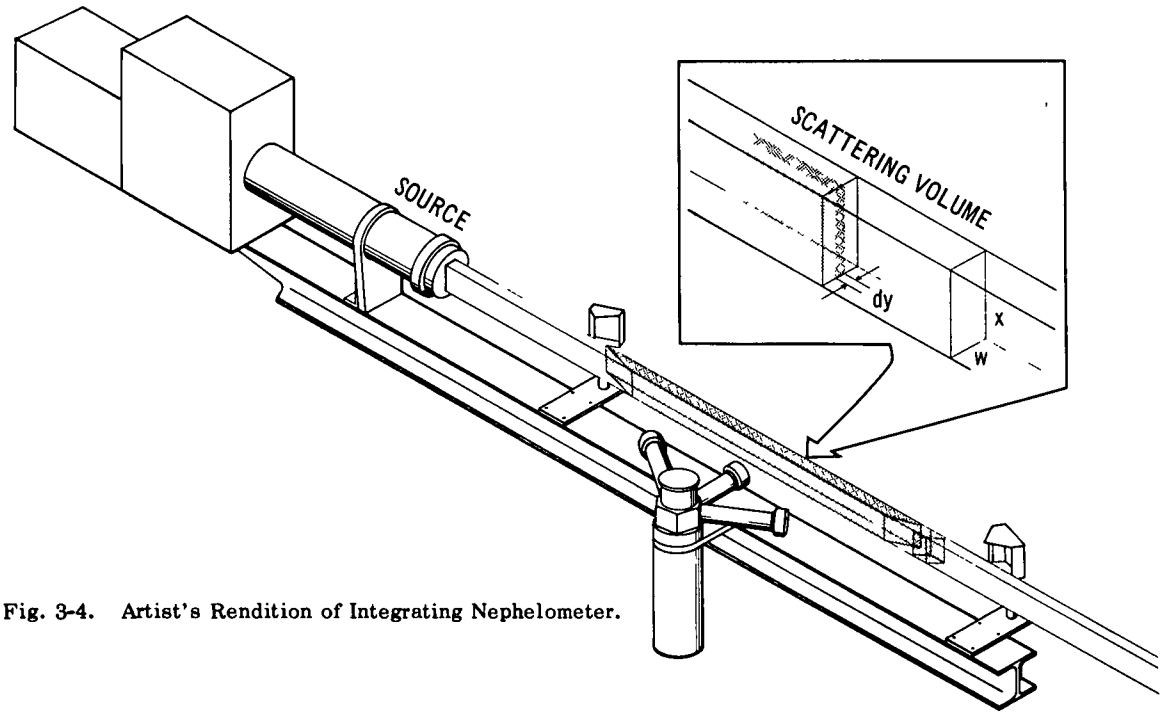


Fig. 3-4. Artist's Rendition of Integrating Nephelometer.

The details of the operational concept and calibration technique for this instrument are covered more thoroughly in two separate memoranda currently being prepared for publication.

Two complete integrating nephelometer instruments were provided for the HAVEN VIEW mission. Each instrument was made up of two mode selector head subassemblies complete with detector and filter subassemblies (one for the S-20 multiplier phototube, the other for standby in case of malfunction), one high-intensity projector, and an ambient light shroud.

All four of the mode selector head subassemblies are identical and interchangeable. The two projectors and shrouds were customized according to whether they were for airborne or ground-based operation.

Dual Irradiometer Assembly. (See Figure 3-1.) The dual irradiometer assembly is a two channel irradiometer. It has two optical input channels but only one optical output. A rotating prism subassembly allows the system operator to select either input channel for optical coupling with the output channel, while simultaneously occulting the other. The resultant time-sharing of a single detector assembly yields a device optimized for ratio type measurements.

The flat plate diffuse collector surfaces used in this assembly are mechanically corrected to yield a cosine collection characteristic within ±2 percent for all angles of incidence between 0 and 80 degrees.

The dual irradiometer assembly is mounted on the aircraft wing so that the flat plate collectors are horizontal. In this configuration, the upper channel receives radiant flux from the entire hemisphere above the aircraft and the lower channel receives radiant flux from the entire hemisphere below the aircraft. These measurements of downwelling and upwelling irradiance can be used both in the calculation of directional terrain reflectances and in inter-system data validation checks.

Large Aperture Telescope Assembly. (See Figure 3-2.) This telescope assembly is used in the radiometer system which functions as a backup system for measuring very low flux levels. The airborne telescope assembly has a 5 degree circular field of view and an objective lens 6.2 centimeters in diameter. With this larger collection aperture, flux levels significantly lower than the detection threshold of the 2π scanner assembly can be reached and adequately measured. The ground-based large aperture telescope field of view is 2 degrees by 5 degrees.

Two large aperture telescope assemblies were provided for the HAVEN VIEW mission. One was assigned to the aircraft for monitoring apparent nadir terrain radiances. The second was assigned to the ground station for measurement of inherent terrain radiance.

Several special purpose ground-based frames and tripods were used with this radiometer. They were primarily aids in taking measurements of directional terrain reflectance. In all cases, they were manually operated devices that functioned to ensure high reproducibility in aiming the telescope optical axis. One such device is illustrated in Figure 3-2.

Variable Path Function Meter Assembly. The variable path function meter is a radiometer and shroud assembly designed to measure the radiant flux scattered in a specific direction from a small, well-defined volume of aerosol which is being naturally illuminated by a 4π light field.

The most significant feature of the current model is that its orientation can be changed during flight. The scattering volume is 1.25 centimeters in diameter and 22.5 centimeters long. It is defined by the cylindrically limited field of view of the component telephotometer and two sunshades, one of which is shown in Figure 3-1. The entire assembly can be rotated 180 degrees in approximately 1 minute. When the aircraft is flying straight and level, this plane of rotation is vertical. Measurements of path function can be made at zenith angles between 0 and 180 degrees at azimuths corresponding to the aircraft heading.

The ability to make direct measurements of path function at inclined lines of sight during ascending and descending daytime flight patterns is essential for validating the data processing technique used with the nighttime data packages.

During Project HAVEN VIEW, this device was utilized in a developmental mode only. The data were utilized for definition of engineering modification requirements and as typical inputs for the development of computerized data processing techniques.

3.2 METEOROLOGICAL SYSTEMS

All of the meteorological systems utilized in this project were purchased items. The operating characteristics of each are available in their manufacturer's brochures. Only a summary of their main features and characteristics are presented in this report.

The airborne meteorological package consists of one Royco model 220 particle counter, one Cambridge model 137-C3 aircraft hygrometer system, one AN/AMQ-17 aerograph set, and two Bourns aneroid pressure transducers.

All the airborne meteorological transducers and sampling probes are located on an external fin which extends outward from the aircraft fuselage. The fin is located on the right side of the aircraft and forward of the propellers. It is illustrated in Figure 3-1.

The ground-based meteorological package was less extensive, consisting only of one Royco model 220 particle counter (discussed in the following paragraph), one Bendix model 566 aspirated hygrometer, one Science Associates windspeed and direction set, and one Taylor model SMT-5-51 aneroid barometer.

AIRBORNE METEOROLOGICAL PACKAGE

Royco Model 220 Particle Counter. This device is used to determine the number and size of aerosol particles which are present in a sample volume of air. To do this, a controlled flow of air is passed through a brightly-illuminated sampling chamber. The illuminated air sample is observed by a sensitive telephotometer system. Whenever an aerosol particle passes through the chamber, it causes a burst of scattered flux which is sensed by the telephotometer. This scattered flux is related to the particle size; with adequate calibration, the device can therefore determine the number of particles per unit volume which pass through the sampling chamber and their approximate size.

The size spectrum measurable with this device is somewhat variable at the discretion of the operator. For the HAVEN VIEW mission, both airborne and ground-based systems were calibrated to count particle sizes occurring between 0.3 and 26.0 micrometer effective diameters. At the normal operating flow rate of 0.1 cubic foot of air per minute, satisfactory particle distributions were accumulated in 4-minute sampling intervals.

The Royco system is the only major system used in this task which does not have its output recorded digitally on magnetic tape. Instead, the particle count is recorded on printed paper tape. As a result, the Royco data are processed independently from the bulk of the project raw data and are not included in the automatic data processing technique discussed in Section 5. The Royco data are normally punched on IBM cards and stored in this format until a demand for its further processing is levied.

Two Royco systems were provided for this task. They are identical systems, with the exception of their inlet plumbing. One system was assigned to the project aircraft for airborne measurements and the other was assigned to the project ground station.

The airborne Royco system inlet plumbing is designed to pick up ram air outside the aircraft, route it at low velocity to the system sensor subassembly, and dump the unused portion plus the system exhaust outside the aircraft. The entire inlet, sample, and exhaust plumbing loop is sealed to prevent contamination of the outside aerosol sample with the pressurized cabin air. The airborne Royco system plumbing has its inlet probe mounted on the meteorological fin assembly. (See Figure 3-1).

The ground station Royco system is located immediately adjacent to the ground station integrating nephelometer. The Royco inlet plumbing in this instance is simply a 15 centimeter piece of straight tubing which connects the system inlet to the integrating nephelometer shroud. In this application, the Royco system samples a portion of the same aerosol that passes through the nephelometer chamber.

Cambridge Model 137-C3 Aircraft Hygrometer System. The Cambridge model 137-C3 hygrometer is a device used for determining the dewpoint of the aerosol surrounding an aircraft during flight. The sensor for this device is located in a restricted flow chamber mounted outside the aircraft beneath the fin assembly and is illustrated in Figure 3-1.

The physical concept upon which the operation of this device is based is the chilled mirror. A thermoelectric heat pump reduces the temperature of the gold plated mirror until moisture from the ambient air flowing past it begins to condense on the mirrored surface. A closed loop servo link is established so that the temperature of the mirror surface is maintained at the nominal dewpoint. An integrally mounted platinum resistance thermometer is used to measure the actual temperature of the mirror. From this measure of the dewpoint temperature and the air temperature, the calculation of aerosol relative humidity is direct and straightforward.

AN/AMQ-17 Aerograph Set. This aerograph set is a standard military inventory item. Its operating characteristics and technical description are covered in USNAF TP-133. Its general function is to automatically measure and record ambient temperature, pressure, and relative humidity in typical airborne applications. It is suitable for use on aircraft operating at flight speeds between 144 and 518 knots (74 and 267 meters per second) and at altitudes up to 67 000 feet (20 kilometers).

Bourns Model 430/530 Absolute Pressure Transducer. This transducer is an aneroid/potentiometer device used to provide pressure altitude data. The static probe located on the meteorological fin is the inlet. The transducer is calibrated over a range of 0 to 15 pounds per square inch absolute, with a static error band of ±1.0 percent or approximately ±10 millibars.

Bourns Model 509 Differential Pressure Transducer. This transducer is an aneroid/potentiometer device used to provide indicated airspeed. The pitot and static probes located on the meteorological fin are the inlets. The transducer is calibrated over a range of 0 to 5 pounds per square inch differential.

GROUND-BASED METEOROLOGICAL PACKAGE

Bendix Model 566 Aspirated Hygrometer. This device is a handheld, battery powered, self-aspirating, wet/dry bulb thermometer. The operator wets the wick of the wet bulb thermometer and turns on the ducted fan. When the wet and dry bulb thermometers stabilize, he reads the two temperatures and calculates dewpoint and relative humidity. Two of these devices were provided for this project. One is assigned to the aircraft for ground checkout. The other is assigned to the ground station for data collection.

Science Associates Windspeed and Direction Set. This battery powered device is assigned to the ground station for determining local surface wind conditions. Data readings are manually recorded on a standardized meteorological observation sheet.

Taylor Model SMT-5-51 Aneroid Barometer. This handheld device is assigned to the ground station for determining local atmospheric pressure. It is temperature-compensated and adjustable for true ground elevation. The dial face is calibrated in inches of mercury.

3.3 CONTROL AND COMMUNICATION SYSTEMS

The control panels, consoles and other support facilities listed in Table 3-1 are described fully in AFCRL-70-0137, Duntley *et al.* (1970), and are not discussed further in this report.

No significant modifications from their previously reported configurations have been accomplished on any of the control and communication systems.

42 CHANNEL DATA LOGGER

The heart of the airborne data collection system is the data logger. This system is designed to accept up to 42 independent analog inputs. The input voltages are specified between 0.000 and ±0.999 volt dc. The system has three modes of operation: (1) normal, (2) calibrate, and (3) manual.

In the NORMAL mode, all 42 input signals are multiplexed into a 240 sample per second array, sequentially converted to digital format, and serially recorded on magnetic tape. Tape speed is 3.56 inches per second. In this mode, the system records continuously until it is stopped either manually by the operator, or by the low tape cutoff. The multiplex array is externally patchable for complete sample rate flexibility. The current sample rate per channel is illustrated in Table 5-1 of the Data Processing Section. The length of one block of data on the tape is 3840 computer words; each word contains 48 bits.

In the CALIBRATE mode, the system starts upon manual command, records one pass through the multiplexer, i.e., 1 second at 240 samples per second, and stops automatically. This mode is normally used for recording direct current calibration checks. At one time it was used for monitoring radiometer "memory flux" levels, but that has been abandoned in favor of a longer recording interval.

In the MANUAL mode, the system works as a multi-input digital voltmeter (DVM). Selector buttons on the front panel allow the operator to select any one of the 42 input channels for visual display. Upon selecting a specific channel, the channel identification number is displayed on a two-digit nixie display and the digital value of the signal voltage on that channel is shown on a separate three-digit plus sign nixie display. In this mode, the operator can monitor the input signals at any time from each transducer system for either calibration checks or troubleshooting.

The data logger also contains the project clock. Project time is displayed in six digits (hours, minutes, and seconds) on both the data logger panel and its remote panel in the right-hand control console. Project time may or may not be set at real time, according to the operator's selection.

The data logger provides synchronizing pulses to the 2π scanner control console. These pulses permit convenient remote control functions to be "anded" at the right-hand control console and establish synchronous data logging for improved data processing efficiencies.

Twelve thumbwheel potentiometers are available on the front panel for the insertion of fixed identification data. This information is automatically recorded each time the tape is started.

20 CHANNEL DATA LOGGER

The ground-based data logger is illustrated in Figure 3-24 of Duntley,*et al.* (1970). This incremental logger is less sophisticated than the airborne system. It accepts up to 20 independent analog signals. Its

input DVM is manually adjusted to accept signals between 0.0000 and ± 1.2000 volts dc; however, the actual input analogs are identical with those in the airborne instrument systems.

This system has two modes of operation: (1) normal and (2) manual.

In the NORMAL mode, the analog signals are measured, serialized, and recorded digitally on magnetic tape. In this mode, the system incrementally records channel by channel at about eight channels per second. Once started, it cycles continuously through the channel sequence until manually stopped by the operator.

In the MANUAL mode, the system operates as a multi-input DVM. A manual channel selection is available with an associated nixie type display.

Project time is displayed on the logger front panel. It is normally synchronized with Greenwich mean time (GMT), local, or when practical, airborne project time.

Ten thumbwheel potentiometers are available on the front panel for the insertion of fixed identification data.

3.4 RADIOMETRIC CALIBRATION PROCEDURES

All the radiometers used in this project are calibrated in essentially the same manner. In each case, the system is calibrated by first determining its relative flux versus high voltage characteristics over the anticipated operating span and second by establishing known absolute flux levels on this voltage curve. The entire calibration procedure is conducted using standard photometric practices, a 3-meter optical bench, and incandescent standards of luminous intensity traceable to the National Bureau of Standards.

LINEARITY CALIBRATION PROCEDURE

The process of establishing the relative flux versus high voltage characteristic curve for each system is simple and direct. The radiometer system is positioned on the optical bench and irradiated with flux from a stabilized incandescent lamp. The mechanical and optical arrangement is such that the amount of flux presented to the detector can be readily varied in increments of 0.10 log unit. The mechanical constraints on positioning the movable lamp housing ensure compliance with the desired inverse square relationship between lamp position and flux at the detector. Therefore, through an iterative process of relocating the lamp housing at a predetermined set of locations on the optical bench and recording the resulting radiometer output signal, one can generate a set of data illustrating the system electrical response to known changes of input radiance. This set of data is commonly referred to as the system linearity calibration.

The linearity calibrations for all radiometers employed in the HAVEN VIEW task extended over a radiance span of 5 log cycles. The electrical circuitry was adjusted to yield an output signal which swung from +250 to −1000 millivolts for this five decade swing in radiant input. The pseudo-logarithmic characteristic of the radiometer measuring circuit results in a linearity calibration typified in Figure 3-5.

Since it was desirable to run these radiometers at maximum sensitivity, the linearity calibrations were extended beyond the normally specified limits of system precision. Each system was forced to the

point where dark current considerations resulted in an uncertainty equivalent to 50 percent of the calibration incremental least count, i.e., if a 0.10 log (26 percent) change in flux results in a 20 millivolt change in output signal, the calibration cutoff point occurs when the uncertainty in the output signal reaches ±10 millivolts.

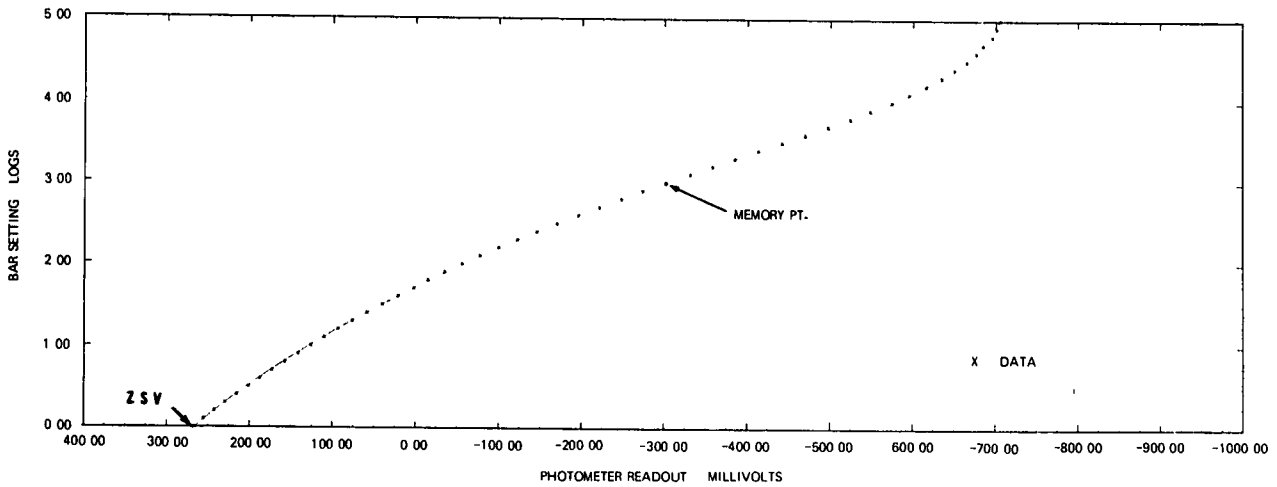


Fig. 3-5. Typical Linearity Calibration Curve.

Due to the characteristic rolloff of the typical linearity calibration curve plus the dark current cutoff specification, the overall system precision index is variable. This is a factor which must be well-understood by those involved in any final data analysis.

For example, in the center of the span, readout uncertainties of ±1 millivolt are typical and linearity slopes of 30 millivolts per 0.1 log change in flux are common. Thus, a readout precision of ±0.003 log unit or ±1 percent of the reading is typical. However, near the dark current cutoff, readout uncertainties of ±10 millivolts are encountered with accompanying linearity slopes of 20 millivolts per 0.1 log change in flux. Under these conditions, a readout precision of only ±0.050 log unit or ±12 percent of the reading is achievable. Extreme caution must be maintained in the evaluation of measurements made near the dark current cutoff.

An additional sequence was inserted into the standardized calibration procedure beginning with the Project HAVEN VIEW pre-deployment calibration. This was the calibration of the "day/night" neutral density filter. The "day/night" neutral density filter, previously mentioned in Section 3.1 under Optical Filter Assembly, is calibrated in series with each of the color selection filters. Thus, its effective neutral density value in each designated spectral band is verified *in situ*.

The day/night filter calibration is accomplished as a continuation of the linearity calibration. In order to measure the approximately 6.0 log change in flux level induced by the day/night filter, a composite technique is required. This technique involves using the calibrated span of the radiometer plus a known additional 2.0 log increment created by using two different lamp positions on the photometric bar. Through this procedural device, a total span of approximately 7.0 logs can be measured, e.g., 5.0 logs radiometer capability plus 2.0 logs through bar manipulation.

ABSOLUTE CALIBRATION PROCEDURE

Once the linearity calibration for the radiometer system has been established, a similar procedure is followed to convert the calibration into absolute units. For this portion of the calibration sequence, an incandescent standard of luminous intensity is used as the flux source. Then absolute levels of irradiance can be presented to the radiometer either directly or via a calibrated reflectance standard.

A typical data sheet for the absolute calibration of a HAVEN VIEW radiometer is shown in Figure 3-6. Five different levels of input radiance are used in the determination of the calibration constant for the system. The calibration constant is referred to as the zero scale value and is labeled ZSV on the calibration forms.

ABSOLUTE CALIBRATION DATA FOR SCAN3 DAY 9846 3MAR72 PRE HAVEN FILTER NO. 6 DAY SKY 7000 DEG

DATE IS YR 1970 MONTH 3 DAY 3 TASK ASSIGNMENT PREHAVEN INSTRUMENT TYPE RADIOMETER

REFLECTANCE OF PATH ATTENUATOR = 100.0 PERCENT REFLECTANCE OF CALIBRATION TARGET 96.0 PERCENT

D1 = LAMP POSITION = D1 + D2 D2 = 0 CM.
TOTAL DISTANCE = D1+D2

SPAN ID	D1 CM	TOTAL DIST. CM	TOTAL DIST.SQ. CM.SQ.	CALC.TGT. B OR E	DETEC. RAW OUTPUT	LOG OF (E0/E)	RAW ZSV	AV. RAW ZSV	F1 LUM. TO RAD. WATTS/LUM.	F2 COLOR MATCH	CORRECTED ZSV
2	70	70.000	4.900E 03	3.561E-02	-276	2.594	1.399E 01	1.413E 01	2.111E-03	1.136E 00	3.391E-02
3	120	120.000	1.440E 04	1.212E-02	-424	3.062	1.399E 01				
4	200	200.000	4.000E 04	4.362E-03	-587	3.508	1.405E 01				
5	300	300.000	9.000E 04	1.939E-03	-739	3.877	1.466E 01				
4	200	200.000	4.000E 04	4.362E-03	-587	3.508	1.405E 01				
3	120	120.000	1.440E 04	1.212E-02	-426	3.068	1.419E 01				
2	70	70.000	4.900E 03	3.561E-02	-276	2.597	1.407E 01				

RADIOMETER UNITS
CALCULATED TARGET LUMINANCE EXPRESSED AS LUMENS/STERADIAN SQ.CM.

CORRECTED ZERO SCALE VALUE IS 3.3910E-02 WATTS/STERADIAN SQ. CM.

TO CHNG HAVENVIEW FLT 6 FROM(W/SR SQ.CM)TO(W/SR SQ.M MICRO M)MULTIPLY BY 5.44800E 04

WITH ABOVE UNIT CONVERSION APPLIED,NEW ZSV IS 1.84739E 03 WATTS/STER. SQ M MICRO M.

STANDARD DEVIATION = 2.1445E-01

FRACTIONAL STANDARD DEVIATION = 1.52 PERCENT

COMPONENTS OF FILTER FACTORS F1 AND F2 ARE
SUBYBARSUM= 2.7033E 07 WESTSTD= 5.7015E 04 WSTSTD= 3.4098E 07 WESTINST= 7.0597E 04 WSTINST= 3.7156E 07

CALIBRATION LAMP IDENTIFICATION
SERIAL NUMBER = 9646
LUMINOUS INTENSITY = 571.00
DISTRIBUTION TEMPERATURE = 2854

IF MILLIVOLT DATA IS LESS THAN THE END OF RULE CUTOFF =-1029.0 IGNORE DATA
THIS TABLE SHOWS MV. FLUCTUATION DURING EACH CALIB. MEASUREMENT

SPANID	STD.DEV. IN MV.	FRAC.STD.DEV. IN PERCENT
2	7.528E-01	2.734E-01
3	2.572E 00	6.071E-01
4	3.361E 00	5.727E-01
5	3.368E 00	4.557E-01

Fig. 3-6. Typical Absolute Calibration Form.

Nine determinations of the calibration constant are made during each calibration run. The average value of the nine determinations is assumed to be the most probable value for the calibration constant. Due to precision limitations, stray light, and related procedural errors, typical standard deviations for the calibration constant are on the order of ±5 percent. Table 3-2 illustrates the quality of typical calibration constants associated with data tabulated in Section 7. It should be noted that the term standard deviation is not rigorously correct in this application since the calibration data set includes some obvious systematic errors due to detector dynamic response as well as some procedural stray light errors. These systematic errors are not removed from the calibration data and as a result, the standard deviation of the calibration constant determination represents a worst-case type of index.

Table 3-2

Radiometer Calibration Constants (ZSV) and
Related Fractional Standard Deviations (δ%)
for Daylight Flights

Radiometer Ident System	MPT SN	Calib Mode	Calib Units	Filter 2 ZSV	Filter 2 δ%	Filter 3 ZSV	Filter 3 δ%	Filter 4 ZSV	Filter 4 δ%	Filter 5 ZSV	Filter 5 δ%	Filter 6 ZSV	Filter 6 δ%	Average % for System
SCAN3	9846	Day	$w/\Omega m^2\mu m$	2.64E+04	±2	4.11E+04	±1	8.72E+04	±2	1.49E+04	±1	1.85E+03	±2	±2
SCAN4	9858	Day	$w/\Omega m^2\mu m$	8.50E+04	±7	1.05E+05	±5	2.18E+05	±4	3.88E+04	±2	4.91E+03	±5	±5
NEPH1-Σ	9828	Night	$w/m^2\mu m$	4.62E-02	±2	7.13E-02	±3	3.24E-01	±2	1.82E-02	±3	2.40E-03	±2	±2
NEPH1-β	9828	Night	$w/\Omega m^2\mu m$	3.95E-02	±3	8.08E-02	±3	7.32E-01	±3	1.88E-02	±2	2.65E-03	±3	±3
D.I. 1	9869	Day	$w/m^2\mu m$	9.43E+04	±7	1.07E+05	±6	4.82E+04	±3	1.15E+05†	±5	3.83E+03	±2	±5
LAT 1	10697	Night*	$w/\Omega m^2\mu m$	1.63E-02	±3	4.39E-02	±3	3.92E-02	±5	7.53E-03	±3	9.34E-04	±2	±3
VPFM	14531	Night	$w/\Omega m^2\mu m$	2.89E+00	±8	1.02E+01	±8	1.84E+02	±12	1.04E+00	±9	1.35E-01	±8	±9
ERT	11783	Night*	$w/\Omega m^2\mu m$	6.07E+02	±5	1.16E+03	±4	2.06E+03	±10	3.02E+02	±4	3.92E+01	±2	±5
NEPH3-Σ	9866	Night	$w/m^2\mu m$	7.83E-02	±1	8.44E-02	±1	3.26E-01	±1	1.64E-02	±1	3.16E-03	±5	±2
NEPH3-β	9866	Night	$w/\Omega m^2\mu m$	6.69E-02	±1	9.10E-02	±1	4.69E-01	±1	1.65E-02	±2	3.53E-03	±1	±1

* Asterisk indicates that the basic night mode absolute calibration was adjusted for daylight using calibrated day/night neutral density filter.

† Dual irradiometer erroneously assembled using nonstandard filter in position 5. Not convertible to pseudo-photopic.

It should also be noted that in some cases, the basic calibration of the radiometer system is accomplished in the night mode. The conversion of the calibration constant to day mode, which allows calibrated measurements at daylight flux levels, is made by applying the day/night neutral density factor. Obviously, an error in the determination of this factor will also contribute to the overall probable error.

All procedural and precision uncertainties are, of course, independent of the absolute accuracy of the standard lamp calibration, which is assumed to be ±3 percent.

At regular intervals during the calibration procedure, the radiometer is automatically exposed to its internal reference source, i.e., Isolite standard of luminous intensity. Since this integral, exceptionally stable source is always available for reinspection by the radiometer during subsequent measurement activities, the long term stability of the detector can be monitored and, when necessary, automatic adjustments to the calibration constant can be readily effected.

CALIBRATION SUMMARY

Two sets of radiometric calibration data are available for application to the HAVEN VIEW field data.

A. The pre-deployment calibration is dated March 1970. Day/night systems were calibrated against both the night source (8.67 horizontal candlepower and 5.0 percent mirror) and the day source (571 horizontal candlepower and no mirror). Most of the day source data are very near the dark cutoff and should be used with caution. The 20 channel incremental data logger was used for recording this calibration data set.

B. The post-deployment calibration is dated October 1970. This post-deployment calibration was delayed due to the late return of the equipment and its damaged condition.

Day/night systems were again calibrated against both the night source (8.67 horizontal candlepower and 5.0 percent mirror) and the day source (592 horizontal candlepower and no mirror). Most of the day source data are again very near the dark cutoff and should be used with caution. The 20 channel incremental data logger was used for recording portions of this calibration data set, but was not working reliably and much of the data was lost. Thus, this data set was converted to card input.

The apparent change in luminous output from the day source, 592 horizontal candlepower up from 571 horizontal candlepower, is due to a recalibration of the lamp on June 11, 1970. This new value is primarily due to a change in the lamp housing exit aperture.

Analysis of these two data sets indicated that the most reliable set of calibration data for application to the HAVEN VIEW field data was the pre-deployment set.

A summary of the radiometric calibration constants applied to the HAVEN VIEW data is tabulated in Table 3-2.

CALIBRATION CORRECTION FACTORS

Two calibration correction factors are shown in Figure 3-6. The first, F1, is a luminance to radiance conversion factor which is used in the specification of nonphotopic system responses. The second, F2, is a color matching factor which is used to compensate for small mismatches between system spectral responses. The generation of these factors is covered in AFCRL-70-0137 and is not repeated here. However, since the Project HAVEN VIEW data include two new spectral responses, a summary of the HAVEN VIEW luminance to radiance conversion factors is presented in Table 3-3.

Table 3-3

Luminance to Radiance Conversion Factors
Peak and Mean Wavelength, Response Area, F1 and F3 for Standard Responses

	Filter 2	Filter 3	Filter 4	Filter 5*	Filter 6	Filter 9
Peak Wavelength (nm)	475	660	750	550	440	555
Mean Wavelength (nm)	478	664	765	557	532	560
Response Area (nm)	19.9	30.2	50.4	78.5	183.5	106.9
F1 (w/lu)						
W_ϵ(2800°K)	1.263E-04	7.136E-04	1.561E-03	1.050E-03	2.112E-03	
W_ϵ(2854°K)	1.304E-04	6.963E-04	1.494E-03	1.052E-03	2.112E-03	
F3 (Sq cm/Sq m μm)	5.031E+05	3.315E+05	1.983E+05	1.273E+05	5.448E+04	

Unit Conversion Factor. The units of distance used on the optical bench during instrument calibrations are cm. The units in which the data are to be published are radiance in $w/\Omega m^2 \mu m$ and irradiance in $w/m^2 \mu m$. In order to change from the calibration units of w/cm^2 a factor of F3 is used defined as follows:

$$F3 = \frac{10^4 \, cm^2}{m^2} \, \frac{1}{\delta\lambda}, \tag{3.1}$$

where $\delta\lambda$ is the response area of the standard. The response area is defined as the area under the relative spectral response curve, $\overline{S_\lambda T_\lambda}$, which is normalized to one at the maximum response:

$$\delta\lambda = \Sigma \, (\overline{S_\lambda T_\lambda}) \, \Delta\lambda \, . \tag{3.2}$$

Since the response area is evaluated in units of nm, Eq. (3.1) must be rewritten as

$$F3 \, \frac{cm^2}{m^2 \mu m} = \frac{10^4 \, cm^2}{m^2} \, \frac{1}{\delta\lambda \, nm} \, \frac{10^3 \, nm}{\mu m} = \frac{10^7 \, cm^2 \, nm}{\delta\lambda nm \, m^2 \mu m} \, . \tag{3.3}$$

The application of factors F1, F2, and F3 is included in Program CALIB.

Photometric Conversion Factor. The pseudo-photopic filter, HAVEN VIEW Filter 5, is calibrated radiometrically and the data presented in radiometric units. In order to compare these data to photometric values, the values are converted to photometric quantities by means of F4, the photometric conversion factor:

$$F4 \, \frac{lu \mu m}{w} = \frac{680 \, lu}{w} \, \frac{\Sigma W_\lambda(T) \, \bar{y} \, \Delta\lambda}{\Sigma W_\lambda(T) (\overline{S_\lambda T_\lambda}) \, \Delta\lambda} \times \frac{\delta\lambda nm \, 10^{-3} \mu m}{nm} \, , \tag{3.4}$$

where $\bar{y}$ is the photopic luminosity function.

In F4, the spectral emittance of the target in the field $W_\lambda(T)$ depends upon the instrument being calibrated. Since the term appears in the numerator and the denominator of the factor, the exact spectral emittance does not need to be used. A relative spectral curve may be substituted so long as the same function is used for both numerator and denominator.

For the nephelometer data, the light source is a Xenon arc lamp whose spectral distribution is approximated by a blackbody radiator of 5500°K. For the scanners, the daytime sky is approximated by a blackbody radiator at 7000°K and the nighttime sky is from data by Johnson *et al.* (1965).

Instrument	T (°K)
Nephelometer	5500°K
Scanners	
Day	7000°K
Night	Johnson *et al.* (1965)

Application of factor F4 changes radiance units of $w/\Omega m^2 \mu m$ to luminance units of $lu/\Omega m^2$ or nit and changes irradiance units of $w/m^2 \mu m$ to illuminance units of lu/m^2 or lux.

The four correction factors are calculated in Program SUPERCK6 which is an update of two previous programs which produced the various spectral summations but did not combine them into factors. Factors F1, F3, and F4 are presented in Tables 3-3 and 3-4, which were generated by Program SUPERCK6.

Table 3-4

Radiance to Luminance Conversion Factors
F4 for Photopic Filter No. 5*

	Radiant Emittance					
F4 (lu μm/w)	4000°K 7.299E+01	5500°K 7.222E+01	7000°K 7.200E+01	10 000°K 7.195E+01	20 000°K 7.211E+01	Night 6.834E+01

*Filter 5 data not applicable to dual irradiometer system.

3.5 STANDARD RESPONSE CHARACTERISTICS FOR BROADBAND SENSORS

All the radiometric instruments both ground-based and airborne used by the Atmospheric Visibility Branch are equipped with automatic filter changing assemblies. Thus, any one of five different spectral filters can be interposed into each instrument's optical path. The combination of the sensor sensitivity S_λ and the filter transmittance T_λ is the resultant sensitivity of the filtered phototube $S_\lambda T_\lambda$. The standard responses which each individual optical system approaches are indicated as $\overline{S_\lambda T_\lambda}$.

PEAK WAVELENGTH

The peak or maximum value of the standard sensor response $\overline{S_\lambda T_\lambda}$ is used to normalize the response values. The wavelength of the maximum value of the standard response is called the "peak wavelength".

RELATIVE SPECTRAL RESPONSE OF STANDARDS

The relative spectral response of a standard $\overline{S_\lambda T_\lambda}$ curve is obtained by normalizing the curve values so that the maximum relative response is 1. The Program RAYLIMIT checks to see if the input standard spectral response curve is normalized, and renormalizes if necessary. It also interpolates to wavelength increments of 5 nanometers if the standard has been specified for only 10 nanometer increments. It is more reasonable to interpolate the relatively smooth response values than to ignore the fine spectral structure of the sun irradiance out of the atmosphere.

A graph of the relative spectral response for the standards used for Project HAVEN VIEW is presented in Figures 1-3 and 3-7. In Figure 3-7, which is the computer-generated plot, a point is plotted for each 5 nanometers in wavelength, but an identifying symbol is printed on only every second point. The relative spectral response values are also presented in Table 3-5.

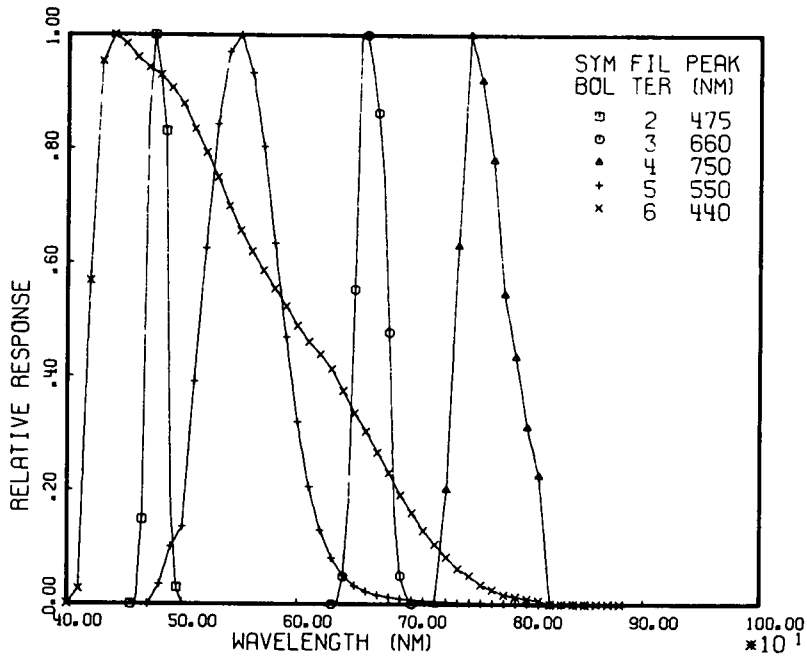


Fig. 3-7. Computer-Generated Plot of Standard Spectral Responses for Project HAVEN VIEW.

Table 3-5

Relative Spectral Response of Standards for Project HAVEN VIEW

Filter Identification and Mean Wavelength

Wavelength (nm)	Filter 2	Filter 3	Filter 4	Filter 5	Filter 6
	478 nm	664 nm	765 nm	557 nm	532 nm
400	0	0	0	0	0
405	0	0	0	0	.0129
410	0	0	0	0	.0258
415	0	0	0	0	.2969
420	0	0	0	0	.5680
425	0	0	0	0	.7605
430	0	0	0	0	.9530
435	0	0	0	0	.9765
440	0	0	0	0	1.0000
445	0	0	0	0	.9920
450	0	0	0	0	.9840
455	0	0	0	0	.9720
460	.0070	0	0	0	.9600
465	.1487	0	0	0	.9510
470	.8481	0	0	0	.9420
475	1.0000	0	0	.0172	.9355
480	.9329	0	0	.0343	.9290
485	.8304	0	0	.0677	.9175
490	.1790	0	0	.1010	.9060
495	.0292	0	0	.1185	.8920
500	0	0	0	.1360	.8780
505	0	0	0	.2635	.8560
510	0	0	0	.3910	.8340
515	0	0	0	.5085	.8135
520	0	0	0	.6260	.7930
525	0	0	0	.7345	.7715
530	0	0	0	.8430	.7500
535	0	0	0	.9065	.7250
540	0	0	0	.9700	.7000
545	0	0	0	.9850	.6785
550	0	0	0	1.0000	.6570
555	0	0	0	.9665	.6385
560	0	0	0	.9330	.6200
565	0	0	0	.8685	.6030
570	0	0	0	.8040	.5860
575	0	0	0	.7195	.5700
580	0	0	0	.6350	.5540
585	0	0	0	.5525	.5385
590	0	0	0	.4700	.5230
595	0	0	0	.3950	.5060
600	0	0	0	.3200	.4890
605	0	0	0	.2630	.4750
610	0	0	0	.2060	.4610
615	0	0	0	.1680	.4500
620	0	0	0	.1300	.4390
625	0	0	0	.1055	.4260
630	0	0	0	.0810	.4130
635	0	.0020	0	.0657	.3935
640	0	.0486	0	.0504	.3740
645	0	.1798	0	.0411	.3545

Table 3-5 (Cont)

Relative Spectral Response of Standards for Project HAVEN VIEW

Filter Identification and Mean Wavelength

Wavelength (nm)	Filter 2	Filter 3	Filter 4	Filter 5	Filter 6
	478 nm	664 nm	765 nm	557 nm	532 nm
650	0	.5531	0	.0318	.3350
655	0	.9948	0	.0268	.3190
660	0	1.0000	0	.0218	.3030
665	0	.9421	0	.0188	.2845
670	0	.8625	0	.0157	.2660
675	0	.7482	0	.0139	.2480
680	0	.4774	0	.0120	.2300
685	0	.1585	0	.0105	.2105
690	0	.0495	0	.0090	.1910
695	0	.0166	0	.0080	.1755
700	0	0	0	.0070	.1600
705	0	0	0	.0061	.1445
710	0	0	0	.0053	.1290
715	0	0	0	.0048	.1170
720	0	0	0	.0042	.1050
725	0	0	.1005	.0038	.0938
730	0	0	.2010	.0033	.0826
735	0	0	.4155	.0030	.0723
740	0	0	.6300	.0026	.0619
745	0	0	.8150	.0025	.0558
750	0	0	1.0000	.0023	.0497
755	0	0	.9595	.0020	.0416
760	0	0	.9190	.0018	.0335
765	0	0	.8495	.0017	.0292
770	0	0	.7800	.0016	.0249
775	0	0	.6620	.0014	.0206
780	0	0	.5440	.0013	.0162
785	0	0	.4890	.0012	.0144
790	0	0	.4340	.0012	.0125
795	0	0	.3720	.0012	.0107
800	0	0	.3100	.0011	.0088
805	0	0	.2675	.0005	.0075
810	0	0	.2250	0	.0062
815	0	0	.1125	0	.0031
820	0	0	-0	0	0
825	0	0	-0	0	0
830	0	0	-0	-0	0
835	0	0	-0	-0	0
840	0	0	-0	-0	0
845	0	0	-0	-0	0
850	0	0	-0	-0	0
855	0	0	-0	0	0
860	0	0	-0	0	0
865	0	0	-0	0	0
870	0	0	-0	0	0
875	0	0	-0	0	0
880	0	0	-0	0	0
885	0	0	-0	0	0
890	0	0	-0	0	0
895	0	0	-0	0	0

MEAN WAVELENGTH

The mean wavelength $\bar{\lambda}$ is defined as

$$\bar{\lambda} = \frac{\sum_{\circ}^{\infty} \lambda \overline{S_\lambda T_\lambda} \Delta\lambda}{\sum_{\circ}^{\infty} \overline{S_\lambda T_\lambda} \Delta\lambda} . \qquad (3.5)$$

The λ is the wavelength of the relative spectral response $\overline{S_\lambda T_\lambda}$.

RESPONSE AREA

The response area is the area under the relative spectral response curve; it is equal to the width of the pass band of a rectangular filter of equivalent area, hence, it is designated as $\delta\lambda$, and defined as illustrated in Eq.(3.2). The radiometric units of watts/$m^2\,\mu m$ are obtained from units of watts/m^2 by dividing by the response area $\delta\lambda$, in appropriate units.

A summary of the response characteristics of the standards for Project HAVEN VIEW is presented in Table 3-6. The first four columns give filter code, peak wavelength, mean wavelength, and response area. The derivation of the values for inherent solar properties and Rayleigh limits in the final column are described in the Visibility Laboratory in-house Technical Note No. 36. The tables and graphs contained in Section 3.5 were produced by Program RAYLIMIT.

Table 3-6

Spectral Characteristics Summary for Project HAVEN VIEW

				Inherent Sun Properties (Johnson)			Rayleigh Atmosphere Properties (15°C)		
Filter Code No.	Peak Wavelength (nm)	Mean Wavelength (nm)	Response Area (nm)	Irradiance ($w/m^2\mu m$)	Radiance ($w/\Omega m^2\mu m$) Average	Center	Attenuation Length (m)	Total Scattering Coefficient (Per m)	Vertical Beam Transmittance
2	475	478	19.9	2.14E+03	3.13E+07	4.07E+07	4.84E+04	2.07E-05	.839
3	660	664	30.2	1.57E+03	2.30E+07	2.75E+07	1.86E+05	5.41E-06	.955
4	750	765	50.4	1.23E+03	1.80E+07	2.10E+07	3.28E+05	3.08E-06	.974
5	550	557	78.5	1.90E+03	2.78E+07	3.47E+07	8.93E+04	1.15E-05	.907
6	440	532	183.5	1.91E+03	2.80E+07	3.55E+07	7.22E+04	1.64E-05	.867

4. DATA COLLECTION METHODS

During the Memmingen portion of the HAVEN VIEW task, two independent activities were maintained simultaneously. The airborne instrument system was one activity and the ground-based instrument system was the other. The basic concept of the experiment was built around the joint operation of these two systems in a highly coordinated and simultaneous measurement routine. The procedural routine was for each system to run full data collection sequences at every opportunity, on a daily schedule. If for any reason the joint sequences were aborted, both systems were to automatically revert to independent operation. Partial data sets were thus often obtained even when the typically unstable local weather conditions became too severe.

4.1 AIRBORNE SYSTEM

The data collection sequence for the airborne system was broken into five standardized elements: (1) preflight warmup and calibration check, (2) straight and level sequences, (3) vertical profile sequences, (4) in-flight calibration checks, and (5) post-flight calibration check.

The airborne data collection was accomplished through the use of an instrumented C-130A aircraft in a manner similar to that reported in AFCRL-70-0137, Duntley *et al.* (1970). During each data collection flight, the aircraft flew a predetermined pattern within the specified test area. An illustration of the typical flight pattern is shown in Figure 4-1. In this stylized pattern, two basic elements, the straight and level and the vertical profile are combined to yield the total mission flight plan. A more detailed description of all flight pattern elements is presented in AFCRL-70-0137. The two primary elements are summarized in the following paragraphs.

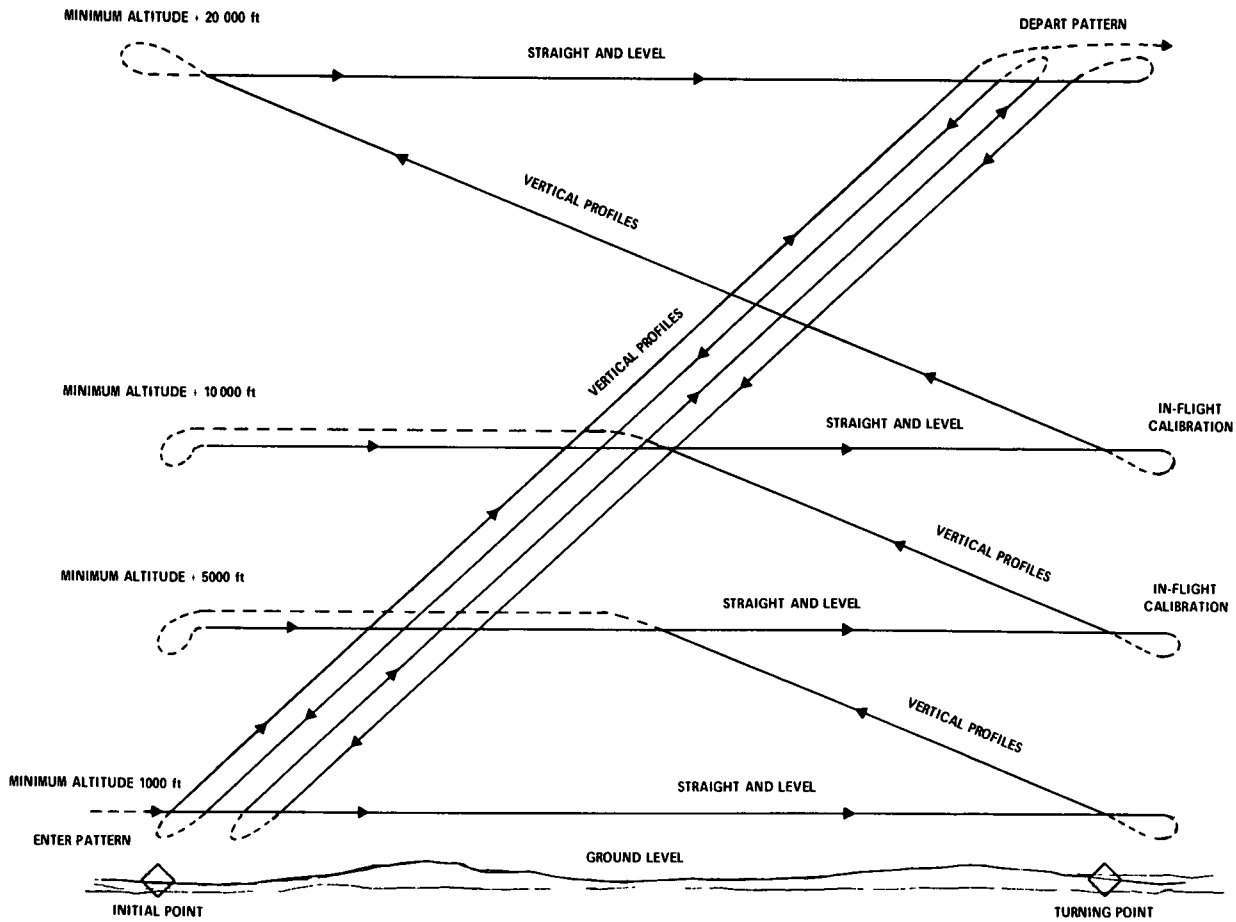


Fig. 4-1. Typical HAVEN VIEW Flight Profile.

STRAIGHT AND LEVEL SEQUENCE

During each straight and level element of the data collection sequence, the pilot maintains a straight and level flight attitude at a maximum indicated airspeed of 150 knots. If weather and terrain permit, the aircraft heading is established crosswind. The ideal pattern for the straight and level sequences would result in all four ground tracks falling on a single line between the initial point and the turn point. See Figure 1-2. The four straight and level elements are actually stacked in a vertical slab of atmosphere approximately 45 miles long, 0.5 mile wide, and 4 miles high.

While the aircraft is traversing the approximately 15-minute long straight and level element, the following types of data collection occur.

1. Automatic 2π scanners map upper and lower hemisphere radiance distributions. Complete radiance maps of both hemispheres are sequentially completed in up to five spectral bands.

2. Integrating nephelometer measures the total scattering coefficient and directional scattering coefficients at $\beta 30°$ and $\beta 150°$. All three measurements are sequentially completed in up to five spectral bands.

3. Variable path function meter is oriented horizontally and measures the horizontal path function sequentially in up to five spectral bands.

4. Equilibrium radiance telephotometer measures the total path radiance of horizontal and near horizontal paths of sight sequentially in up to five spectral bands.

5. Dual irradiometer measures the total upwelling and total downwelling irradiance. Both upwelling and downwelling measurements are sequentially completed in up to five spectral bands.

6. Large aperture telephotometer measures apparent terrain radiances. This measurement is also made sequentially in up to five spectral bands.

7. Royco particle counter runs a standard 10-minute accumulation cycle and automatically prints out the accumulated particle distribution.

8. Peripheral data are recorded continuously. These data include airspeed, pitch, roll, altitude, outside temperature, outside pressure, outside dewpoint temperature, control panel selector settings, and project time.

VERTICAL PROFILE SEQUENCE

During each vertical profile element of the data collection sequence, the pilot maintains an approximately level attitude, a straight heading, a maximum indicated airspeed of 150 knots, and an average rate of descent or ascent of 1000 feet per minute. Up to five vertical profile elements are run during each data collection sequence. These elements are conducted in the same vertical slab of atmosphere that was defined by the preceding four straight and level elements.

While the aircraft is traversing the climb or descent legs, the following types of data collection occur.

1. Integrating nephelometer measures total scattering coefficient only. Each ascent and descent is run continuously from top to bottom in the same spectral band in order not to miss the fine structure in the scattering coefficient versus altitude profile. Thus, a complete climb or descent is required for the measurement in each of the selected spectral bands.

2. Variable path function meter is oriented vertically, such that it measures the path function as seen by a vertically downward-looking observer. The selection of spectral bands is matched with the integrating nephelometer sequence. Alternate look angles are available whenever appropriate.

3. Equilibrium radiance telephotometer measures the total path radiance of horizontal and near horizontal paths of sight. The selection of spectral bands is matched with the integrating nephelometer.

4. Dual irradiometer measures total upwelling irradiance only. The selection of spectral bands is matched with the integrating nephelometer.

5. Large aperture telephotometer monitors apparent nadir terrain radiance. These measurements are for control and intercomparison only. The selection of spectral bands is matched with the integrating nephelometer.

6. Peripheral data are recorded continuously. These data are the same as during the straight and level sequences.

During each mission, top priority is given to those systems essential for the recovery of beam transmission and path radiance data. Thus, the primary systems are the integrating nephelometer and the upper and lower hemisphere scanners. All other systems are either peripheral or backup and are therefore subject to cannibalization or abandonment in the event of any malfunction which affects a primary system.

At the conclusion of each mission, the data which have been recorded and stored on magnetic tape are returned to the Laboratory for computer reduction and analysis.

4.2 GROUND-BASED SYSTEM

The ground-based data collection sequence was designed to supplement the airborne data whenever the aircraft was operating in the immediate vicinity. However, it is also complete enough to stand alone when the aircraft mission is diverted or aborted.

The ground-based instrument system has several operational responsibilities. First, it must supply a ground level data base to allow interpolation of various measurements between ground altitude and the lowest attainable aircraft altitude. Second, it must supply long term temporal sampling of those meteorological and radiometric quantities which relate to the project task. The ground station has run several 24-hour data sequences to monitor temporal variations in particle concentrations and scattering coefficients. This long term continuous measurement capability may in fact be the most significant capability inherent in the system. Third, the ground system serves as a spare parts and repair facility for the entire air/ground operation. In the event of a catastropic failure in a primary airborne instrument or assembly, the equivalent piece of instrumentation is reassigned to the aircraft from the ground-based system. The aircraft can then return to service with a minimum of "down time" and repairs can be accomplished under the more convenient ground station conditions.

DATA COLLECTION SEQUENCE

The ground-based system was assigned three radiometer systems, three meteorological instruments, a Royco particle counter system, and communications equipment. The ground-based data collection sequence is not as automatic as the airborne sequence, but is otherwise quite similar. However, there is a basic difference in priorities. During each ground-based data sequence, top priority was given to those systems essential for the recovery of inherent background radiances. Consequently, the primary systems used were the large aperture telephotometer and the automatic 2π scanner.

The ground-based data collection was accomplished through the use of an instrumented van in a manner similar to that reported in AFCRL-70-0137. This van was located on the Memmingen Air Base and was maintained in this location throughout the entire deployment.

Ground-based data were collected in a fixed pattern on a repetitive basis during each designated data day. The HAVEN VIEW ground station data collection pattern consisted of the radiometric sequence listed below, plus a continuous Royco sampling at 10-minute accumulation intervals. A detailed description of each of these data collection sequences is presented in AFCRL-70-0137, and thus, is not repeated here.

1. Nephelometer Set, Σ, $\beta 30$, $\beta 150$
2. 2π Scanner Set, upper and lower hemispheres
3. Nephelometer Set, Σ only
4. LAT-GONIO Set, ϕ = 0, 90, 180
   θ = 92, 95, 100, 105, 120, 135, 180
5. Nephelometer Set, Σ, $\beta 30$, $\beta 150$.

Typical elapsed times necessary to complete the pattern in all five spectral bands were 10 minutes per nephelometer set, 90 minutes per LAT-GONIO set, and 45 minutes per 2π scanner set.

As with the airborne data, all ground-based measurements were recorded in digital format on magnetic tape for computerized reduction and analysis upon return to the Laboratory.

Upon return to the Laboratory, it was discovered that the ground data logger did not function normally during the HAVEN VIEW data collection. A data dump of the contents of the magnetic tape indicated that data could be retrieved only by hand selection. Thus, the selected data were hand-transcribed to punch cards and then processed by computer. Since the process of hand selection was time-consuming and costly, retrieval was limited to the total volume scattering coefficient data from the nephelometer on the appropriate days for the seven HAVEN VIEW flights for which data had been processed.

5. DATA PROCESSING

5.1 AIRBORNE DATA

As in any reasonably complex, multi-input sample data system, there is a large amount of data handling required before the scientific analyst ever sees the package. The degree of sophistication utilized for this portion of Project HAVEN VIEW data is illustrated in Figure 5-1. In this generalized flow chart, the step-by-step processing of the raw field data is illustrated for the convenience of project organization and control and does not include the details of the actual computer programming.

The airborne data and ground-based data are processed separately as illustrated in the data flow schedule. There are two primary reasons for this approach. First, the recording format of the two data loggers is significantly different. Second, each data collection sequence, airborne and ground-based, is considered to be a completely independent activity and therefore must be reduced to useable format in the most direct manner possible.

As noted in Table 5-1, several classes of data are recorded during an airborne data set: (1) radiometer outputs, (2) selector control codes, (3) transducer orientation and flight attitude signals, and (4) calibration voltages, etc. All systems, regardless of type, have been designed for an electrical output between 0 and ±1 volt dc for full scale. The data logger has a least count of ±1 millivolt and records in digital format at a multiplex rate of 240 samples per second and a tape rate of 3.56 inches per second at a recording density of 200 bits per inch (bpi).

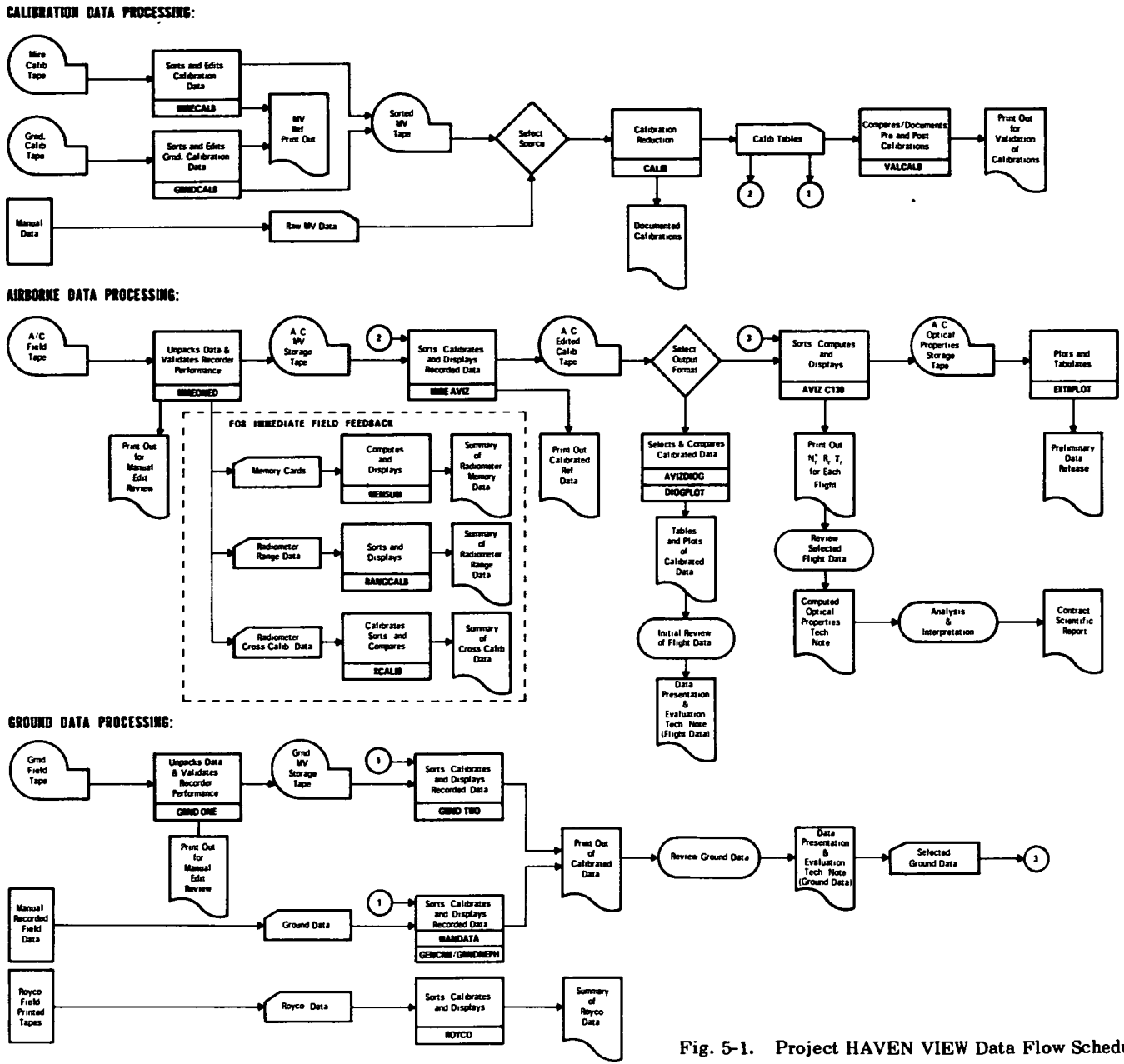


Fig. 5-1. Project HAVEN VIEW Data Flow Schedule.

Table 5-1

Airborne Data Classifications

Analog Input Channel	Signal Class	Samples Per Second	Item Description
01	R	60	Upper Hemisphere Radiance
02	O/C	15	Upper Hemisphere 2π Scanner Azimuth
03	O/C	3	Upper Hemisphere 2π Scanner Elevation
04	R	60	Lower Hemisphere Radiance
05	O/C	15	Lower Hemisphere 2π Scanner Azimuth
06	O/C	3	Lower Hemisphere 2π Scanner Elevation
07	R	2	Large Aperture Telephotometer Radiance
08	R	2	Irradiance, Right Dual
09	K	2	Calibration Reference
10	R	4	Integrating Nephelometer (right)
11	K	4	Variable Path Function Meter Radiance
12	R	4	Equilibrium Radiance Telephotometer Gradient
13	K	4	Equilibrium Radiance Telephotometer Radiance
14	M	1	AN/AMQ-17 Relative Humidity
15	K	2	Calibration Reference
16	K	2	Variable Path Function Meter Orientation
17	K	2	Phot Power Supply Monitor
18	K	2	Calibration Reference
19	K	2	Calibration Reference
20	K	2	Calibration Reference
21	O/C	2	Calibration Reference
22	M	1	Cambridge 137-C3 Dewpoint Temperature
23	O/C	3	Optical Filter Identification
24	O/C	2	Integrating Nephelometer Mode Selector (right)
25	K	2	Calibration Reference
26	O/C	2	Bourns Model 430/530 Static Pressure
27	O/C	3	Roll
28	O/C	2	Pitch
29	O/C	1	Magnetic Heading
30	O/C	1	Indicated Airspeed
31	K	1	Calibration Reference
32	O/C	2	Source Check +990 mv
33	O/C	2	Source Check −990 mv
34	O/C	3	Analog/Digital Zero Check 000 mv
35	M	3	AN/AMQ-17 Temperature
36	R	2	Calibration Reference
37	M	3	AN/AMQ-17 Static Pressure
38	K	3	Calibration Performance
39	O/C	2	Analog/Digital Span Check + 950 mv
40	O/C	2	Irradiometer Prism Identification
41	K	3	Calibration Reference
42	K	2	Calibration Reference

R = Radiometer Signal
O/C = Orientation and Control Signal
M = Meteorological Signals
K = Internal Calibration Signal

PHASE I

The first phase in the airborne data processing schedule, Program MIREONED, is designed to verify the electrical quality of the recorded data and build in some insurance against data loss through mishandling. It also has an additional feature of extracting data samples in millivolt format for later use in the data evaluation procedure. This millivolt format is also useful as a vehicle for fast turnaround of data to the field team. Program MIREONED operates on the raw field tape in the following manner.

1. Examines data channels 34 and 39 which monitor analog/digital calibration input voltages of 0.000 and 0.950 volt dc.

2. Corrects all channels for errors due to minor variations in analog/digital zero and/or span calibration. Rejects all data blocks having analog/digital zero or span variations exceeding 10 millivolts.

3. Examines each 3480-word data block and tabulates its status, i.e., electrical calibration and parity.

4. Prints out block status tally for editing and evaluation.

5. Sorts data which are stored in original analog/digital multiplex array into ordered sequential sets by analog input channel. This operation in effect gets all 2π scanner data into one set, all dewpoint data into another set, and all pitch and roll data into another, etc. All data within a set are ordered chronologically by project time.

6. Transfers validated and corrected data to 800 bpi storage tapes. These tapes are kept as the second copy storage tape to protect against future data loss due to mishandling.

7. Prints out radiometer system memory summaries and punches out data samplings on cards which are used both for data editing and evaluation.

8. Punches out data cards in millivolt form which are used for selected system cross-calibration checks.

The first phase contains Program RANGECALB which uses the pre-deployment calibrations to give immediate field team feedback of the data samples extracted by MIREONED.

PHASE II

In the second phase of the data processing schedule, Program MIREAVIZ is designed to convert the myriad of raw millivolt values on the data storage tape into interpretable tables of calibrated engineering quantities. Program MIREAVIZ is the most comprehensive and expensive routine in the entire schedule. However, it is the application of this routine which allows the results of a 3-hour data collection flight to be available for preliminary analysis within 48 hours of the tape arrival at the computer center.

Program MIREAVIZ operates on the data storage tape in the following manner.

1. Applies the appropriate calibration values to each set of data. This operation, depending upon the system, involves the application of multiplicative factors, the interpolation between tabular values, or the calculation of inter-set ratios.

2. Calculates and applies calibration updates to all radiometer channels based upon "memory calibration" readings interspersed within the basic data.

3. Performs sample calculations to illustrate data quality. Compares results against predetermined standards of maximum and minimum allowable values. Flags all data falling outside allowable limits.

4. Produces printout sheets tabulating results of all operations performed. These sheets contain tables of all measured values as a function of time and/or altitude. In addition to the tabular presentation, selected quantities can be printer-plotted upon demand. These general purpose displays are used for in-house analysis. They are complete, including all calibration values used.

5. Generates an output tape which represents the edited data in calibrated format.

Programs AVIZDIOG and DIOGPLOT use the output tape from MIREAVIZ to further edit and display the flight data in tabular and graphical format.

The basic functions of these programs are:

1. Calculate some intermediate derived quantities and sort by tighter specifications on data quality.

2. Generate printout sheets which tabulate the data in a format that facilitates data diagnostic analysis.

3. Perform automatic diagnostic criterion checks and tabulate results.

4. Plot associated data from different flight elements for diagnostic review.

These displays are directly inserted with preliminary analysis comments into the end product of this phase, the flight "data presentation and evaluation" technical note.

PHASE III

Subsequent to the review of the data presentation technical notes, a decision is made as to whether a data flight is of appropriate quality to process for path radiance and directional path reflectance. Once selected for further processing, a flight is further reviewed to determine if any required data are missing which can be estimated on the basis of available data in the flight, or to determine if specific data are of poor quality and should be deleted. Any data adjustments required are accomplished using Program DIOGEDIT (not illustrated in Figure 5-1).

The end routine, Program AVIZC130, has a great deal of versatility for selecting the manner in which the computations are to be made. The decision is based on the review of the flight data presentation technical note. The flexibility of this program initially caused program storage problems, so a program overlay technique was utilized. This allowed the combination of several programs and even decreased the expense of this stage of processing. The refinement of the data by AVIZC130 into path radiance (N^*), directional path reflectance (R^*), and contrast transmittance (τ_r) results in the generation of a computed optical properties technical note. This note subsequent to evaluation and review becomes the basic input to all project technical reports. At present, Program EXTRPLOT produces the graphs using the results from AVIZC130 stored on magnetic tape. Eventually, EXTRPLOT will be incorporated into AVIZC130.

5.2 GROUND-BASED DATA

The data processing associated with the ground-based data set is similar in concept to that applied to the airborne data. The primary differences are the result of a different recording format between the two data loggers and the significantly lesser amount of data resulting from the ground station. As noted in Table 5-2, the same general classes of data are handled, but in much smaller quantities. Again, all systems, regardless of type, have been designed for an electrical output between 0 and ±1 volt dc for full scale. The data logger is normally adjusted for a least count of ±0.1 millivolt. It also records in digital format; however, the normal incremental sample rate is only approximately eight samples per second.

Table 5-2

Ground-Based Data Classifications

Analog Input Channel	Signal Class	Measured Quantity
00	O/C	Automatic 2π Scanner Elevation
01	R	Automatic 2π Scanner Radiance
02	O/C	Automatic 2π Scanner Azimuth
03	R	Automatic 2π Scanner Radiance
04	O/C	Automatic 2π Scanner Azimuth
05	R	Automatic 2π Scanner Radiance
06	O/C	Automatic 2π Scanner Elevation
07	R	Automatic 2π Scanner Radiance
08	O/C	Automatic 2π Scanner Azimuth
09	R	Automatic 2π Scanner Radiance
10	O/C	Automatic 2π Scanner Azimuth
11	R	Automatic 2π Scanner Radiance
12	R	Large Aperture Telephotometer
13	R	Automatic 2π Scanner, w/irradiance attachment
14	O/C	Large Aperture Telephotomer, Zenith Angle
15	O/C	Calibration Reference
16	R	Automatic 2π Scanner, w/irradiance attachment
17	R	Integrating Nephelometer (left)
18	R	Integrating Nephelometer (right)
19	O/C	Integrating Nephelometer Mode

R = Radiometer Signal
O/C Orientation and Control Signal

PHASE I

The first phase of the ground-based data processing schedule, Program GRNDONE, has the same general function as in the airborne case. It is designed to verify the quality of the recorded data, determine the useable quantity of data available, and provide data storage tapes for further processing.

