**Improved Sea Surface Reflectance Calculations Using Fully Resolved Sea Surfaces and Polarized Ray Tracing**

Curtis Mobley

Accurate prediction of sea surface reflectance is required for subtraction of sun glint and reflected sky radiances from measured total upwelling radiances. Surface reflectances are usually estimated using either analytical or single-scattering Monte Carlo simulations based on the Cox-Munk wind-speed wave-slope model. Although the Cox-Munk equations do a reasonable job of describing sea surface slope statistics, they cannot resolve wave elevations. Proper simulation of surface reflectance requires three things. First, the sea surface must account for both elevation and slope statistics at all spatial scales from long gravity waves (which dominate the elevation variance) to short gravity and capillary waves (which contribute much of the slope variance). Second, effects of wave shadowing and multiple scattering between waves (which become important for large incident angles from the surface normal) must be modeled. Finally, the reflectance calculations must account for polarization. The first requirement can be met if sea surfaces are simulated using Fourier transform techniques based on wave variance spectra. The second and third requirements are met by using Monte Carlo ray tracing that includes multiple scattering and the full Stokes vector formulation for polarization.

Compared to estimates based on unpolarized ray tracing with Cox-Munk surfaces, irradiance reflectances are of order 10% different for fully resolved surfaces and polarized ray tracing. Differences can be tens of percent or greater for radiance reflectances, depending on the solar zenith angle, sky polarization, wind speed, and viewing direction. The new algorithms and code are computationally efficient and allow for improved predictions of sun glint and sky reflectance as needed to estimate the water-leaving radiance.

[curtis.mobley@sequoiasci.com](mailto:curtis.mobley@sequoiasci.com); Sequoia Scientific, Inc., 2700 Richards Road, Suite 107, Bellevue, WA 98005