

# Ocean Optics Hyperspectral radiometer Above-water reflectance

## Introduction

This instrument will measure water-leaving remote-sensing reflectance ( $R_{RS}$ ) which is determined as the water-leaving radiance ( $L_W$ ) over the downwelling irradiance ( $E_D$ ).

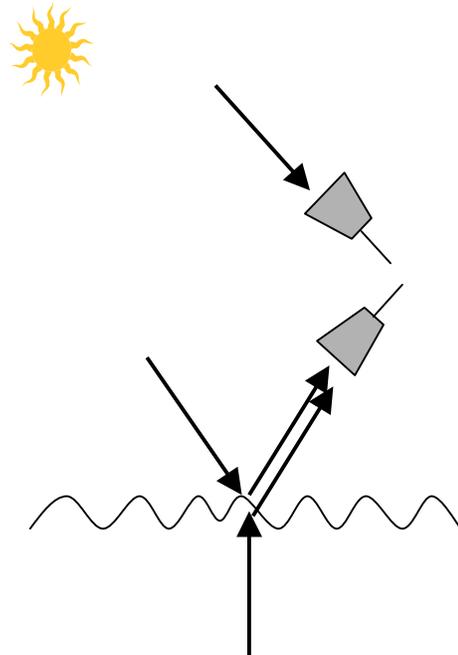
$$R_{RS} = L_W / E_D$$

However, the measured radiance ( $L_M$ ) by the above-water radiometer is composed of the water-leaving component and the light reflected on the surface of the water as well. To eliminate the last component, Mobley (1999) has proposed to measure the downwelling light ( $L_{SKY}$ ), with respect of the zenith angle ( $45^\circ$ ) and to multiply this signal to a “reflectance factor  $\rho$ ”. The water-leaving radiance is then calculated as:

$$L_W = L_M - \rho L_{SKY}$$

The downwelling irradiance is measured using a Spectralon plaque, which diffuse perfectly the incident light. This plaque should stay horizontal. However, if the ship is rolling, make sure it doesn't tilt toward or away from the sun.

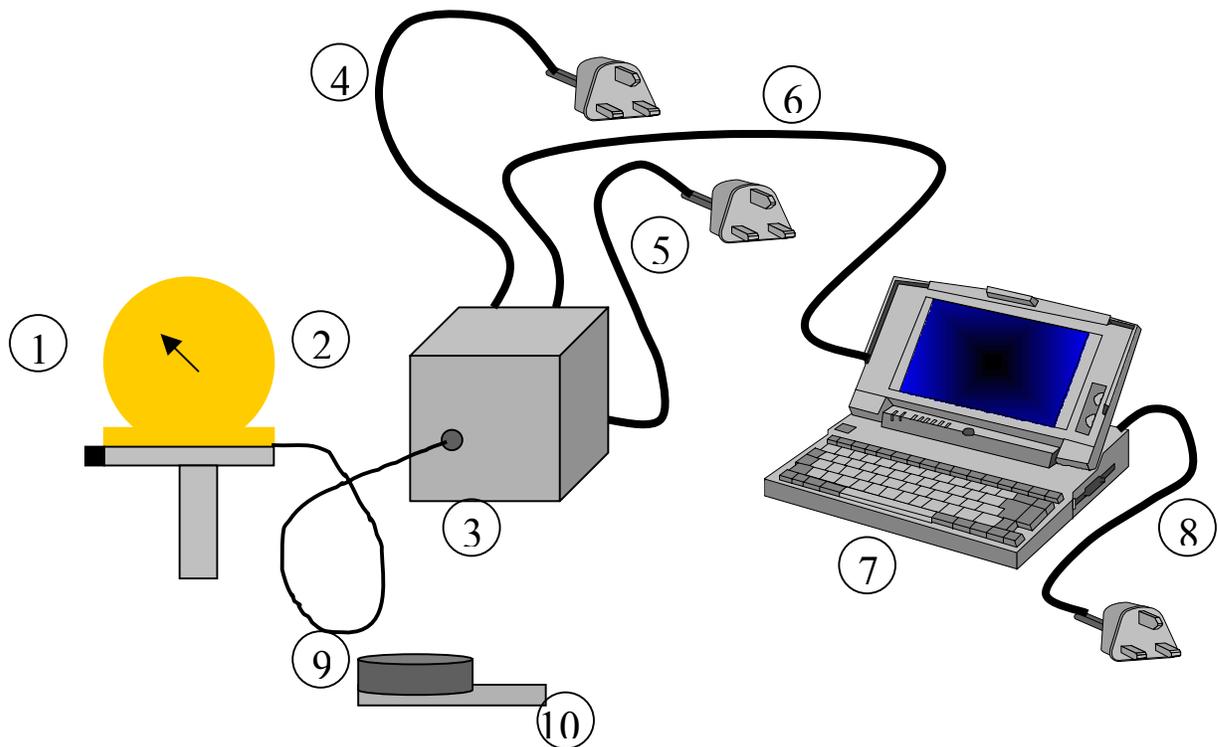
To estimate the remote-sensing reflectance we then need three types of measurements, a “sea” measurement, a “spectralon” measurement and a “sky” measurement. As it is pointed out in the NASA protocol, the light measurements should be made at an azimuth angle of  $90^\circ$  to  $180^\circ$  from the sun to reduce the reflected light component in the measured light.