Program GRNDONE operates on the raw field tape in the following manner.

1. Examines each ten character word and identifies and tabulates its classification and parity.
2. Prints out tape status tally and data classification summary for editing and evaluation.
3. Sorts the data, which are stored in the original multiplex array, into ordered sequential sets by analog input channel.
4. Transfers acceptable data to storage tapes. All data are stored in millivolt values in the original field tape format.

Ground-based data that were recorded manually are also processed in a systematic fashion. In Phase I, the data are transcribed and punched onto cards in a generalized radiometer system format. Each system measurement, in each of the spectral bands, is recorded on one card with its memory and identifying information. This one card format was designed for conciseness and to facilitate processing procedures.

PHASE II

The second phase of the ground-based data processing, Program GRNDTWO, is designed to convert the raw millivolt values on the storage tape into interpretable tables of calibrated engineering quantities.

Program GRNDTWO operates on the data storage tape in the following manner.

1. Applies the appropriate calibration values to each set of data.
2. Calculates and applies calibration updates to all radiometer channels.
3. Performs sample calculations to illustrate data quality. Flags all data falling outside pre-established allowable limits.
4. Reorders automatic 2π scanner data into a stylized array suitable for manual analysis.
5. Produces printout sheets tabulating results of all operations performed. These sheets contain tables of all measured values as a function of project time. These general purpose displays are used for in-house analysis, delivery to authorized outside users, and selection of ground data to be card-inputted into Phase III of the airborne data processing flow, etc.

Due to the reasonably small quantities involved and the sometimes very specialized utilization of the ground-based data, there was no automatic processing beyond GRNDTWO.

The processing of nonstandard tape-recorded data sets requires the revision back to card format for efficient processing. To handle this procedure, Program GRNDCNVT (not illustrated in Fig. 5-1) is used to reduce the data to the radiometer system card format. This card format is then used to complete this phase of the processing in the manual data mode.

The manual data are presently being processed by separate programs, depending upon the system from which the data were derived. Program GENCRM is used to process the contrast reduction meter data. The program is suitable for use with all contrast reduction meter data modes (sky scanning, solar transmissometer disk, and irradiometer), as well as other system ground gonio or downwelling irradiance measurements. Program GRNDNEPH is used for ground nephelometer data reduction. In both programs data are:

1. Displayed in their original card configuration to facilitate validation.
2. Displayed with appropriate calibration values applied to each set of data. Data falling outside allowable limits are flagged and not used in further computations.
3. Sorted, displayed, and end parameters computed in such a fashion for direct inclusion into ground "data presentation and evaluation" technical notes.

It is planned to incorporate these programs (GRNDCNVT, GENCRM, and GRNDNEPH) into one program, MANDATA, to give the system more continuity.

5.3 CALIBRATION DATA

The calibration data are the heart of the data processing system in that any data processed are only as good as the calibrations applied to them. The calibration data are presently being recorded on tape to help eliminate the human bias in the system and are being handled in a phased procedure similar to that used in the general data processing technique. The data can be recorded on either the airborne or the ground data logging system. In a Phase I procedure, these data on tape go through the programs MIRECALB or GRNDCALB respectively to verify the electrical quality of the radiometer data and associated monitored parameters. The data are sorted and stored in set fashion for Phase II processing. Program CALIB performs this processing by generating documentation printouts and standard radiometer calibration card decks which can be used by any of the system's programs for calibrating field data. These card decks are also used by Program VALCALB which, in its documentation mode, can be used to generate printout for direct insertion into a technical note. This program also has a comparison mode which is used to compare pre- and post-deployment calibration sets. This mode is a particularly useful tool in calibration verification.

5.4 DATA TAPES

The data processing sequences discussed in the previous paragraphs produce output tapes containing a broad catalog of calibrated data. These tapes are useable as data inputs to a multiplicity of diverse problems requiring a knowledge of atmospheric optical properties. Thus the data tape numbers and the computer job numbers that produced the data tables and graphs reported herein are summarized in Table 5-3 to simplify future retrieval.

Table 5-3

Processed Data Tapes and Runs of Programs
for Producing Tables (AVIZC130) and Graphs (EXTRPLOT)

HAVEN VIEW Flight	AVIZDIOG Tape No.	AVIZDIOG File No.	Job No.	AVIZC130 Date	AVIZC130 Tape No.	File No.	EXTRPLOT Job No.	EXTRPLOT Date
C-134	VL-386	5	4833	1/13/72	VL-307C	1	2921	2/15/72
C-137	VL-386	2	5366	10/02/71	VL-307C	4	2726	2/10/72
C-138	VL-386	7	4780	10/01/71	VL-307C	5	2848	2/14/72
C-139	VL-386	11	5191	1/24/72	VL-307C	2	2709	2/09/72
C-142	VL-386	6	5829	9/22/71	VL-307C	6	2850	2/14/72
C-143	VL-386	3	4490	2/07/72	VL-307C	3	2839	2/14/72

6. GENERAL WEATHER SUMMARY

6.1 GENERAL SUMMARY

Meteorological data available for analysis included daily surface synoptic charts prepared by the German Weather Service (Deutscher Wetterdienst) for the period 1 May to 6 June 1970. The surface charts were for 6-hour intervals: 0000, 0600, 1200, and 1800 GMT. The 500-millibar charts were for 0000 and 1200 GMT. Also available for days when flights were conducted were the hourly reports made by the Weather Office at Memmingen Air Base, stream lines taken from the 850- and 500-millibar charts, and time versus attitude cross sections of weather conditions. On the cross sections were included: surface wind, visibility, temperature, dewpoint, clouds, and upper level winds and atmospheric stability estimates when available. The stability estimates were obtained from either the Munich or Stuttgart soundings, whichever were nearest in time and space to Memmingen relative to the general flow patterns. Cloud tops were estimated from an examination of the moisture content of the soundings but are subject to large errors. These time versus altitude cross sections were provided by the Weather Office at Memmingen.

On many of the days, there was a very weak pressure gradient in the area of interest on the surface charts. It would have been helpful to have been able to draw intermediate isobars for further definition of the pattern. Since the available charts did not show pressure and the winds were light, this was not practical.

During the period of deployment in Germany, the weather conditions were far from optimum. Most of the days when flights were conducted were partly cloudy to overcast, often with several layers of clouds. These conditions made it impossible to orient the ground and airborne instruments to obtain a clear path to the sun.

During the period 19 May to 6 June 1970, there was a series of weak frontal passages accompanied by light rain. On the average, these frontal passages occurred about every third day.

This section includes a discussion of the surface and 500-millibar charts for all of the flights. Listed in tabular form are the hourly reports made by the Weather Office at Memmingen Air Base. The meteorological data taken by the Visibility Laboratory ground station (on site at Memmingen Air Base) are in agreement with the weather station. They are not included separately because they are not as complete.

6.2 SYNOPTIC CONDITIONS

FLIGHT C-131 ON 19 MAY 1970

The surface charts show a ridge of high pressure oriented west-east over western Europe with a 1035-millibar high centered south of Ireland at 49° N 10° W. During the day, the ridge weakened slightly. At 500 millibars, there was a cold trough oriented northeast-southwest and located just south of the area of interest. There was a high centered off the coast of France and Spain with a ridge extending to Denmark and northern Germany. At 500 millibars, there was a slight warming noted with a 2 degree rise in temperature from 0000 to 1200 GMT. Winds aloft were moderate northeasterly at 500 millibars and light to moderate below. The airmass was modified unstable maritime polar.

FLIGHT C-132 ON 23 MAY 1970

The surface charts have a ridge of high pressure from France eastward to Poland, including the area of interest. There was little change during the day. There was a complex storm with the low center at 53° N and 30° W and from this system, a warm front extended into western Great Britain. The 500-millibar chart showed Memmingen on the back side of a cold trough. A ridge oriented north-south along 10° W and from 40° to 60° N at 0000 GMT moved to 5° W by 1200 GMT bringing warmer air with a 5°C rise in 12 hours at the upper air station reporting north of Memmingen. Winds aloft were moderate to strong northwesterly. The airmass was unstable maritime polar.

FLIGHT C-133 ON 25 MAY 1970 (MORNING)

A 1025-millibar high extended from the tip of Sweden southward through central Italy on the 0000 GMT surface chart. By 0600 GMT, the axis of the high had moved eastward with Memmingen on the back side of the high. High pressure weakened throughout the day. At 500 millibars, there was a ridge on a north northeast-south southwest line from Sweden to Algeria passing through Memmingen. Moist air was being brought in from the eastern Atlantic with light westerly winds at and below 500 millibars. The airmass was unstable maritime polar.

FLIGHT C-134 ON 25 MAY 1970 (EVENING)

The high that was present on the morning charts weakened throughout the afternoon; the Memmingen area was in a col with very weak circulation. The 500-millibar chart has a ridge on a north northeast-south southwest line from Sweden to Algeria. The winds were light westerly bringing in moist air from the eastern Atlantic. The airmass was unstable maritime polar.

FLIGHT C-135 ON 26 MAY 1970

A ridge of high pressure over the Memmingen area was part of a high centered at 49° N 9° W as shown on the 1200 GMT surface chart. At 500 millibars, there was light to moderate northwesterly flow with the transition from trough to ridge. The airmass was modified unstable maritime polar.

FLIGHT C-136 ON 27 MAY 1970

The surface charts show that there was a weak cold frontal passage during the morning followed by a weak ridge moving in over the area. The circulation at the surface was very weak. The 500-millibar charts indicate that the Memmingen region was situated at the leading edge of a ridge which extended over Great Britain and Ireland from a high off the French coast. The flow over Germany was from the North Sea. There was also a cold trough in the Baltic Sea and over Sweden with a breakoff cold low over Poland by 1200 GMT. The flow aloft was moderate northwest to north and there was a drop in temperature of 4°C between 0000 GMT and 1200 GMT. The airmass was unstable maritime polar.

FLIGHT C-137 ON 28 MAY 1970

The Memmingen area was situated in a col with very weak circulation at the surface. At 500 millibars, a cold low over Poland had deepened and the Memmingen area was on the back side of the low with moderate northerly winds. The airmass was unstable maritime polar.

FLIGHT C-138 ON 29 MAY 1970

The Memmingen area was located in a col with very weak circulation at the surface. There was a cold front with waves off Norway and through central France. At 500 millibars, there was a deepening trough with a breakoff low moving into the Black Sea as shown on the 1200 GMT chart. The winds were moderate northwesterly. There was a 3°C drop in temperature between 0000 GMT and 1200 GMT. The airmass was unstable maritime polar.

FLIGHT C-139 ON 3 JUNE 1970

On the surface charts, a high pressure cell centered in the North Sea was moving east-northeastward. The Memmingen area was in the southeast sector of the high. During the day, the pressure gradient weakened over southern Germany and by 1800 GMT, there was a col over southern Germany, Austria, Switzerland, and northern Italy. The 500-millibar chart has a ridge through France and Germany with a low located in central Poland. There were moderate northerly winds. The airmass was unstable continental polar at low levels and unstable maritime polar aloft.

FLIGHT C-140 ON 4 JUNE 1970

The surface charts show a high centered at 60°N 15°E at 0000 GMT with Memmingen in the south-central portion of the high. Pressure over the area gradually filled and by 1800 GMT, Memmingen was in a col. The 500-millibar chart has a deepening low over Yugoslavia at 0000 GMT which dominated most of central Europe by 1200 GMT. The wind pattern changed from northeasterly on the 0000 GMT chart to east-southeasterly on the 1200 GMT chart. There was a 6°C drop in temperature between 0000 GMT and 1200 GMT. The airmass was unstable continental polar.

FLIGHT C-141 ON 5 JUNE 1970

The surface charts indicate that the Memmingen area was in a col with weak circulation. There was a cold front passing through Spain during the day and a 1030-millibar high in the Black Sea. There was also a low over central Poland. The 500-millibar charts show that lows covered most of western Europe with one center west of the Memmingen area and a deepening low off Portugal. The flow was moderate to light southeasterly. The airmass was unstable continental polar.

FLIGHT C-142 ON 6 JUNE 1970 (MORNING)

There was a very weak circulation indicated on the surface charts with the Memmingen area in a col. There was a warm front in southern Italy and France that moved slowly northeastward. The 500-millibar chart also shows a weak circulation. A filling low was moving into Portugal from the eastern Atlantic. The airmass was unstable continental polar.

FLIGHT C-143 ON 6 JUNE 1970 (EVENING)

The surface charts showed a warm front that was moving slowly northeastward through southern Italy and France. The Memmingen area was in a col. At 500 millibars, a filling low was moving into Portugal from the eastern Atlantic. The airmass was unstable continental polar.

FLIGHT C-144 ON 7 JUNE 1970

The surface charts show a stationary front over the Memmingen area with moist air at the lower levels being brought in from the Mediterranean. In conjunction with the front, there was some thundershower activity after 1605 GMT. On the 500-millibar chart, there is a filling low over Portugal and Spain, a ridge over northern Italy, with the Memmingen area in a col. The circulation was weak and the winds were light northwesterly. The airmass was unstable maritime polar at the surface and unstable continental polar at the upper levels.

6.3 TABULAR SUMMARY AND GLOSSARY

A summary of the daily meteorological observations taken at the Memmingen Air Base on the days during which data flights were made is presented in Table 6-1. A glossary of the most often used symbols is also included.

METEOROLOGICAL GLOSSARY AND ABBREVIATIONS

Sky and Ceiling. Sky cover symbols are in ascending order. Figures preceding symbols are heights in hundreds of feet above station. Sky cover symbols are:

○	Clear: less than 0.1 sky cover
◐	Scattered: 0.1 to less than 0.6 sky cover
◍	Broken: 0.6 to 0.9 sky cover
⊕	Overcast: more than 0.9 sky cover
-	Thin (when prefixed)
-X	Partial obscuration: 0.1 to less than 1.0 sky hidden by precipitation or obstruction to vision (bases at surface)
X	Obscuration: 1.0 sky hidden by precipitation or obstruction to vision (bases at surface)

Letter preceding height of layer identifies ceiling layer and indicates how ceiling height was obtained. Thus:

A	Aircraft
B	Balloon (pilot or ceiling)
D	Estimated height of cirriform clouds on basis of persistency
E	Estimated height of noncirriform clouds
M	Measured
R	Radiosonde balloon or radar
U	Height of cirriform ceiling layer unknown
/	Height of cirriform nonceiling layer unknown
"V"	Immediately following numerical value indicates a varying ceiling
W	Indefinite

Visibility. Reported in kilometers.

Weather and Obstruction to Vision Symbols.

A	Hail	IF	Ice fog
AP	Small hail	K	Smoke
BD	Blowing dust	L	Drizzle
BN	Blowing sand	R	Rain
BS	Blowing snow	RW	Rain showers
D	Dust	S	Snow
E	Sleet	SG	Snow grains
EW	Sleet showers	SP	Snow pellets
F	Fog	SW	Snow showers
GF	Ground fog	T	Thunderstorms
H	Haze	ZL	Freezing drizzle
IC	Ice crystals	ZR	Freezing rain

Cloud Abbreviations.

Ac	Altocumulus	Cs	Cirrostratus
As	Altostratus	Cu	Cumulus
Cb	Cumulonimbus	Ns	Nimbostratus
Cc	Cirrocumulus	Sc	Stratocumulus
Ci	Cirrus	St	Stratus

Wind. Direction in ten's of degrees from true north, speed in knots. A 0000 indicates calm. A G indicates gusty. A Q indicates squall. Peak speed of gusts, when reported, follows G or Q. The contraction WSHFT in remarks followed by time group (GMT) indicates wind shift and its time of occurrence.

EXAMPLES:

0129 is 010 degrees, 29 knots.

3627G40 is 360 degrees, 27 knots, peak speed in gusts of 40 knots.

Table 6-1

STANDARD METEOROLOGICAL DATA SHEET

Field Site: Memmingen, Germany – Data Source: Weather Station No. 645, Memmingen, Germany

Flight No.	Date/Time (GMT)	Sky and Ceiling (Hundreds of Feet)	Visibility (km)	Temp. (°C)	Dewpoint (°C)	Wind Direction and Speed (Ten's of Degrees/Knots)	Remarks Cloud Type and Amount
C-131	19 May 70 0552	250 ⊕	15	9.8	6.2	0000	1/8 Ci
	0652	250 ⊕	12	10.8	6.0	0202	3/8 Ci
	0752	25 ⊕ 250 ⊕	15	12.8	5.0	0407	1/8 Cu 3/8 Ci
	0852	40 ⊕ E250 ⊕	30	13.2	1.3	0510	2/8 Cu 6/8 Ci
	0952	45 ⊕ E250 ⊕	30	13.2	2.5	0610	1/8 Cu 7/8 Ci
	1052	45 ⊕ E250 ⊕	30	15.4	3.4	0508	1/8 Cu 7/8 Ci
C-132	23 May 70 0752	15 ⊕ E20 ⊕ 90 ⊕	15	6.7	2.4	2916	1/8 Cu 5/8 Cu 5/8 Ac
	0852	15 ⊕ 20 ⊕ E80 ⊕	20	7.6	0.2	2813	1/8 Cu 4/8 Cu 8/8 As
	0952	15 ⊕ 20 ⊕ E80 ⊕	25	8.4	0.2	3011	1/8 Cu 4/8 Cu 8/8 As
	1052	15 ⊕ E20 ⊕ 80 ⊕	30	8.4	0.2	3007	1/8 Cu 5/8 Cu 8/8 As
	1152	15 ⊕ E20 ⊕ 90 ⊕	30 RW	8.6	0.4	2708	3/8 Cu 4/8 Cu 8/8 As Rain Showers
	1252	20 ⊕ E30 ⊕ 90 ⊕	15 RW	9.3	2.4	3009	3/8 Cu 5/8 Sc 3/8 As Rain Showers
C-133	25 May 70 0552	100 ⊕ E250 ⊕	40	7.0	3.6	2104	3/8 Ac 6/8 Ci
	0652	100 ⊕ E250 ⊕	40	10.8	4.6	2104	1/8 Ac 6/8 Ci
	0752	100 ⊕ E250 ⊕	40	12.6	4.9	2404	2/8 Ac 6/8 Ci
	0852	100 ⊕ E250 ⊕	40	15.0	6.0	2404	2/8 Ac 6/8 Cs
	0952	E100 ⊕ 250 ⊕	30	15.6	7.4	3103	5/8 Ac 7/8 Cs

Table 6-1 (cont.)

STANDARD METEOROLOGICAL DATA SHEET

Field Site: Memmingen, Germany – Data Source: Weather Station No. 645, Memmingen, Germany

Flight No.	Date/Time (GMT)	Sky and Ceiling (Hundreds of Feet)	Visibility (km)	Temp. (°C)	Dewpoint (°C)	Wind Direction and Speed (Ten's of Degrees/Knots)	Remarks Cloud Type and Amount
C-134	25 May 70 1452	50 ⓘ E120 ⓘ 200 ⓘ	30	19.4	7.9	2406	1/8 Cu 5/8 Ac 6/8 Cs
	1552	50 ⓘ E120 ⓘ 200 ⓘ	30	19.0	8.0	3304	1/8 Cu 5/8 Ac 5/8 Cs
	1652	70 ⓘ E200 ⓘ	30	18.4	7.9	2406	3/8 Ac 6/8 Cs
	1752	45 ⓘ 120 ⓘ E200 ⓘ	20	18.0	9.4	2902	2/8 Cu 4/8 Ac 5/8 Cs
	1852	45 ⓘ 120 ⓘ E200 ⓘ	20	15.4	11.4	0000	1/8 Cu 2/8 Ac 5/8 Cs
C-135	26 May 70 1952	80 ⓘ E200 ⓘ	9	8.6	4.6	0602	3/8 Ac 5/8 Ci
	2052	80 ⓘ 200 ⓘ	12	8.4	4.1	1804	2/8 Ac 4/8 Ci
	2152	200 ⓘ	12	7.5	4.5	1804	3/8 Ci
	2252	200 ⓘ	12	7.1	4.5	1802	4/8 Ci
	2352	50 ⓘ E200 ⓘ	12	8.3	5.4	2104	2/8 Sc 6/8 Ci
C-136	27 May 70 1452	10 ⓘ 25 ⓘ E40 ⓘ	8	15.2	5.0	2707	1/8 Cu 4/8 Cu 8/8 Sc
	1552	30 ⓘ 45 ⓘ	12	13.6	5.6	3511	4/8 Cu 3/8 Sc
	1652	30 ⓘ 45 ⓘ	12	12.0	5.4	3512	3/8 Cu 3/8 Sc
	1758	25 ⓘ 45 ⓘ	12	11.0	5.0	3612	1/8 Cu 1/8 Sc
	1852	40 ⓘ 80 ⓘ	12	9.4	4.7	3614	1/8 Sc 1/8 Ac
C-137	28 May 70 1352	30 ⓘ E50 ⓘ	15	13.0	5.3	3602	2/8 Cu 6/8 Sc
	1452	30 ⓘ E50 ⓘ 200 ⓘ	20	13.4	5.4	2304	1/8 Cu 6/8 Sc 2/8 Ci
	1552	35 ⓘ 50 ⓘ 200 ⓘ	20	13.7	5.4	2304	1/8 Cu 3/8 Sc 2/8 Ci

Table 6-1 (cont.)

STANDARD METEOROLOGICAL DATA SHEET

Field Site: Memmingen, Germany – Data Source: Weather Station No. 645, Memmingen, Germany

Flight No.	Date/Time (GMT)	Sky and Ceiling (Hundreds of Feet)	Visibility (km)	Temp. (°C)	Dewpoint (°C)	Wind Direction and Speed (Ten's of Degrees/Knots)	Remarks Cloud Type and Amount
C-137	28 May 70 1652	50 ⓘ	20	13.6	4.6	0402	3/8 Cu
	1752	50 ⓘ	20	13.1	3.7	0303	2/8 Sc
C-138	29 May 70 0752	140 ⓘ E250 ⓘ	13	15.9	5.9	1202	1/8 Ac 7/8 Ci
	0852	30 ⓘ E250 ⓘ	20	16.1	8.4	1202	1/8 Cu 6/8 Ci
	0952	35 ⓘ 180 ⓘ E220 ⓘ	25	16.8	7.4	3002	2/8 Cu 3/8 Ac 6/8 Ci
	1052	40 ⓘ 140 ⓘ E220 ⓘ	25	17.9	5.7	2104	3/8 Cu 1/8 Ac 5/8 Ci
	1152	40 ⓘ 140 ⓘ E220 ⓘ	30	18.0	4.4	2306	3/8 Cu 1/8 Ac 6/8 Cs
C-139	03 Jun 70 1152	40 ⓘ	30	14.0	2.6	0410	2/8 Cu 4/8 Ci
	1252	40 ⓘ 250 ⓘ	30	14.4	5.1	0611	2/8 Cu 2/8 Ci
	1352	40 ⓘ 250 ⓘ	30	15.4	3.7	0711	2/8 Cu 2/8 Ci
	1452	40 ⓘ 250 ⓘ	30	15.4	3.1	0510	2/8 Cu 3/8 Ci
	1552	40 ⓘ 250 ⓘ	20	14.9	1.8	2514	2/8 Cu 4/8 Ci
C-140	04 Jun 70 0652	12 ⓘ E15 ⓘ	15	8.0	4.1	0614	1/8 Cu 7/8 Cu
	0752	9 ⓘ E18 ⓘ	15	8.9	4.4	0617	2/8 Cu 7/8 Cu
	0852	13 ⓘ E22 ⓘ	15	---	---	0618	2/8 Cu 7/8 Cu
	0935	E27 ⓘ	15	---	---	0520	6/8 Cu
	0952	E30 ⓘ	20	12.8	5.1	0617	6/8 Cu
	1052	E30 ⓘ	20	13.4	4.6	0618	6/8 Cu

Table 6-1 (cont.)

STANDARD METEOROLOGICAL DATA SHEET

Field Site: Memmingen, Germany – Data Source: Weather Station No. 645, Memmingen, Germany

Flight No.	Date/Time (GMT)	Sky and Ceiling (Hundreds of Feet)	Visibility (km)	Temp. (°C)	Dewpoint (°C)	Wind Direction and Speed (Ten's of Degrees/Knots)	Remarks Cloud Type and Amount
C-140	04 Jun 70 1152	E35⊕	20	13.0	3.9	0519	7/8 Cu
C-141	05 Jun 70 1352	40⊖ 200⊖	30	19.6	5.7	3503	2/8 Cu 2/8 Ci
	1452	40⊖ 200⊖	30	20.1	6.0	0205	2/8 Cu 2/8 Ci
	1552	40⊖ 200⊖	30	19.3	5.6	3504	2/8 Cu 3/8 Ci
	1652	40⊖ 80⊖ 200⊖	30	18.0	7.0	0205	2/8 Cb 1/8 Cu 1/8 Ac 4/8 Ci
	1752	40⊖ 50⊖ E100⊕ 200⊕	20	17.1	8.6	0204	2/8 Cb 3/8 Sc 5/8 Ac 2/8 Ci
C-142	06 Jun 70 0752	10⊖	7-F	14.6	11.8	0204	2/8 Cu Light Fog
	0852	12⊖	8	16.8	9.4	0504	3/8 Cu
	0952	20⊖	10	---	---	0612	2/8 Cu
	1052	20⊖	10	18.9	9.4	0712	2/8 Cu
	1152	25⊖ 250⊖	10	19.8	9.5	0712	2/8 Cu 1/8 Ci
C-143	06 Jun 70 1352	35⊖ 250⊖	20	20.3	9.7	0714	2/8 Cu 4/8 Ci
	1452	40⊖ E200⊕	15	20.0	9.9	0516	2/8 Cu 6/8 Ci
	1552	90⊖ E200⊕	15	18.1	10.0	0618	3/8 Ac 7/8 Ci
	1652	E100⊕ 200⊕	15	17.4	10.4	0717	5/8 Ac 7/8 Ci
	1752	60⊖ E120⊕ 200⊕	15	18.0	9.6	0615	1/8 Sc 6/8 Ac 7/8 Ci
C-144	07 Jun 70 1152	35⊖ 50⊖ 80⊖	15	21.9	12.4	Light and Variable	3/8 Cu 3/8 Sc 2/8 Ac
	1252	35⊖ 50⊖ 80⊖	15	21.5	12.3	3003	3/8 Cu 2/8 Sc 3/8 Ac

Table 6-1 (cont.)

STANDARD METEOROLOGICAL DATA SHEET

Field Site: Memmingen, Germany – Data Source: Weather Station No. 645, Memmingen, Germany

Flight No.	Date/Time (GMT)	Sky and Ceiling (Hundreds of Feet)	Visibility (km)	Temp. (°C)	Dewpoint (°C)	Wind Direction and Speed (Ten's of Degrees/Knots)	Remarks Cloud Type and Amount
C-144	07 Jun 70 1352	35⊕	15	21.4	11.8	3502	4/8 Cu
	1452	35⊕	15	23.4	12.3	2504	3/8 Cu
	1552	35⊕E40⊕	15	22.8	13.6	0603	2/8 Cb 6/8 Cu
	1605	E35⊕40⊕	10 TRW			3508	8/8 Cb 3/8 Cu Thundershowers
	1635	E30⊕80⊕	6 TRW			1418	6/8 Cb 2/8 Cu Thundershowers
	1652	E30⊕	6 TRW A	19.4	11.6	1418	8/8 Cb Thundershowers & Hail

7. AIRBORNE DATA

7.1 FLIGHT SUMMARY

Between 23 May and 7 June 1970, 13 flights were made in Germany in the Memmingen area. The flights were conducted along an east-west route between Mindelheim and Mengen, passing approximately 8 to 16 kilometers (5 to 10 miles) north of Memmingen. Typical cloudy-sky conditions encountered during these flights are illustrated in Figure 7-1. The typical terrain was heavily cultivated, rolling pastureland occasionally interrupted by large patches of dark forest. (See Figure 7-2).

Six of the flights were selected as having data appropriate for obtaining path radiance and path reflectance. Data are presented tabularly and graphically in sets by flight number. A detailed description and report of weather characteristics are given as the introductory page of each data set.

Table 7-1 contains a summary of pertinent data for the six flights being reported. The flight numbers are sequential. The times under the Total Time of Data-Taking column are Greenwich Mean Time (GMT) and in parentheses, Local Civil Time (LCT), which is GMT plus 1 hour. In the description of the Sky Near Sun column, clear indicates that the apparent sun radiance was calculated according to Section 2.10 and cloud indicates that the highest measured sky radiance was accepted as the apparent sun radiance. The sun zenith angles are tabulated for the time when sky radiance data-taking began and at the conclusion of the sky radiance data-taking. The maximum flight altitude is noted in column 11.

The beam transmittance is extrapolated from space to the highest altitude of flight as described in Section 2.10 only when there is a clear sky above. The results of this extrapolation are not included in the sets of data tables by flight. These extrapolations and the resultant space-to-ground beam transmittance, when combined with the beam transmittance based on the total scattering coefficient profile, are presented for the three clear-day flights in Table 7-2.

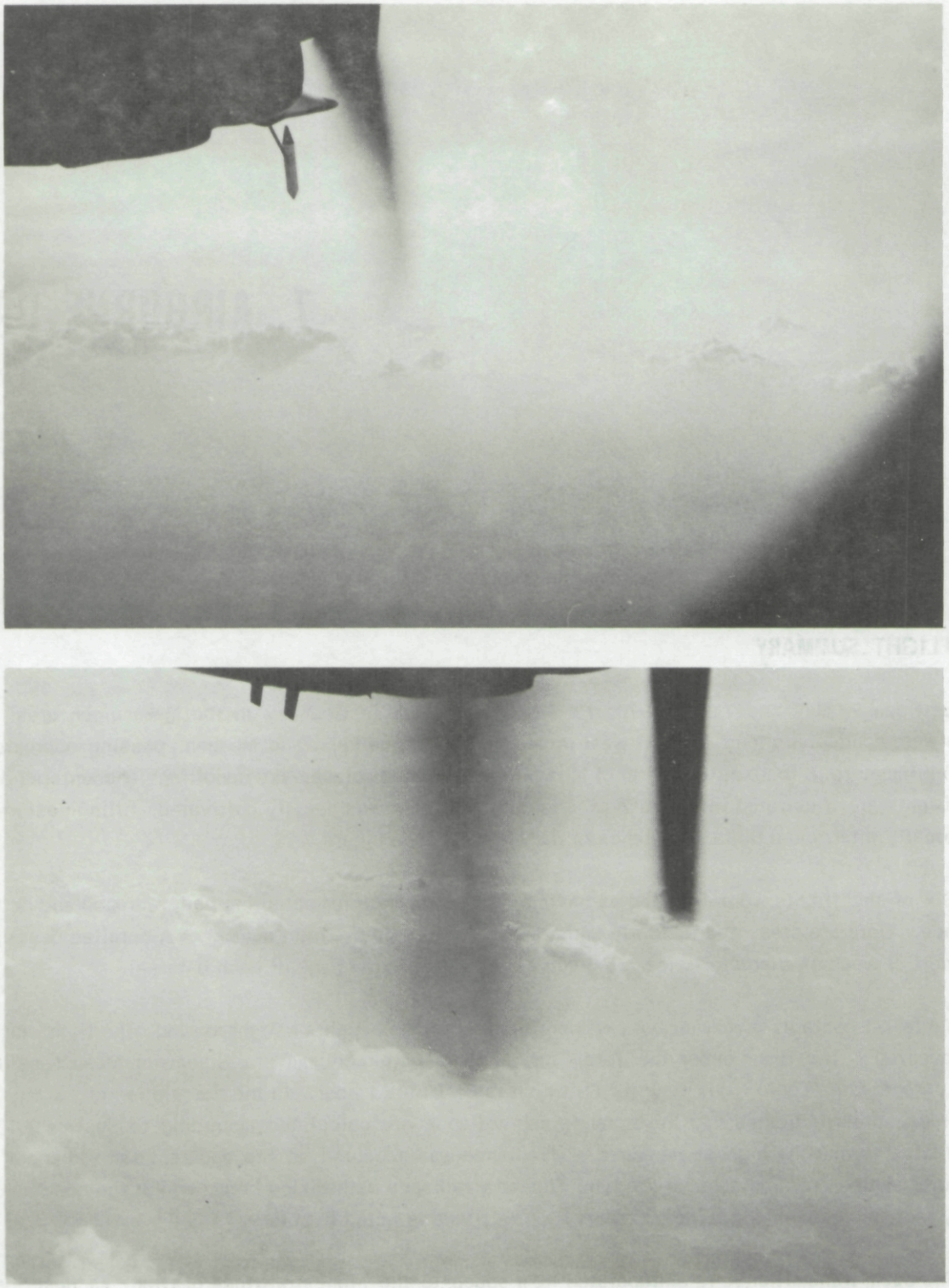


Fig. 7-1. Memmingen Track Typical Sky Conditions.

Fig. 7-2. Memmingen Track Typical Terrain Features.

Table 7-1

HAVEN VIEW Flight Data at
Memmingen Site for Filters 2, 6, 5, and 3

Flight Number	Date 1970	Total Time of Data-Taking				Sky Near Sun	Sun Zenith Angle			Maximum Flight Altitude (m) AGL
		Start		End			Start	Transit	End	
		GMT	LCT	GMT	LCT					
C-134	25 May	1508	(1608)	1641	(1741)	Cloud	50.6	---	61.7	2460
C-137	28 May	1418	(1518)	1543	(1643)	Clear	44.8	---	55.1	2490
C-138	29 May	0829	(0929)	1039	(1139)	Clear	42.6	---	29.7	4920

C-139	03 June	1247	(1347)	1511	(1611)	Cloud	31.3	---	44.8	4830
C-142	06 June	0825	(0925)	1045	(1145)	Clear	42.7	---	30.2	4950
C-143	06 June	1406	(1506)	1628	(1728)	Cloud	41.8	---	58.9	4980

Table 7-2

Space-to-Sensor Vertical Beam Transmittance

Date 1970	Flight Number	Sensor Altitude (m) AGL	Vertical Beam Transmittance			
			Filter 2	Filter 6	Filter 5	Filter 3
28 May	C-137	3000	0.584	0.601	0.655	0.699
		0	0.362	0.401	0.460	0.536
29 May	C-138	5100	0.561	0.614	0.709	0.682
		0	0.262	0.277	0.371	0.440
06 June	C-142	5100	0.643	0.685	0.722	0.786
		0	0.383	0.441	0.511	0.602

7.2 DESCRIPTION OF DATA TABLES AND GRAPHS

DATA TABLES

Data are presented in tables of:

Irradiance
Directional Reflectance of Background
Total Scattering Coefficient
Beam Transmittance from Ground to Altitude
Path Radiance from Ground to Altitude
Directional Path Reflectance from Ground to Altitude.

Each optical property is tabulated in the tables as a function of altitude above ground level except for the directional reflectance of background which is tabulated as a function of zenith angle. The data are further divided by optical filters which are given in order of increasing wavelength. The tables of directional reflectance of background, path radiance from ground to altitude, and direction path reflectance from ground to altitude are presented in four sets of four azimuths with respect to the sun of 0, 90, 180, and 270 degrees.

Irradiances. The downwelling irradiances H(z,d) and upwelling irradiances H(z,u), albedos H(z,u)/H(z,d), scalar irradiances h(z,d), h(z,u), and h(z), and scalar albedos h(z,u)/h(z,d) are presented in columnar form as a function of altitude. The irradiances are computed from measurements of sky and terrain radiance made by the airborne hemispherical scanner system at each of the flight profile level altitudes.

The altitudes are given in meters above ground level for the altitudes of flight. There are four tables of irradiance for each flight, one table for each optical filter. The dimensions and units for the irradiances are "w $m^{-2}\mu m^{-1}$." Albedos are, of course, dimensionless.

The irradiances for Filter Code Number 5 can be converted to illuminance values in units of lumens per square meter by multiplying each irradiance by the factor 72.0 luμm/w.

Directional Reflectance of Background. The directional background reflectance ${}_bR_o(z,\theta,\phi)$ is tabulated by zenith angle in four columns for the four optical filters. A table is presented for each of the four azimuthal points. Reflectance is dimensionless. These reflectances are based on the apparent terrain radiance and the downwelling irradiance measured at the minimum aircraft altitude.

It should be stressed again that the reflectances presented in this section are typical of the average terrain beneath the flight path. The lower hemisphere scanner has a 5 degree circular field of view and during the data interval, the aircraft is traveling at approximately 150 knots. Both of these characteristics contribute to the optical smearing of the measurement area and the attendant radiometric averaging.

The background reflectance required as input to a contrast transmittance computation must represent the actual background at the immediate boundary of the target object. This will not necessarily be the same as the average reflectance of the surrounding general area.

Inherent and Apparent Background Radiances. The background radiance is not included in these tables. The inherent radiance of the background immediately surrounding the target may be computed from the directional reflectance of the background ${}_bR_o(0,\theta,\phi)$ and the downwelling irradiance $H(z_t d)$:

$$ {}_bN_o(z_t,\theta,\phi) = \frac{1}{\pi} {}_bR_o(z_t,\theta,\phi)\, H(z_t,d) . \tag{7.1} $$

The downwelling irradiance at the lowest flight altitude for each filter may be used as the ground level irradiance with reasonable accuracy (Duntley *et al.* (1970), p. 7-25). The apparent background radiance ${}_bN_r(z,\theta,\phi)$ at the sensor altitude z can be computed as follows:

$$ {}_bN_r(z,\theta,\phi) = {}_bN_o(z_t,\theta,\phi)\, T_r(z,\theta) + N_r^*(z,\theta,\phi) . \tag{7.2} $$

The beam transmittances $T_r(z,\theta)$ and the path radiances $N_r^*(z,\theta,\phi)$ from ground altitude are given in the tables to be described later.

The background radiances for Filter Code Number 5 may be converted to luminance values with units of $lu/\Omega m^2$ by multiplying the radiance by the factor 72.0 $lu\mu m/w$.

Total Scattering Coefficient. The total volume scattering coefficient s(z) is tabulated by altitude in four columns for the four optical filters. The altitude is given in meters, above ground level, at 30 meter (98.4 foot) increments. The dimension and unit for the total scattering coefficient is "m^{-1}".

At the bottom of the total scattering coefficient table are given the first and last data altitudes. This is the lowest and highest altitude of data measurements. When ground-based measurements of total scattering coefficient are available, the first data altitude is ground level.

The total scattering coefficient is used for the calculation of atmospheric beam transmittance in the next set of tables using the equations of the Theory, Section 2.

Beam Transmittance from Ground to Altitude. The atmospheric beam transmittance is tabulated for the slant paths of sight, between ground and the altitude shown, for the seven zenith angles from 93 to 180 degrees. There are four tables, one for each optical filter. This property is dimensionless.

The beam transmittance is computed from measurements of total scattering coefficient. The assumption is made that there is no significant atmospheric absorption in the pass bands of the measurements, whence the atmospheric attenuation coefficient $\alpha(z)$ is assumed equivalent to the scattering coefficient s(z).

Path Radiance from Ground to Altitude. Path radiance $N_r^*(z,\theta,\phi)$ is tabulated for the slant paths of sight, between ground and the altitude shown, for the seven zenith angles from 93 to 180 degrees.

The path radiance is computed from measurements of total scattering coefficient, measurements of sky and terrain radiances, and a catalog of proportional directional scattering coefficients based upon the work of Barteneva (1960).

There are four sets of data tables, one set for each of the four cardinal azimuths from the sun, 0, 90, 180, and 270 degrees. Each set is listed on a single sheet and contains four tables, one for each spectral filter. The dimensions and units are "$w\Omega^{-1}m^{-2}\mu m^{-1}$".

The path radiance values for Filter 5 may be converted to path luminance values with units of $lu/\Omega m^2$ by multiplying the radiance by the factor 72.0 $lu\mu m/w$.

Directional Path Reflectance from Ground to Altitude. Directional path reflectance $R_r^*(z,\theta,\phi)$ is also tabulated for the downward-looking slant paths of sight, between ground and the altitude shown, for the seven zenith angles from 93 to 180 degrees. The directional path reflectance is computed from the previously derived values of path radiance, beam transmittance, and total downwelling irradiance.

There are four sets of data tables, one set for each of the four cardinal azimuths from the sun, 0, 90, 180, and 270 degrees. Each set is listed on a single sheet and contains four tables, one for each spectral filter. This property is dimensionless.

Contrast Transmittance. Contrast transmittance ${}_b\tau_t(z,\theta,\phi)$ is not tabulated. This optical property is a function of the directional path reflectance and the directional background reflectance against which an object is viewed. The directional background reflectance reported herein is measured by the airborne radiometer. Thus, it is the average reflectance of many individual areas integrated into one value by the 5 degree circular field of the radiometer. The background reflectance against which the object is viewed will probably never be the same as the reflectance of the average terrain. If the area of the background is sufficiently small, its reflectance will have no appreciable effect on the path reflectance. In such cases, **decoupling** exists between the object background area and the atmospheric path reflectance and the contrast transmittance may be calculated by Eq. 3 of Duntley (1969) repeated below:

$$ {}_b\tau_r(z,\theta,\phi) = \left\{ 1 + [R_r^*(z,\theta,\phi) / {}_bR_o(z_t,\theta,\phi)] \right\}^{-1} . \qquad (7.3) $$

DATA GRAPHS

Data are also presented in graphs of:

Temperature
Total Scattering Coefficient
Equivalent Attenuation Length from Ground to Altitude
Vertical Beam Transmittance from Ground to Altitude
Path Radiance from Ground to Altitude
Directional Path Reflectance from Ground to Altitude.

Note that the altitude scale on the graphs for the first flight (C-134) and for the temperature graph of the second flight (C-137) is different than for the remaining four. These graphs depict maximum flight altitudes below 3 kilometers and hence, are graphed on a 0 to 3 kilometer scale. The remaining graphs are on a 0 to 6 kilometer scale.

Temperature. The free air temperature in degrees Celsius is graphed as a function of altitude above ground (AGL). The indicated filter code is used as a synchronizing index. The temperature-coded Filter 2 data were collected simultaneously with radiometric data for Filters 2 and 3. The temperature was measured by an airborne AMQ-17 aerograph system.

Total Scattering Coefficient. The total volume scattering coefficient $s(z)$ in m^{-1} is graphed using a single average value for each 30 meter change in altitude. Identifying symbols for the spectral filters appear at every fifth data point, or at 150 meter intervals. These same data were tabulated in the total scattering coefficient table.

Equivalent Attenuation Length from Ground to Altitude. The attenuation length $L(z)$ is the reciprocal of the attenuation coefficient $a(z)$. The equivalent attenuation length $\bar{L}(z)$ is a pseudo attenuation length which when combined with its altitude z, can be used directly in the equation (Boileau (1964) Eq. 6.1):

$$T_r(z,\theta) = \exp \left\{ [-z/\bar{L}(z)] \sec\theta \right\} . \qquad (7.4)$$

The equivalent attenuation length permits easy calculation of the atmospheric beam transmittance between ground level and altitude z above ground level for a downward path of sight, or between altitude and ground level for the upward path of sight.

The equivalent attenuation length $\bar{L}(z)$ in kilometers, for the path between ground and altitude, is graphed for each 30 meter change in altitude. Spectral identifying symbols appear at 150 meter intervals or every fifth data point.

Vertical Beam Transmittance from Ground to Altitude. The vertical beam transmittance $T_r(0,0)$ or $T_r(z,180)$ between ground and altitude is graphed for each 30 meter interval. Spectral identifying symbols appear at 150 meter intervals or every fifth data point. This represents smaller altitude increments than in the tabular display of beam transmittance.

Path Radiance from Ground to Altitude. The path radiance $N_r^*(z,\theta,\phi)$ is graphed for downward-looking slant paths between ground and the altitude shown. Each graph is for one path of sight for all four optical filters. The first graph is for the vertical downward path of sight, the second and third are for zenith angles 120 and 100 degrees toward the azimuth of the sun. These are data selected from the path radiance tables.

Directional Path Reflectance from Ground to Altitude. The directional path reflectance $R_r^*(z,\theta,\phi)$ is also graphed for downward-looking slant paths between ground and the altitude shown. Each

graph is for one path of sight and four optical filters. The first graph is for the vertical downward path of sight, the second and third are for zenith angles 120 and 100 degrees toward the azimuth of the sun. These selected paths of sight are the same as for the path radiance graphs. The data were selected from the many paths of sight tabulated in the directional path reflectance tables.

7.3 PRESENTATION OF DATA TABLES AND GRAPHS

Tabular listings and graphical displays of the data discussed in Section 7.2 are presented in the pages immediately following. Users should be aware that regardless of the display format, the data values are valid to, at best, only three significant figures. The tables of beam transmittance and directional reflectance of the background, in particular, should be rounded off to two digits prior to further application.

It should also be remembered that all values in the data tables except scattering coefficient are computed values based upon the measured values of upper and lower hemisphere radiances. All other direct radiometric measurements made by the airborne data systems are used only for corroboration and cross-checking.

All altitudes presented in the data tables, in the flight description, and in the graphs are given as above ground level (AGL).

FLIGHT C-134 – DESCRIPTION OF FLIGHT AND WEATHER CHARACTERISTICS

Overcast afternoon. The day was nearly overcast with a heavy haze at the lower altitudes. The late afternoon flight was conducted along an east-west route between Mindelheim and Mengen, passing approximately 8 to 16 kilometers (5 to 10 miles) north of Memmingen. The typical terrain was heavily cultivated, rolling pastureland occasionally interrupted by large patches of dark forest. The data-taking started at 1508 GMT (1608 LCT) and continued until 1641 GMT (1741 LCT). The sun zenith angle during sky radiance data-taking was 50.6 degrees at the start and 61.7 degrees at the end. The highest flight altitude was 2460 meters above ground level.

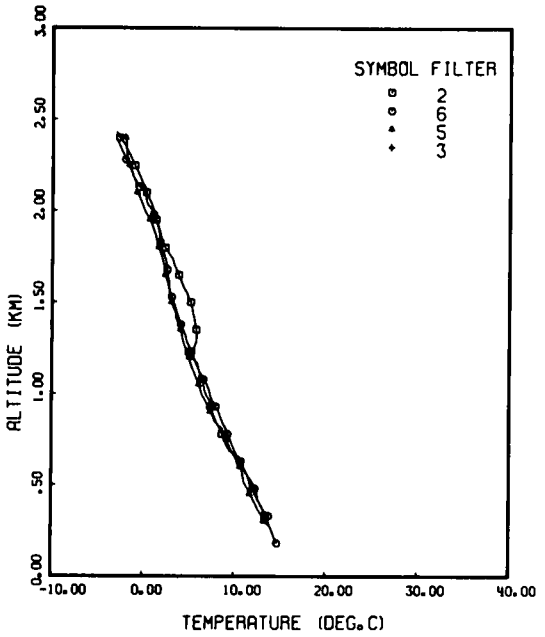
Flight C-134 originated at Rhein-Main (260 kilometers by air from Memmingen) where there was a heavy haze at low altitudes with visibility estimated at 5 to 6 miles (8 to 10 kilometers). Near the beginning of data-taking at 1452 GMT, Memmingen was reporting 1/8 cumulus clouds at 1500 meters, 5/8 altocumulus at 3600 meters, and 6/8 cirrostratus at 6000 meters. Visibility was recorded as 30 kilometers (19 miles).

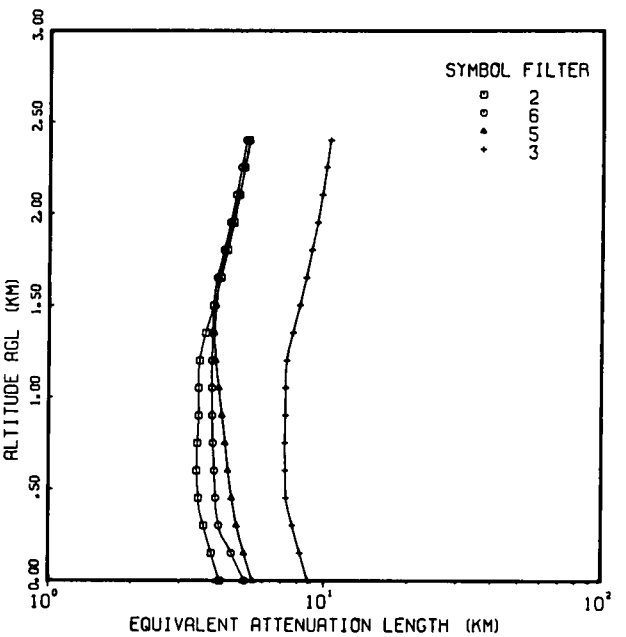
During the flight, the estimated visibility at 285 meters was 15 miles (24 kilometers). There was a haze layer at 900 meters with the well-defined top varying from 1200 to 1660 meters. There was a clear layer reported at 2400 meters with an overcast estimated above 3300 meters. In the clear layer, the visibility was estimated at 15 miles (24 kilometers).

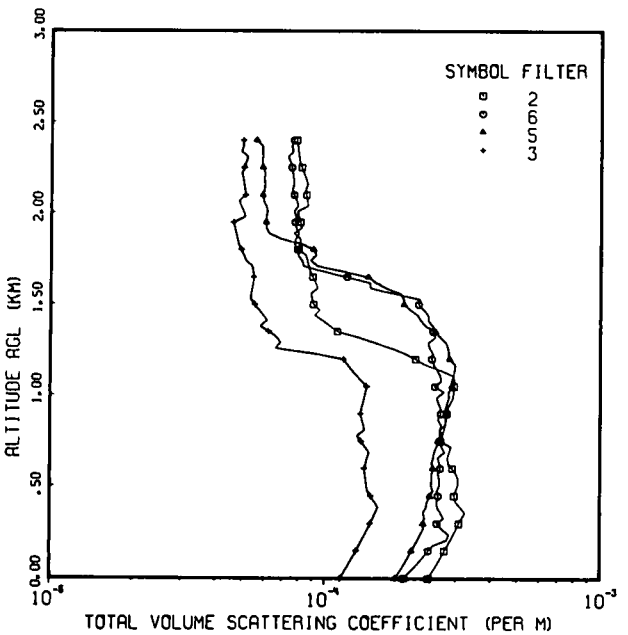
At 1652 GMT, near the end of data-taking, Memmingen was reporting 3/8 altocumulus at 2100 meters and 6/8 cirrostratus at 6000 meters. Visibility was recorded as 30 kilometers (19 miles).

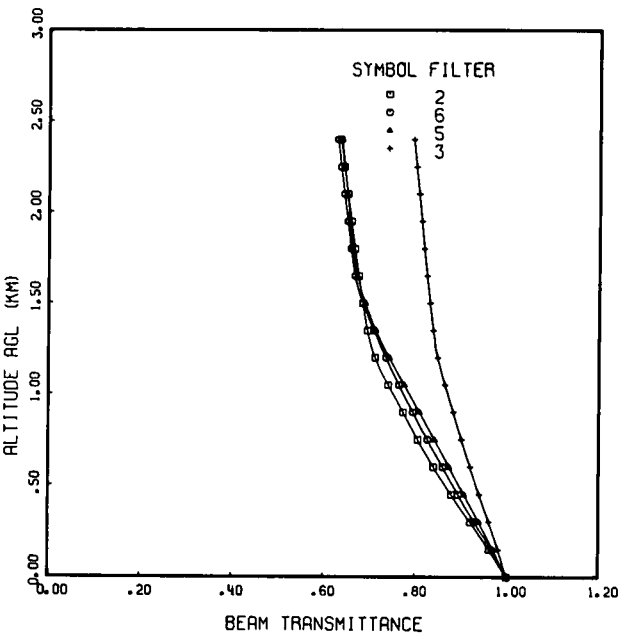
The high that was present on the morning surface charts weakened throughout the afternoon; the Memmingen area was in a col with very weak circulation. The 500 millibar chart shows a ridge on a north northeast–south southwest line from Sweden to Algeria. The winds were light westerly bringing in warm moist air from the eastern Atlantic. The airmass was unstable maritime polar.

FLIGHT NO. C-134

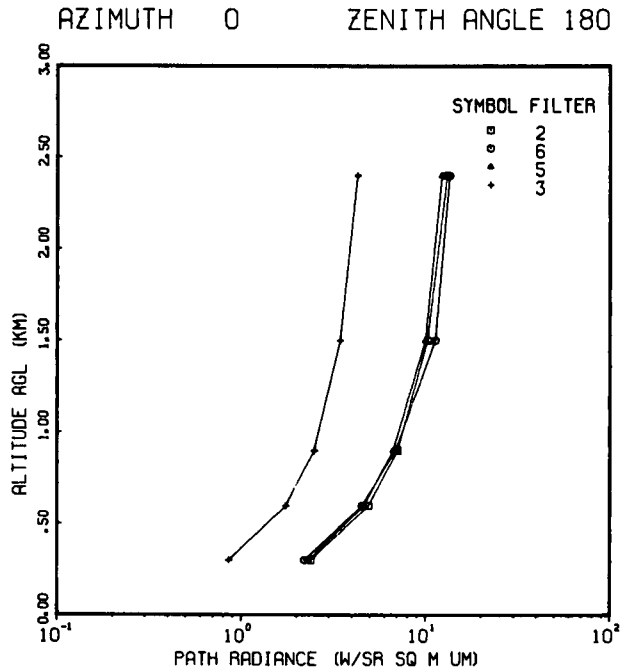








FLIGHT C-134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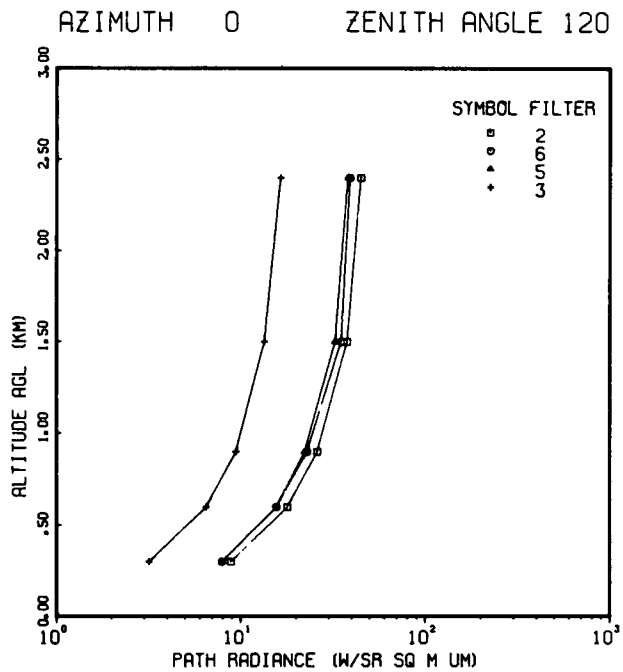
SYMBOL FILTER
2
3
5
6
9
ALTITUDE AGL (KM)
PATH RADIANCE (W/SR SQ M UM)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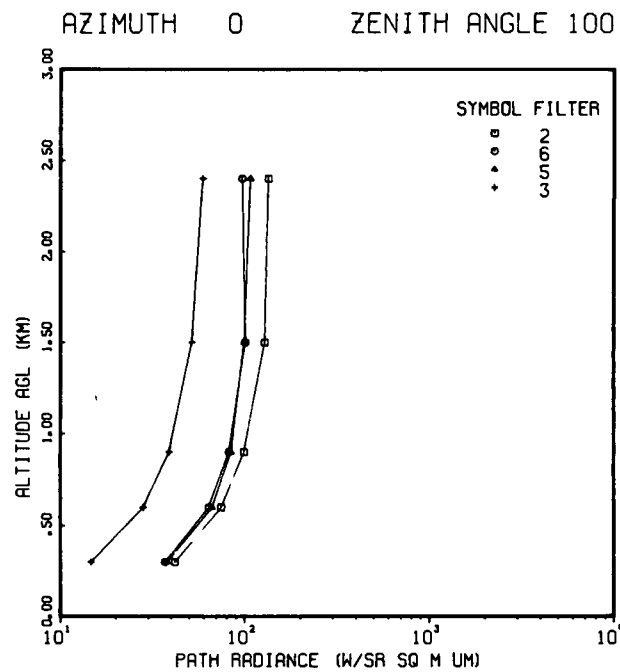
SYMBOL FILTER
2
3
5
6
9
ALTITUDE AGL (KM)
PATH RADIANCE (W/SR SQ M UM)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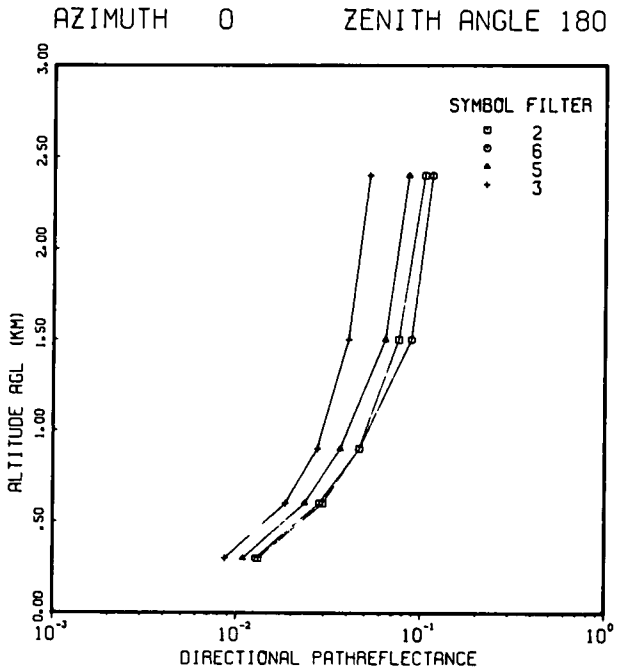
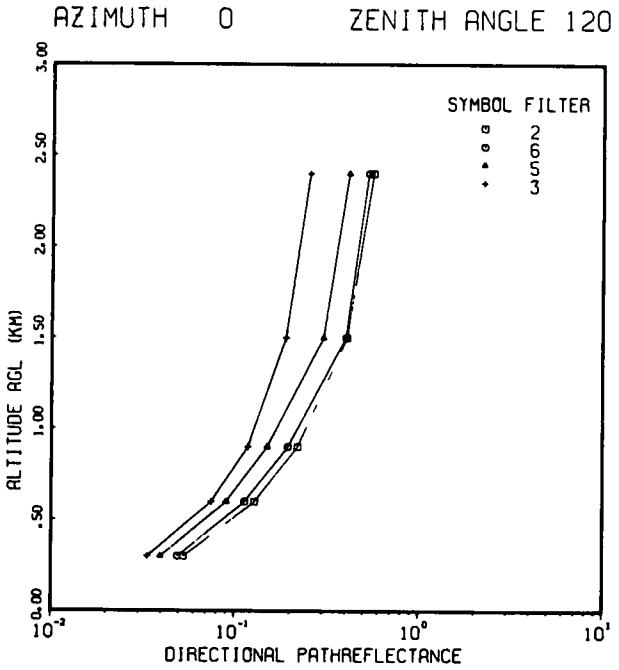
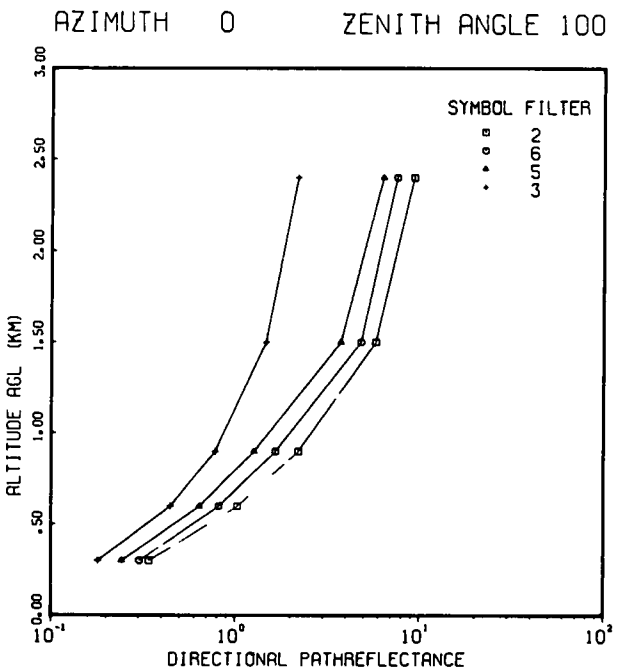
SYMBOL FILTER
2
3
5
6
9
ALTITUDE AGL (KM)
PATH RADIANCE (W/SR SQ M UM)

FLIGHT C-134


AZIMUTH 0 ZENITH ANGLE 180
SYMBOL FILTER
2
6
5
3
ALTITUDE AGL (KM)
DIRECTIONAL PATHREFLECTANCE


AZIMUTH 0 ZENITH ANGLE 120
SYMBOL FILTER
2
6
5
3
ALTITUDE AGL (KM)
DIRECTIONAL PATHREFLECTANCE


AZIMUTH 0 ZENITH ANGLE 100
SYMBOL FILTER
2
6
5
3
ALTITUDE AGL (KM)
DIRECTIONAL PATHREFLECTANCE

FLIGHT NO. C-134
IRRADIANCE

FLIGHT NO.C-134 FILTER NO. 2
IRRADIANCE (W/SQ M UM)

ALTITUDE (METERS)	DOWN-WELLING	UP-WELLING	ALBEDO	SCALAR DOWNWELLING	SCALAR UPWELLING	SCALAR TOTAL	SCALAR ALBEDO
277	6.196E 02	2.557E 01	.041	1.159E 03	7.950E 01	1.239E 03	.069
1183	6.442E 02	5.785E 01	.090	1.292E 03	1.737E 02	1.465E 03	.134
2445	5.016E 02	6.993E 01	.139	1.046E 03	2.036E 02	1.250E 03	.195

FLIGHT NO.C-134 FILTER NO. 6
IRRADIANCE (W/SQ M UM)

ALTITUDE (METERS)	DOWN-WELLING	UP-WELLING	ALBEDO	SCALAR DOWNWELLING	SCALAR UPWELLING	SCALAR TOTAL	SCALAR ALBEDO
274	5.842E 02	3.745E 01	.064	1.086E 03	9.556E 01	1.182E 03	.088
1182	5.326E 02	4.428E 01	.083	1.051E 03	1.316E 02	1.182E 03	.125
2390	3.163E 02	3.635E 01	.115	6.520E 02	1.260E 02	7.780E 02	.193

FLIGHT NO.C-134 FILTER NO. 5
IRRADIANCE (W/SQ M UM)

ALTITUDE (METERS)	DOWN-WELLING	UP-WELLING	ALBEDO	SCALAR DOWNWELLING	SCALAR UPWELLING	SCALAR TOTAL	SCALAR ALBEDO
280	7.081E 02	4.956E 01	.070	1.317E 03	1.160E 02	1.433E 03	.088
1182	4.460E 02	3.535E 01	.079	9.187E 02	1.104E 02	1.029E 03	.120
2429	4.809E 02	4.467E 01	.093	1.034E 03	1.277E 02	1.162E 03	.123

FLIGHT NO.C-134 FILTER NO. 3
IRRADIANCE (W/SQ M UM)

ALTITUDE (METERS)	DOWN-WELLING	UP-WELLING	ALBEDO	SCALAR DOWNWELLING	SCALAR UPWELLING	SCALAR TOTAL	SCALAR ALBEDO
272	3.216E 02	2.082E 01	.065	6.800E 02	5.854E 01	7.385E 02	.086
1183	3.058E 02	2.663E 01	.087	6.616E 02	8.693E 01	7.485E 02	.131
2429	2.807E 02	3.039E 01	.108	6.219E 02	9.678E 01	7.187E 02	.156

FLIGHT NO. C-134
DIRECTIONAL REFLECTANCE OF BACKGROUND

FLIGHT NO. C-134
AZIMUTH OF PATH OF SIGHT = 0
DIRECTIONAL REFLECTANCE OF BACKGROUND

ZENITH ANGLE	FILTERS 2	6	5	3
93	.24762	.33205	.14591	.36333
95	.25576	.27824	.10769	.30122
97	.16215	.22650	.10370	.21464
100	.11880	.15143	.10582	.16190
120	.03980	.06018	.07493	.03196
150	.02384	.06439	.06310	.04224
180	.02696	.02265	.02929	.03802

FLIGHT NO. C-134
AZIMUTH OF PATH OF SIGHT = 90
DIRECTIONAL REFLECTANCE OF BACKGROUND

ZENITH ANGLE	FILTERS 2	6	5	3
93	.21656	.18470	.13965	.24924
95	.19788	.11322	.10856	.14988
97	.16659	.09507	.09302	.15394
100	.08425	.08984	.07326	.13489
120	.04344	.04865	.06529	.06370
150	.02395	.04533	.06293	.05268
180	.02696	.02265	.02929	.03802

FLIGHT NO. C-134
AZIMUTH OF PATH OF SIGHT = 180
DIRECTIONAL REFLECTANCE OF BACKGROUND

ZENITH ANGLE	FILTERS 2	6	5	3
93	.19582	.17339	.16686	.26036
95	.14838	.13105	.14209	.16894
97	.10695	.11202	.12386	.14127
100	.06981	.09717	.11830	.11615
120	.05237	.08317	.09786	.05356
150	.02768	.06919	.07150	.04803
180	.02696	.02265	.02929	.03802

FLIGHT NO. C-134
AZIMUTH OF PATH OF SIGHT = 270
DIRECTIONAL REFLECTANCE OF BACKGROUND

ZENITH ANGLE	FILTERS 2	6	5	3
93	.16918	.15531	.13363	.20033
95	.14066	.14289	.09243	.20212
97	.10521	.12335	.08433	.14220
100	.07687	.09451	.08501	.09034
120	.04914	.06301	.07583	.06438
150	.02572	.07065	.08376	.04738
180	.02696	.02265	.02929	.03802

FLIGHT NO. C-134
TOTAL VOLUME SCATTERING COEFFICIENT

DATE 52570 FLIGHT NO. C-134 GROUND LEVEL ALTITUDE (M)= 629

ALTITUDE (M)	TOTAL VOLUME SCATTERING COEFFICIENT (PER M) FILTERS 2	6	5	3
0	2.380E-04	1.930E-04	1.810E-04	1.140E-04
30	2.450E-04	2.021E-04	1.863E-04	1.173E-04
60	2.520E-04	2.113E-04	1.916E-04	1.205E-04
90	2.590E-04	2.204E-04	1.968E-04	1.238E-04
120	2.660E-04	2.296E-04	2.021E-04	1.270E-04
150	2.730E-04	2.387E-04	2.074E-04	1.303E-04
180	2.800E-04	2.478E-04	2.127E-04	1.335E-04
210	2.870E-04	2.784E-04	2.179E-04	1.368E-04
240	2.940E-04	2.836E-04	2.232E-04	1.401E-04
270	3.010E-04	2.674E-04	2.285E-04	1.433E-04
300	3.080E-04	2.563E-04	2.285E-04	1.466E-04
330	3.150E-04	2.708E-04	2.311E-04	1.498E-04
360	3.238E-04	2.639E-04	2.289E-04	1.531E-04
390	3.114E-04	2.565E-04	2.343E-04	1.564E-04
420	2.990E-04	2.566E-04	2.359E-04	1.518E-04
450	2.955E-04	2.587E-04	2.413E-04	1.472E-04
480	3.002E-04	2.559E-04	2.475E-04	1.426E-04
510	3.050E-04	2.615E-04	2.435E-04	1.417E-04
540	3.061E-04	2.613E-04	2.451E-04	1.409E-04
570	3.004E-04	2.580E-04	2.449E-04	1.400E-04
600	2.907E-04	2.631E-04	2.473E-04	1.391E-04
630	2.809E-04	2.612E-04	2.452E-04	1.409E-04
660	2.789E-04	2.573E-04	2.478E-04	1.427E-04
690	2.832E-04	2.729E-04	2.499E-04	1.445E-04
720	2.875E-04	2.649E-04	2.547E-04	1.398E-04
750	2.633E-04	2.621E-04	2.578E-04	1.351E-04
780	2.670E-04	2.682E-04	2.632E-04	1.304E-04
810	2.707E-04	2.622E-04	2.601E-04	1.394E-04
840	2.744E-04	2.644E-04	2.739E-04	1.376E-04
870	2.758E-04	2.571E-04	2.748E-04	1.358E-04
900	2.772E-04	2.636E-04	2.750E-04	1.343E-04
930	2.786E-04	2.636E-04	2.749E-04	1.358E-04
960	2.854E-04	2.582E-04	2.783E-04	1.373E-04
990	2.923E-04	2.545E-04	2.821E-04	1.388E-04
1020	2.933E-04	2.713E-04	2.815E-04	1.403E-04
1050	2.944E-04	2.503E-04	2.897E-04	1.414E-04
1080	2.955E-04	2.647E-04	2.884E-04	1.358E-04
1110	2.922E-04	2.621E-04	2.940E-04	1.301E-04
1140	2.615E-04	2.557E-04	2.957E-04	1.244E-04
1170	2.308E-04	2.485E-04	2.974E-04	1.204E-04
1200	2.131E-04	2.439E-04	2.835E-04	1.165E-04
1230	1.953E-04	2.462E-04	2.811E-04	9.107E-05
1260	1.741E-04	2.401E-04	2.799E-04	6.567E-05
1290	1.529E-04	2.363E-04	2.755E-04	6.869E-05
1320	1.317E-04	2.511E-04	2.624E-04	6.630E-05
1350	1.105E-04	2.464E-04	2.514E-04	6.202E-05
1380	1.041E-04	2.465E-04	2.313E-04	5.774E-05
1410	9.764E-05	2.366E-04	2.224E-04	6.138E-05
1440	9.119E-05	2.366E-04	2.164E-04	5.934E-05
1470	9.523E-05	2.281E-04	2.035E-04	5.731E-05
1500	9.034E-05	2.183E-04	1.929E-04	5.527E-05

