Evaluating Clear Sky, Diurnal Cycle, and Representation Errors in OCO Retrievals: A Synthesis of Models and Observations

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We investigated the clear sky, diurnal, and representation bias from the Orbiting Carbon Observatory (OCO) using both continuous observations and a coupled regional ecosystem-atmosphere model (SiB2-RAMS). The clear sky bias in the near-surface continuous CO_2 concentrations was determined by detrending the CO_2 concentration time-series, creating a clear sky subset from daytime CO_2 concentrations, fitting two harmonics to both the clear sky subset as well as all the total daytime CO_2 measurements, and subtracting the fit for the total daytime CO_2 measurements from the clear sky fit. At both WLEF and Harvard Forest, clear sky measurements experienced a negative bias relative to the complete daytime dataset with the greatest magnitude in the winter (Figure 1). We hypothesize that this is due to a deeper boundary layer on clear days. Since OCO will measure the total column CO_2, the dilution effects of a deeper boundary layer will not influence the satellite measurements, and we suspect that the satellite will have a larger bias during the summer of approximately 0.1-0.3 ppm because of a negative bias in net ecosystem exchange (NEE) and that the wintertime bias will be minimal

Using SiB-RAMS, we performed a 10-day simulation in August centered over WLEF to help determine the spatial representativeness bias, the diurnal bias, and the clear sky bias. By vertically integrating the CO_2 concentrations to create total column CO_2 and by averaging ten 1-km wide horizontal grid increments in a 100 km by 100 km domain, we were able to emulate an OCO retrieval. We will discuss all three biases from this run.

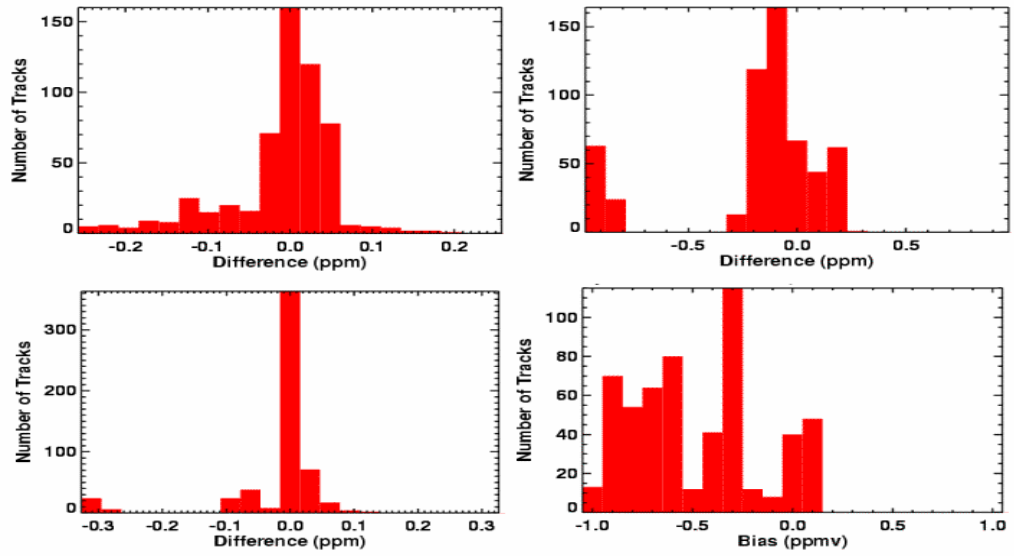

Figure 1. Results from our 10-day simulation in August. The top left panel displays the sampling distribution of the spatial representativeness bias at 1900 UT (1 p.m. local standard time). The top right panel shows the sampling distribution of the diurnal bias at 1900 UT, which was calculated by subtracting the diurnal mean from each of the possible satellite tracks at 1900 UT. The bottom left panel shows the distribution of the clear sky bias for each of the possible satellite tracks, and the bottom right panel displays the total bias, which was calculated by subtracting the emulated tracks in the model from the mean over the entire 10-day period.