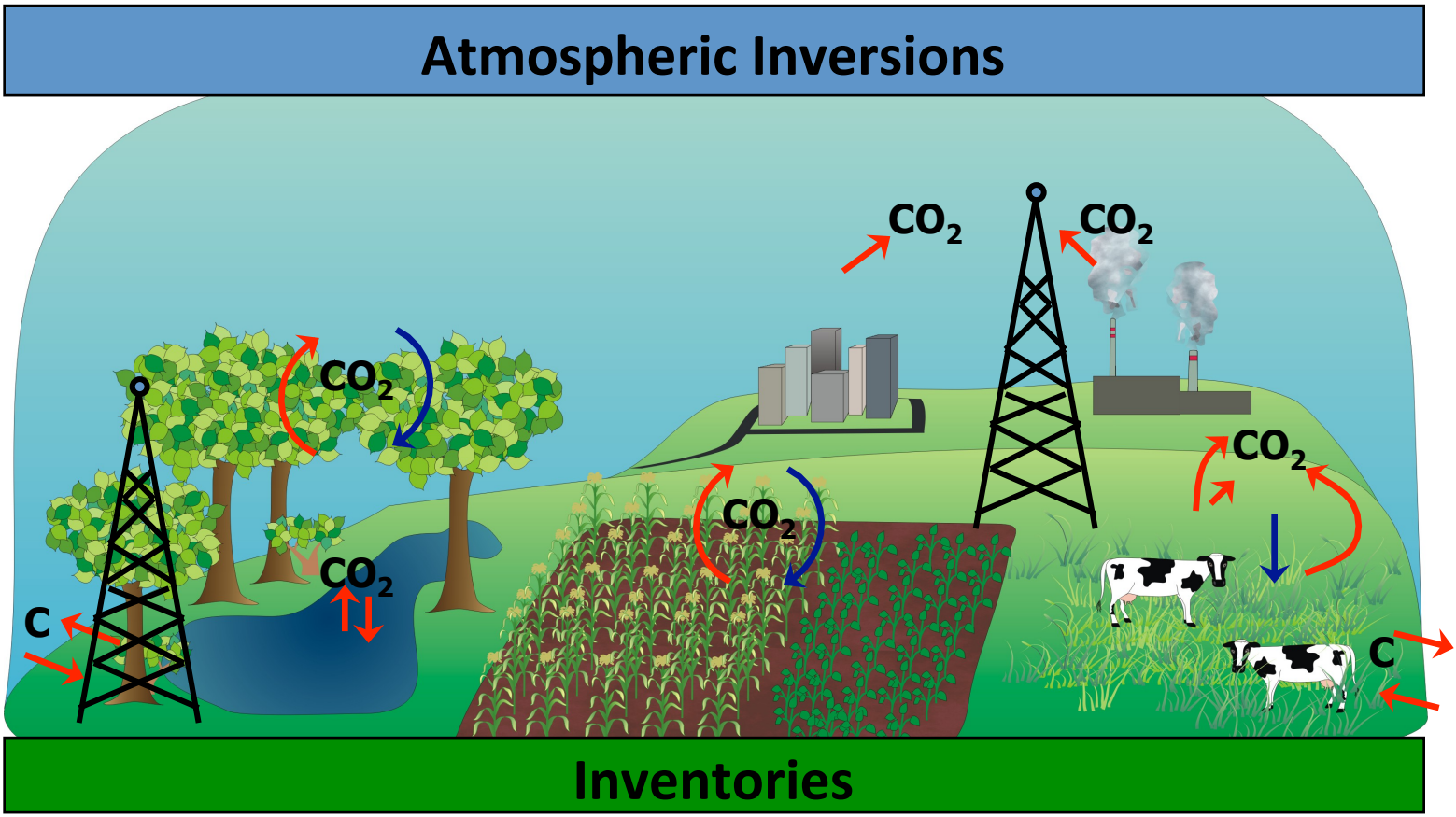
Comparing, Attributing, and Reconciling Differences Between Inventory and Inversion Estimates for the MCI Region

Dan Cooley[1], Stephen Ogle[2], Andrew Schuh[3]
Ken Davis[4], Thomas Lauvaux[4], F.J. Breidt[1], Tris West[5]
and the MCI Science Team

[1]Colorado State University, Statistics
[2]Colorado State University, NREL
[3]Colorado State University, Atmospheric Science
[4]Pennsylvania State University, Atmospheric Science
[5]Joint Global Change Research Institute, PNNL

We gratefully acknowledge funding support from the National Aeronautics and Space Administration, Earth Sciences Division, to Colorado State University (agreement #NNX08AK08G)

"Top-Down" verses "Bottom Up" Flux Estimates

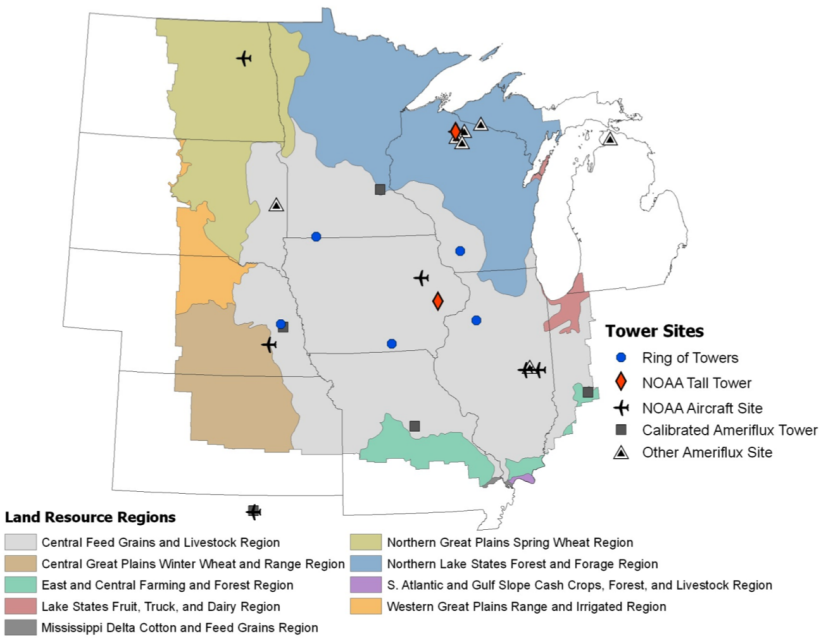


MCI Project

Underlying Question: How well can we estimate carbon flux for a particular region?

