ASSESSING THE UNCERTAINTY OF THE OCEAN WATER BIDIRECTIONAL REFLECTANCE MODEL


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Introduction

- Characterization of the ocean water bidirectional reflectance distribution function (BRDF) is important for ocean color remote sensing.
- Morel, Antoine, and Gentili (2002) have created a look-up-table (LUT) of the ocean water BRDF based on bio-optical models and radiative transfer simulations (hereafter referring to as MAG2002).
- Here we evaluate the uncertainty of the MAG2002 LUT by studying the response of the BRDF to the ocean water Inherent Optical Properties (IOP) variations.
- This uncertainty study helps us better assess the uncertainty of satellite ocean color products.

Vector Radiative Transfer (VRT) Model

BRDF Formulas:

\[ L_b(\theta_a, \phi_a, \phi_w, \lambda, \text{IOP}) = E_d(\theta_a, \phi_a) R(\theta_w, \phi_w) \frac{f(\theta_w, \phi_w, \text{IOP})}{Q(\theta_a, \phi_a, \phi_w, \text{IOP})} \frac{b_b}{a} \]

- \( b_b \): backscattering coefficient.
- \( a \): absorption coefficient.
- \( f \): the coefficient which relates the irradiance reflectance to the ratio \( b_b/a \).
- \( Q \): the ratio of upward irradiance to the in-water upward radiance.
- \( W \): wind speed.
- \( L_w \): water leaving radiance.
- \( E_d \): downwelling irradiance.
- \( R \): the effects of light reflection by and transmission through the air-sea interface.

Simulation parameters:

- Wavelength, \( \lambda \) (seven values): 412.5, 442.5, 490, 510, 560, 620, and 660 nm.
- Chlorophyll a concentration (six values): 0.03, 0.1, 0.3, 1.0, 3.0, and 10.0 mg m\(^{-3}\).
- CDOM absorption factor, \( \Phi \) (five values): 0.1, 0.5, 1.0, 2.0, and 10.
- Scattering coefficient factor, \( \Phi \) (three values): 0.5, 1.0, and 2.0.
- Ocean water polarization at 90°, \( p(90°) \) (five values): 0.5, 0.6, 0.66, 0.7, and 0.8.
- Solar zenith angle, \( \theta \) (six values): 0°, 15°, 30°, 45°, 60°, and 75°.
- Viewing azimuth angle, \( \phi \) (13 values): 0°–180° with increments of 15°.

Results:

- Angular distribution of \( \zeta \)
- Histogram of \( \zeta \) without Raman
- Histogram of \( \zeta \) with Raman

Summary

A systematic evaluation of the MAG2002 BRDF LUT is performed. General consistency is observed. Difference remains due to the different radiative transfer modeling details, singles scattering phase functions, IOPs. The framework will be used to generate the BRDF LUT for VIIRS and MODIS.