Radiometry lab:

Group 1. In-water Radiometry measurements off the dock.

The object is to get familiar with operating the Hyperpro radiometer. Because we are in shallow water, a full water cast is not possible, so we will mainly be working with the radiometer in two floating configurations. Acquiring data and setting up computer described in Appendix B.

A) Without the floats on the radiometer (in profiling mode…see picture below), on the sunny side of the dock, collect data as you lower and raise the radiometer 5 times to a depth of 3 m. This will allow you to calculate the upwelling radiance attenuation.
B) Down on the dock deploy the radiometer buoy in the TSRB configuration (See picture at end of document, placing the buoy between sun and dock (if possible). Compare on the screen the Ed and Lu spectra. Observe qualitatively how the Lu spectrum changes as you pull the buoy slowly vertically out of the water.
C) Collect measurements with the buoy in full sunlight and in various positions around the dock (shadowed and non-shadowed). End with a collection of measurements in the best possible location.
D) Deploy the radiometer with the "Lee" configuration and make measurements in full sunlight.

Computations for in-water data

a. Accumulate the cast data and calculate the diffuse radiance attenuation coefficient.
b. How do the irradiance spectra change when the buoy is in full sun light, in the shadow of dock?
c. How does the upwelling radiance spectra change when in the various situations?
d. Calculate Rrs from this system, how does the Rrs vary for the various situations.
e. Compute the Rrs and nLw for the SeaWIFS spectral bands.
f. Compute Ed(PAR) from hyperspectral data (400 to 700 nm) and SeaWIFS bands (extrapolate if needed) and compare these to each other.
g. Compare the Ed measured with that calculated with Greg and Carder (script provided by Emmanuel).

While doing these measurements listed above, make measurements of the direct solar irradiance using the Microtops sunphotometer. A current protocol for using a Microtops is given by Knobelspiesse (2003). During the sky measurement period, try to make a set of Microtops measurements every 10 minutes. NOTE THESE MEASUREMENTS ONLY MAKE SENSE IF THERE IS A CLEAR UNOBSTRUCTED (no cloud) VIEW OF THE SUN, IF THIS IS NOT THE CASE SKIP IT.

Instructions

A) (in general) enter location of site…it will already be done in this case

B) (in general) make sure time is accurate …it will be already done in this case.

C) turn on Microtops. Leave cover closed.

D) after instrument has done initialization and returned to "RDY Manual…." Open cover and point towards sun. Hint…eliminate shadow on your hands holding the sunphotometer and on the sunphotometer face…this will get you in the ball park to get the sun in the Sun target window…center sun in this bulls eye.

E) press scan and keep instrument pointed at sun. Jiggle around a little while holding it targeted on sun….one advantage of being old and shaky. This is in case the sun target is not aligned perfectly with the detector telescope.

F) Instrument will automatically collect 25 measurements, keeping the top value. Repeat this process 5 times, turn off instrument and turn it back on (to reset dark), then repeat another 10 times.

G) Turn off instrument and put in shaded spot until the next measurement.

Computations for Microtops data:

a) Gather the data from all of the groups and plot the irradiance measured (in instrument counts) vs air mass (1/cos (solar zenith angle)) for each channel. The solar zenith angle can be calculated from a solar ephemeris program when one knows the measurement location and time (it is also calculated by the instrument internally and is in the data file).

b) plot the optical depth vs time through the measurement period.

Group 2. Above water radiometry.

A) With the SAS radiometer system, explore collecting data with radiometers at several sensor zenith angles (30, 35, 40 and 45 degree, for both Li and Lt at one azimuth angle of your choice), and several azimuth angles (0, 45, 90, 135 and 180 for one sensor zenith angle). Mobley's (1999) recommended values are 40 degrees for Li and Lt and at 135 degrees azimuth angle away from the sun. Remember that this system also logs a reference irradiance measurement. Note changes in the sky and water during the measurements.

B) Arrange for a simultaneous measurement with the SAS and Group 1, all making optimum measurements.

C) Collect reference irradiance data with and without occulting the direct sun from the sensor (when the direct solar beam is blocked it is the diffuse downwelling irradiance).

