The Impact of Polarization on OCO-2 Bias Mitigation in the Vicinity of Clouds

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NASA's Orbiting Carbon Observatory-2 (OCO-2) satellite measures spectral radiances in the O_2-A band at 0.76 µm, a weak CO_2 band at 1.61 µm, and a strong CO_2 band at 2.06 µm to retrieve the dry-air CO_2 column mixing ratio (X_{CO2}). Accurate X_{CO2} measurements are crucial for understanding carbon emission and sink fluxes. OCO-2 captures only a single polarization direction, making the degree of polarization (DOP) an important factor in signal intensity. Our research has demonstrated that clouds near OCO-2 footprints introduce retrieval biases due to the one-dimensional radiative transfer (RT) model used in the current algorithm, which does not account for scattered photons from nearby clouds. We have employed the EaR^{3}T-OCO simulator with MCARaTS (Monte Carlo Atmospheric Radiative Transfer Simulator) as the unpolarized three-dimensional (3D) RT engine for land observations [1], where light is often minimally polarized and can be assumed unpolarized. A mitigation approach has been proposed to minimize cloud-induced X_{CO2} retrieval bias over land in Nadir mode [2].

However, ocean glint-reflected solar radiance typically exhibits a higher DOP [3, 4]. When clouds contribute to the signal, the resulting radiances may be less polarized, potentially leading to inaccuracies in X_{CO2} bias correction if changes in polarization are overlooked. This study aims to explore the impact of accounting for polarization in reducing X_{CO2} biases induced by nearby clouds. We propose implementing SHDOM (Spherical Harmonic Discrete Ordinate Method) as another 3D-RT engine in our EaR^{3}T-OCO simulator, capable of simulating polarized [5]. In addition to the water reflection, aerosol particles can also change the DOP of receiving radiance. By considering polarization, we target enhancing the accuracy of cloud-induced X_{CO2} bias correction at various solar-sensor geometry and aerosol loading for ocean glint observations. The findings from this study are expected to provide valuable insights for future satellite missions focusing on polarimetric measurements, thereby greatly enhancing the overall accuracy of global CO_2 monitoring.

References

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