Resolving CO_2 Flux Estimates from Atmospheric Inversions and Inventories in the Mid-Continent Region

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ABSTRACT

Atmospheric inversions and inventories represent two lines of evidence on CO2 fluxes at large spatial scales, but these approaches often do not provide consistent results. Inversions rely on CO2 concentration measurements to infer fluxes between the terrestrial surface and atmosphere. Inventories are typically conducted using models to predict changes in C pools, or CO2 fluxes directly, based on various driving variables influencing uptake and release of CO2 from the terrestrial surface. Our objective is to reconcile estimates between these approaches, to the extent possible for the Mid-Continent Intensive (MCI) Study Region of North America, shown in Fig. 1.

INTRODUCTION

The net exchange of CO2 between the terrestrial biosphere and atmosphere remains a key uncertainty in the carbon cycle. While terrestrial ecosystems in northern latitudes appear to be a net sink of about 2 Pg C yr-1 (Houghton 2003), uncertainties remain about the magnitude, inter-annual variability, geographic distribution, and causal mechanisms for the sink (Bousquet et al. 2000, Kaufmann and Stock 2003, Houghton 2003). Previous estimates of the North American C budget using atmospheric inversions and inventories have yielded disparate results, with a substantially larger C sink inferred from atmospheric inversions (Houghton and Hackler 2000, Gurney et al. 2002, Houghton 2003). Pacala et al. (2001) suggested that results are not necessarily inconsistent given the large uncertainty surrounding the inversions, but until results can be systematically compared and reconciled with more precision than previous attempts, our confidence in estimating terrestrial C dynamics and identifying sources and sinks is limited (NACP 2005). Moreover, accurate quantification of terrestrial sources and sinks in addition to understanding of the controls on the size and longevity of the apparent northern latitude sink are critical research needs identified for the North American Carbon Program (CCWG 1999, NACP 2005).

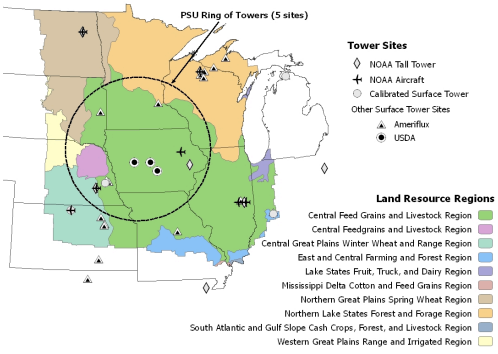

Fig. 1: Region of interest for MCI

RESULTS

We have compared results from the two approaches to understand the consistencies and inconsistencies. This exploratory phase entails investigation via graphical tools, testing for spatial and temporal autocorrelations, and a regression analysis where the differences between the inventories and inversions are regressed against both inventory estimates and land-use characteristics. For 2000-2005, there was very little correlation between the results from these approaches, presumably because the inversions were not well constrained with only one tower observation site in the region.

Additional observations became available in 2007 (Fig. 2) including a focused campaign in the MCI region (Richardson et al. 2007). A coupled biosphere-atmosphere model, SiBRAMS with SiBCROP (Corbin et al. 2007, Lokupitiya et al. 2009), was run to produce a priori flux and concentration fields for the atmospheric inversion. Initial comparisons have been made between long term mean inventory NEE (Fig. 3) and the a priori atmospheric model showing better agreement with the inventory than previous models.

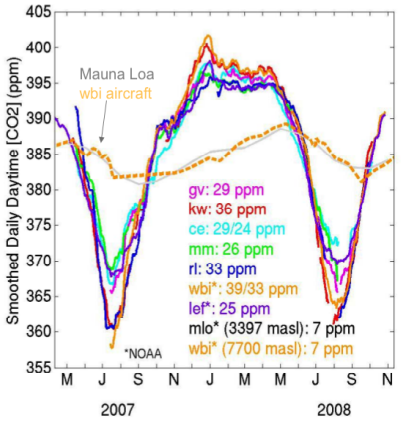

Fig. 2: Time series of CO2 concentration data from

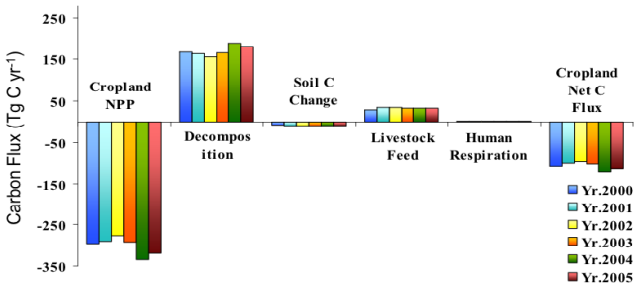

Fig. 3: A carbon budget for the MCI

FUTURE WORK

Inventories are currently being assembled for 2007 and 2008 and Lagrangian particle based sampling footprints for CO_2 observing towers are being constructed (Schuh et al. 2009) in preparation for an atmospheric inversion of the CO_2 residuals. Preliminary results will be shown at ICDC if available. The atmospheric inversion results and comparison to inventory will be showcased in a special session at the meeting of the American Geophysical Union (AGU) in San Francisco in December 2009.

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