Why the Mid-Continent Region?

- Inventory components well monitored.
- Relatively simple region to model for an inversion.
- Ring of towers (beginning in summer 2007).



MCI Project

Underlying Question: How well can we estimate carbon flux for a particular region?

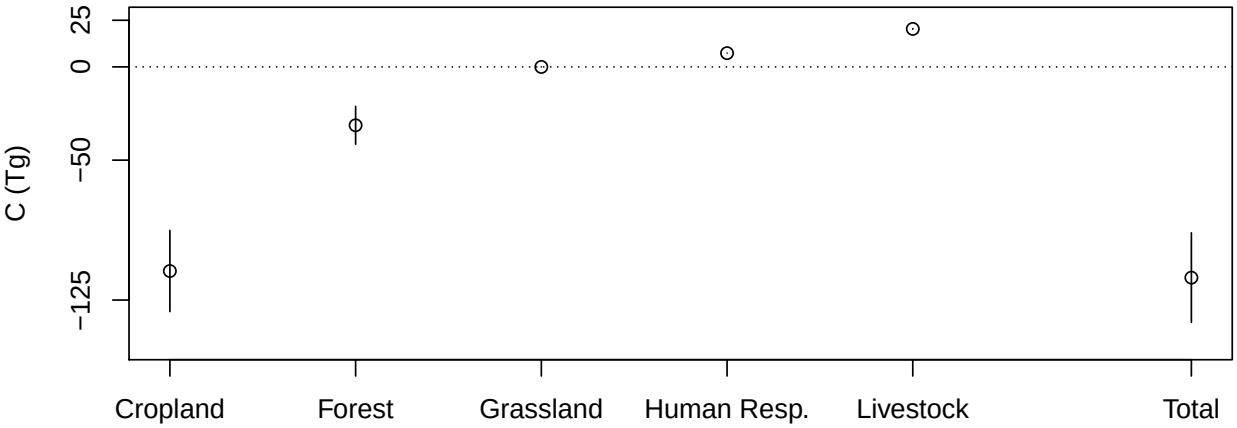
Inventory: Produce high-quality inventory estimates for all significant sources in the region and *understand the uncertainties* and mechanisms associated with these estimates. Compare and combine inventory estimates produced by different contributors and methods.

Inversion: Produce and compare inversions at multiple resolutions/spatial scales.

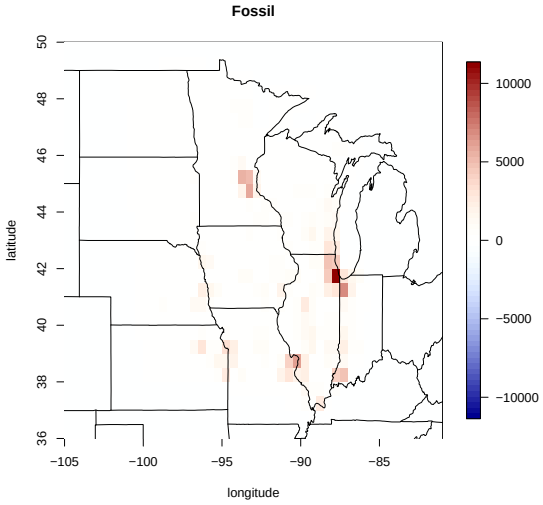
- High resolution, regional scale (PSU)
- Medium resolution, continental scale (CSU, UMich)
- Low resolution, global scale (Carbon Tracker)

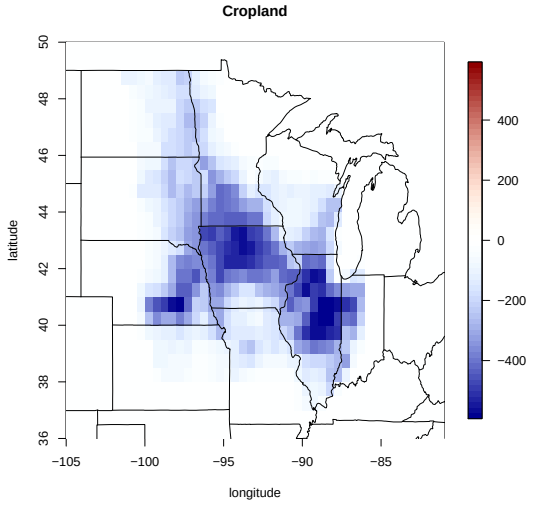
My Objective: Compare, reconcile, combine(?) the two sources.

