Evaluating Satellite CO2 Measurements with Coarse-grid Comparisons and High-performance Aircraft Surveys
Britton
Stephens
National Center for Atmospheric Research
Benjamin Gaubert, National Center for Atmospheric Research
David Baker, Colorado State University
Thomas Taylor, Colorado State University
Poster
We track relative XCO2 biases between the different observing modes of OCO-2 and OCO-3 as a function of latitude and time of year by comparing observations in overlapping 10-degree latitude by 10-degree longitude boxes. Similar calculations on concentrations from matching samples from global atmospheric transport model simulations show that these differences should be very small (< 0.2 ppm). In contrast, OCO-2 v11.1 exhibits annual-mean ocean glint (OG) minus land nadir (LN) relative biases of -0.8 ppm (OG lower than LN) within 10 degrees of the Equator and +0.5 to +1.0 ppm (OG higher than LN) at high northern latitudes in summer. Biases of similar magnitude in OCO-2 v10 data led to large differences in fluxes estimated by the OCO-2 v10 MIP.

Starting with OCO-2 v7, with northern hemisphere OG-LN differences larger than -1.0 ppm, each version of OCO-2 through v10 has shown a steady reduction in OG-LN relative biases. OCO-2 v11.1 reduced OG-LN relative biases with respect to v10 at high latitudes at the expense of greater biases at the Equator. OCO-3 v10 relative OG-LN differences are very similar to those of OCO-2 v10, suggesting a common set of causes. OCO-2 v11.1 land glint (LG) minus LN differences are small (< 0.2 ppm) at all latitudes.

Coarse-grid comparisons are agnostic as to which observing mode is responsible for the OG-LN differences. Independent partial-column observations from aircraft have the potential to attribute biases to either or a combination of each mode. We have conducted indirect comparisons between OCO-2 and the global airborne observations from the NASA ATom project, via the OCO-2 v10 MIP posterior concentration fields. These suggest that most of the OCO-2 OG-LN relative bias is caused by bias in the OG observations.

Direct XCO2 comparisons to the collection of ~500 individual ATom profiles should be possible by assuming stratospheric contributions taken from the OCO-2 prior product or a model. In future work, we plan to make these direct comparisons. We also plan to evaluate GOSAT and any future versions of OCO-2 XCO2 using our coarse-grid approach.
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