Estimating Terrestrial Carbon Fluxes from Atmospheric CO_2 in the Mid-Continent (MCI) Region

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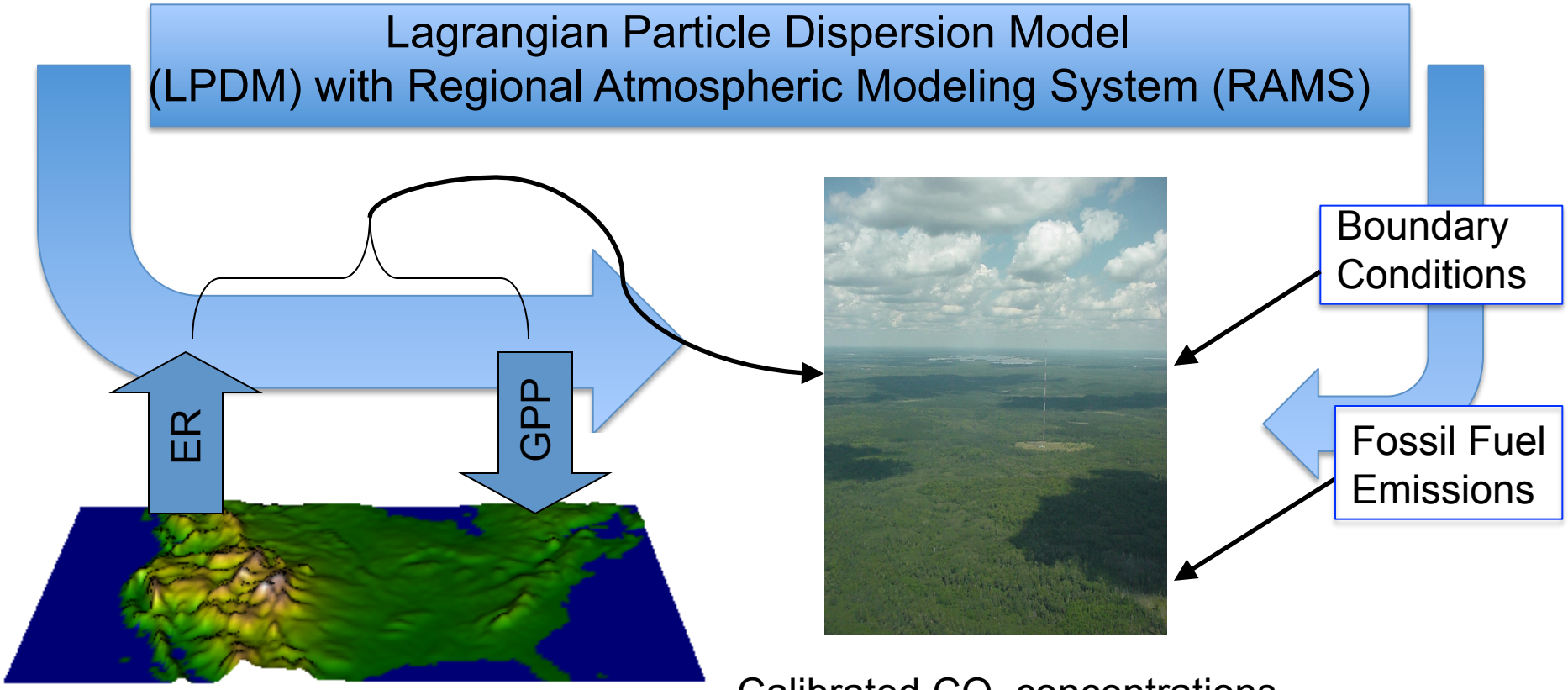
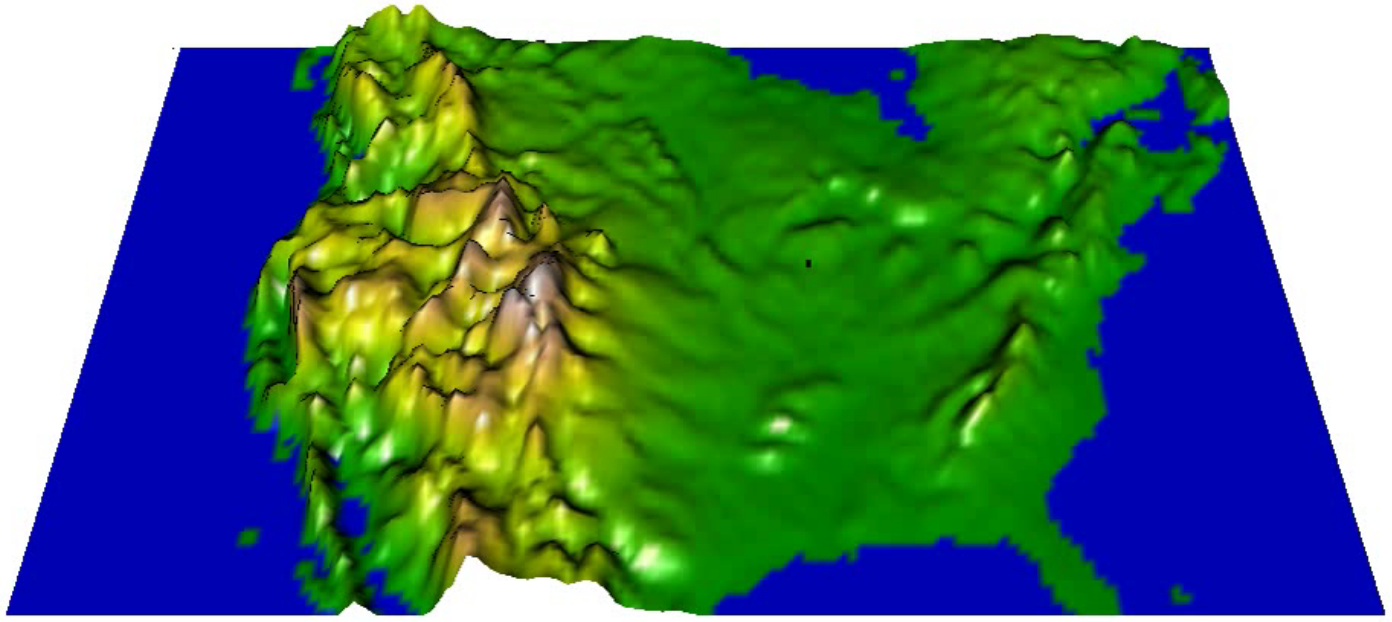
Basic Atmospheric CO_2 Inversion Components



