An Approach for Estimating Multi-Species Boundary Values for Air Entering the North American Domain

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Studies of North American greenhouse and pollutant gas budgets require knowledge of the upwind boundary condition. For CO_2, some studies have taken boundary values from CarbonTracker. However, no comparable product is available for other gases such as CH_4, N_2O or CO. Furthermore, CarbonTracker residuals show strong seasonally-varying bias for certain Pacific marine boundary layer (e.g. Cold Bay and Shemya Island) and aircraft (e.g. Trinidad Head, Estevan Point, and Texas Gulf Coast) sites. Biased boundary values can lead to substantial systematic errors in inferred continental fluxes.

We have developed a method for creating empirical boundary value curtains for CO_2, N_2O, CH_4 and CO that represent the time-, latitude- and height-variation of air entering the continent from the West. The product has 1km resolution in the vertical from the surface to 8km. The method assumes that the vertical gradient with respect to the Marine Boundary Layer (MBL) reference varies with season but is constant from year to year. This assumption is not valid for all species (e.g. certain refrigerants with rapidly changing abundance), but the method does seem to capture most of the observed variability for CO_2, N_2O, CH_4 and CO. We also provide corresponding seasonal, latitudinal, and height-dependent error estimates for the product.

We will compare the empirical CO_2 boundary values with corresponding estimates from CarbonTracker for selected sampling sites in North America. We will also present residuals for MBL and aircraft sites for all gases. Finally, we will use trajectories and data from Atlantic sites to examine to what extent it is valid to use only data from the Pacific to estimate the boundary condition for North America.

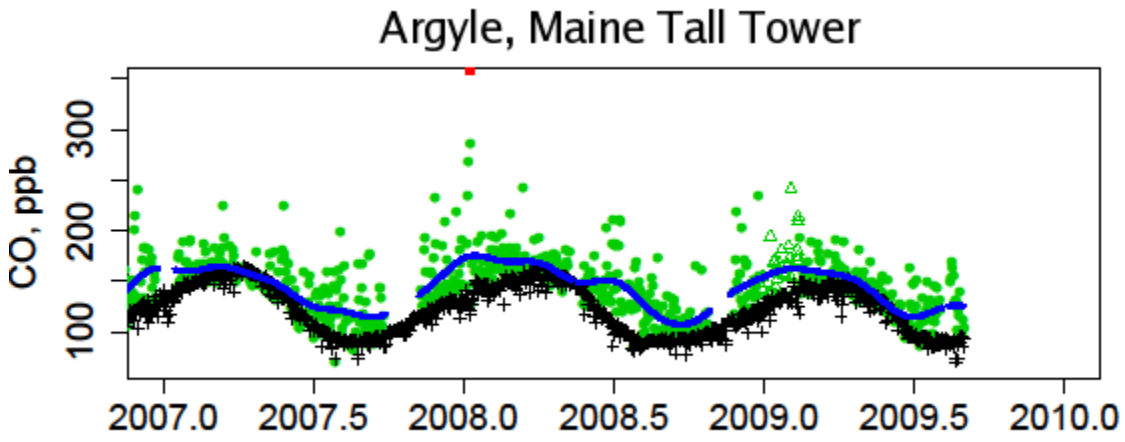

Figure 1. Afternoon mean carbon monoxide data collected at the Argyle, Maine Tall Tower (AMT) site (green; red=off scale) along with boundary values from our new empirical boundary product selected according to the latitude at the end of a 10-day back trajectory (black). The blue line is a smoothed representation of the AMT afternoon values.