FLIGHT NO. C-134
TOTAL VOLUME SCATTERING COEFFICIENT

DATE 52570 FLIGHT NO. C-134 GROUND LEVEL ALTITUDE (M)= 629

ALTITUDE (M)	TOTAL VOLUME SCATTERING COEFFICIENT (PER M)			
FILTERS	2	6	5	3
1530	8.928E-05	2.205E-04	1.922E-04	5.323E-05
1560	8.823E-05	1.781E-04	1.877E-04	5.369E-05
1590	9.362E-05	1.455E-04	1.656E-04	5.415E-05
1620	9.167E-05	1.455E-04	1.517E-04	5.461E-05
1650	8.971E-05	1.195E-04	1.428E-04	5.474E-05
1680	8.775E-05	9.945E-05	1.173E-04	5.439E-05
1710	8.666E-05	8.289E-05	9.325E-05	5.405E-05
1740	8.558E-05	8.197E-05	8.764E-05	5.123E-05
1770	8.450E-05	7.914E-05	9.246E-05	5.017E-05
1800	7.946E-05	7.875E-05	9.013E-05	4.912E-05
1830	8.017E-05	7.691E-05	8.177E-05	4.807E-05
1860	8.088E-05	7.744E-05	6.849E-05	4.757E-05
1890	7.628E-05	7.977E-05	6.189E-05	4.707E-05
1920	8.181E-05	7.780E-05	6.064E-05	4.656E-05
1950	8.069E-05	7.721E-05	6.048E-05	4.606E-05
1980	7.957E-05	7.813E-05	6.052E-05	5.098E-05
2010	7.845E-05	7.628E-05	6.103E-05	5.005E-05
2040	8.587E-05	7.915E-05	6.054E-05	4.912E-05
2070	8.532E-05	7.811E-05	5.911E-05	4.819E-05
2100	8.477E-05	7.644E-05	5.880E-05	5.092E-05
2130	8.421E-05	7.510E-05	5.951E-05	5.054E-05
2160	8.575E-05	7.636E-05	5.975E-05	5.017E-05
2190	8.432E-05	7.596E-05	5.942E-05	4.980E-05
2220	8.289E-05	7.543E-05	5.996E-05	4.925E-05
2250	8.146E-05	7.491E-05	5.881E-05	5.017E-05
2280	8.003E-05	7.402E-05	5.830E-05	5.102E-05
2310	7.960E-05	7.241E-05	5.865E-05	5.188E-05
2340	7.916E-05	7.593E-05	5.857E-05	4.898E-05
2370	7.873E-05	7.471E-05	5.867E-05	5.007E-05
2400	7.829E-05	7.630E-05	5.571E-05	4.991E-05
FIRST DATA ALT	0	0	0	0
LAST DATA ALT	2400	2400	2400	2370

FLIGHT NO. C-134
BEAM TRANSMITTANCE FROM GROUND TO ALTITUDE

FLIGHT NO. C-134 FILTER NO. 2
BEAM TRANSMITTANCE FROM GROUND TO ALTITUDE

ALTITUDE	ZENITH ANGLE OF PATH OF SIGHT (DEG)						
M	93	95	97	100	120	150	180
300	.2066919	.3897874	.5106832	.6239872	.8489170	.9097673	.9213669
600	.0344891	.1350363	.2406922	.3680435	.7067053	.8183851	.8406577
900	.0066090	.0514052	.1218429	.2282436	.5986516	.7436207	.7737258
1500	.0005165	.0121168	.0446996	.1129170	.4688422	.6457541	.6847205
2400	.0000769	.0046949	.0240926	.0731775	.4032761	.5919629	.6350403

FLIGHT NO. C-134 FILTER NO. 6
BEAM TRANSMITTANCE FROM GROUND TO ALTITUDE

ALTITUDE	ZENITH ANGLE OF PATH OF SIGHT (DEG)						
M	93	95	97	100	120	150	180
300	.2495497	.4362091	.5533408	.6601274	.8656800	.9200963	.9304193
600	.0542658	.1768107	.2915626	.4210556	.7405160	.8407670	.8605324
900	.0113063	.0705530	.1524694	.2671427	.6322808	.7674593	.7951609
1500	.0005340	.0122060	.0447298	.1129706	.4689195	.6458156	.6847770
2400	.0000661	.0042289	.0222832	.0692759	.3956748	.5854951	.6290269

FLIGHT NO. C-134 FILTER NO. 5
BEAM TRANSMITTANCE FROM GROUND TO ALTITUDE

ALTITUDE	ZENITH ANGLE OF PATH OF SIGHT (DEG)						
M	93	95	97	100	120	150	180
300	.3023564	.4892754	.6005790	.6991923	.8831388	.9307645	.9397547
600	.0745759	.2135545	.3334434	.4626457	.7651420	.8567980	.8747239
900	.0160344	.0866469	.1763141	.2958224	.6550749	.7833134	.8093670
1500	.0006273	.0133454	.0475523	.1179277	.4759656	.6514006	.6899026
2400	.0000892	.0049975	.0250114	.0751252	.4069718	.5950889	.6379434

FLIGHT NO. C-134 FILTER NO. 3
BEAM TRANSMITTANCE FROM GROUND TO ALTITUDE

ALTITUDE	ZENITH ANGLE OF PATH OF SIGHT (DEG)						
M	93	95	97	100	120	150	180
300	.4712137	.6378396	.7256177	.7984401	.9248028	.9558692	.9616667
600	.1995606	.3835320	.5057622	.6197612	.8469159	.9085285	.9202803
900	.0874472	.2366732	.3598249	.4880418	.7794751	.8660281	.8828789
1500	.0249791	.1162470	.2196545	.3451610	.6911250	.8079193	.8313393
2400	.0083093	.0661093	.1511495	.2655176	.6309424	.7665209	.7943188

FLIGHT NO. C-134
PATH RADIANCE FROM GROUND TO ALTITUDE
AZIMUTH OF PATH OF SIGHT = 0

AZIMUTH OF PATH OF SIGHT = 0

FLIGHT NO. C-134 FILTER NO. 2

PATH RADIANCE FROM GROUND TO ALTITUDE (W/SR SQ M UM)

ALTITUDE M	ZENITH ANGLE OF PATH OF SIGHT (DEG) 93	95	97	100	120	150	180
300	1.181E 02	8.289E 01	6.067E 01	4.197E 01	8.843E 00	3.044E 00	2.394E 00
600	1.523E 02	1.249E 02	1.004E 02	7.478E 01	1.792E 01	6.280E 00	4.909E 00
900	1.758E 02	1.511E 02	1.271E 02	9.912E 01	2.599E 01	9.169E 00	7.089E 00
1500	2.013E 02	1.793E 02	1.570E 02	1.284E 02	3.769E 01	1.346E 01	1.025E 01
2400	1.782E 02	1.703E 02	1.564E 02	1.340E 02	4.469E 01	1.695E 01	1.310E 01

FLIGHT NO. C-134 FILTER NO. 6

PATH RADIANCE FROM GROUND TO ALTITUDE (W/SR SQ M UM)

ALTITUDE M	ZENITH ANGLE OF PATH OF SIGHT (DEG) 93	95	97	100	120	150	180
300	1.086E 02	7.419E 01	5.370E 01	3.703E 01	7.895E 00	2.826E 00	2.201E 00
600	1.325E 02	1.079E 02	8.602E 01	6.383E 01	1.562E 01	5.786E 00	4.527E 00
900	1.389E 02	1.228E 02	1.046E 02	8.231E 01	2.293E 01	8.788E 00	6.903E 00
1500	1.347E 02	1.281E 02	1.178E 02	1.008E 02	3.496E 01	1.430E 01	1.133E 01
2400	1.060E 02	1.092E 02	1.063E 02	9.663E 01	3.899E 01	1.685E 01	1.349E 01

FLIGHT NO. C-134 FILTER NO. 5

PATH RADIANCE FROM GROUND TO ALTITUDE (W/SR SQ M UM)

ALTITUDE M	ZENITH ANGLE OF PATH OF SIGHT (DEG) 93	95	97	100	120	150	180
300	1.212E 02	7.971E 01	5.648E 01	3.812E 01	7.879E 00	2.870E 00	2.312E 00
600	1.483E 02	1.178E 02	9.200E 01	6.671E 01	1.557E 01	5.784E 00	4.651E 00
900	1.461E 02	1.292E 02	1.090E 02	8.441E 01	2.225E 01	8.393E 00	6.705E 00
1500	1.362E 02	1.279E 02	1.171E 02	9.945E 01	3.245E 01	1.265E 01	9.993E 00
2400	1.442E 02	1.341E 02	1.235E 02	1.070E 02	3.806E 01	1.537E 01	1.226E 01

FLIGHT NO. C-134 FILTER NO. 3

PATH RADIANCE FROM GROUND TO ALTITUDE (W/SR SQ M UM)

ALTITUDE M	ZENITH ANGLE OF PATH OF SIGHT (DEG) 93	95	97	100	120	150	180
300	5.083E 01	3.125E 01	2.172E 01	1.468E 01	3.167E 00	1.111E 00	8.535E-01
600	7.548E 01	5.372E 01	3.989E 01	2.818E 01	6.488E 00	2.278E 00	1.742E 00
900	8.750E 01	6.814E 01	5.315E 01	3.890E 01	9.426E 00	3.288E 00	2.492E 00
1500	9.756E 01	8.225E 01	6.772E 01	5.177E 01	1.340E 01	4.621E 00	3.451E 00
2400	9.958E 01	8.789E 01	7.502E 01	5.921E 01	1.640E 01	5.719E 00	4.266E 00

FLIGHT NO. C-134
PATH RADIANCE FROM GROUND TO ALTITUDE
AZIMUTH OF PATH OF SIGHT = 90

AZIMUTH OF PATH OF SIGHT = 90

FLIGHT NO. C-134 FILTER NO. 2

PATH RADIANCE FROM GROUND TO ALTITUDE (W/SR SQ M UM)

ALTITUDE	ZENITH ANGLE OF PATH OF SIGHT (DEG)						
M	93	95	97	100	120	150	180
300	6.219E 01	4.475E 01	3.363E 01	2.429E 01	6.644E 00	2.947E 00	2.394E 00
600	7.610E 01	6.496E 01	5.398E 01	4.216E 01	1.330E 01	6.055E 00	4.909E 00
900	8.246E 01	7.474E 01	6.561E 01	5.393E 01	1.900E 01	8.794E 00	7.089E 00
1500	8.930E 01	8.393E 01	7.710E 01	6.677E 01	2.701E 01	1.282E 01	1.025E 01
2400	8.808E 01	8.520E 01	8.044E 01	7.201E 01	3.249E 01	1.623E 01	1.310E 01

FLIGHT NO. C-134 FILTER NO. 6

PATH RADIANCE FROM GROUND TO ALTITUDE (W/SR SQ M UM)

ALTITUDE	ZENITH ANGLE OF PATH OF SIGHT (DEG)						
M	93	95	97	100	120	150	180
300	5.294E 01	3.709E 01	2.756E 01	1.981E 01	5.597E 00	2.659E 00	2.201E 00
600	6.597E 01	5.487E 01	4.482E 01	3.460E 01	1.116E 01	5.447E 00	4.527E 00
900	7.121E 01	6.409E 01	5.576E 01	4.552E 01	1.654E 01	8.279E 00	6.903E 00
1500	7.424E 01	7.124E 01	6.643E 01	5.850E 01	2.579E 01	1.350E 01	1.133E 01
2400	6.680E 01	6.693E 01	6.480E 01	5.956E 01	2.946E 01	1.599E 01	1.349E 01

FLIGHT NO. C-134 FILTER NO. 5

PATH RADIANCE FROM GROUND TO ALTITUDE (W/SR SQ M UM)

ALTITUDE	ZENITH ANGLE OF PATH OF SIGHT (DEG)						
M	93	95	97	100	120	150	180
300	6.467E 01	4.365E 01	3.180E 01	2.247E 01	6.063E 00	2.796E 00	2.312E 00
600	7.881E 01	6.433E 01	5.167E 01	3.920E 01	1.193E 01	5.621E 00	4.651E 00
900	7.714E 01	7.021E 01	6.094E 01	4.931E 01	1.695E 01	8.120E 00	6.705E 00
1500	7.051E 01	6.840E 01	6.449E 01	5.719E 01	2.437E 01	1.213E 01	9.993E 00
2400	7.268E 01	7.011E 01	6.680E 01	6.062E 01	2.841E 01	1.474E 01	1.226E 01

FLIGHT NO. C-134 FILTER NO. 3

PATH RADIANCE FROM GROUND TO ALTITUDE (W/SR SQ M UM)

ALTITUDE	ZENITH ANGLE OF PATH OF SIGHT (DEG)						
M	93	95	97	100	120	150	180
300	2.958E 01	1.807E 01	1.325E 01	9.256E 00	2.454E 00	1.073E 00	8.535E-01
600	4.306E 01	3.075E 01	2.386E 01	1.746E 01	4.982E 00	2.196E 00	1.742E 00
900	4.847E 01	3.808E 01	3.091E 01	2.351E 01	7.147E 00	3.157E 00	2.492E 00
1500	5.162E 01	4.409E 01	3.768E 01	3.007E 01	9.961E 00	4.409E 00	3.451E 00
2400	5.129E 01	4.659E 01	4.099E 01	3.373E 01	1.202E 01	5.433E 00	4.266E 00

FLIGHT NO. C-134
PATH RADIANCE FROM GROUND TO ALTITUDE
AZIMUTH OF PATH OF SIGHT = 180

AZIMUTH OF PATH OF SIGHT = 180

FLIGHT NO. C-134 FILTER NO. 2

PATH RADIANCE FROM GROUND TO ALTITUDE (W/SR SQ M UM)

ALTITUDE M	ZENITH ANGLE OF PATH OF SIGHT (DEG) 93	95	97	100	120	150	180
300	5.458E 01	3.962E 01	3.005E 01	2.202E 01	6.748E 00	3.126E 00	2.394E 00
600	6.559E 01	5.668E 01	4.762E 01	3.777E 01	1.336E 01	6.375E 00	4.909E 00
900	6.941E 01	6.389E 01	5.682E 01	4.752E 01	1.878E 01	9.163E 00	7.089E 00
1500	7.435E 01	7.054E 01	6.559E 01	5.783E 01	2.624E 01	1.318E 01	1.025E 01
2400	8.218E 01	7.798E 01	7.333E 01	6.601E 01	3.275E 01	1.684E 01	1.310E 01

FLIGHT NO. C-134 FILTER NO. 6

PATH RADIANCE FROM GROUND TO ALTITUDE (W/SR SQ M UM)

ALTITUDE M	ZENITH ANGLE OF PATH OF SIGHT (DEG) 93	95	97	100	120	150	180
300	5.044E 01	3.557E 01	2.662E 01	1.934E 01	5.933E 00	2.842E 00	2.201E 00
600	6.285E 01	5.261E 01	4.328E 01	3.376E 01	1.179E 01	5.810E 00	4.527E 00
900	6.782E 01	6.142E 01	5.380E 01	4.438E 01	1.742E 01	8.808E 00	6.903E 00
1500	7.093E 01	6.839E 01	6.415E 01	5.704E 01	2.700E 01	1.429E 01	1.133E 01
2400	6.476E 01	6.495E 01	6.311E 01	5.846E 01	3.082E 01	1.686E 01	1.349E 01

FLIGHT NO. C-134 FILTER NO. 5

PATH RADIANCE FROM GROUND TO ALTITUDE (W/SR SQ M UM)

ALTITUDE M	ZENITH ANGLE OF PATH OF SIGHT (DEG) 93	95	97	100	120	150	180
300	5.518E 01	3.788E 01	2.808E 01	2.035E 01	6.417E 00	3.063E 00	2.312E 00
600	6.786E 01	5.615E 01	4.580E 01	3.555E 01	1.254E 01	6.118E 00	4.651E 00
900	6.749E 01	6.192E 01	5.437E 01	4.485E 01	1.760E 01	8.745E 00	6.705E 00
1500	6.521E 01	6.294E 01	5.942E 01	5.316E 01	2.501E 01	1.283E 01	9.993E 00
2400	7.303E 01	6.933E 01	6.562E 01	5.966E 01	3.036E 01	1.577E 01	1.226E 01

FLIGHT NO. C-134 FILTER NO. 3

PATH RADIANCE FROM GROUND TO ALTITUDE (W/SR SQ M UM)

ALTITUDE M	ZENITH ANGLE OF PATH OF SIGHT (DEG) 93	95	97	100	120	150	180
300	2.585E 01	1.634E 01	1.169E 01	8.263E 00	2.416E 00	1.109E 00	8.535E-01
600	3.706E 01	2.728E 01	2.090E 01	1.546E 01	4.860E 00	2.257E 00	1.742E 00
900	4.075E 01	3.311E 01	2.675E 01	2.057E 01	6.881E 00	3.222E 00	2.492E 00
1500	4.193E 01	3.728E 01	3.200E 01	2.583E 01	9.399E 00	4.450E 00	3.451E 00
2400	4.221E 01	3.903E 01	3.471E 01	2.896E 01	1.134E 01	5.479E 00	4.266E 00

FLIGHT NO. C-134
PATH RADIANCE FROM GROUND TO ALTITUDE
AZIMUTH OF PATH OF SIGHT = 270

AZIMUTH OF PATH OF SIGHT = 270

FLIGHT NO. C-134 FILTER NO. 2

PATH RADIANCE FROM GROUND TO ALTITUDE (W/SR SQ M UM)

ALTITUDE M	ZENITH ANGLE OF PATH OF SIGHT (DEG) 93	95	97	100	120	150	180
300	6.068E 01	4.359E 01	3.273E 01	2.361E 01	6.532E 00	2.957E 00	2.394E 00
600	7.216E 01	6.185E 01	5.148E 01	4.023E 01	1.290E 01	6.029E 00	4.909E 00
900	7.530E 01	6.888E 01	6.077E 01	5.014E 01	1.808E 01	8.664E 00	7.089E 00
1500	7.860E 01	7.432E 01	6.870E 01	5.990E 01	2.503E 01	1.244E 01	1.025E 01
2400	8.280E 01	7.880E 01	7.395E 01	6.604E 01	3.028E 01	1.571E 01	1.310E 01

FLIGHT NO. C-134 FILTER NO. 6

PATH RADIANCE FROM GROUND TO ALTITUDE (W/SR SQ M UM)

ALTITUDE M	ZENITH ANGLE OF PATH OF SIGHT (DEG) 93	95	97	100	120	150	180
300	5.667E 01	3.963E 01	2.940E 01	2.107E 01	5.892E 00	2.748E 00	2.201E 00
600	6.931E 01	5.778E 01	4.721E 01	3.639E 01	1.166E 01	5.618E 00	4.527E 00
900	7.283E 01	6.599E 01	5.758E 01	4.707E 01	1.711E 01	8.512E 00	6.903E 00
1500	7.318E 01	7.072E 01	6.632E 01	5.871E 01	2.622E 01	1.381E 01	1.133E 01
2400	6.597E 01	6.628E 01	6.442E 01	5.949E 01	2.984E 01	1.630E 01	1.349E 01

FLIGHT NO. C-134 FILTER NO. 5

PATH RADIANCE FROM GROUND TO ALTITUDE (W/SR SQ M UM)

ALTITUDE M	ZENITH ANGLE OF PATH OF SIGHT (DEG) 93	95	97	100	120	150	180
300	5.767E 01	3.921E 01	2.879E 01	2.057E 01	5.974E 00	2.885E 00	2.312E 00
600	7.105E 01	5.824E 01	4.707E 01	3.604E 01	1.173E 01	5.778E 00	4.651E 00
900	7.089E 01	6.448E 01	5.611E 01	4.569E 01	1.660E 01	8.295E 00	6.705E 00
1500	6.764E 01	6.513E 01	6.116E 01	5.416E 01	2.377E 01	1.224E 01	9.993E 00
2400	7.190E 01	6.862E 01	6.493E 01	5.863E 01	2.795E 01	1.488E 01	1.226E 01

FLIGHT NO. C-134 FILTER NO. 3

PATH RADIANCE FROM GROUND TO ALTITUDE (W/SR SQ M UM)

ALTITUDE M	ZENITH ANGLE OF PATH OF SIGHT (DEG) 93	95	97	100	120	150	180
300	2.745E 01	1.816E 01	1.327E 01	9.229E 00	2.423E 00	1.067E 00	8.535E-01
600	4.156E 01	3.091E 01	2.391E 01	1.741E 01	4.893E 00	2.173E 00	1.742E 00
900	4.738E 01	3.827E 01	3.097E 01	2.344E 01	6.965E 00	3.105E 00	2.492E 00
1500	5.062E 01	4.431E 01	3.775E 01	2.998E 01	9.597E 00	4.296E 00	3.451E 00
2400	5.149E 01	4.682E 01	4.106E 01	3.363E 01	1.162E 01	5.297E 00	4.266E 00

FLIGHT NO. C-134
DIRECTIONAL PATH REFLECTANCE FROM GROUND TO ALTITUDE
AZIMUTH OF PATH OF SIGHT = 0

AZIMUTH OF PATH OF SIGHT = 0

FLIGHT NO. C-134 FILTER NO. 2

DIRECTIONAL PATH REFLECTANCE FROM GROUND TO ALTITUDE

ALTITUDE	ZENITH ANGLE OF PATH OF SIGHT (DEG)						
M	93	95	97	100	120	150	180
300	2.897E 00	1.078E 00	6.023E-01	3.410E-01	5.281E-02	1.696E-02	1.317E-02
600	2.239E 01	4.691E 00	2.115E 00	1.030E 00	1.286E-01	3.891E-02	2.961E-02
900	1.348E 02	1.490E 01	5.291E 00	2.202E 00	2.201E-01	6.252E-02	4.645E-02
1500	1.976E 03	7.502E 01	1.781E 01	5.764E 00	4.076E-01	1.057E-01	7.592E-02
2400	1.174E 04	1.839E 02	3.291E 01	9.281E 00	5.618E-01	1.452E-01	1.046E-01

FLIGHT NO. C-134 FILTER NO. 6

DIRECTIONAL PATH REFLECTANCE FROM GROUND TO ALTITUDE

ALTITUDE	ZENITH ANGLE OF PATH OF SIGHT (DEG)						
M	93	95	97	100	120	150	180
300	2.340E 00	9.146E-01	5.218E-01	3.016E-01	4.904E-02	1.652E-02	1.272E-02
600	1.313E 01	3.282E 00	1.587E 00	8.151E-01	1.134E-01	3.701E-02	2.829E-02
900	6.605E 01	9.360E 00	3.688E 00	1.657E 00	1.950E-01	6.157E-02	4.668E-02
1500	1.356E 03	5.643E 01	1.416E 01	4.799E 00	4.009E-01	1.191E-01	8.896E-02
2400	8.632E 03	1.388E 02	2.566E 01	7.501E 00	5.299E-01	1.548E-01	1.153E-01

FLIGHT NO. C-134 FILTER NO. 5

DIRECTIONAL PATH REFLECTANCE FROM GROUND TO ALTITUDE

ALTITUDE	ZENITH ANGLE OF PATH OF SIGHT (DEG)						
M	93	95	97	100	120	150	180
300	1.779E 00	7.228E-01	4.173E-01	2.419E-01	3.958E-02	1.368E-02	1.092E-02
600	8.822E 00	2.447E 00	1.224E 00	6.398E-01	9.028E-02	2.995E-02	2.359E-02
900	4.041E 01	6.616E 00	2.743E 00	1.266E 00	1.507E-01	4.754E-02	3.676E-02
1500	9.630E 02	4.253E 01	1.092E 01	3.742E 00	3.025E-01	8.617E-02	6.427E-02
2400	7.171E 03	1.190E 02	2.192E 01	6.321E 00	4.149E-01	1.146E-01	8.527E-02

FLIGHT NO. C-134 FILTER NO. 3

DIRECTIONAL PATH REFLECTANCE FROM GROUND TO ALTITUDE

ALTITUDE	ZENITH ANGLE OF PATH OF SIGHT (DEG)						
M	93	95	97	100	120	150	180
300	1.054E 00	4.786E-01	2.925E-01	1.796E-01	3.346E-02	1.135E-02	8.670E-03
600	3.695E 00	1.368E 00	7.705E-01	4.442E-01	7.484E-02	2.449E-02	1.849E-02
900	9.776E 00	2.813E 00	1.443E 00	7.788E-01	1.181E-01	3.709E-02	2.757E-02
1500	3.816E 01	6.912E 00	3.012E 00	1.465E 00	1.895E-01	5.587E-02	4.056E-02
2400	1.171E 02	1.299E 01	4.849E 00	2.178E 00	2.539E-01	7.289E-02	5.247E-02

FLIGHT NO. C-134
DIRECTIONAL PATH REFLECTANCE FROM GROUND TO ALTITUDE
AZIMUTH OF PATH OF SIGHT = 90

AZIMUTH OF PATH OF SIGHT = 90

FLIGHT NO. C-134 FILTER NO. 2

DIRECTIONAL PATH REFLECTANCE FROM GROUND TO ALTITUDE

ALTITUDE	ZENITH ANGLE OF PATH OF SIGHT (DEG)						
M	93	95	97	100	120	150	180
300	1.525E 00	5.821E-01	3.339E-01	1.974E-01	3.968E-02	1.642E-02	1.317E-02
600	1.119E 01	2.439E 00	1.137E 00	5.808E-01	9.544E-02	3.751E-02	2.961E-02
900	6.326E 01	7.372E 00	2.730E 00	1.198E 00	1.609E-01	5.996E-02	4.645E-02
1500	8.767E 02	3.512E 01	8.746E 00	2.998E 00	2.921E-01	1.007E-01	7.592E-02
2400	5.804E 03	9.201E 01	1.693E 01	4.989E 00	4.085E-01	1.390E-01	1.046E-01

FLIGHT NO. C-134 FILTER NO. 6

DIRECTIONAL PATH REFLECTANCE FROM GROUND TO ALTITUDE

ALTITUDE	ZENITH ANGLE OF PATH OF SIGHT (DEG)						
M	93	95	97	100	120	150	180
300	1.141E 00	4.572E-01	2.679E-01	1.613E-01	3.477E-02	1.554E-02	1.272E-02
600	6.537E 00	1.669E 00	8.267E-01	4.418E-01	8.100E-02	3.484E-02	2.829E-02
900	3.387E 01	4.885E 00	1.967E 00	9.163E-01	1.407E-01	5.801E-02	4.668E-02
1500	7.476E 02	3.138E 01	7.985E 00	2.784E 00	2.958E-01	1.124E-01	8.896E-02
2400	5.438E 03	8.510E 01	1.564E 01	4.623E 00	4.004E-01	1.469E-01	1.153E-01

FLIGHT NO. C-134 FILTER NO. 5

DIRECTIONAL PATH REFLECTANCE FROM GROUND TO ALTITUDE

ALTITUDE	ZENITH ANGLE OF PATH OF SIGHT (DEG)						
M	93	95	97	100	120	150	180
300	9.490E-01	3.958E-01	2.350E-01	1.426E-01	3.046E-02	1.333E-02	1.092E-02
600	4.689E 00	1.336E 00	6.876E-01	3.759E-01	6.920E-02	2.911E-02	2.359E-02
900	2.135E 01	3.595E 00	1.533E 00	7.396E-01	1.148E-01	4.599E-02	3.676E-02
1500	4.987E 02	2.274E 01	6.017E 00	2.152E 00	2.272E-01	8.264E-02	6.427E-02
2400	3.615E 03	6.224E 01	1.185E 01	3.580E 00	3.097E-01	1.099E-01	8.527E-02

FLIGHT NO. C-134 FILTER NO. 3

DIRECTIONAL PATH REFLECTANCE FROM GROUND TO ALTITUDE

ALTITUDE	ZENITH ANGLE OF PATH OF SIGHT (DEG)						
M	93	95	97	100	120	150	180
300	6.133E-01	2.767E-01	1.784E-01	1.133E-01	2.592E-02	1.097E-02	8.670E-03
600	2.108E 00	7.834E-01	4.609E-01	2.753E-01	5.746E-02	2.361E-02	1.849E-02
900	5.415E 00	1.572E 00	8.392E-01	4.706E-01	8.957E-02	3.561E-02	2.757E-02
1500	2.019E 01	3.705E 00	1.676E 00	8.512E-01	1.408E-01	5.331E-02	4.056E-02
2400	6.030E 01	6.885E 00	2.649E 00	1.241E 00	1.862E-01	6.924E-02	5.247E-02

FLIGHT NO. C-134
DIRECTIONAL PATH REFLECTANCE FROM GROUND TO ALTITUDE
AZIMUTH OF PATH OF SIGHT = 180

AZIMUTH OF PATH OF SIGHT = 180

FLIGHT NO. C-134 FILTER NO. 2

DIRECTIONAL PATH REFLECTANCE FROM GROUND TO ALTITUDE

ALTITUDE	ZENITH ANGLE OF PATH OF SIGHT (DEG)						
M	93	95	97	100	120	150	180
300	1.339E 00	5.154E-01	2.984E-01	1.789E-01	4.030E-02	1.742E-02	1.317E-02
600	9.642E 00	2.128E 00	1.003E 00	5.203E-01	9.583E-02	3.949E-02	2.961E-02
900	5.325E 01	6.301E 00	2.364E 00	1.056E 00	1.591E-01	6.248E-02	4.645E-02
1500	7.299E 02	2.952E 01	7.439E 00	2.597E 00	2.838E-01	1.035E-01	7.592E-02
2400	5.416E 03	8.422E 01	1.543E 01	4.574E 00	4.118E-01	1.442E-01	1.046E-01

FLIGHT NO. C-134 FILTER NO. 6

DIRECTIONAL PATH REFLECTANCE FROM GROUND TO ALTITUDE

ALTITUDE	ZENITH ANGLE OF PATH OF SIGHT (DEG)						
M	93	95	97	100	120	150	180
300	1.087E 00	4.385E-01	2.587E-01	1.575E-01	3.685E-02	1.661E-02	1.272E-02
600	6.228E 00	1.600E 00	7.981E-01	4.311E-01	8.563E-02	3.716E-02	2.829E-02
900	3.225E 01	4.681E 00	1.897E 00	8.934E-01	1.482E-01	6.171E-02	4.668E-02
1500	7.143E 02	3.013E 01	7.711E 00	2.715E 00	3.096E-01	1.190E-01	8.896E-02
2400	5.272E 03	8.258E 01	1.523E 01	4.537E 00	4.188E-01	1.549E-01	1.153E-01

FLIGHT NO. C-134 FILTER NO. 5

DIRECTIONAL PATH REFLECTANCE FROM GROUND TO ALTITUDE

ALTITUDE	ZENITH ANGLE OF PATH OF SIGHT (DEG)						
M	93	95	97	100	120	150	180
300	8.098E-01	3.435E-01	2.075E-01	1.291E-01	3.224E-02	1.460E-02	1.092E-02
600	4.037E 00	1.167E 00	6.094E-01	3.409E-01	7.274E-02	3.168E-02	2.359E-02
900	1.867E 01	3.171E 00	1.368E 00	6.727E-01	1.192E-01	4.954E-02	3.676E-02
1500	4.612E 02	2.093E 01	5.544E 00	2.000E 00	2.332E-01	8.742E-02	6.427E-02
2400	3.632E 03	6.155E 01	1.164E 01	3.523E 00	3.310E-01	1.176E-01	8.527E-02

FLIGHT NO. C-134 FILTER NO. 3

DIRECTIONAL PATH REFLECTANCE FROM GROUND TO ALTITUDE

ALTITUDE	ZENITH ANGLE OF PATH OF SIGHT (DEG)						
M	93	95	97	100	120	150	180
300	5.360E-01	2.503E-01	1.574E-01	1.011E-01	2.552E-02	1.133E-02	8.670E-03
600	1.814E 00	6.949E-01	4.037E-01	2.437E-01	5.606E-02	2.427E-02	1.849E-02
900	4.552E 00	1.367E 00	7.263E-01	4.118E-01	8.624E-02	3.635E-02	2.757E-02
1500	1.640E 01	3.133E 00	1.423E 00	7.311E-01	1.329E-01	5.381E-02	4.056E-02
2400	4.963E 01	5.768E 00	2.244E 00	1.066E 00	1.756E-01	6.983E-02	5.247E-02

FLIGHT NO. C-134
DIRECTIONAL PATH REFLECTANCE FROM GROUND TO ALTITUDE
AZIMUTH OF PATH OF SIGHT = 270

AZIMUTH OF PATH OF SIGHT = 270

FLIGHT NO. C-134 FILTER NO. 2

DIRECTIONAL PATH REFLECTANCE FROM GROUND TO ALTITUDE

ALTITUDE	ZENITH ANGLE OF PATH OF SIGHT (DEG)						
M	93	95	97	100	120	150	180
300	1.488E 00	5.671E-01	3.249E-01	1.919E-01	3.901E-02	1.648E-02	1.317E-02
600	1.061E 01	2.322E 00	1.084E 00	5.542E-01	9.254E-02	3.735E-02	2.961E-02
900	5.777E 01	6.794E 00	2.529E 00	1.114E 00	1.531E-01	5.908E-02	4.645E-02
1500	7.716E 02	3.110E 01	7.792E 00	2.690E 00	2.707E-01	9.767E-02	7.592E-02
2400	5.456E 03	8.510E 01	1.556E 01	4.576E 00	3.807E-01	1.346E-01	1.046E-01

FLIGHT NO. C-134 FILTER NO. 6

DIRECTIONAL PATH REFLECTANCE FROM GROUND TO ALTITUDE

ALTITUDE	ZENITH ANGLE OF PATH OF SIGHT (DEG)						
M	93	95	97	100	120	150	180
300	1.221E 00	4.885E-01	2.857E-01	1.716E-01	3.660E-02	1.606E-02	1.272E-02
600	6.868E 00	1.757E 00	8.706E-01	4.647E-01	8.465E-02	3.593E-02	2.829E-02
900	3.464E 01	5.029E 00	2.031E 00	9.475E-01	1.455E-01	5.964E-02	4.668E-02
1500	7.369E 02	3.115E 01	7.972E 00	2.795E 00	3.007E-01	1.149E-01	8.896E-02
2400	5.371E 03	8.428E 01	1.555E 01	4.618E 00	4.055E-01	1.497E-01	1.153E-01

FLIGHT NO. C-134 FILTER NO. 5

DIRECTIONAL PATH REFLECTANCE FROM GROUND TO ALTITUDE

ALTITUDE	ZENITH ANGLE OF PATH OF SIGHT (DEG)						
M	93	95	97	100	120	150	180
300	8.463E-01	3.556E-01	2.127E-01	1.305E-01	3.001E-02	1.375E-02	1.092E-02
600	4.227E 00	1.210E 00	6.263E-01	3.456E-01	6.805E-02	2.992E-02	2.359E-02
900	1.962E 01	3.302E 00	1.412E 00	6.854E-01	1.125E-01	4.699E-02	3.676E-02
1500	4.785E 02	2.165E 01	5.706E 00	2.038E 00	2.216E-01	8.338E-02	6.427E-02
2400	3.576E 03	6.092E 01	1.152E 01	3.463E 00	3.047E-01	1.110E-01	8.527E-02

FLIGHT NO. C-134 FILTER NO. 3

DIRECTIONAL PATH REFLECTANCE FROM GROUND TO ALTITUDE

ALTITUDE	ZENITH ANGLE OF PATH OF SIGHT (DEG)						
M	93	95	97	100	120	150	180
300	5.692E-01	2.781E-01	1.787E-01	1.129E-01	2.560E-02	1.090E-02	8.670E-03
600	2.034E 00	7.873E-01	4.618E-01	2.744E-01	5.644E-02	2.337E-02	1.849E-02
900	5.293E 00	1.580E 00	8.407E-01	4.692E-01	8.729E-02	3.503E-02	2.757E-02
1500	1.980E 01	3.724E 00	1.679E 00	8.487E-01	1.357E-01	5.194E-02	4.056E-02
2400	6.054E 01	6.919E 00	2.654E 00	1.237E 00	1.799E-01	6.751E-02	5.247E-02

FLIGHT C-137 – DESCRIPTION OF FLIGHT AND WEATHER CHARACTERISTICS

It was a sunlight afternoon. There were several layers of scattered clouds and a moderate haze at the lower altitudes. The flight was conducted along an east-west route between Mindelheim and Mengen, passing approximately 8 to 16 kilometers (5 to 10 miles) north of Memmingen. The typical terrain was heavily cultivated, rolling pastureland occasionally interrupted by large patches of dark forest. The data-taking started at 1418 GMT (1518 LCT) and continued until 1543 GMT (1643 LCT). The sun zenith angle during sky radiance data-taking was 44.8 degrees at the start and 55.1 degrees at the end. The highest flight altitude was 2490 meters above ground level.

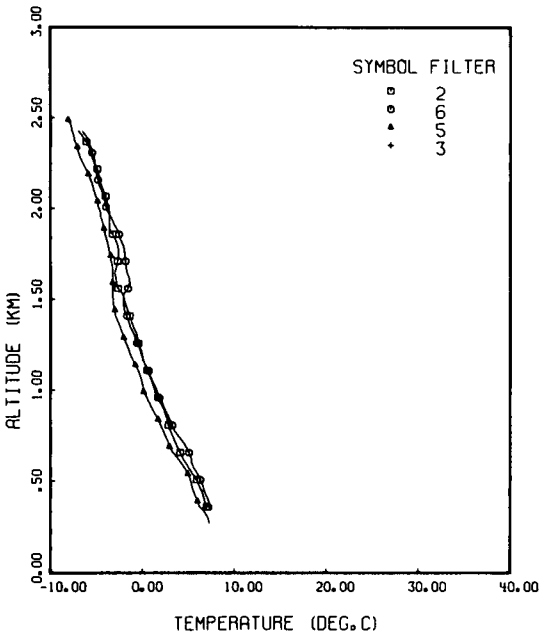
About the time data-taking commenced, Memmingen was reporting 2/8 cumulus at 900 meters and 6/8 stratocumulus at 1500 meters. Visibility was reported as 15 kilometers (9 miles).

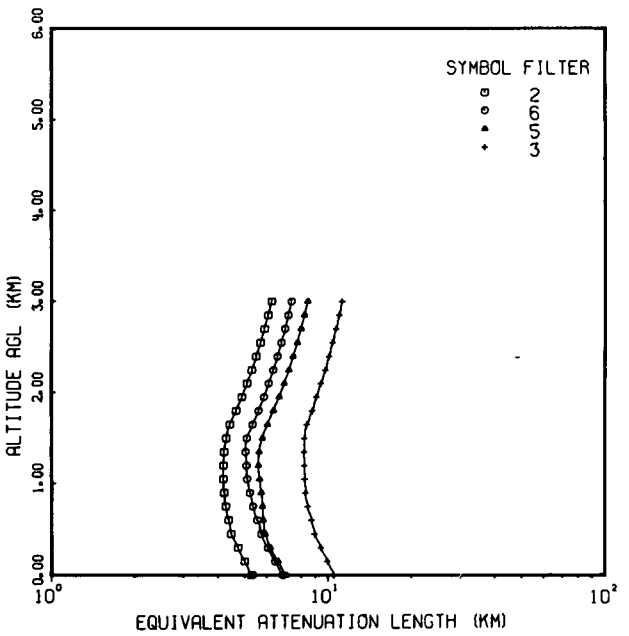
During the flight, the aircrew reported scattered cumulus and stratocumulus at an estimated 0.3 with bases at 1049 meters and tops at 1809 meters. There were no higher clouds. There was a moderate haze at 285 meters.

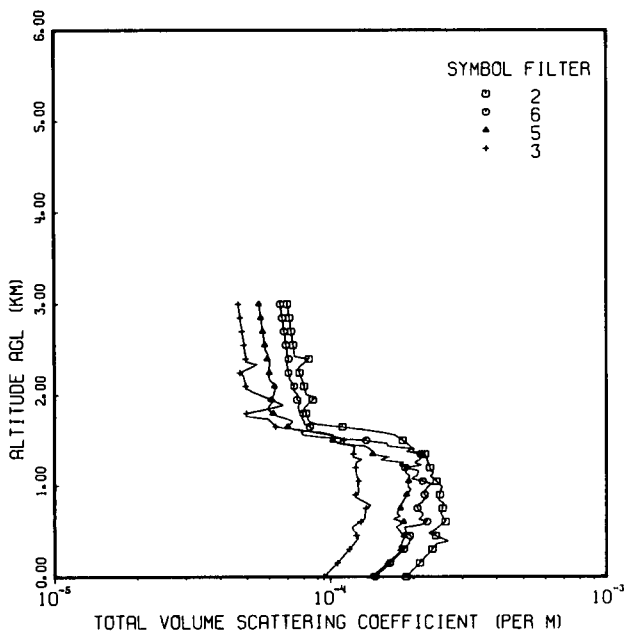
When data-taking ended, Memmingen was reporting 1/8 cumulus at 1050 meters, 3/8 stratocumulus at 1500 meters, and 2/8 cirrus at 6000 meters. Visibility was reported as 20 kilometers (12 miles).

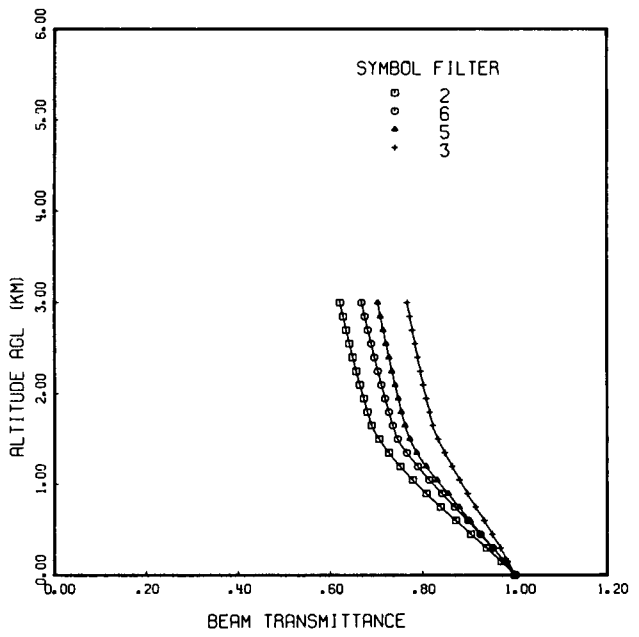
The Memmingen area was situated in a col with very weak circulation at the surface. At 500 millibars, a cold low over Poland had deepened and the Memmingen area was on the back side of the low with moderate northerly winds. The airmass was unstable maritime polar.

FLIGHT NO. C-137

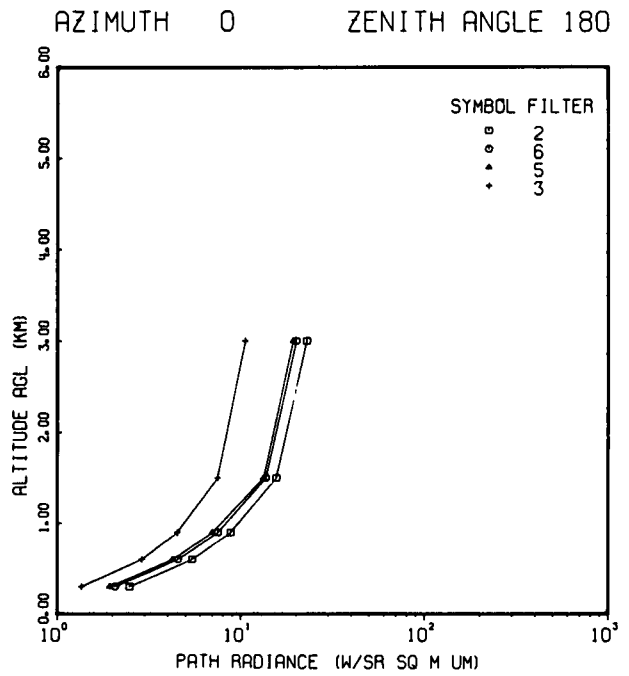


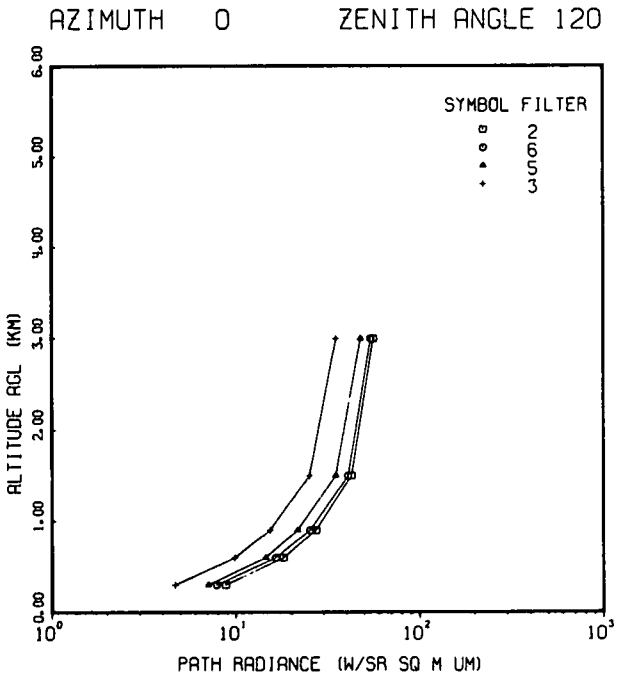


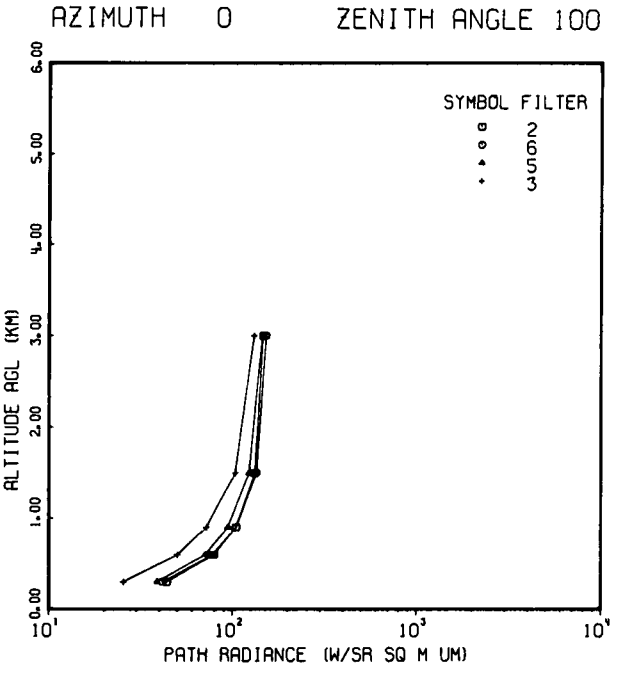




FLIGHT NO. C-137

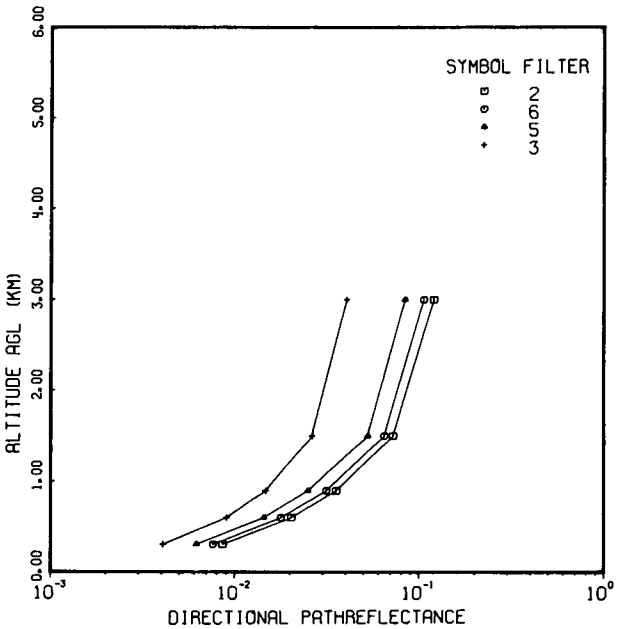




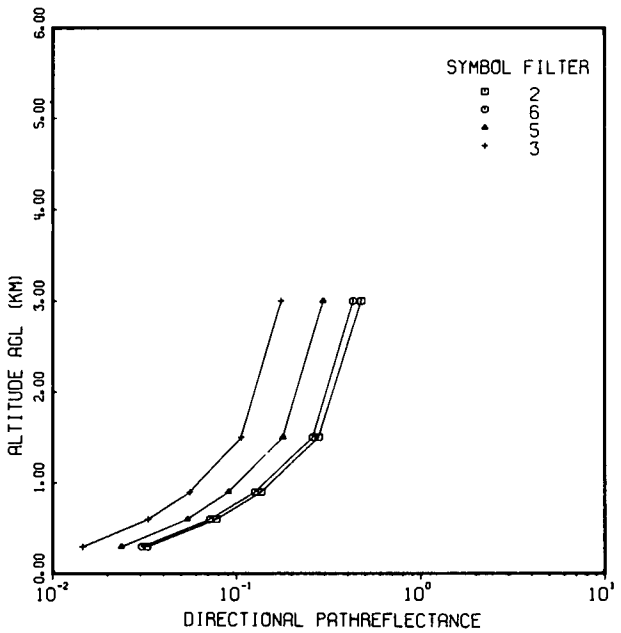


FLIGHT NO. C-137

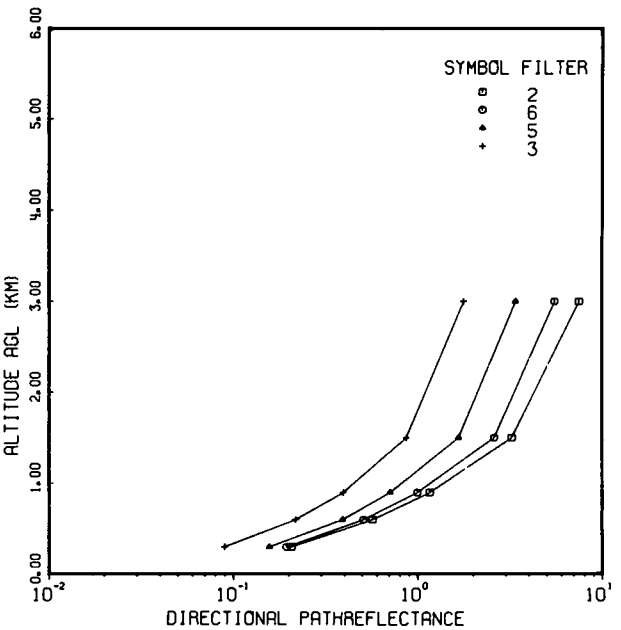
AZIMUTH 0 ZENITH ANGLE 180



AZIMUTH 0 ZENITH ANGLE 120



AZIMUTH 0 ZENITH ANGLE 100



FLIGHT NO. C-137
IRRADIANCE

FLIGHT NO.C-137 FILTER NO. 2
IRRADIANCE (W/SQ M UM)

ALTITUDE (METERS)	DOWN-WELLING	UP-WELLING	ALBEDO	SCALAR DOWNWELLING	SCALAR UPWELLING	SCALAR TOTAL	SCALAR ALBEDO
304	9.633E 02	2.788E 01	.029	1.594E 03	8.488E 01	1.679E 03	.053
1906	8.623E 02	7.312E 01	.085	1.470E 03	2.240E 02	1.694E 03	.152
2459	8.916E 02	8.831E 01	.128	1.305E 03	2.615E 02	1.567E 03	.200

FLIGHT NO.C-137 FILTER NO. 4
IRRADIANCE (W/SQ M UM)

ALTITUDE (METERS)	DOWN-WELLING	UP-WELLING	ALBEDO	SCALAR DOWNWELLING	SCALAR UPWELLING	SCALAR TOTAL	SCALAR ALBEDO
309	3.923E 02	3.905E 01	.044	1.584E 03	1.030E 02	1.688E 03	.065
1937	6.134E 02	1.282E 02	.209	1.171E 03	3.395E 02	1.510E 03	.289
2468	5.415E 02	1.341E 02	.248	1.156E 03	3.086E 02	1.464E 03	.267

FLIGHT NO.C-137 FILTER NO. 5
IRRADIANCE (W/SQ M UM)

ALTITUDE (METERS)	DOWN-WELLING	UP-WELLING	ALBEDO	SCALAR DOWNWELLING	SCALAR UPWELLING	SCALAR TOTAL	SCALAR ALBEDO
306	1.031E 03	4.379E 01	.042	1.753E 03	1.032E 02	1.856E 03	.059
1916	7.534E 02	1.890E 02	.251	1.290E 03	3.826E 02	1.673E 03	.297
2469	8.042E 02	8.745E 01	.145	1.262E 03	2.501E 02	1.513E 03	.198

FLIGHT NO.C-137 FILTER NO. 3
IRRADIANCE (W/SQ M UM)

ALTITUDE (METERS)	DOWN-WELLING	UP-WELLING	ALBEDO	SCALAR DOWNWELLING	SCALAR UPWELLING	SCALAR TOTAL	SCALAR ALBEDO
300	1.073E 03	4.381E 01	.041	1.688E 03	9.950E 01	1.788E 03	.059
1918	8.895E 02	8.474E 01	.095	1.412E 03	2.568E 02	1.668E 03	.182
2471	8.061E 02	7.928E 01	.098	1.419E 03	2.024E 02	1.622E 03	.143

FLIGHT NO. C-137
DIRECTIONAL REFLECTANCE OF BACKGROUND

FLIGHT NO. C-137
AZIMUTH OF PATH OF SIGHT = 0
DIRECTIONAL REFLECTANCE OF BACKGROUND

ZENITH ANGLE	FILTERS 2	6	5	3
93	.26178	.29255	.16784	.27545
95	.14827	.18430	.14180	.10645
97	.10716	.15247	.10932	.07965
100	.06279	.11031	.07658	.06924
120	.03418	.03535	.03427	.03304
150	.02136	.01276	.04670	.02303
180	.01704	.00595	.02298	.01489

FLIGHT NO. C-137
AZIMUTH OF PATH OF SIGHT = 90
DIRECTIONAL REFLECTANCE OF BACKGROUND

ZENITH ANGLE	FILTERS 2	6	5	3
93	.14327	.11367	.09589	.07759
95	.12451	.07515	.07849	.05960
97	.11474	.07603	.06217	.03828
100	.08636	.07116	.03200	.04898
120	.01609	.04290	.04717	.04747
150	.01147	.03770	.05576	.02850
180	.01704	.00595	.02298	.01489

FLIGHT NO. C-137
AZIMUTH OF PATH OF SIGHT = 180
DIRECTIONAL REFLECTANCE OF BACKGROUND

ZENITH ANGLE	FILTERS 2	6	5	3
93	.10615	.08632	.08470	.05462
95	.08724	.07703	.06867	.04157
97	.06337	.07906	.07483	.03716
100	.06525	.08045	.04864	.03376
120	.06577	.04163	.03804	.04441
150	.01899	.05012	.06727	.03511
180	.01704	.00595	.02298	.01489

FLIGHT NO. C-137
AZIMUTH OF PATH OF SIGHT = 270
DIRECTIONAL REFLECTANCE OF BACKGROUND

ZENITH ANGLE	FILTERS 2	6	5	3
93	.10848	.10276	.08969	.06374
95	.07306	.08228	.05497	.04598
97	.04778	.08870	.04045	.03880
100	.03130	.07432	.04089	.03814
120	.04005	.02964	.05112	.02550
150	.01843	.02527	.05504	.07208
180	.01704	.00595	.02298	.01489

FLIGHT NO. C-137
TOTAL VOLUME SCATTERING COEFFICIENT

DATE 52870 FLIGHT NO. C-137 GROUND LEVEL ALTITUDE (M)= 629

ALTITUDE (M)	TOTAL VOLUME SCATTERING COEFFICIENT (PER M)			
FILTERS	2	6	5	3
0	1.880E-04	1.450E-04	1.410E-04	9.470E-05
30	1.926E-04	1.490E-04	1.452E-04	9.696E-05
60	1.972E-04	1.529E-04	1.493E-04	9.922E-05
90	2.018E-04	1.569E-04	1.535E-04	1.015E-04
120	2.064E-04	1.609E-04	1.577E-04	1.037E-04
150	2.110E-04	1.648E-04	1.618E-04	1.060E-04
180	2.156E-04	1.688E-04	1.660E-04	1.083E-04
210	2.202E-04	1.728E-04	1.701E-04	1.105E-04
240	2.248E-04	1.768E-04	1.743E-04	1.128E-04
270	2.294E-04	1.807E-04	1.785E-04	1.150E-04
300	2.340E-04	1.847E-04	1.802E-04	1.173E-04
330	2.385E-04	1.887E-04	1.773E-04	1.196E-04
360	2.431E-04	1.926E-04	1.822E-04	1.218E-04
390	2.679E-04	1.926E-04	1.822E-04	1.241E-04
420	2.544E-04	1.979E-04	1.849E-04	1.263E-04
450	2.408E-04	1.941E-04	1.850E-04	1.244E-04
480	2.273E-04	1.890E-04	1.806E-04	1.229E-04
510	2.394E-04	1.870E-04	1.780E-04	1.215E-04
540	2.457E-04	1.854E-04	1.730E-04	1.200E-04
570	2.521E-04	2.146E-04	1.802E-04	1.245E-04
600	2.617E-04	2.242E-04	1.840E-04	1.289E-04
630	2.583E-04	2.095E-04	1.692E-04	1.334E-04
660	2.549E-04	2.157E-04	1.759E-04	1.337E-04
690	2.516E-04	2.173E-04	1.738E-04	1.340E-04
720	2.537E-04	2.097E-04	1.753E-04	1.343E-04
750	2.549E-04	2.068E-04	1.797E-04	1.346E-04
780	2.561E-04	2.060E-04	1.789E-04	1.403E-04
810	2.574E-04	2.136E-04	1.828E-04	1.348E-04
840	2.470E-04	2.174E-04	1.840E-04	1.294E-04
870	2.482E-04	2.254E-04	1.873E-04	1.239E-04
900	2.494E-04	2.194E-04	1.887E-04	1.232E-04
930	2.507E-04	2.180E-04	1.932E-04	1.268E-04
960	2.519E-04	2.224E-04	1.962E-04	1.263E-04
990	2.542E-04	2.253E-04	1.904E-04	1.259E-04
1020	2.492E-04	2.345E-04	1.900E-04	1.255E-04
1050	2.423E-04	2.157E-04	1.919E-04	1.287E-04
1080	2.364E-04	1.973E-04	1.919E-04	1.291E-04
1110	2.305E-04	2.068E-04	1.935E-04	1.247E-04
1140	2.361E-04	2.076E-04	1.878E-04	1.243E-04
1170	2.312E-04	2.077E-04	1.889E-04	1.239E-04
1200	2.297E-04	1.862E-04	1.899E-04	1.236E-04
1230	2.277E-04	2.135E-04	1.778E-04	1.232E-04
1260	2.257E-04	2.016E-04	1.941E-04	1.244E-04
1290	2.238E-04	2.123E-04	1.929E-04	1.302E-04
1320	2.218E-04	2.108E-04	1.637E-04	1.309E-04
1350	2.198E-04	2.124E-04	1.423E-04	1.213E-04
1380	1.995E-04	1.891E-04	1.425E-04	1.217E-04
1410	1.999E-04	2.014E-04	1.385E-04	1.221E-04
1440	1.942E-04	1.617E-04	1.331E-04	1.225E-04
1470	1.884E-04	1.604E-04	1.091E-04	1.062E-04
1500	1.827E-04	1.348E-04	1.021E-04	1.117E-04

FLIGHT NO. C-137
TOTAL VOLUME SCATTERING COEFFICIENT

DATE 52870 FLIGHT NO. C-137 GROUND LEVEL ALTITUDE (M)= 629

ALTITUDE (M)	TOTAL VOLUME SCATTERING COEFFICIENT (PER M)			
FILTERS	2	6	5	3
1530	1.770E-04	9.986E-05	1.017E-04	1.081E-04
1560	1.713E-04	7.971E-05	1.022E-04	9.796E-05
1590	1.536E-04	7.824E-05	9.243E-05	8.781E-05
1620	1.321E-04	8.556E-05	7.393E-05	7.767E-05
1650	1.107E-04	8.448E-05	7.018E-05	6.343E-05
1680	8.923E-05	8.063E-05	7.174E-05	6.210E-05
1710	8.364E-05	8.030E-05	7.329E-05	6.076E-05
1740	8.303E-05	7.921E-05	6.447E-05	5.943E-05
1770	8.242E-05	7.924E-05	6.445E-05	4.978E-05
1800	8.181E-05	7.976E-05	6.203E-05	4.970E-05
1830	8.120E-05	7.718E-05	6.031E-05	5.565E-05
1860	8.048E-05	7.644E-05	5.976E-05	6.161E-05
1890	8.244E-05	7.670E-05	6.016E-05	6.756E-05
1920	8.440E-05	7.838E-05	6.157E-05	6.447E-05
1950	8.636E-05	7.581E-05	6.105E-05	6.139E-05
1980	8.632E-05	7.634E-05	6.207E-05	5.830E-05
2010	8.195E-05	7.601E-05	6.265E-05	5.522E-05
2040	8.143E-05	7.430E-05	6.221E-05	5.213E-05
2070	8.091E-05	7.338E-05	6.224E-05	5.011E-05
2100	8.039E-05	7.396E-05	6.286E-05	4.945E-05
2130	7.988E-05	7.298E-05	6.254E-05	4.920E-05
2160	7.936E-05	7.218E-05	6.063E-05	4.895E-05
2190	7.875E-05	7.085E-05	6.001E-05	4.869E-05
2220	7.813E-05	7.158E-05	5.971E-05	4.844E-05
2250	7.752E-05	7.083E-05	6.009E-05	4.701E-05
2280	7.691E-05	7.053E-05	6.028E-05	4.955E-05
2310	7.698E-05	7.029E-05	6.001E-05	5.208E-05
2340	7.926E-05	6.952E-05	6.063E-05	5.462E-05
2370	8.155E-05	6.980E-05	6.014E-05	4.966E-05
2400	8.384E-05	7.013E-05	5.918E-05	4.951E-05
2430	7.434E-05	7.011E-05	5.947E-05	4.935E-05
2460	7.411E-05	6.990E-05	5.934E-05	4.920E-05
2490	7.388E-05	6.968E-05	5.831E-05	4.905E-05
2520	7.364E-05	6.946E-05	5.813E-05	4.789E-05
2550	7.341E-05	6.924E-05	5.794E-05	4.674E-05
2580	7.318E-05	6.902E-05	5.776E-05	4.859E-05
2610	7.295E-05	6.881E-05	5.758E-05	4.343E-05
2640	7.273E-05	6.859E-05	5.740E-05	4.828E-05
2670	7.250E-05	6.838E-05	5.722E-05	4.813E-05
2700	7.227E-05	6.816E-05	5.704E-05	4.798E-05
2730	7.204E-05	6.795E-05	5.686E-05	4.783E-05
2760	7.182E-05	6.774E-05	5.668E-05	4.768E-05
2790	7.159E-05	6.752E-05	5.651E-05	4.753E-05
2820	7.137E-05	6.731E-05	5.633E-05	4.738E-05
2850	7.115E-05	6.710E-05	5.615E-05	4.723E-05
2880	7.092E-05	6.689E-05	5.598E-05	4.709E-05
2910	7.070E-05	6.668E-05	5.580E-05	4.694E-05
2940	7.048E-05	6.647E-05	5.563E-05	4.679E-05
2970	7.026E-05	6.627E-05	5.546E-05	4.665E-05
3000	7.004E-05	6.606E-05	5.529E-05	4.650E-05
FIRST DATA ALT	0	0	0	0
LAST DATA ALT	2430	2430	2490	2370

FLIGHT NO. C-137
BEAM TRANSMITTANCE FROM GROUND TO ALTITUDE

FLIGHT NO. C-137 FILTER NO. 2
BEAM TRANSMITTANCE FROM GROUND TO ALTITUDE

ALTITUDE M	ZENITH ANGLE OF PATH OF SIGHT (DEG) 93	95	97	100	120	150	180
300	.2956859	.4828048	.5949071	.6945515	.8810987	.9295225	.9386686
600	.0731366	.2059072	.3249080	.4543023	.7603213	.8536772	.8719640
900	.0155086	.0849992	.1739639	.2930495	.6529359	.7818356	.8080445
1500	.0009630	.0172347	.0570572	.1340160	.4975820	.6683204	.7053949
3000	.0000358	.0034220	.0198723	.0639264	.3847842	.5761360	.6203097

FLIGHT NO. C-137 FILTER NO. 6
BEAM TRANSMITTANCE FROM GROUND TO ALTITUDE

ALTITUDE M	ZENITH ANGLE OF PATH OF SIGHT (DEG) 93	95	97	100	120	150	180
300	.3859614	.5661201	.6664460	.7521685	.9058258	.9444952	.9517488
600	.1235205	.2682742	.4127633	.5373933	.8059934	.8829182	.8977714
900	.0346218	.1366168	.2435385	.3710927	.7087332	.8197401	.8418630
1500	.0029302	.0327384	.0896084	.1839670	.5554525	.7121505	.7452868
3000	.0001744	.0081623	.0361746	.0972391	.4451238	.6266864	.6671760

FLIGHT NO. C-137 FILTER NO. 5
BEAM TRANSMITTANCE FROM GROUND TO ALTITUDE

ALTITUDE M	ZENITH ANGLE OF PATH OF SIGHT (DEG) 93	95	97	100	120	150	180
300	.3930609	.5723270	.6716396	.7562775	.9075414	.9455275	.9526497
600	.1364752	.3059581	.4306578	.5536403	.8143740	.8882069	.9024267
900	.0467986	.1634594	.2766975	.4058724	.7311308	.8345984	.8550619
1500	.0058024	.0492769	.1197078	.2254292	.5960776	.7417730	.7720606
3000	.0009119	.0149313	.0549190	.1304714	.4929713	.6647380	.7021192

FLIGHT NO. C-137 FILTER NO. 3
BEAM TRANSMITTANCE FROM GROUND TO ALTITUDE

ALTITUDE M	ZENITH ANGLE OF PATH OF SIGHT (DEG) 93	95	97	100	120	150	180
300	.5421552	.6936117	.7703287	.8326592	.9383796	.9639461	.9687000
600	.2640350	.4[illegible]07	.5692393	.6734653	.8717150	.9237941	.9336568
900	.1282529	.2855279	.4104374	.5357238	.8051229	.8823675	.8972864
1500	.0266827	.1200250	.2241211	.3500720	.6945244	.8102112	.8333813
3000	.0044615	.0426728	.1130190	.2165135	.5877821	.7357953	.7666695

FLIGHT NO. C-137
PATH RADIANCE FROM GROUND TO ALTITUDE
AZIMUTH OF PATH OF SIGHT = 0

AZIMUTH OF PATH OF SIGHT = 0

FLIGHT NO. C-137 FILTER NO. 4

PATH RADIANCE FROM GROUND TO ALTITUDE (W/SR SQ M UM)

ALTITUDE M	ZENITH ANGLE OF PATH OF SIGHT (DEG) 93	95	97	100	120	150	180
300	1.396E 02	9.298E 01	6.551E 01	4.408E 01	8.837E 00	3.044E 00	2.483E 00
600	1.786E 02	1.413E 02	1.099E 02	7.949E 01	1.822E 01	6.564E 00	5.447E 00
900	1.976E 02	1.632E 02	1.361E 02	1.047E 02	2.740E 01	1.040E 01	8.830E 00
1500	1.935E 02	1.785E 02	1.597E 02	1.339E 02	4.279E 01	1.776E 01	1.565E 01
3000	1.943E 02	1.830E 02	1.691E 02	1.472E 02	5.625E 01	2.538E 01	2.295E 01

FLIGHT NO. C-137 FILTER NO. 6

PATH RADIANCE FROM GROUND TO ALTITUDE (W/SR SQ M UM)