20 Days of Backward ***Transport***

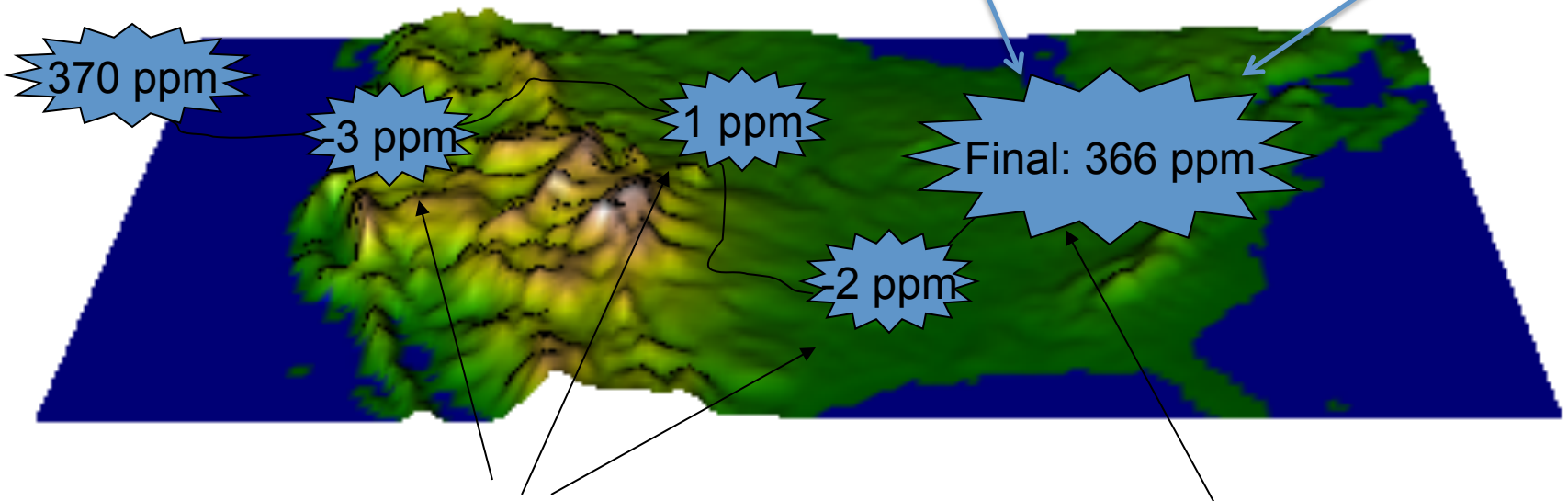
WLEF Tower Park Falls WI, USA



Transport Model: Conceptualizing

"Observed" at 2PM on 7/7/2004: 368 ppm

"Calculated" for 2PM on 7/7/2004: 370 ppm - 3 ppm + 1 ppm - 2 ppm = *366 ppm*



Carbon drawdown in upwind areas must be too strong since the observed CO_2 at the tower is higher than what we predict