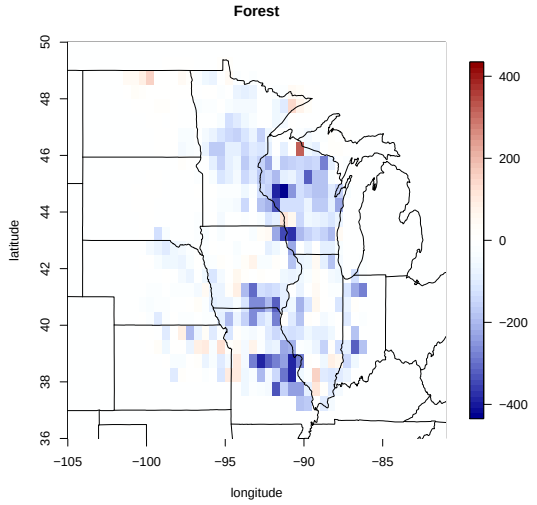
Inventory Components



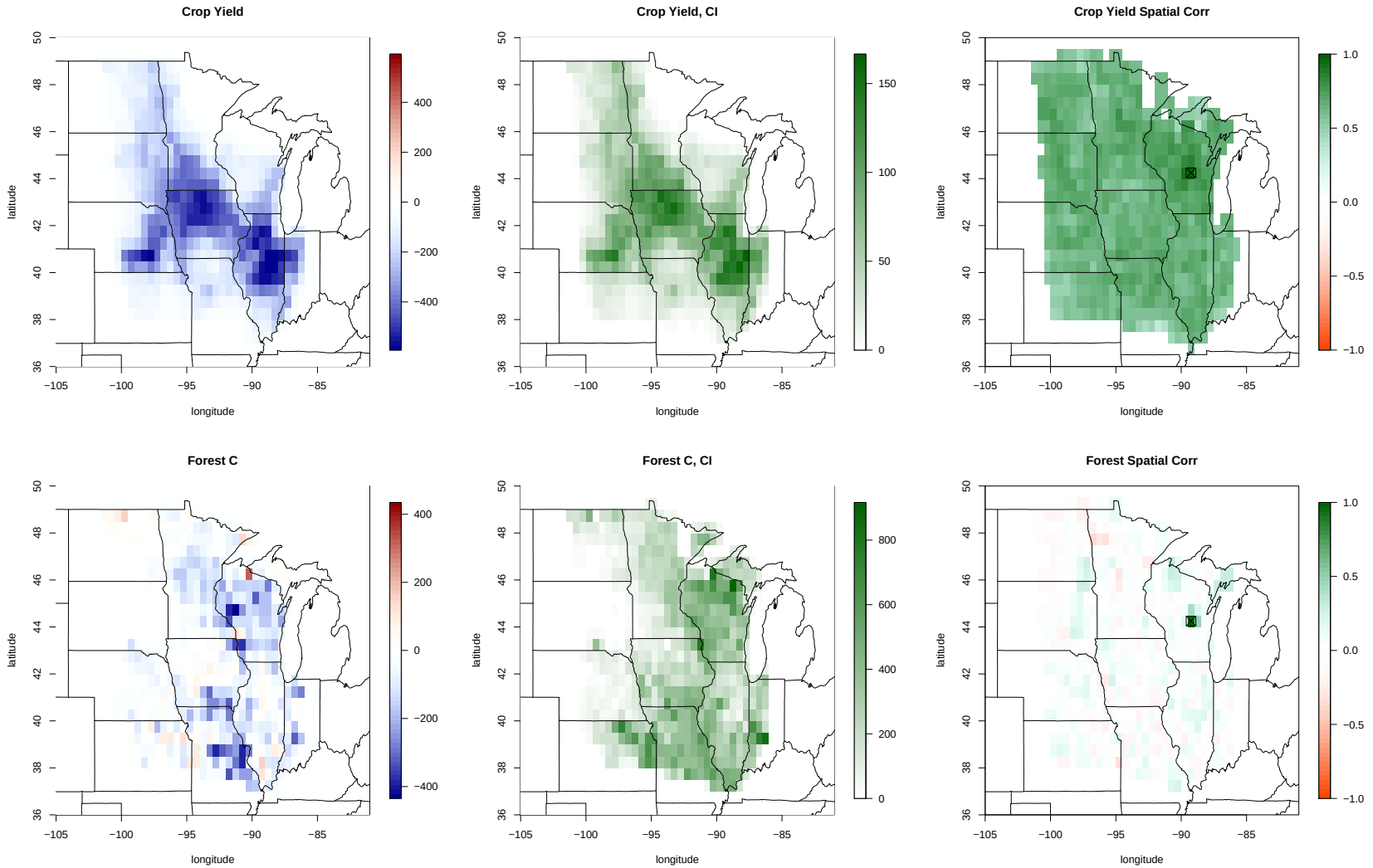
Not shown: Fossil: $\sim$ 250 Tg



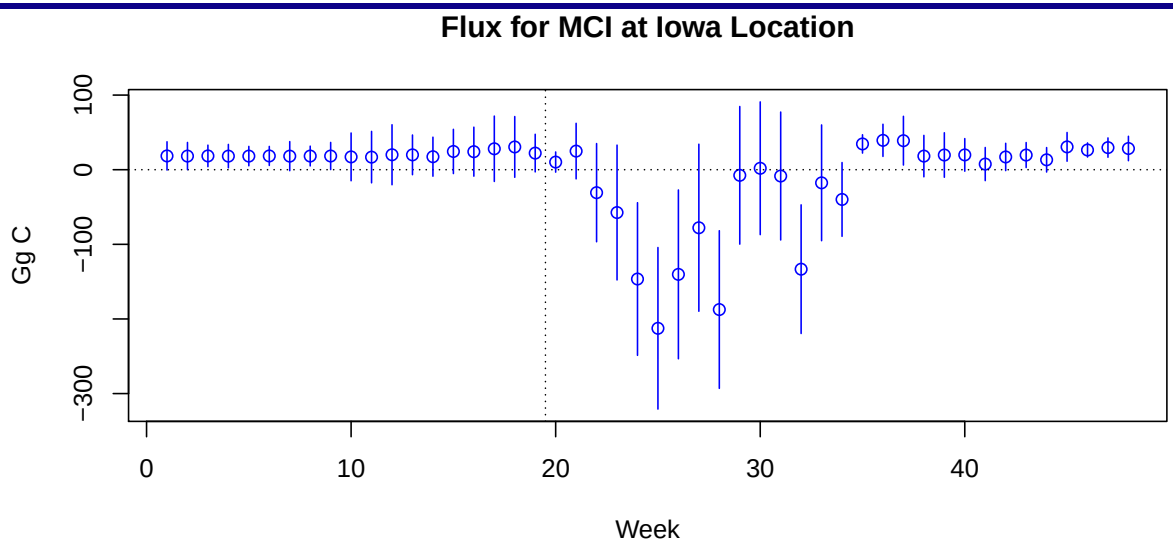


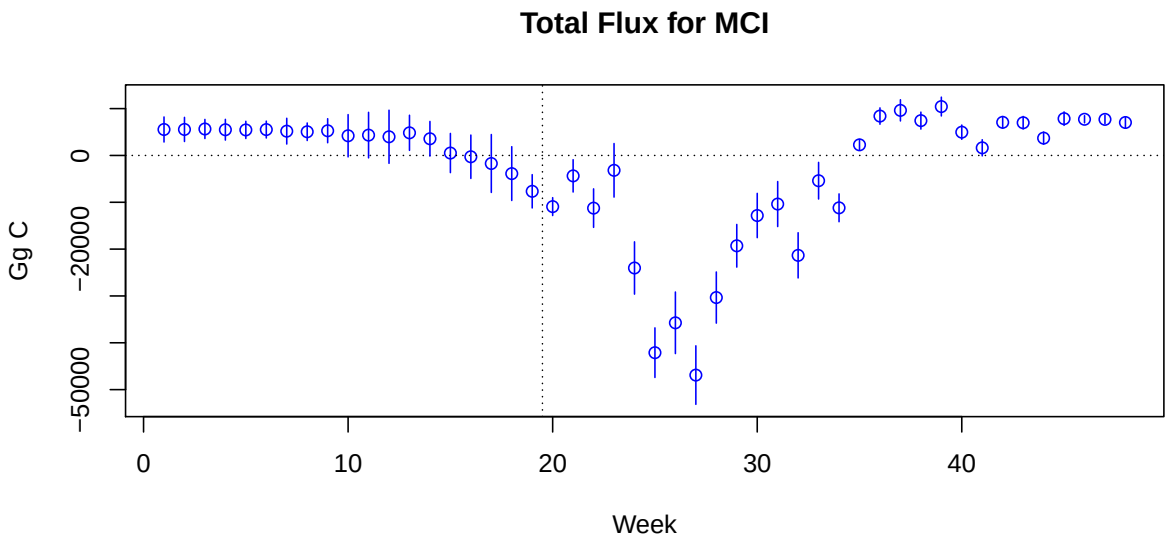


Inventory and Uncertainty



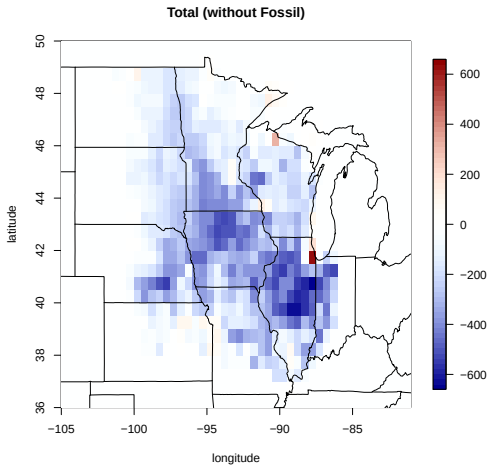
PSU Inversion, Weekly Estimates

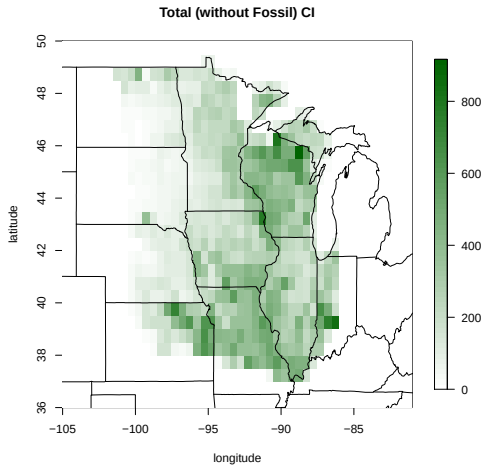