D) Along side measurements with the SAS have someone use the Hydrocolor app on an iphone to make measurements of the same surface for comparison to the SAS.

For Hydrocolor: basically follow instructions listed on phone: Take picture of photographers grey card while card is placed on a level unshaded surface. Move phone around to match inclinometer green line between green arrows and compass rose match up with green arrow. (press capture). Then do the same with the sky and water images. Come up with a good file name system to name the file for later.

COMPUTATIONS:

a) From the data collected with the SAS system, compute the above-water remote-sensing reflectances for different measurement angles. How variable are they? Use Mobley's (1999) equation to compute remote-sensing reflectance: Rrs=(Lt-0.028Li)/Ed.

b) Obtain the simultaneous data from the people in group 2 and compute the remote sensing reflectance obtained with each technique. How do they compare? Are there regions of the spectrum, or locations where one method might be advantageous over another?

c) From the total and diffuse irradiance measurements, calculate the direct solar irradiance. Compare the spectra and magnitude of the direct and diffuse irradiance. Calculate the spectral direct/total spectral irradiance.

d) How do hydrocolor reflectance's compare with the SAS derived reflectance's?

Appendix A, information for calculations

Calculating remote sensing reflectance: (Rrs = Lw/Es)

Above water method:

Here one is measuring the light coming out of the water by using instruments above the surface. The corrections that must be applied need to correct for sky glint coming from the surface.

Rrs = (Lt-Lg)/Es

Lg= Lsky *Reflectivity of surface

In water method (floating device):

Here one measures the upwelling light below the surface of the water, and must correct for the attenuation of the light from the measurement depth to the surface and then for the transmission through the air-sea interface. A measurement of Es, above the surface is used to form Rrs.

Rrs = (Lu(z) T(z) Taw /Es

Where Taw is the transmission of the air-water interface = 0.54

T(z) is the radiance transmission from the measurement depth to the water surface:

T(z) = exp(KLu * z) assuming constant KLu

New Lee method:

This shouldn't have any corrections, except possibly shading: MAKE SURE THE IMMERSION CORRECTION IS OFF IN THE SOFTWARE.

Rrs = Lmeasured/Es

In water method, casts:

Here one forms the Lu(-), upwelling radiance just below the surface from subsurface casts using a profiling radiometer or buoy with multiple measurement depths. Es comes from a reference measurement above the surface. If the measurements are done with a profiling radiometer, multiple casts (10) are done very quickly over the first 20m or so of the water column. These multiple casts are combined to determine Lu(-) and then this Lu(-) is propagated through the surface.

Calculating PAR

$$\text{PAR} = \sum_{400nm}^{700nm} Ehc/\lambda(\Delta\lambda)$$

Where h is Planks constant (6.63 x 10^{-34} m^2 kg/s), and c is the speed of light (3 x 10^8 m/s).

Calculate SeaWIFS band

$$Rrs(\lambda) = \frac{\sum_{lower\lambda}^{upper\lambda} Rrs(\lambda')(\Delta\lambda')}{\sum_{lower\lambda}^{upper\lambda} (\Delta\lambda')}$$

SeaWIFS bands: assume the following square spectral bands:

1) Centered at 412 nm, 20 nm wide

2) Centered at 443 nm, 20 nm wide

3) Centered at 490 nm, 20 nm wide

4) Centered at 510 nm, 20 nm wide

5) Centered at 555 nm, 20 nm wide

Appendix B

Using Hyperpro…NOTE NO DOWNWELLING IRRADIANCE AT THIS TIME:

1) using Latitude E 6530 computer, with only Hyperpro attached to it. Must have instrument plugged into computer, using serial-USB converter at this time.

2) in the program portion of windows there is a file called “Satlantic” find this folder and in it the program “Satview”. Open Satview

3) Under Setup on the menu bar is a command “resource List”. Open this and make sure that Com3 is listed.

4) Under setup on the menu bar is a command “add Instrument”. Chose this command, then select for the instrument package the folder “hyperPro_March_cal” on the desktop.

5) double right click the suitcase icon on the top, then chose form the pop up menu “read From…”. In the window that pops up, choose Com3. All of the red icons should switch to have a green square around them on the instruments. Assuming you have the hyperpro deck box plugged in already.