ALTITUDE M	ZENITH ANGLE OF PATH OF SIGHT (DEC) 93	95	97	100	120	150	180
300	1.443E 02	9.009E 01	6.212E 01	4.159E 01	7.880E 00	2.563E 00	2.070E 00
600	1.869E 02	1.456E 02	1.091E 02	7.754E 01	1.649E 01	5.603E 00	4.561E 00
900	2.074E 02	1.733E 02	1.397E 02	1.052E 02	2.545E 01	9.165E 00	7.538E 00
1500	2.039E 02	1.880E 02	1.660E 02	1.358E 02	4.112E 01	1.643E 01	1.376E 01
3000	2.073E 02	1.935E 02	1.776E 02	1.528E 02	5.454E 01	2.364E 01	2.020E 01

FLIGHT NO. C-137 FILTER NO. 5

PATH RADIANCE FROM GROUND TO ALTITUDE (W/SR SQ M UM)

ALTITUDE M	ZENITH ANGLE OF PATH OF SIGHT (DEC) 93	95	97	100	120	150	180
300	1.389E 02	8.711E 01	5.940E 01	3.885E 01	7.090E 00	2.386E 00	1.937E 00
600	1.693E 02	1.385E 02	1.026E 02	7.114E 01	1.453E 01	5.154E 00	4.267E 00
900	2.001E 02	1.635E 02	1.294E 02	9.466E 01	2.178E 01	8.276E 00	7.033E 00
1500	1.981E 02	1.793E 02	1.549E 02	1.233E 02	3.511E 01	1.507E 01	1.337E 01
3000	2.155E 02	1.951E 02	1.744E 02	1.457E 02	4.796E 01	2.164E 01	1.940E 01

FLIGHT NO. C-137 FILTER NO. 3

PATH RADIANCE FROM GROUND TO ALTITUDE (W/SR SQ M UM)

ALTITUDE M	ZENITH ANGLE OF PATH OF SIGHT (DEC) 93	95	97	100	120	150	180
300	1.008E 02	5.937E 01	3.965E 01	2.550E 01	4.689E 00	1.609E 00	1.355E 00
600	1.599E 02	1.056E 02	7.473E 01	5.012E 01	9.898E 00	3.433E 00	2.890E 00
900	1.865E 02	1.380E 02	1.032E 02	7.214E 01	1.539E 01	5.384E 00	4.520E 00
1500	2.068E 02	1.745E 02	1.387E 02	1.037E 02	2.528E 01	8.975E 00	7.488E 00
3000	2.314E 02	1.946E 02	1.654E 02	1.314E 02	3.525E 01	1.279E 01	1.062E 01

FLIGHT NO. C-137
PATH RADIANCE FROM GROUND TO ALTITUDE
AZIMUTH OF PATH OF SIGHT = 90

AZIMUTH OF PATH OF SIGHT = 90

FLIGHT NO. C-137 FILTER NO. 2

PATH RADIANCE FROM GROUND TO ALTITUDE (W/SR SQ M UM)

ALTITUDE M	ZENITH ANGLE OF PATH OF SIGHT (DEG) 93	95	97	100	120	150	180
300	6.137E 01	4.218E 01	3.083E 01	2.208E 01	6.256E 00	3.008E 00	2.483E 00
600	7.940E 01	6.473E 01	5.221E 01	4.014E 01	1.301E 01	6.514E 00	5.447E 00
900	8.484E 01	7.602E 01	6.573E 01	5.363E 01	1.983E 01	1.039E 01	8.830E 00
1500	9.063E 01	8.616E 01	7.981E 01	7.018E 01	3.176E 01	1.794E 01	1.565E 01
3000	9.434E 01	9.225E 01	8.855E 01	8.165E 01	4.343E 01	2.588E 01	2.295E 01

FLIGHT NO. C-137 FILTER NO. 6

PATH RADIANCE FROM GROUND TO ALTITUDE (W/SR SQ M UM)

ALTITUDE M	ZENITH ANGLE OF PATH OF SIGHT (DEG) 93	95	97	100	120	150	180
300	5.651E 01	3.699E 01	2.637E 01	1.859E 01	5.174E 00	2.495E 00	2.070E 00
600	7.830E 01	6.017E 01	4.680E 01	3.505E 01	1.091E 01	5.438E 00	4.561E 00
900	8.480E 01	7.318E 01	6.122E 01	4.856E 01	1.705E 01	8.853E 00	7.538E 00
1500	8.849E 01	8.365E 01	7.622E 01	6.564E 01	2.820E 01	1.574E 01	1.376E 01
3000	8.698E 01	8.539E 01	8.169E 01	7.442E 01	3.773E 01	2.246E 01	2.020E 01

FLIGHT NO. C-137 FILTER NO. 5

PATH RADIANCE FROM GROUND TO ALTITUDE (W/SR SQ M UM)

ALTITUDE M	ZENITH ANGLE OF PATH OF SIGHT (DEG) 93	95	97	100	120	150	180
300	5.414E 01	3.510E 01	2.487E 01	1.736E 01	4.676E 00	2.288E 00	1.937E 00
600	7.557E 01	5.694E 01	4.381E 01	3.240E 01	9.774E 00	4.983E 00	4.267E 00
900	8.326E 01	6.977E 01	5.724E 01	4.458E 01	1.512E 01	8.100E 00	7.033E 00
1500	9.008E 01	8.317E 01	7.412E 01	6.239E 01	2.585E 01	1.509E 01	1.337E 01
3000	8.739E 01	8.561E 01	8.096E 01	7.239E 01	3.535E 01	2.164E 01	1.940E 01

FLIGHT NO. C-137 FILTER NO. 3

PATH RADIANCE FROM GROUND TO ALTITUDE (W/SR SQ M UM)

ALTITUDE M	ZENITH ANGLE OF PATH OF SIGHT (DEG) 93	95	97	100	120	150	180
300	3.584E 01	2.194E 01	1.526E 01	1.061E 01	3.027E 00	1.573E 00	1.355E 00
600	5.624E 01	3.879E 01	2.870E 01	2.081E 01	6.380E 00	3.352E 00	2.890E 00
900	6.500E 01	5.028E 01	3.947E 01	2.985E 01	9.894E 00	5.243E 00	4.520E 00
1500	7.003E 01	6.169E 01	5.263E 01	4.262E 01	1.618E 01	8.695E 00	7.488E 00
3000	6.881E 01	6.426E 01	5.886E 01	5.055E 01	2.243E 01	1.232E 01	1.062E 01

FLIGHT NO. C-137
PATH RADIANCE FROM GROUND TO ALTITUDE
AZIMUTH OF PATH OF SIGHT = 180

AZIMUTH OF PATH OF SIGHT = 180

FLIGHT NO. C-137 FILTER NO. 2

PATH RADIANCE FROM GROUND TO ALTITUDE (W/SR SQ M UM)

ALTITUDE M	ZENITH ANGLE OF PATH OF SIGHT (DEG) 93	95	97	100	120	150	180
300	5.171E 01	3.619E 01	2.689E 01	1.976E 01	6.842E 00	3.541E 00	2.483E 00
600	6.940E 01	5.720E 01	4.680E 01	3.690E 01	1.471E 01	7.838E 00	5.447E 00
900	7.832E 01	7.056E 01	6.170E 01	5.150E 01	2.359E 01	1.292E 01	8.830E 00
1500	9.213E 01	8.779E 01	8.168E 01	7.327E 01	4.116E 01	2.351E 01	1.565E 01
3000	1.179E 02	1.139E 02	1.089E 02	1.011E 02	6.607E 01	3.725E 01	2.295E 01

FLIGHT NO. C-137 FILTER NO. 6

PATH RADIANCE FROM GROUND TO ALTITUDE (W/SR SQ M UM)

ALTITUDE M	ZENITH ANGLE OF PATH OF SIGHT (DEG) 93	95	97	100	120	150	180
300	4.763E 01	3.163E 01	2.318E 01	1.682E 01	5.676E 00	2.864E 00	2.070E 00
600	6.613E 01	5.310E 01	4.211E 01	3.242E 01	1.228E 01	6.315E 00	4.561E 00
900	7.780E 01	6.761E 01	5.742E 01	4.670E 01	2.000E 01	1.047E 01	7.538E 00
1500	8.986E 01	8.482E 01	7.785E 01	6.829E 01	3.565E 01	1.921E 01	1.376E 01
3000	9.916E 01	9.685E 01	9.272E 01	8.542E 01	5.178E 01	2.829E 01	2.020E 01

FLIGHT NO. C-137 FILTER NO. 5

PATH RADIANCE FROM GROUND TO ALTITUDE (W/SR SQ M UM)

ALTITUDE M	ZENITH ANGLE OF PATH OF SIGHT (DEG) 93	95	97	100	120	150	180
300	4.539E 01	3.019E 01	2.189E 01	1.581E 01	5.297E 00	2.776E 00	1.937E 00
600	6.530E 01	5.016E 01	3.942E 01	3.019E 01	1.135E 01	6.128E 00	4.267E 00
900	7.550E 01	6.404E 01	5.350E 01	4.296E 01	1.824E 01	1.015E 01	7.033E 00
1500	8.942E 01	8.265E 01	7.468E 01	6.438E 01	3.321E 01	1.945E 01	1.337E 01
3000	9.883E 01	9.577E 01	9.157E 01	8.217E 01	4.890E 01	2.839E 01	1.940E 01

FLIGHT NO. C-137 FILTER NO. 3

PATH RADIANCE FROM GROUND TO ALTITUDE (W/SR SQ M UM)

ALTITUDE M	ZENITH ANGLE OF PATH OF SIGHT (DEG) 93	95	97	100	120	150	180
300	2.602E 01	1.771E 01	1.266E 01	9.191E 00	3.482E 00	1.994E 00	1.355E 00
600	4.451E 01	3.158E 01	2.403E 01	1.816E 01	7.347E 00	4.238E 00	2.890E 00
900	5.653E 01	4.168E 01	3.255E 01	2.638E 01	1.141E 01	6.604E 00	4.520E 00
1500	5.928E 01	5.311E 01	4.625E 01	3.869E 01	1.872E 01	1.086E 01	7.488E 00
3000	6.131E 01	5.917E 01	5.491E 01	4.866E 01	2.641E 01	1.524E 01	1.062E 01

FLIGHT NO. C-137
PATH RADIANCE FROM GROUND TO ALTITUDE
AZIMUTH OF PATH OF SIGHT = 270

AZIMUTH OF PATH OF SIGHT = 270

FLIGHT NO. C-137 FILTER NO. 2

PATH RADIANCE FROM GROUND TO ALTITUDE (W/SR SQ M UM)

ALTITUDE M	ZENITH ANGLE OF PATH OF SIGHT (DEG) 93	95	97	100	120	150	180
300	5.860E 01	4.029E 01	2.939E 01	2.104E 01	6.150E 00	3.021E 00	2.483E 00
600	7.573E 01	6.180E 01	4.977E 01	3.826E 01	1.280E 01	6.557E 00	5.447E 00
900	8.075E 01	7.251E 01	6.266E 01	5.115E 01	1.952E 01	1.050E 01	8.830E 00
1500	8.594E 01	8.202E 01	7.608E 01	6.659E 01	3.131E 01	1.823E 01	1.565E 01
3000	8.982E 01	8.781E 01	8.432E 01	7.779E 01	4.247E 01	2.628E 01	2.295E 01

FLIGHT NO. C-137 FILTER NO. 6

PATH RADIANCE FROM GROUND TO ALTITUDE (W/SR SQ M UM)

ALTITUDE M	ZENITH ANGLE OF PATH OF SIGHT (DEG) 93	95	97	100	120	150	180
300	5.336E 01	3.513E 01	2.517E 01	1.782E 01	5.100E 00	2.487E 00	2.070E 00
600	7.420E 01	5.731E 01	4.479E 01	3.370E 01	1.079E 01	5.453E 00	4.561E 00
900	8.085E 01	7.006E 01	5.896E 01	4.690E 01	1.698E 01	8.962E 00	7.538E 00
1500	8.544E 01	8.100E 01	7.406E 01	6.404E 01	2.842E 01	1.620E 01	1.376E 01
3000	8.431E 01	8.347E 01	8.015E 01	7.340E 01	3.878E 01	2.377E 01	2.020E 01

FLIGHT NO. C-137 FILTER NO. 5

PATH RADIANCE FROM GROUND TO ALTITUDE (W/SR SQ M UM)

ALTITUDE M	ZENITH ANGLE OF PATH OF SIGHT (DEG) 93	95	97	100	120	150	180
300	5.625E 01	3.650E 01	2.582E 01	1.800E 01	4.964E 00	2.438E 00	1.937E 00
600	7.773E 01	5.974E 01	4.515E 01	3.336E 01	1.029E 01	5.286E 00	4.267E 00
900	8.419E 01	7.094E 01	5.824E 01	4.533E 01	1.573E 01	8.538E 00	7.033E 00
1500	8.794E 01	8.199E 01	7.336E 01	6.186E 01	2.629E 01	1.57CE 01	1.337E 01
3000	8.573E 01	8.435E 01	7.983E 01	7.157E 01	3.585E 01	2.245E 01	1.940E 01

FLIGHT NO. C-137 FILTER NO. 3

PATH RADIANCE FROM GROUND TO ALTITUDE (W/SR SQ M UM)

ALTITUDE M	ZENITH ANGLE OF PATH OF SIGHT (DEG) 93	95	97	100	120	150	180
300	3.792E 01	2.325E 01	1.613E 01	1.120E 01	3.249E 00	1.689E 00	1.355E 00
600	5.900E 01	4.080E 01	3.018E 01	2.186E 01	6.817E 00	3.589E 00	2.890E 00
900	6.719E 01	5.233E 01	4.110E 01	3.108E 01	1.049E 01	5.590E 00	4.520E 00
1500	6.995E 01	6.249E 01	5.361E 01	4.354E 01	1.690E 01	9.185E 00	7.488E 00
3000	6.073E 01	6.052E 01	5.645E 01	4.947E 01	2.265E 01	1.302E 01	1.062E 01

FLIGHT NO. C-137
DIRECTIONAL PATH REFLECTANCE FROM GROUND TO ALTITUDE
AZIMUTH OF PATH OF SIGHT = 0

AZIMUTH OF PATH OF SIGHT = 0

FLIGHT NO. C-137 FILTER NO. 2

DIRECTIONAL PATH REFLECTANCE FROM GROUND TO ALTITUDE

ALTITUDE M	ZENITH ANGLE OF PATH OF SIGHT (DEG)						
	93	95	97	100	120	150	180
300	1.540E 00	6.281E-01	3.592E-01	2.070E-01	3.271E-02	1.068E-02	8.628E-03
600	8.307E 00	2.239E 00	1.103E 00	5.707E-01	7.817E-02	2.508E-02	2.037E-02
900	3.945E 01	6.261E 00	2.552E 00	1.165E 00	1.369E-01	4.340E-02	3.564E-02
1500	6.564E 02	3.377E 01	9.127E 00	3.237E 00	2.805E-01	8.668E-02	7.238E-02
3000	1.770E 04	1.744E 02	2.775E 01	7.51CE 00	4.768E-01	1.437E-01	1.207E-01

FLIGHT NO. C-137 FILTER NO. 6

DIRECTIONAL PATH REFLECTANCE FROM GROUND TO ALTITUDE

ALTITUDE M	ZENITH ANGLE OF PATH OF SIGHT (DEG)						
	93	95	97	100	120	150	180
300	1.317E 00	5.641E-01	3.287E-01	1.947E-01	3.063E-02	9.654E-03	7.656E-03
600	5.613E 00	1.780E 00	9.303E-01	5.080E-01	7.204E-02	2.234E-02	1.789E-02
900	2.109E 01	4.469E 00	2.020E 00	9.981E-01	1.265E-01	3.937E-02	3.152E-02
1500	2.475E 02	2.022E 01	6.523E 00	2.600E 00	2.606E-01	8.125E-02	6.500E-02
3000	4.184E 03	3.348E 01	1.731E 01	5.533E 00	4.314E-01	1.328E-01	1.066E-01

FLIGHT NO. C-137 FILTER NO. 5

DIRECTIONAL PATH REFLECTANCE FROM GROUND TO ALTITUDE

ALTITUDE M	ZENITH ANGLE OF PATH OF SIGHT (DEG)						
	93	95	97	100	120	150	180
300	1.077E 00	4.639E-01	2.695E-01	1.565E-01	2.381E-02	7.691E-03	6.198E-03
600	4.226E 00	1.379E 00	7.260E-01	3.916E-01	5.437E-02	1.769E-02	1.441E-02
900	1.303E 01	3.047E 00	1.425E 00	7.107E-01	9.079E-02	3.022E-02	2.506E-02
1500	1.040E 02	1.109E 01	3.945E 00	1.667E 00	1.795E-01	6.191E-02	5.276E-02
3000	1.283E 03	3.982E 01	9.678E 00	3.403E 00	2.965E-01	9.921E-02	8.421E-02

FLIGHT NO. C-137 FILTER NO. 3

DIRECTIONAL PATH REFLECTANCE FROM GROUND TO ALTITUDE

ALTITUDE M	ZENITH ANGLE OF PATH OF SIGHT (DEG)						
	93	95	97	100	120	150	180
300	5.443E-01	2.515E-01	1.527E-01	8.969E-02	1.463E-02	4.887E-03	4.096E-03
600	1.766E 00	6.820E-01	3.644E-01	2.179E-01	3.325E-02	1.098E-02	9.064E-03
900	4.542E 00	1.415E 00	7.351E-01	3.943E-01	5.596E-02	1.787E-02	1.475E-02
1500	2.275E 01	4.109E 00	1.812E 00	8.677E-01	1.066E-01	3.244E-02	2.631E-02
3000	1.957E 02	1.370E 01	4.363E 00	1.777E 00	1.756E-01	5.091E-02	4.057E-02

FLIGHT NO. C-137
DIRECTIONAL PATH REFLECTANCE FROM GROUND TO ALTITUDE
AZIMUTH OF PATH OF SIGHT = 90

AZIMUTH OF PATH OF SIGHT = 90

FLIGHT NO. C-137 FILTER NO. 2

DIRECTIONAL PATH REFLECTANCE FROM GROUND TO ALTITUDE

ALTITUDE M	ZENITH ANGLE OF PATH OF SIGHT (DEG) 93	95	97	100	120	150	180
300	6.769E-01	2.849E-01	1.690E-01	1.037E-01	2.316E-02	1.055E-02	8.628E-03
600	3.692E 00	1.025E 00	5.241E-01	2.882E-01	5.580E-02	2.489E-02	2.037E-02
900	1.784E 01	2.917E 00	1.232E 00	5.969E-01	9.906E-02	4.335E-02	3.564E-02
1500	3.070E 02	1.63CE 01	4.562E 00	1.708E 00	2.081E-01	8.754E-02	7.238E-02
3000	8.593E 03	8.792E 01	1.453E 01	4.166E 00	3.681E-01	1.465E-01	1.207E-01

FLIGHT NO. C-137 FILTER NO. 6

DIRECTIONAL PATH REFLECTANCE FROM GROUND TO ALTITUDE

ALTITUDE M	ZENITH ANGLE OF PATH OF SIGHT (DEG) 93	95	97	100	120	150	180
300	5.155E-01	2.300E-01	1.393E-01	8.702E-02	2.011E-02	9.301E-03	7.656E-03
600	2.232E 00	7.348E-01	3.992E-01	2.297E-01	4.765E-02	2.169E-02	1.789E-02
900	8.624E 00	1.886E 00	8.850E-01	4.667E-01	8.468E-02	3.802E-02	3.152E-02
1500	1.074E 02	8.946E 00	2.955E 00	1.256E 00	1.787E-01	7.781E-02	6.500E-02
3000	1.748E 03	2.683E 01	7.962E 00	2.695E 00	2.984E-01	1.262E-01	1.066E-01

FLIGHT NO. C-137 FILTER NO. 5

DIRECTIONAL PATH REFLECTANCE FROM GROUND TO ALTITUDE

ALTITUDE M	ZENITH ANGLE OF PATH OF SIGHT (DEG) 93	95	97	100	120	150	180
300	4.198E-01	1.869E-01	1.128E-01	6.996E-02	1.570E-02	7.374E-03	6.198E-03
600	1.688E 00	5.672E-01	3.100E-01	1.784E-01	3.658E-02	1.716E-02	1.441E-02
900	5.422E 00	1.301E 00	6.305E-01	3.347E-01	6.304E-02	2.958E-02	2.506E-02
1500	4.731E 01	5.144E 00	1.887E 00	8.434E-01	1.321E-01	6.184E-02	5.276E-02
3000	5.202E 02	1.751E 01	4.493E 00	1.691E 00	2.185E-01	9.921E-02	8.421E-02

FLIGHT NO. C-137 FILTER NO. 3

DIRECTIONAL PATH REFLECTANCE FROM GROUND TO ALTITUDE

ALTITUDE M	ZENITH ANGLE OF PATH OF SIGHT (DEG) 93	95	97	100	120	150	180
300	1.930E-01	9.265E-02	5.800E-02	3.732E-02	9.446E-03	4.779E-03	4.096E-03
600	9.236E-01	2.950E-01	1.476E-01	9.049E-02	2.143E-02	1.062E-02	9.064E-03
900	1.583E 00	5.157E-01	2.813E-01	1.632E-01	3.599E-02	1.740E-02	1.475E-02
1500	7.685E 00	1.505E 00	6.877E-01	3.565E-01	6.823E-02	3.143E-02	2.631E-02
3000	5.652E 01	4.41CE 00	1.525E 00	6.891E-01	1.117E-01	4.902E-02	4.057E-02

FLIGHT NO. C-137
DIRECTIONAL PATH REFLECTANCE FROM GROUND TO ALTITUDE
AZIMUTH OF PATH OF SIGHT = 180

AZIMUTH OF PATH OF SIGHT = 180

FLIGHT NO. C-137 FILTER NO. 2

DIRECTIONAL PATH REFLECTANCE FROM GROUND TO ALTITUDE

ALTITUDE M	ZENITH ANGLE OF PATH OF SIGHT (DEG) 93	95	97	100	120	150	180
300	5.703E-01	2.445E-01	1.474E-01	9.280E-02	2.532E-02	1.242E-02	8.628E-03
600	3.227E 00	9.061E-01	4.698E-01	2.649E-01	6.310E-02	2.995E-02	2.037E-02
900	1.647E 01	2.707E 00	1.157E 00	5.732E-01	1.178E-01	5.388E-02	3.564E-02
1500	3.120E 02	1.661E 01	4.680E 00	1.788E 00	2.698E-01	1.148E-01	7.238E-02
3000	1.074E 04	1.084E 02	1.785E 01	5.157E 00	5.600E-01	2.108E-01	1.207E-01

FLIGHT NO. C-137 FILTER NO. 6

DIRECTIONAL PATH REFLECTANCE FROM GROUND TO ALTITUDE

ALTITUDE M	ZENITH ANGLE OF PATH OF SIGHT (DEG) 93	95	97	100	120	150	180
300	4.343E-01	1.980E-01	1.225E-01	7.873E-02	2.206E-02	1.068E-02	7.656E-03
600	1.942E 00	6.496E-01	3.592E-01	2.124E-01	5.363E-02	2.518E-02	1.789E-02
900	7.712E 00	1.742E 00	8.361E-01	4.431E-01	9.937E-02	4.497E-02	3.152E-02
1500	1.091E 02	9.162E 00	3.059E 00	1.307E 00	2.260E-01	9.499E-02	6.500E-02
3000	7.092E 03	4.179E 01	9.037E 00	3.093E 00	4.096E-01	1.589E-01	1.066E-01

FLIGHT NO. C-137 FILTER NO. 5

DIRECTIONAL PATH REFLECTANCE FROM GROUND TO ALTITUDE

ALTITUDE M	ZENITH ANGLE OF PATH OF SIGHT (DEG) 93	95	97	100	120	150	180
300	3.519E-01	1.617E-01	9.931E-02	6.373E-02	1.779E-02	8.948E-03	6.198E-03
600	1.458E 00	4.996E-01	2.790E-01	1.660E-01	4.246E-02	2.103E-02	1.441E-02
900	4.916E 00	1.194E 00	5.993E-01	3.226E-01	7.603E-02	3.708E-02	2.506E-02
1500	4.696E 01	5.124E 00	1.971E 00	8.703E-01	1.698E-01	7.992E-02	5.276E-02
3000	5.985E 02	1.955E 01	5.026E 00	1.919E 00	3.023E-01	1.301E-01	8.421E-02

FLIGHT NO. C-137 FILTER NO. 3

DIRECTIONAL PATH REFLECTANCE FROM GROUND TO ALTITUDE

ALTITUDE M	ZENITH ANGLE OF PATH OF SIGHT (DEG) 93	95	97	100	120	150	180
300	1.514E-01	7.474E-02	4.813E-02	3.232E-02	1.097E-02	6.057E-03	4.096E-03
600	4.938E-01	2.041E-01	1.236E-01	7.896E-02	2.468E-02	1.344E-02	9.064E-03
900	1.270E 00	4.275E-01	2.091E-01	1.442E-01	4.151E-02	2.192E-02	1.475E-02
1500	5.506E 00	1.236E 00	5.043E-01	3.234E-01	7.854E-02	3.927E-02	2.631E-02
3000	5.124E 01	4.060E 00	1.423E 00	6.581E-01	1.316E-01	6.065E-02	4.057E-02

FLIGHT NO. C-137

DIRECTIONAL PATH REFLECTANCE FROM GROUND TO ALTITUDE

AZIMUTH OF PATH OF SIGHT = 270

AZIMUTH OF PATH OF SIGHT = 270

FLIGHT NO. C-137 FILTER NO. 2

DIRECTIONAL PATH REFLECTANCE FROM GROUND TO ALTITUDE

ALTITUDE M	ZENITH ANGLE OF PATH OF SIGHT (DEG) 93	95	97	100	120	150	180
300	6.466E-01	2.722E-01	1.611E-01	9.879E-02	2.276E-02	1.060E-02	8.628E-03
600	3.521E 00	9.789E-01	4.996E-01	2.747E-01	5.489E-02	2.505E-02	2.037E-02
900	1.699E 01	2.782E 00	1.175E 00	5.692E-01	9.752E-02	4.379E-02	3.564E-02
1500	2.911E 02	1.552E 01	4.349E 00	1.63CE 00	2.052E-01	8.695E-02	7.238E-02
3000	8.181E 03	8.369E 01	1.384E 01	3.968E 00	3.600E-01	1.488E-01	1.207E-01

FLIGHT NO. C-137 FILTER NO. 6

DIRECTIONAL PATH REFLECTANCE FROM GROUND TO ALTITUDE

ALTITUDE M	ZENITH ANGLE OF PATH OF SIGHT (DEG) 93	95	97	100	120	150	180
300	4.868E-01	2.185E-01	1.329E-01	8.343E-02	1.983E-02	9.271E-03	7.656E-03
600	2.115E 00	6.999E-01	3.820E-01	2.208E-01	4.715E-02	2.175E-02	1.789E-02
900	8.223E 00	1.866E 00	8.510E-01	4.450E-01	8.433E-02	3.849E-02	3.152E-02
1500	1.037E 02	8.711E 00	2.910E 00	1.226E 00	1.801E-01	8.009E-02	6.500E-02
3000	1.702E 03	3.600E 01	7.812E 00	2.658E 00	3.067E-01	1.336E-01	1.066E-01

FLIGHT NO. C-137 FILTER NO. 5

DIRECTIONAL PATH REFLECTANCE FROM GROUND TO ALTITUDE

ALTITUDE M	ZENITH ANGLE OF PATH OF SIGHT (DEG) 93	95	97	100	120	150	180
300	4.361E-01	1.944E-01	1.172E-01	7.253E-02	1.667E-02	7.857E-03	6.198E-03
600	1.736E 00	5.851E-01	3.195E-01	1.836E-01	3.852E-02	1.814E-02	1.441E-02
900	5.482E 00	1.323E 00	6.415E-01	3.404E-01	6.557E-02	3.118E-02	2.506E-02
1500	4.619E 01	5.070E 00	1.868E 00	8.363E-01	1.344E-01	6.449E-02	5.276E-02
3000	5.103E 02	1.722E 01	4.430E 00	1.672E 00	2.216E-01	1.029E-01	8.421E-02

FLIGHT NO. C-137 FILTER NO. 3

DIRECTIONAL PATH REFLECTANCE FROM GROUND TO ALTITUDE

ALTITUDE M	ZENITH ANGLE OF PATH OF SIGHT (DEG) 93	95	97	100	120	150	180
300	2.049E-01	9.819E-02	6.133E-02	3.939E-02	1.014E-02	5.132E-03	4.096E-03
600	6.542E-01	2.637E-01	1.552E-01	9.504E-02	2.290E-02	1.138E-02	9.064E-03
900	1.630E 00	5.367E-01	2.929E-01	1.699E-01	3.816E-02	1.855E-02	1.475E-02
1500	7.677E 00	1.525E 00	7.004E-01	3.642E-01	7.127E-02	3.320E-02	2.631E-02
3000	5.135E 01	4.153E 00	1.463E 00	6.650E-01	1.128E-01	5.183E-02	4.057E-02

FLIGHT C-138 – DESCRIPTION OF FLIGHT AND WEATHER CHARACTERISTICS

It was a sunlight morning. The day started with middle and high cloud layers and a lower cumulus developed during this flight. The flight was conducted along an east-west route between Mindelheim and Mengen, passing approximately 8 to 16 kilometers (5 to 10 miles) north of Memmingen. The typical terrain was heavily cultivated, rolling pastureland occasionally interrupted by large patches of dark forest. The data-taking started at 0829 GMT (0929 LCT) and continued until 1039 GMT (1139 LCT). The sun zenith angle during sky radiance data-taking was 42.6 degrees at the start and 29.7 degrees at the end. The highest flight altitude was 4920 meters above ground level.

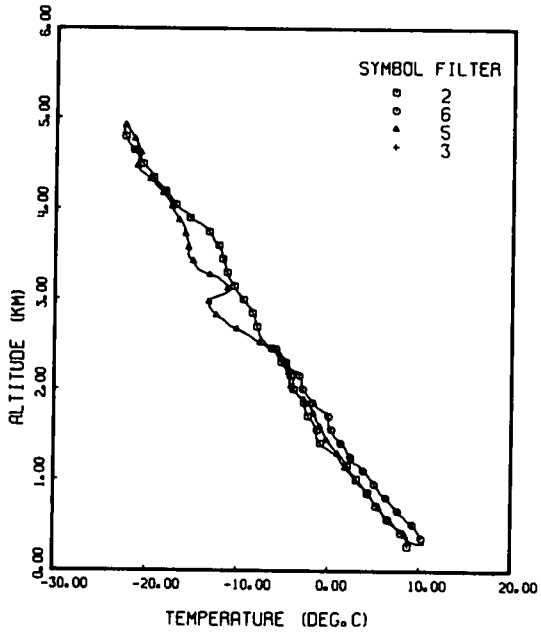
At the time data-taking started, Memmingen was reporting 1/8 cumulus at 900 meters and 6/8 cirrus at 7500 meters. Visibility was reported as 20 kilometers (12 miles).

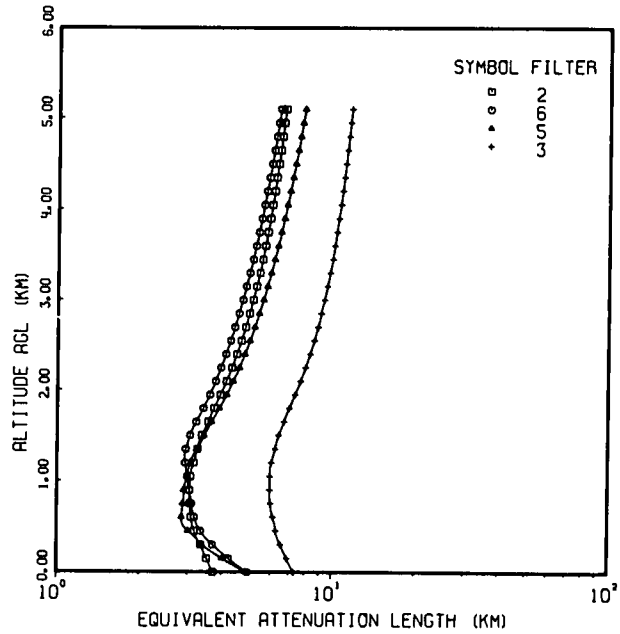
Early in the flight, the aircrew reported clear overhead with an estimated low altitude visibility of 3 to 4 miles (5 to 6 kilometers). During a later ascent, the aircraft passed through some thin clouds at 740 meters, and at 0947 hours, through the altocumulus deck at 3790 meters. Later in the flight, while the aircraft was at 2418 meters, cumulus buildups were observed below the flight path.

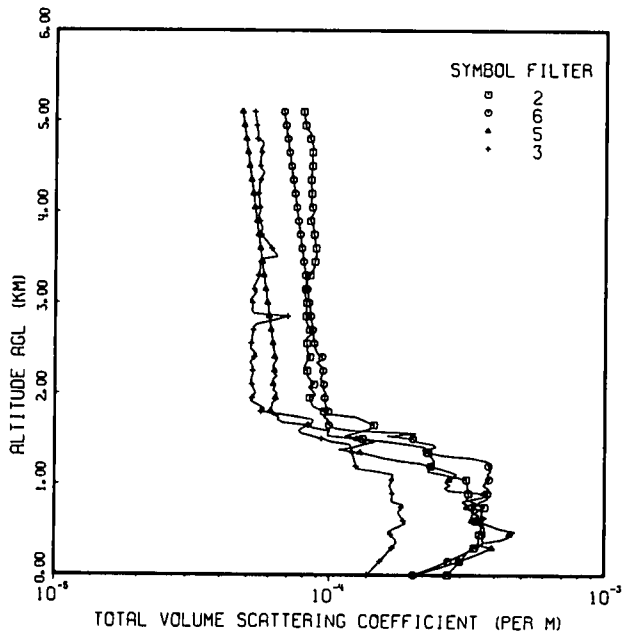
About the time data collection ended, Memmingen was reporting 3/8 cumulus at 1200 meters, 1/8 altocumulus at 4200 meters and 5/8 cirrostratus at 6600 meters. Visibility was reported as 25 kilometers (16 miles).

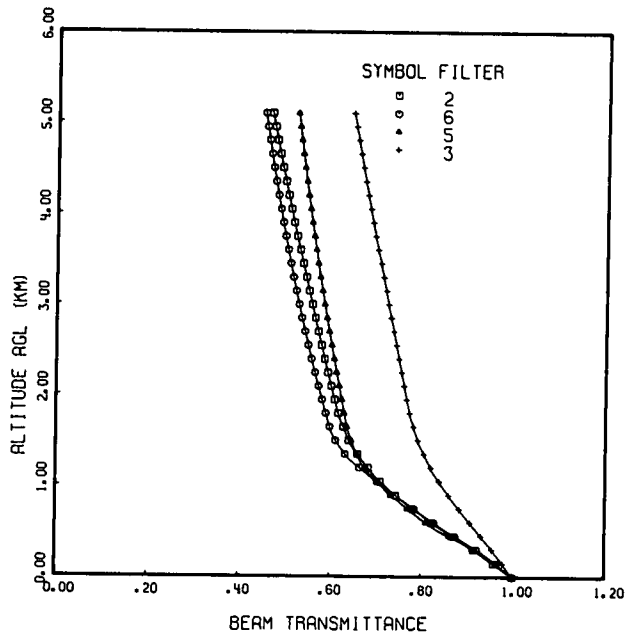
The Memmingen area was located in a col with very weak circulation at the surface. There was a cold front with waves off Norway and through central France. At 500 millibars, there was a deepening trough with a break-off low moving into the Black Sea shown on the 1200 GMT chart. The winds were moderate northwesterly. There was a 3°C drop in temperature between 0000 and 1200 GMT. The airmass was unstable maritime polar.

FLIGHT NO. C-138

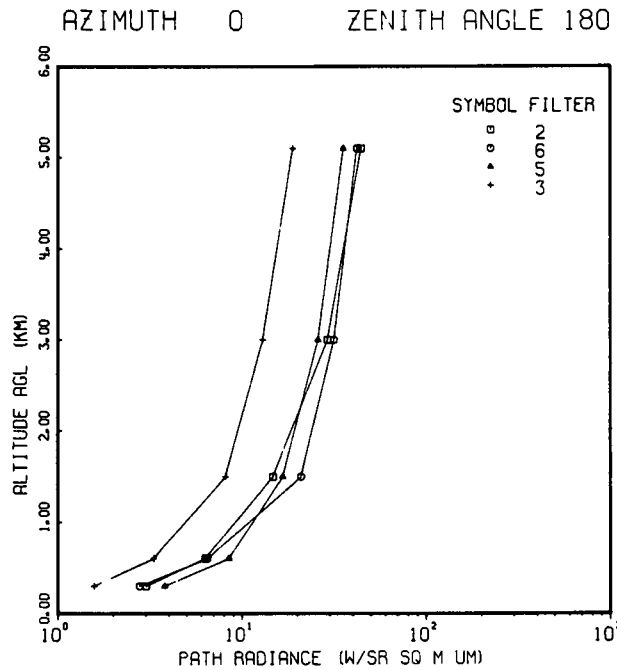


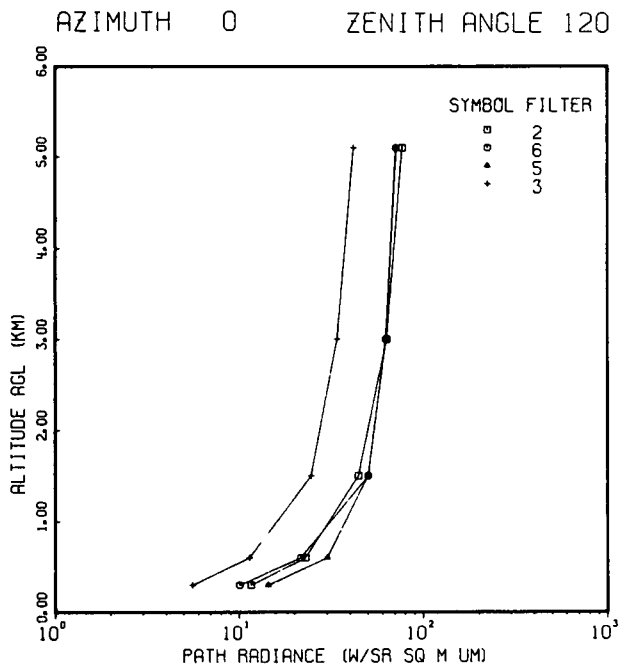


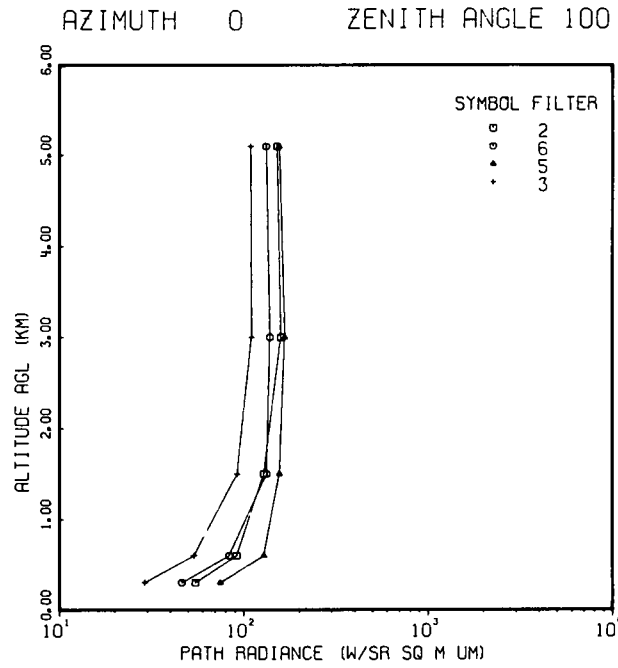




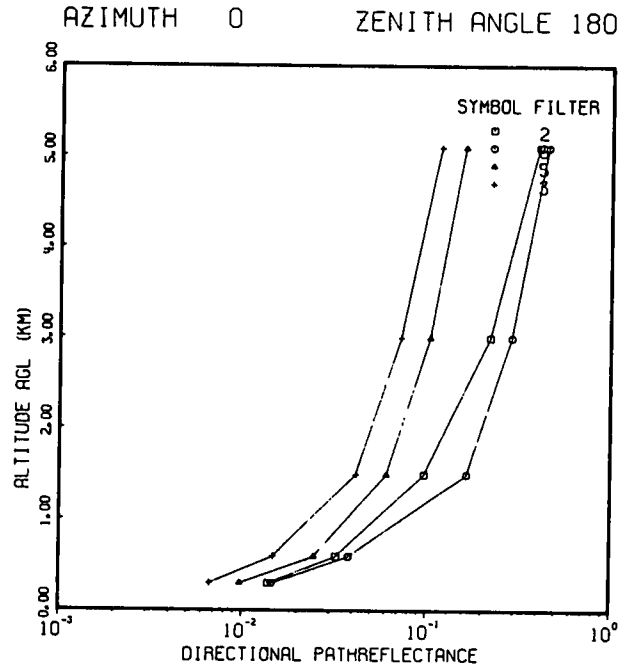
FLIGHT NO. C-138

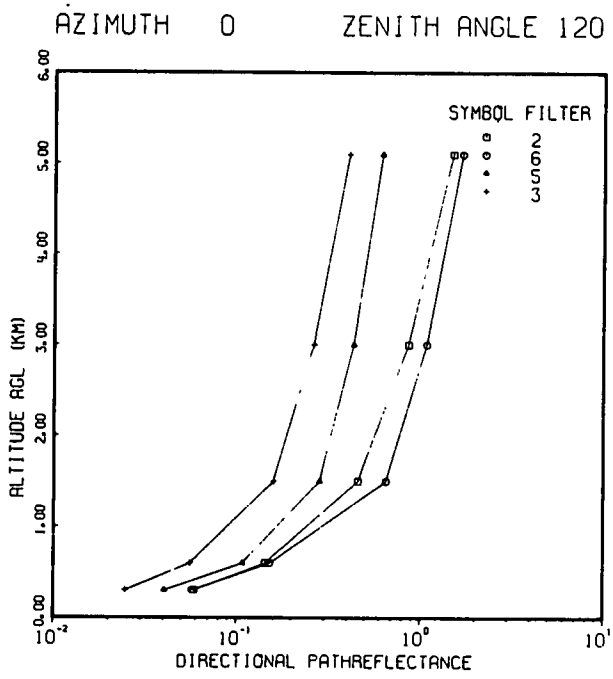


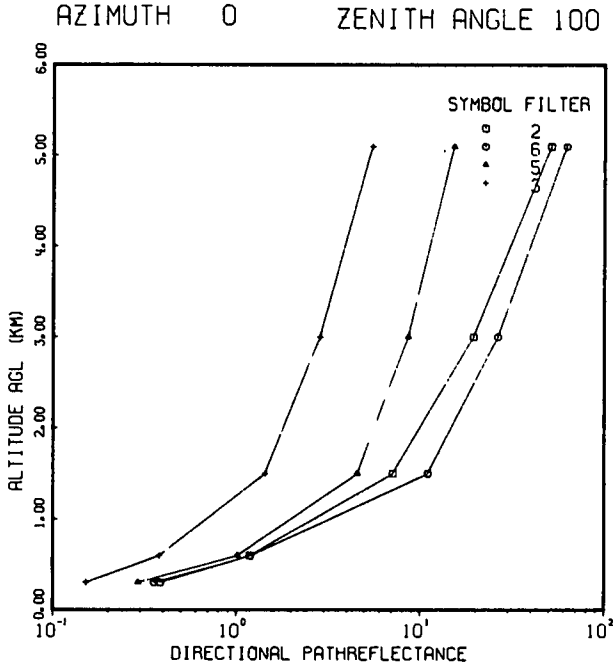




FLIGHT NO. C-138







FLIGHT NO. C-138
IRRADIANCE

FLIGHT NO.C-138 FILTER NO. 2
IRRADIANCE (W/SQ M UM)

ALTITUDE (METERS)	DOWN-WELLING	UP-WELLING	ALBEDO	SCALAR DOWNWELLING	SCALAR UPWELLING	SCALAR TOTAL	SCALAR ALBEDO
353	7.446E 02	3.489E 01	.047	1.308E 03	1.181E 02	1.426E 03	.090
1284	9.303E 02	5.613E 01	.060	1.481E 03	1.743E 02	1.655E 03	.118
2473	2.082E 03	9.537E 01	.046	2.726E 03	2.503E 02	2.976E 03	.092
4914	1.114E 03	1.133E 02	.102	1.491E 03	2.939E 02	1.785E 03	.197

FLIGHT NO.C-138 FILTER NO. 6
IRRADIANCE (W/SQ M UM)

ALTITUDE (METERS)	DOWN-WELLING	UP-WELLING	ALBEDO	SCALAR DOWNWELLING	SCALAR UPWELLING	SCALAR TOTAL	SCALAR ALBEDO
363	6.503E 02	4.627E 01	.071	1.164E 03	1.235E 02	1.287E 03	.106
1303	1.223E 03	6.159E 01	.050	1.782E 03	1.654E 02	1.948E 03	.093
2454	1.363E 03	7.297E 01	.054	1.886E 03	2.068E 02	2.093E 03	.110
4930	1.054E 03	1.205E 02	.114	1.415E 03	2.867E 02	1.704E 03	.204

FLIGHT NO.C-138 FILTER NO. 5
IRRADIANCE (W/SQ M UM)

ALTITUDE (METERS)	DOWN-WELLING	UP-WELLING	ALBEDO	SCALAR DOWNWELLING	SCALAR UPWELLING	SCALAR TOTAL	SCALAR ALBEDO
362	1.336E 03	4.237E 01	.032	2.124E 03	1.263E 02	2.250E 03	.059
1284	1.456E 03	5.089E 01	.035	2.102E 03	1.575E 02	2.260E 03	.075
2454	1.752E 03	9.865E 01	.056	2.443E 03	2.576E 02	2.707E 03	.105
4930	1.163E 03	1.198E 02	.103	1.506E 03	2.944E 02	1.800E 03	.196

FLIGHT NO.C-138 FILTER NO. 3
IRRADIANCE (W/SQ M UM)

ALTITUDE (METERS)	DOWN-WELLING	UP-WELLING	ALBEDO	SCALAR DOWNWELLING	SCALAR UPWELLING	SCALAR TOTAL	SCALAR ALBEDO
363	7.794E 02	4.052E 01	.052	1.259E 03	1.108E 02	1.370E 03	.088
1238	1.012E 03	5.613E 01	.055	1.455E 03	1.446E 02	1.599E 03	.099
2471	1.470E 03	7.120E 01	.048	1.926E 03	1.866E 02	2.114E 03	.097
4927	9.085E 02	1.016E 02	.112	1.144E 03	2.339E 02	1.378E 03	.205

FLIGHT NO. C-138
DIRECTIONAL REFLECTANCE OF BACKGROUND

FLIGHT NO. C-138
AZIMUTH OF PATH OF SIGHT = 0
DIRECTIONAL REFLECTANCE OF BACKGROUND

ZENITH ANGLE	FILTERS 2	6	5	3
93	.39138	.40699	.19352	.32341
95	.30484	.33872	.14783	.18489
97	.20523	.27304	.10841	.15642
100	.17014	.19714	.07962	.10587
120	.05917	.08268	.04037	.04728
150	.01842	.04499	.00839	.06298
180	.03372	.01912	.02333	.04070

FLIGHT NO. C-138
AZIMUTH OF PATH OF SIGHT = 90
DIRECTIONAL REFLECTANCE OF BACKGROUND

ZENITH ANGLE	FILTERS 2	6	5	3
93	.20405	.18940	.11372	.13190
95	.17010	.15107	.08838	.10235
97	.08827	.11751	.07171	.09176
100	.09186	.09753	.05001	.06627
120	.05700	.07929	.03604	.03696
150	.01791	.04031	.02676	.03592
180	.03372	.01912	.02333	.04070

FLIGHT NO. C-138
AZIMUTH OF PATH OF SIGHT = 180
DIRECTIONAL REFLECTANCE OF BACKGROUND

ZENITH ANGLE	FILTERS 2	6	5	3
93	.14065	.14314	.06656	.08292
95	.11286	.09477	.05806	.07044
97	.10299	.09325	.05502	.05660
100	.06279	.08473	.05631	.05894
120	.06577	.04647	.02634	.05081
150	.02787	.05565	.01641	.04523
180	.03372	.01912	.02333	.04070

FLIGHT NO. C-138
AZIMUTH OF PATH OF SIGHT = 270
DIRECTIONAL REFLECTANCE OF BACKGROUND

ZENITH ANGLE	FILTERS 2	6	5	3
93	.18591	.21140	.09749	.13415
95	.11341	.11254	.06199	.07794
97	.13324	.08033	.05700	.07114
100	.08457	.06614	.03707	.06304
120	.05155	.06547	.03729	.03787
150	.02816	.05639	.01492	.04078
180	.03372	.01912	.02333	.04070

FLIGHT NO. C-138
TOTAL VOLUME SCATTERING COEFFICIENT

DATE 52970 FLIGHT NO. C-138 GROUND LEVEL ALTITUDE (M)= 629

ALTITUDE (M)	TOTAL VOLUME SCATTERING COEFFICIENT (PER M)			
	FILTERS 2	6	5	3
0	2.690E-04	2.020E-04	2.020E-04	1.370E-04
30	2.748E-04	2.156E-04	2.209E-04	1.402E-04
60	2.807E-04	2.292E-04	2.398E-04	1.434E-04
90	2.865E-04	2.428E-04	2.586E-04	1.466E-04
120	2.924E-04	2.565E-04	2.775E-04	1.497E-04
150	2.982E-04	2.701E-04	2.964E-04	1.529E-04
180	3.041E-04	2.837E-04	3.153E-04	1.561E-04
210	3.099E-04	2.973E-04	3.341E-04	1.593E-04
240	3.158E-04	3.109E-04	3.530E-04	1.625E-04
270	3.216E-04	3.245E-04	3.719E-04	1.657E-04
300	3.357E-04	3.382E-04	3.908E-04	1.689E-04
330	3.488E-04	3.518E-04	3.520E-04	1.720E-04
360	3.490E-04	3.654E-04	3.661E-04	1.752E-04
390	3.492E-04	3.601E-04	4.213E-04	1.743E-04
420	3.495E-04	3.625E-04	4.496E-04	1.706E-04
450	3.511E-04	3.584E-04	4.522E-04	1.669E-04
480	3.544E-04	3.683E-04	4.754E-04	1.631E-04
510	3.577E-04	3.664E-04	4.141E-04	1.720E-04
540	3.574E-04	3.644E-04	3.887E-04	1.808E-04
570	3.487E-04	3.515E-04	3.668E-04	1.896E-04
600	3.400E-04	3.524E-04	3.295E-04	1.855E-04
630	3.312E-04	3.736E-04	3.362E-04	1.829E-04
660	3.286E-04	3.545E-04	3.501E-04	1.803E-04
690	3.388E-04	3.594E-04	3.295E-04	1.777E-04
720	3.491E-04	3.542E-04	3.369E-04	1.800E-04
750	3.662E-04	3.295E-04	3.198E-04	1.824E-04
780	3.491E-04	3.453E-04	3.170E-04	1.848E-04
810	3.319E-04	3.530E-04	3.027E-04	1.680E-04
840	3.148E-04	3.749E-04	3.352E-04	1.683E-04
870	3.211E-04	3.769E-04	3.764E-04	1.685E-04
900	3.201E-04	3.761E-04	3.662E-04	1.687E-04
930	3.191E-04	3.822E-04	2.698E-04	1.676E-04
960	3.181E-04	3.773E-04	2.622E-04	1.663E-04
990	3.169E-04	3.612E-04	2.753E-04	1.650E-04
1020	3.157E-04	3.693E-04	2.630E-04	1.672E-04
1050	3.146E-04	3.804E-04	2.716E-04	1.682E-04
1080	2.853E-04	3.815E-04	2.823E-04	1.692E-04
1110	2.561E-04	3.746E-04	2.902E-04	1.701E-04
1140	2.269E-04	3.856E-04	2.705E-04	1.481E-04
1170	2.302E-04	3.637E-04	2.505E-04	1.262E-04
1200	2.335E-04	3.790E-04	2.318E-04	1.244E-04
1230	2.369E-04	3.887E-04	2.126E-04	1.236E-04
1260	2.402E-04	3.705E-04	1.730E-04	1.228E-04
1290	2.361E-04	3.260E-04	1.558E-04	1.221E-04
1320	2.321E-04	2.540E-04	1.414E-04	1.213E-04
1350	2.280E-04	2.254E-04	1.288E-04	1.205E-04
1380	2.240E-04	2.173E-04	1.079E-04	1.197E-04
1410	2.222E-04	2.439E-04	1.228E-04	1.189E-04
1440	1.920E-04	2.376E-04	1.332E-04	1.182E-04
1470	1.617E-04	2.058E-04	1.463E-04	1.004E-04
1500	1.315E-04	2.005E-04	1.254E-04	9.312E-05

FLIGHT NO. C-138
TOTAL VOLUME SCATTERING COEFFICIENT

DATE 52970 FLIGHT NO. C-138 GROUND LEVEL ALTITUDE (M)= 629

ALTITUDE (M)	TOTAL VOLUME SCATTERING COEFFICIENT (PER M) FILTERS 2	6	5	3
1530	1.136E-04	1.615E-04	9.827E-05	8.585E-05
1560	1.236E-04	2.062E-04	9.851E-05	7.858E-05
1590	1.336E-04	1.191E-04	9.955E-05	7.690E-05
1620	1.437E-04	1.027E-04	8.666E-05	8.014E-05
1650	1.447E-04	9.925E-05	8.313E-05	8.338E-05
1680	1.377E-04	9.753E-05	6.680E-05	8.661E-05
1710	1.308E-04	9.877E-05	6.444E-05	8.682E-05
1740	1.238E-04	9.469E-05	6.509E-05	7.655E-05
1770	9.938E-05	9.690E-05	6.161E-05	6.627E-05
1800	9.500E-05	9.887E-05	6.082E-05	5.599E-05
1830	9.062E-05	9.790E-05	6.079E-05	5.792E-05
1860	8.624E-05	9.687E-05	6.180E-05	5.960E-05
1890	8.559E-05	9.613E-05	6.154E-05	5.329E-05
1920	8.494E-05	9.545E-05	6.321E-05	5.128E-05
1950	8.429E-05	9.577E-05	6.329E-05	5.200E-05
1980	8.894E-05	9.573E-05	6.390E-05	5.273E-05
2010	8.734E-05	9.664E-05	6.292E-05	5.345E-05
2040	8.573E-05	9.465E-05	6.173E-05	5.293E-05
2070	8.337E-05	9.418E-05	6.303E-05	5.241E-05
2100	8.744E-05	9.492E-05	6.218E-05	5.189E-05
2130	8.588E-05	9.439E-05	6.201E-05	5.136E-05
2160	8.432E-05	9.229E-05	6.202E-05	5.154E-05
2190	8.276E-05	9.288E-05	6.440E-05	5.195E-05
2220	8.267E-05	9.446E-05	6.237E-05	5.236E-05
2250	8.257E-05	9.435E-05	6.281E-05	5.226E-05
2280	8.006E-05	9.411E-05	6.216E-05	5.216E-05
2310	8.101E-05	9.192E-05	6.218E-05	5.205E-05
2340	8.196E-05	8.902E-05	6.310E-05	5.121E-05
2370	8.291E-05	9.375E-05	6.409E-05	5.210E-05
2400	8.466E-05	9.355E-05	6.285E-05	5.299E-05
2430	8.354E-05	9.027E-05	6.266E-05	5.387E-05
2460	8.243E-05	8.886E-05	6.246E-05	5.258E-05
2490	8.234E-05	8.813E-05	6.226E-05	5.130E-05
2520	8.225E-05	8.791E-05	6.207E-05	5.146E-05
2550	8.217E-05	8.768E-05	6.187E-05	5.162E-05
2580	8.208E-05	8.736E-05	6.168E-05	5.179E-05
2610	8.199E-05	8.708E-05	6.149E-05	5.195E-05
2640	8.464E-05	8.681E-05	6.129E-05	5.211E-05
2670	8.667E-05	8.654E-05	6.110E-05	5.228E-05
2700	8.436E-05	8.627E-05	6.091E-05	5.244E-05
2730	8.350E-05	8.600E-05	6.072E-05	5.261E-05
2760	8.264E-05	8.573E-05	6.053E-05	5.351E-05
2790	8.178E-05	8.546E-05	6.034E-05	5.903E-05
2820	8.158E-05	8.519E-05	6.015E-05	6.456E-05
2850	8.154E-05	8.493E-05	5.996E-05	7.009E-05
2880	8.149E-05	8.466E-05	5.978E-05	5.263E-05
2910	8.145E-05	8.440E-05	5.959E-05	5.178E-05
2940	8.140E-05	8.413E-05	5.940E-05	5.189E-05
2970	8.223E-05	8.387E-05	5.922E-05	5.199E-05
3000	8.168E-05	8.361E-05	5.903E-05	5.210E-05

FLIGHT NO. C-138
TOTAL VOLUME SCATTERING COEFFICIENT

DATE 52970 FLIGHT NO. C-138 GROUND LEVEL ALTITUDE (M)= 629

ALTITUDE (M)	TOTAL VOLUME SCATTERING COEFFICIENT (PER M) FILTERS 2	6	5	3
3030	8.154E-05	8.335E-05	5.885E-05	5.094E-05
3060	8.120E-05	8.309E-05	5.866E-05	5.203E-05
3090	8.066E-05	8.283E-05	5.848E-05	5.313E-05
3120	8.092E-05	8.257E-05	5.830E-05	5.422E-05
3150	8.118E-05	8.231E-05	5.812E-05	5.278E-05
3180	8.144E-05	8.205E-05	5.794E-05	5.244E-05
3210	8.170E-05	8.180E-05	5.775E-05	5.325E-05
3240	8.212E-05	8.154E-05	5.757E-05	5.406E-05
3270	8.319E-05	8.129E-05	5.740E-05	5.488E-05
3300	8.427E-05	8.104E-05	5.722E-05	5.452E-05
3330	8.534E-05	8.078E-05	5.704E-05	5.507E-05
3360	8.642E-05	8.053E-05	5.686E-05	5.525E-05
3390	8.723E-05	8.028E-05	5.668E-05	5.543E-05
3420	8.735E-05	8.003E-05	5.651E-05	5.561E-05
3450	8.775E-05	7.976E-05	5.633E-05	5.579E-05
3480	8.815E-05	7.953E-05	5.616E-05	5.548E-05
3510	8.856E-05	7.929E-05	5.598E-05	6.411E-05
3540	8.896E-05	7.904E-05	5.581E-05	6.308E-05
3570	8.867E-05	7.880E-05	5.563E-05	6.206E-05
3600	8.838E-05	7.855E-05	5.546E-05	6.103E-05
3630	8.808E-05	7.831E-05	5.529E-05	6.000E-05
3660	8.779E-05	7.806E-05	5.512E-05	5.898E-05
3690	8.749E-05	7.782E-05	5.495E-05	5.795E-05
3720	8.720E-05	7.758E-05	5.478E-05	5.692E-05
3750	8.690E-05	7.734E-05	5.461E-05	5.590E-05
3780	8.661E-05	7.710E-05	5.444E-05	5.487E-05
3810	8.631E-05	7.686E-05	5.427E-05	5.648E-05
3840	8.602E-05	7.662E-05	5.410E-05	5.604E-05
3870	8.573E-05	7.638E-05	5.393E-05	5.561E-05
3900	8.425E-05	7.615E-05	5.376E-05	5.517E-05
3930	8.365E-05	7.591E-05	5.360E-05	5.474E-05
3960	8.517E-05	7.567E-05	5.343E-05	5.430E-05
3990	8.669E-05	7.544E-05	5.326E-05	5.492E-05
4020	8.613E-05	7.521E-05	5.310E-05	5.554E-05
4050	8.556E-05	7.497E-05	5.293E-05	5.520E-05
4080	8.440E-05	7.474E-05	5.277E-05	5.486E-05
4110	8.460E-05	7.451E-05	5.261E-05	5.452E-05
4140	8.481E-05	7.428E-05	5.244E-05	5.479E-05
4170	8.501E-05	7.405E-05	5.228E-05	5.456E-05
4200	8.495E-05	7.382E-05	5.212E-05	5.434E-05
4230	8.490E-05	7.359E-05	5.196E-05	5.456E-05
4260	8.484E-05	7.336E-05	5.180E-05	5.465E-05
4290	8.436E-05	7.313E-05	5.164E-05	5.474E-05
4320	8.437E-05	7.290E-05	5.148E-05	5.483E-05
4350	8.438E-05	7.268E-05	5.132E-05	5.536E-05
4380	8.520E-05	7.245E-05	5.116E-05	5.589E-05
4410	8.459E-05	7.223E-05	5.100E-05	5.641E-05
4440	8.488E-05	7.200E-05	5.084E-05	5.694E-05
4470	8.517E-05	7.178E-05	5.068E-05	5.548E-05
4500	8.547E-05	7.156E-05	5.052E-05	5.514E-05

FLIGHT NO. C-138
TOTAL VOLUME SCATTERING COEFFICIENT

DATE 52970 FLIGHT NO. C-138 GROUND LEVEL ALTITUDE (M)= 629

ALTITUDE (M)	TOTAL VOLUME SCATTERING COEFFICIENT (PER M)			
FILTERS	2	6	5	3
4530	8.537E-05	7.134E-05	5.037E-05	5.480E-05
4560	8.527E-05	7.111E-05	5.021E-05	5.505E-05
4590	8.517E-05	7.089E-05	5.005E-05	5.529E-05
4620	8.507E-05	7.067E-05	4.990E-05	5.553E-05
4650	8.542E-05	7.045E-05	4.974E-05	5.577E-05
4680	8.577E-05	7.023E-05	4.959E-05	5.507E-05
4710	8.612E-05	7.001E-05	4.943E-05	5.586E-05
4740	8.534E-05	6.980E-05	4.928E-05	5.666E-05
4770	8.456E-05	6.958E-05	4.913E-05	5.619E-05
4800	8.378E-05	6.936E-05	4.897E-05	5.377E-05
4830	8.300E-05	6.915E-05	4.882E-05	5.377E-05
4860	8.447E-05	6.893E-05	4.867E-05	5.378E-05
4890	8.260E-05	6.872E-05	4.852E-05	5.378E-05
4920	8.074E-05	6.850E-05	4.837E-05	5.361E-05
4950	8.048E-05	6.829E-05	4.822E-05	5.344E-05
4980	8.023E-05	6.807E-05	4.806E-05	5.327E-05
5010	7.998E-05	6.786E-05	4.791E-05	5.311E-05
5040	7.973E-05	6.765E-05	4.776E-05	5.294E-05
5070	7.948E-05	6.744E-05	4.762E-05	5.278E-05
5100	7.923E-05	6.723E-05	4.747E-05	5.261E-05
FIRST DATA ALT	0	0	0	0
LAST DATA ALT	4920	2490	2400	4890

FLIGHT NO. C-138
BEAM TRANSMITTANCE FROM GROUND TO ALTITUDE

FLIGHT NO. C-138 FILTER NO. 2
BEAM TRANSMITTANCE FROM GROUND TO ALTITUDE

ALTITUDE M	ZENITH ANGLE OF PATH OF SIGHT (DEG) 93	95	97	100	120	150	180
300	.1761982	.3567383	.4794179	.5969248	.8359450	.9017150	.9143003
600	.0229061	.1058363	.2023682	.3258656	.6774543	.7986538	.8230761
1500	.0001365	.0055493	.0257418	.0766581	.4098369	.5975041	.6401851
3000	.0000034	.0009498	.0082633	.0345320	.3106917	.5092093	.5573972
5100	.0000000	.0000882	.0019225	.0124098	.2177569	.4147419	.4666443

FLIGHT NO. C-138 FILTER NO. 6
BEAM TRANSMITTANCE FROM GROUND TO ALTITUDE

ALTITUDE M	ZENITH ANGLE OF PATH OF SIGHT (DEG) 93	95	97	100	120	150	180
300	.2102985	.3937591	.5143505	.6271286	.8503989	.9106839	.9221707
600	.0257240	.1132917	.2123327	.3370450	.6854373	.8040738	.8279114
1500	.0000557	.0032515	.0175911	.0586835	.3735168	.5663347	.6111602
3000	.0000011	.0005054	.0053336	.0253970	.2792458	.4787847	.5284371
5100	.0000000	.0000576	.0014617	.0102386	.2036873	.3990526	.4513173

FLIGHT NO. C-138 FILTER NO. 5
BEAM TRANSMITTANCE FROM GROUND TO ALTITUDE

ALTITUDE M	ZENITH ANGLE OF PATH OF SIGHT (DEG) 93	95	97	100	120	150	180
300	.1807326	.3596238	.4821106	.5992758	.8370870	.9024259	.9149246
600	.0169824	.0884692	.1780542	.2978683	.6566449	.7843967	.8103363
1500	.0001575	.0060711	.0274908	.0802777	.4164566	.6030572	.6453345
3000	.0000085	.0016575	.0122370	.0454879	.3418946	.5381366	.5847175
5100	.0000001	.0003420	.0049062	.0239511	.2736167	.4731904	.5230857

FLIGHT NO. C-138 FILTER NO. 3
BEAM TRANSMITTANCE FROM GROUND TO ALTITUDE

ALTITUDE M	ZENITH ANGLE OF PATH OF SIGHT (DEG) 93	95	97	100	120	150	180
300	.4134524	.5499022	.6862920	.7678194	.9123278	.9484034	.9551585
600	.1490731	.3224253	.4470061	.5683081	.8216033	.8928761	.9065337
1500	.0093532	.0653198	.1461709	.2593490	.6258125	.7629166	.7910831
3000	.0009913	.0216449	.0710127	.1562598	.5248390	.6892186	.7244578
5100	.0000325	.0047214	.0273794	.0800491	.4160444	.6027125	.6450151

FLIGHT NO. C-138
PATH RADIANCE FROM GROUND TO ALTITUDE
AZIMUTH OF PATH OF SIGHT = 0

AZIMUTH OF PATH OF SIGHT = 0

FLIGHT NO. C-138 FILTER NO. 2

PATH RADIANCE FROM GROUND TO ALTITUDE (W/SR SQ M UM)

ALTITUDE M	ZENITH ANGLE OF PATH OF SIGHT (DEG) 93	95	97	100	120	150	180
300	1.557E 02	1.091E 02	7.843E 01	5.467E 01	1.160E 01	3.788E 00	3.013E 00
600	1.706E 02	1.475E 02	1.205E 02	9.166E 01	2.299E 01	7.882E 00	6.334E 00
1500	1.789E 02	1.659E 02	1.512E 02	1.289E 02	4.459E 01	1.760E 01	1.474E 01
3000	2.239E 02	2.035E 02	1.842E 02	1.591E 02	6.347E 01	3.006E 01	2.917E 01
5100	1.580E 02	1.625E 02	1.605E 02	1.507E 02	7.719E 01	4.254E 01	4.445E 01

FLIGHT NO. C-138 FILTER NO. 6

PATH RADIANCE FROM GROUND TO ALTITUDE (W/SR SQ M UM)

ALTITUDE M	ZENITH ANGLE OF PATH OF SIGHT (DEG) 93	95	97	100	120	150	180
300	1.368E 02	9.338E 01	6.645E 01	4.614E 01	1.005E 01	3.490E 00	2.775E 00
600	1.578E 02	1.348E 02	1.096E 02	8.339E 01	2.162E 01	7.981E 00	6.515E 00
1500	1.822E 02	1.686E 02	1.537E 02	1.335E 02	5.035E 01	2.293E 01	2.096E 01
3000	1.658E 02	1.614E 02	1.533E 02	1.389E 02	6.260E 01	3.221E 01	3.166E 01
5100	1.439E 02	1.430E 02	1.400E 02	1.320E 02	7.126E 01	4.072E 01	4.213E 01

FLIGHT NO. C-138 FILTER NO. 5

PATH RADIANCE FROM GROUND TO ALTITUDE (W/SR SQ M UM)

ALTITUDE M	ZENITH ANGLE OF PATH OF SIGHT (DEG) 93	95	97	100	120	150	180
300	2.230E 02	1.543E 02	1.094E 02	7.448E 01	1.438E 01	4.593E 00	3.797E 00
600	2.380E 02	2.083E 02	1.708E 02	1.288E 02	3.018E 01	1.018E 01	8.516E 00
1500	2.100E 02	1.984E 02	1.821E 02	1.561E 02	5.025E 01	1.921E 01	1.669E 01
3000	2.143E 02	2.030E 02	1.891E 02	1.668E 02	6.311E 01	2.776E 01	2.594E 01
5100	1.629E 02	1.681E 02	1.660E 02	1.553E 02	7.177E 01	3.589E 01	3.561E 01

FLIGHT NO. C-138 FILTER NO. 3

PATH RADIANCE FROM GROUND TO ALTITUDE (W/SR SQ M UM)

