A Multi-Sensor Approach to Cloud and Aerosol Detection in Support of OCO-2 XCO₂ Retrieval Validation
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Introduction
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 (XCO₂) 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. Using a custom cloud mask developed from the MODIS 1-km cloud flag and cirrus reflectance, Taylor et al. [2016] investigated discrepancies between OCO-2 and MODIS cloud detection.

Case Studies
1. May 14, 2015 (OCO-2 nadir orbit 04605a):

2. August 17, 2015 (OCO-2 nadir orbit 05992a):

Question 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?

Methodology:
• Bypass initial cloud screening process and feed every OCO-2 sounding into the L2 retrieval algorithm
• Compare the operational XCO₂ values to those generated without the cloud pre-screeners for soundings that the Taylor et al. MODIS cloud flag marks as clear

Results (focusing on case study areas between dashed lines):
• Many of the reintroduced soundings do converge and produce comparable XCO₂ values to the surrounding operational values.
• Further analysis is necessary to determine which OCO-2 pre-screening tests removed these soundings in the operational algorithm to determine if they can be included in the future

Question 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?

Methodology:
• Generate a co-located OCO-2/MODIS cloud mask product (MYD35) to investigate all cloud test outcomes

Results:
• Certain features in the MODIS cloud mask can be visually traced to a single test but most features will require additional analysis to pull apart.

Question 3:
What is the quality of the OCO-2 XCO₂ retrieval in areas of Type 2 error?

Methodology:
• Use post-processed OCO-2 Lite files to determine the quality flags and warn levels

Results:
• Approximately 75% of soundings in the Lite File fail the Quality Control (QC) test
• Of the 25% that pass QC, approximately 88.4% of those are soundings that MODIS agrees are clear and 11.5% are soundings that MODIS marks as cloudy

Further investigation:
• Only 62 soundings meet the criteria for inclusion in the Lite File and approximately 82% of those fail QC
• Even the 9 quality controlled soundings that OCO-2 and MODIS agree are clear have a relatively high median warn level (11)