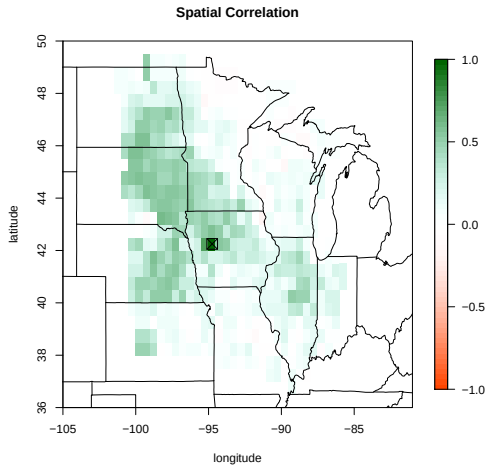


Total Inventory/PSU Inversion Annual Total

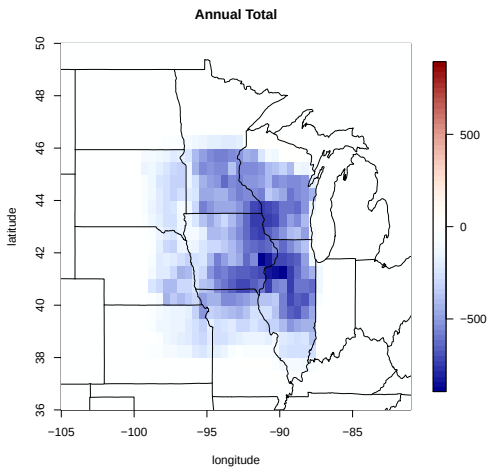
Inventory

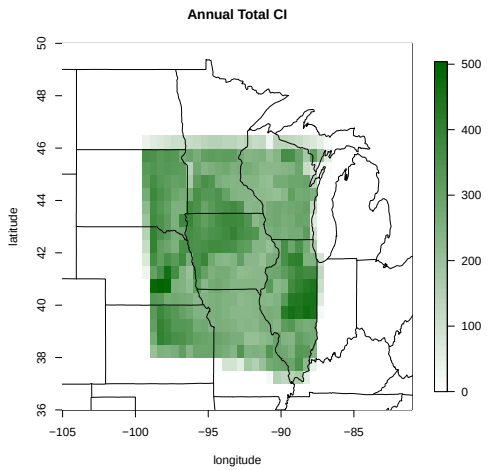


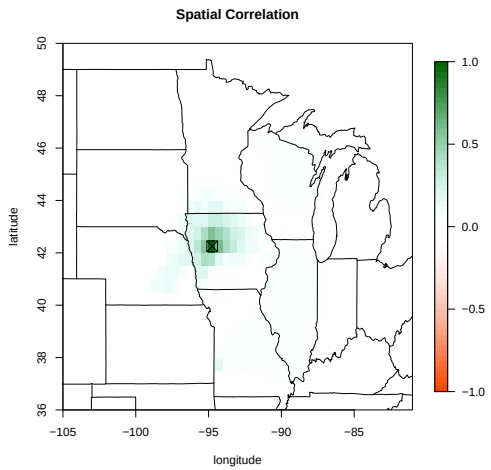




Inversion

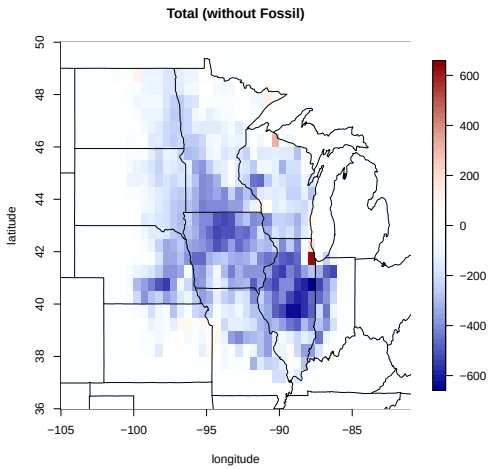




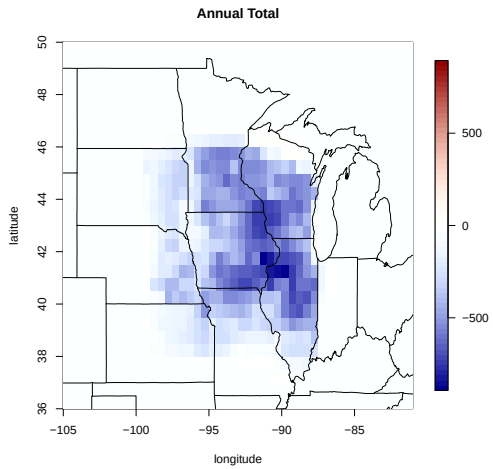