ALTITUDE M	ZENITH ANGLE OF PATH OF SIGHT (DEG) 93	95	97	100	120	150	180
300	1.138E 02	6.618E 01	4.389E 01	2.892E 01	5.569E 00	1.898E 00	1.573E 00
600	1.486E 02	1.066E 02	7.722E 01	5.375E 01	1.137E 01	3.982E 00	3.322E 00
1500	1.602E 02	1.412E 02	1.180E 02	9.226E 01	2.471E 01	9.480E 00	8.146E 00
3000	1.697E 02	1.543E 02	1.351E 02	1.104E 02	3.416E 01	1.437E 01	1.301E 01
5100	1.259E 02	1.283E 02	1.227E 02	1.088E 02	4.207E 01	1.985E 01	1.890E 01

FLIGHT NO. C-138
PATH RADIANCE FROM GROUND TO ALTITUDE
AZIMUTH OF PATH OF SIGHT = 90

AZIMUTH OF PATH OF SIGHT = 90

FLIGHT NO. C-138 FILTER NO. 2

PATH RADIANCE FROM GROUND TO ALTITUDE (W/SR SQ M UM)

ALTITUDE M	ZENITH ANGLE OF PATH OF SIGHT (DEG) 93	95	97	100	120	150	180
300	6.896E 01	4.975E 01	3.697E 01	2.723E 01	8.039E 00	3.678E 00	3.013E 00
600	7.612E 01	6.763E 01	5.708E 01	4.592E 01	1.600E 01	7.670E 00	6.334E 00
1500	8.450E 01	7.993E 01	7.506E 01	6.759E 01	3.214E 01	1.741E 01	1.474E 01
3000	1.296E 02	1.179E 02	1.079E 02	9.641E 01	5.087E 01	3.197E 01	2.917E 01
5100	1.036E 02	1.070E 02	1.067E 02	1.028E 02	6.671E 01	4.690E 01	4.445E 01

FLIGHT NO. C-138 FILTER NO. 6

PATH RADIANCE FROM GROUND TO ALTITUDE (W/SR SQ M UM)

ALTITUDE M	ZENITH ANGLE OF PATH OF SIGHT (DEG) 93	95	97	100	120	150	180
300	6.174E 01	4.327E 01	3.175E 01	2.323E 01	6.920E 00	3.363E 00	2.775E 00
600	7.318E 01	6.387E 01	5.340E 01	4.271E 01	1.511E 01	7.749E 00	6.515E 00
1500	9.678E 01	9.163E 01	8.564E 01	7.694E 01	3.849E 01	2.321E 01	2.096E 01
3000	1.127E 02	1.074E 02	1.014E 02	9.292E 01	5.191E 01	3.379E 01	3.166E 01
5100	9.505E 01	9.742E 01	9.725E 01	9.422E 01	6.232E 01	4.402E 01	4.213E 01

FLIGHT NO. C-138 FILTER NO. 5

PATH RADIANCE FROM GROUND TO ALTITUDE (W/SR SQ M UM)

ALTITUDE M	ZENITH ANGLE OF PATH OF SIGHT (DEG) 93	95	97	100	120	150	180
300	8.488E 01	6.082E 01	4.493E 01	3.283E 01	9.528E 00	4.590E 00	3.797E 00
600	9.297E 01	8.374E 01	7.138E 01	5.763E 01	2.019E 01	1.020E 01	8.516E 00
1500	1.000E 02	9.165E 01	8.617E 01	7.713E 01	3.575E 01	1.962E 01	1.669E 01
3000	1.331E 02	1.204E 02	1.103E 02	9.827E 01	4.938E 01	2.950E 01	2.594E 01
5100	1.114E 02	1.130E 02	1.110E 02	1.045E 02	6.111E 01	3.953E 01	3.561E 01

FLIGHT NO. C-138 FILTER NO. 3

PATH RADIANCE FROM GROUND TO ALTITUDE (W/SR SQ M UM)

ALTITUDE M	ZENITH ANGLE OF PATH OF SIGHT (DEG) 93	95	97	100	120	150	180
300	4.230E 01	2.551E 01	1.767E 01	1.254E 01	3.632E 00	1.828E 00	1.573E 00
600	5.577E 01	4.142E 01	3.135E 01	2.347E 01	7.456E 00	3.845E 00	3.322E 00
1500	6.437E 01	5.863E 01	5.113E 01	4.243E 01	1.684E 01	9.319E 00	8.146E 00
3000	7.741E 01	7.104E 01	6.396E 01	5.503E 01	2.488E 01	1.471E 01	1.301E 01
5100	6.720E 01	6.798E 01	6.579E 01	6.061E 01	3.282E 01	2.101E 01	1.890E 01

FLIGHT NO. C-138
PATH RADIANCE FROM GROUND TO ALTITUDE
AZIMUTH OF PATH OF SIGHT = 180

AZIMUTH OF PATH OF SIGHT = 180

FLIGHT NO. C-138 FILTER NO. 2

PATH RADIANCE FROM GROUND TO ALTITUDE (W/SR SQ M UM)

ALTITUDE M	ZENITH ANGLE OF PATH OF SIGHT (DEG) 93	95	97	100	120	150	180
300	5.974E 01	4.314E 01	3.257E 01	2.458E 01	8.603E 00	4.277E 00	3.013E 00
600	6.523E 01	5.888E 01	5.045E 01	4.154E 01	1.712E 01	8.912E 00	6.334E 00
1500	7.594E 01	7.226E 01	6.939E 01	6.265E 01	3.468E 01	2.050E 01	1.474E 01
3000	1.340E 02	1.218E 02	1.117E 02	1.014E 02	6.315E 01	4.522E 01	2.917E 01
5100	1.085E 02	1.135E 02	1.144E 02	1.129E 02	8.736E 01	7.070E 01	4.445E 01

FLIGHT NO. C-138 FILTER NO. 6

PATH RADIANCE FROM GROUND TO ALTITUDE (W/SR SQ M UM)

ALTITUDE M	ZENITH ANGLE OF PATH OF SIGHT (DEG) 93	95	97	100	120	150	180
300	5.330E 01	3.782E 01	2.805E 01	2.085E 01	7.077E 00	3.785E 00	2.775E 00
600	6.350E 01	5.613E 01	4.748E 01	3.867E 01	1.570E 01	8.867E 00	6.515E 00
1500	8.624E 01	8.317E 01	7.927E 01	7.341E 01	4.375E 01	2.890E 01	2.096E 01
3000	1.088E 02	1.042E 02	9.945E 01	9.355E 01	6.267E 01	4.606E 01	3.166E 01
5100	9.767E 01	1.003E 02	1.007E 02	9.971E 01	7.845E 01	6.335E 01	4.213E 01

FLIGHT NO. C-138 FILTER NO. 5

PATH RADIANCE FROM GROUND TO ALTITUDE (W/SR SQ M UM)

ALTITUDE M	ZENITH ANGLE OF PATH OF SIGHT (DEG) 93	95	97	100	120	150	180
300	6.635E 01	4.866E 01	3.672E 01	2.779E 01	1.038E 01	5.553E 00	3.797E 00
600	7.289E 01	6.713E 01	5.843E 01	4.884E 01	2.198E 01	1.237E 01	8.516E 00
1500	7.747E 01	7.492E 01	7.165E 01	6.615E 01	3.883E 01	2.421E 01	1.669E 01
3000	1.231E 02	1.102E 02	1.009E 02	9.147E 01	5.606E 01	3.862E 01	2.594E 01
5100	1.067E 02	1.088E 02	1.066E 02	1.020E 02	7.161E 01	5.433E 01	3.561E 01

FLIGHT NO. C-138 FILTER NO. 3

PATH RADIANCE FROM GROUND TO ALTITUDE (W/SR SQ M UM)

ALTITUDE M	ZENITH ANGLE OF PATH OF SIGHT (DEG) 93	95	97	100	120	150	180
300	3.449E 01	2.131E 01	1.507E 01	1.104E 01	4.000E 00	2.210E 00	1.573E 00
600	4.530E 01	3.451E 01	2.668E 01	2.063E 01	8.205E 00	4.664E 00	3.322E 00
1500	5.153E 01	4.813E 01	4.299E 01	3.694E 01	1.845E 01	1.154E 01	8.146E 00
3000	6.478E 01	6.290E 01	5.715E 01	5.049E 01	2.781E 01	1.847E 01	1.301E 01
5100	6.109E 01	6.225E 01	6.079E 01	5.738E 01	3.702E 01	2.649E 01	1.890E 01

FLIGHT NO. C-138
PATH RADIANCE FROM GROUND TO ALTITUDE
AZIMUTH OF PATH OF SIGHT = 270

AZIMUTH OF PATH OF SIGHT = 270

FLIGHT NO. C-138 FILTER NO. 2

PATH RADIANCE FROM GROUND TO ALTITUDE (W/SR SQ M UM)

ALTITUDE M	ZENITH ANGLE OF PATH OF SIGHT (DEG) 93	95	97	100	120	150	180
300	6.960E 01	5.030E 01	3.735E 01	2.750E 01	8.140E 00	3.766E 00	3.013E 00
600	7.686E 01	6.838E 01	5.767E 01	4.635E 01	1.618E 01	7.833E 00	6.334E 00
1500	8.514E 01	8.070E 01	7.566E 01	6.799E 01	3.222E 01	1.754E 01	1.474E 01
3000	1.275E 02	1.165E 02	1.069E 02	9.573E 01	5.079E 01	3.229E 01	2.917E 01
5100	1.037E 02	1.067E 02	1.062E 02	1.023E 02	6.671E 01	4.745E 01	4.445E 01

FLIGHT NO. C-138 FILTER NO. 6

PATH RADIANCE FROM GROUND TO ALTITUDE (W/SR SQ M UM)

ALTITUDE M	ZENITH ANGLE OF PATH OF SIGHT (DEG) 93	95	97	100	120	150	180
300	6.174E 01	4.329E 01	3.170E 01	2.313E 01	6.841E 00	3.356E 00	2.775E 00
600	7.164E 01	6.297E 01	5.272E 01	4.217E 01	1.492E 01	7.765E 00	6.515E 00
1500	8.682E 01	8.337E 01	7.892E 01	7.192E 01	3.792E 01	2.374E 01	2.096E 01
3000	1.022E 02	9.769E 01	9.323E 01	8.653E 01	5.148E 01	3.503E 01	3.166E 01
5100	9.380E 01	9.452E 01	9.360E 01	9.046E 01	6.193E 01	4.534E 01	4.213E 01

FLIGHT NO. C-138 FILTER NO. 5

PATH RADIANCE FROM GROUND TO ALTITUDE (W/SR SQ M UM)

ALTITUDE M	ZENITH ANGLE OF PATH OF SIGHT (DEG) 93	95	97	100	120	150	180
300	7.956E 01	5.645E 01	4.173E 01	3.058E 01	9.250E 00	4.576E 00	3.797E 00
600	8.581E 01	7.757E 01	6.619E 01	5.360E 01	1.957E 01	1.017E 01	8.516E 00
1500	9.766E 01	8.397E 01	7.917E 01	7.116E 01	3.431E 01	1.957E 01	1.669E 01
3000	1.241E 02	1.118E 02	1.023E 02	9.114E 01	4.688E 01	2.902E 01	2.594E 01
5100	1.036E 02	1.055E 02	1.029E 02	9.659E 01	5.718E 01	3.841E 01	3.561E 01

FLIGHT NO. C-138 FILTER NO. 3

PATH RADIANCE FROM GROUND TO ALTITUDE (W/SR SQ M UM)

ALTITUDE M	ZENITH ANGLE OF PATH OF SIGHT (DEG) 93	95	97	100	120	150	180
300	4.312E 01	2.609E 01	1.805E 01	1.281E 01	3.754E 00	1.882E 00	1.573E 00
600	5.640E 01	4.210E 01	3.187E 01	2.386E 01	7.681E 00	3.952E 00	3.322E 00
1500	6.218E 01	5.722E 01	5.018E 01	4.183E 01	1.696E 01	9.502E 00	8.146E 00
3000	7.950E 01	7.187E 01	6.428E 01	5.505E 01	2.477E 01	1.479E 01	1.301E 01
5100	8.651E 01	8.707E 01	8.552E 01	8.034E 01	3.278E 01	2.112E 01	1.890E 01

FLIGHT NO. C-138
DIRECTIONAL PATH REFLECTANCE FROM GROUND TO ALTITUDE
AZIMUTH OF PATH OF SIGHT = 0

AZIMUTH OF PATH OF SIGHT = 0

FLIGHT NO. C-138 FILTER NO. 2

DIRECTIONAL PATH REFLECTANCE FROM GROUND TO ALTITUDE

ALTITUDE M	ZENITH ANGLE OF PATH OF SIGHT (DEG) 93	95	97	100	120	150	180
300	3.686E 00	1.290E 00	6.902E-01	3.864E-01	5.856E-02	1.772E-02	1.390E-02
600	3.143E 01	5.879E 00	2.511E 00	1.187E 00	1.432E-01	4.164E-02	3.247E-02
1500	5.527E 03	1.261E 02	2.478E 01	7.092E 00	4.590E-01	1.243E-01	9.717E-02
3000	2.806E 05	9.041E 02	9.405E 01	1.944E 01	8.619E-01	2.490E-01	2.208E-01
5100	5.077E 07	7.775E 03	3.522E 02	5.125E 01	1.496E 00	4.328E-01	4.018E-01

FLIGHT NO. C-138 FILTER NO. 6

DIRECTIONAL PATH REFLECTANCE FROM GROUND TO ALTITUDE

ALTITUDE M	ZENITH ANGLE OF PATH OF SIGHT (DEG) 93	95	97	100	120	150	180
300	3.142E 00	1.146E 00	6.241E-01	3.554E-01	5.710E-02	1.851E-02	1.454E-02
600	2.963E 01	5.750E 00	2.493E 00	1.195E 00	1.524E-01	4.795E-02	3.802E-02
1500	1.580E 04	2.505E 02	4.222E 01	1.099E 01	6.511E-01	1.956E-01	1.657E-01
3000	7.314E 05	1.543E 03	1.389E 02	2.641E 01	1.083E 00	3.250E-01	2.894E-01
5100	1.284E 08	1.198E 04	4.626E 02	6.226E 01	1.690E 00	4.930E-01	4.510E-01

FLIGHT NO. C-138 FILTER NO. 5

DIRECTIONAL PATH REFLECTANCE FROM GROUND TO ALTITUDE

ALTITUDE M	ZENITH ANGLE OF PATH OF SIGHT (DEG) 93	95	97	100	120	150	180
300	2.897E 00	1.007E 00	5.327E-01	2.917E-01	4.033E-02	1.195E-02	9.743E-03
600	3.290E 01	5.526E 00	2.251E 00	1.015E 00	1.079E-01	3.045E-02	2.467E-02
1500	3.129E 03	7.670E 01	1.555E 01	4.564E 00	2.833E-01	7.478E-02	6.072E-02
3000	5.900E 04	2.874E 02	3.627E 01	8.610E 00	4.333E-01	1.211E-01	1.041E-01
5100	2.596E 06	1.154E 03	7.944E 01	1.522E 01	6.158E-01	1.781E-01	1.598E-01

FLIGHT NO. C-138 FILTER NO. 3

DIRECTIONAL PATH REFLECTANCE FROM GROUND TO ALTITUDE

ALTITUDE M	ZENITH ANGLE OF PATH OF SIGHT (DEG) 93	95	97	100	120	150	180
300	1.109E 00	4.522E-01	2.577E-01	1.518E-01	2.460E-02	8.067E-03	6.637E-03
600	4.018E 00	1.332E 00	6.963E-01	3.812E-01	5.577E-02	1.797E-02	1.477E-02
1500	6.902E 01	8.712E 00	3.254E 00	1.434E 00	1.591E-01	5.009E-02	4.151E-02
3000	6.901E 02	2.874E 01	7.670E 00	2.849E 00	2.624E-01	8.405E-02	7.237E-02
5100	1.562E 04	1.095E 02	1.806E 01	5.476E 00	4.076E-01	1.327E-01	1.181E-01

FLIGHT NO. C-138
DIRECTIONAL PATH REFLECTANCE FROM GROUND TO ALTITUDE
AZIMUTH OF PATH OF SIGHT = 90

AZIMUTH OF PATH OF SIGHT = 90

FLIGHT NO. C-138 FILTER NO. 2

DIRECTIONAL PATH REFLECTANCE FROM GROUND TO ALTITUDE

ALTITUDE M	ZENITH ANGLE OF PATH OF SIGHT (DEG) 93	95	97	100	120	150	180
300	1.633E 00	5.884E-01	3.253E-01	1.925E-01	4.057E-02	1.721E-02	1.390E-02
600	1.402E 01	2.696E 00	1.190E 00	5.945E-01	9.967E-02	4.051E-02	3.247E-02
1500	2.611E 03	6.077E 01	1.230E 01	3.720E 00	3.308E-01	1.229E-01	9.717E-02
3000	1.624E 05	5.236E 02	5.509E 01	1.178E 01	6.908E-01	2.648E-01	2.208E-01
5100	3.329E 07	5.117E 03	2.341E 02	3.494E 01	1.293E 00	4.771E-01	4.018E-01

FLIGHT NO. C-138 FILTER NO. 6

DIRECTIONAL PATH REFLECTANCE FROM GROUND TO ALTITUDE

ALTITUDE M	ZENITH ANGLE OF PATH OF SIGHT (DEG) 93	95	97	100	120	150	180
300	1.416E 00	5.308E-01	2.982E-01	1.789E-01	3.931E-02	1.784E-02	1.454E-02
600	1.374E 01	2.723E 00	1.215E 00	6.122E-01	1.065E-01	4.655E-02	3.802E-02
1500	8.392E 03	1.361E 02	2.352E 01	6.333E 00	4.978E-01	1.980E-01	1.657E-01
3000	4.969E 05	1.026E 03	9.186E 01	1.768E 01	8.981E-01	3.409E-01	2.894E-01
5100	8.433E 07	8.164E 03	3.214E 02	4.446E 01	1.478E 00	5.329E-01	4.510E-01

FLIGHT NO. C-138 FILTER NO. 5

DIRECTIONAL PATH REFLECTANCE FROM GROUND TO ALTITUDE

ALTITUDE M	ZENITH ANGLE OF PATH OF SIGHT (DEG) 93	95	97	100	120	150	180
300	1.102E 00	3.970E-01	2.188E-01	1.286E-01	2.672E-02	1.194E-02	9.743E-03
600	1.285E 01	2.222E 00	9.410E-01	4.542E-01	7.219E-02	3.053E-02	2.467E-02
1500	1.431E 03	3.544E 01	7.358E 00	2.256E 00	2.015E-01	7.637E-02	6.072E-02
3000	3.664E 04	1.765E 02	2.116E 01	5.071E 00	3.391E-01	1.287E-01	1.041E-01
5100	1.775E 06	7.795E 02	5.313E 01	1.024E 01	5.243E-01	1.961E-01	1.598E-01

FLIGHT NO. C-138 FILTER NO. 3

DIRECTIONAL PATH REFLECTANCE FROM GROUND TO ALTITUDE

ALTITUDE M	ZENITH ANGLE OF PATH OF SIGHT (DEG) 93	95	97	100	120	150	180
300	4.124E-01	1.743E-01	1.038E-01	6.583E-02	1.604E-02	7.770E-03	6.637E-03
600	1.538E 00	5.179E-01	2.827E-01	1.664E-01	3.657E-02	1.736E-02	1.477E-02
1500	7.774E 01	3.618E 00	1.410E 00	6.594E-01	1.085E-01	4.923E-02	4.151E-02
3000	3.147E 02	1.323E 01	3.631E 00	1.420E 00	1.911E-01	8.600E-02	7.237E-02
5100	8.333E 03	5.803E 01	9.685E 00	3.052E 00	3.180E-01	1.405E-01	1.181E-01

FLIGHT NO. C-138
DIRECTIONAL PATH REFLECTANCE FROM GROUND TO ALTITUDE
AZIMUTH OF PATH OF SIGHT = 180

AZIMUTH OF PATH OF SIGHT = 180

FLIGHT NO. C-138 FILTER NO. 2

DIRECTIONAL PATH REFLECTANCE FROM GROUND TO ALTITUDE

ALTITUDE M	ZENITH ANGLE OF PATH OF SIGHT (DEG) 93	95	97	100	120	150	180
300	1.391E 00	5.102E-01	2.866E-01	1.737E-01	4.342E-02	2.001E-02	1.390E-02
600	1.201E 01	2.347E 00	1.052E 00	5.378E-01	1.066E-01	4.708E-02	3.247E-02
1500	2.346E 03	5.493E 01	1.121E 01	3.448E 00	3.570E-01	1.448E-01	9.717E-02
3000	1.679E 05	5.411E 02	5.703E 01	1.238E 01	8.576E-01	3.747E-01	2.208E-01
5100	3.487E 07	5.431E 03	2.512E 02	3.839E 01	1.693E 00	7.192E-01	4.018E-01

FLIGHT NO. C-138 FILTER NO. 6

DIRECTIONAL PATH REFLECTANCE FROM GROUND TO ALTITUDE

ALTITUDE M	ZENITH ANGLE OF PATH OF SIGHT (DEG) 93	95	97	100	120	150	180
300	1.224E 00	4.640E-01	2.634E-01	1.606E-01	4.02CE-02	2.008E-02	1.454E-02
600	1.193E 01	2.393E 00	1.080E 00	5.543E-01	1.107E-01	5.327E-02	3.802E-02
1500	7.478E 03	1.236E 02	2.177E 01	6.043E 00	5.658E-01	2.465E-01	1.657E-01
3000	4.799E 05	9.960E 02	9.007E 01	1.779E 01	1.084E 00	4.648E-01	2.894E-01
5100	9.717E 07	8.408E 03	3.379E 02	4.705E 01	1.861E 00	7.670E-01	4.510E-01

FLIGHT NO. C-138 FILTER NO. 5

DIRECTIONAL PATH REFLECTANCE FROM GROUND TO ALTITUDE

ALTITUDE M	ZENITH ANGLE OF PATH OF SIGHT (DEG) 93	95	97	100	120	150	180
300	8.617E-01	3.176E-01	1.788E-01	1.089E-01	2.911E-02	1.445E-02	9.743E-03
600	1.008E 01	1.781E 00	7.703E-01	3.849E-01	7.858E-02	3.703E-02	2.467E-02
1500	1.155E 03	2.897E 01	6.118E 00	1.934E 00	2.189E-01	9.425E-02	6.072E-02
3000	3.389E 04	1.561E 02	1.936E 01	4.720E 00	3.849E-01	1.685E-01	1.041E-01
5100	1.700E 06	7.469E 02	5.100E 01	9.994E 00	6.144E-01	2.695E-01	1.598E-01

FLIGHT NO. C-138 FILTER NO. 3

DIRECTIONAL PATH REFLECTANCE FROM GROUND TO ALTITUDE

ALTITUDE M	ZENITH ANGLE OF PATH OF SIGHT (DEG) 93	95	97	100	120	150	180
300	3.363E-01	1.456E-01	8.830E-02	5.796E-02	1.767E-02	9.393E-03	6.637E-03
600	1.225E 00	4.314E-01	2.406E-01	1.463E-01	4.024E-02	2.105E-02	1.477E-02
1500	2.221E 01	2.970E 00	1.185E 00	5.742E-01	1.188E-01	6.095E-02	4.151E-02
3000	2.797E 02	1.171E 01	3.244E 00	1.302E 00	2.136E-01	1.080E-01	7.237E-02
5100	7.580E 03	5.314E 01	8.950E 00	2.869E 00	3.586E-01	1.771E-01	1.181E-01

FLIGHT NO. C-138
DIRECTIONAL PATH REFLECTANCE FROM GROUND TO ALTITUDE
AZIMUTH OF PATH OF SIGHT = 270

AZIMUTH OF PATH OF SIGHT = 270

FLIGHT NO. C-138 FILTER NO. 2

DIRECTIONAL PATH REFLECTANCE FROM GROUND TO ALTITUDE

ALTITUDE	ZENITH ANGLE OF PATH OF SIGHT (DEG)						
M	93	95	97	100	120	150	180
300	1.649E 00	5.949E-01	3.287E-01	1.944E-01	4.108E-02	1.762E-02	1.390E-02
600	1.416E 01	2.726E 00	1.202E 00	6.000E-01	1.008E-01	4.138E-02	3.247E-02
1500	2.631E 03	6.105E 01	1.240E 01	3.742E 00	3.317E-01	1.239E-01	9.717E-02
3000	1.598E 05	5.174E 02	5.459E 01	1.170E 01	6.897E-01	2.676E-01	2.208E-01
5100	3.332E 07	5.102E 03	2.330E 02	3.477E 01	1.293E 00	4.827E-01	4.018E-01

FLIGHT NO. C-138 FILTER NO. 6

DIRECTIONAL PATH REFLECTANCE FROM GROUND TO ALTITUDE

ALTITUDE	ZENITH ANGLE OF PATH OF SIGHT (DEG)						
M	93	95	97	100	120	150	180
300	1.418E 00	5.311E-01	2.978E-01	1.782E-01	3.886E-02	1.780E-02	1.454E-02
600	1.345E 01	2.685E 00	1.199E 00	6.044E-01	1.052E-01	4.665E-02	3.802E-02
1500	7.528E 03	1.239E 02	2.167E 01	5.920E 00	4.904E-01	2.025E-01	1.657E-01
3000	4.508E 05	9.356E 02	8.444E 01	1.646E 01	8.907E-01	3.534E-01	2.894E-01
5100	8.371E 07	7.921E 03	3.094E 02	4.268E 01	1.469E 00	5.489E-01	4.510E-01

FLIGHT NO. C-138 FILTER NO. 5

DIRECTIONAL PATH REFLECTANCE FROM GROUND TO ALTITUDE

ALTITUDE	ZENITH ANGLE OF PATH OF SIGHT (DEG)						
M	93	95	97	100	120	150	180
300	1.020E 00	3.685E-01	2.032E-01	1.198E-01	2.594E-02	1.190E-02	9.743E-03
600	1.186E 01	2.058E 00	8.726E-01	4.224E-01	6.996E-02	3.044E-02	2.467E-02
1500	1.307E 03	3.247E 01	6.761E 00	2.081E 00	1.934E-01	7.617E-02	6.072E-02
3000	3.418E 04	1.584E 02	1.963E 01	4.703E 00	3.219E-01	1.266E-01	1.041E-01
5100	1.654E 06	7.241E 02	4.922E 01	9.466E 00	4.905E-01	1.905E-01	1.598E-01

FLIGHT NO. C-138 FILTER NO. 3

DIRECTIONAL PATH REFLECTANCE FROM GROUND TO ALTITUDE

ALTITUDE	ZENITH ANGLE OF PATH OF SIGHT (DEG)						
M	93	95	97	100	120	150	180
300	4.204E-01	1.782E-01	1.060E-01	6.724E-02	1.658E-02	7.996E-03	6.637E-03
600	1.525E 00	5.263E-01	2.874E-01	1.692E-01	3.767E-02	1.784E-02	1.477E-02
1500	2.680E 01	3.531E 00	1.334E 00	6.501E-01	1.093E-01	5.020E-02	4.151E-02
3000	3.232E 02	1.338E 01	3.648E 00	1.420E 00	1.902E-01	8.652E-02	7.237E-02
5100	8.252E 03	5.777E 01	9.646E 00	3.038E 00	3.176E-01	1.412E-01	1.181E-01

FLIGHT C-139 – DESCRIPTION OF FLIGHT AND WEATHER CHARACTERISTICS

It was an overcast afternoon. There was scattered high cirrus and scattered cumulus covering 3/10 of the sky with bases at 1.2 and tops at 1.8 kilometers. The flight was conducted along an east-west route between Mindelheim and Mengen, passing approximately 8 to 16 kilometers (5 to 10 miles) north of Memmingen. The typical terrain was heavily cultivated, rolling pastureland occasionally interrupted by large patches of dark forest. The data-taking started at 1247 GMT (1347 LCT) and continued until 1511 GMT (1611 LCT). The sun zenith angle during sky radiance data-taking was 31.3 degrees at the start and 44.8 degrees at the end. The highest flight altitude was 4830 meters above ground level.

About the time data-taking began, Memmingen was reporting 2/8 cumulus at 1200 meters and 2/8 cirrus at 7500 meters. Visibility was reported as 30 kilometers (19 miles).

Early in the flight, the aircrew reported 0.1 scattered cumulus on the horizon with moderate haze. The haze top was estimated at 1809 meters. During the early portions of the flight between 1253 and 1401 GMT, the sky was clear above 1800 meters. Scattered cumulus was estimated at 0.3 with bases at 1200 meters and tops at 1800 meters.

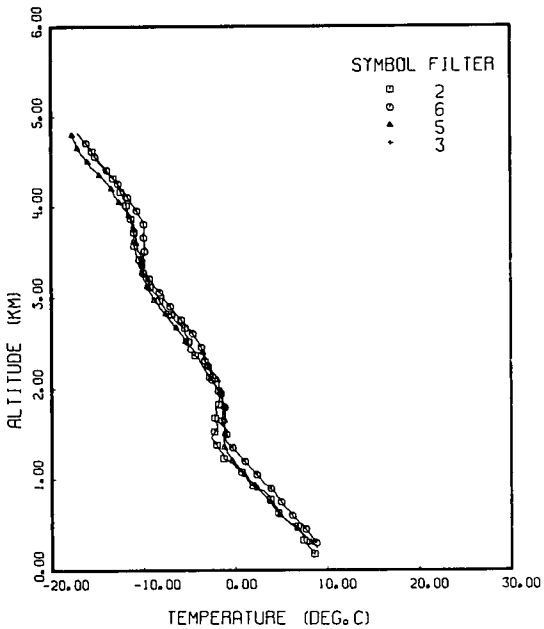
Later in the flight, subsequent to 1438 GMT, light haze extended to 4700 meters with a poorly-defined top and light cirrus was reported above 4860 meters.

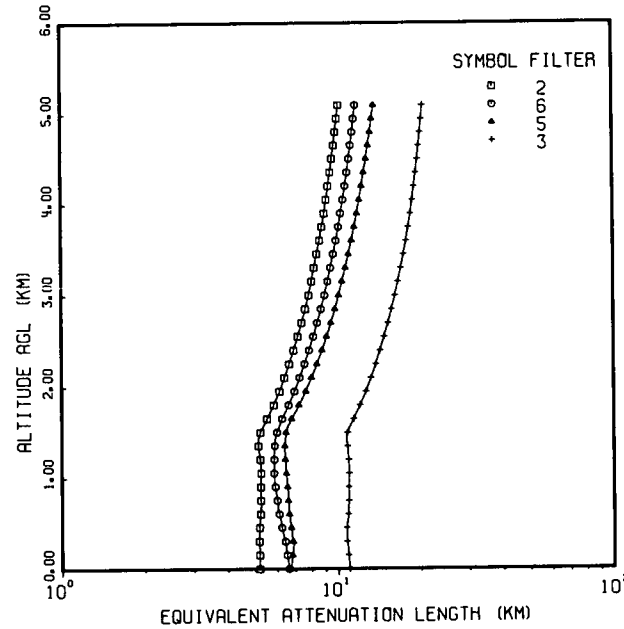
Toward the end of the flight, subsequent to 1451 GMT, there were clouds above 4770 meters, and the sun was obscured.

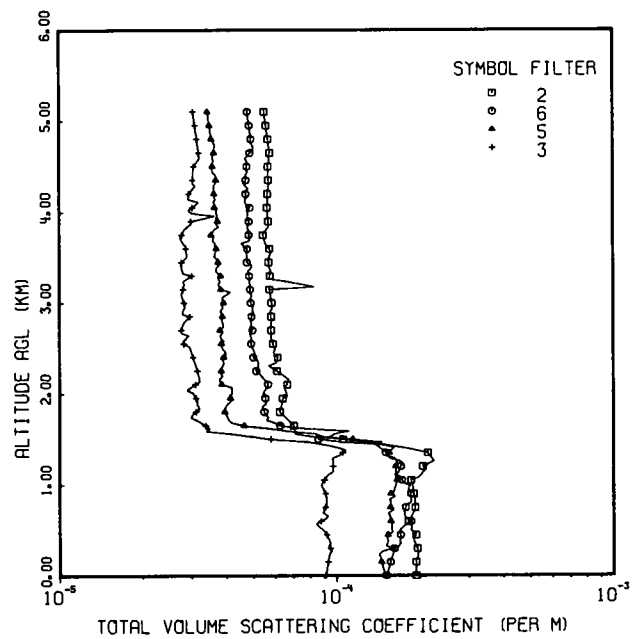
About the time data-taking was completed, Memmingen was reporting 2/8 cumulus at 1200 meters and 3/8 cirrus at 7500 meters. Visibility was reported as 30 kilometers (19 miles).

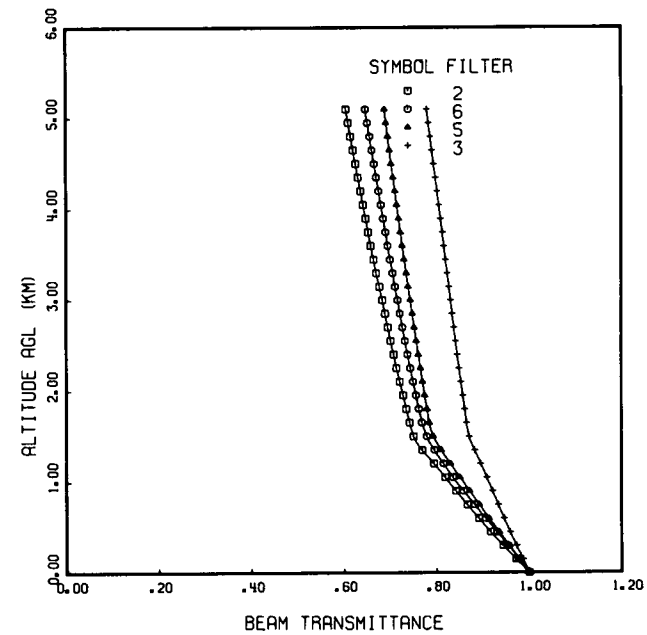
The surface charts show a high pressure cell centered in the North Sea moving east-northeastward. The Memmingen area was in the southeast sector of the high. During the day, the pressure gradient weakened over southern Germany and by 1800 GMT, there was a col over Southern Germany, Austria, Switzerland, and northern Italy. The 500-millibar chart shows a ridge through France and Germany with a low located in central Poland. There were moderate northerly winds. The airmass was unstable continental polar at low levels and unstable maritime polar aloft.

FLIGHT NO. C-139

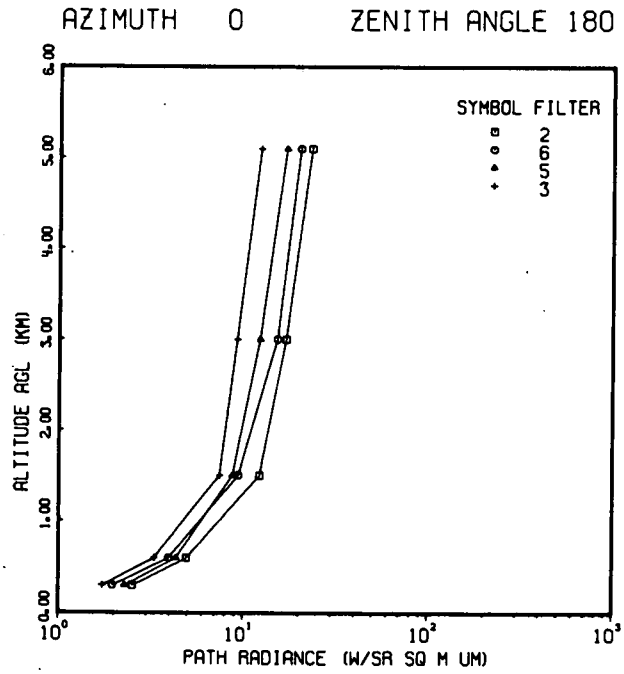


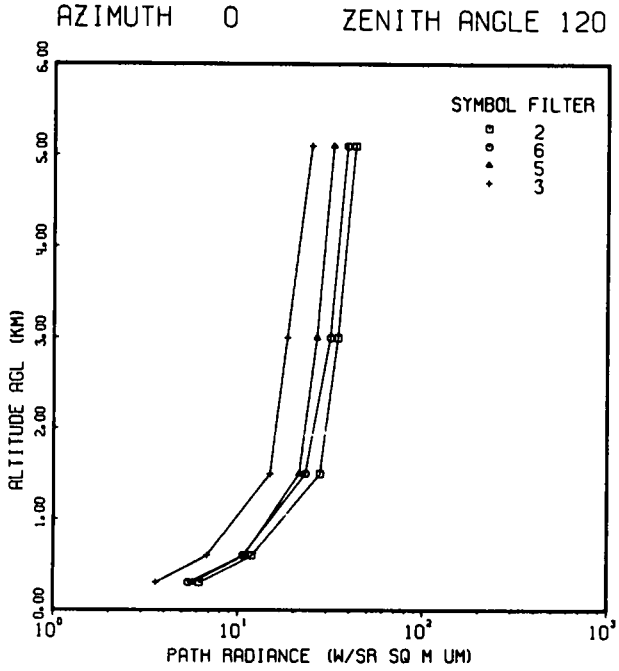


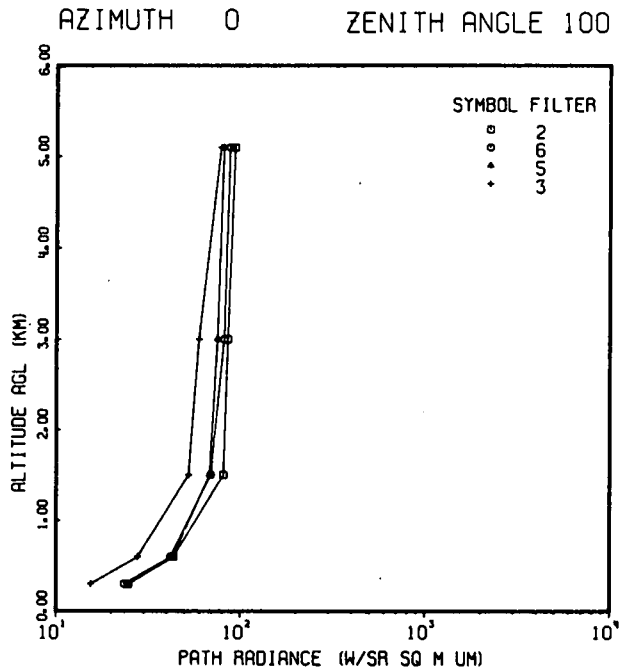




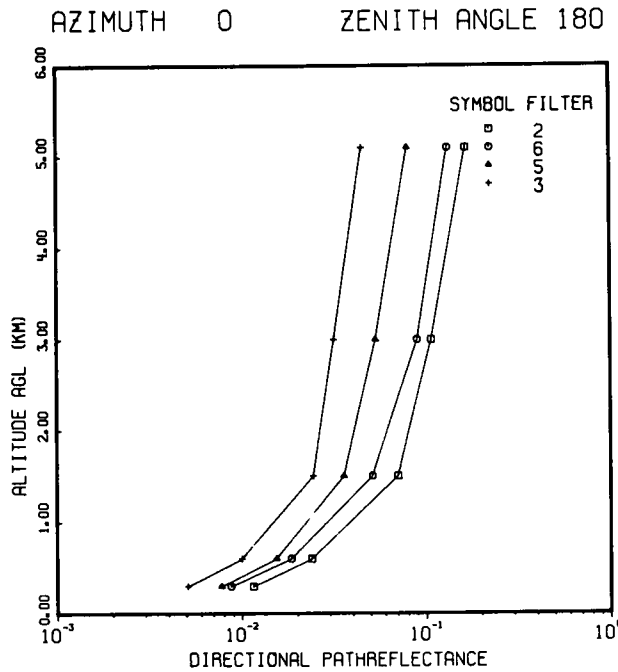
FLIGHT NO. C-139

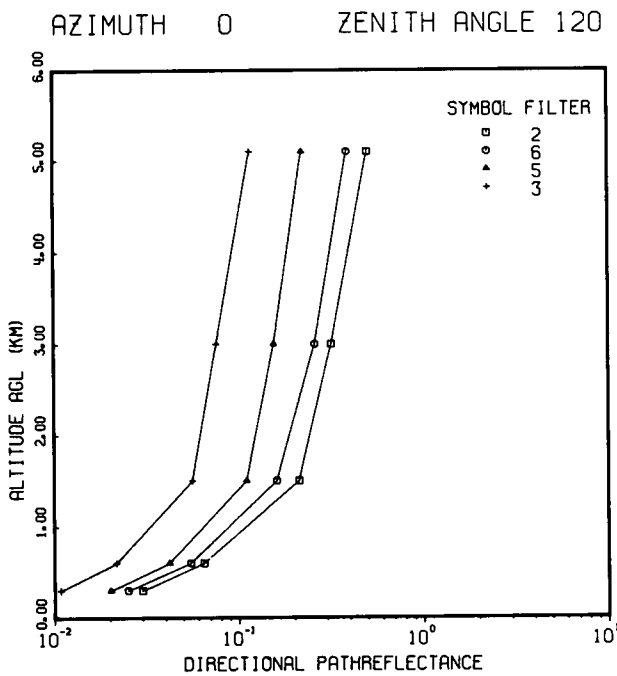


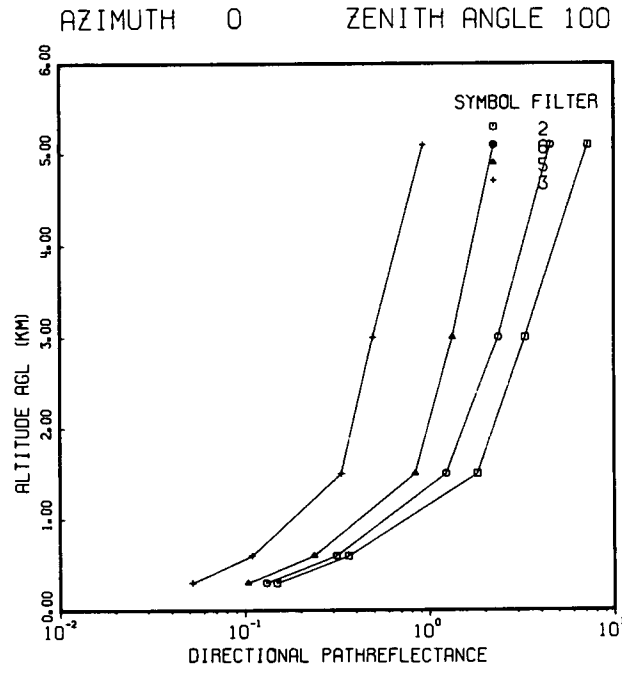




FLIGHT NO. C-139







FLIGHT NO. C-139
IRRADIANCE

FLIGHT NO.C-139 FILTER NO. 2
IRRADIANCE (W/SQ M UM)

ALTITUDE (METERS)	DOWN-WELLING	UP-WELLING	ALBEDO	SCALAR DOWNWELLING	SCALAR UPWELLING	SCALAR TOTAL	SCALAR ALBEDO
149	7.294E 02	3.328E 01	.046	1.138E 03	8.241E 01	1.220E 03	.072
1156	8.748E 02	4.981E 01	.057	1.293E 03	1.387E 02	1.431E 03	.107
2416	5.215E 02	7.259E 01	.139	8.739E 02	1.907E 02	1.065E 03	.218
4823	6.368E 02	8.585E 01	.135	1.054E 03	2.277E 02	1.282E 03	.216

FLIGHT NO.C-139 FILTER NO. 6
IRRADIANCE (W/SQ M UM)

ALTITUDE (METERS)	DOWN-WELLING	UP-WELLING	ALBEDO	SCALAR DOWNWELLING	SCALAR UPWELLING	SCALAR TOTAL	SCALAR ALBEDO
153	7.427E 02	2.181E 01	.029	1.209E 03	5.950E 01	1.269E 03	.049
1157	4.438E 02	6.428E 01	.145	7.989E 02	1.539E 02	9.528E 02	.193
2395	7.395E 02	1.375E 02	.186	1.134E 03	2.907E 02	1.424E 03	.256
4820	4.241E 02	8.316E 01	.196	7.595E 02	2.248E 02	9.843E 02	.296

FLIGHT NO.C-139 FILTER NO. 5
IRRADIANCE (W/SQ M UM)

ALTITUDE (METERS)	DOWN-WELLING	UP-WELLING	ALBEDO	SCALAR DOWNWELLING	SCALAR UPWELLING	SCALAR TOTAL	SCALAR ALBEDO
153	9.699E 02	3.745E 01	.039	1.456E 03	8.955E 01	1.545E 03	.062
1158	4.113E 02	5.592E 01	.136	7.961E 02	1.376E 02	9.337E 02	.173
2397	6.246E 02	8.092E 01	.130	9.750E 02	2.029E 02	1.178E 03	.208

FLIGHT NO.C-139 FILTER NO. 3
IRRADIANCE (W/SQ M UM)

ALTITUDE (METERS)	DOWN-WELLING	UP-WELLING	ALBEDO	SCALAR DOWNWELLING	SCALAR UPWELLING	SCALAR TOTAL	SCALAR ALBEDO
152	1.101E 03	3.321E 01	.030	1.503E 03	7.486E 01	1.578E 03	.050
2396	5.647E 02	4.609E 01	.082	8.163E 02	1.290E 02	9.453E 02	.158
4823	1.060E 03	5.605E 01	.053	1.533E 03	1.498E 02	1.682E 03	.098

FLIGHT NO. C-139
DIRECTIONAL REFLECTANCE OF BACKGROUND

FLIGHT NO. C-139
AZIMUTH OF PATH OF SIGHT = 0
DIRECTIONAL REFLECTANCE OF BACKGROUND

ZENITH ANGLE	FILTERS 2	6	5	3
93	.10690	.12035	.12679	.08841
95	.17306	.12401	.08831	.05018
97	.13062	.09506	.06974	.04647
100	.07874	.05401	.06662	.05170
120	.04711	.01716	.02287	.01129
150	.04096	.01275	.05619	.03903
180	.05400	.06779	.01958	.04720

FLIGHT NO. C-139
AZIMUTH OF PATH OF SIGHT = 90
DIRECTIONAL REFLECTANCE OF BACKGROUND

ZENITH ANGLE	FILTERS 2	6	5	3
93	.14293	.11940	.07211	.04827
95	.10594	.07091	.07059	.04413
97	.08891	.07350	.06045	.03517
100	.07440	.06673	.04698	.03153
120	.03103	.02179	.02389	.02795
150	.05574	.01369	.03564	.02140
180	.05400	.06779	.01958	.04720

FLIGHT NO. C-139
AZIMUTH OF PATH OF SIGHT = 180
DIRECTIONAL REFLECTANCE OF BACKGROUND

ZENITH ANGLE	FILTERS 2	6	5	3
93	.14640	.08745	.08108	.05076
95	.09457	.07426	.06869	.04900
97	.07588	.06115	.06296	.04667
100	.06222	.06485	.06202	.03930
120	.06241	.02236	.03135	.01724
150	.05630	.02930	.02903	.04655
180	.05400	.06779	.01958	.04720

FLIGHT NO. C-139
AZIMUTH OF PATH OF SIGHT = 270
DIRECTIONAL REFLECTANCE OF BACKGROUND

ZENITH ANGLE	FILTERS 2	6	5	3
93	.10823	.09018	.09571	.06051
95	.08329	.06884	.05962	.04364
97	.07150	.07968	.05127	.03246
100	.06137	.05831	.04795	.03305
120	.05102	.02229	.01909	.01464
150	.04792	.01816	.04671	.04515
180	.05400	.06779	.01958	.04720

FLIGHT NO. C-139
TOTAL VOLUME SCATTERING COEFFICIENT

DATE 60370 FLIGHT NO. C-139 GROUND LEVEL ALTITUDE (M)= 629

ALTITUDE (M)	TOTAL VOLUME SCATTERING COEFFICIENT (PER M)			
FILTERS	2	6	5	3
0	1.930E-04	1.510E-04	1.490E-04	9.120E-05
30	1.930E-04	1.520E-04	1.482E-04	9.155E-05
60	1.930E-04	1.531E-04	1.473E-04	9.190E-05
90	1.930E-04	1.541E-04	1.465E-04	9.224E-05
120	1.930E-04	1.552E-04	1.456E-04	9.259E-05
150	1.930E-04	1.562E-04	1.448E-04	9.294E-05
180	1.930E-04	1.573E-04	1.439E-04	9.329E-05
210	1.960E-04	1.583E-04	1.431E-04	9.364E-05
240	1.958E-04	1.593E-04	1.422E-04	9.399E-05
270	1.956E-04	1.604E-04	1.460E-04	9.590E-05
300	1.955E-04	1.614E-04	1.584E-04	9.472E-05
330	1.935E-04	1.674E-04	1.509E-04	9.355E-05
360	1.915E-04	1.700E-04	1.525E-04	9.498E-05
390	1.896E-04	1.690E-04	1.529E-04	9.396E-05
420	1.888E-04	1.711E-04	1.518E-04	9.294E-05
450	1.933E-04	1.697E-04	1.530E-04	9.191E-05
480	1.893E-04	1.699E-04	1.592E-04	9.089E-05
510	1.853E-04	1.696E-04	1.581E-04	8.871E-05
540	1.868E-04	1.742E-04	1.576E-04	8.652E-05
570	1.842E-04	1.791E-04	1.581E-04	8.433E-05
600	1.817E-04	1.859E-04	1.569E-04	8.782E-05
630	1.841E-04	1.780E-04	1.569E-04	9.131E-05
660	1.865E-04	1.761E-04	1.555E-04	9.289E-05
690	1.889E-04	1.757E-04	1.535E-04	8.906E-05
720	1.913E-04	1.753E-04	1.599E-04	9.003E-05
750	1.919E-04	1.773E-04	1.565E-04	9.099E-05
780	1.917E-04	1.793E-04	1.558E-04	9.195E-05
810	1.916E-04	1.864E-04	1.571E-04	9.195E-05
840	1.914E-04	1.850E-04	1.553E-04	9.215E-05
870	1.913E-04	1.835E-04	1.624E-04	9.171E-05
900	1.894E-04	1.851E-04	1.570E-04	9.126E-05
930	1.876E-04	1.843E-04	1.619E-04	9.018E-05
960	1.886E-04	1.818E-04	1.621E-04	8.910E-05
990	1.875E-04	1.836E-04	1.632E-04	8.802E-05
1020	1.864E-04	1.748E-04	1.640E-04	8.894E-05
1050	1.854E-04	1.722E-04	1.652E-04	9.037E-05
1080	1.978E-04	1.705E-04	1.637E-04	9.179E-05
1110	2.015E-04	1.640E-04	1.626E-04	9.322E-05
1140	2.053E-04	1.680E-04	1.638E-04	9.715E-05
1170	2.091E-04	1.673E-04	1.635E-04	9.704E-05
1200	2.048E-04	1.705E-04	1.635E-04	9.694E-05
1230	2.140E-04	1.737E-04	1.657E-04	9.683E-05
1260	2.245E-04	1.696E-04	1.651E-04	9.673E-05
1290	2.208E-04	1.558E-04	1.623E-04	9.662E-05
1320	2.170E-04	1.522E-04	1.514E-04	1.025E-04
1350	2.132E-04	1.505E-04	1.548E-04	1.052E-04
1380	1.927E-04	1.578E-04	1.464E-04	1.078E-04
1410	1.722E-04	1.610E-04	1.427E-04	1.003E-04
1440	1.517E-04	1.449E-04	1.376E-04	8.968E-05
1470	1.286E-04	1.049E-04	1.457E-04	7.910E-05
1500	1.055E-04	6.593E-05	1.146E-04	5.794E-05

FLIGHT NO. C-139
TOTAL VOLUME SCATTERING COEFFICIENT

DATE 60370 FLIGHT NO. C-139 GROUND LEVEL ALTITUDE (M)= 629

ALTITUDE (M)	TOTAL VOLUME SCATTERING COEFFICIENT (PER M)			
FILTERS	2	6	5	3
1530	8.244E-05	9.517E-05	8.823E-05	4.995E-05
1560	7.111E-05	9.840E-05	8.405E-05	4.196E-05
1590	7.080E-05	1.106E-04	6.686E-05	3.397E-05
1620	7.048E-05	7.584E-05	5.664E-05	3.495E-05
1650	7.017E-05	6.267E-05	4.650E-05	3.376E-05
1680	6.861E-05	5.997E-05	4.200E-05	3.257E-05
1710	6.706E-05	5.592E-05	4.092E-05	3.138E-05
1740	6.551E-05	5.699E-05	4.048E-05	2.986E-05
1770	6.395E-05	5.588E-05	4.009E-05	3.024E-05
1800	6.240E-05	5.491E-05	3.960E-05	3.117E-05
1830	6.289E-05	5.472E-05	3.975E-05	3.210E-05
1860	6.337E-05	5.414E-05	3.998E-05	3.179E-05
1890	6.360E-05	5.587E-05	4.065E-05	3.147E-05
1920	6.383E-05	5.562E-05	4.175E-05	3.155E-05
1950	6.406E-05	5.546E-05	4.156E-05	3.117E-05
1980	6.650E-05	5.604E-05	4.130E-05	3.080E-05
2010	6.590E-05	5.441E-05	4.221E-05	3.043E-05
2040	6.529E-05	5.534E-05	4.190E-05	2.886E-05
2070	6.469E-05	5.642E-05	4.201E-05	2.995E-05
2100	6.642E-05	5.682E-05	3.868E-05	3.104E-05
2130	6.684E-05	5.663E-05	3.818E-05	3.212E-05
2160	6.727E-05	5.474E-05	3.788E-05	3.206E-05
2190	6.520E-05	5.389E-05	3.896E-05	3.199E-05
2220	6.313E-05	5.274E-05	3.838E-05	3.177E-05
2250	6.106E-05	5.138E-05	3.843E-05	3.155E-05
2280	5.899E-05	5.262E-05	3.849E-05	3.133E-05
2310	5.692E-05	5.232E-05	3.909E-05	3.110E-05
2340	6.075E-05	5.226E-05	3.935E-05	3.088E-05
2370	6.094E-05	5.211E-05	3.897E-05	3.066E-05
2400	6.147E-05	5.023E-05	3.927E-05	3.044E-05
2430	5.986E-05	5.104E-05	4.011E-05	3.022E-05
2460	5.950E-05	5.069E-05	3.984E-05	2.999E-05
2490	6.009E-05	5.021E-05	3.903E-05	2.977E-05
2520	5.961E-05	4.945E-05	3.863E-05	2.955E-05
2550	5.913E-05	4.940E-05	3.850E-05	2.818E-05
2580	5.865E-05	4.897E-05	3.946E-05	2.799E-05
2610	5.816E-05	4.945E-05	3.842E-05	2.872E-05
2640	5.817E-05	4.916E-05	3.813E-05	2.945E-05
2670	5.818E-05	4.877E-05	3.887E-05	2.762E-05
2700	5.820E-05	4.990E-05	3.808E-05	2.762E-05
2730	5.821E-05	4.900E-05	3.903E-05	2.780E-05
2760	5.827E-05	4.939E-05	3.937E-05	2.798E-05
2790	5.833E-05	4.934E-05	3.883E-05	2.832E-05
2820	5.840E-05	4.919E-05	3.868E-05	2.896E-05
2850	5.823E-05	4.952E-05	3.890E-05	2.960E-05
2880	5.807E-05	5.041E-05	3.863E-05	2.783E-05
2910	5.791E-05	5.009E-05	3.825E-05	2.808E-05
2940	5.871E-05	4.980E-05	3.902E-05	2.833E-05
2970	5.855E-05	5.019E-05	3.876E-05	2.859E-05
3000	5.838E-05	4.913E-05	3.929E-05	2.924E-05

FLIGHT NO. C-139
TOTAL VOLUME SCATTERING COEFFICIENT

DATE 60370 FLIGHT NO. C-139 GROUND LEVEL ALTITUDE (M)= 629

ALTITUDE (M)	TOTAL VOLUME SCATTERING COEFFICIENT (PER M) FILTERS 2	6	5	3
3030	5.821E-05	4.899E-05	3.901E-05	2.804E-05
3060	5.804E-05	4.931E-05	3.881E-05	2.783E-05
3090	5.784E-05	4.960E-05	4.024E-05	2.763E-05
3120	5.764E-05	4.865E-05	4.164E-05	2.781E-05
3150	5.744E-05	4.895E-05	3.829E-05	2.800E-05
3180	8.312E-05	4.871E-05	3.787E-05	2.818E-05
3210	7.455E-05	4.911E-05	3.759E-05	2.837E-05
3240	6.598E-05	4.850E-05	3.823E-05	2.801E-05
3270	5.741E-05	4.891E-05	3.759E-05	2.909E-05
3300	5.765E-05	4.857E-05	3.841E-05	3.018E-05
3330	5.789E-05	4.850E-05	3.753E-05	2.804E-05
3360	5.813E-05	4.812E-05	3.681E-05	2.787E-05
3390	5.756E-05	4.942E-05	3.710E-05	2.771E-05
3420	5.735E-05	4.975E-05	3.784E-05	2.754E-05
3450	5.714E-05	4.778E-05	3.761E-05	2.769E-05
3480	5.693E-05	4.761E-05	3.751E-05	2.833E-05
3510	5.740E-05	4.798E-05	3.638E-05	2.897E-05
3540	5.788E-05	4.747E-05	3.660E-05	2.896E-05
3570	5.835E-05	4.801E-05	3.682E-05	2.884E-05
3600	5.756E-05	4.788E-05	3.708E-05	2.872E-05
3630	5.658E-05	4.671E-05	3.681E-05	2.860E-05
3660	5.561E-05	4.560E-05	3.656E-05	2.815E-05
3690	5.527E-05	4.884E-05	3.587E-05	2.771E-05
3720	5.492E-05	4.876E-05	3.622E-05	2.743E-05
3750	5.458E-05	4.848E-05	3.546E-05	2.774E-05
3780	5.524E-05	4.939E-05	3.590E-05	2.806E-05
3810	5.613E-05	4.830E-05	3.645E-05	2.837E-05
3840	5.703E-05	4.791E-05	3.780E-05	2.918E-05
3870	5.699E-05	4.842E-05	3.702E-05	2.999E-05
3900	5.694E-05	4.861E-05	3.753E-05	2.997E-05
3930	5.690E-05	4.803E-05	3.693E-05	3.326E-05
3960	5.678E-05	4.796E-05	3.744E-05	3.654E-05
3990	5.666E-05	4.823E-05	3.716E-05	3.011E-05
4020	5.654E-05	4.776E-05	3.702E-05	2.940E-05
4050	5.642E-05	4.898E-05	3.654E-05	3.029E-05
4080	5.682E-05	4.791E-05	3.677E-05	3.118E-05
4110	5.679E-05	4.697E-05	3.623E-05	3.207E-05
4140	5.675E-05	4.715E-05	3.667E-05	2.937E-05
4170	5.672E-05	4.781E-05	3.645E-05	2.941E-05
4200	5.669E-05	4.730E-05	3.635E-05	2.945E-05
4230	5.665E-05	4.750E-05	3.626E-05	2.999E-05
4260	5.726E-05	4.624E-05	3.625E-05	3.054E-05
4290	5.721E-05	4.712E-05	3.634E-05	3.108E-05
4320	5.715E-05	4.626E-05	3.673E-05	3.040E-05
4350	5.710E-05	4.742E-05	3.704E-05	3.044E-05
4380	5.705E-05	4.744E-05	3.715E-05	3.048E-05
4410	5.699E-05	4.736E-05	3.676E-05	3.052E-05
4440	5.694E-05	4.805E-05	3.530E-05	3.056E-05
4470	5.689E-05	4.727E-05	3.577E-05	3.060E-05
4500	5.683E-05	4.776E-05	3.591E-05	3.064E-05

FLIGHT NO. C-139
TOTAL VOLUME SCATTERING COEFFICIENT

DATE 60370 FLIGHT NO. C-139 GROUND LEVEL ALTITUDE (M)= 629

ALTITUDE (M)	TOTAL VOLUME SCATTERING COEFFICIENT (PER M)			
FILTERS	2	6	5	3
4530	5.678E-05	4.791E-05	3.590E-05	3.117E-05
4560	5.763E-05	4.783E-05	3.62CE-05	3.169E-05
4590	5.739E-05	4.694E-05	3.594E-05	3.221E-05
4620	5.715E-05	4.820E-05	3.583E-05	3.211E-05
4650	5.779E-05	4.899E-05	3.636E-05	3.201E-05
4680	5.761E-05	5.023E-05	3.637E-05	3.191E-05
4710	5.743E-05	5.057E-05	3.651E-05	3.181E-05
4740	5.725E-05	4.988E-05	3.652E-05	3.171E-05
4770	5.707E-05	4.911E-05	3.609E-05	3.161E-05
4800	5.690E-05	4.948E-05	3.554E-05	3.152E-05
4830	5.672E-05	4.929E-05	3.542E-05	3.142E-05
4860	5.654E-05	4.914E-05	3.531E-05	3.132E-05
4890	5.637E-05	4.898E-05	3.520E-05	3.122E-05
4920	5.619E-05	4.883E-05	3.509E-05	3.112E-05
4950	5.601E-05	4.868E-05	3.498E-05	3.103E-05
4980	5.584E-05	4.853E-05	3.488E-05	3.093E-05
5010	5.567E-05	4.837E-05	3.477E-05	3.083E-05
5040	5.549E-05	4.822E-05	3.466E-05	3.074E-05
5070	5.532E-05	4.807E-05	3.455E-05	3.064E-05
5100	5.514E-05	4.792E-05	3.444E-05	3.055E-05
FIRST DATA ALT	0	0	0	0
LAST DATA ALT	4650	4830	4800	4590

FLIGHT NO. C-139
BEAM TRANSMITTANCE FROM GROUND TO ALTITUDE

FLIGHT NO. C-139 FILTER NO. 2
BEAM TRANSMITTANCE FROM GROUND TO ALTITUDE

ALTITUDE M	ZENITH ANGLE OF PATH OF SIGHT (DEG) 93	95	97	100	120	150	180
300	.3260733	.5119295	.6203150	.7152398	.8901262	.9350091	.9434650
600	.1074261	.2655331	.3894559	.5159129	.7946554	.8757260	.8914345
1500	.0033148	.0355182	.0950199	.1916956	.5634480	.7180512	.7506317
3000	.0002799	.0106922	.0436733	.1110911	.4661953	.6436468	.6827850
5100	.0000067	.0021369	.0161771	.0553317	.3659650	.5596954	.6049504

FLIGHT NO. C-139 FILTER NO. 6
BEAM TRANSMITTANCE FROM GROUND TO ALTITUDE

ALTITUDE M	ZENITH ANGLE OF PATH OF SIGHT (DEG) 93	95	97	100	120	150	180
300	.4055977	.5832178	.6807533	.7634652	.9105277	.9473226	.9542157
600	.1485766	.3218416	.4464607	.5678214	.8215588	.8927227	.9063988
1500	.0069433	.0547245	.1288900	.2374303	.6069124	.7495278	.7790458
3000	.0007658	.0187512	.0643516	.1458231	.5123891	.6797315	.7158136
5100	.0000324	.0048295	.0279955	.0813091	.4183071	.6046028	.6467667

FLIGHT NO. C-139 FILTER NO. 5
BEAM TRANSMITTANCE FROM GROUND TO ALTITUDE

ALTITUDE M	ZENITH ANGLE OF PATH OF SIGHT (DEG) 93	95	97	100	120	150	180
300	.4299133	.6038839	.6978795	.7768951	.9160586	.9506407	.9571095
600	.1730612	.3524467	.4762866	.5941859	.8346109	.9008838	.9135704
1500	.0099540	.0674831	.1493579	.2633048	.6291113	.7652358	.7931654
3000	.0017009	.0293419	.0878130	.1813723	.5527190	.7101251	.7434508
5100	.0001323	.0102391	.0466538	.1163595	.4737577	.6496544	.6883006

FLIGHT NO. C-139 FILTER NO. 3
BEAM TRANSMITTANCE FROM GROUND TO ALTITUDE

ALTITUDE M	ZENITH ANGLE OF PATH OF SIGHT (DEG) 93	95	97	100	120	150	180
300	.5840305	.7251771	.7951869	.8514273	.9456719	.9682640	.9724566
600	.3424547	.5289124	.6357458	.7276808	.8954732	.9382478	.9462944
1500	.0632884	.1991135	.3203965	.4498658	.7577344	.8519990	.8704794
3000	.0187735	.1101212	.2181597	.3435549	.6900065	.8071641	.8306663
5100	.0028398	.0480801	.1303210	.2392774	.6085480	.7506933	.7800948

FLIGHT NO. C-139
PATH RADIANCE FROM GROUND TO ALTITUDE
AZIMUTH OF PATH OF SIGHT = 0

AZIMUTH OF PATH OF SIGHT = 0

FLIGHT NO. C-139 FILTER NO. 2

PATH RADIANCE FROM GROUND TO ALTITUDE (W/SR SQ M UM)

ALTITUDE M	ZENITH ANGLE OF PATH OF SIGHT (DEG) 93	95	97	100	120	150	180
300	8.216E 01	5.132E 01	3.543E 01	2.469E 01	6.187E 00	2.765E 00	2.524E 00
600	1.045E 02	7.878E 01	5.934E 01	4.356E 01	1.192E 01	5.402E 00	4.953E 00
1500	1.229E 02	1.130E 02	9.899E 01	8.112E 01	2.782E 01	1.315E 01	1.229E 01
3000	1.040E 02	1.035E 02	9.735E 01	8.537E 01	3.455E 01	1.740E 01	1.702E 01
5100	1.156E 02	1.095E 02	1.033E 02	9.300E 01	4.277E 01	2.295E 01	2.330E 01

FLIGHT NO. C-139 FILTER NO. 6

PATH RADIANCE FROM GROUND TO ALTITUDE (W/SR SQ M UM)

ALTITUDE M	ZENITH ANGLE OF PATH OF SIGHT (DEG) 93	95	97	100	120	150	180
300	8.590E 01	5.105E 01	3.454E 01	2.353E 01	5.384E 00	2.176E 00	1.965E 00
600	1.066E 02	7.856E 01	5.827E 01	4.201E 01	1.064E 01	4.409E 00	3.971E 00
1500	1.028E 02	9.584E 01	8.435E 01	6.924E 01	2.315E 01	1.044E 01	9.435E 00
3000	1.143E 02	1.058E 02	9.563E 01	8.159E 01	3.143E 01	1.574E 01	1.526E 01
5100	1.073E 02	1.041E 02	9.806E 01	8.745E 01	3.864E 01	2.053E 01	2.023E 01

FLIGHT NO. C-139 FILTER NO. 5

PATH RADIANCE FROM GROUND TO ALTITUDE (W/SR SQ M UM)

ALTITUDE M	ZENITH ANGLE OF PATH OF SIGHT (DEG) 93	95	97	100	120	150	180
300	9.354E 01	5.470E 01	3.674E 01	2.487E 01	5.711E 00	2.454E 00	2.289E 00
600	1.155E 02	8.318E 01	6.090E 01	4.343E 01	1.082E 01	4.681E 00	4.348E 00
1500	1.019E 02	9.578E 01	8.386E 01	6.816E 01	2.147E 01	9.495E 00	8.779E 00
3000	1.031E 02	9.768E 01	8.850E 01	7.488E 01	2.660E 01	1.252E 01	1.229E 01
5100	1.041E 02	9.935E 01	9.229E 01	8.092E 01	3.255E 01	1.639E 01	1.702E 01

FLIGHT NO. C-139 FILTER NO. 3

PATH RADIANCE FROM GROUND TO ALTITUDE (W/SR SQ M UM)

ALTITUDE M	ZENITH ANGLE OF PATH OF SIGHT (DEG) 93	95	97	100	120	150	180
300	6.707E 01	3.588E 01	2.333E 01	1.546E 01	3.585E 00	1.674E 00	1.732E 00
600	9.541E 01	5.925E 01	4.071E 01	2.785E 01	6.799E 00	3.205E 00	3.315E 00
1500	1.085E 02	8.922E 01	7.023E 01	5.252E 01	1.494E 01	7.235E 00	7.454E 00
3000	1.023E 02	9.119E 01	7.609E 01	5.955E 01	1.841E 01	9.028E 00	9.249E 00
5100	1.38[illegible]	1.178E 02	9.908E 01	7.811E 01	2.464E 01	1.219E 01	1.239E 01

FLIGHT NO. C-139
PATH RADIANCE FROM GROUND TO ALTITUDE
AZIMUTH OF PATH OF SIGHT = 90

AZIMUTH OF PATH OF SIGHT = 90

FLIGHT NO. C-139 FILTER NO. 2

PATH RADIANCE FROM GROUND TO ALTITUDE (W/SR SQ M UM)

