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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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