Gradients of Column CO_2 Across North America from Aircraft and Tall Tower Measurements in the NOAA/ESRL Global Greenhouse Gas Reference Network

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This study analyzes seasonal and spatial patterns of column CO_2 over the North America using *in situ* aircraft and tall tower measurements from the NOAA/ESRL Global Greenhouse Gas Reference Network over the period of 2004 to 2015. The long-term trend of background CO_2 from Mauna Loa Observatory is first subtracted from all measurements before comparisons. We found that the largest spatial gradients of CO_2 among the seven regions we defined across North America appear below 2km during summer time, while upper layer data (above 5km) show little contribution to spatial gradients. Although individual CO_2 profiles have relatively large variability across different heights, the long-term mean profiles show clear seasonal propagations of surface signals to levels above. Strong seasonality also exists on the time series of column averaged CO_2 from aircraft measurements. Large spatial gradients of long-term mean column CO_2 mainly occurred during June to August with strong summer drawdowns. Since Carbon Tracker modeled CO_2 agrees well with our aircraft measurements and AirCore measurements, modeled CO_2 from upper layer (~ 340 mbar to 0 mbar) are utilized with aircraft and tall tower data to produce the whole atmospheric column CO_2 (XCO_2). We found that the XCO_2 gradients across North America mainly reflect the large-scale circulation patterns instead of only surface source and sink. The long-term mean summer drawdowns at the northern regions are stronger by ~ 3ppm than the southern regions. This spatial gradient of XCO_2 is only half of the amount reported in a recent study in Europe (Reuter et al., 2014).

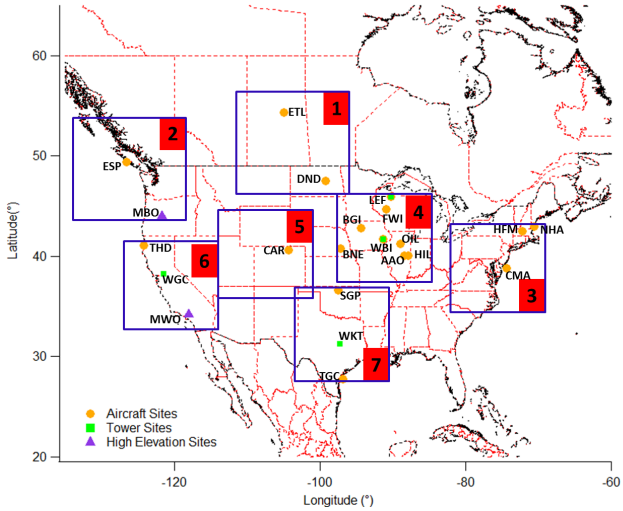

Figure 1. Aircraft and Tall Tower Sites in the NOAA/ESRL Global Greenhouse Gas Reference Network that are analyzed in this study. Seven regions are defined for spatial comparisions.

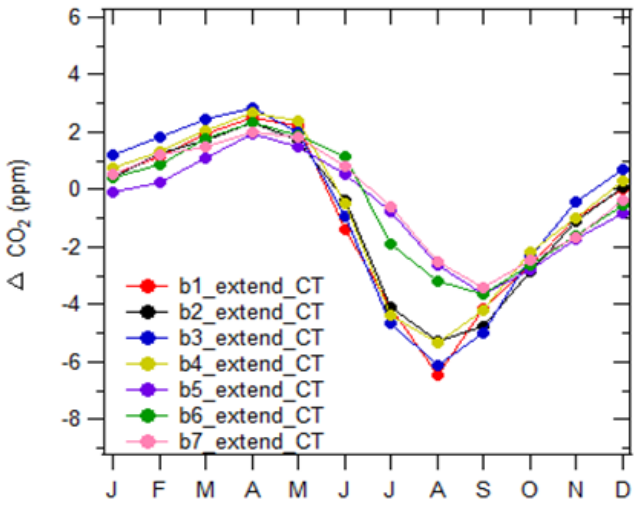

Figure 2. Long-term mean XCO_2 calculated from aircraft and tall tower measurements combined with upper levels Carbon Tracker modeled data. B1 to B7 in figure legend represent the regions in Figure 1.