Estimating North America Carbon Fluxes Through Lagrangian Inverse Modeling for CO₂ and OCS

H. Chen¹, S.A. Montzka¹, A.E. Andrews¹, C. Sweeney², A.R. Jacobson², G. Petron², M.E. Trudeau², A. Karion², P. Novelli¹, K. Masarie¹, B.R. Miller², C. Gerbig³, J.E. Campbell¹, M. Abu-Naser¹, J.A. Berry⁵, I.T. Baker⁴, A.S. Denning⁶, T. Nehrkorn⁷, J. Eluszkiewicz⁷ and P.P. Tans¹

¹NOAA Earth System Research Laboratory, 325 Broadway, Boulder, CO 80305; 303-928-9072, E-mail: Huilin.Chen@noaa.gov
²Cooperative Institute for Research in Environmental Sciences, University of Colorado, Boulder, CO 80309
³Max Planck Institute (MPI) for Biogeochemistry, Jena, Germany
⁴University of California, Sierra Nevada Research Institute, Merced, CA 95343
⁵Carnegie Institution for Science, Department of Global Ecology, Stanford, CA 94305
⁶Colorado State University, Ft. Collins, CO 80523
⁷Atmospheric and Environmental Research, Inc., Lexington, MA 02421

Understanding biospheric CO₂ fluxes is paramount if climate studies are to be able to analyze the response of terrestrial ecosystems to climate change and monitor fossil fuel emissions reductions. Carbonyl sulfide (OCS) may be a useful tracer to provide a constraint on Gross Primary Production (GPP). Here we simulate both OCS and CO₂ using the Stochastic Time-Inverted Lagrangian Transport (STILT) model coupled with various biospheric fluxes, such as fluxes estimated from the Simple Biosphere (SiB) model, CarbonTracker, and from the Carnegie-Ames-Stanford Approach (CASA) model. The STILT model is driven by Weather Research and Forecast meteorological fields. This study uses measurements of OCS and CO₂ in 2008 from the NOAA/ESRL tall tower and aircraft air sampling networks, with ~ 6,000 observations in total. Biospheric OCS fluxes are estimated from a GPP-based model coupled with the GPP estimates from above mentioned biosphere models. The Soil uptakes of OCS from SiB and Kettle et al 2002 are assessed in the Lagrangian data assimilation framework, and are optimized using atmospheric observations of OCS and molecular H₂. Empirical boundary curtains are built based on observations at the NOAA/ESRL marine boundary layer stations and from aircraft vertical profiles, and are utilized as the lateral boundary conditions for OCS and CO₂ for North America. Comparison of the simulations for both OCS and CO₂ using different biospheric fluxes provides an opportunity to assess the performance of both the biospheric models and the representation of atmospheric transport. In addition, we will estimate the carbon fluxes for North America from a joint inversion for OCS and CO₂ in a Bayesian synthesis framework, in which the GPP and Respiration are separately optimized for each vegetation type.

Figure 1. Modeled and observed tall tower OCS concentrations at LEF (left), and simulated OCS components: plant and soil uptake (right).