Trace Gas Images of the Alaskan Atmosphere: The First Year of Measurements from the Carbon in Arctic Reservoirs Vulnerability Experiment (CARVE)

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Arctic and Boreal soils are estimated to hold more than twice the amount of carbon presently in the atmosphere. These regions are warming faster than any other region on Earth, leading to the possibility of large releases of carbon as CO_2 and/or CH_4 in the coming century. Moreover, the Arctic and Boreal carbon cycle represents a prime example of a potentially vigorous climate-carbon cycle positive feedback system, in which CO_2 and CH_4 releases will exacerbate warming and thus lead to more carbon emission, *et cetera*. Our current knowledge of the controls on CO_2 and CH_4 release from northern ecosystems, including wetlands, permafrost soils, and fires is poor, limiting our ability to assess the validity of predictive models. The object of CARVE is to link Alaskan tower and aircraft-based measurements of CO_2 and CH_4 with remotely-sensed surface hydrology and fire emissions over seasons and years.

Here, we will present analysis of trace gas data collected at a tower recently established in central Alaska by the NOAA/CIRES CARVE team. *In situ* measurements of CO_2, CH_4 and CO as well as daily air sampling for laboratory measurement of more than 50 additional mixing and isotope ratios commenced in October 2011. These measurements will form the year-round backbone for summertime CARVE aircraft missions, and will help us establish a long-term baseline for future Alaskan greenhouse gas changes. Analysis of back trajectories (Figure 1) shows that this site has sensitivity over large regions of wetlands and discontinuous permafrost, where we expect the greatest sensitivity to changing moisture and temperature. A first look at fall and winter CO_2, $d^{13}C$ and CO observations (Figure 2) suggest that CO_2 variations at the site can be influenced both by terrestrial biosphere exchange and pollution, although the broad suite of anthropogenic tracers measured should allow us to identify these events. We will additionally present examples of how the wide array of biogenic and anthropogenic tracers we measure, including stable and radio-isotope ratios of CO_2 and CH_4, will provide unique capabilities for the attribution of Arctic and Boreal greenhouse gas variations.

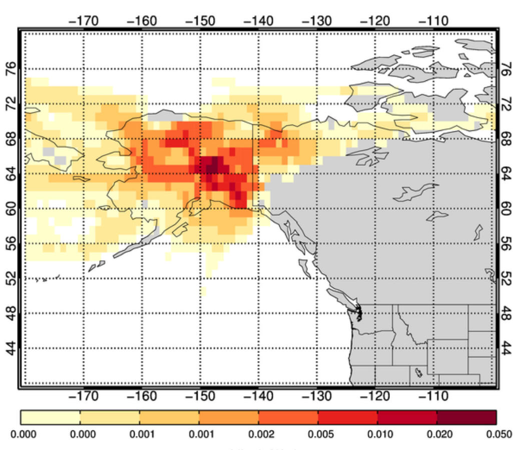

Figure 1. Average surface sensitivity (in units of mole fraction per flux; i.e. "footprint") for November, 2011 for discrete air samples collected at the CRV tower northeast of Fairbanks, AK.

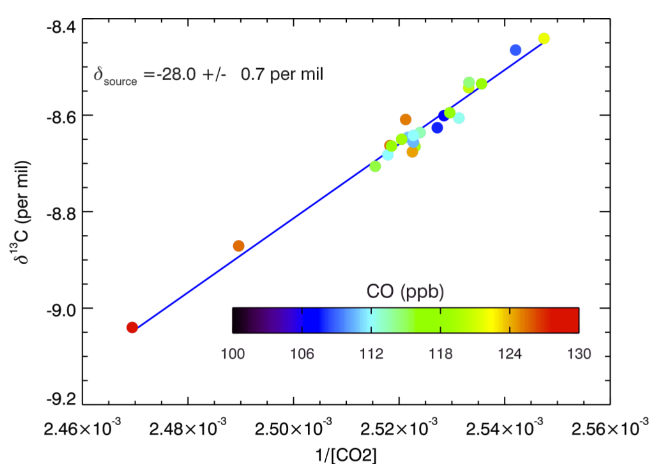

Figure 2. "Keeling" plot showing the $\delta^{13}C$ isotopic signature responsible for observed CO_2 variations. Data are color-coded according to their CO mole fraction as an indication of the degree to which combustion, as opposed to biospheric exchange has impacted CO_2.