New Results from the NOAA ESRL Collaborative Tall Tower Network for Monitoring Carbon Dioxide and Related Gases

A.E. Andrews[1], J.D. Kofler[2], J.C. Williams[3], M.E. Trudeau[4], P.S. Bakwin[1], C. Zhao[2], K.A. Masarie[1], D.H. Neff[2], D.R. Kitzis[2], P.P. Tans[1], K.J. Davis[5], A.R. Desai[6], S.C. Wofsy[7], W.J. Munger[7], D.J. Wolfe[1], M.L. Fischer[8], M.J. Parker[9], S.D. Wekker[10], C.O. Stanier[11], G. Petron[2], A.M. Michalak[12], J. Eluszkiewicz[13], T. Nehrkorn[13], K.R. Gurney[14], W. Peters[15] and A.R. Jacobson[2]

[1]NOAA Earth System Research Laboratory, 325 Broadway, Boulder, CO 80305; 303-497-6773, E-mail: Arlyn.Andrews@noaa.gov
[2]Cooperative Institute for Research in Environmental Sciences, University of Colorado, Boulder, CO 80309
[3]Science and Technology Corporation, Boulder, CO 80305
[4]Cooperative Institute for Research in Atmospheres, Colorado State University, Fort Collins, CO 80521
[5]Department of Meteorology, Penn State University, University Park, PA 16802
[6]University of Wisconsin, Madison, WI 53706-1481
[7]Harvard University, Cambridge, MA 02138
[8]Lawrence Berkeley National Laboratory, Berkeley, CA 94720
[9]Savannah River National Laboratory and Savannah River Nuclear Solutions LLC, Aiken, SC 29808
[10]University of Virginia, Charlottesville, VA 22904
[11]University of Iowa, Iowa City, IA 52242
[12]University of Michigan, Ann Arbor, MI 48109
[13]Atmospheric and Environmental Research, Inc., Lexington, MA 02421-3136
[14]Purdue University, West Lafayette, IN 47907
[15]Department of Environmental Sciences, Wageningen University & Research Center, Wageningen, Netherlands

NOAA ESRL began making measurements from tall towers in the 1990s in order to extend long-term carbon-cycle gas monitoring to continental areas. Existing television, radio and cell phone towers are utilized as sampling platforms for *in situ* and flask sampling of CO_2 and other atmospheric trace gases, including CO. Tall tower CO_2 mixing ratio measurements are sensitive to upwind fluxes over scales of hundreds of kilometers. Such measurements therefore place strong constraints on estimates of regional scale carbon budgets. CO is an indicator of combustion, and elevated levels can result from urban or industrial emissions or from biomass burning. CO data contribute to the interpretation of CO_2 measurements by helping to identify and quantify pollution episodes. The tall tower sites are part of the North American Carbon Program and are a primary data source for ESRL's CarbonTracker CO_2 data assimilation system. The network has become a highly collaborative enterprise, with contributions from a host of university, private sector, and government partners. The sites are equipped with high-precision semi-continuous CO_2 and CO analyzers, and most also have automated flask sampling equipment that collects an air sample approximately once per day. We will present important features of the data from each site, including seasonal and diurnal cycles and daytime vertical gradients for CO_2 and CO. We have used the Stochastic Time Inverted Lagrangian Transport model to compute sampling footprints for each site. The footprints are combined with optimized fluxes from CarbonTracker and with the Vulcan inventory to estimate the contributions of ecosystem, fire, ocean and fossil fuel fluxes.

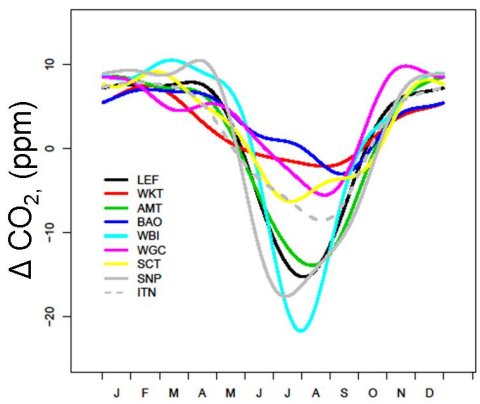

Figure 1. The mean seasonal cycle of CO_2 observed at the tall towers. An estimated background value representing the CO_2 concentration before the air encountered the continent was subtracted from the data in order to isolate the variability associated with North American emissions and uptake. The result is the signal that drives data assimilation and inverse model estimates of the North American carbon budget.