

A Lagrangian Particle Dispersion Model Approach for Evaluating CarbonTracker

A. Andrews¹, A. Hirsch², A. Michalak³, C. Sweeney², S. Wofsy⁴, J. Eluszkiewicz⁵, T. Nehrkorn⁵, A. Jacobson², K. Masarie¹, W. Peters^{2,6}, and P. Tans¹

¹NOAA Earth System Research Laboratory, 325 Broadway, Boulder, CO 80305; 303-497-6773, Fax: 303-497-6290, E-mail: Arlyn.Andrews@noaa.gov

²Cooperative Institute for Research in Environmental Sciences, University of Colorado, Boulder, CO 80309

³Department of Civil and Environmental Engineering, and Department of Atmospheric, Oceanic and Space Sciences, University of Michigan, Ann Arbor, MI 48109

⁴Department of Earth and Planetary Sciences, Harvard University, Cambridge, MA 02138

⁵Atmospheric and Environmental Research, Inc., Lexington, MA 02421

⁶Wageningen University and Research Center, Wageningen, 6708 PB, the Netherlands

Lagrangian particle dispersion models (LPDMs) are gaining popularity for analysis and inverse-modeling of carbon dioxide measurements obtained from tall towers and aircraft. LPDMs suffer minimal numerical diffusion and are thus well-suited for studying highly variable data obtained in the vicinity of strong sources and sinks. Here, we explore the potential to use an LPDM as a pseudo-adjoint for the CarbonTracker CO₂ data assimilation system. For this work, we have chosen the Stochastic Time-Inverted Lagrangian Transport (STILT) model driven by a customized, high-resolution version of the Weather Research and Forecasting (WRF) model. Two years of meteorological driver data, 2004 and 2006, are available with 1.6km resolution in the vicinity of three NOAA Earth System Research Laboratory tall tower sites and 10 km resolution over much of the continental US. Sampling footprints from the LPDM can be used to critically examine various aspects of the CarbonTracker framework. For example, LPDM footprints can be convolved with CarbonTracker fluxes to isolate differences in simulated transport between STILT-WRF and the TM5 model used for CarbonTracker. Footprints can also be used to quantitatively project CarbonTracker residuals onto ecosystem maps or onto gridded meteorological driver data such as temperature, short-wave radiation and soil moisture. High-resolution STILT-WRF simulations can be used to develop strategies for minimizing model representation errors during CarbonTracker's assimilation step, when differences between observed and simulated CO₂ are used to adjust fluxes.

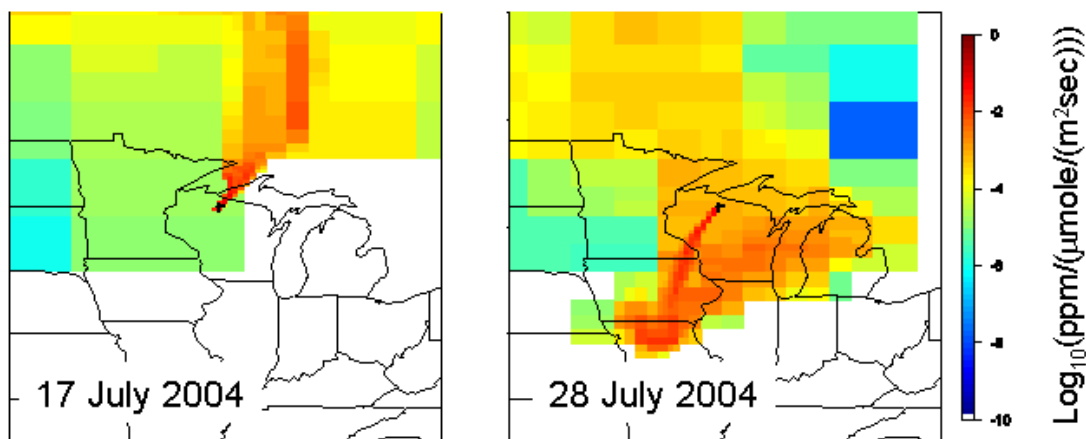


Figure 1. Typical mid-afternoon STILT footprints for the Park Falls, WI (LEF) tall tower site. The color scale is logarithmic and represents sensitivity to surface flux.