A Multi-sensor Approach to Cloud and Aerosol Detection in Support of OCO-2 XCO_2 Retrieval Validation

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The Orbiting Carbon Observatory-2 (OCO-2) satellite is the first dedicated to remote sensing of carbon dioxide. Accurate measurements of the column-averaged dry-air mole fraction of carbon dioxide (XCO_2) require scenes that are sufficiently clear of scattering material, making effective cloud and aerosol screening very important. The strategic placement of OCO-2 in the A-Train satellite constellation allows co-located comparisons with other instruments that have effective cloud and aerosol detection capabilities. This work uses both the Moderate Resolution Imaging Spectrometer (MODIS) aboard the Aqua platform and the Cloud-Aerosol Lidar with Orthogonal Polarization (CALIOP) lidar aboard the Cloud-Aerosol Lidar and Infrared Pathfinder Satellite Observations (CALIPSO) satellite to evaluate OCO-2 cloud screening.

Using a customized cloud mask derived from the MODIS cloud product for four 16-day periods in winter (December) and spring (April-May), Taylor et al. [AMT, 2016] found approximately 85% agreement in cloud detection between OCO-2 and MODIS. Disagreement between the sensors was separated into two cases with approximately 10% of soundings identified as clear by MODIS and cloudy by OCO-2 (Type 1 error) and approximately 5% identified as cloudy by MODIS and clear by OCO-2 (Type 2 error).

Our goal is to understand and characterize these cloud detection discrepancies by adding CALIOP cloud and aerosol measurements to this analysis. Specifically, we seek to answer the following questions:

1. For Type 1 error soundings where the OCO-2 cloud screeners identify a cloud while MODIS says it is clear, should the sounding be passed into the retrieval algorithm?
2. In cases of Type 2 error where MODIS identifies a cloud but OCO-2 identifies a clear scene, which MODIS cloud flags contribute to this conclusion?
3. What is the quality of the OCO-2 XCO_2 retrieval in areas of Type 2 error?

This work provides preliminary responses to these questions based on an in-depth case study analysis.

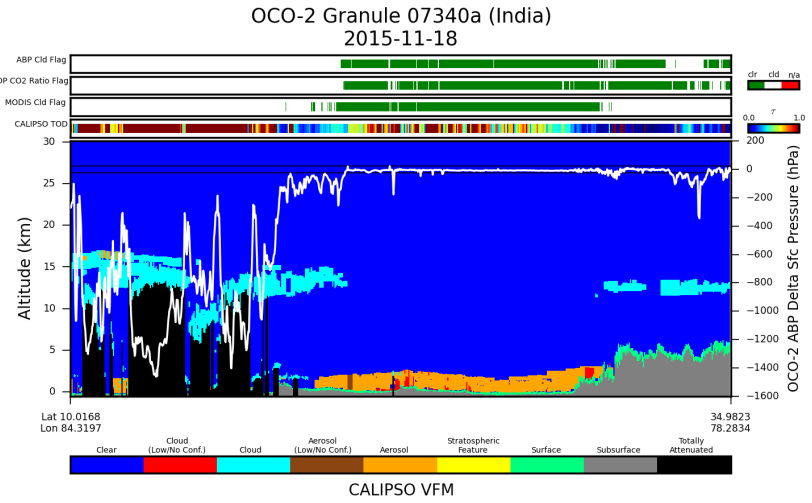

Figure 1. CALIPSO Vertical Feature Mask and 5-km Total Optical Depth, OCO-2 ABP and IDP cloud screening flags and delta surface pressure, and custom MODIS cloud flag from Taylor et al. [AMT, 2016]