What is EcoLight-S?

Numerical Optics Ltd

EcoLight-S(ubroutine) is an extremely fast RTE (radiative transfer equation) solver developed for use as the radiative-transfer component of coupled physical-biological-optical ecosystem models, or as the forward-model core of implicit inverse models. HydroLight and EcoLight are intended for stand-alone use as research tools and have a graphical user interface for entering the inputs needed to solve the RTE. EcoLight-S is a collection of subroutines to be imbedded in the user's own code and has no graphical user interface or built-in bio-geo-optical or sky models. Other differences in these codes can be summarized as follows:

- **HydroLight** solves the unpolarized RTE with high accuracy to compute in-water and water-leaving radiance distributions as functions of depth, polar and azimuthal directions, and wavelength. The emphasis is on accuracy of the RTE solution, with run time being of secondary importance. The HydroLight-EcoLight user interface gives the user many options for defining the inputs needed to solve the RTE. For example, there are built-in bio-geo-optical models that allow the user to indirectly define the needed absorption and scattering properties of the water body from inputs such as chlorophyll, CDOM, and mineral particle concentrations and mass-specific absorption and scattering spectra.

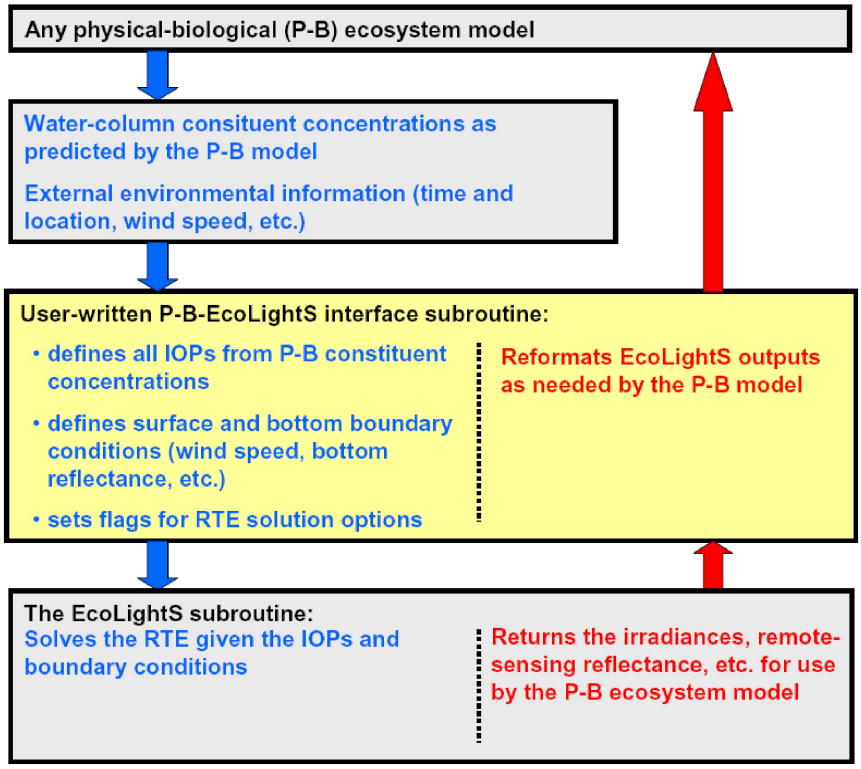
- **EcoLight** solves the azimuthally averaged RTE to obtain the same high-accuracy irradiances, reflectances, and nadir- and zenith-viewing radiances as HydroLight. EcoLight run times are much faster than HydroLight because the azimuthal dependence of the radiance distribution is not computed. HydroLight and EcoLight are bundled together and run within the same user interface.

- **EcoLight-S** is purely an RTE solver that emphasizes fast run times at the expense of (a user-selectable level of) accuracy. EcoLight-S has various options such as solving the RTE to dynamically determined depths at selected wavelengths, with unsolved depths and wavelengths being obtained by extrapolation or interpolation. Such options can greatly reduce the run time, but also reduce the accuracy of the computed irradiances and other quantities. The inputs for EcoLight-S are the same as for HydroLight, namely the inherent optical properties (IOPs; the absorption and scattering properties) of the water body, the incident sky radiance, and the bottom reflectance (in finite-depth waters). All inputs needed to solve the RTE must be explicitly defined by the user before calling the EcoLight-S subroutine. There are no built-in bio-geo-optical (or sky, etc.) models within EcoLight-S, although such models can be called by the user's own program to obtain the inputs needed by EcoLight-S. Although there is no user interface for EcoLight-S, the software comes with "fill in the blank" templates and example driver programs showing how to define the needed inputs. EcoLight-S is entirely new code written in Fortran 95, except for a few public-code Fortran 77 legacy routines for standard mathematical operations.

Please contact John Hedley at Numerical Optics Ltd, j.d.hedley@numopt.com,
+44 1884 675070, for further information about EcoLight-S technical details and licensing.

Using EcoLight-S

The figure shows the conceptual use of EcoLight-S in an ecosystem model. Ecosystem models predict component concentrations (chlorophyll, CDOM, minerals, nutrients, etc.) as functions of location and time. To use EcoLight-S to compute the corresponding light field within the water, these component concentrations must be converted to absorption and scattering properties. That can be done in many ways, but in any case, the user must convert the state variables of the particular ecosystem model to the information needed to solve the RTE.



Use of EcoLight-S as the optics component of a coupled physical-biological-optical ecosystem model.

The table shows run time in seconds for simulations of pure water and turbid Case 2 water. For each simulation, the times in the left column are for a Xeon 2.00 GHz CPU and Windows XP; times in the right column are for an Intel Core i5, 2.40 GHz, 32 bit CPU and Windows 7. Runs were 400-700 nm by 10 nm. PAR values for all simulations were the same to within 3% at all depths for the respective simulations.

model	**pure water to 400 m 0.1% PAR depth > 400 m Secchi depth ≈151 m**		**turbid Case 2 to 40 m 0.1% PAR depth ≈20 m Secchi depth ≈4.9 m**	
HydroLight v. 5.1	811.4	229.8	462.0	123.2
EcoLight v. 5.1	13.0	4.5	7.9	3.0
EcoLight-S, no optimization	9.3	2.78	5.33	1.61
EcoLight-S, with optimization	0.61	0.19	0.30	0.09