An Ensemble Data Assimilation System to Estimate Regional CO_2 Fluxes for North America

W. Peters[1,2], L. Bruhwiler[2], J. Miller[1,2] A. Hirsch[1,2], M. Krol[3], and P. Tans[2]

[1]Cooperative Institute for Research in Environmental Sciences, University of Colorado, Boulder 80309; 303-497-4556; Fax: 303-497-6290; E-mail: Wouter.Peters@noaa.gov
[2]NOAA Climate Monitoring and Diagnostics Laboratory, Boulder, CO 80305
[3]Institute for Marine and Atmospheric Research Utrecht (IMAU), Utrecht, The Netherlands

CMDL is committed to provide detailed estimates of the distribution and magnitude of sources and sinks of CO_2 within the conterminous United States. Therefore, the atmospheric observation network is rapidly expanding as part of the North American Carbon Program (NACP). New atmospheric observations need to be combined (assimilated) into a tracer transport model to untangle regional scale CO_2 fluxes that are optimally consistent with the observations. Ideally, this transport model spans the global domain to ensure consistency with observed global constraints on the carbon cycle and to compare the North American carbon budget to that of other countries. However, data assimilation with many observations and many unknown fluxes in a global-to-regional scale framework poses many challenges.

We have built such a data assimilation system combining state-of-the-art Ensemble Kalman Filter techniques with the two-way nested global transport model TM5. TM5 satisfies the need for high-resolution modeling in a global domain in a computationally efficient way by calculating detailed transport (~70 × 100 km) for the United States, nested within a global simulation with a coarser (~400 × 600 km) grid. The System for Ensemble Assimilation of Tracers in the Atmosphere (SEAT-A) can ingest quasi-continuous observations, estimate surface fluxes and their uncertainty at the model grid-scale, and requires only forward model simulations. SEAT-A can easily be extended to additionally assimilate CO_2 isotopes or weakly nonlinear tracers such as CO or CH_4. The first CO_2 flux estimates for North America during 2000-2003 performed with observations from CMDL sites and the SEAT-A framework are presented in Figure 1.

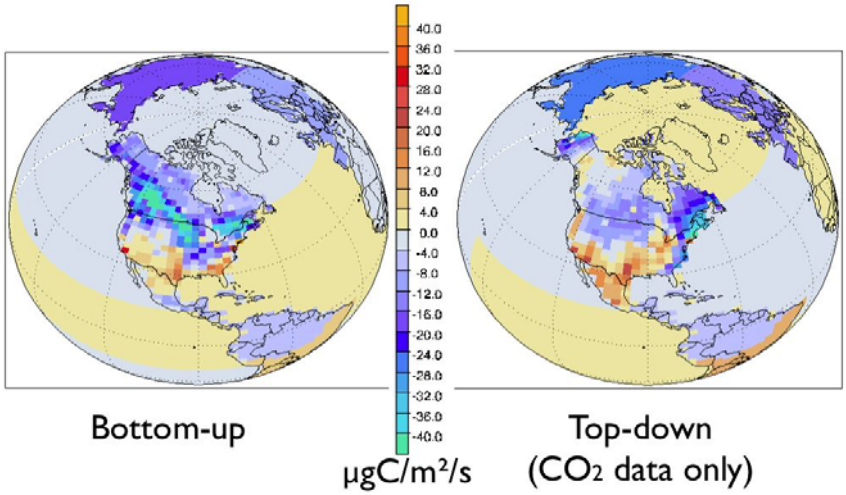

Figure 1. Comparison between the mean CO_2 flux distribution for July 7-15, 2001 calculated from bottom-up estimates and process models of the carbon cycle (left), and derived from the CMDL Cooperative Air Sampling Network CO_2 observations using the SEAT-A data assimilation framework (right).