

CHAPTER IV OPTICAL PROPERTIES AT EXTREME DEPTHS

10.0 Introduction

In this chapter we examine some theoretical and experimental evidence for possible regular behavior of apparent optical properties at deep and shallow depths in natural bodies of water. These extreme depths in a natural hydrosol are the settings of interesting and complex radiometric interactions of light from the sky with the body of the medium. The observed interactions at these depths are exaggerated either because of the extreme proximity of the air-water boundary or because of its extreme remoteness and thus present to both theoretical and experimental workers a challenging puzzle to unravel and bring conceptual order to the understanding of the light field observations at these depths. In the attempt to understand the radiometric phenomena at extreme depths, we shall be led to supplement the collection of laws governing the optical properties derived in Chapter 9 (which hold for all depths in a natural hydrosol). Furthermore, by concentrating on the extreme depths in the present chapter, we can extract correspondingly more detailed behavior of the observable K-functions of both the radiance and irradiance fields. Our investigations are based on the general equation of transfer and on the exact two-flow equations for irradiance of Chapter 5; in particular we shall make extensive use of the accurate two-D model for irradiance fields developed in Chapter 8.

We shall begin with the study of irradiance fields at shallow depths in media with calm surfaces, our primary aim being to discern from both theoretical and experimental clues, the precise nature of the depth-behavior of the upward and downward irradiance fields $H(z, \pm)$ at these depths. By examining these fields via their K-functions $K(z, \pm)$ we shall, as it were, be examining them under a powerful magnifying glass by means of which every tendency of decay or growth of $H(z, \pm)$ is limned in bold relief against a conceptual background of algebraic signs and magnitudes of derivatives.

The second half of the chapter is devoted to the study of the natural light fields at great optical depths as they occur in oceans harbors, and deep lakes. At remote distances from the generally disturbing air-water boundary of the medium, the radiance distributions eventually attain a smooth, characteristic shape independent of the external lighting conditions and dependent only on the inherent optical properties of the medium. The problem of the nature of the

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light field at great depths in natural waters has been completely solved only recently. As a result of having a theoretical basis for the existence of the regular behavior of the light field at great depths (for most practical purposes, beyond 10-20 attenuation lengths), we can justify certain simplifications of the models for light fields below such depth intervals. In particular, in such regions the classical canonical form of the equation of transfer [Chapter 4] for radiance, and the two-D model for irradiance (Chapter 8) can be demonstrated to serve as accurate tools with which to quantitatively predict the magnitudes of the natural light fields.