CarbonTracker-Lagrange: A New Tool for Regional- to Continental-scale Flux Estimation

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CarbonTracker-Lagrange (CT-L) is a prototype inverse modeling framework for regional quantification of greenhouse gas fluxes, including anthropogenic emissions and biological uptake. CT-L uses sampling footprints, also known as influence functions, to relate atmospheric measurements to upwind fluxes and boundary values. First-guess or prior fluxes are adjusted using Bayesian methods to provide optimal agreement with available observations. Alternatively, geostatistical inverse modeling techniques may be used to estimate fluxes without relying on prior flux estimates. Footprints are pre-computed and the optimization algorithms are efficient, so many variants of the calculation can be performed. For example, we can test alternate prior flux estimates, data weighting scenarios and assignment of flux error covariance parameters.

To date, a library of footprints has been generated for measurements made during 2007 - 2010 using the Stochastic Time-Inverted Lagrangian Transport model driven by meteorological output from the Weather Research Forecast (WRF) model. WRF was run with 30-40 km resolution for an outer domain that covers nearly all of North America and with 10 km resolution over the continental U.S. Footprints are species independent and can be used to simulate any long-lived constituent. CT-L can also use footprints from the FLEXPART and HYSPLIT models and a variety of meteorological driver datasets. Planned applications for CT-L include developing objective methods for combining surface and airborne *in situ* observations with ground-based and satellite-borne column CO_2 sensors, with particular emphasis on evaluating the extent to which column and *in situ* measurements enable separate estimation of surface fluxes and boundary inflow for North America. We will also conduct realistic Observing System Simulation Experiments to consider how the density and uncertainty of the measurements impact flux estimates, and we plan to eventually use multiple models to investigate the impact of errors in simulated atmospheric transport.

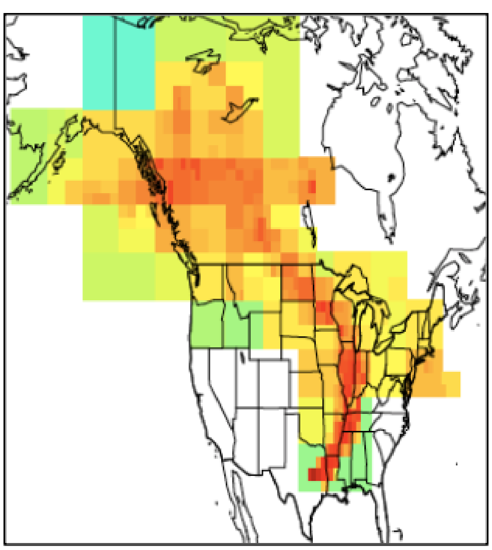

Figure 1. Sampling footprint for a mid-afternoon measurement from the WKT tall tower site near Moody, TX, showing the sensitivity to surface fluxes on a logarithmic scale.