## Protocol

### Set up of the instrument

- Insert the fibre optic (2) in the hole at the front of the Ocean Optics reader (3).
- Connect the Ocean Optics reader (3) to the laptop (7). Connect the laptop to the power (8).
- Connect the Ocean Optics reader (3) to the power (4 and 5) (back side of the reader) following the order that is indicated on the wire (top first and bottom second). If the Ocean Optics reader is functional, a red light will appear in the front side of the reader, it will turn to green when the temperature has reached  $\sim 20^{\circ}\text{C}$ . If the Ocean Optics reader is not connected properly, a flashing red light will show up, disconnect the reader and reconnect it to the power by inserting first the wire at the top of the reader and then the one at the bottom.
- Turn on the computer (7) and double-click on the Ocean Optics icon. The system is now installed. The system should be installed and turned on for at least 10 min before the acquisition of the data to let it warm up and stabilise.
- You will have to acquire data from the sea. Then you take data from the Spectralon plaque (9) to get the downwelling irradiance. To get this measurement, be sure the spectralon plaque is levelled horizontally and aim the fibre optic to the spectralon plaque (9). You will also take measurements of the light from the sky to get the light that is reflected on the surface of the ocean. To get these measurements, you aim the fibre optic to the sky. Make sure that you respect the angles, a zenith angle of  $45^{\circ}$  from the nadir direction and the same azimuth angle than when you made the other measurements (between  $90^{\circ}$  and  $180^{\circ}$  away from the sun). To get these data, you will have to put a 1% filter in front of the optical fibre to reduce the incident light.



### Acquisition of the data

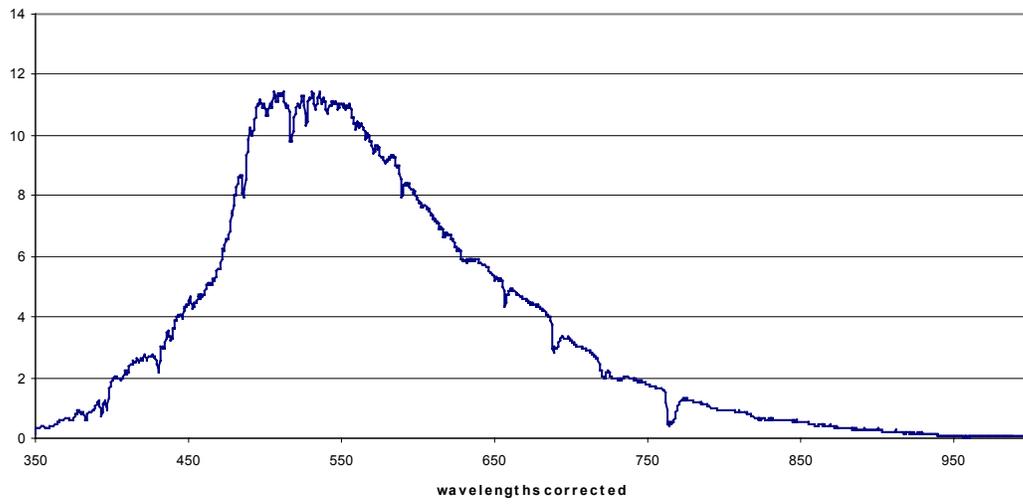
1. Once the program is turned on, configure the acquisition. Click on “Time Acquisition”, then “Configure” and then “Configure Acquisition”. A “time Acquisition configuration” window will appear. You have to change the name of the files (month, day, year, type of measurement, eg. aug142003spectralon, aug142003sea, aug142003sky). If you want to change the place to save the file (ex: leg2 instead than leg1) you press on the “...” button next to the filename window, change the pathway, add the filename and press save. Make sure that you “save full spectrum with each acquisition” and that you “save every acquisition”. These options should already be selected. Press “OK”
2. Activate the time acquisition. Press “Time Acquisition” and then “Activate Time Acquisition” or press the clock located directly over the “integration time” window in the toolbar. The system is now ready to collect the data.
3. Change the magnitude of the spectrum. Before you collect the data, make sure that you have a spectrum that uses the maximum of the available magnitude without saturating at 4000. The maximum of the spectrum should reach about 3000-3500. To change the magnitude of the spectrum, change the “integration time” which is located directly over the graph. The integration time on a sunny day is usually about 40-50 msec for the sea measurements, about 15-25 msec for the Spectralon measurements and about 150 msec for the sky measurements (after the 1% filter is added in front of the optical fibre). The minimum is 3 msec

4. Make sure that the “average” is 5. Each spectrum will be the average of five spectra.
5. Make sure the spectrum is “Corrected for the Electrical Dark”. This will correct for inherent dark noises
6. Make sure you are in Scope mode (S on the toolbar or scope mode in “spectrum” menu)
7. Make a dark measurement. Put your finger in front of the fibre optic to block all incident light and click on the “dark bulb” button or press on “spectrum” and then “store dark”. Then click on the “- dark bulb” button or press on “spectrum” and the “scope mode minus dark”. After you have subtracted the dark, the spectrum should be absolutely flat. The correction for the dark should be done every time you change the value of the “time acquisition”.
8. You are ready to acquire the data. Press on “Time Acquisition” and then “Start” or click on the green triangle in the toolbar (over the integration time). You will see the number of the acquisition files at the bottom of the spectrum. Take about 10 files for each type of measurements (sea, Spectralon, sky).
9. Change the type of measurements. Click on “Time Acquisition” then “Stop” or on the “red square” of the toolbar. Restart from the step 1 of the acquisition of the data.
10. Note the number of files that you have acquire for each type of measurement and the time that you have started and finished the measurements and make sure all the files (sea, sky and spectralon) are saved in the computer.

This protocol have been established in collaboration with  
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### upwelling radiance



### Reflectance for corrected wavelength in Bedford Basin, jan 10 2001