Why Combine Inventory and Inversion Estimates?

Combined Inventory 2007



PSU Posterior Total 2007



+ Spatially rich
− Temporally poor
+ Sees the ground
− Does not see atmosphere
+ Sees individual components

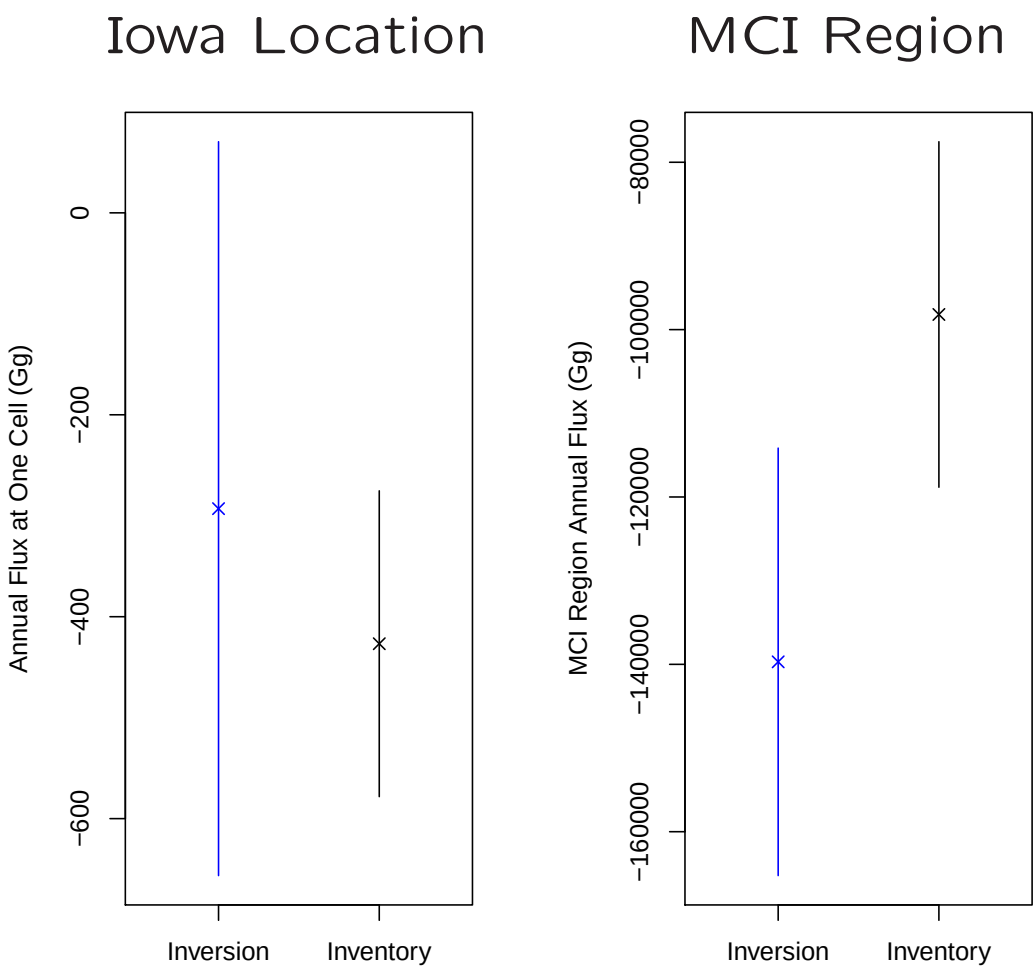
− Not as rich spatially
+ Temporally rich
− Indirectly sees the ground
+ Sees the atmosphere
+ Sees the total flux

