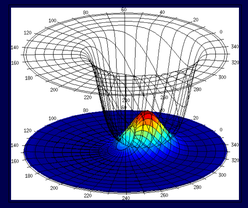

Improving the Description of Sunglint for Accurate Prediction of Remotely-Sensed Radiances

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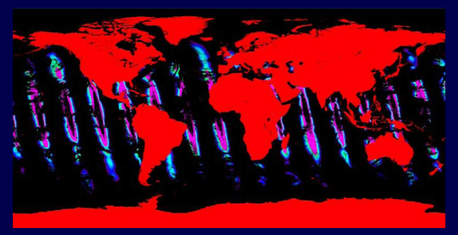

Introduction

An accurate treatment of sunglint would improve current correction schemes and rescue a significant portion of data presently discarded as "glint contaminated". In current satellite imagery, corrections limited to the region at the edge of the glint assume the sunglint radiance to be directly transmitted through the atmosphere. We show that the errors incurred by ignoring multiple scattering are very significant.

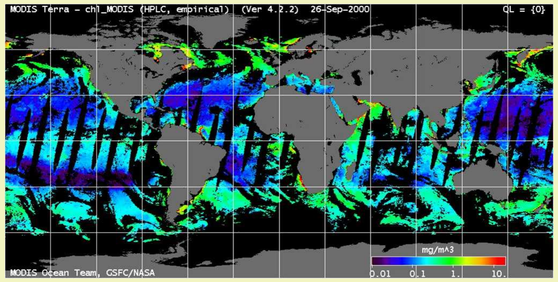

Figure 1: Global chlorophyll concentration retrieved from MODIS. Alternate black swaths are sunglint contaminated regions (other are gaps between swaths).

Method

- Instead of a simplistic Direct Transmittance approach (**DTR**, beam 2 in the figure), we employ a rigorous RT code[1] which accounts for multiple scattering[2] (**MSR** approach, beams $2 + 3$)

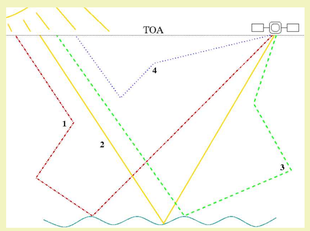

Figure 2: Contributions to top-of-the-atmosphere radiance. (1) Diffuse downward component reflected from the surface; (2) Direct beam; (3) Beam suffering (multiple) scattering after reflection; (4) (Multiply) scattered beam reaching the detector without hitting the surface.

- We compute the Sun-normalized sunglint (**SNS**) TOA radiances at 490 nm as a function of surface roughness and atmospheric status, and the DTR relative error

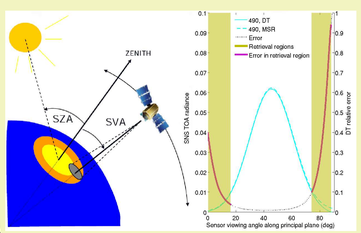

Figure 3: SNS TOA radiance for a purely Rayleigh scattering atmosphere and error incurred by the DTR approach at a representative channel (490 nm). SZA = 40°, wind speed = 5 m/s.

Simulation results

Rayleigh atmosphere with tropospheric (T50) and oceanic (O99) aerosols below 2 km

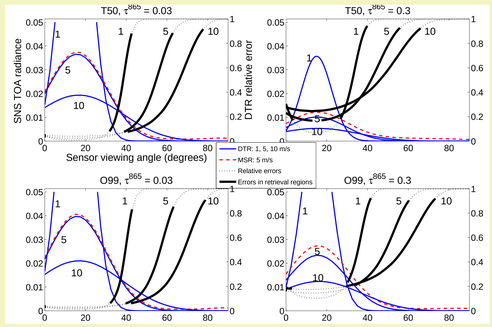

Figure 4: SNS TOA radiance at three representative wind speeds (1, 5 and 10 m/s), for SZA = 15°. Upper row: small aerosol particles (T50) in small (*left panel*) and large amounts (*right panel*). Bottom row: same loadings of large aerosol particles (O99).

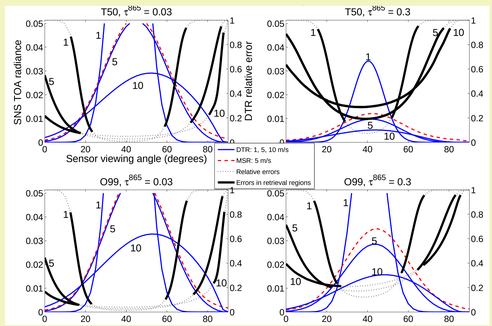

Figure 5: Same as Fig. 4, but for a SZA of 40°.

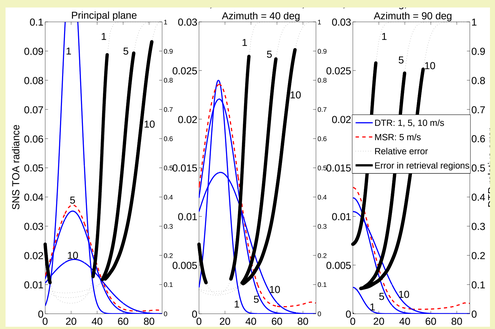

Figure 6: Azimuthal dependence of the SNS TOA radiance and relative error bands for an atmosphere containing an aerosol mixture T50 : O99 = 0.98 : 0.02 (τ^{865}=0.1): principal plane (*left*), 40° (*center*) and 90° of azimuth (*right*).

Summary

- Neglecting the contribution of multiple scattering to sunglint TOA radiances leads to high errors (10%-90%)
- Errors are essentially wind speed, solar zenith angle and azimuth independent
- Corrections for multiple reflections among surface facets and shadowing should be accounted for at grazing geometries
- Look-up-tables can provide reliable TOA radiances whenever the sunglint corrections are needed.

Other effects

Multiple reflections at the surface and **shadowing** are important at grazing geometries

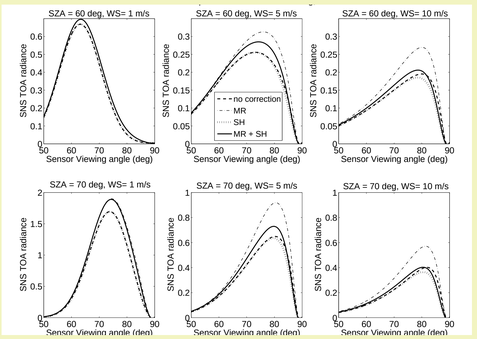

Figure 7: Effect of multiple reflections (MR) and shadowing (SH) on the SNS TOA radiance in a Rayleigh scattering atmosphere, for SZAs of 60° (*upper row*) and 70° (*bottom row*). From *left* to *right*, the plots pertain to wind speeds of 1, 5 and 10 m/s.

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References

1. Spurr, R. J. D., "LIDORT and VLIDORT: Linearized pseudo-spherical scalar and vector discrete ordinate radiative transfer models for use in remote sensing retrieval problems."; Light Scattering Reviews, A. Kokhanovsky Ed., Springer, vol. 3 (2008), *in press*.
2. Ottaviani et al., "Improving the Description of Sunglint for Accurate Prediction of Remotely-Sensed Radiance"; J. Quant. Spectrosc. Radiat. Transfer (2008), *submitted*.