6) double click on SATHPL0174, which causes a control panel to pop open. Choose Lu Spectral view which opens a spectral plot of the data at that time on the detector.

7) under menu bar for Log, chose options. In logging options change directory to OO2015_Rad_dock. In File naming mode…choose User defined and exit this panel.

8) in main panel write in name for logfile in the “Next Log” spot. (need to push “edit” first).

9) in the control panel for the SATHPL0174, choose properties and set immersed to be which wet (in the case of the profile and the TSRB type package, dry in the case of the Lee method).

10) when ready to start logging, press start logging. Press stop logging when appropriate.

11) Probably want to change the file name at this point before doing the next logging….repeat 10-11 as necessary.

Appendix C

Using HyperSAS…NOTE: The downwelling irradiance will be collected with this computer so we will want to keep logging this data to be able to provide it to the group doing the inwater work.

1) using Dell Studio computer, with only Hyperpro attached to it. Must have instruments plugged into computer, using Serial to USB hub converter at this time.

2) in the program portion of windows there is a program “Satview”. Open Satview

3) Under Setup on the menu bar is a command “resource List”. Open this and make sure that Com8,9,10, and 11 are listed.

4) Under setup on the menu bar is a command “add Instrument”. Chose this command, then select for the instrument package the folder “HyperSAS” on the desktop.

5) Add another instrument, the HSE187, the file for this is in the HyperPro_March_cal folder.

6) double right click the suitcase icon on the of the THS0009, then choose from the pop up menu “read From…”. In the window that pops up, choose Com10. All of the red icons should switch to have a green square around them on the instruments.

7) double right click the suitcase icon of the HSE0187, then choose from the pop up menu “read From…”. In the window that pops up, choose Com8. All of the red icons should switch to have a green square around them on the instruments.

8) double click on SATHSE0187, which causes a control panel to pop open. Choose Lu Spectral view which opens a spectral plot of the data at that time on the detector.

9) double click on SATHL0251, which causes a control panel to pop open. Choose Lu Spectral view which opens a spectral plot of the data at that time on the detector. Do the same with SATHL0250.

10) under menu bar for Log, chose options. In logging options change directory to OO2015_Rad_dock. In File naming mode…choose User defined and exit this panel.

11) in main panel write in name for logfile in the “Next Log” spot. (need to push “edit” first).

12) Choose the control panel for each of the three sensors, choose properties and make sure all of them have immersed unchecked.

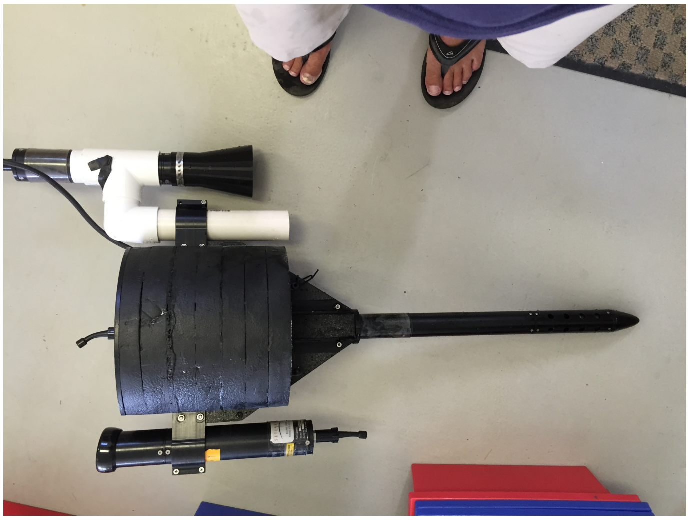
13) When ready to start logging, press start logging. Press stop logging when appropriate.

14) Probably want to change the file name at this point before doing the next logging….repeat 10-11 as necessary.

Appendix D, pictures of instrument

Hyperpro in profile mode

Hyperpro in TSRB mode (Tethered Surface Radiometer Buoy)



Hyperpro in Lee mode (should have PVC pipe on other side to balance instrument out. We may add weights to do this.