HydroLight and EcoLight Lab 2 Exercises

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Today we want to learn how to model more complex water bodies, input in depth profiles of Chl or mineral particle concentrations, input measured absorption and scattering data, put bottoms at finite depths, etc., and examine the various kinds of output.

Closure: A common use of H is to check closure (internal consistency) between IOPs and radiometric variables or AOPs. For example, you read in your ac-9 or ac-S absorption and scattering data, let H predict E_d and K_d and R_{rs} and such, and then compare H's E_d or K_d or R_{rs} with your measured E_d or K_d or R_{rs}. Then try to figure out why the predicted and measured values disagree, which they almost always do.

Exercise 1: Inputting measured Chl(z) data.

What you learn: How to input measured Chl(z) data and then use an IOP model to define the IOPs for Case 1 water. How sky conditions effect irradiances, K's, Rrs, etc.

There is a "HydroLight Standard Format" (HSF) for any type of data file to be read by HydroLight, e.g. for files containing Chl profiles, ac-9 data, or measured sky irradiances. Example data files of various types are found in the data\Examples directory. We'll look at these during the lab and I'll point out what is important in putting your data into the HSF.

The "Classic Case 1" IOP model uses *Light and Water* Eqns 3.27 and 3.40 to convert a Chl concentration to the absorption coef *a* and the scattering coef *b*, as functions of depth and wavelength. You still have to pick a scattering phase function. The "New Case 1" IOP model determines everything from the Chl value.

Create a file with depth vs. Chl data, and use it to input a Chl(z) profile. Start with the example file HE5\data\Examples\Chlzdata.txt and modify it. Be sure to save your file as an ASCII text file (not a Word or Excel file, and not a DOS Unicode file) with a new name, like Curt_Chlz.txt. (Note: Notepad or Wordpad are what I used for this kind of work. Use save as → save as type MS DOS format. The recommended place for such files is the HE5\data\user directory.)

Run 1. Pick the Classic Case 1 IOP model and browse for this file in the concentration profile box option "by a standard format user-supplied data file" box. Pick a bb/b value of 0.01 or 0.02, and other typical values for sun angle, etc. Run from 400-700 nm by 10 nm. Do the run to 25 m, say, and save the output every 5 m, with an infinitely deep bottom.

Run 2. Use the same Chl(z) data file and do a run with the New Case 1 IOP model, and all else the same. Compare the two sets of output for things like $E_d(z)$, R_{rs}, Secchi depth, etc.

For these runs, you can use the Excel macros (on output\Hydrolight\excel\MULTIWL.xls, etc.) to look at and plot the results. The MULTIWL.xls macros create spreadsheets with one variable (e.g., the absorption coef or E_d) per page as a function of depth and wavelength. The SINGLEWL.xls macros group related variables (e.g., all of the irradiances or all of the K functions) and show the depth dependence in blocks of one wavelength per block.

Notice how the various K functions (K_d, K_u, K_{Lu}, etc) depend on depth and wavelength. Ditto for $R = E_u/E_d$ and the mean cosines. Plot the R_{rs} spectra for these two runs.

Repeat one of your runs with the IOPs the same, but change the sky conditions. Put the sun at 0, 30, 60, and heavy overcast (100% cloud cover). How do the different sky conditions affect the irradiances, K functions, reflectances, and mean cosines?

Exercise 2: Inputting IOPs from *a*, *c*, and b_b sensors.

What you learn: How to input measured IOPs, rather than using an IOP model to define the IOPs.

You are always better off measuring the IOPs than trying to estimate them from Chl or mineral concentrations and a bio-geo-optical model to obtain the IOPs from the concentrations. The most common way to do this is with ac-9 data (or ac-S, or data from other instruments).

File HE5/data/examples/ac9data.txt contains some ac-9 data on the HSF for a and c data. Take a look at this file to see the format for this type of data. Note that if you have ac-S data, the format is the same, but then you would have 80 wavelengths instead of 9. **Note that ac-9 data are assumed to have had water a and c values subtracted out; H will automatically add pure water values to the a and c values in the file.**

File HE5/data/examples/Hydroscat6.txt contains some Hydroscat-6 data on the HSF for bb data. Take a look at this file to see the format for this type of data. **Note that bb data are assumed to include the water bb values; H will not add pure water bb values to bb values in the file.**

Use these files and the "IOP DATA" IOP option to do some runs with measured data. If you have your own ac9 or bb data, put it on files of the same format, and use your own data.

Exercise 3: Simulating Case 2 water.

What you learn: How to build up a water body with Chl, extra CDOM, or mineral components.