How Can We Combine Estimates?

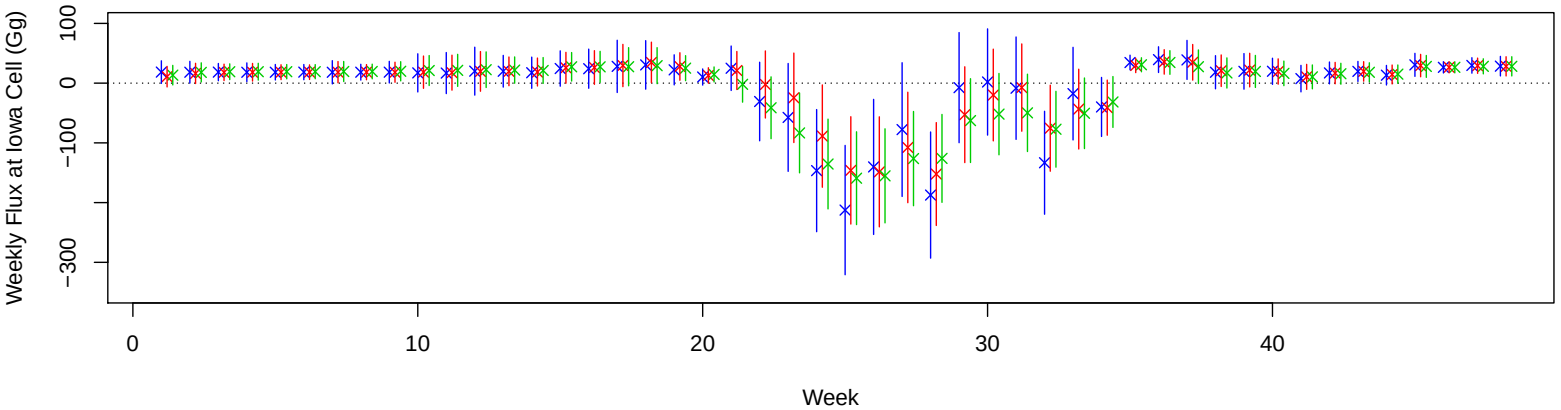
We propose a relatively simple Kalman Filter/Smoother approach.

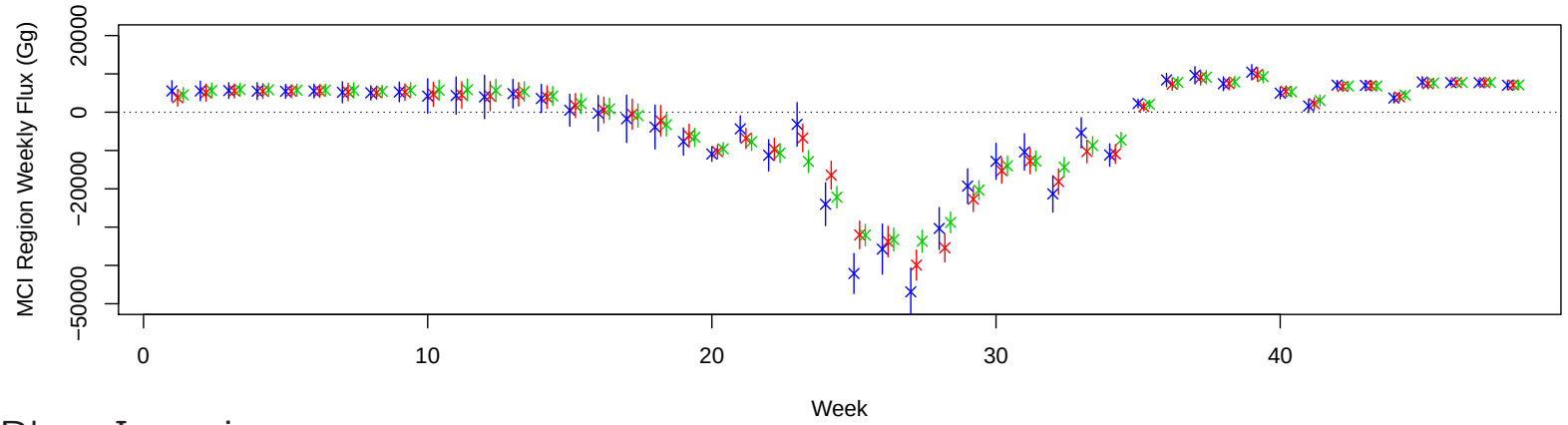
- state is the weekly (total/componentwise) flux at each location.
- observations are weekly flux estimates at each location from the inversion, and (at year end) the annual flux estimated by the inventory (year 2007).
- state is advanced using a random walk with possibly time-varying variance.