ALTITUDE M	ZENITH ANGLE OF PATH OF SIGHT (DEG) 93	95	97	100	120	150	180
300	5.601E 01	3.584E 01	2.532E 01	1.815E 01	5.505E 00	2.889E 00	2.524E 00
600	6.841E 01	5.331E 01	4.125E 01	3.130E 01	1.051E 01	5.658E 00	4.953E 00
1500	7.401E 01	7.037E 01	6.379E 01	5.478E 01	2.399E 01	1.391E 01	1.229E 01
3000	7.136E 01	7.048E 01	6.709E 01	6.069E 01	3.057E 01	1.875E 01	1.702E 01
5100	7.608E 01	7.437E 01	7.202E 01	6.734E 01	3.858E 01	2.496E 01	2.330E 01

FLIGHT NO. C-139 FILTER NO. 6

PATH RADIANCE FROM GROUND TO ALTITUDE (W/SR SQ M UM)

ALTITUDE M	ZENITH ANGLE OF PATH OF SIGHT (DEG) 93	95	97	100	120	150	180
300	5.076E 01	3.084E 01	2.136E 01	1.512E 01	4.411E 00	2.254E 00	1.965E 00
600	6.433E 01	4.922E 01	3.655E 01	2.732E 01	8.745E 00	4.550E 00	3.971E 00
1500	6.736E 01	6.296E 01	5.607E 01	4.727E 01	1.932E 01	1.067E 01	9.435E 00
3000	7.900E 01	7.367E 01	6.733E 01	5.879E 01	2.717E 01	1.624E 01	1.526E 01
5100	7.239E 01	7.232E 01	6.979E 01	6.432E 01	3.435E 01	2.140E 01	2.023E 01

FLIGHT NO. C-139 FILTER NO. 5

PATH RADIANCE FROM GROUND TO ALTITUDE (W/SR SQ M UM)

ALTITUDE M	ZENITH ANGLE OF PATH OF SIGHT (DEG) 93	95	97	100	120	150	180
300	5.359E 01	3.216E 01	2.222E 01	1.576E 01	4.791E 00	2.599E 00	2.289E 00
600	6.935E 01	5.065E 01	3.795E 01	2.818E 01	9.123E 00	4.945E 00	4.348E 00
1500	7.238E 01	6.696E 01	5.864E 01	4.850E 01	1.853E 01	9.994E 00	8.779E 00
3000	7.174E 01	6.903E 01	6.326E 01	5.470E 01	2.363E 01	1.358E 01	1.229E 01
5100	7.146E 01	7.023E 01	6.673E 01	6.018E 01	2.969E 01	1.828E 01	1.702E 01

FLIGHT NO. C-139 FILTER NO. 3

PATH RADIANCE FROM GROUND TO ALTITUDE (W/SR SQ M UM)

ALTITUDE M	ZENITH ANGLE OF PATH OF SIGHT (DEG) 93	95	97	100	120	150	180
300	3.698E 01	2.044E 01	1.376E 01	9.646E 00	3.053E 00	1.821E 00	1.732E 00
600	5.258E 01	3.375E 01	2.402E 01	1.738E 01	5.793E 00	3.488E 00	3.315E 00
1500	5.965E 01	5.084E 01	4.155E 01	3.282E 01	1.275E 01	7.886E 00	7.454E 00
3000	5.536E 01	5.160E 01	4.487E 01	3.711E 01	1.572E 01	9.845E 00	9.249E 00
5100	6.669E 01	6.078E 01	5.419E 01	4.601E 01	2.082E 01	1.317E 01	1.239E 01

FLIGHT NO. C-139
PATH RADIANCE FROM GROUND TO ALTITUDE
AZIMUTH OF PATH OF SIGHT = 180

AZIMUTH OF PATH OF SIGHT = 180

FLIGHT NO. C-139 FILTER NO. 2

PATH RADIANCE FROM GROUND TO ALTITUDE (W/SR SQ M UM)

ALTITUDE	ZENITH ANGLE OF PATH OF SIGHT (DEG)						
M	93	95	97	100	120	150	180
300	5.004E 01	3.253E 01	2.337E 01	1.717E 01	6.001E 00	3.408E 00	2.524E 00
600	6.141E 01	4.855E 01	3.817E 01	2.968E 01	1.149E 01	6.716E 00	4.953E 00
1500	6.897E 01	6.587E 01	6.034E 01	5.301E 01	2.688E 01	1.708E 01	1.229E 01
3000	7.563E 01	7.327E 01	6.946E 01	6.358E 01	3.801E 01	2.537E 01	1.702E 01
5100	8.645E 01	8.477E 01	8.222E 01	7.809E 01	5.550E 01	3.803E 01	2.330E 01

FLIGHT NO. C-139 FILTER NO. 6

PATH RADIANCE FROM GROUND TO ALTITUDE (W/SR SQ M UM)

ALTITUDE	ZENITH ANGLE OF PATH OF SIGHT (DEG)						
M	93	95	97	100	120	150	180
300	4.398E 01	2.711E 01	1.906E 01	1.383E 01	4.693E 00	2.645E 00	1.965E 00
600	5.567E 01	4.234E 01	3.257E 01	2.494E 01	9.265E 00	5.308E 00	3.971E 00
1500	6.027E 01	5.650E 01	5.085E 01	4.382E 01	2.090E 01	1.270E 01	9.435E 00
3000	8.228E 01	7.539E 01	6.883E 01	6.102E 01	3.488E 01	2.308E 01	1.526E 01
5100	7.505E 01	7.581E 01	7.369E 01	6.907E 01	4.555E 01	3.119E 01	2.023E 01

FLIGHT NO. C-139 FILTER NO. 5

PATH RADIANCE FROM GROUND TO ALTITUDE (W/SR SQ M UM)

ALTITUDE	ZENITH ANGLE OF PATH OF SIGHT (DEG)						
M	93	95	97	100	120	150	180
300	4.786E 01	2.922E 01	2.054E 01	1.499E 01	5.361E 00	3.181E 00	2.289E 00
600	6.011E 01	4.492E 01	3.430E 01	2.624E 01	1.003E 01	5.992E 00	4.348E 00
1500	5.921E 01	5.587E 01	5.004E 01	4.274E 01	1.977E 01	1.204E 01	8.779E 00
3000	7.201E 01	6.683E 01	6.104E 01	5.372E 01	2.915E 01	1.882E 01	1.229E 01
5100	7.813E 01	7.561E 01	7.153E 01	6.531E 01	4.146E 01	2.826E 01	1.702E 01

FLIGHT NO. C-139 FILTER NO. 3

PATH RADIANCE FROM GROUND TO ALTITUDE (W/SR SQ M UM)

ALTITUDE	ZENITH ANGLE OF PATH OF SIGHT (DEG)						
M	93	95	97	100	120	150	180
300	3.461E 01	1.956E 01	1.347E 01	9.839E 00	3.920E 00	2.735E 00	1.732E 00
600	4.936E 01	3.239E 01	2.358E 01	1.776E 01	7.436E 00	5.220E 00	3.315E 00
1500	5.682E 01	4.935E 01	4.119E 01	3.380E 01	1.636E 01	1.165E 01	7.454E 00
3000	5.362E 01	5.073E 01	4.497E 01	3.853E 01	2.019E 01	1.438E 01	9.249E 00
5100	6.489E 01	6.055E 01	5.519E 01	4.855E 01	2.755E 01	1.931E 01	1.239E 01

FLIGHT NO. C-139
PATH RADIANCE FROM GROUND TO ALTITUDE
AZIMUTH OF PATH OF SIGHT = 270

AZIMUTH OF PATH OF SIGHT = 270

FLIGHT NO. C-139 FILTER NO. 2

PATH RADIANCE FROM GROUND TO ALTITUDE (W/SR SQ M UM)

ALTITUDE M	ZENITH ANGLE OF PATH OF SIGHT (DEG) 93	95	97	100	120	150	180
300	5.605E 01	3.595E 01	2.546E 01	1.832E 01	5.619E 00	2.956E 00	2.524E 00
600	6.817E 01	5.326E 01	4.132E 01	3.145E 01	1.067E 01	5.762E 00	4.953E 00
1500	7.303E 01	6.951E 01	6.312E 01	5.432E 01	2.395E 01	1.397E 01	1.229E 01
3000	7.108E 01	7.002E 01	6.660E 01	6.024E 01	3.042E 01	1.875E 01	1.702E 01
5100	7.528E 01	7.370E 01	7.140E 01	6.684E 01	3.854E 01	2.518E 01	2.330E 01

FLIGHT NO. C-139 FILTER NO. 6

PATH RADIANCE FROM GROUND TO ALTITUDE (W/SR SQ M UM)

ALTITUDE M	ZENITH ANGLE OF PATH OF SIGHT (DEG) 93	95	97	100	120	150	180
300	5.165E 01	3.135E 01	2.169E 01	1.532E 01	4.439E 00	2.267E 00	1.965E 00
600	6.401E 01	4.819E 01	3.656E 01	2.732E 01	8.758E 00	4.581E 00	3.971E 00
1500	6.293E 01	5.955E 01	5.350E 01	4.549E 01	1.921E 01	1.088E 01	9.435E 00
3000	7.768E 01	7.209E 01	6.601E 01	5.795E 01	2.809E 01	1.735E 01	1.526E 01
5100	6.804E 01	6.885E 01	6.690E 01	6.218E 01	3.495E 01	2.275E 01	2.023E 01

FLIGHT NO. C-139 FILTER NO. 5

PATH RADIANCE FROM GROUND TO ALTITUDE (W/SR SQ M UM)

ALTITUDE M	ZENITH ANGLE OF PATH OF SIGHT (DEG) 93	95	97	100	120	150	180
300	5.494E 01	3.295E 01	2.273E 01	1.607E 01	4.821E 00	2.626E 00	2.289E 00
600	6.737E 01	4.980E 01	3.746E 01	2.787E 01	9.080E 00	4.993E 00	4.348E 00
1500	5.892E 01	5.665E 01	5.091E 01	4.308E 01	1.775E 01	1.006E 01	8.779E 00
3000	6.560E 01	6.196E 01	5.694E 01	4.969E 01	2.265E 01	1.355E 01	1.229E 01
5100	6.899E 01	6.643E 01	6.261E 01	5.636E 01	2.856E 01	1.809E 01	1.702E 01

FLIGHT NO. C-139 FILTER NO. 3

PATH RADIANCE FROM GROUND TO ALTITUDE (W/SR SQ M UM)

ALTITUDE M	ZENITH ANGLE OF PATH OF SIGHT (DEG) 93	95	97	100	120	150	180
300	3.775E 01	2.093E 01	1.414E 01	9.956E 00	3.193E 00	1.939E 00	1.732E 00
600	5.356E 01	3.450E 01	2.463E 01	1.790E 01	6.039E 00	3.700E 00	3.315E 00
1500	6.016E 01	5.150E 01	4.221E 01	3.346E 01	1.314E 01	8.257E 00	7.454E 00
3000	5.482E 01	5.154E 01	4.503E 01	3.740E 01	1.603E 01	1.020E 01	9.249E 00
5100	6.149E 01	5.750E 01	5.195E 01	4.465E 01	2.101E 01	1.368E 01	1.239E 01

FLIGHT NO. C-139
DIRECTIONAL PATH REFLECTANCE FROM GROUND TO ALTITUDE
AZIMUTH OF PATH OF SIGHT = 0

AZIMUTH OF PATH OF SIGHT = 0

FLIGHT NO. C-139 FILTER NO. 2

DIRECTIONAL PATH REFLECTANCE FROM GROUND TO ALTITUDE

ALTITUDE	ZENITH ANGLE OF PATH OF SIGHT (DEG)						
M	93	95	97	100	120	150	180
300	1.085E 00	4.318E-01	2.460E-01	1.487E-01	2.994E-02	1.274E-02	1.152E-02
600	4.188E 00	1.278E 00	6.563E-01	3.637E-01	6.462E-02	2.657E-02	2.393E-02
1500	1.597E 02	1.371E 01	4.487E 00	1.823E 00	2.126E-01	7.890E-02	7.053E-02
3000	1.600E 03	4.171E 01	9.600E 00	3.310E 00	3.192E-01	1.165E-01	1.074E-01
5100	7.398E 04	2.206E 02	2.750E 01	7.239E 00	5.034E-01	1.766E-01	1.659E-01

FLIGHT NO. C-139 FILTER NO. 6

DIRECTIONAL PATH REFLECTANCE FROM GROUND TO ALTITUDE

ALTITUDE	ZENITH ANGLE OF PATH OF SIGHT (DEG)						
M	93	95	97	100	120	150	180
300	8.959E-01	3.703E-01	2.146E-01	1.304E-01	2.501E-02	9.717E-03	8.713E-03
600	3.036E 00	1.033E 00	5.521E-01	3.129E-01	5.478E-02	2.089E-02	1.853E-02
1500	6.266E 01	7.408E 00	2.768E 00	1.234E 00	1.613E-01	5.890E-02	5.123E-02
3000	6.314E 02	2.386E 01	6.286E 00	2.367E 00	2.595E-01	9.798E-02	9.017E-02
5100	1.401E 04	9.116E 01	1.482E 01	4.556E 00	3.907E-01	1.437E-01	1.323E-01

FLIGHT NO. C-139 FILTER NO. 5

DIRECTIONAL PATH REFLECTANCE FROM GROUND TO ALTITUDE

ALTITUDE	ZENITH ANGLE OF PATH OF SIGHT (DEG)						
M	93	95	97	100	120	150	180
300	7.048E-01	2.934E-01	1.705E-01	1.037E-01	2.020E-02	8.361E-03	7.746E-03
600	2.162E 00	7.645E-01	4.142E-01	2.367E-01	4.199E-02	1.683E-02	1.542E-02
1500	3.317E 01	4.598E 00	1.819E 00	8.384E-01	1.105E-01	4.019E-02	3.585E-02
3000	1.964E 02	1.078E 01	3.264E 00	1.337E 00	1.559E-01	5.710E-02	5.356E-02
5100	2.549E 03	3.143E 01	6.408E 00	2.253E 00	2.225E-01	8.172E-02	8.011E-02

FLIGHT NO. C-139 FILTER NO. 3

DIRECTIONAL PATH REFLECTANCE FROM GROUND TO ALTITUDE

ALTITUDE	ZENITH ANGLE OF PATH OF SIGHT (DEG)						
M	93	95	97	100	120	150	180
300	3.278E-01	1.412E-01	8.374E-02	5.183E-02	1.082E-02	4.935E-03	5.085E-03
600	7.952E-01	3.197E-01	1.828E-01	1.092E-01	2.167E-02	9.750E-03	9.999E-03
1500	4.895E 00	1.279E 00	6.256E-01	3.332E-01	5.627E-02	2.424E-02	2.444E-02
3000	1.556E 01	2.364E 00	9.953E-01	4.947E-01	7.616E-02	3.192E-02	3.178E-02
5100	1.395E 02	6.994E 00	2.170E 00	9.317E-01	1.165E-01	4.635E-02	4.532E-02

FLIGHT NO. C-139
DIRECTIONAL PATH REFLECTANCE FROM GROUND TO ALTITUDE
AZIMUTH OF PATH OF SIGHT = 90

AZIMUTH OF PATH OF SIGHT = 90

FLIGHT NO. C-139 FILTER NO. 2

DIRECTIONAL PATH REFLECTANCE FROM GROUND TO ALTITUDE

ALTITUDE	ZENITH ANGLE OF PATH OF SIGHT (DEG)						
M	93	95	97	100	120	150	180
300	7.398E-01	3.016E-01	1.758E-01	1.093E-01	2.664E-02	1.331E-02	1.152E-02
600	2.743E 00	8.647E-01	4.562E-01	2.613E-01	5.697E-02	2.783E-02	2.393E-02
1500	9.617E 01	8.533E 00	2.892E 00	1.231E 00	1.834E-01	8.345E-02	7.053E-02
3000	1.098E 03	2.839E 01	6.617E 00	2.353E 00	2.824E-01	1.255E-01	1.074E-01
5100	4.868E 04	1.499E 02	1.918E 01	5.242E 00	4.541E-01	1.921E-01	1.659E-01

FLIGHT NO. C-139 FILTER NO. 6

DIRECTIONAL PATH REFLECTANCE FROM GROUND TO ALTITUDE

ALTITUDE	ZENITH ANGLE OF PATH OF SIGHT (DEG)						
M	93	95	97	100	120	150	180
300	5.294E-01	2.237E-01	1.328E-01	8.378E-02	2.049E-02	1.007E-02	8.713E-03
600	1.832E 00	6.338E-01	3.463E-01	2.035E-01	4.503E-02	2.156E-02	1.853E-02
1500	4.104E 01	4.867E 00	1.840E 00	8.422E-01	1.346E-01	6.020E-02	5.123E-02
3000	4.368E 02	1.662E 01	4.426E 00	1.705E 00	2.243E-01	1.010E-01	9.017E-02
5100	9.449E 03	6.336E 01	1.055E 01	3.346E 00	3.474E-01	1.497E-01	1.323E-01

FLIGHT NO. C-139 FILTER NO. 5

DIRECTIONAL PATH REFLECTANCE FROM GROUND TO ALTITUDE

ALTITUDE	ZENITH ANGLE OF PATH OF SIGHT (DEG)						
M	93	95	97	100	120	150	180
300	4.038E-01	1.725E-01	1.032E-01	6.571E-02	1.694E-02	8.856E-03	7.746E-03
600	1.298E 00	4.655E-01	2.581E-01	1.536E-01	3.541E-02	1.778E-02	1.542E-02
1500	2.355E 01	3.214E 00	1.272E 00	5.966E-01	9.543E-02	4.230E-02	3.585E-02
3000	1.366E 02	7.620E 00	2.334E 00	9.768E-01	1.385E-01	6.195E-02	5.356E-02
5100	1.750E 03	2.222E 01	4.633E 00	1.675E 00	2.030E-01	9.115E-02	8.011E-02

FLIGHT NO. C-139 FILTER NO. 3

DIRECTIONAL PATH REFLECTANCE FROM GROUND TO ALTITUDE

ALTITUDE	ZENITH ANGLE OF PATH OF SIGHT (DEG)						
M	93	95	97	100	120	150	180
300	1.807E-01	8.044E-02	4.938E-02	3.233E-02	9.215E-03	5.369E-03	5.085E-03
600	4.382E-01	1.821E-01	1.078E-01	6.818E-02	1.847E-02	1.061E-02	9.999E-03
1500	2.690E 00	7.288E-01	3.701E-01	2.082E-01	4.803E-02	2.642E-02	2.444E-02
3000	8.417E 00	1.337E 00	5.870E-01	3.083E-01	6.502E-02	3.481E-02	3.178E-02
5100	6.703E 01	3.608E 00	1.187E 00	5.488E-01	9.765E-02	5.009E-02	4.532E-02

FLIGHT NO. C-139
DIRECTIONAL PATH REFLECTANCE FROM GROUND TO ALTITUDE
AZIMUTH OF PATH OF SIGHT = 180

AZIMUTH OF PATH OF SIGHT = 180

FLIGHT NO. C-139 FILTER NO. 2

DIRECTIONAL PATH REFLECTANCE FROM GROUND TO ALTITUDE

ALTITUDE	ZENITH ANGLE OF PATH OF SIGHT (DEG)						
M	93	95	97	100	120	150	180
300	6.609E-01	2.737E-01	1.623E-01	1.034E-01	2.903E-02	1.570E-02	1.152E-02
600	2.462E 00	7.875E-01	4.221E-01	2.477E-01	6.228E-02	3.303E-02	2.393E-02
1500	8.961E 01	7.988E 00	2.735E 00	1.191E 00	2.055E-01	1.024E-01	7.053E-02
3000	1.164E 03	2.952E 01	6.850E 00	2.465E 00	3.511E-01	1.698E-01	1.074E-01
5100	5.532E 04	1.709E 02	2.189E 01	6.078E 00	6.531E-01	2.927E-01	1.659E-01

FLIGHT NO. C-139 FILTER NO. 6

DIRECTIONAL PATH REFLECTANCE FROM GROUND TO ALTITUDE

ALTITUDE	ZENITH ANGLE OF PATH OF SIGHT (DEG)						
M	93	95	97	100	120	150	180
300	4.587E-01	1.966E-01	1.184E-01	7.662E-02	2.180E-02	1.181E-02	8.713E-03
600	1.585E 00	5.565E-01	3.086E-01	1.858E-01	4.771E-02	2.515E-02	1.853E-02
1500	3.672E 01	4.368E 00	1.669E 00	7.807E-01	1.457E-01	7.168E-02	5.123E-02
3000	4.545E 02	1.701E 01	4.524E 00	1.770E 00	2.879E-01	1.436E-01	9.017E-02
5100	9.797E 03	6.640E 01	1.113E 01	3.593E 00	4.606E-01	2.182E-01	1.323E-01

FLIGHT NO. C-139 FILTER NO. 5

DIRECTIONAL PATH REFLECTANCE FROM GROUND TO ALTITUDE

ALTITUDE	ZENITH ANGLE OF PATH OF SIGHT (DEG)						
M	93	95	97	100	120	150	180
300	3.606E-01	1.567E-01	9.531E-02	6.249E-02	1.896E-02	1.084E-02	7.746E-03
600	1.125E 00	4.129E-01	2.333E-01	1.431E-01	3.894E-02	2.154E-02	1.542E-02
1500	1.927E 01	2.682E 00	1.085E 00	5.257E-01	1.018E-01	5.098E-02	3.585E-02
3000	1.371E 02	7.378E 00	2.252E 00	9.593E-01	1.708E-01	8.584E-02	5.356E-02
5100	1.913E 03	2.392E 01	4.966E 00	1.818E 00	2.834E-01	1.409E-01	8.011E-02

FLIGHT NO. C-139 FILTER NO. 3

DIRECTIONAL PATH REFLECTANCE FROM GROUND TO ALTITUDE

ALTITUDE	ZENITH ANGLE OF PATH OF SIGHT (DEG)						
M	93	95	97	100	120	150	180
300	1.691E-01	7.700E-02	4.836E-02	3.298E-02	1.183E-02	8.062E-03	5.085E-03
600	4.114E-01	1.748E-01	1.059E-01	6.967E-02	2.370E-02	1.588E-02	9.999E-03
1500	2.562E 00	7.075E-01	3.670E-01	2.144E-01	6.162E-02	3.901E-02	2.444E-02
3000	8.153E 00	1.315E 00	5.883E-01	3.201E-01	8.353E-02	5.086E-02	3.178E-02
5100	6.522E 01	3.595E 00	1.209E 00	5.792E-01	1.292E-01	7.343E-02	4.532E-02

FLIGHT NO. C-139
DIRECTIONAL PATH REFLECTANCE FROM GROUND TO ALTITUDE
AZIMUTH OF PATH OF SIGHT = 270

AZIMUTH OF PATH OF SIGHT = 270

FLIGHT NO. C-139 FILTER NO. 2

DIRECTIONAL PATH REFLECTANCE FROM GROUND TO ALTITUDE

ALTITUDE	ZENITH ANGLE OF PATH OF SIGHT (DEG)						
M	93	95	97	100	120	150	180
300	7.403E-01	3.025E-01	1.768E-01	1.103E-01	2.719E-02	1.362E-02	1.152E-02
600	2.733E 00	8.640E-01	4.569E-01	2.626E-01	5.783E-02	2.834E-02	2.393E-02
1500	9.489E 01	8.430E 00	2.861E 00	1.220E 00	1.831E-01	8.378E-02	7.053E-02
3000	1.094E 03	2.821E 01	6.568E 00	2.335E 00	2.811E-01	1.254E-01	1.074E-01
5100	4.817E 04	1.485E 02	1.901E 01	5.203E 00	4.536E-01	1.938E-01	1.659E-01

FLIGHT NO. C-139 FILTER NO. 6

DIRECTIONAL PATH REFLECTANCE FROM GROUND TO ALTITUDE

ALTITUDE	ZENITH ANGLE OF PATH OF SIGHT (DEG)						
M	93	95	97	100	120	150	180
300	5.387E-01	2.274E-01	1.348E-01	8.490E-02	2.062E-02	1.012E-02	8.713E-03
600	1.822E 00	6.334E-01	3.464E-01	2.036E-01	4.509E-02	2.170E-02	1.853E-02
1500	3.834E 01	4.603E 00	1.756E 00	8.104E-01	1.339E-01	6.138E-02	5.123E-02
3000	4.290E 02	1.626E 01	4.339E 00	1.681E 00	2.319E-01	1.080E-01	9.017E-02
5100	8.882E 03	6.031E 01	1.011E 01	3.235E 00	3.534E-01	1.592E-01	1.323E-01

FLIGHT NO. C-139 FILTER NO. 5

DIRECTIONAL PATH REFLECTANCE FROM GROUND TO ALTITUDE

ALTITUDE	ZENITH ANGLE OF PATH OF SIGHT (DEG)						
M	93	95	97	100	120	150	180
300	4.140E-01	1.767E-01	1.055E-01	6.698E-02	1.705E-02	8.946E-03	7.746E-03
600	1.261E 00	4.577E-01	2.548E-01	1.520E-01	3.524E-02	1.795E-02	1.542E-02
1500	1.917E 01	2.719E 00	1.104E 00	5.300E-01	9.140E-02	4.258E-02	3.585E-02
3000	1.249E 02	6.840E 00	2.100E 00	8.874E-01	1.327E-01	6.179E-02	5.356E-02
5100	1.689E 03	2.102E 01	4.347E 00	1.569E 00	1.953E-01	9.022E-02	8.011E-02

FLIGHT NO. C-139 FILTER NO. 3

DIRECTIONAL PATH REFLECTANCE FROM GROUND TO ALTITUDE

ALTITUDE	ZENITH ANGLE OF PATH OF SIGHT (DEG)						
M	93	95	97	100	120	150	180
300	1.845E-01	8.239E-02	5.074E-02	3.337E-02	9.636E-03	5.714E-03	5.085E-03
600	4.464E-01	1.862E-01	1.106E-01	7.020E-02	1.925E-02	1.126E-02	9.999E-03
1500	2.713E 00	7.382E-01	3.760E-01	2.123E-01	4.949E-02	2.766E-02	2.444E-02
3000	8.334E 00	1.336E 00	5.890E-01	3.107E-01	6.630E-02	3.607E-02	3.178E-02
5100	6.180E 01	3.413E 00	1.138E 00	5.327E-01	9.853E-02	5.203E-02	4.532E-02

FLIGHT C-142 – DESCRIPTION OF FLIGHT AND WEATHER CHARACTERISTICS

It was a sunlight morning. There was a moderate to heavy haze up to a cumulus cloud deck with bases at 745 and tops at 1250 meters and a clear sky above 1250 meters. The flight was conducted along an east-west route between Mindelheim and Mengen, passing approximately 8 to 16 kilometers (5 to 10 miles) north of Memmingen. The typical terrain was heavily cultivated, rolling pastureland occasionally interrupted by large patches of dark forest. The data-taking started at 0825 GMT (0925 LCT) and continued until 1045 GMT (1145 LCT). The sun zenith angle during sky radiance data-taking was 42.7 degrees at the start and 30.2 degrees at the end. The highest flight altitude was 4950 meters above ground level.

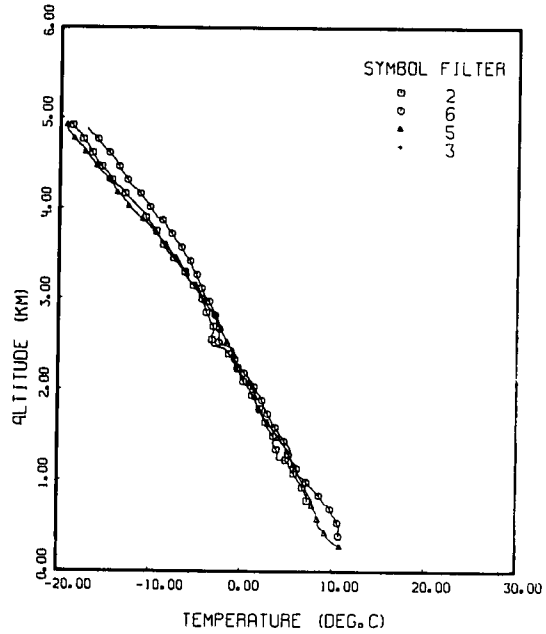
Just prior to the time data-taking began, Memmingen was reporting 2/8 cumulus at 300 meters. Visibility was reported as 7 kilometers (4 to 5 miles) with light fog.

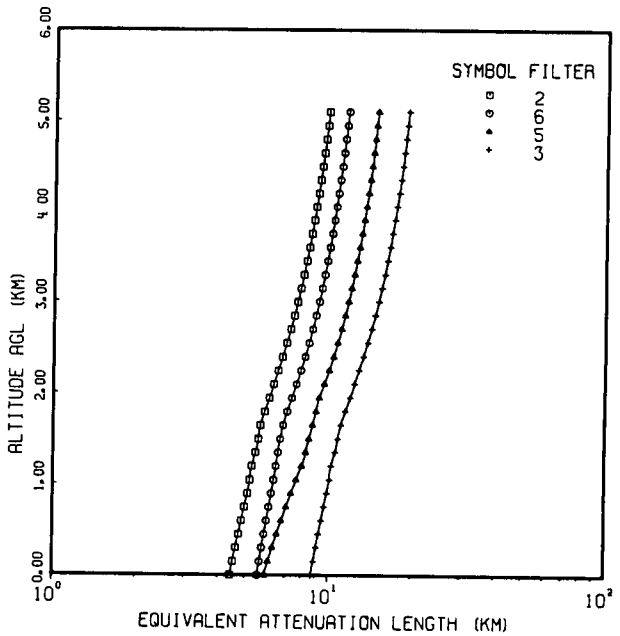
During the flight, the aircrew reported moderate to heavy haze up to a cumulus cloud deck with bases at 745 meters and tops at 1250 meters. At 1250 meters, the visibility was estimated at 6 miles (10 kilometers) with scattered cumulus below the flight path. From 1250 meters to 4920 meters, there was light haze with clear skies above.

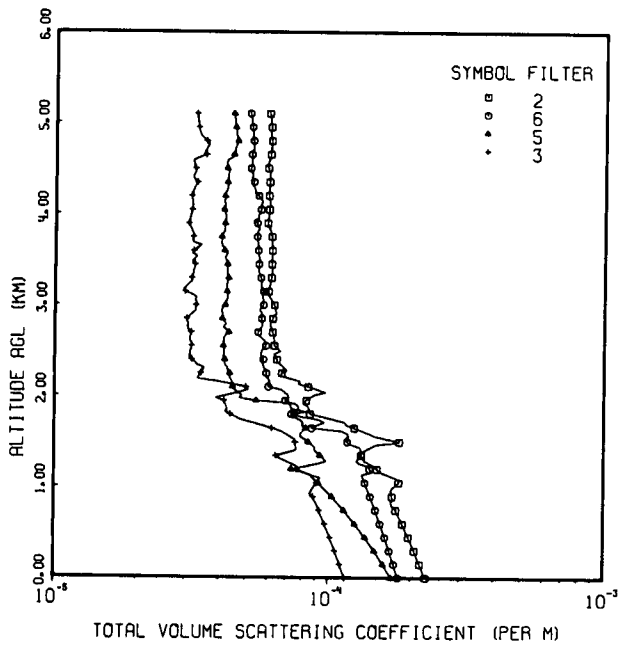
At the time data-taking ended, Memmingen was reporting 2/8 cumulus at 600 meters. Visibility was reported as 10 kilometers (6 miles).

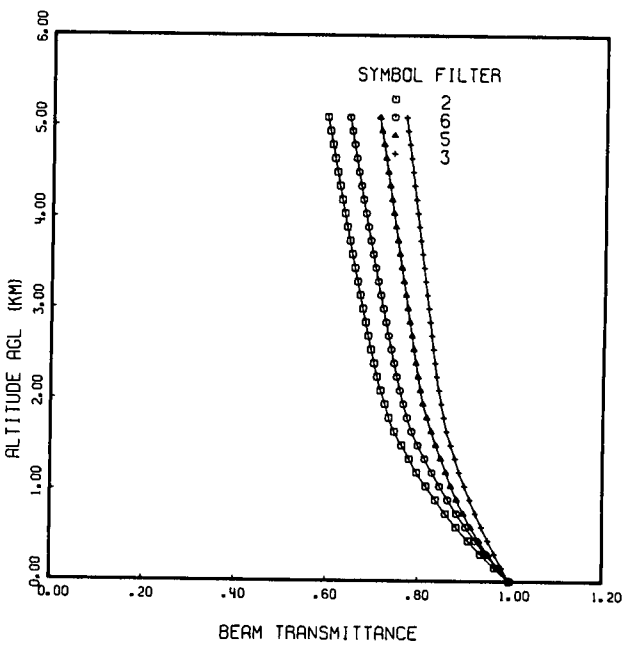
The surface charts show a very weak circulation with the Memmingen area in a col. There was a warm front in southern Italy and France that was moving slowly northeastward. The 500-millibar chart also had a weak circulation. A filling low was moving into Portugal from the eastern Atlantic. The airmass was unstable continental polar.

FLIGHT NO. C-142

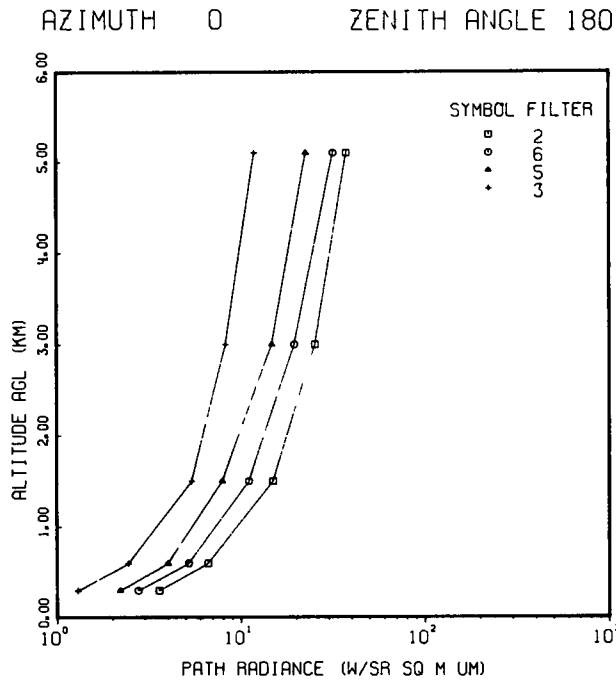


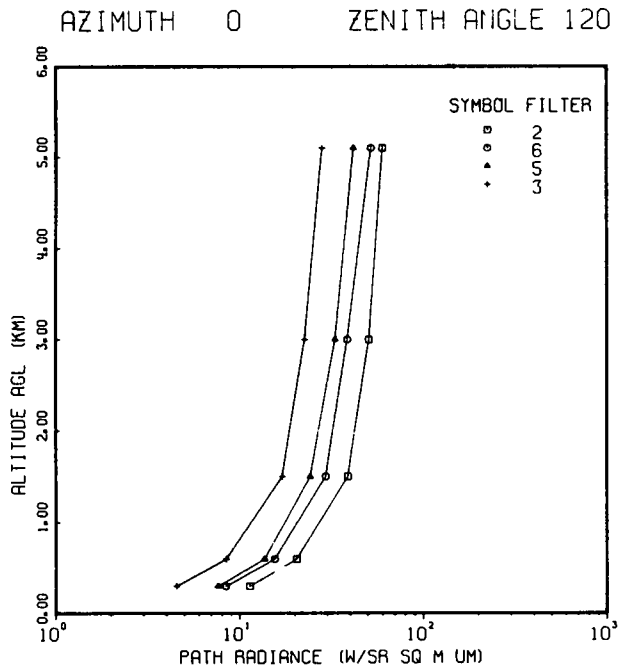


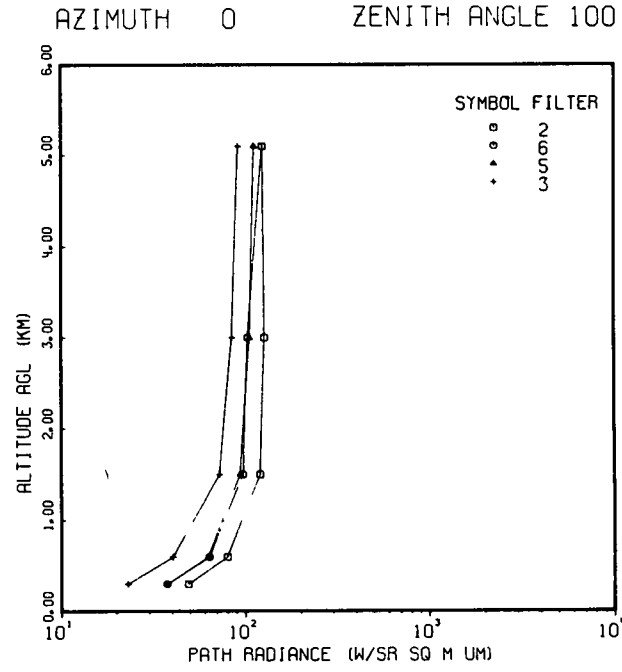




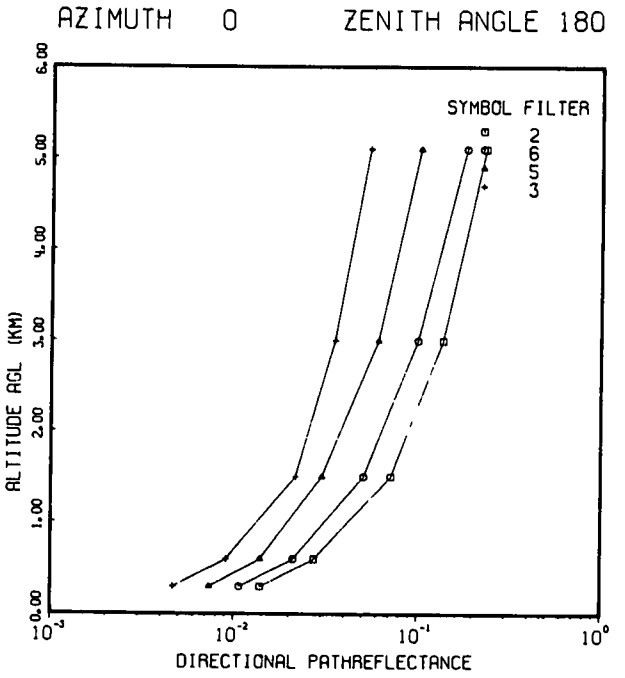
FLIGHT NO. C-142

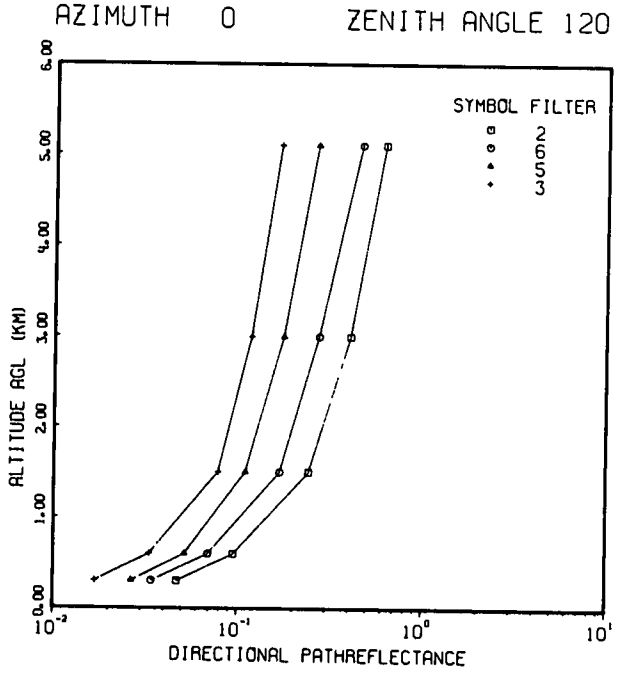


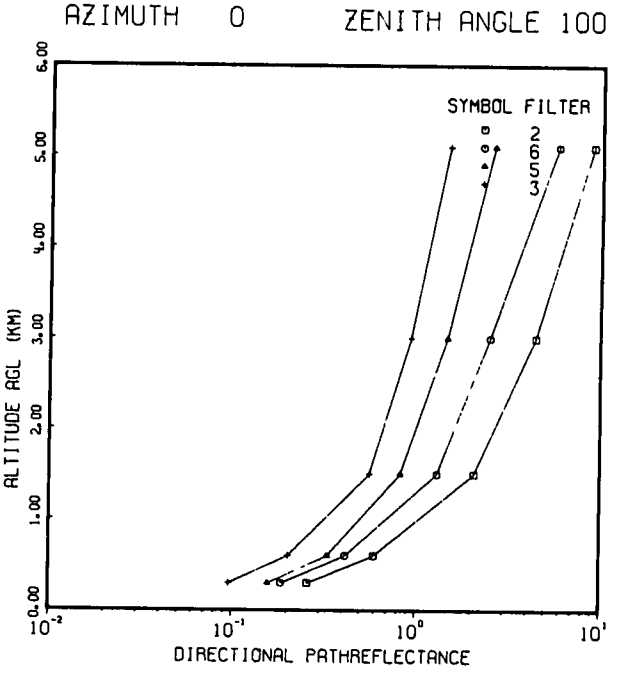




FLIGHT NO. C-142







FLIGHT NO. C-142
IRRADIANCE

FLIGHT NO.C-142 FILTER NO. 2
IRRADIANCE (W/SQ M UM)

ALTITUDE (METERS)	DOWN-WELLING	UP-WELLING	ALBEDO	SCALAR DOWNWELLING	SCALAR UPWELLING	SCALAR TOTAL	SCALAR ALBEDO
745	8.603E 02	6.102E 01	.071	1.458E 03	2.020E 02	1.660E 03	.139
2433	1.129E 03	6.719E 01	.059	1.616E 03	1.917E 02	1.808E 03	.119
4922	1.219E 03	7.761E 01	.064	1.614E 03	2.096E 02	1.823E 03	.130

FLIGHT NO.C-142 FILTER NO. 6
IRRADIANCE (W/SQ M UM)

ALTITUDE (METERS)	DOWN-WELLING	UP-WELLING	ALBEDO	SCALAR DOWNWELLING	SCALAR UPWELLING	SCALAR TOTAL	SCALAR ALBEDO
743	8.548E 02	5.495E 01	.064	1.411E 03	1.493E 02	1.560E 03	.106
1248	9.101E 02	4.487E 01	.049	1.358E 03	1.389E 02	1.497E 03	.102
2442	1.030E 03	6.449E 01	.063	1.406E 03	1.673E 02	1.573E 03	.119
4925	1.911E 03	9.016E 01	.047	2.416E 03	2.239E 02	2.640E 03	.093

FLIGHT NO.C-142 FILTER NO. 5
IRRADIANCE (W/SQ M UM)

ALTITUDE (METERS)	DOWN-WELLING	UP-WELLING	ALBEDO	SCALAR DOWNWELLING	SCALAR UPWELLING	SCALAR TOTAL	SCALAR ALBEDO
745	9.862E 02	4.872E 01	.049	1.607E 03	1.410E 02	1.748E 03	.088
1247	1.029E 03	6.025E 01	.059	1.511E 03	1.608E 02	1.672E 03	.106
2442	1.193E 03	6.371E 01	.053	1.650E 03	1.640E 02	1.814E 03	.099
4925	1.247E 03	8.021E 01	.064	1.607E 03	1.937E 02	1.800E 03	.121

FLIGHT NO.C-142 FILTER NO. 3
IRRADIANCE (W/SQ M UM)

ALTITUDE (METERS)	DOWN-WELLING	UP-WELLING	ALBEDO	SCALAR DOWNWELLING	SCALAR UPWELLING	SCALAR TOTAL	SCALAR ALBEDO
745	9.009E 02	4.764E 01	.053	1.380E 03	1.371E 02	1.517E 03	.099
1248	1.085E 03	4.694E 01	.043	1.571E 03	1.272E 02	1.699E 03	.081
2437	9.984E 02	4.769E 01	.048	1.338E 03	1.268E 02	1.465E 03	.095
4925	1.326E 03	5.544E 01	.042	1.635E 03	1.439E 02	1.779E 03	.088

FLIGHT NO. C-142
DIRECTIONAL REFLECTANCE OF BACKGROUND

FLIGHT NO. C-142
AZIMUTH OF PATH OF SIGHT = 0
DIRECTIONAL REFLECTANCE OF BACKGROUND

ZENITH ANGLE	FILTERS 2	6	5	3
93	.41962	.33361	.27814	.29291
95	.40162	.32027	.25634	.26492
97	.39708	.24505	.22837	.23776
100	.32204	.22109	.17364	.20600
120	.14688	.07551	.06014	.07799
150	.03890	.04927	.03575	.03368
180	.02873	.05467	.03584	.06163

FLIGHT NO. C-142
AZIMUTH OF PATH OF SIGHT = 90
DIRECTIONAL REFLECTANCE OF BACKGROUND

ZENITH ANGLE	FILTERS 2	6	5	3
93	.21241	.11511	.10724	.11420
95	.19004	.12364	.10354	.09879
97	.20277	.09012	.08786	.08897
100	.18438	.08169	.07707	.06748
120	.05308	.03722	.04107	.06533
150	.03834	.05450	.03575	.04422
180	.02873	.05467	.03584	.06163

FLIGHT NO. C-142
AZIMUTH OF PATH OF SIGHT = 180
DIRECTIONAL REFLECTANCE OF BACKGROUND

ZENITH ANGLE	FILTERS 2	6	5	3
93	.17707	.11181	.10557	.09277
95	.12913	.09180	.09429	.08278
97	.12163	.09034	.08060	.09514
100	.14946	.08242	.07121	.06324
120	.04783	.07788	.06794	.05921
150	.05268	.07899	.04644	.04999
180	.02873	.05467	.03584	.06163

FLIGHT NO. C-142
AZIMUTH OF PATH OF SIGHT = 270
DIRECTIONAL REFLECTANCE OF BACKGROUND

ZENITH ANGLE	FILTERS 2	6	5	3
93	.23812	.17813	.16140	.17959
95	.17431	.09506	.10630	.12519
97	.15346	.10614	.09675	.10295
100	.15621	.09139	.08161	.07234
120	.08374	.06341	.03293	.05601
150	.03941	.05308	.03799	.05674
180	.02873	.05467	.03584	.06163

FLIGHT NO. C-142
TOTAL VOLUME SCATTERING COEFFICIENT

DATE 60670 FLIGHT NO. C-142 GROUND LEVEL ALTITUDE (M)= 629

ALTITUDE (M)	TOTAL VOLUME SCATTERING COEFFICIENT (PER M) FILTERS 2	6	5	3
0	2.260E-04	1.800E-04	1.700E-04	1.150E-04
30	2.240E-04	1.787E-04	1.678E-04	1.141E-04
60	2.220E-04	1.775E-04	1.655E-04	1.132E-04
90	2.200E-04	1.762E-04	1.633E-04	1.123E-04
120	2.180E-04	1.749E-04	1.610E-04	1.114E-04
150	2.161E-04	1.737E-04	1.588E-04	1.105E-04
180	2.141E-04	1.724E-04	1.566E-04	1.096E-04
210	2.121E-04	1.712E-04	1.543E-04	1.087E-04
240	2.101E-04	1.699E-04	1.521E-04	1.078E-04
270	2.081E-04	1.686E-04	1.499E-04	1.069E-04
300	2.061E-04	1.674E-04	1.476E-04	1.060E-04
330	2.041E-04	1.661E-04	1.454E-04	1.051E-04
360	2.021E-04	1.648E-04	1.431E-04	1.042E-04
390	2.001E-04	1.636E-04	1.409E-04	1.033E-04
420	1.981E-04	1.623E-04	1.387E-04	1.024E-04
450	1.962E-04	1.610E-04	1.364E-04	1.015E-04
480	1.942E-04	1.598E-04	1.342E-04	1.006E-04
510	1.922E-04	1.585E-04	1.319E-04	9.968E-05
540	1.902E-04	1.572E-04	1.297E-04	9.877E-05
570	1.882E-04	1.560E-04	1.275E-04	9.787E-05
600	1.862E-04	1.547E-04	1.252E-04	9.697E-05
630	1.842E-04	1.535E-04	1.230E-04	9.607E-05
660	1.822E-04	1.522E-04	1.208E-04	9.517E-05
690	1.802E-04	1.509E-04	1.185E-04	9.427E-05
720	1.782E-04	1.497E-04	1.163E-04	9.337E-05
750	1.763E-04	1.484E-04	1.140E-04	9.246E-05
780	1.743E-04	1.471E-04	1.118E-04	9.156E-05
810	1.693E-04	1.459E-04	1.096E-04	9.066E-05
840	1.692E-04	1.446E-04	1.073E-04	8.976E-05
870	1.717E-04	1.433E-04	1.051E-04	8.886E-05
900	1.706E-04	1.421E-04	1.029E-04	8.796E-05
930	1.696E-04	1.408E-04	1.006E-04	8.519E-05
960	1.685E-04	1.395E-04	9.837E-05	8.640E-05
990	1.705E-04	1.383E-04	9.614E-05	8.761E-05
1020	1.754E-04	1.370E-04	9.390E-05	8.883E-05
1050	1.803E-04	1.358E-04	9.166E-05	9.027E-05
1080	1.819E-04	1.345E-04	8.942E-05	9.172E-05
1110	1.724E-04	1.332E-04	8.718E-05	9.316E-05
1140	1.629E-04	1.320E-04	8.623E-05	8.472E-05
1170	1.534E-04	1.449E-04	8.013E-05	8.056E-05
1200	1.500E-04	1.411E-04	7.304E-05	7.639E-05
1230	1.466E-04	1.402E-04	8.206E-05	7.667E-05
1260	1.406E-04	1.290E-04	9.145E-05	7.312E-05
1290	1.348E-04	1.258E-04	9.819E-05	6.956E-05
1320	1.332E-04	1.287E-04	9.574E-05	6.601E-05
1350	1.316E-04	1.309E-04	9.301E-05	6.397E-05
1380	1.300E-04	1.283E-04	9.113E-05	6.996E-05
1410	1.362E-04	1.313E-04	8.871E-05	7.595E-05
1440	1.424E-04	1.298E-04	8.887E-05	7.580E-05
1470	1.487E-04	1.197E-04	8.706E-05	7.552E-05
1500	1.806E-04	1.168E-04	8.406E-05	7.525E-05

FLIGHT NO. C-142
TOTAL VOLUME SCATTERING COEFFICIENT

DATE 60670 FLIGHT NO. C-142 GROUND LEVEL ALTITUDE (M)= 629

ALTITUDE (M)	TOTAL VOLUME SCATTERING COEFFICIENT (PER M) FILTERS 2	6	5	3
1530	1.634E-04	1.147E-04	8.182E-05	7.498E-05
1560	1.462E-04	1.177E-04	7.872E-05	7.218E-05
1590	1.394E-04	1.170E-04	7.849E-05	6.939E-05
1620	1.316E-04	1.105E-04	8.068E-05	6.659E-05
1650	1.237E-04	8.661E-05	8.241E-05	6.181E-05
1680	1.158E-04	9.027E-05	7.962E-05	5.709E-05
1710	1.141E-04	9.619E-05	8.038E-05	5.236E-05
1740	1.045E-04	9.208E-05	7.873E-05	4.763E-05
1770	9.494E-05	7.957E-05	7.396E-05	4.563E-05
1800	8.534E-05	7.290E-05	7.439E-05	4.363E-05
1830	8.480E-05	8.249E-05	7.581E-05	4.162E-05
1860	8.425E-05	7.264E-05	7.736E-05	4.262E-05
1890	8.371E-05	7.240E-05	7.723E-05	4.220E-05
1920	7.990E-05	7.151E-05	7.468E-05	4.178E-05
1950	8.271E-05	6.915E-05	5.425E-05	4.136E-05
1980	8.551E-05	7.113E-05	4.693E-05	3.851E-05
2010	8.831E-05	7.093E-05	4.804E-05	4.266E-05
2040	9.739E-05	6.886E-05	4.680E-05	4.680E-05
2070	9.061E-05	6.694E-05	4.501E-05	5.094E-05
2100	8.384E-05	6.005E-05	4.446E-05	4.965E-05
2130	7.706E-05	5.999E-05	4.483E-05	4.412E-05
2160	7.827E-05	6.044E-05	4.418E-05	3.859E-05
2190	7.222E-05	6.004E-05	4.375E-05	3.306E-05
2220	6.616E-05	5.865E-05	4.318E-05	3.352E-05
2250	6.706E-05	5.905E-05	4.344E-05	3.399E-05
2280	7.012E-05	5.874E-05	4.260E-05	3.446E-05
2310	6.827E-05	5.776E-05	4.257E-05	3.493E-05
2340	6.642E-05	5.718E-05	4.174E-05	3.300E-05
2370	6.458E-05	5.690E-05	4.146E-05	3.228E-05
2400	6.433E-05	5.744E-05	4.160E-05	3.156E-05
2430	6.352E-05	5.640E-05	4.114E-05	3.084E-05
2460	6.270E-05	5.608E-05	4.120E-05	3.099E-05
2490	6.639E-05	5.661E-05	4.124E-05	3.115E-05
2520	6.477E-05	5.713E-05	4.145E-05	3.130E-05
2550	6.288E-05	5.872E-05	4.107E-05	3.145E-05
2580	6.278E-05	5.827E-05	4.115E-05	3.160E-05
2610	6.268E-05	5.795E-05	4.115E-05	3.089E-05
2640	6.259E-05	5.632E-05	4.112E-05	3.102E-05
2670	6.242E-05	5.485E-05	4.183E-05	3.116E-05
2700	6.193E-05	5.488E-05	4.299E-05	3.130E-05
2730	6.144E-05	5.595E-05	4.198E-05	3.037E-05
2760	6.094E-05	5.644E-05	4.097E-05	3.039E-05
2790	6.049E-05	5.703E-05	4.200E-05	3.041E-05
2820	6.119E-05	5.606E-05	4.133E-05	3.043E-05
2850	6.189E-05	5.643E-05	4.055E-05	3.010E-05
2880	6.258E-05	5.586E-05	4.063E-05	3.091E-05
2910	6.375E-05	5.652E-05	4.064E-05	3.173E-05
2940	6.343E-05	5.557E-05	4.022E-05	3.254E-05
2970	6.311E-05	5.579E-05	4.068E-05	3.238E-05
3000	6.279E-05	5.723E-05	4.165E-05	3.254E-05

FLIGHT NO. C-142
TOTAL VOLUME SCATTERING COEFFICIENT

DATE 60670 FLIGHT NO. C-142 GROUND LEVEL ALTITUDE (M)= 629

ALTITUDE (M)	TOTAL VOLUME SCATTERING COEFFICIENT (PER M) FILTERS 2	6	5	3
3030	6.195E-05	5.705E-05	4.150E-05	3.270E-05
3060	6.110E-05	5.701E-05	4.225E-05	3.228E-05
3090	6.026E-05	5.682E-05	4.225E-05	3.268E-05
3120	5.941E-05	5.640E-05	4.231E-05	3.117E-05
3150	5.966E-05	5.717E-05	4.214E-05	2.965E-05
3180	5.990E-05	5.621E-05	4.208E-05	2.928E-05
3210	6.015E-05	5.627E-05	4.193E-05	3.005E-05
3240	6.044E-05	5.597E-05	4.215E-05	3.081E-05
3270	6.073E-05	5.656E-05	4.230E-05	3.158E-05
3300	6.102E-05	5.592E-05	4.267E-05	3.133E-05
3330	6.131E-05	5.574E-05	4.228E-05	3.157E-05
3360	6.144E-05	5.490E-05	4.213E-05	3.181E-05
3390	6.157E-05	5.463E-05	4.227E-05	3.192E-05
3420	6.114E-05	5.519E-05	4.213E-05	3.204E-05
3450	6.116E-05	5.499E-05	4.222E-05	3.215E-05
3480	6.117E-05	5.558E-05	4.204E-05	3.138E-05
3510	6.119E-05	5.520E-05	4.156E-05	3.209E-05
3540	6.126E-05	5.481E-05	4.154E-05	3.280E-05
3570	6.132E-05	5.467E-05	4.222E-05	3.138E-05
3600	6.139E-05	5.466E-05	4.118E-05	3.185E-05
3630	6.145E-05	5.463E-05	4.114E-05	3.291E-05
3660	6.133E-05	5.462E-05	4.021E-05	3.397E-05
3690	6.120E-05	5.417E-05	4.003E-05	3.150E-05
3720	6.108E-05	5.397E-05	4.029E-05	3.157E-05
3750	6.105E-05	5.399E-05	4.011E-05	3.165E-05
3780	6.071E-05	5.393E-05	4.023E-05	3.173E-05
3810	6.037E-05	5.411E-05	4.105E-05	3.137E-05
3840	6.003E-05	5.515E-05	4.119E-05	3.105E-05
3870	5.880E-05	5.402E-05	4.114E-05	3.074E-05
3900	5.895E-05	5.402E-05	4.118E-05	3.042E-05
3930	5.911E-05	5.235E-05	4.125E-05	3.064E-05
3960	5.926E-05	5.493E-05	4.157E-05	3.080E-05
3990	5.942E-05	5.447E-05	4.150E-05	3.096E-05
4020	5.957E-05	5.529E-05	4.110E-05	3.112E-05
4050	5.973E-05	5.569E-05	4.093E-05	3.129E-05
4080	5.989E-05	5.602E-05	4.125E-05	3.145E-05
4110	6.004E-05	5.573E-05	4.129E-05	3.143E-05
4140	6.020E-05	5.649E-05	4.083E-05	3.134E-05
4170	5.941E-05	5.572E-05	4.125E-05	3.125E-05
4200	5.945E-05	5.458E-05	4.117E-05	3.116E-05
4230	5.948E-05	5.300E-05	4.133E-05	3.140E-05
4260	5.948E-05	5.291E-05	4.187E-05	3.165E-05
4290	5.956E-05	5.253E-05	4.202E-05	3.190E-05
4320	5.964E-05	5.156E-05	4.221E-05	3.227E-05
4350	5.971E-05	5.237E-05	4.204E-05	3.264E-05
4380	5.978E-05	5.187E-05	4.218E-05	3.178E-05
4410	5.985E-05	5.146E-05	4.214E-05	3.153E-05
4440	5.992E-05	5.200E-05	4.226E-05	3.190E-05
4470	5.945E-05	5.056E-05	4.244E-05	3.226E-05
4500	5.897E-05	5.102E-05	4.183E-05	3.204E-05

FLIGHT NO. C-142
TOTAL VOLUME SCATTERING COEFFICIENT

DATE 60670 FLIGHT NO. C-142 GROUND LEVEL ALTITUDE (M)= 629

ALTITUDE (M)	TOTAL VOLUME SCATTERING COEFFICIENT (PER M)			
FILTERS	2	6	5	3
4530	5.842E-05	5.146E-05	4.197E-05	3.182E-05
4560	5.895E-05	5.148E-05	4.172E-05	3.159E-05
4590	5.948E-05	5.124E-05	4.191E-05	3.163E-05
4620	6.001E-05	5.162E-05	4.384E-05	3.336E-05
4650	6.011E-05	5.143E-05	4.426E-05	3.509E-05
4680	6.021E-05	5.141E-05	4.472E-05	3.461E-05
4710	6.031E-05	5.214E-05	4.463E-05	3.510E-05
4740	6.042E-05	5.222E-05	4.492E-05	3.558E-05
4770	6.057E-05	5.222E-05	4.523E-05	3.607E-05
4800	6.073E-05	5.209E-05	4.575E-05	3.519E-05
4830	6.041E-05	5.137E-05	4.578E-05	3.430E-05
4860	6.015E-05	5.184E-05	4.514E-05	3.342E-05
4890	5.989E-05	5.186E-05	4.507E-05	3.322E-05
4920	6.020E-05	5.170E-05	4.498E-05	3.302E-05
4950	6.051E-05	5.153E-05	4.484E-05	3.292E-05
4980	6.032E-05	5.137E-05	4.470E-05	3.282E-05
5010	6.013E-05	5.121E-05	4.456E-05	3.271E-05
5040	5.994E-05	5.105E-05	4.442E-05	3.261E-05
5070	5.975E-05	5.089E-05	4.428E-05	3.251E-05
5100	5.957E-05	5.073E-05	4.414E-05	3.241E-05
FIRST DATA ALT	0	0	0	0
LAST DATA ALT	4950	4890	4920	4920

FLIGHT NO. C-142
BEAM TRANSMITTANCE FROM GROUND TO ALTITUDE

FLIGHT NO. C-142 FILTER NO. 2
BEAM TRANSMITTANCE FROM GROUND TO ALTITUDE

ALTITUDE	ZENITH ANGLE OF PATH OF SIGHT (DEG)						
M	93	95	97	100	120	150	180
300	.2869969	.4743703	.5875202	.6884876	.8784194	.9278896	.9372403
600	.0905800	.2400178	.3625069	.4905920	.7808872	.8669336	.8836782
1500	.0045818	.0432006	.1093479	.2115536	.5830703	.7323841	.7835904
3000	.0002258	.0094293	.0399754	.1044031	.4562498	.6356830	.6754627
5100	.0000048	.0017592	.0141596	.0503936	.3542743	.5493019	.5952095

FLIGHT NO. C-142 FILTER NO. 6
BEAM TRANSMITTANCE FROM GROUND TO ALTITUDE

ALTITUDE	ZENITH ANGLE OF PATH OF SIGHT (DEG)						
M	93	95	97	100	120	150	180
300	.3666149	.5490856	.6521122	.7407781	.9010381	.9416098	.9492303
600	.1422953	.3138841	.4386912	.5608683	.8180508	.8905200	.9044616
1500	.0112201	.0727490	.1577745	.2736328	.6375739	.7711621	.7984823
3000	.0009030	.0203080	.0678227	.1512998	.5189922	.6847752	.7204112
5100	.0000310	.0045883	.0268580	.0789762	.4140993	.6010840	.6435055

FLIGHT NO. C-142 FILTER NO. 5
BEAM TRANSMITTANCE FROM GROUND TO ALTITUDE

ALTITUDE	ZENITH ANGLE OF PATH OF SIGHT (DEG)						
M	93	95	97	100	120	150	180
300	.3994736	.5779970	.6764267	.7600566	.9091137	.9464730	.9534746
600	.1789705	.3598061	.4834715	.6004625	.8376623	.9027840	.9152389
1500	.0289864	.1270836	.2340646	.3609015	.7019121	.8151758	.8378019
3000	.0040826	.0472528	.1217463	.2281166	.5985359	.7435377	.7736510
5100	.0002865	.0146503	.0586661	.1366573	.5009662	.6709410	.7077896

FLIGHT NO. C-142 FILTER NO. 3
BEAM TRANSMITTANCE FROM GROUND TO ALTITUDE

ALTITUDE	ZENITH ANGLE OF PATH OF SIGHT (DEG)						
M	93	95	97	100	120	150	180
300	.5281442	.6829068	.7618581	.8262228	.9358541	.9624474	.9673955
600	.2908726	.4800724	.5934516	.6933585	.8805727	.9292021	.9383884
1500	.0621745	.1977897	.3193213	.4488058	.7571138	.8515961	.8701229
3000	.0138494	.0929302	.1940290	.3163824	.6705414	.7939383	.8188659
5100	.0018235	.0381491	.1115595	.2145474	.5859229	.7344507	.7654560

FLIGHT NO. C-142
PATH RADIANCE FROM GROUND TO ALTITUDE
AZIMUTH OF PATH OF SIGHT = 0

AZIMUTH OF PATH OF SIGHT = 0

FLIGHT NO. C-142 FILTER NO. 2

PATH RADIANCE FROM GROUND TO ALTITUDE (W/SR SQ M UM)

ALTITUDE M	ZENITH ANGLE OF PATH OF SIGHT (DEG) 93	95	97	100	120	150	180
300	1.557E 02	1.006E 02	7.033E 01	4.877E 01	1.131E 01	4.298E 00	3.588E 00
600	1.818E 02	1.420E 02	1.087E 02	7.976E 01	2.038E 01	7.931E 00	6.650E 00
1500	1.776E 02	1.663E 02	1.467E 02	1.202E 02	3.878E 01	1.659E 01	1.500E 01
3000	1.546E 02	1.525E 02	1.439E 02	1.271E 02	5.057E 01	2.462E 01	2.540E 01
5100	1.394E 02	1.378E 02	1.338E 02	1.237E 02	6.005E 01	3.247E 01	3.783E 01

FLIGHT NO. C-142 FILTER NO. 6

PATH RADIANCE FROM GROUND TO ALTITUDE (W/SR SQ M UM)

ALTITUDE M	ZENITH ANGLE OF PATH OF SIGHT (DEG) 93	95	97	100	120	150	180
300	1.335E 02	8.106E 01	5.516E 01	3.746E 01	8.402E 00	3.187E 00	2.764E 00
600	1.649E 02	1.206E 02	8.899E 01	6.347E 01	1.545E 01	5.975E 00	5.201E 00
1500	1.524E 02	1.414E 02	1.215E 02	9.710E 01	2.932E 01	1.223E 01	1.109E 01
3000	1.311E 02	1.289E 02	1.196E 02	1.030E 02	3.852E 01	1.827E 01	1.959E 01
5100	1.753E 02	1.580E 02	1.435E 02	1.239E 02	5.198E 01	2.778E 01	3.199E 01

FLIGHT NO. C-142 FILTER NO. 5

PATH RADIANCE FROM GROUND TO ALTITUDE (W/SR SQ M UM)

ALTITUDE M	ZENITH ANGLE OF PATH OF SIGHT (DEG) 93	95	97	100	120	150	180
300	1.439E 02	8.475E 01	5.661E 01	3.758E 01	7.611E 00	2.648E 00	2.202E 00
600	1.804E 02	1.260E 02	9.036E 01	6.258E 01	1.359E 01	4.810E 00	4.011E 00
1500	1.719E 02	1.510E 02	1.230E 02	9.347E 01	2.420E 01	9.214E 00	7.944E 00
3000	1.538E 02	1.461E 02	1.289E 02	1.054E 02	3.307E 01	1.454E 01	1.481E 01
5100	1.433E 02	1.392E 02	1.291E 02	1.115E 02	4.185E 01	2.082E 01	2.280E 01

FLIGHT NO. C-142 FILTER NO. 3

PATH RADIANCE FROM GROUND TO ALTITUDE (W/SR SQ M UM)

ALTITUDE M	ZENITH ANGLE OF PATH OF SIGHT (DEG) 93	95	97	100	120	150	180
300	9.960E 01	5.425E 01	3.516E 01	2.284E 01	4.520E 00	1.561E 00	1.295E 00
600	1.377E 02	8.737E 01	6.002E 01	4.031E 01	8.414E 00	2.944E 00	2.447E 00
1500	1.651E 02	1.309E 02	1.004E 02	7.218E 01	1.700E 01	6.303E 00	5.419E 00
3000	1.481E 02	1.328E 02	1.102E 02	8.439E 01	2.261E 01	9.129E 00	8.283E 00
5100	1.363E 02	1.283E 02	1.130E 02	9.151E 01	2.821E 01	1.251E 01	1.194E 01

FLIGHT NO. C-142
PATH RADIANCE FROM GROUND TO ALTITUDE
AZIMUTH OF PATH OF SIGHT = 90

AZIMUTH OF PATH OF SIGHT = 90

FLIGHT NO. C-142 FILTER NO. 2

PATH RADIANCE FROM GROUND TO ALTITUDE (W/SR SQ M UM)

ALTITUDE	ZENITH ANGLE OF PATH OF SIGHT (DEG)						
M	93	95	97	100	120	150	180
300	7.643E 01	5.080E 01	3.676E 01	2.699E 01	8.598E 00	4.247E 00	3.588E 00
600	8.923E 01	7.171E 01	5.681E 01	4.413E 01	1.550E 01	7.837E 00	6.650E 00
1500	9.435E 01	8.916E 01	8.063E 01	6.944E 01	3.043E 01	1.690E 01	1.500E 01
3000	9.744E 01	9.494E 01	9.016E 01	8.198E 01	4.258E 01	2.663E 01	2.540E 01
5100	9.553E 01	9.503E 01	9.299E 01	8.800E 01	5.302E 01	3.709E 01	3.783E 01

FLIGHT NO. C-142 FILTER NO. 6

PATH RADIANCE FROM GROUND TO ALTITUDE (W/SR SQ M UM)

ALTITUDE	ZENITH ANGLE OF PATH OF SIGHT (DEG)						
M	93	95	97	100	120	150	180
300	5.907E 01	3.689E 01	2.599E 01	1.875E 01	5.893E 00	3.133E 00	2.764E 00
600	7.298E 01	5.489E 01	4.194E 01	3.176E 01	1.083E 01	5.875E 00	5.201E 00
1500	7.487E 01	6.988E 01	6.162E 01	5.168E 01	2.160E 01	1.241E 01	1.109E 01
3000	8.357E 01	7.885E 01	7.276E 01	6.414E 01	3.117E 01	2.008E 01	1.959E 01
5100	1.083E 02	1.005E 02	9.313E 01	8.333E 01	4.491E 01	3.159E 01	3.199E 01

FLIGHT NO. C-142 FILTER NO. 5

PATH RADIANCE FROM GROUND TO ALTITUDE (W/SR SQ M UM)

