Toward Improvement on Estimation of North American CO_2 Fluxes from CarbonTracker-Lagrange: A High-Resolution Regional Inverse Modeling System for Assimilating Atmospheric CO_2

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NOAA's CarbonTracker is a global modeling system for deriving carbon dioxide (CO_2) exchange between the atmosphere and Earth's surface based on atmospheric CO_2 mole fraction measurements. It was developed in 2007 and has been providing an independent atmospheric perspective of CO_2 fluxes from natural ecosystems for comparison to inventory- and process-based flux products. Given recent advances in inverse modeling and atmospheric transport simulation, limitations in CarbonTracker's inversion setup and coarse resolution of atmospheric transport, however, may limit its ability to retrieve the most accurate carbon fluxes. Within NOAA, we have been developing a high-resolution regional inverse modeling system for improving estimation of North American CO_2 fluxes, CarbonTracker-Lagrange. In this system, we computed tracer-independent footprints using high-resolution Weather Research and Forecasting (WRF) meteorology. We further improved the inversion setup by solving for weekly scaling factors of $1^o \times 1^o$ grid-scale fluxes with optimization of diurnal cycles of CO_2, whereas in CarbonTracker, it only optimizes weekly scaling factors of CO_2 fluxes from large ecoregions. Here, we will demonstrate that, in a synthetic-data experiment, results obtained from grid-scale inversions with optimization of diurnal cycles will reduce aggregation errors and improve estimation of North American CO_2 fluxes compared to inversion results obtained from only optimization of ecoregion-based fluxes (a CarbonTracker-like setup) (Fig. 1). We will further discuss the differences between fluxes derived from our new inversion system and those estimated from CarbonTracker using real atmospheric data for 2007 – 2014.

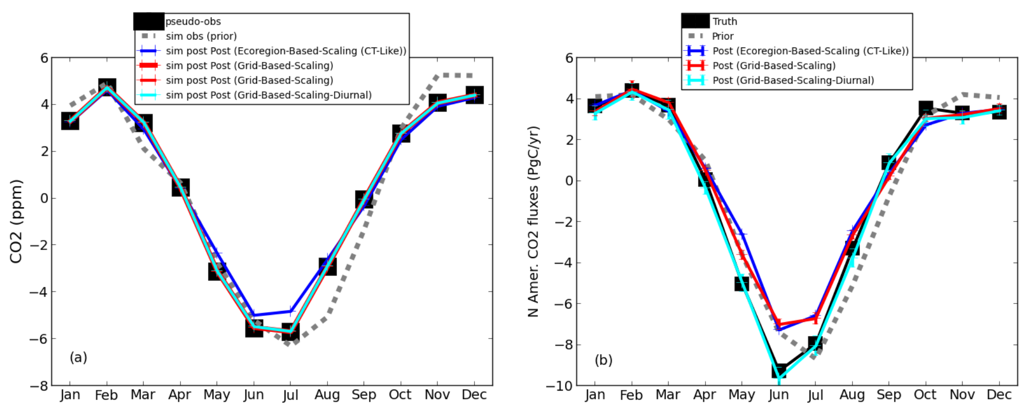

Figure 1. Observations (a) and fluxes (b) created and simulated in a synthetic-data experiment. Assumed true fluxes and the resulted average CO_2 mole fraction changes at NOAA's air sampling sites were indicated by black squares. Prior fluxes and the corresponding average CO_2 mole fraction changes were indicated by dashed lines. Posterior fluxes, derived from three different inversion setups: solving for ecoregion-based scaling factors (blue), solving for grid-based scaling factors (red), and solving for grid-based scaling factors with optimization of diurnal cycles of CO_2 (cyan), and their corresponding CO_2 mole fraction changes were noted by other colored lines.