Challenge of Combining Estimates



Weekly Flux Estimates



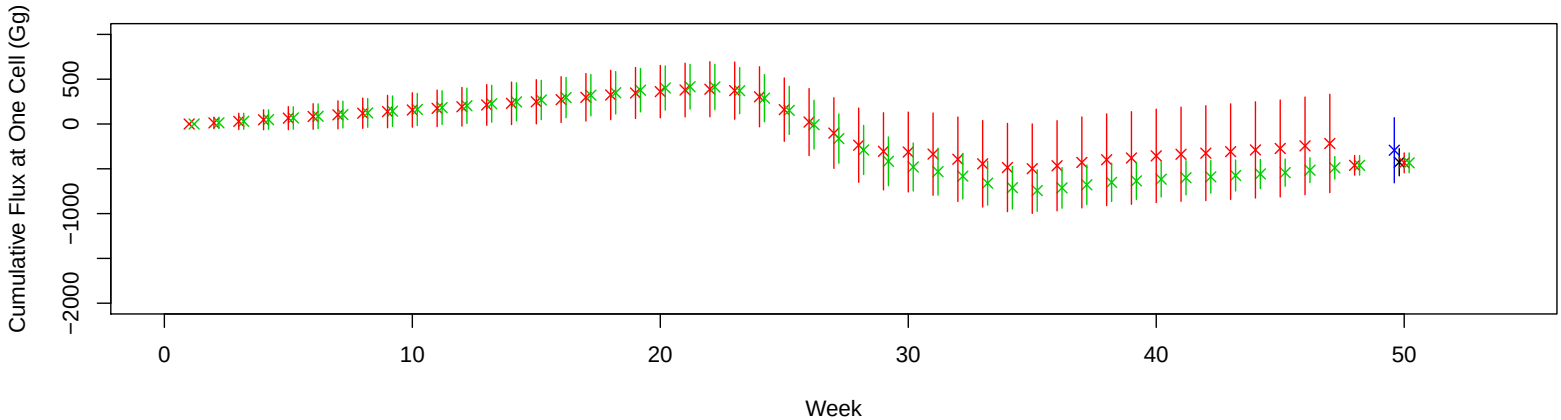


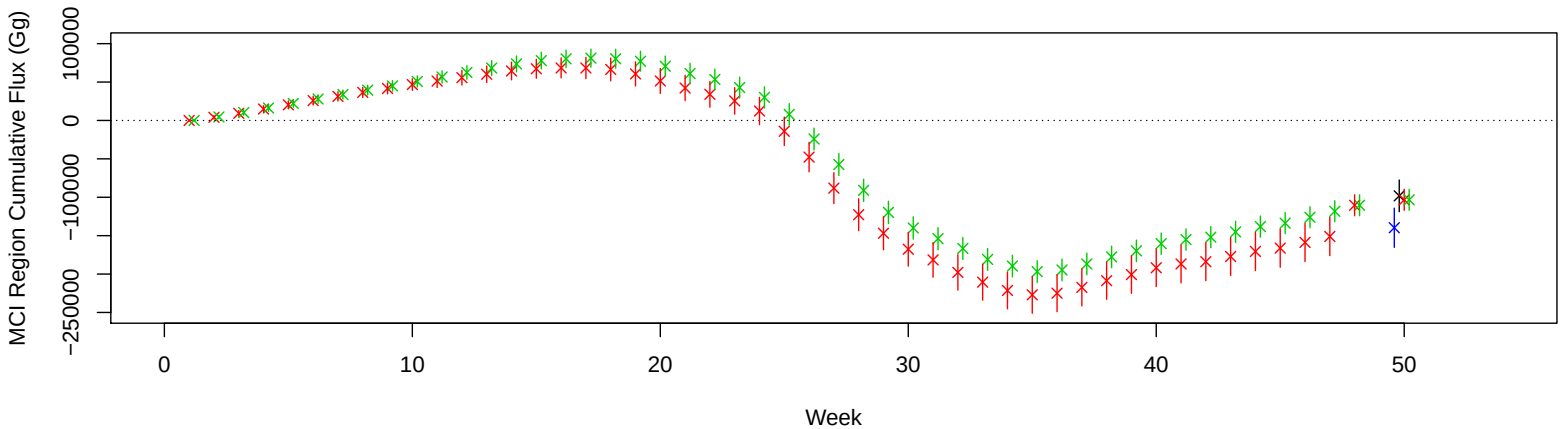
Blue: Inversion

Red: Forward Filter

Green: Backward Smoother

Cumulative Flux Estimates





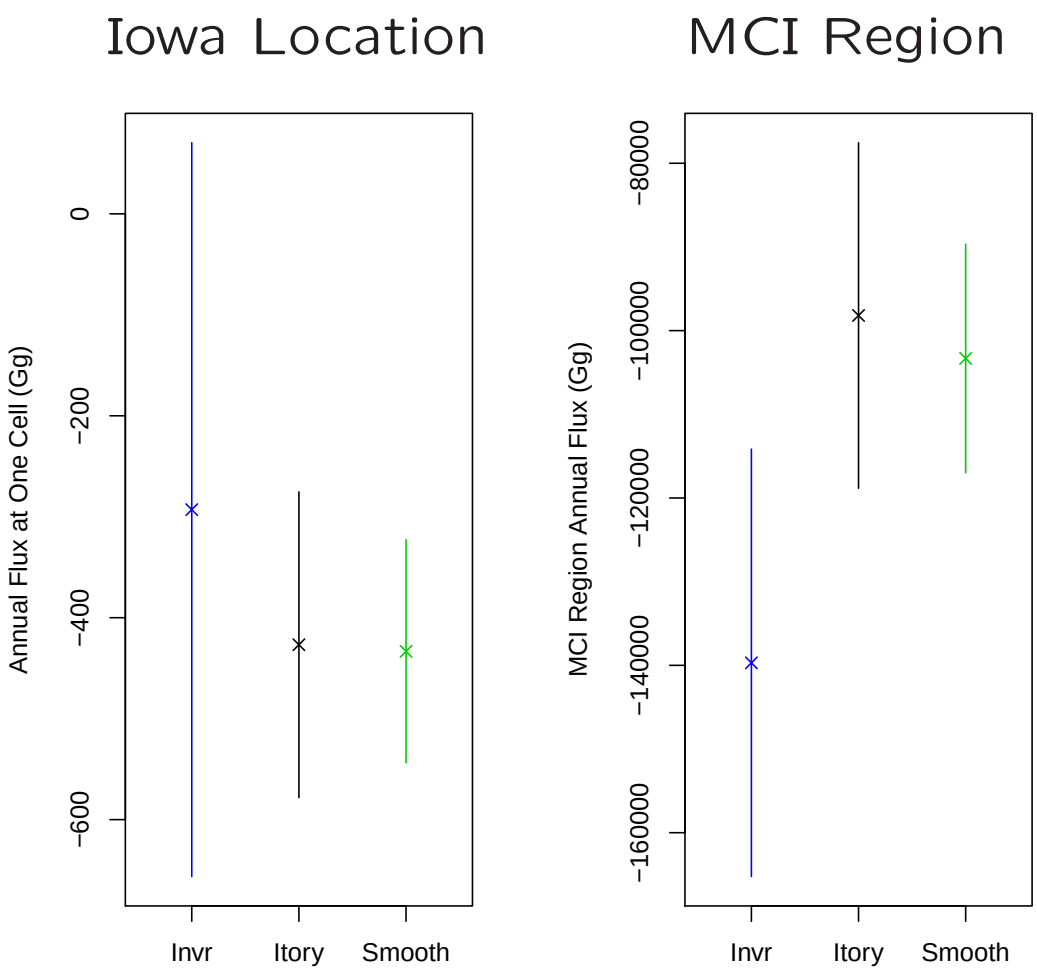
Blue: Inversion

Black: Inventory

Red: Forward Filter

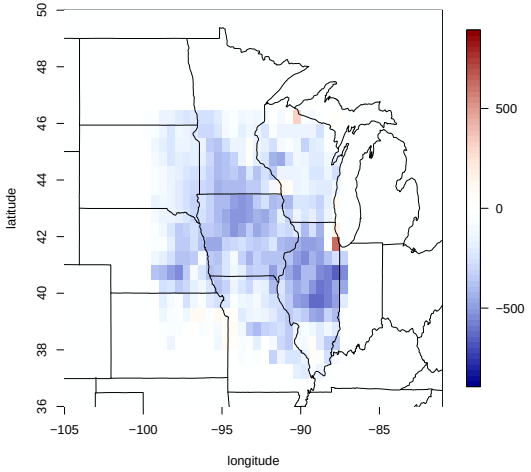
Green: Backward Smoother

Regional Flux Estimates

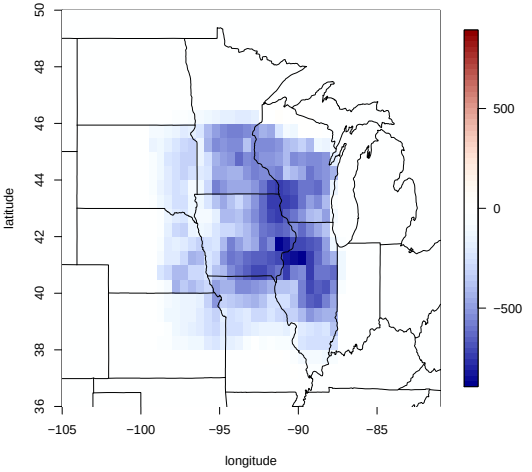


Annual Flux Estimate Maps

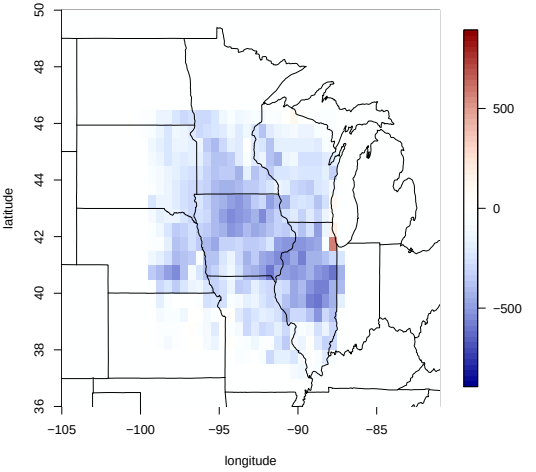
Inventory



Inversion



Smoother



Work in Progress

Work on Kalman filter/smoother

- Disaggregate the state into different components.
- Estimation of state equation parameters.
- Run filter/smoother for 2007 and 2008 when data become available.
- Compare results of filter/smoother for different inversions.

More about MCI project and data

- Stephen Ogle' Poster F-129, Poster Session III (Wed)
- Tris West's Poster G-167, Poster Session IV (Thur)
- Stephen Ogle's Poster H-184, Poster Session IV (Thur)
- Andrew Schuh's talk 4:00 Thur.
- Arlyn Andrew's Poster E-119, Poster Session III (Wed)