ALTITUDE	ZENITH ANGLE OF PATH OF SIGHT (DEG)						
M	93	95	97	100	120	150	180
300	5.720E 01	3.483E 01	2.424E 01	1.728E 01	5.105E 00	2.592E 00	2.202E 00
600	7.170E 01	5.176E 01	3.870E 01	2.877E 01	9.118E 00	4.708E 00	4.011E 00
1500	7.422E 01	6.617E 01	5.582E 01	4.503E 01	1.678E 01	9.137E 00	7.944E 00
3000	8.461E 01	7.775E 01	6.916E 01	5.863E 01	2.539E 01	1.557E 01	1.481E 01
5100	8.587E 01	8.297E 01	7.753E 01	6.898E 01	3.457E 01	2.318E 01	2.280E 01

FLIGHT NO. C-142 FILTER NO. 3

PATH RADIANCE FROM GROUND TO ALTITUDE (W/SR SQ M UM)

ALTITUDE	ZENITH ANGLE OF PATH OF SIGHT (DEG)						
M	93	95	97	100	120	150	180
300	3.545E 01	2.008E 01	1.367E 01	9.675E 00	2.924E 00	1.501E 00	1.295E 00
600	4.901E 01	3.233E 01	2.333E 01	1.707E 01	5.443E 00	2.830E 00	2.447E 00
1500	5.979E 01	4.919E 01	3.969E 01	3.116E 01	1.127E 01	6.137E 00	5.419E 00
3000	6.012E 01	5.453E 01	4.711E 01	3.887E 01	1.582E 01	9.169E 00	8.283E 00
5100	6.311E 01	5.923E 01	5.353E 01	4.595E 01	2.094E 01	1.297E 01	1.194E 01

FLIGHT NO. C-142
PATH RADIANCE FROM GROUND TO ALTITUDE
AZIMUTH OF PATH OF SIGHT = 180

AZIMUTH OF PATH OF SIGHT = 180

FLIGHT NO. C-142 FILTER NO. 2

PATH RADIANCE FROM GROUND TO ALTITUDE (W/SR SQ M UM)

ALTITUDE M	ZENITH ANGLE OF PATH OF SIGHT (DEG) 93	95	97	100	120	150	180
300	7.145E 01	4.830E 01	3.541E 01	2.648E 01	9.636E 00	5.066E 00	3.588E 00
600	8.342E 01	6.819E 01	5.473E 01	4.330E 01	1.737E 01	9.349E 00	6.650E 00
1500	9.334E 01	8.886E 01	8.121E 01	7.133E 01	3.784E 01	2.297E 01	1.500E 01
3000	1.060E 02	1.040E 02	9.982E 01	9.294E 01	6.410E 01	4.451E 01	2.540E 01
5100	1.041E 02	1.059E 02	1.056E 02	1.038E 02	8.808E 01	6.952E 01	3.783E 01

FLIGHT NO. C-142 FILTER NO. 6

PATH RADIANCE FROM GROUND TO ALTITUDE (W/SR SQ M UM)

ALTITUDE M	ZENITH ANGLE OF PATH OF SIGHT (DEG) 93	95	97	100	120	150	180
300	5.640E 01	3.607E 01	2.590E 01	1.918E 01	7.107E 00	3.915E 00	2.764E 00
600	6.968E 01	5.367E 01	4.180E 01	3.249E 01	1.307E 01	7.341E 00	5.201E 00
1500	7.267E 01	6.887E 01	6.178E 01	5.322E 01	2.630E 01	1.591E 01	1.109E 01
3000	8.785E 01	8.299E 01	7.725E 01	7.023E 01	4.406E 01	3.193E 01	1.959E 01
5100	1.143E 02	1.081E 02	1.018E 02	9.461E 01	6.690E 01	5.428E 01	3.199E 01

FLIGHT NO. C-142 FILTER NO. 5

PATH RADIANCE FROM GROUND TO ALTITUDE (W/SR SQ M UM)

ALTITUDE M	ZENITH ANGLE OF PATH OF SIGHT (DEG) 93	95	97	100	120	150	180
300	5.260E 01	3.270E 01	2.313E 01	1.689E 01	5.938E 00	3.143E 00	2.202E 00
600	6.593E 01	4.860E 01	3.692E 01	2.813E 01	1.061E 01	5.709E 00	4.011E 00
1500	7.040E 01	6.335E 01	5.417E 01	4.474E 01	1.999E 01	1.153E 01	7.944E 00
3000	9.063E 01	8.314E 01	7.468E 01	6.508E 01	3.821E 01	2.595E 01	1.481E 01
5100	9.209E 01	9.066E 01	8.619E 01	7.938E 01	5.446E 01	4.103E 01	2.280E 01

FLIGHT NO. C-142 FILTER NO. 3

PATH RADIANCE FROM GROUND TO ALTITUDE (W/SR SQ M UM)

ALTITUDE M	ZENITH ANGLE OF PATH OF SIGHT (DEG) 93	95	97	100	120	150	180
300	3.155E 01	1.831E 01	1.269E 01	9.224E 00	3.390E 00	1.892E 00	1.295E 00
600	4.362E 01	2.948E 01	2.166E 01	1.628E 01	6.311E 00	3.567E 00	2.447E 00
1500	5.308E 01	4.486E 01	3.693E 01	2.987E 01	1.336E 01	7.893E 00	5.419E 00
3000	5.655E 01	5.184E 01	4.552E 01	3.868E 01	1.935E 01	1.206E 01	8.283E 00
5100	6.014E 01	5.738E 01	5.280E 01	4.683E 01	2.604E 01	1.735E 01	1.194E 01

FLIGHT NO. C-142
PATH RADIANCE FROM GROUND TO ALTITUDE
AZIMUTH OF PATH OF SIGHT = 270

AZIMUTH OF PATH OF SIGHT = 270

FLIGHT NO. C-142 FILTER NO. 2

PATH RADIANCE FROM GROUND TO ALTITUDE (W/SR SQ M UM)

ALTITUDE M	ZENITH ANGLE OF PATH OF SIGHT (DEG) 93	95	97	100	120	150	180
300	6.796E 01	4.960E 01	3.692E 01	2.701E 01	8.539E 00	4.283E 00	3.588E 00
600	8.669E 01	7.172E 01	5.706E 01	4.416E 01	1.539E 01	7.904E 00	6.650E 00
1500	9.488E 01	9.029E 01	8.080E 01	6.940E 01	3.027E 01	1.706E 01	1.500E 01
3000	9.530E 01	9.348E 01	8.989E 01	8.174E 01	4.252E 01	2.695E 01	2.540E 01
5100	9.532E 01	9.420E 01	9.305E 01	8.806E 01	5.319E 01	3.748E 01	3.783E 01

FLIGHT NO. C-142 FILTER NO. 6

PATH RADIANCE FROM GROUND TO ALTITUDE (W/SR SQ M UM)

ALTITUDE M	ZENITH ANGLE OF PATH OF SIGHT (DEG) 93	95	97	100	120	150	180
300	6.056E 01	3.804E 01	2.683E 01	1.938E 01	6.164E 00	3.260E 00	2.764E 00
600	7.481E 01	5.660E 01	4.329E 01	3.284E 01	1.133E 01	6.113E 00	5.201E 00
1500	7.505E 01	7.056E 01	6.241E 01	5.245E 01	2.205E 01	1.266E 01	1.109E 01
3000	8.387E 01	7.926E 01	7.328E 01	6.471E 01	3.160E 01	2.032E 01	1.959E 01
5100	1.103E 02	1.024E 02	9.510E 01	8.531E 01	4.642E 01	3.251E 01	3.199E 01

FLIGHT NO. C-142 FILTER NO. 5

PATH RADIANCE FROM GROUND TO ALTITUDE (W/SR SQ M UM)

ALTITUDE M	ZENITH ANGLE OF PATH OF SIGHT (DEG) 93	95	97	100	120	150	180
300	5.841E 01	3.570E 01	2.482E 01	1.767E 01	5.191E 00	2.607E 00	2.202E 00
600	7.322E 01	5.306E 01	3.962E 01	2.943E 01	9.272E 00	4.734E 00	4.011E 00
1500	7.680E 01	6.836E 01	5.757E 01	4.638E 01	1.725E 01	9.292E 00	7.944E 00
3000	8.572E 01	7.920E 01	7.059E 01	5.990E 01	2.601E 01	1.582E 01	1.481E 01
5100	8.755E 01	8.462E 01	7.913E 01	7.046E 01	3.538E 01	2.354E 01	2.280E 01

FLIGHT NO. C-142 FILTER NO. 3

PATH RADIANCE FROM GROUND TO ALTITUDE (W/SR SQ M UM)

ALTITUDE M	ZENITH ANGLE OF PATH OF SIGHT (DEG) 93	95	97	100	120	150	180
300	3.683E 01	2.096E 01	1.425E 01	1.007E 01	3.048E 00	1.562E 00	1.295E 00
600	5.091E 01	3.376E 01	2.432E 01	1.777E 01	5.675E 00	2.945E 00	2.447E 00
1500	5.806E 01	4.894E 01	3.975E 01	3.137E 01	1.168E 01	6.444E 00	5.419E 00
3000	5.922E 01	5.409E 01	4.692E 01	3.891E 01	1.634E 01	9.609E 00	8.283E 00
5100	6.330E 01	5.944E 01	5.383E 01	4.637E 01	2.166E 01	1.352E 01	1.194E 01

FLIGHT NO. C-142
DIRECTIONAL PATH REFLECTANCE FROM GROUND TO ALTITUDE
AZIMUTH OF PATH OF SIGHT = 0

AZIMUTH OF PATH OF SIGHT = 0

FLIGHT NO. C-142 FILTER NO. 2

DIRECTIONAL PATH REFLECTANCE FROM GROUND TO ALTITUDE

ALTITUDE M	ZENITH ANGLE OF PATH OF SIGHT (DEG) 93	95	97	100	120	150	180
300	1.982E 00	7.744E-01	4.371E-01	2.587E-01	4.701E-02	1.692E-02	1.398E-02
600	7.331E 00	2.161E 00	1.095E 00	5.937E-01	9.530E-02	3.341E-02	2.748E-02
1500	1.415E 02	1.405E 01	4.898E 00	2.075E 00	2.429E-01	8.274E-02	7.175E-02
3000	2.501E 03	5.907E 01	1.315E 01	4.446E 00	4.048E-01	1.414E-01	1.373E-01
5100	1.072E 05	2.861E 02	3.451E 01	8.967E 00	6.190E-01	2.159E-01	2.321E-01

FLIGHT NO. C-142 FILTER NO. 6

DIRECTIONAL PATH REFLECTANCE FROM GROUND TO ALTITUDE

ALTITUDE M	ZENITH ANGLE OF PATH OF SIGHT (DEG) 93	95	97	100	120	150	180
300	1.338E 00	5.426E-01	3.108E-01	1.859E-01	3.427E-02	1.244E-02	1.070E-02
600	4.258E 00	1.412E 00	7.455E-01	4.159E-01	6.939E-02	2.466E-02	2.113E-02
1500	4.991E 01	7.143E 00	2.829E 00	1.304E 00	1.690E-01	5.827E-02	5.105E-02
3000	5.337E 02	2.332E 01	6.482E 00	2.503E 00	2.728E-01	9.807E-02	9.994E-02
5100	2.081E 04	1.265E 02	1.964E 01	5.765E 00	4.614E-01	1.698E-01	1.827E-01

FLIGHT NO. C-142 FILTER NO. 5

DIRECTIONAL PATH REFLECTANCE FROM GROUND TO ALTITUDE

ALTITUDE M	ZENITH ANGLE OF PATH OF SIGHT (DEG) 93	95	97	100	120	150	180
300	1.148E 00	4.671E-01	2.666E-01	1.575E-01	2.667E-02	8.914E-03	7.356E-03
600	3.211E 00	1.115E 00	5.954E-01	3.320E-01	5.170E-02	1.697E-02	1.396E-02
1500	1.889E 01	3.786E 00	1.674E 00	8.251E-01	1.098E-01	3.601E-02	3.021E-02
3000	1.200E 02	9.852E 00	3.372E 00	1.471E 00	1.760E-01	6.230E-02	6.097E-02
5100	1.594E 03	3.027E 01	7.011E 00	2.600E 00	2.662E-01	9.884E-02	1.026E-01

FLIGHT NO. C-142 FILTER NO. 3

DIRECTIONAL PATH REFLECTANCE FROM GROUND TO ALTITUDE

ALTITUDE M	ZENITH ANGLE OF PATH OF SIGHT (DEG) 93	95	97	100	120	150	180
300	6.577E-01	2.770E-01	1.609E-01	9.641E-02	1.684E-02	5.657E-03	4.668E-03
600	1.651E 00	6.346E-01	3.527E-01	2.027E-01	3.332E-02	1.105E-02	9.093E-03
1500	9.263E 00	2.308E 00	1.097E 00	5.608E-01	7.830E-02	2.581E-02	2.172E-02
3000	3.730E 01	4.982E 00	1.980E 00	9.301E-01	1.176E-01	4.010E-02	3.528E-02
5100	2.606E 02	1.173E 01	3.533E 00	1.487E 00	1.679E-01	5.941E-02	5.440E-02

FLIGHT NO. C-142
DIRECTIONAL PATH REFLECTANCE FROM GROUND TO ALTITUDE
AZIMUTH OF PATH OF SIGHT = 90

AZIMUTH OF PATH OF SIGHT = 90

FLIGHT NO. C-142 FILTER NO. 2

DIRECTIONAL PATH REFLECTANCE FROM GROUND TO ALTITUDE

ALTITUDE	ZENITH ANGLE OF PATH OF SIGHT (DEG)						
M	93	95	97	100	120	150	180
300	9.725E-01	3.911E-01	2.285E-01	1.431E-01	3.575E-02	1.672E-02	1.398E-02
600	3.598E 00	1.091E 00	5.723E-01	3.285E-01	7.246E-02	3.301E-02	2.748E-02
1500	7.520E 01	7.537E 00	2.693E 00	1.199E 00	1.906E-01	8.426E-02	7.175E-02
3000	1.576E 03	3.677E 01	8.237E 00	2.868E 00	3.408E-01	1.530E-01	1.373E-01
5100	7.342E 04	1.973E 02	2.398E 01	6.377E 00	5.466E-01	2.466E-01	2.321E-01

FLIGHT NO. C-142 FILTER NO. 6

DIRECTIONAL PATH REFLECTANCE FROM GROUND TO ALTITUDE

ALTITUDE	ZENITH ANGLE OF PATH OF SIGHT (DEG)						
M	93	95	97	100	120	150	180
300	5.922E-01	2.469E-01	1.465E-01	9.301E-02	2.404E-02	1.223E-02	1.070E-02
600	1.885E 00	6.426E-01	3.513E-01	2.081E-01	4.867E-02	2.424E-02	2.113E-02
1500	2.452E 01	3.530E 00	1.435E 00	6.941E-01	1.245E-01	5.914E-02	5.105E-02
3000	3.401E 02	1.427E 01	3.943E 00	1.558E 00	2.207E-01	1.078E-01	9.994E-02
5100	1.286E 04	8.046E 01	1.274E 01	3.878E 00	3.985E-01	1.931E-01	1.827E-01

FLIGHT NO. C-142 FILTER NO. 5

DIRECTIONAL PATH REFLECTANCE FROM GROUND TO ALTITUDE

ALTITUDE	ZENITH ANGLE OF PATH OF SIGHT (DEG)						
M	93	95	97	100	120	150	180
300	4.561E-01	1.919E-01	1.142E-01	7.243E-02	1.789E-02	8.724E-03	7.356E-03
600	1.276E 00	4.583E-01	2.550E-01	1.527E-01	3.468E-02	1.661E-02	1.396E-02
1500	8.157E 00	1.659E 00	7.597E-01	3.975E-01	7.618E-02	3.571E-02	3.021E-02
3000	6.602E 01	5.242E 00	1.810E 00	8.188E-01	1.352E-01	6.670E-02	6.097E-02
5100	9.549E 02	1.804E 01	4.210E 00	1.608E 00	2.198E-01	1.101E-01	1.026E-01

FLIGHT NO. C-142 FILTER NO. 3

DIRECTIONAL PATH REFLECTANCE FROM GROUND TO ALTITUDE

ALTITUDE	ZENITH ANGLE OF PATH OF SIGHT (DEG)						
M	93	95	97	100	120	150	180
300	2.341E-01	1.025E-01	6.257E-02	4.084E-02	1.089E-02	5.438E-03	4.668E-03
600	5.876E-01	2.349E-01	1.371E-01	8.587E-02	2.156E-02	1.062E-02	9.093E-03
1500	3.353E 00	8.672E-01	4.335E-01	2.421E-01	5.190E-02	2.513E-02	2.172E-02
3000	1.514E 01	2.046E 00	8.467E-01	4.284E-01	8.225E-02	4.027E-02	3.528E-02
5100	1.207E 02	5.414E 00	1.673E 00	7.468E-01	1.246E-01	6.156E-02	5.440E-02

FLIGHT NO. C-142
DIRECTIONAL PATH REFLECTANCE FROM GROUND TO ALTITUDE
AZIMUTH OF PATH OF SIGHT = 180

AZIMUTH OF PATH OF SIGHT = 180

FLIGHT NO. C-142 FILTER NO. 2

DIRECTIONAL PATH REFLECTANCE FROM GROUND TO ALTITUDE

ALTITUDE M	ZENITH ANGLE OF PATH OF SIGHT (DEG) 93	95	97	100	120	150	180
300	9.092E-01	3.718E-01	2.201E-01	1.404E-01	4.006E-02	1.994E-02	1.398E-02
600	3.363E 00	1.037E 00	5.513E-01	3.223E-01	8.121E-02	3.938E-02	2.748E-02
1500	7.439E 01	7.512E 00	2.712E 00	1.231E 00	2.370E-01	1.145E-01	7.175E-02
3000	1.715E 03	4.029E 01	9.119E 00	3.251E 00	5.130E-01	2.557E-01	1.373E-01
5100	8.001E 04	2.198E 02	2.724E 01	7.522E 00	9.079E-01	4.622E-01	2.321E-01

FLIGHT NO. C-142 FILTER NO. 6

DIRECTIONAL PATH REFLECTANCE FROM GROUND TO ALTITUDE

ALTITUDE M	ZENITH ANGLE OF PATH OF SIGHT (DEG) 93	95	97	100	120	150	180
300	5.654E-01	2.414E-01	1.460E-01	9.516E-02	2.899E-02	1.528E-02	1.070E-02
600	1.800E 00	6.284E-01	3.502E-01	2.129E-01	5.870E-02	3.030E-02	2.113E-02
1500	2.380E 01	3.479E 00	1.439E 00	7.147E-01	1.516E-01	7.583E-02	5.105E-02
3000	3.575E 02	1.502E 01	4.186E 00	1.706E 00	3.120E-01	1.714E-01	9.994E-02
5100	1.357E 04	8.655E 01	1.394E 01	4.403E 00	5.937E-01	3.319E-01	1.827E-01

FLIGHT NO. C-142 FILTER NO. 5

DIRECTIONAL PATH REFLECTANCE FROM GROUND TO ALTITUDE

ALTITUDE M	ZENITH ANGLE OF PATH OF SIGHT (DEG) 93	95	97	100	120	150	180
300	4.194E-01	1.802E-01	1.089E-01	7.081E-02	2.081E-02	1.058E-02	7.356E-03
600	1.174E 00	4.303E-01	2.433E-01	1.492E-01	4.033E-02	2.014E-02	1.396E-02
1500	7.736E 00	1.588E 00	7.373E-01	3.949E-01	9.070E-02	4.504E-02	3.021E-02
3000	7.072E 01	5.605E 00	1.954E 00	9.088E-01	2.034E-01	1.112E-01	6.097E-02
5100	1.024E 03	1.971E 01	4.680E 00	1.850E 00	3.463E-01	1.948E-01	1.026E-01

FLIGHT NO. C-142 FILTER NO. 3

DIRECTIONAL PATH REFLECTANCE FROM GROUND TO ALTITUDE

ALTITUDE M	ZENITH ANGLE OF PATH OF SIGHT (DEG) 93	95	97	100	120	150	180
300	2.083E-01	9.348E-02	5.808E-02	3.893E-02	1.263E-02	6.856E-03	4.668E-03
600	5.230E-01	2.142E-01	1.273E-01	8.186E-02	2.499E-02	1.339E-02	9.093E-03
1500	2.977E 00	7.909E-01	4.033E-01	2.321E-01	6.153E-02	3.232E-02	2.172E-02
3000	1.424E 01	1.945E 00	8.181E-01	4.264E-01	1.006E-01	5.298E-02	3.528E-02
5100	1.150E 02	5.246E 00	1.651E 00	7.612E-01	1.550E-01	8.237E-02	5.440E-02

FLIGHT NO. C-142
DIRECTIONAL PATH REFLECTANCE FROM GROUND TO ALTITUDE
AZIMUTH OF PATH OF SIGHT = 270

AZIMUTH OF PATH OF SIGHT = 270

FLIGHT NO. C-142 FILTER NO. 2

DIRECTIONAL PATH REFLECTANCE FROM GROUND TO ALTITUDE

ALTITUDE	ZENITH ANGLE OF PATH OF SIGHT (DEG)						
M	93	95	97	100	120	150	180
300	8.648E-01	3.819E-01	2.295E-01	1.432E-01	3.550E-02	1.686E-02	1.398E-02
600	3.495E 00	1.091E 00	5.748E-01	3.287E-01	7.196E-02	3.329E-02	2.748E-02
1500	7.563E 01	7.633E 00	2.699E 00	1.198E 00	1.896E-01	8.509E-02	7.175E-02
3000	1.541E 03	3.620E 01	8.212E 00	2.859E 00	3.403E-01	1.548E-01	1.373E-01
5100	7.326E 04	1.956E 02	2.400E 01	6.382E 00	5.483E-01	2.491E-01	2.321E-01

FLIGHT NO. C-142 FILTER NO. 6

DIRECTIONAL PATH REFLECTANCE FROM GROUND TO ALTITUDE

ALTITUDE	ZENITH ANGLE OF PATH OF SIGHT (DEG)						
M	93	95	97	100	120	150	180
300	6.071E-01	2.546E-01	1.512E-01	9.616E-02	2.514E-02	1.273E-02	1.070E-02
600	1.932E 00	6.627E-01	3.626E-01	2.152E-01	5.091E-02	2.523E-02	2.113E-02
1500	2.458E 01	3.565E 00	1.454E 00	7.044E-01	1.271E-01	6.033E-02	5.105E-02
3000	3.413E 02	1.434E 01	3.971E 00	1.572E 00	2.238E-01	1.091E-01	9.994E-02
5100	1.309E 04	8.203E 01	1.301E 01	3.970E 00	4.120E-01	1.988E-01	1.827E-01

FLIGHT NO. C-142 FILTER NO. 5

DIRECTIONAL PATH REFLECTANCE FROM GROUND TO ALTITUDE

ALTITUDE	ZENITH ANGLE OF PATH OF SIGHT (DEG)						
M	93	95	97	100	120	150	180
300	4.658E-01	1.967E-01	1.169E-01	7.407E-02	1.819E-02	8.773E-03	7.356E-03
600	1.303E 00	4.698E-01	2.611E-01	1.561E-01	3.526E-02	1.671E-02	1.396E-02
1500	8.441E 00	1.714E 00	7.835E-01	4.094E-01	7.829E-02	3.631E-02	3.021E-02
3000	6.688E 01	5.340E 00	1.847E 00	8.365E-01	1.384E-01	6.779E-02	6.097E-02
5100	9.737E 02	1.840E 01	4.297E 00	1.643E 00	2.250E-01	1.118E-01	1.026E-01

FLIGHT NO. C-142 FILTER NO. 3

DIRECTIONAL PATH REFLECTANCE FROM GROUND TO ALTITUDE

ALTITUDE	ZENITH ANGLE OF PATH OF SIGHT (DEG)						
M	93	95	97	100	120	150	180
300	2.432E-01	1.070E-01	6.522E-02	4.251E-02	1.136E-02	5.659E-03	4.668E-03
600	6.104E-01	2.452E-01	1.429E-01	8.938E-02	2.247E-02	1.105E-02	9.093E-03
1500	3.257E 00	8.629E-01	4.341E-01	2.438E-01	5.379E-02	2.639E-02	2.172E-02
3000	1.491E 01	2.030E 00	8.434E-01	4.289E-01	8.495E-02	4.221E-02	3.528E-02
5100	1.210E 02	5.434E 00	1.683E 00	7.538E-01	1.289E-01	6.421E-02	5.440E-02

FLIGHT C-143 – DESCRIPTION OF FLIGHT AND WEATHER CHARACTERISTICS

It was an overcast afternoon. The day was nearly overcast with a moderate to heavy haze at the lower altitudes. The flight was conducted along an east-west route between Mindelheim and Mengen, passing approximately 8 to 16 kilometers (5 to 10 miles) north of Memmingen. The typical terrain was heavily cultivated, rolling pastureland occasionally interrupted by large patches of dark forest. The data-taking started at 1406 GMT (1506 LCT) and continued until 1628 GMT (1728 LCT). The sun zenith angle during sky radiance data-taking was 41.8 degrees at the start and 58.9 degrees at the end. The highest flight altitude was 4980 meters above ground level.

About the time data-taking commenced, Memmingen was reporting 2/8 cumulus at 1050 meters and 4/8 cirrus at 7500 meters. Visibility was reported as 20 kilometers (12 miles).

Early in the flight, the aircrew reported moderate to heavy haze below 1200 meters with scattered clouds overhead. Light cirrus was reported above 5000 meters.

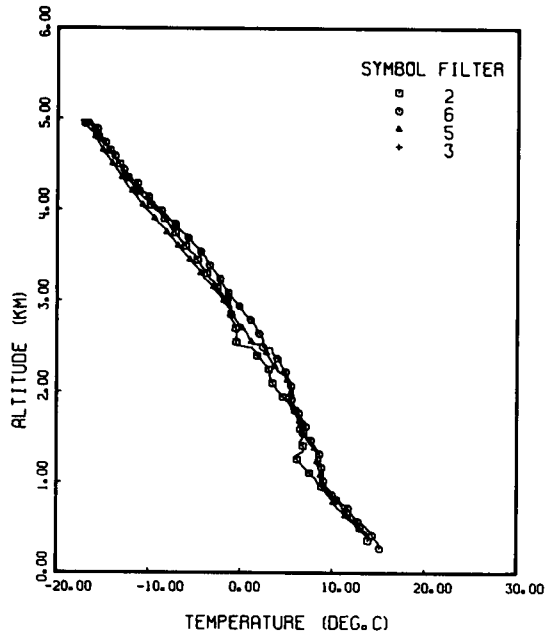
During the ascent to 3048 meters, the flight path was in the clouds. By 1540 GMT at 4976 meters, the flight was under a full overcast.

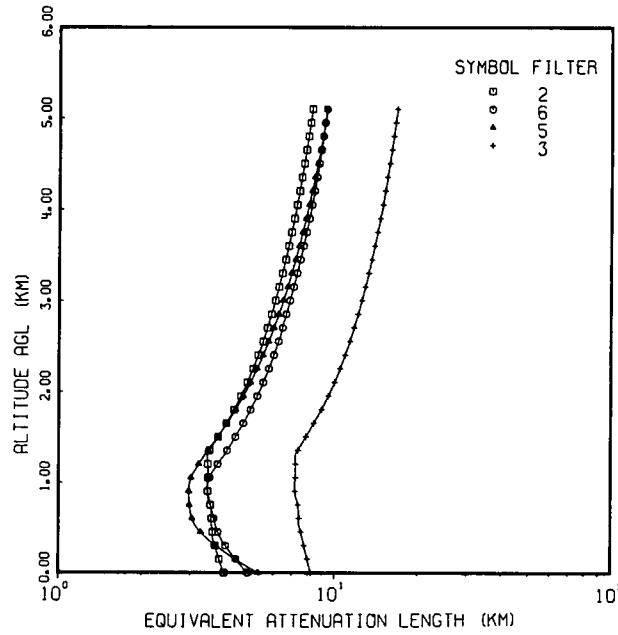
Toward the end of the flight at 1644 GMT, and at 1830 meters, the flight path was in moderate to heavy haze, with visibility estimated at 5 miles (8 kilometers).

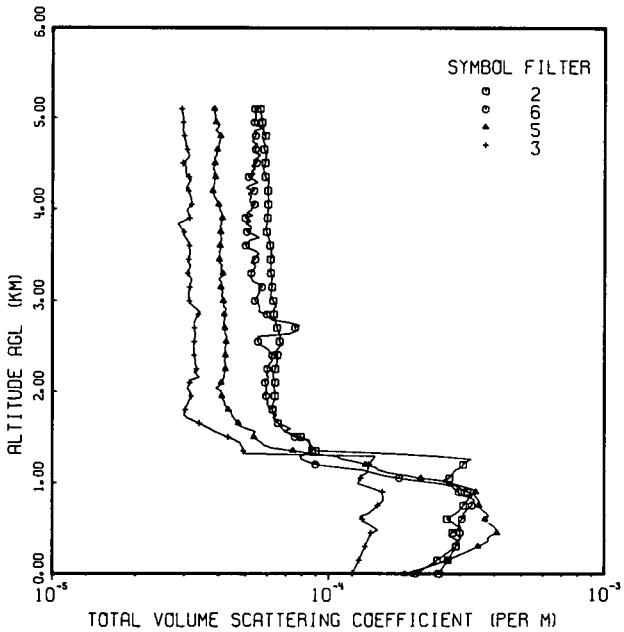
About the time data-taking was completed, Memmingen was reporting 5/8 altocumulus at 3000 meters and 7/8 cirrus at 6000 meters. Visibility was reported as 15 kilometers (9 miles).

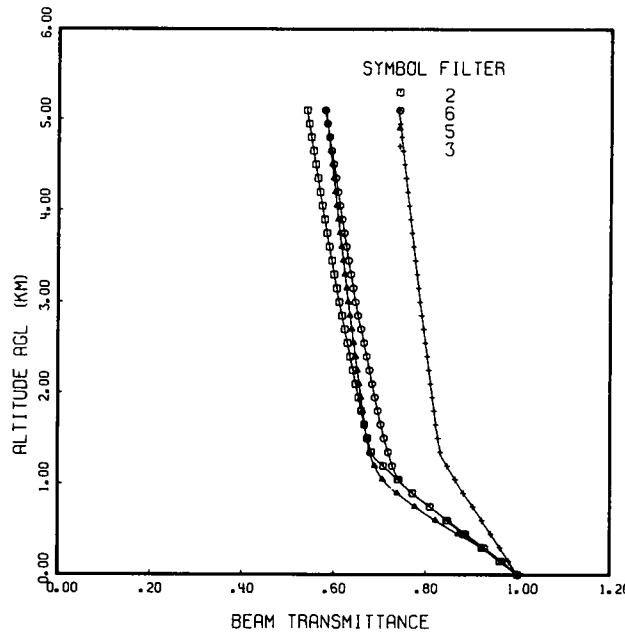
The surface charts show a warm front through southern Italy and France moving slowly northeastward. The Memmingen area was in a col. At 500 millibars, a filling low was moving into Portugal from the eastern Atlantic. The airmass was unstable continental polar.

FLIGHT NO. C-143

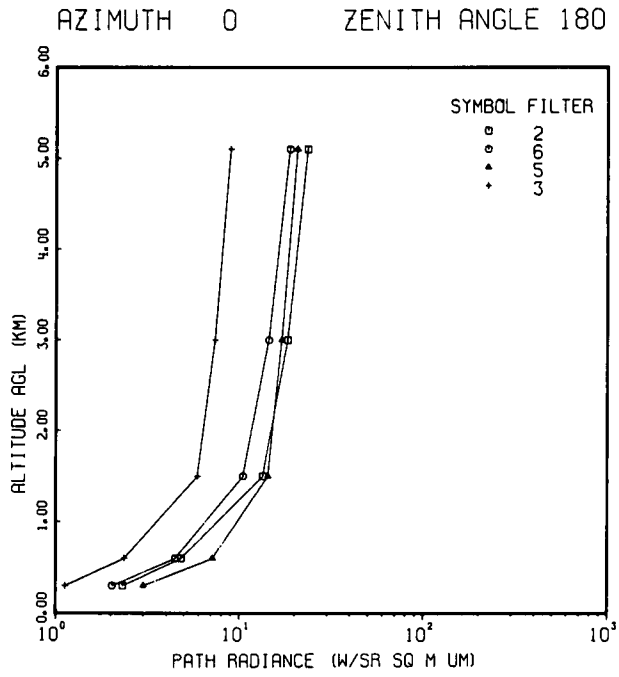


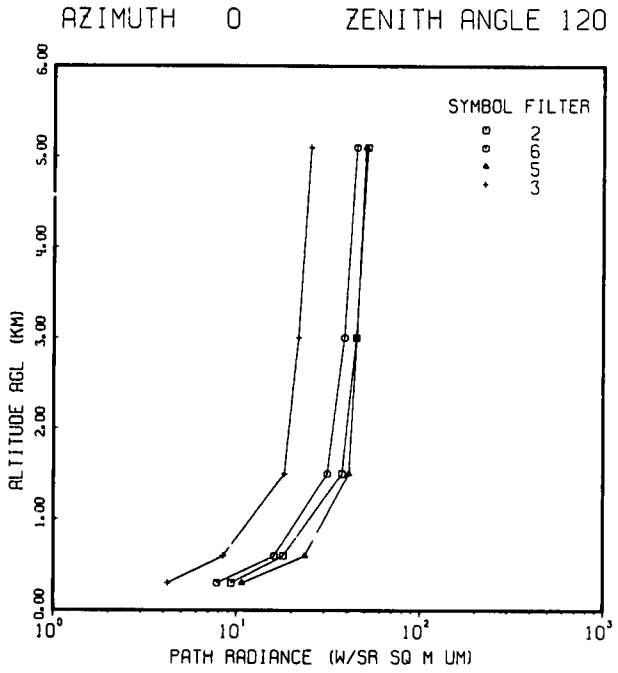


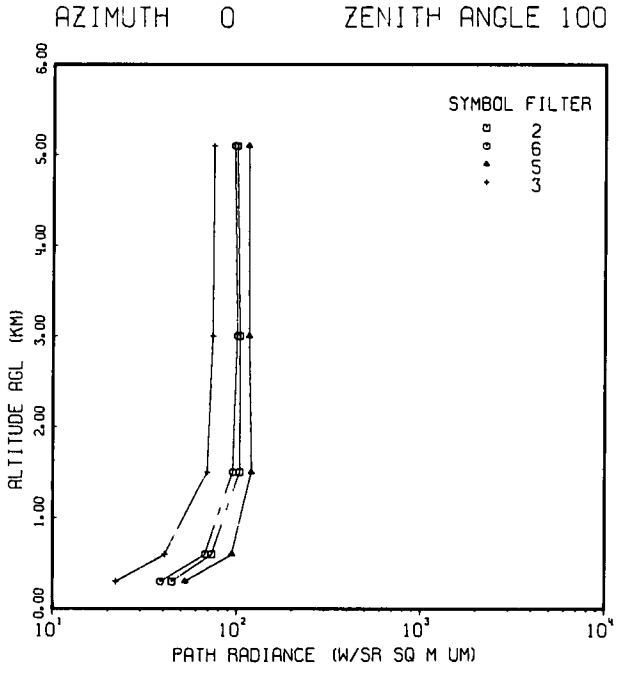




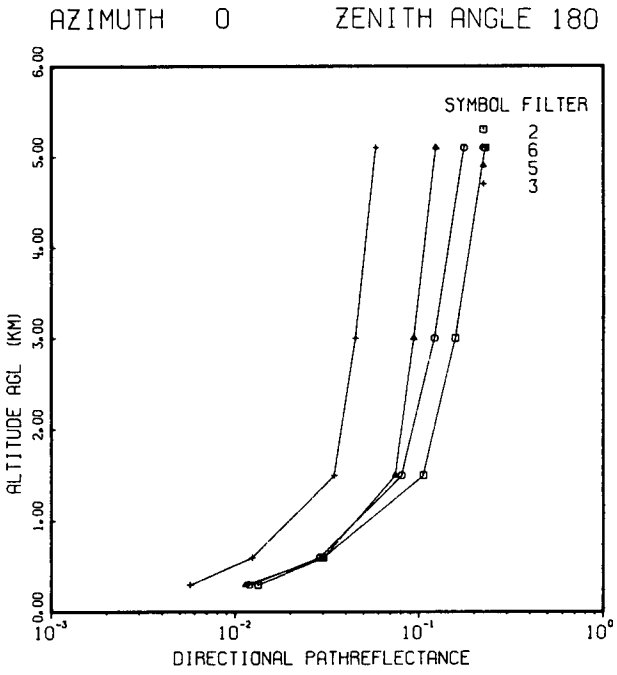
FLIGHT NO. C-143

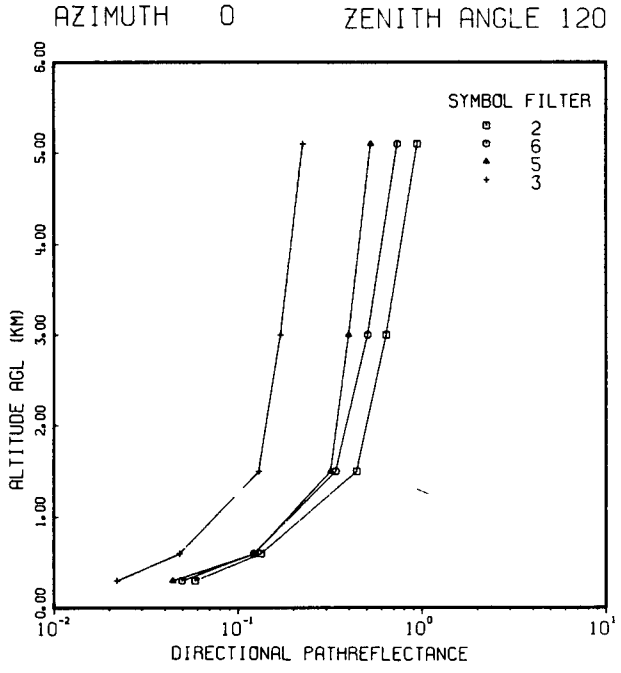


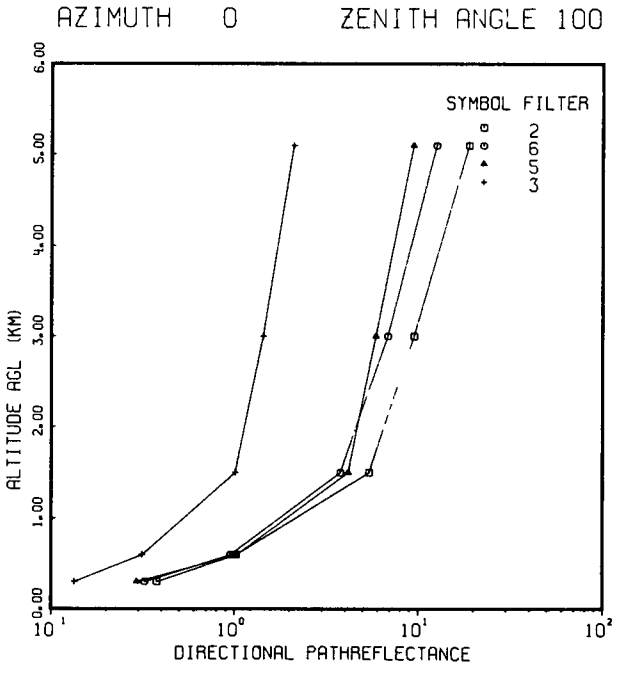




FLIGHT NO. C-143







FLIGHT NO. C-143
IRRADIANCE

FLIGHT NO.C-143 FILTER NO. 2
IRRADIANCE (W/SQ M UM)

ALTITUDE (METERS)	DOWN-WELLING	UP-WELLING	ALBEDO	SCALAR DOWNWELLING	SCALAR UPWELLING	SCALAR TOTAL	SCALAR ALBEDO
336	5.920E 02	2.678E 01	.045	1.143E 03	8.039E 01	1.223E 03	.070
1606	6.462E 02	4.642E 01	.072	1.172E 03	1.383E 02	1.310E 03	.118
2496	5.744E 02	4.131E 01	.073	1.085E 03	1.316E 02	1.216E 03	.121
4981	4.577E 02	4.626E 01	.101	9.273E 02	1.383E 02	1.066E 03	.149

FLIGHT NO.C-143 FILTER NO. 6
IRRADIANCE (W/SQ M UM)

ALTITUDE (METERS)	DOWN-WELLING	UP-WELLING	ALBEDO	SCALAR DOWNWELLING	SCALAR UPWELLING	SCALAR TOTAL	SCALAR ALBEDO
352	5.749E 02	2.754E 01	.048	1.065E 03	7.045E 01	1.135E 03	.066
1607	5.173E 02	4.879E 01	.094	1.014E 03	1.449E 02	1.159E 03	.143
2500	5.063E 02	4.889E 01	.097	9.961E 02	1.311E 02	1.127E 03	.132
4975	4.595E 02	3.483E 01	.076	9.235E 02	1.029E 02	1.026E 03	.111

FLIGHT NO.C-143 FILTER NO. 5
IRRADIANCE (W/SQ M UM)

ALTITUDE (METERS)	DOWN-WELLING	UP-WELLING	ALBEDO	SCALAR DOWNWELLING	SCALAR UPWELLING	SCALAR TOTAL	SCALAR ALBEDO
260	8.964E 02	3.128E 01	.035	1.523E 03	7.678E 01	1.599E 03	.050
1607	5.264E 02	4.426E 01	.084	1.051E 03	1.365E 02	1.188E 03	.130
2500	5.249E 02	3.412E 01	.065	1.026E 03	1.065E 02	1.132E 03	.104
4974	5.786E 02	3.938E 01	.068	1.172E 03	1.075E 02	1.279E 03	.092

FLIGHT NO.C-143 FILTER NO. 3
IRRADIANCE (W/SQ M UM)

ALTITUDE (METERS)	DOWN-WELLING	UP-WELLING	ALBEDO	SCALAR DOWNWELLING	SCALAR UPWELLING	SCALAR TOTAL	SCALAR ALBEDO
304	6.485E 02	3.227E 01	.050	1.117E 03	8.01CE 01	1.197E 03	.072
1607	5.529E 02	3.847E 01	.070	9.528E 02	1.012E 02	1.054E 03	.106
2500	4.539E 02	2.891E 01	.064	8.516E 02	8.576E 01	9.376E 02	.101
4974	3.641E 02	3.201E 01	.088	7.254E 02	9.190E 01	8.173E 02	.127

FLIGHT NO. C-143
DIRECTIONAL REFLECTANCE OF BACKGROUND

FLIGHT NO. C-143
AZIMUTH OF PATH OF SIGHT = 0
DIRECTIONAL REFLECTANCE OF BACKGROUND

ZENITH ANGLE	FILTERS 2	6	5	3
93	.31611	.20364	.13895	.24701
95	.23672	.19758	.11171	.16470
97	.16881	.15414	.09070	.10457
100	.13804	.12530	.05643	.08372
120	.05637	.02732	.01995	.05478
150	.02477	.03528	.02137	.01308
180	.02306	.05079	.03315	.05164

FLIGHT NO. C-143
AZIMUTH OF PATH OF SIGHT = 90
DIRECTIONAL REFLECTANCE OF BACKGROUND

ZENITH ANGLE	FILTERS 2	6	5	3
93	.20534	.15697	.10104	.09404
95	.17132	.11967	.07725	.10773
97	.15050	.10289	.04857	.07712
100	.08549	.06740	.05619	.06665
120	.04985	.05096	.03643	.04837
150	.02463	.04685	.02222	.02445
180	.02306	.05079	.03315	.05164

FLIGHT NO. C-143
AZIMUTH OF PATH OF SIGHT = 180
DIRECTIONAL REFLECTANCE OF BACKGROUND

ZENITH ANGLE	FILTERS 2	6	5	3
93	.13838	.12332	.07548	.09111
95	.10788	.09055	.05726	.07459
97	.10231	.08474	.05287	.07083
100	.09561	.07906	.05490	.06851
120	.05784	.06232	.05809	.06317
150	.02648	.05613	.02798	.02612
180	.02306	.05079	.03315	.05164

FLIGHT NO. C-143
AZIMUTH OF PATH OF SIGHT = 270
DIRECTIONAL REFLECTANCE OF BACKGROUND

ZENITH ANGLE	FILTERS 2	6	5	3
93	.14779	.15037	.08282	.15080
95	.12768	.10994	.07308	.07433
97	.10221	.07081	.06202	.06518
100	.08297	.05305	.04678	.04815
120	.04636	.03166	.02778	.06325
150	.03512	.03635	.02350	.03389
180	.02306	.05079	.03315	.05164

FLIGHT NO. C-143
TOTAL VOLUME SCATTERING COEFFICIENT

DATE 60670 FLIGHT NO. C-143 GROUND LEVEL ALTITUDE (M)= 629

ALTITUDE (M)	TOTAL VOLUME SCATTERING COEFFICIENT (PER M) FILTERS 2	6	5	3
0	2.510E-04	2.070E-04	1.890E-04	1.220E-04
30	2.549E-04	2.152E-04	2.049E-04	1.234E-04
60	2.588E-04	2.234E-04	2.209E-04	1.247E-04
90	2.627E-04	2.316E-04	2.368E-04	1.261E-04
120	2.667E-04	2.398E-04	2.528E-04	1.274E-04
150	2.706E-04	2.481E-04	2.687E-04	1.288E-04
180	2.745E-04	2.563E-04	2.847E-04	1.302E-04
210	2.784E-04	2.645E-04	3.006E-04	1.315E-04
240	2.823E-04	2.727E-04	3.166E-04	1.329E-04
270	2.862E-04	2.809E-04	3.325E-04	1.342E-04
300	2.902E-04	2.893E-04	3.485E-04	1.356E-04
330	2.941E-04	2.943E-04	3.644E-04	1.369E-04
360	2.980E-04	2.911E-04	3.803E-04	1.383E-04
390	2.853E-04	3.027E-04	3.780E-04	1.397E-04
420	2.719E-04	2.980E-04	3.880E-04	1.410E-04
450	2.813E-04	2.999E-04	4.080E-04	1.424E-04
480	2.906E-04	3.012E-04	4.105E-04	1.510E-04
510	2.999E-04	3.014E-04	4.011E-04	1.459E-04
540	2.896E-04	2.981E-04	3.916E-04	1.409E-04
570	2.793E-04	2.973E-04	3.744E-04	1.350E-04
600	2.690E-04	3.043E-04	3.694E-04	1.325E-04
630	2.786E-04	3.142E-04	3.809E-04	1.301E-04
660	2.883E-04	3.079E-04	3.760E-04	1.394E-04
690	2.979E-04	3.142E-04	3.636E-04	1.432E-04
720	3.010E-04	3.225E-04	3.556E-04	1.470E-04
750	3.085E-04	3.310E-04	3.511E-04	1.508E-04
780	3.139E-04	3.340E-04	3.476E-04	1.546E-04
810	3.193E-04	3.381E-04	3.513E-04	1.582E-04
840	3.248E-04	3.289E-04	3.444E-04	1.577E-04
870	3.328E-04	2.994E-04	3.383E-04	1.572E-04
900	3.193E-04	2.962E-04	3.423E-04	1.566E-04
930	3.057E-04	2.862E-04	3.315E-04	1.469E-04
960	2.934E-04	2.815E-04	3.073E-04	1.371E-04
990	2.753E-04	2.573E-04	2.822E-04	1.274E-04
1020	2.572E-04	2.115E-04	2.637E-04	1.290E-04
1050	2.741E-04	1.802E-04	2.161E-04	1.305E-04
1080	2.789E-04	1.572E-04	1.897E-04	1.321E-04
1110	2.837E-04	1.440E-04	1.630E-04	1.382E-04
1140	2.886E-04	1.327E-04	1.516E-04	1.387E-04
1170	3.039E-04	1.083E-04	1.476E-04	1.393E-04
1200	3.087E-04	8.962E-05	1.362E-04	1.398E-04
1230	3.135E-04	8.415E-05	1.253E-04	1.424E-04
1260	3.300E-04	7.960E-05	1.109E-04	1.449E-04
1290	2.499E-04	7.897E-05	1.067E-04	1.474E-04
1320	1.699E-04	8.312E-05	8.651E-05	4.955E-05
1350	8.982E-05	8.749E-05	7.443E-05	4.911E-05
1380	8.820E-05	8.524E-05	6.211E-05	4.868E-05
1410	8.657E-05	8.551E-05	5.827E-05	4.825E-05
1440	8.493E-05	8.557E-05	5.697E-05	4.781E-05
1470	8.329E-05	8.514E-05	5.498E-05	4.553E-05
1500	7.935E-05	7.535E-05	5.364E-05	4.325E-05

FLIGHT NO. C-143
TOTAL VOLUME SCATTERING COEFFICIENT

DATE 60670 FLIGHT NO. C-143 GROUND LEVEL ALTITUDE (M)= 629

ALTITUDE (M)	TOTAL VOLUME SCATTERING COEFFICIENT (PER M)			
	FILTERS 2	6	5	3
1530	7.405E-05	7.324E-05	5.353E-05	4.097E-05
1560	6.875E-05	6.938E-05	5.433E-05	3.875E-05
1590	7.301E-05	6.812E-05	5.059E-05	3.714E-05
1620	6.931E-05	6.695E-05	4.757E-05	3.553E-05
1650	6.556E-05	6.553E-05	4.711E-05	3.393E-05
1680	6.436E-05	6.487E-05	4.628E-05	3.232E-05
1710	6.382E-05	6.271E-05	4.531E-05	3.072E-05
1740	6.327E-05	6.491E-05	4.470E-05	2.980E-05
1770	6.273E-05	6.255E-05	4.431E-05	3.000E-05
1800	6.278E-05	6.246E-05	4.334E-05	3.020E-05
1830	6.282E-05	6.055E-05	4.278E-05	3.046E-05
1860	6.287E-05	5.973E-05	4.181E-05	3.078E-05
1890	6.336E-05	6.021E-05	4.201E-05	3.110E-05
1920	6.385E-05	5.910E-05	4.120E-05	3.143E-05
1950	6.387E-05	5.935E-05	4.105E-05	3.175E-05
1980	6.389E-05	5.837E-05	4.084E-05	3.152E-05
2010	6.367E-05	5.962E-05	4.077E-05	3.129E-05
2040	6.346E-05	5.931E-05	3.902E-05	3.081E-05
2070	6.325E-05	5.946E-05	4.055E-05	3.106E-05
2100	6.393E-05	5.879E-05	4.080E-05	3.131E-05
2130	6.354E-05	5.962E-05	4.129E-05	3.156E-05
2160	6.314E-05	6.044E-05	4.187E-05	3.402E-05
2190	6.275E-05	5.962E-05	4.192E-05	3.326E-05
2220	6.340E-05	6.014E-05	4.193E-05	3.250E-05
2250	6.405E-05	5.978E-05	4.222E-05	3.326E-05
2280	6.471E-05	6.071E-05	4.221E-05	3.304E-05
2310	6.490E-05	6.120E-05	4.222E-05	3.281E-05
2340	6.509E-05	6.236E-05	4.183E-05	3.300E-05
2370	6.528E-05	6.168E-05	4.221E-05	3.278E-05
2400	6.513E-05	6.241E-05	4.227E-05	3.255E-05
2430	6.497E-05	6.129E-05	4.246E-05	3.244E-05
2460	6.482E-05	6.066E-05	4.212E-05	3.240E-05
2490	6.625E-05	5.840E-05	4.215E-05	3.236E-05
2520	6.769E-05	5.633E-05	4.244E-05	3.247E-05
2550	6.640E-05	5.534E-05	4.248E-05	3.258E-05
2580	6.618E-05	5.535E-05	4.283E-05	3.270E-05
2610	6.679E-05	5.558E-05	4.271E-05	3.281E-05
2640	6.617E-05	7.255E-05	4.210E-05	3.292E-05
2670	6.555E-05	7.644E-05	4.204E-05	3.264E-05
2700	6.492E-05	7.559E-05	4.202E-05	3.256E-05
2730	6.459E-05	7.857E-05	4.184E-05	3.252E-05
2760	6.419E-05	7.159E-05	4.168E-05	3.246E-05
2790	6.379E-05	6.216E-05	4.196E-05	3.284E-05
2820	6.327E-05	6.023E-05	4.203E-05	3.322E-05
2850	6.323E-05	5.962E-05	4.165E-05	3.360E-05
2880	6.319E-05	5.573E-05	4.216E-05	3.406E-05
2910	6.315E-05	5.609E-05	4.269E-05	3.321E-05
2940	6.448E-05	5.597E-05	4.161E-05	3.235E-05
2970	6.368E-05	5.545E-05	4.159E-05	3.150E-05
3000	6.288E-05	5.390E-05	4.150E-05	3.129E-05

FLIGHT NO. C-143
TOTAL VOLUME SCATTERING COEFFICIENT

DATE 60670 FLIGHT NO. C-143 GROUND LEVEL ALTITUDE (M)= 629

ALTITUDE (M)	TOTAL VOLUME SCATTERING COEFFICIENT (PER M) FILTERS 2	6	5	3
3030	6.219E-05	5.454E-05	4.147E-05	3.108E-05
3060	6.151E-05	5.531E-05	4.091E-05	3.110E-05
3090	6.183E-05	5.604E-05	4.131E-05	3.112E-05
3120	6.203E-05	5.546E-05	4.101E-05	3.114E-05
3150	6.222E-05	5.717E-05	4.066E-05	3.132E-05
3180	6.175E-05	5.642E-05	4.084E-05	3.150E-05
3210	6.201E-05	5.300E-05	4.076E-05	3.167E-05
3240	6.227E-05	5.243E-05	3.992E-05	3.185E-05
3270	6.253E-05	5.222E-05	4.133E-05	3.132E-05
3300	6.170E-05	5.225E-05	4.133E-05	3.080E-05
3330	6.087E-05	5.289E-05	4.060E-05	3.105E-05
3360	6.171E-05	5.397E-05	4.086E-05	3.130E-05
3390	6.160E-05	5.403E-05	4.115E-05	3.155E-05
3420	6.150E-05	5.207E-05	4.007E-05	3.082E-05
3450	6.140E-05	5.410E-05	4.011E-05	3.101E-05
3480	6.232E-05	5.366E-05	4.022E-05	3.120E-05
3510	6.199E-05	5.598E-05	4.028E-05	3.139E-05
3540	6.166E-05	5.442E-05	4.018E-05	3.134E-05
3570	6.139E-05	5.109E-05	4.060E-05	3.128E-05
3600	6.119E-05	4.991E-05	4.036E-05	3.122E-05
3630	6.100E-05	5.097E-05	4.030E-05	3.110E-05
3660	6.080E-05	5.191E-05	4.082E-05	3.064E-05
3690	6.032E-05	5.598E-05	4.066E-05	3.019E-05
3720	5.991E-05	5.341E-05	4.058E-05	2.974E-05
3750	5.950E-05	5.039E-05	4.060E-05	2.985E-05
3780	5.910E-05	5.219E-05	4.090E-05	2.938E-05
3810	5.934E-05	5.214E-05	4.035E-05	2.892E-05
3840	5.959E-05	4.991E-05	4.065E-05	2.848E-05
3870	5.984E-05	5.239E-05	4.079E-05	2.991E-05
3900	5.987E-05	4.978E-05	4.113E-05	3.134E-05
3930	5.990E-05	5.300E-05	4.089E-05	3.111E-05
3960	6.007E-05	5.025E-05	4.092E-05	3.088E-05
3990	6.024E-05	5.256E-05	4.030E-05	3.064E-05
4020	6.040E-05	5.260E-05	4.010E-05	3.127E-05
4050	6.024E-05	5.384E-05	3.988E-05	3.189E-05
4080	6.008E-05	5.157E-05	3.961E-05	3.179E-05
4110	6.032E-05	5.186E-05	3.907E-05	3.169E-05
4140	6.020E-05	5.242E-05	3.842E-05	3.158E-05
4170	6.008E-05	5.088E-05	3.815E-05	3.134E-05
4200	6.009E-05	5.358E-05	3.792E-05	3.109E-05
4230	6.010E-05	5.003E-05	3.818E-05	3.039E-05
4260	6.012E-05	5.188E-05	3.828E-05	3.084E-05
4290	6.071E-05	5.513E-05	3.853E-05	3.130E-05
4320	5.979E-05	5.338E-05	3.846E-05	3.175E-05
4350	5.886E-05	5.114E-05	3.886E-05	3.107E-05
4380	5.850E-05	5.391E-05	3.828E-05	3.040E-05
4410	5.814E-05	5.213E-05	3.668E-05	3.037E-05
4440	5.799E-05	5.417E-05	3.817E-05	3.033E-05
4470	5.838E-05	5.229E-05	3.820E-05	3.029E-05
4500	5.876E-05	5.473E-05	3.867E-05	2.958E-05

FLIGHT NO. C-143
TOTAL VOLUME SCATTERING COEFFICIENT

DATE 60670 FLIGHT NO. C-143 GROUND LEVEL ALTITUDE (M)= 629

ALTITUDE (M)	TOTAL VOLUME SCATTERING COEFFICIENT (PER M)			
FILTERS	2	6	5	3
4530	5.915E-05	5.315E-05	3.872E-05	3.029E-05
4560	5.923E-05	5.529E-05	3.851E-05	3.100E-05
4590	5.930E-05	5.630E-05	3.918E-05	3.119E-05
4620	5.938E-05	5.375E-05	3.924E-05	3.092E-05
4650	5.826E-05	5.427E-05	3.945E-05	3.066E-05
4680	5.838E-05	5.319E-05	4.004E-05	3.039E-05
4710	5.850E-05	5.506E-05	4.011E-05	3.030E-05
4740	5.774E-05	5.268E-05	4.016E-05	3.021E-05
4770	5.830E-05	5.311E-05	4.042E-05	3.012E-05
4800	5.887E-05	5.425E-05	4.054E-05	2.993E-05
4830	5.789E-05	5.440E-05	4.019E-05	2.974E-05
4860	5.772E-05	5.376E-05	3.880E-05	2.955E-05
4890	5.754E-05	5.810E-05	3.960E-05	2.961E-05
4920	5.737E-05	5.373E-05	4.014E-05	2.967E-05
4950	5.720E-05	5.353E-05	3.897E-05	2.967E-05
4980	5.702E-05	5.452E-05	3.885E-05	2.967E-05
5010	5.684E-05	5.435E-05	3.873E-05	2.958E-05
5040	5.666E-05	5.418E-05	3.861E-05	2.949E-05
5070	5.648E-05	5.401E-05	3.849E-05	2.939E-05
5100	5.631E-05	5.384E-05	3.837E-05	2.930E-05
FIRST DATA ALT	0	0	0	0
LAST DATA ALT	4950	4980	4950	4980

FLIGHT NO. C-143
BEAM TRANSMITTANCE FROM GROUND TO ALTITUDE

FLIGHT NO. C-143 FILTER NO. 2
BEAM TRANSMITTANCE FROM GROUND TO ALTITUDE

ALTITUDE M	ZENITH ANGLE OF PATH OF SIGHT (DEG) 93	95	97	100	120	150	180
300	.2095382	.3930218	.5137197	.6265887	.8501446	.9105266	.9220328
600	.0389443	.1452000	.2534757	.3816559	.7156756	.8243666	.8459761
1500	.0003702	.0099343	.0388014	.1022417	.4529471	.6330222	.6730134
3000	.0000234	.0027920	.0174381	.0583247	.3727220	.5656386	.6105096
5100	.0000003	.0004987	.0062176	.0282830	.2898813	.4892296	.5384063

FLIGHT NO. C-143 FILTER NO. 6
BEAM TRANSMITTANCE FROM GROUND TO ALTITUDE

ALTITUDE M	ZENITH ANGLE OF PATH OF SIGHT (DEG) 93	95	97	100	120	150	180
300	.2387218	.4248108	.5429947	.6514407	.8617066	.9176557	.9282815
600	.0417010	.1511064	.2606869	.3892442	.7205857	.8276272	.8488732
1500	.0010349	.0182699	.0598107	.1385230	.5033310	.6727677	.7094582
3000	.0000771	.0054843	.0278111	.0809328	.4176338	.6040407	.6462459
5100	.0000018	.0011839	.0110953	.0424662	.3338294	.5307706	.5777798

FLIGHT NO. C-143 FILTER NO. 5
BEAM TRANSMITTANCE FROM GROUND TO ALTITUDE

ALTITUDE M	ZENITH ANGLE OF PATH OF SIGHT (DEG) 93	95	97	100	120	150	180
300	.2119895	.3956203	.5160696	.6285989	.8510908	.9111116	.9225458
600	.0223052	.1040205	.1997762	.3229307	.6753291	.7972063	.8217841
1500	.0003520	.0097605	.0384916	.1016681	.4520629	.6323084	.6723562
3000	.0000405	.0040135	.0226389	.0700501	.3972049	.5868012	.6302420
5100	.0000016	.0011896	.0113937	.0432645	.3359957	.5327563	.5796513

FLIGHT NO. C-143 FILTER NO. 3
BEAM TRANSMITTANCE FROM GROUND TO ALTITUDE

ALTITUDE M	ZENITH ANGLE OF PATH OF SIGHT (DEG) 93	95	97	100	120	150	180
300	.4752345	.6411223	.7282947	.8005063	.9256332	.9563646	.9620983
600	.2085489	.3937427	.5153203	.6279582	.8507894	.9109253	.9223825
1500	.0222357	.1084468	.2090452	.3333747	.6828357	.8023104	.8263387
3000	.0056143	.0573516	.1396566	.2511824	.6188971	.7580378	.7867001
5100	.0006785	.0238935	.0823471	.1733735	.5441285	.7037318	.7376507

FLIGHT NO. C-143
PATH RADIANCE FROM GROUND TO ALTITUDE
AZIMUTH OF PATH OF SIGHT = 0

AZIMUTH OF PATH OF SIGHT = 0

FLIGHT NO. C-143 FILTER NO. 2

PATH RADIANCE FROM GROUND TO ALTITUDE (W/SR SQ M UM)

ALTITUDE M	ZENITH ANGLE OF PATH OF SIGHT (DEG) 93	95	97	100	120	150	180
300	1.321E 02	8.995E 01	6.394E 01	4.449E 01	9.347E 00	3.047E 00	2.319E 00
600	1.449E 02	1.220E 02	9.750E 01	7.340E 01	1.799E 01	6.219E 00	4.831E 00
1500	1.345E 02	1.293E 02	1.200E 02	1.040E 02	3.760E 01	1.597E 01	1.343E 01
3000	1.158E 02	1.169E 02	1.135E 02	1.038E 02	4.480E 01	2.106E 01	1.823E 01
5100	1.058E 02	1.058E 02	1.047E 02	9.974E 01	5.145E 01	2.654E 01	2.335E 01

FLIGHT NO. C-143 FILTER NO. 6

PATH RADIANCE FROM GROUND TO ALTITUDE (W/SR SQ M UM)

ALTITUDE M	ZENITH ANGLE OF PATH OF SIGHT (DEG) 93	95	97	100	120	150	180
300	1.208E 02	7.997E 01	5.606E 01	3.853E 01	7.812E 00	2.583E 00	2.030E 00
600	1.366E 02	1.140E 02	9.048E 01	6.756E 01	1.608E 01	5.617E 00	4.476E 00
1500	1.323E 02	1.253E 02	1.136E 02	9.557E 01	3.123E 01	1.263E 01	1.048E 01
3000	1.242E 02	1.211E 02	1.141E 02	1.006E 02	3.862E 01	1.698E 01	1.441E 01
5100	1.036E 02	1.054E 02	1.038E 02	9.688E 01	4.478E 01	2.159E 01	1.867E 01

FLIGHT NO. C-143 FILTER NO. 5

PATH RADIANCE FROM GROUND TO ALTITUDE (W/SR SQ M UM)

ALTITUDE M	ZENITH ANGLE OF PATH OF SIGHT (DEG) 93	95	97	100	120	150	180
300	1.608E 02	1.085E 02	7.641E 01	5.263E 01	1.072E 01	3.688E 00	2.998E 00
600	1.743E 02	1.517E 02	1.240E 02	9.465E 01	2.362E 01	8.655E 00	7.141E 00
1500	1.581E 02	1.520E 02	1.404E 02	1.204E 02	4.097E 01	1.684E 01	1.429E 01
3000	1.319E 02	1.349E 02	1.303E 02	1.169E 02	4.509E 01	1.963E 01	1.691E 01
5100	1.325E 02	1.296E 02	1.256E 02	1.156E 02	5.030E 01	2.347E 01	2.052E 01

FLIGHT NO. C-143 FILTER NO. 3

PATH RADIANCE FROM GROUND TO ALTITUDE (W/SR SQ M UM)

ALTITUDE M	ZENITH ANGLE OF PATH OF SIGHT (DEG) 93	95	97	100	120	150	180
300	9.135E 01	5.120E 01	3.354E 01	2.203E 01	4.202E 00	1.393E 00	1.126E 00
600	1.275E 02	8.343E 01	5.913E 01	4.071E 01	8.460E 00	2.898E 00	2.364E 00
1500	1.240E 02	1.096E 02	9.050E 01	6.948E 01	1.827E 01	6.999E 00	5.908E 00
3000	1.111E 02	1.053E 02	9.207E 01	7.413E 01	2.171E 01	8.671E 00	7.351E 00
5100	9.409E 01	9.438E 01	8.760E 01	7.476E 01	2.520E 01	1.057E 01	8.919E 00

FLIGHT NO. C-143
PATH RADIANCE FROM GROUND TO ALTITUDE
AZIMUTH OF PATH OF SIGHT = 90

AZIMUTH OF PATH OF SIGHT = 90

FLIGHT NO. C-143 FILTER NO. 2

PATH RADIANCE FROM GROUND TO ALTITUDE (W/SR SQ M UM)

ALTITUDE M	ZENITH ANGLE OF PATH OF SIGHT (DEG) 93	95	97	100	120	150	180
300	6.724E 01	4.680E 01	3.405E 01	2.456E 01	6.675E 00	2.897E 00	2.319E 00
600	7.609E 01	6.493E 01	5.296E 01	4.127E 01	1.305E 01	5.958E 00	4.831E 00
1500	8.309E 01	7.952E 01	7.417E 01	6.579E 01	2.971E 01	1.586E 01	1.343E 01
3000	8.573E 01	8.326E 01	7.944E 01	7.277E 01	3.728E 01	2.121E 01	1.823E 01
5100	8.196E 01	8.152E 01	7.990E 01	7.587E 01	4.462E 01	2.693E 01	2.335E 01

FLIGHT NO. C-143 FILTER NO. 6

PATH RADIANCE FROM GROUND TO ALTITUDE (W/SR SQ M UM)

ALTITUDE M	ZENITH ANGLE OF PATH OF SIGHT (DEG) 93	95	97	100	120	150	180
300	5.401E 01	3.673E 01	2.649E 01	1.906E 01	5.329E 00	2.500E 00	2.030E 00
600	6.307E 01	5.357E 01	4.363E 01	3.404E 01	1.112E 01	5.453E 00	4.476E 00
1500	7.075E 01	6.664E 01	6.095E 01	5.298E 01	2.295E 01	1.243E 01	1.048E 01
3000	7.435E 01	7.151E 01	6.730E 01	6.062E 01	2.973E 01	1.689E 01	1.441E 01
5100	7.661E 01	7.455E 01	7.166E 01	6.649E 01	3.663E 01	2.176E 01	1.867E 01

FLIGHT NO. C-143 FILTER NO. 5

PATH RADIANCE FROM GROUND TO ALTITUDE (W/SR SQ M UM)

ALTITUDE M	ZENITH ANGLE OF PATH OF SIGHT (DEG) 93	95	97	100	120	150	180
300	7.029E 01	4.896E 01	3.569E 01	2.586E 01	7.397E 00	3.544E 00	2.998E 00
600	7.745E 01	6.937E 01	5.864E 01	4.710E 01	1.651E 01	8.379E 00	7.141E 00
1500	7.400E 01	7.276E 01	6.912E 01	6.231E 01	2.962E 01	1.659E 01	1.429E 01
3000	7.459E 01	7.330E 01	7.070E 01	6.529E 01	3.397E 01	1.963E 01	1.691E 01
5100	8.283E 01	7.942E 01	7.623E 01	7.098E 01	3.974E 01	2.372E 01	2.052E 01

FLIGHT NO. C-143 FILTER NO. 3

PATH RADIANCE FROM GROUND TO ALTITUDE (W/SR SQ M UM)

ALTITUDE M	ZENITH ANGLE OF PATH OF SIGHT (DEG) 93	95	97	100	120	150	180
300	3.035E 01	2.019E 01	1.488E 01	9.988E 00	2.742E 00	1.321E 00	1.126E 00
600	4.577E 01	3.411E 01	2.655E 01	1.872E 01	5.586E 00	2.759E 00	2.364E 00
1500	5.655E 01	5.016E 01	4.332E 01	3.435E 01	1.274E 01	6.788E 00	5.908E 00
3000	5.751E 01	5.304E 01	4.712E 01	3.898E 01	1.559E 01	8.458E 00	7.351E 00
5100	5.779E 01	5.492E 01	5.026E 01	4.353E 01	1.881E 01	1.032E 01	8.919E 00