Now use IOP model Case2 to do a series of runs to simulate the transition in R_{rs} as you go from Case 1 to Case 2 water with increasing mineral and/or CDOM concentrations. For example, you might: set Chl = 1 mg/m^3, let the CDOM be a function of Chl like in Case 1 water, and then do runs with a mineral concentration of 0, 0.25, 0.50, 1.0, 2.0, 5.0, 10.0 gm/m^3, with all else being held constant. Maybe use a phase function with 1% backscatter fraction for Chl-bearing particles and 3% for the mineral particles. Then plot R_{rs} as a function of wavelength and mineral concentration.

Alternatively, you might hold the mineral concentration fixed at 1 gm/m^3, but vary the type of mineral (from the selection of calcareous sand, red clay, yellow clay, and brown earth).

Note: if you want, save these R_{rs} spectra for later, when you can run them through an inversion model that obtains Chl from R_{rs}, to see how well the inversion does. In principle, you would retrieve the same Chl value for each spectrum, but that won't happen.

Exercise 4: Simulating optically shallow water.

What you learn: How to put a finite-depth bottom in H, and see the effect of bottom reflectance on R_{rs} and K functions.

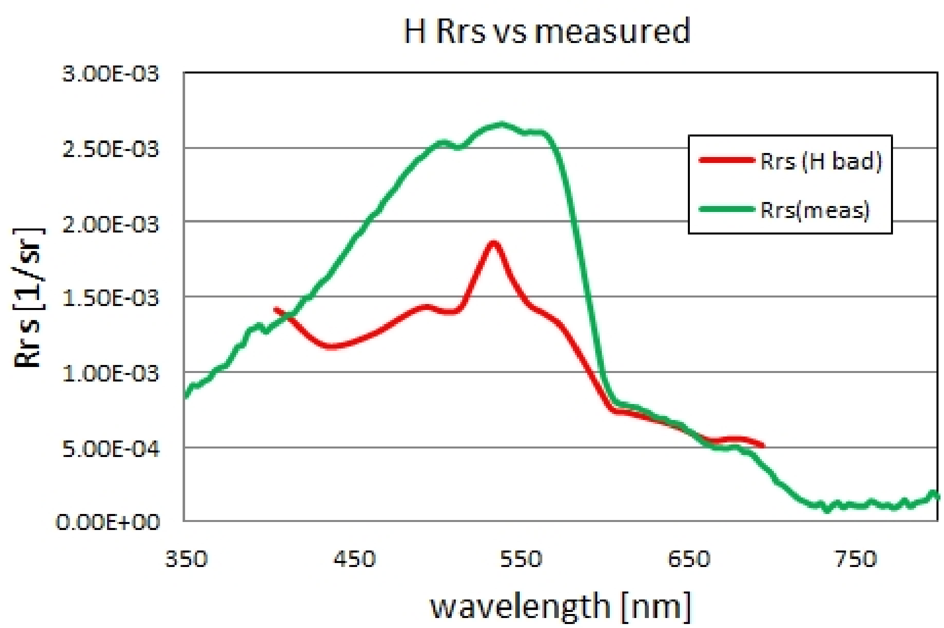
File AC9_Bahamas.txt has ac9 data that were measured in very clear water in the Bahamas. Use the IOP DATA option to read in this ac9 data. Do a run from 400 to 700 by 10 or 20 nm. On the Bottom Boundary Condition form, pick the options for a finite depth, and bottom reflectance dependent on wavelength, and then pick the coral sand bottom reflectance file. Do runs with the bottom placed at 5, 10, 20, and 30 m, and infinitely deep water run down to 30 m. Save the output at 1 m intervals. Plot R_{rs} for the different bottom depths to see how deep the water has to be before you don't "see" the bottom in R_{rs}. Now plot K_{Lu} at 550 nm vs depth to see how the bottom reflectance affects K_{Lu} as you get near the bottom. How is K_d (550) affected by the bottom?

Exercise 5: Providing HydroLight User Support

The most common HydroLight user support question I get is something like, "I used H to compute R_{rs} (or whatever) and compare with what I measured, and they don't agree. What is wrong with H?"

Figure 2 shows an actual example of this. The user had the ac-9 data contained on file AC9_IndianOcean.txt. The user used this ac-9 data in H with the IOP DATA option, and used a backscatter fraction of 0.01 to determine the phase function. Use this IOP input, with the sun at 30 deg in a clear sky, infinitely deep water, run down to 20 m, 400 to 700 nm by 10 nm, and reproduce the user's curve. **Then figure out "what is wrong with HydroLight" and fix the problem.** Then do the run again an see if the H output gives a better fit to the measured R_{rs}.

The first questions to ask yourself are, "Does the measured R_{rs} curve (green) look realistic?" and "Does the HydroLight-computed (red) curve look realistic?" OK, now you're on your own. (BTW, it took me less than one minute to figure out and solve the problem.)



You get the idea. Play with HydroLight all you want for the rest of the course. Now is the time to get your questions answered.