FLIGHT NO. C-143
PATH RADIANCE FROM GROUND TO ALTITUDE
AZIMUTH OF PATH OF SIGHT = 180

AZIMUTH OF PATH OF SIGHT = 180

FLIGHT NO. C-143 FILTER NO. 2

PATH RADIANCE FROM GROUND TO ALTITUDE (W/SR SQ M UM)

ALTITUDE M	ZENITH ANGLE OF PATH OF SIGHT (DEG) 93	95	97	100	120	150	180
300	5.403E 01	3.811E 01	2.809E 01	2.069E 01	6.494E 00	3.082E 00	2.319E 00
600	6.318E 01	5.415E 01	4.462E 01	3.545E 01	1.294E 01	6.427E 00	4.831E 00
1500	7.940E 01	7.547E 01	7.029E 01	6.292E 01	3.226E 01	1.818E 01	1.343E 01
3000	8.922E 01	8.558E 01	8.108E 01	7.445E 01	4.247E 01	2.485E 01	1.823E 01
5100	8.631E 01	8.623E 01	8.461E 01	8.073E 01	5.191E 01	3.136E 01	2.335E 01

FLIGHT NO. C-143 FILTER NO. 6

PATH RADIANCE FROM GROUND TO ALTITUDE (W/SR SQ M UM)

ALTITUDE M	ZENITH ANGLE OF PATH OF SIGHT (DEG) 93	95	97	100	120	150	180
300	4.281E 01	2.962E 01	2.173E 01	1.604E 01	5.338E 00	2.717E 00	2.030E 00
600	5.203E 01	4.446E 01	3.667E 01	2.929E 01	1.133E 01	5.966E 00	4.476E 00
1500	6.793E 01	6.299E 01	5.744E 01	5.044E 01	2.503E 01	1.394E 01	1.048E 01
3000	7.587E 01	7.244E 01	6.783E 01	6.137E 01	3.378E 01	1.923E 01	1.441E 01
5100	7.786E 01	7.636E 01	7.367E 01	6.890E 01	4.201E 01	2.470E 01	1.867E 01

FLIGHT NO. C-143 FILTER NO. 5

PATH RADIANCE FROM GROUND TO ALTITUDE (W/SR SQ M UM)

ALTITUDE M	ZENITH ANGLE OF PATH OF SIGHT (DEG) 93	95	97	100	120	150	180
300	5.451E 01	3.874E 01	2.881E 01	2.154E 01	7.606E 00	4.053E 00	2.998E 00
600	6.405E 01	5.771E 01	4.947E 01	4.083E 01	1.752E 01	9.661E 00	7.141E 00
1500	7.252E 01	7.003E 01	6.624E 01	6.040E 01	3.384E 01	1.948E 01	1.429E 01
3000	8.141E 01	7.775E 01	7.390E 01	6.832E 01	4.088E 01	2.361E 01	1.691E 01
5100	9.395E 01	8.984E 01	8.582E 01	8.014E 01	5.071E 01	2.915E 01	2.052E 01

FLIGHT NO. C-143 FILTER NO. 3

PATH RADIANCE FROM GROUND TO ALTITUDE (W/SR SQ M UM)

ALTITUDE M	ZENITH ANGLE OF PATH OF SIGHT (DEG) 93	95	97	100	120	150	180
300	2.479E 01	1.757E 01	1.216E 01	8.728E 00	2.942E 00	1.540E 00	1.126E 00
600	4.149E 01	2.952E 01	2.203E 01	1.655E 01	6.046E 00	3.234E 00	2.364E 00
1500	5.118E 01	4.553E 01	3.891E 01	3.214E 01	1.431E 01	8.114E 00	5.908E 00
3000	5.250E 01	4.872E 01	4.329E 01	3.686E 01	1.742E 01	1.000E 01	7.351E 00
5100	5.364E 01	5.097E 01	4.683E 01	4.107E 01	2.046E 01	1.185E 01	8.919E 00

FLIGHT NO. C-143
PATH RADIANCE FROM GROUND TO ALTITUDE
AZIMUTH OF PATH OF SIGHT = 270

AZIMUTH OF PATH OF SIGHT = 270

FLIGHT NO. C-143 FILTER NO. 2

PATH RADIANCE FROM GROUND TO ALTITUDE (W/SR SQ M UM)

ALTITUDE M	ZENITH ANGLE OF PATH OF SIGHT (DEG) 93	95	97	100	120	150	180
300	6.624E 01	4.618E 01	3.363E 01	2.430E 01	6.665E 00	2.916E 00	2.319E 00
600	7.554E 01	6.441E 01	5.254E 01	4.098E 01	1.305E 01	6.002E 00	4.831E 00
1500	8.542E 01	8.129E 01	7.548E 01	6.671E 01	2.997E 01	1.605E 01	1.343E 01
3000	8.758E 01	8.513E 01	8.108E 01	7.407E 01	3.770E 01	2.145E 01	1.823E 01
5100	8.136E 01	8.142E 01	8.006E 01	7.616E 01	4.478E 01	2.706E 01	2.335E 01

FLIGHT NO. C-143 FILTER NO. 6

PATH RADIANCE FROM GROUND TO ALTITUDE (W/SR SQ M UM)

ALTITUDE M	ZENITH ANGLE OF PATH OF SIGHT (DEG) 93	95	97	100	120	150	180
300	5.813E 01	3.940E 01	2.830E 01	2.024E 01	5.471E 00	2.500E 00	2.030E 00
600	6.809E 01	5.758E 01	4.668E 01	3.620E 01	1.143E 01	5.463E 00	4.476E 00
1500	7.735E 01	7.236E 01	6.579E 01	5.673E 01	2.366E 01	1.253E 01	1.048E 01
3000	7.814E 01	7.570E 01	7.128E 01	6.396E 01	3.039E 01	1.698E 01	1.441E 01
5100	7.752E 01	7.604E 01	7.346E 01	6.829E 01	3.694E 01	2.173E 01	1.867E 01

FLIGHT NO. C-143 FILTER NO. 5

PATH RADIANCE FROM GROUND TO ALTITUDE (W/SR SQ M UM)

ALTITUDE M	ZENITH ANGLE OF PATH OF SIGHT (DEG) 93	95	97	100	120	150	180
300	6.510E 01	4.989E 01	3.631E 01	2.625E 01	7.503E 00	3.646E 00	2.998E 00
600	8.077E 01	7.190E 01	6.043E 01	4.830E 01	1.675E 01	8.578E 00	7.141E 00
1500	8.259E 01	7.907E 01	7.411E 01	6.590E 01	3.008E 01	1.678E 01	1.429E 01
3000	8.261E 01	7.969E 01	7.601E 01	6.922E 01	3.428E 01	1.968E 01	1.691E 01
5100	8.262E 01	8.177E 01	7.885E 01	7.331E 01	3.984E 01	2.374E 01	2.052E 01

FLIGHT NO. C-143 FILTER NO. 3

PATH RADIANCE FROM GROUND TO ALTITUDE (W/SR SQ M UM)

ALTITUDE M	ZENITH ANGLE OF PATH OF SIGHT (DEG) 93	95	97	100	120	150	180
300	4.191E 01	2.423E 01	1.641E 01	1.138E 01	3.031E 00	1.394E 00	1.126E 00
600	5.743E 01	4.015E 01	2.937E 01	2.133E 01	6.163E 00	2.908E 00	2.364E 00
1500	6.545E 01	5.793E 01	4.879E 01	3.913E 01	1.392E 01	7.105E 00	5.908E 00
3000	6.521E 01	6.035E 01	5.302E 01	4.401E 01	1.689E 01	8.798E 00	7.351E 00
5100	6.248E 01	6.009E 01	5.513E 01	4.762E 01	2.001E 01	1.065E 01	8.919E 00

FLIGHT NO. C-143
DIRECTIONAL PATH REFLECTANCE FROM GROUND TO ALTITUDE
AZIMUTH OF PATH OF SIGHT = 0

AZIMUTH OF PATH OF SIGHT = 0

FLIGHT NO. C-143 FILTER NO. 2

DIRECTIONAL PATH REFLECTANCE FROM GROUND TO ALTITUDE

ALTITUDE M	ZENITH ANGLE OF PATH OF SIGHT (DEG) 93	95	97	100	120	150	180
300	3.346E 00	1.215E 00	6.605E-01	3.768E-01	5.835E-02	1.776E-02	1.335E-02
600	1.974E 01	4.458E 00	2.041E 00	1.021E 00	1.334E-01	4.003E-02	3.030E-02
1500	1.928E 03	6.906E 01	1.641E 01	5.398E 00	4.405E-01	1.339E-01	1.059E-01
3000	2.629E 04	2.222E 02	3.455E 01	9.445E 00	6.379E-01	1.976E-01	1.585E-01
5100	1.632E 06	1.126E 03	8.939E 01	1.872E 01	9.418E-01	2.879E-01	2.301E-01

FLIGHT NO. C-143 FILTER NO. 6

DIRECTIONAL PATH REFLECTANCE FROM GROUND TO ALTITUDE

ALTITUDE M	ZENITH ANGLE OF PATH OF SIGHT (DEG) 93	95	97	100	120	150	180
300	2.765E 00	1.029E 00	5.642E-01	3.233E-01	4.955E-02	1.538E-02	1.195E-02
600	1.790E 01	4.122E 00	1.897E 00	9.485E-01	1.219E-01	3.709E-02	2.882E-02
1500	6.985E 02	3.749E 01	1.038E 01	3.770E 00	3.390E-01	1.026E-01	8.073E-02
3000	8.809E 03	1.206E 02	2.242E 01	6.796E 00	5.053E-01	1.536E-01	1.219E-01
5100	3.084E 05	4.864E 02	5.112E 01	1.247E 01	7.331E-01	2.223E-01	1.766E-01

FLIGHT NO. C-143 FILTER NO. 5

DIRECTIONAL PATH REFLECTANCE FROM GROUND TO ALTITUDE

ALTITUDE M	ZENITH ANGLE OF PATH OF SIGHT (DEG) 93	95	97	100	120	150	180
300	2.659E 00	9.614E-01	5.189E-01	2.934E-01	4.415E-02	1.419E-02	1.139E-02
600	2.738E 01	5.110E 00	2.175E 00	1.027E 00	1.226E-01	3.805E-02	3.046E-02
1500	1.575E 03	5.459E 01	1.278E 01	4.152E 00	3.177E-01	9.332E-02	7.446E-02
3000	1.142E 04	1.178E 02	2.017E 01	5.851E 00	3.978E-01	1.173E-01	9.403E-02
5100	2.982E 05	3.817E 02	3.863E 01	9.366E 00	5.247E-01	1.544E-01	1.241E-01

FLIGHT NO. C-143 FILTER NO. 3

DIRECTIONAL PATH REFLECTANCE FROM GROUND TO ALTITUDE

ALTITUDE M	ZENITH ANGLE OF PATH OF SIGHT (DEG) 93	95	97	100	120	150	180
300	3.316E-01	3.869E-01	2.231E-01	1.334E-01	2.199E-02	7.057E-03	5.668E-03
600	2.646E 00	1.027E 00	5.559E-01	3.141E-01	4.817E-02	1.541E-02	1.242E-02
1500	2.702E 01	4.894E 00	2.097E 00	1.010E 00	1.296E-01	4.226E-02	3.464E-02
3000	9.585E 01	8.899E 00	3.194E 00	1.430E 00	1.700E-01	5.541E-02	4.527E-02
5100	6.719E 02	1.914E 01	5.154E 00	2.089E 00	2.244E-01	7.278E-02	5.858E-02

FLIGHT NO. C-143
DIRECTIONAL PATH REFLECTANCE FROM GROUND TO ALTITUDE
AZIMUTH OF PATH OF SIGHT = 90

AZIMUTH OF PATH OF SIGHT = 90

FLIGHT NO. C-143 FILTER NO. 2

DIRECTIONAL PATH REFLECTANCE FROM GROUND TO ALTITUDE

ALTITUDE M	93	95	97	ZENITH ANGLE OF PATH OF SIGHT (DEG) 100	120	150	180
300	1.703E 00	6.320E-01	3.517E-01	2.080E-01	4.167E-02	1.689E-02	1.335E-02
600	1.037E 01	2.373E 00	1.109E 00	5.739E-01	9.678E-02	3.836E-02	3.030E-02
1500	1.191E 03	4.248E 01	1.014E 01	3.415E 00	3.481E-01	1.330E-01	1.059E-01
3000	1.946E 04	1.583E 02	2.418E 01	6.621E 00	5.308E-01	1.990E-01	1.585E-01
5100	1.264E 06	8.675E 02	6.820E 01	1.424E 01	8.168E-01	2.921E-01	2.301E-01

FLIGHT NO. C-143 FILTER NO. 6

DIRECTIONAL PATH REFLECTANCE FROM GROUND TO ALTITUDE

ALTITUDE M	93	95	97	ZENITH ANGLE OF PATH OF SIGHT (DEG) 100	120	150	180
300	1.236E 00	4.729E-01	2.667E-01	1.599E-01	3.380E-02	1.489E-02	1.195E-02
600	3.266E 00	1.938E 00	9.146E-01	4.779E-01	8.434E-02	3.601E-02	2.882E-02
1500	3.736E 02	1.993E 01	5.509E 00	2.090E 00	2.492E-01	1.009E-01	8.073E-02
3000	5.272E 03	7.126E 01	1.322E 01	4.093E 00	3.891E-01	1.528E-01	1.219E-01
5100	2.281E 05	3.441E 02	3.529E 01	8.557E 00	5.996E-01	2.241E-01	1.766E-01

FLIGHT NO. C-143 FILTER NO. 5

DIRECTIONAL PATH REFLECTANCE FROM GROUND TO ALTITUDE

ALTITUDE M	93	95	97	ZENITH ANGLE OF PATH OF SIGHT (DEG) 100	120	150	180
300	1.162E 00	4.337E-01	2.424E-01	1.442E-01	3.046E-02	1.363E-02	1.139E-02
600	1.217E 01	2.337E 00	1.020E 00	5.111E-01	8.569E-02	3.684E-02	3.046E-02
1500	7.367E 02	2.613E 01	6.294E 00	2.148E 00	2.296E-01	9.193E-02	7.446E-02
3000	9.455E 03	6.400E 01	1.204E 01	3.266E 00	2.997E-01	1.172E-01	9.403E-02
5100	1.864E 05	2.340E 02	2.345E 01	5.750E 00	4.145E-01	1.561E-01	1.241E-01

FLIGHT NO. C-143 FILTER NO. 3

DIRECTIONAL PATH REFLECTANCE FROM GROUND TO ALTITUDE

ALTITUDE M	93	95	97	ZENITH ANGLE OF PATH OF SIGHT (DEG) 100	120	150	180
300	3.094E-01	1.526E-01	9.109E-02	6.045E-02	1.435E-02	6.690E-03	5.668E-03
600	1.063E 00	4.197E-01	2.496E-01	1.444E-01	3.181E-02	1.467E-02	1.242E-02
1500	1.232E 01	2.241E 00	1.004E 00	4.991E-01	9.037E-02	4.099E-02	3.464E-02
3000	4.963E 01	4.480E 00	1.635E 00	7.519E-01	1.220E-01	5.406E-02	4.527E-02
5100	4.127E 02	1.114E 01	2.957E 00	1.216E 00	1.674E-01	7.105E-02	5.858E-02

FLIGHT NO. C-143
DIRECTIONAL PATH REFLECTANCE FROM GROUND TO ALTITUDE
AZIMUTH OF PATH OF SIGHT = 180

AZIMUTH OF PATH OF SIGHT = 180

FLIGHT NO. C-143 FILTER NO. 2

DIRECTIONAL PATH REFLECTANCE FROM GROUND TO ALTITUDE

ALTITUDE	ZENITH ANGLE OF PATH OF SIGHT (DEG)						
M	93	95	97	100	120	150	180
300	1.368E 00	5.146E-01	2.902E-01	1.752E-01	4.054E-02	1.796E-02	1.335E-02
600	8.610E 00	1.979E 00	9.343E-01	4.929E-01	9.594E-02	4.138E-02	3.030E-02
1500	1.138E 03	4.032E 01	9.614E 00	3.266E 00	3.779E-01	1.526E-01	1.059E-01
3000	2.025E 04	1.627E 02	2.468E 01	6.774E 00	6.047E-01	2.331E-01	1.585E-01
5100	1.331E 06	9.176E 02	7.222E 01	1.515E 01	9.504E-01	3.402E-01	2.301E-01

FLIGHT NO. C-143 FILTER NO. 6

DIRECTIONAL PATH REFLECTANCE FROM GROUND TO ALTITUDE

ALTITUDE	ZENITH ANGLE OF PATH OF SIGHT (DEG)						
M	93	95	97	100	120	150	180
300	9.801E-01	3.810E-01	2.187E-01	1.346E-01	3.386E-02	1.618E-02	1.195E-02
600	6.818E 00	1.608E 00	7.687E-01	4.113E-01	8.591E-02	3.939E-02	2.882E-02
1500	3.587E 02	1.884E 01	5.248E 00	1.990E 00	2.718E-01	1.132E-01	8.073E-02
3000	5.379E 03	7.218E 01	1.333E 01	4.144E 00	4.420E-01	1.740E-01	1.219E-01
5100	2.319E 05	3.525E 02	3.629E 01	8.867E 00	6.877E-01	2.543E-01	1.766E-01

FLIGHT NO. C-143 FILTER NO. 5

DIRECTIONAL PATH REFLECTANCE FROM GROUND TO ALTITUDE

ALTITUDE	ZENITH ANGLE OF PATH OF SIGHT (DEG)						
M	93	95	97	100	120	150	180
300	9.012E-01	3.431E-01	1.956E-01	1.201E-01	3.132E-02	1.559E-02	1.139E-02
600	1.006E 01	1.944E 00	8.678E-01	4.431E-01	9.091E-02	4.247E-02	3.046E-02
1500	7.220E 02	2.515E 01	6.031E 00	2.082E 00	2.624E-01	1.080E-01	7.446E-02
3000	7.045E 03	6.789E 01	1.144E 01	3.418E 00	3.607E-01	1.410E-01	9.403E-02
5100	2.114E 05	2.647E 02	2.640E 01	6.492E 00	5.289E-01	1.918E-01	1.241E-01

FLIGHT NO. C-143 FILTER NO. 3

DIRECTIONAL PATH REFLECTANCE FROM GROUND TO ALTITUDE

ALTITUDE	ZENITH ANGLE OF PATH OF SIGHT (DEG)						
M	93	95	97	100	120	150	180
300	3.037E-01	1.328E-01	8.086E-02	5.283E-02	1.540E-02	7.803E-03	5.668E-03
600	9.639E-01	3.632E-01	2.071E-01	1.277E-01	3.443E-02	1.720E-02	1.242E-02
1500	1.115E 01	2.034E 00	9.017E-01	4.671E-01	1.016E-01	4.899E-02	3.464E-02
3000	4.530E 01	4.116E 00	1.502E 00	7.110E-01	1.364E-01	6.392E-02	4.527E-02
5100	3.830E 02	1.033E 01	2.755E 00	1.148E 00	1.822E-01	8.156E-02	5.858E-02

FLIGHT NO. C-143
DIRECTIONAL PATH REFLECTANCE FROM GROUND TO ALTITUDE
AZIMUTH OF PATH OF SIGHT = 270

AZIMUTH OF PATH OF SIGHT = 270

FLIGHT NO. C-143 FILTER NO. 2

DIRECTIONAL PATH REFLECTANCE FROM GROUND TO ALTITUDE

ALTITUDE	ZENITH ANGLE OF PATH OF SIGHT (DEG)						
M	93	95	97	100	120	150	180
300	1.678E 00	6.236E-01	3.475E-01	2.058E-01	4.161E-02	1.700E-02	1.335E-02
600	1.029E 01	2.354E 00	1.100E 00	5.698E-01	9.879E-02	3.864E-02	3.030E-02
1500	1.224E 03	4.342E 01	1.032E 01	3.463E 00	3.512E-01	1.345E-01	1.059E-01
3000	1.988E 04	1.618E 02	2.467E 01	6.740E 00	5.368E-01	2.013E-01	1.585E-01
5100	1.254E 06	8.664E 02	6.833E 01	1.429E 01	8.198E-01	2.936E-01	2.301E-01

FLIGHT NO. C-143 FILTER NO. 6

DIRECTIONAL PATH REFLECTANCE FROM GROUND TO ALTITUDE

ALTITUDE	ZENITH ANGLE OF PATH OF SIGHT (DEG)						
M	93	95	97	100	120	150	180
300	1.331E 00	5.068E-01	2.848E-01	1.698E-01	3.470E-02	1.489E-02	1.195E-02
600	8.924E 00	2.082E 00	9.786E-01	5.082E-01	8.665E-02	3.608E-02	2.882E-02
1500	4.085E 02	2.164E 01	6.011E 00	2.238E 00	2.569E-01	1.018E-01	8.073E-02
3000	5.540E 03	7.543E 01	1.401E 01	4.319E 00	3.977E-01	1.537E-01	1.219E-01
5100	2.308E 05	3.510E 02	3.618E 01	8.788E 00	6.047E-01	2.237E-01	1.766E-01

FLIGHT NO. C-143 FILTER NO. 5

DIRECTIONAL PATH REFLECTANCE FROM GROUND TO ALTITUDE

ALTITUDE	ZENITH ANGLE OF PATH OF SIGHT (DEG)						
M	93	95	97	100	120	150	180
300	1.076E 00	4.419E-01	2.466E-01	1.463E-01	3.090E-02	1.403E-02	1.139E-02
600	1.269E 01	2.419E 00	1.060E 00	5.242E-01	8.695E-02	3.771E-02	3.046E-02
1500	8.222E 02	2.839E 01	6.748E 00	2.272E 00	2.332E-01	9.300E-02	7.446E-02
3000	7.150E 03	6.958E 01	1.177E 01	3.463E 00	3.025E-01	1.176E-01	9.403E-02
5100	1.859E 05	2.409E 02	2.425E 01	5.938E 00	4.156E-01	1.562E-01	1.241E-01

FLIGHT NO. C-143 FILTER NO. 3

DIRECTIONAL PATH REFLECTANCE FROM GROUND TO ALTITUDE

ALTITUDE	ZENITH ANGLE OF PATH OF SIGHT (DEG)						
M	93	95	97	100	120	150	180
300	4.273E-01	1.831E-01	1.091E-01	6.889E-02	1.587E-02	7.061E-03	5.668E-03
600	1.334E 00	4.941E-01	2.761E-01	1.646E-01	3.509E-02	1.546E-02	1.242E-02
1500	1.426E 01	2.588E 00	1.131E 00	5.686E-01	9.876E-02	4.290E-02	3.464E-02
3000	5.627E 01	5.098E 00	1.839E 00	8.488E-01	1.322E-01	5.623E-02	4.527E-02
5100	4.462E 02	1.218E 01	3.243E 00	1.331E 00	1.782E-01	7.329E-02	5.858E-02

7.4 DATA INTERPRETATION

The six flights reported herein were made under partially cloudy skies (Flights C-137, C-138, and C-142) or overcast (Flights C-134, C-139, and C-143). The presence of clouds often indicates unstable optical conditions. Fortunately, the integrative method used for obtaining path radiance can be applied during unstable conditions but caution should be taken in interpreting the results.

TEMPERATURE

The six flights were conducted at a latitude of 48°N and thus can be profitably compared to the U.S. Standard Atmosphere Supplements for 45°N latitude. To facilitate this comparison, the temperature profiles* for the six flights are superimposed on a graph of the temperature profile for 45°N for January, Spring-Fall, and July in Figure 7-3. Note that the altitude scale is above mean sea level with the ground level value of 629 meters indicated on the scale.

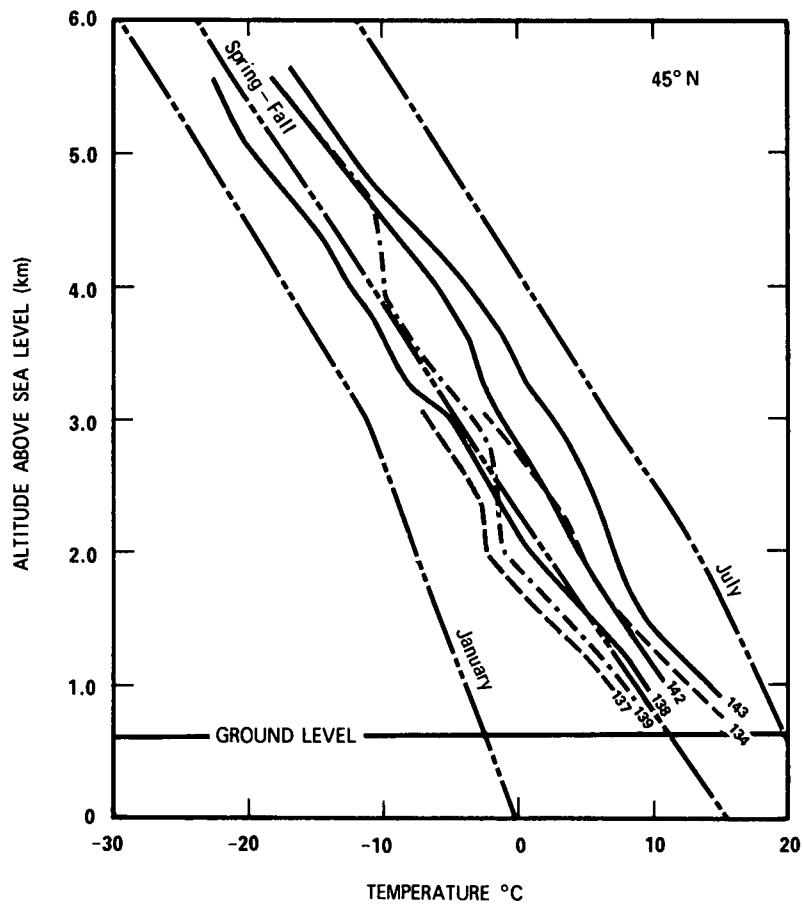


Fig. 7-3. Temperature from the Six Flights and the U. S. Standard Atmosphere Supplements for 45° N Latitude.

* Flight temperatures are graphical averages.

As expected, the flights cluster about the Spring-Fall temperature profile. The coldest flight is C-137, slightly colder than the Spring-Fall standard. Flights C-138 and C-139 are intermediate, being both higher and lower than the standard depending on altitude. The remaining three flights, C-134, C-142, and C-143, are warmer than the Spring-Fall profile.

IRRADIANCE

The downwelling irradiance at the lowest straight and level altitude is used as the irradiance for computing the directional reflectance of the terrain and the directional path reflectance. The low altitude irradiance for the photopic Filter 5 can be compared to the ground level values of Brown (1952). The illuminance values of Brown have been converted to irradiance units for unobscured sun, average cloud, and extreme black storm cloud conditions and are depicted in Figure 7-4. Superimposed on the same figure are the low altitude downwelling irradiance values for Filter 5 for the six flights. Since the three flights with partial clouds had unobscured suns, it is reasonable that these irradiances cluster about Brown's curve for the unobscured sun. The value for Flight C-138, however, appears slightly high. The values for the three overcast flights lie between Brown's curves for unobscured sun and average clouds, indicating perhaps a tenuous rather than a thick overcast (see Figure 7-1).

The low altitude irradiance values for all four filters are graphed as a function of mean wavelength of filter in Figure 7-5 on the same irradiance scale as the previous figure. The curve for the sun above the atmosphere is based on values for each filter computed from spectral values of Johnson (1954). This graph indicates that Flights C-137, C-139, and C-142 are fairly consistent by filter, but Flights C-134, C-138, and C-143 show a high variability. The value of downwelling irradiance for Filter 5, Flight C-138, appears high relative to the other filters, as it did in comparison to Brown's values. Two indications of anomalous behavior should alert users to the possibility of instrumental malfunction.

DIRECTIONAL REFLECTANCE OF TERRAIN

The tables of directional reflectance of the background (terrain) presented with each flight are derived from data obtained with the lower hemisphere scanner at the lowest flight altitude. This instrument is a telephotometer with a 5 degree field of view. The tabular values of reflectance, therefore, relate to an average radiance throughout that field of view. It is completely possible that no part of the terrain has that value of reflectance. Almost certainly, objects of interest will be located on a background having a different reflectance than that tabulated for the terrain. That is why ground-based measurements of directional reflectances of backgrounds are also made during the flight interval to help provide appropriate values for generating contrast transmittance for a given problem. The effect of background reflectance on the contrast transmittance is not a trivial one. Care should be used in selecting the appropriate value for use in specific problems.

Summary Table 7-3 presents airborne data on directional reflectance of the terrain for the nadir path of sight. This summary is ordered by sun zenith angle and is presented for conceptual purposes. For the nadir path of sight at the lowest altitude of all the flights, 152 meters, a 5 degree field would cover a circle 13 meters in diameter; whereas, at the lowest altitude for Flight C-142, 745 meters, a 5 degree field

would cover a circle 65 meters in diameter. In addition, the nadir value is the average of the values obtained during one azimuth revolution of the scanner (5 seconds). At the low altitude and flight speeds of 156 and 163 knots, the distance covered in 5 seconds is 400 to 420 meters. Thus, the tabulated nadir reflectances relate to an average radiance in an area between 13 x 413 or 65 x 485 meters in size.

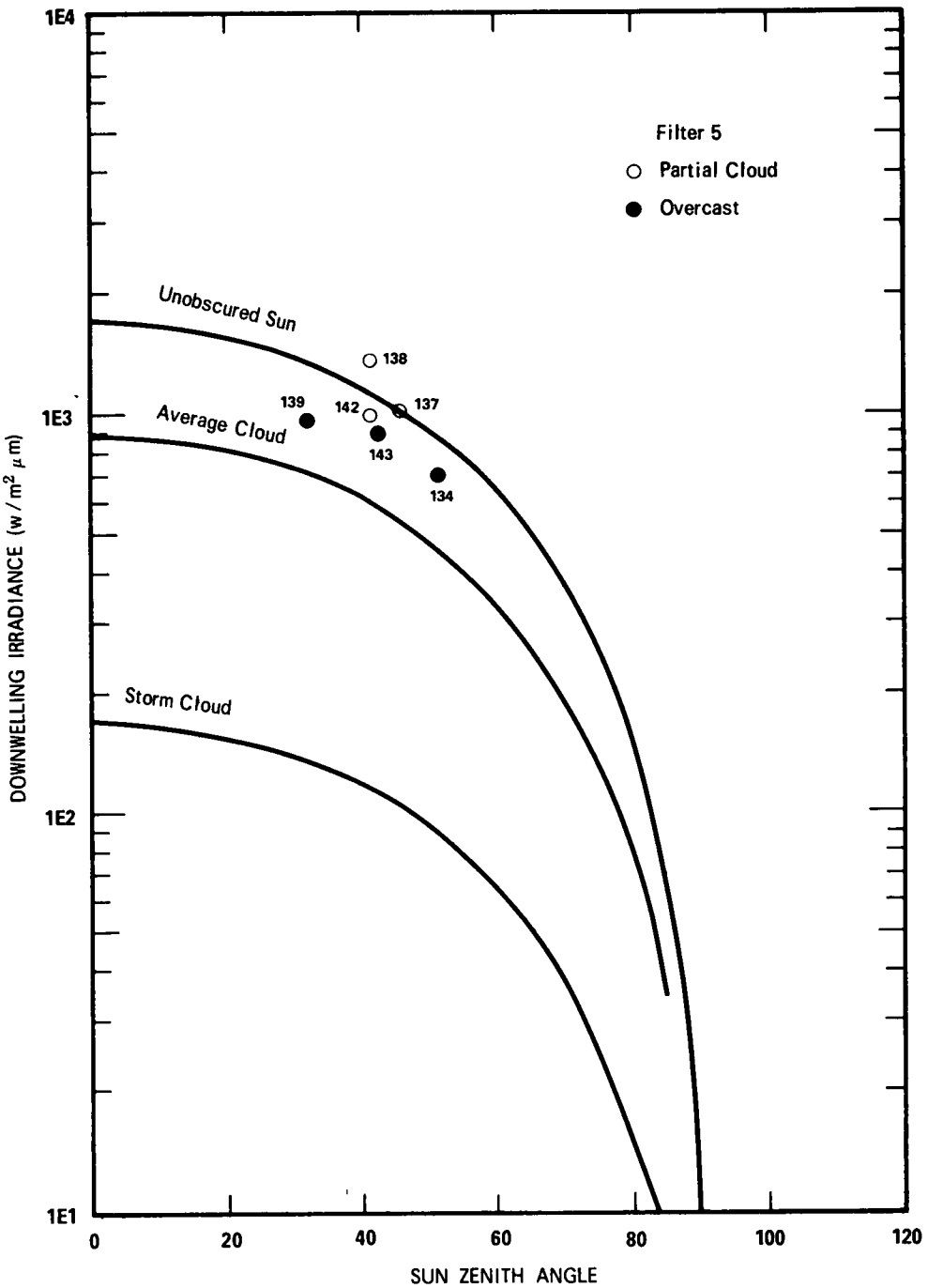


Fig. 7-4. Downwelling Radiance Versus Sun Zenith Angle.

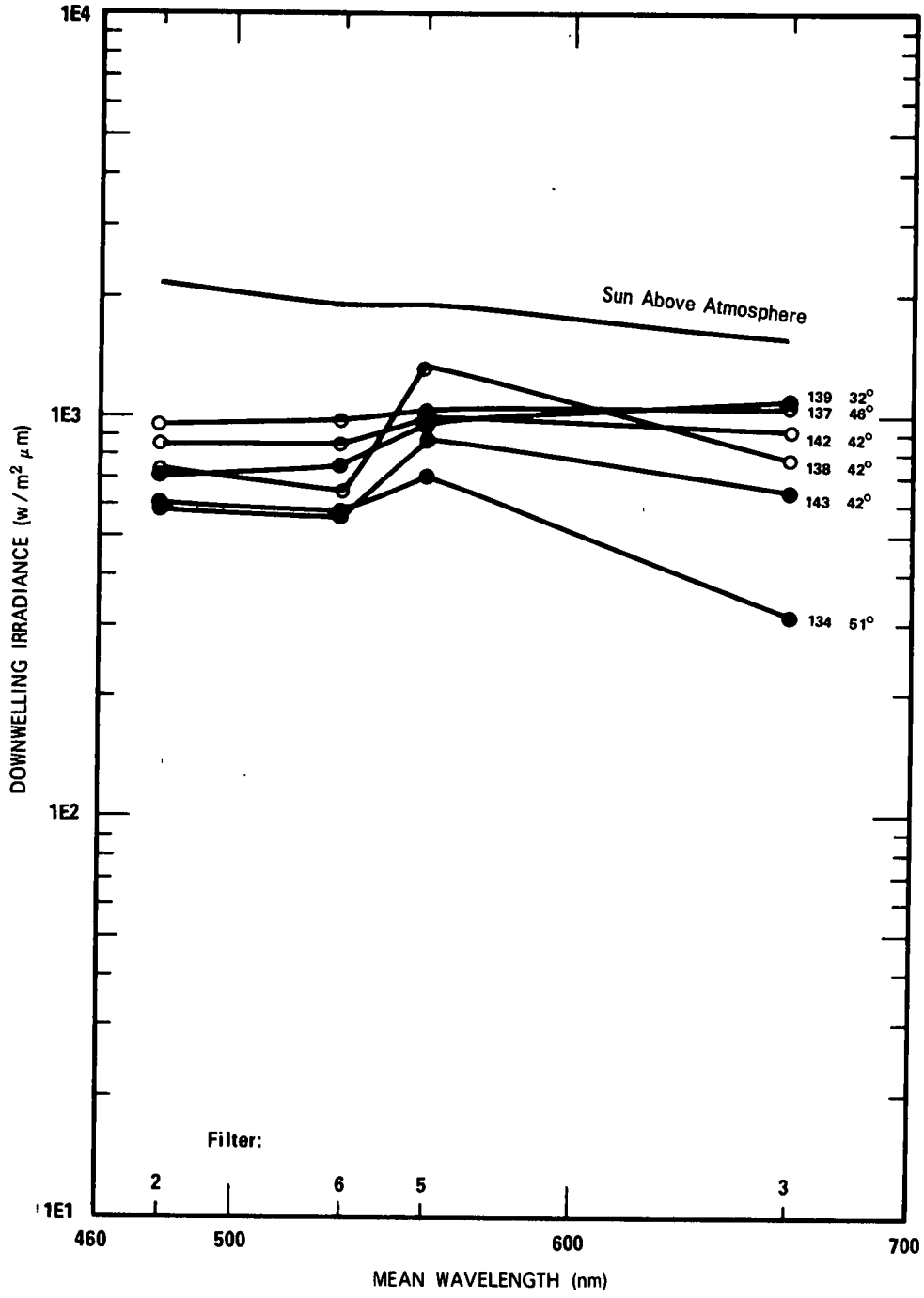


Fig. 7-5. Low Altitude Downwelling Irradiance by Wavelength.

Table 7-3

Nadir Terrain Reflectances based on Airborne Scanners over a Green, Heavily Cultivated Area Interrupted by Dark Forest Patches

Date 1970	Flight Number	Weather	Average Altitude (m) AGL	Average Sun Zenith Angle (Day)	Nadir Reflectance Filter 2	Filter 6	Filter 5	Filter 3
03 June	C-139	Overcast	152	32	.054	.068	.020	.047
06 June	C-143	Overcast	313	42	.023	.051	.033	.052
06 June	C-142	Clear	745	42	.029	.055	.036	.062
-----								
29 May	C-138	Clear	360	42	.034	.019	.023	.041
28 May	C-137	Clear	305	46	.017	.006	.023	.015
25 May	C-134	Overcast	276	51	.027	.023	.029	.038

The terrain was described as having occasional patches of dark forest interrupted by green heavily cultivated, rolling pastureland (see Figure 7-2). The reflectances in Table 7-3 are very low. The reflectance of a black surface is 4 percent. Under natural illumination, a lower reflectance cannot be achieved except by a highly textured surface with deep shadows. Thus, the reflectances less than 4 percent would be due to the dark forested areas.

The inconsistency filter to filter and flight to flight is a direct function of the patchiness of the terrain.

An additional source of potential error in the terrain reflectance data is the use of two separate instruments to obtain the data, i.e., upper hemisphere scanner and lower hemisphere scanner. Any error in the cross-calibration between these two systems is injected directly into the computed value of terrain reflectance. Since these day mode data have an additional increment of uncertainty due to the day mode absolute calibration discussed in Section 3, caution should be utilized in the interpretation of these low percentage values. Improved in-flight cross-calibration procedures have been instituted subsequent to the collection of these data.

TOTAL SCATTERING COEFFICIENT

The total volume scattering coefficient data were measured during the vertical profile sequences of each flight. In all six flights, the vertical profile data for Filters 2 and 3 were measured by time-sharing during the ascents made between the straight and level sequences. The vertical profile for Filter 5 was

made when descending from the highest straight and level altitude; it began 1 to 1-1/2 hours after the beginning of the first ascent using Filters 2 and 3. The vertical profile for Filter 6, an ascent, completed the flight. Ground-based nephelometer data measured during the flight were available and were used for all six flights.

For simultaneous data, the order of the scattering coefficient data by filter generally should be the inverse of the mean wavelength of the filters, i.e., s(Filter 2) > s(6) > s(5) > s(3). Flights C-137, C-139, and C-142 exhibit this characteristic, indicating that the optical characteristics of the atmosphere in the flight track were relatively stable during the flight period. Flight C-134 clearly shows a change in the height of the haze layer during the 1 hour between the data for Filters 2 and 3 (haze top between 1.0 and and 1.5 kilometers) and Filters 5 and 6 (haze top between 1.5 and 2.0 kilometers). Flights C-138 and C-143 show both a slight change of haze layer height and increase in haze density for Filters 5 and 6 compared to Filter 2.

Characteristic of all six flights is a hazy layer at the low altitudes (haze top between 1 and 2 kilometers) and a relatively clear area above the haze.

During all flights except Flight C-142 it was possible to take airborne data at altitudes often considerably lower than 0.5 kilometer. Thus, for most of the flights, the low altitude total scattering profile in the haze is well-documented. However, the shape of the total scattering profile between 0 and 1 kilometer for Flight C-142 was not documented and is merely an interpolation between the ground-based value and the lowest flight altitude near 1 kilometer.

Thus, the apparent difference in low altitude haze characteristics between Flight C-142 and the other flights is not a real measured difference but due to the absence of data at the 0 to 1 kilometer altitudes for Flight C-142.

The lapse rate of the measured total scattering coefficients above the haze layer is less than the density lapse rate for all the flights with data above 3 kilometers (Flights C-138, C-139, C-142, and C-143). This was not expected and an investigation is underway to determine if this characteristic could be due to instrument error. For Flight C-138, the total scattering coefficients for Filters 5 and 6 were extrapolated above 2.5 kilometers according to the density lapse rate, whereas the scattering coefficients for Filters 2 and 3 from 2.5 to 5.1 kilometers are measured values. Thus, the graph for Flight C-138 in Section 7.3 directly illustrates the difference in lapse rates between the scattering coefficient and the density.

EQUIVALENT ATTENUATION LENGTH AND BEAM TRANSMITTANCE

At ground level, the equivalent attenuation length is the reciprocal of the total scattering coefficient. As altitude increases, the equivalent attenuation length shows the cumulative effect of summing s(z) from ground level to the altitude z. The vertical beam transmittance starts at 1.0 and similarly shows the cumulative effect of the summation of the total scattering coefficient. For simultaneous data, the order by filter of the equivalent attenuation length $\bar{L}$ and the beam transmittance should be the same as the mean wavelength of the filter, i.e., $\bar{L}$(Filter 3) > $\bar{L}$(5) > $\bar{L}$(6) > $\bar{L}$(2). Flights C-137, C-139, and C-142 display this feature due to the atmospheric optical stability during the flight. Flights C-134, C-138, and

C-143 again reflect the variability encountered due to the time lapse between the Filter 2 and 3 data, and the Filter 5 and 6 data. Also, the equivalent attenuation length for Flight C-138 shows the effect of extrapolating the Filter 5 and 6 data from 2.5 to 5 kilometers using the density lapse rate which is greater than the s(z) lapse rate measured for Filters 2 and 3.

EQUILIBRIUM RADIANCE

Equilibrium radiance Eq. 2.18 is obtained by using an integrative method. An advantage of this method is the ability to handle highly variable data, variable in the sense of changing flux levels due to real changes occurring in space and/or time during the flight. Although the terrain over which a data flight takes place is chosen for its consistency of terrain appearance, specific features vary in position relative to the plane as it flies the track. Anomalies in the sky lighting distribution occur due to subtle changes in the weather. Clouds may alternately cover and uncover the sun, or the thickness of the clouds may vary. These unpredictable local occurrances contribute to the variability of the overall flux level and directional radiance pattern, and these two properties define the equilibrium radiance. The values of equilibrium radiance derived using the integrative method are directly descriptive of the real conditions encountered and measured during the flight.

Under comparatively stable conditions, equilibrium radiance tends to be relatively invariant with altitude. Several atmospheric models are based upon this tendency [Duntley (1948) and Gordon (1969)]. However, for the six Memmingen flights, the equilibrium radiance was a more erratic quantity. The standard deviation with altitude had a range of less than 1 to 77 percent with the nadir path of sight often having standard deviations at the high end of that range. To illustrate this, the equilibrium radiance for the photopic response (Filter 5) is graphed in Figure 7-6 for the nadir path of sight. Flight C-142 was one of the more optically stable flights in terms of consistency in irradiance and total scattering coefficient, but the standard deviation for the nadir path equilibrium radiance varied from 24 to 50 percent for the four filters (Filter 5 standard deviation is 46 percent). Thus, the atmospheric models cited above are inapplicable to the Memmingen flights.

There is a certain amount of consistency, however, in the equilibrium reflectance for the lowest altitude for the nadir path of sight. Equilibrium reflectance R_q is derived from the equilibrium radiance and the downwelling irradiance:

$$R_q(z,\theta,\phi) = N_q(z,\theta,\phi)\,\pi / H(z,d) \; . \tag{7.5}$$

Since the apparent radiance of a terrain, background, or object tends to approach the equilibrium radiance, a look at the equilibrium reflectance at the lowest altitude will tell us whether a terrain will increase or decrease in radiance with altitude, at least initially. The nadir equilibrium reflectances for the six flights are given in Table 7-4. There is no correlation of the equilibrium reflectance with sun zenith angle or filter. Neither is there any apparent correlation with cloudiness or degree of overcast. But there is a rough overall consistency with the reflectances in a range of 0.10 to 0.22. All the nadir terrain reflectances are much lower than the equilibrium reflectances and, therefore, the apparent terrain radiance will increase with altitude, at least at the lower altitudes.

Another general observation can be made, that is, that the equilibrium reflectance generally increased for the longer slant paths (as the zenith angles approached 90 degrees).

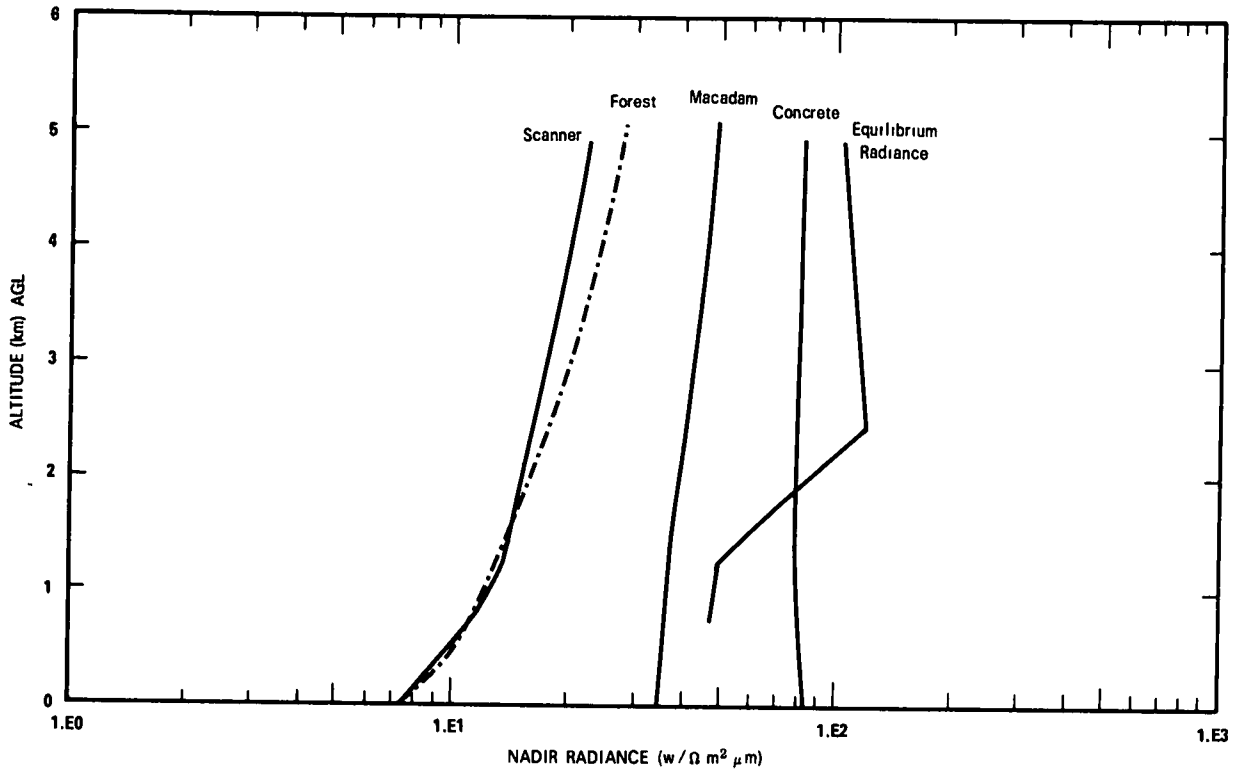


Fig. 7-6. Equilibrium and Apparent Radiance for Flight C-142 Filter 5 (Photopic) for the Nadir Path of Sight.

Table 7-4

Nadir Equilibrium Reflectance of Lowest Altitude

Date 1970	Flight Number	Weather	Altitude (m) AGL	Sun Zenith Angle	Nadir Equilibrium Reflectance Filter 2	Filter 6	Filter 5	Filter 3
03 June	C-139	Overcast	152	32	0.19	0.18	0.18	0.18
06 June	C-143	Overcast	313	42	0.16	0.16	0.14	0.14
06 June	C-142	Partial Cloud	745	42	0.21	0.20	0.15	0.14
29 May	C-138	Partial Cloud	360	42	0.15	0.17	0.10	0.14
28 May	C-137	Partial Cloud	305	46	0.13	0.15	0.12	0.13
25 May	C-134	Overcast	276	51	0.15	0.17	0.17	0.22

PATH RADIANCE

The path radiance is calculated from the values of equilibrium radiance for a given path of sight by means of Eq. 2.16 and 2.17. Thus, the path radiance combines the values of equilibrium radiance from each of the several altitudes. The required path radiance is essentially a scattered radiance in a given path at any one instant. The derived value, however, represents an averaging of the light conditions present during the entire flight (the use of integral Eq. 2.16 and 2.17 effectively combines the variable data into a crude average of the prevalent condition). The averaging, however, is progressive. The lowest altitude value is derived solely from the low altitude data, whereas at the highest altitude, all the data are averaged. Thus, the path radiances represent neither the clearest nor the cloudiest portion of a flight, but a crude combination of the various segments.

The derived path radiances are relatively smooth functions in comparison to the equilibrium radiances due to the averaging process of the integration in Eq. 2.16. For simultaneous data, path radiance would be expected to decrease with increasing wavelength. The representative graphs of path radiance in Section 7.3 indicate that this held for Flights C-137 and C-142 at zenith angles 180 and 120 degrees, but not for 100 degrees or for the other flights. This inconsistency with filter is a direct result of optical instability during those flights.

The path radiance enters into the equation for contrast transmittance, Eq. 2.2, into the equation for directional path reflectance, Eq. 2.4, and into the equation for computing apparent radiance, Eq. 7.2. By rearranging Eq. 7.2, we obtain an equation for predicting the inherent radiance of the terrain at ground level ${}_bN_o(o,\theta,\phi)$ from the apparent radiance at the lowest flight altitude, the derived path radiance, and the beam transmittance:

$$ {}_bN_o(o,\theta,\phi) = [\,{}_bN_r(z,\theta,\phi) - N_r^*(z,\theta,\phi)\,] / T_r(z,\theta)\ . \tag{7.6} $$

The resultant inherent radiance for the nadir path of sight for Flight C-142 Filter 5 (photopic) is 7.2 $w/\Omega m^2 \mu m$. Then using Eq. 2.5, we obtain a reflectance of 0.023. This low reflectance is indicative of the dark forest portions of the terrain underlying the flight track. The measured scanner radiances and the extrapolated ground value are graphed in Figure 7-6 and labeled as "scanner".

For conceptual purposes, we have computed the apparent nadir radiances for three types of backgrounds appropriate to Flight C-142 Filter 5 (photopic) using Eq. 7.2. The three backgrounds chosen are: a forested area with a reflectance of 0.023 (the derived inherent terrain reflectance for the flight), Macadam with a reflectance of 0.113, and aged white concrete with a reflectance of 0.266. The latter two photopic reflectances are from Table 3-2 of Gordon (1964). The radiances for these three backgrounds are graphed in Figure 7-6. The macadam and concrete illustrate surfaces often used for roads.

The predicted forest radiances closely follow the scanner radiances at the lower altitudes and are slightly higher at the upper altitudes. Note how the background radiances tend to approach the equilibrium radiances. Both the forest and macadam radiances increase monotonically with altitude since both are always less than the equilibrium radiance and tend to approach it. However, the inherent concrete radiance is greater than the low altitude equilibrium radiance so it slightly decreases with altitude until it crosses the equilibrium radiance.

CONTRAST TRANSMITTANCE

The contrast transmittance can be expressed as the beam transmittance times the ratio of the inherent to apparent background radiance:

$$ {}_{b}r_{r}(z,\theta,\phi) = T_{r}(z,\theta)\ {}_{b}N_{o}(o,\theta,\phi) / {}_{b}N_{r}(z,\theta,\phi)\ . \tag{7.7} $$

Thus, the contrast transmittance is a direct function of the background and the manner in which the background radiance changes with altitude. The contrast transmittance for a background lower in reflectance than the equilibrium reflectance will always be smaller than the beam transmittance. This is illustrated in Figure 7-7 by the forest and macadam backgrounds for the nadir path of sight for Flight C-142 Filter 5 (photopic). This is true because the ratio of inherent to apparent background radiance will always be less than 1 (since apparent radiance increases with altitude as shown in Figure 7-6). On the other hand, the contrast transmittance for a background higher in reflectance than the equilibrium reflectance will have a contrast transmittance greater than the beam transmittance as illustrated by the concrete at low altitude. At the high altitudes, the concrete radiance having crossed the equilibrium radiance curve, the contrast transmittance changes slope and approaches the beam transmittance.

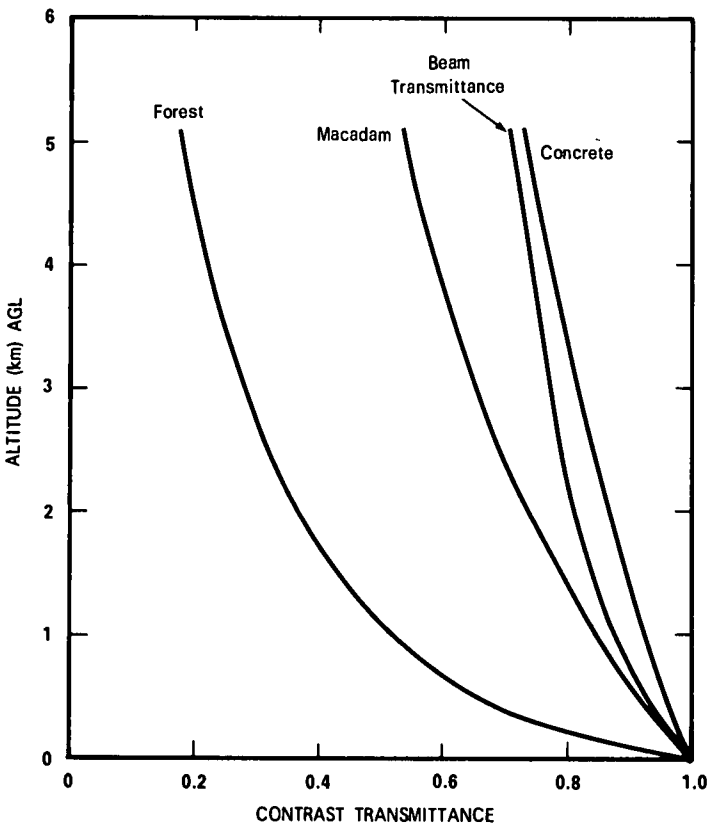


Fig. 7-7. Beam Transmittance and Contrast Transmittance for Flight C-142 Filter 5 Nadir Path of Sight.

The above example emphasizes the importance of selecting the appropriate background reflectances for computing valid contrast transmittance values. Photopic reflectances of backgrounds are available for clear days with moderately high suns in Gordon (1964) and Gordon and Church (1966a) and for overcast skies in Gordon and Church (1966b).

DIRECTIONAL PATH REFLECTANCE

Using the data from the two scanners to obtain both the path radiance $N_r^*(z,\theta,\phi)$ and the downwelling irradiance $H(z,d)$ adds to the reliability of the path reflectance $R_r^*(z,\theta,\phi)$ since these two quantities are ratioed in Eq. 2.4 to obtain path reflectance. In this way, any absolute error in the calibration of the scanners is effectively minimized. Also, since both the path radiance and the downwelling irradiance are obtained by integration of a large number of radiance measurements, precision errors tend to cancel or average out.

For simultaneous data, the directional path reflectance should decrease with wavelength. Again, Flights C-137, C-139, and C-142 show this regularity in the representative graphs of path reflectance in Section 7.3. Flights C-134 and C-138 show Filters 5 and 3 in the expected order but Filters 2 and 6 are at times out of order. The Flight C-143 graphs indicate that Filters 2 and 3 properly bracket the other two filters, but Filters 5 and 6 are irregular. It is advisable to use the data for Flights C-137, C-139, and C-142 in any problem requiring filter comparisons.

8. GROUND-BASED DATA

8.1 DAILY SUMMARY

The twofold purpose of the ground station is (1) to provide measurements of inherent background radiance and reflectance appropriate for use with airborne measurements, and (2) to provide continuity of measurement by establishing ground-level values of downwelling irradiance and total scattering coefficient. The fulfillment of the first purpose was emphasized when the ground station was in operation but the aircraft was not operating in the same area. This situation occurred during the first portion of the ground-based operation 4 May through 19 May 1970. Both purposes were automatically accomplished whenever the aircraft flight profiles were made in the near vicinity of the ground site. This situation occurred during the second portion of the deployment between 19 May and 7 June 1970. Unfortunately, an undetected data logger fault made post mission data retrieval extremely difficult and costly. As a result, only the data required for providing end point information for the flight profiles has been reduced; thus, emphasizing the second basic function of the ground station.

It was found in an earlier study (Duntley *et al.*, 1970) that it is reasonable to use the airborne downwelling irradiance at the lowest flight altitude to obtain directional path reflectance. On the other hand, the same study indicated that ground-based measurements of total volume scattering coefficient are needed because they cannot be adequately predicted by low altitude measurements. Thus, since data retrieval was limited, only the total volume scattering coefficient values appropriate to seven HAVEN VIEW flights were processed. They are presented herein.

Figure 1-2 presents the Memmingen area in detail. It gives the location of the flight track. The Memmingen Air Base where the ground station was located is noted by an airplane silhouette. Also indicated are the city of Memmingen and the village of Stephansried where the spectral data of Buchtemann and Hohn (1970) were measured during Project HAVEN VIEW.

A summary of all the ground station data packages for Memmingen, Germany, is presented in Table 8-1. The sets for which the nephelometer data have been processed are presented in this section and designated with an asterisk. The ground-based system data collection methods are described in detail in Section 4.2. The instruments employed are fully described in Section 3.

Table 8-1

HAVEN VIEW European Field Expedition
Summary of Ground Station Data Package
Memmingen A.B., Germany

Date	Atmospheric Conditions	Remarks
04 May 70	Broken clouds, moving fast	Full Set
05 May 70	Clear light haze	Full set
07 May 70	Cloudy, 90 percent overcast	Neph. and Royco only
08 May 70	Overcast	Neph. and Royco only
09 May 70	70 percent cloud, blue sky in holes	Abort: lamp failure
14 May 70	Light haze	Full set
19 May 70	Clear, thin cirrus	Full set
23 May 70	Overcast, full cloud cover	Neph. and Royco only
25 May 70	Light cloud	Full set
25 May 70*	High uniform cloud deck	Full set
26 May 70	Night, clear with late buildup	Neph. and Royco only
27 May 70	High broken cumulus	Neph. and Royco only
28 May 70*	90 percent cumulus	Neph. and Royco only
29 May 70*	High cirrus	Full set
02 June 70	50 percent cumulus	Neph. and Royco only
03 June 70*	Scattered cumulus, clear during run	Full set
05 June 70*	Clear, scattered cumulus	Full set
06 June 70*	High thin cirrus	Full set
06 June 70*	Split, clear east, overcast west	Neph. and Royco only
07 June 70	Broken cumulus, overcast	No scanner

* Processed Nephelometer Data

8.2 PRESENTATION OF GROUND-BASED DATA

The nephelometer data are presented in two forms:

1. Chronological Summary of Total Volume Scattering Coefficient
2. Average Total Volume Scattering Coefficient per Flight.

The data are presented by filter, with the filters in order of increasing mean wavelength. Note that Filter 4, a relatively narrow band optical filter with a mean wavelength of 765 nanometers, has been included although airborne data were limited to Filters 2, 6, 5, and 3. (Refer to Section 3.5 for further details on the spectral responses of the filters).

CHRONOLOGICAL SUMMARY OF TOTAL VOLUME SCATTERING COEFFICIENT, s(o)

Table 8-2 is a summary which presents in chronological order the total volume scattering coefficient per meter. These values were obtained using the average value of the irradiance of the reflected light from the calibration target (HR), measured both before and after the irradiance of the light scattered from the light beam. The second and third columns indicate the time period for each set of scattering coefficients. A set is comprised of five measurements, one for each filter. The numbers of the concurrent flights and the beginning and ending times for the flights are indicated in the last three columns.

Table 8-2

Project HAVEN VIEW

Ground-Based Nephelometer Data Chronological Summary

Date	Time GMT		Total Volume Scattering Coefficient per Meter					Flight Time (GMT)		
	Begin	End	Filter 2	Filter 6	Filter 5	Filter 3	Filter 4	Flight Number	Begin	End
25 May 70	0905	0913	2.17E-4	1.63E-4	1.62E-4	1.02E-4	7.33E-5	C-134	1508	1640
	1410	1415	2.72E-4	2.12E-4	2.11E-4	1.21E-4	8.83E-5			
	1630	1612	2.34E-4	1.93E-4	1.81E-4	1.14E-4	8.04E-5			
28 May 70	1434	1442	2.03E-4	1.44E-4	1.46E-4	9.62E-5	6.69E-5	C-137	1418	1543
	1459	1509	1.85E-4	1.49E-4	1.40E-4	9.56E-5	6.46E-5			
	1633	1641	1.77E-4	1.43E-4	1.36E-4	9.23E-5	6.00E-5			
29 May 70	0827	0837	2.94E-4	2.17E-4	2.15E-4	1.42E-4	1.06E-4	C-138	829	1039
	1054	1103	2.44E-4	1.87E-4	1.89E-4	1.33E-4	9.51E-5			
03 June 70	1233	1242	1.89E-4	1.59E-4	1.49E-4	8.83E-5	6.54E-5	C-139	1247	1511
	1329	1331	1.93E-4	1.57E-4	1.57E-4	9.36E-5	6.84E-5			
	1500	1508	1.96E-4	1.38E-4	1.42E-4	9.18E-5	6.43E-5			
05 June 70	1404	1415	1.58E-4	1.30E-4	1.21E-4	7.94E-5	5.10E-5	C-141	1451	1664
	1512	1516	1.60E-4	1.30E-4	1.22E-4	8.00E-5	5.15E-5			
	1622	1630	1.78E-4	1.51E-4	1.42E-4	9.13E-5	6.00E-5			
06 June 70	0843	0851	2.62E-4	2.01E-4	1.92E-4	1.34E-4	9.11E-5	C-142	0745	1045
	0935	0937	2.28E-4	1.83E-4	1.69E-4	1.13E-4	7.73E-5			
	1046	1059	1.90E-4	1.56E-4	1.51E-4	9.83E-5	6.71E-5			
06 June 70	1424	1434	2.63E-4	2.13E-4	2.07E-4	1.32E-4	9.51E-5	C-143	1406	1627
	1540	1549	2.45E-4	2.05E-4	1.79E-4	1.18E-4	8.29E-5			
	1627	1637	2.45E-4	2.05E-4	1.82E-4	1.18E-4	8.29E-5			

AVERAGE TOTAL VOLUME SCATTERING COEFFICIENT PER FLIGHT

To simplify the programming to obtain the average coefficient per flight, the data in Table 8-3 for 5 June 1970 have been placed between the morning and afternoon data of 6 June 1970. This separates the 6 June data into the period appropriate for Flights C-142 and C-143. The "s average" is the average per flight of the total volume scattering coefficients obtained using the average HR.

Table 8-3

Project HAVEN VIEW

Processed Data for Integrating Nephelometer

	Time GMT		Average Scattering Coefficient "S" per Meter									
Date	Begin	End	No. Pts.	Filter 2	No. Pts.	Filter 6	No. Pts.	Filter 5	No. Pts.	Filter 3	No. Pts.	Filter 4
25 May 70	907	1605	3	2.414E-4	3	1.894E-4	3	1.850E-4	3	1.124E-4	3	8.068E-5
28 May 70	1437	1635	3	1.883E-4	3	1.455E-4	3	1.406E-4	3	9.471E-5	3	6.381E-5
29 May 70	830	1056	2	2.692E-4	2	2.017E-4	2	2.021E-4	2	1.372E-4	2	1.005E-4
03 June 70	1235	1502	3	1.925E-4	3	1.512E-4	3	1.494E-4	3	9.123E-5	3	6.604E-5
06 June 70	845	1046	3	2.267E-4	3	1.799E-4	3	1.706E-4	3	1.151E-4	3	7.850E-5
05 June 70	1406	1623	3	1.654E-4	3	1.369E-4	3	1.281E-4	3	8.357E-5	3	5.417E-5
06 June 70	1427	1637	3	2.508E-4	3	2.075E-4	3	1.895E-4	3	1.227E-4	3	8.697E-5

8.3 DATA INTERPRETATION AND EVALUATION

The total volume scattering coefficient values are reasonable. However, they could not have been predicted by the airborne values measured at the lowest flight altitude. Hence, they represent a unique and necessary part of the measured optical properties describing the atmosphere during each flight.

The average value per flight given in Table 8-3 was used as the ground-level total volume scattering coefficient $s(o)$ for all the flights except Flight C-134. An average of the two afternoon data sets was used for Flight C-134, excluding the morning set. These average ground-level values are the $s(o)$ values presented in the tables and graphs of total volume scattering coefficient for each flight in Section 7.3.

The visibility "VV" reports in Section 6.3 from Memmingen at the beginning and ending of each flight can be compared to the photopic total volume scattering coefficient s (Filter 5) by assuming no absorption; thus

$$s = \frac{3}{VV} . \qquad (8.1)$$

Values of scattering coefficient s computed from the reported estimated visibilities are presented in Table 8-4, Column 4. The measured values of s for Filter 5 are given in Column 3. The visibilities calculated from the measured s values are compared with the reported estimated visibilities in Columns 5

and 6. Columns 3 and 4 compare reasonably well except for 25 May 1970 (Flight C-134) and the morning values for 6 June 1970 (Flight C-142). On 25 May 1970, the ground station measured s values are twice as large as the s values calculated from the estimated visibilities, and on the morning of 6 June, the ground station measured s values are one half the Memmingen values.

For the fourteen samples illustrated in Table 8-4, reported visibility was lower than measured visibility on three occasions (20 percent), approximately equal to measured visibility on three occasions (20 percent), and higher than measured visibility on eight occasions (60 percent).

Table 8-4

Measured Photopic Total Volume Scattering Coefficients, s,
Compared with Reported Visibility Estimates, VV

Date	Ground Station Data Interval (GMT)		Ground Station Measured s (Filter 5, per m)	Memmingen Calculated s (per m)	Ground Station Calculated Visibility (km)	Memmingen Reported Visibility (km)	Memmingen Weather Report (GMT)
25 May 70	Begin	1410-15	2.11E-4	1.0E-4	14.2	30	1452
	End	1603-12	1.81E-4	1.0E-4	16.6	30	1552
28 May 70	Begin	1434-42	1.46E-4	2.0E-4	20.5	15	1352
	End	1633-41	1.36E-4	1.5E-4	20.1	20	1652
29 May 70	Begin	0827-37	2.15E-4	2.3E-4	14.0	13	0752
	End	1054-63	1.89E-4	1.2E-4	15.9	25	1052
03 June 70	Begin	1233-42	1.49E-4	1.0E-4	20.1	30	1252
	End	1500-08	1.42E-4	1.0E-4	21.1	30	1452
05 June 70	Begin	1404-15	1.21E-4	1.0E-4	24.8	30	1352
	End	1622-30	1.42E-4	1.0E-4	21.1	30	1652
06 June 70	Begin	0843-51	1.92E-4	3.8E-4	15.6	8	0852
	End	1046-59	1.51E-4	3.0E-4	19.9	10	1052
06 June 70	Begin	1424-34	2.07E-4	1.5E-4	14.5	20	1352
	End	1627-37	1.82E-4	2.0E-4	16.5	15	1652

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Major Maul, Chef Flugbetriebstaffel
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13 ABSTRACT

This report presents atmospheric optical data collected in the daytime in Germany chiefly with airborne instruments during a field expedition in the spring of 1970. Results from six flights are presented. The data include irradiance, directional reflectance of terrain, total volume scattering coefficients, atmospheric beam transmittance, path radiance, and directional path reflectance. Data for sunlight and overcast conditions were derived for downward-looking paths of sight inclined at seven zenith angles (93, 95, 97, 100, 120, 150, and 180 degrees) from maximum altitudes of 2400 to 5100 meters AGL and lower in four spectral regions, as follows: two narrow band optical filters with mean wavelengths of 478 and 664 nanometers; and two broad band sensitivities, one representing the S-20 multiplier phototube incorporating an ultraviolet rejection filter with a mean wavelength of 532 nanometers, the other representing the photopic response with a mean wavelength of 557 nanometers.

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Atmospheric Beam Transmittance						
Atmospheric Contrast Transmittance						
Atmospheric Path Reflectance						
Daytime Radiance						
Daytime Irradiance						
Terrain Reflectance						
Radiometry						
Atmospheric Optical Properties						