WLEF Tower

Definition: *"Monkeying around"*

State space equation:

$$\boldsymbol{y}^{(t)} = G^{(t)}\,\boldsymbol{\beta}^{(t-1)} + \boldsymbol{w}^{(t)}$$

$$\boldsymbol{\beta}^{(t)} = \boldsymbol{\beta}^{(t-1)} + \boldsymbol{v}^{(t)}$$

– $y^{(t)}$ is a tower observation at time t

– $G^{(t)}$ is the influence function constructed from the transport model and deterministic carbon flux estimate

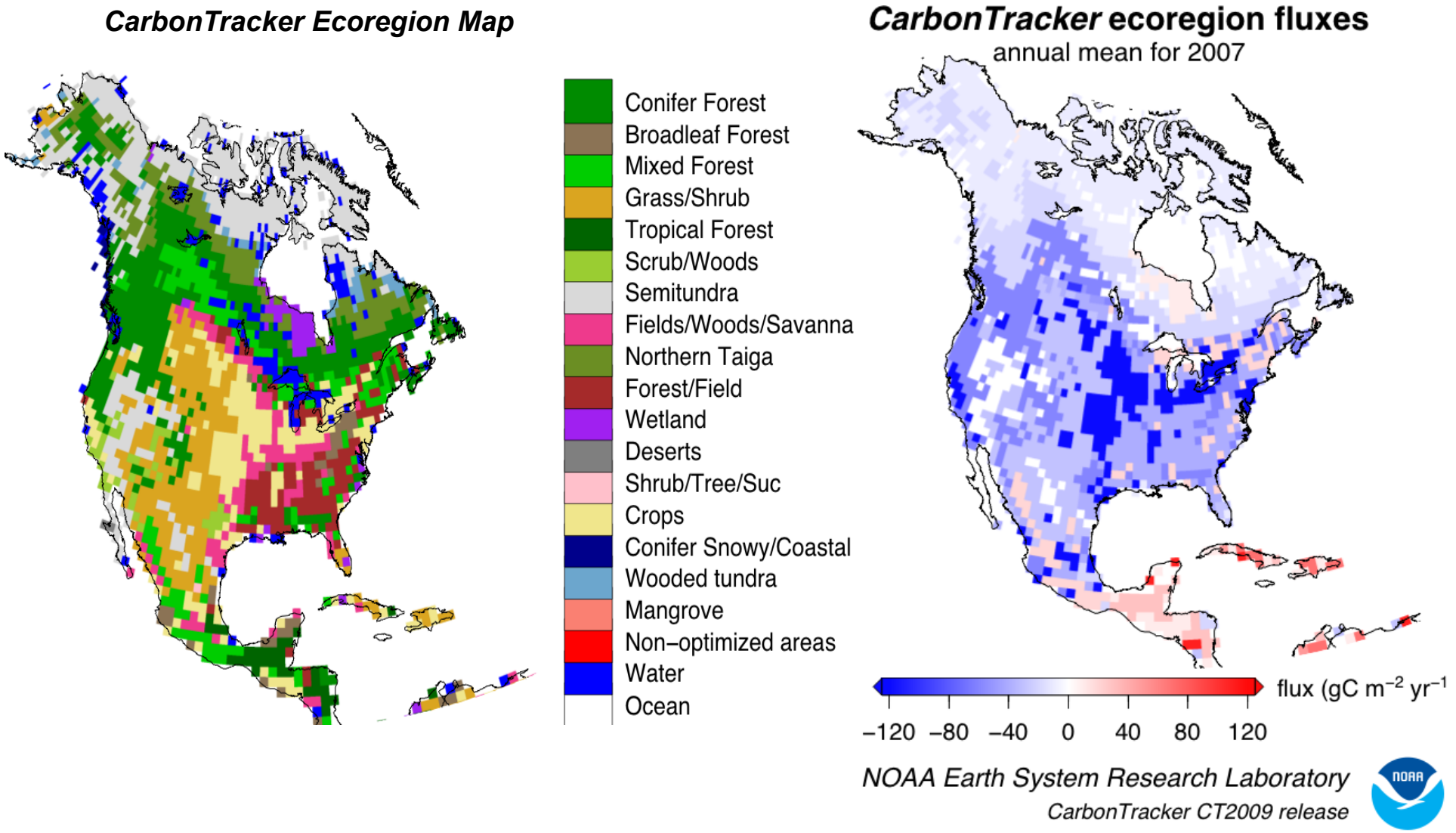
– typical row in $G^{(t)}$ is $[g_{Resp,i,j,1} \cdots, g_{Resp,i,j,d}; g_{GPP,i,j,1} \cdots, g_{GPP,i,j,d}]$ for i^{th} tower, j^{th} time point, and pixel $k = 1, \ldots, d$

– $\boldsymbol{\beta}^{(t)}$ is a correction factor (regression coefficients), usually centered around 1

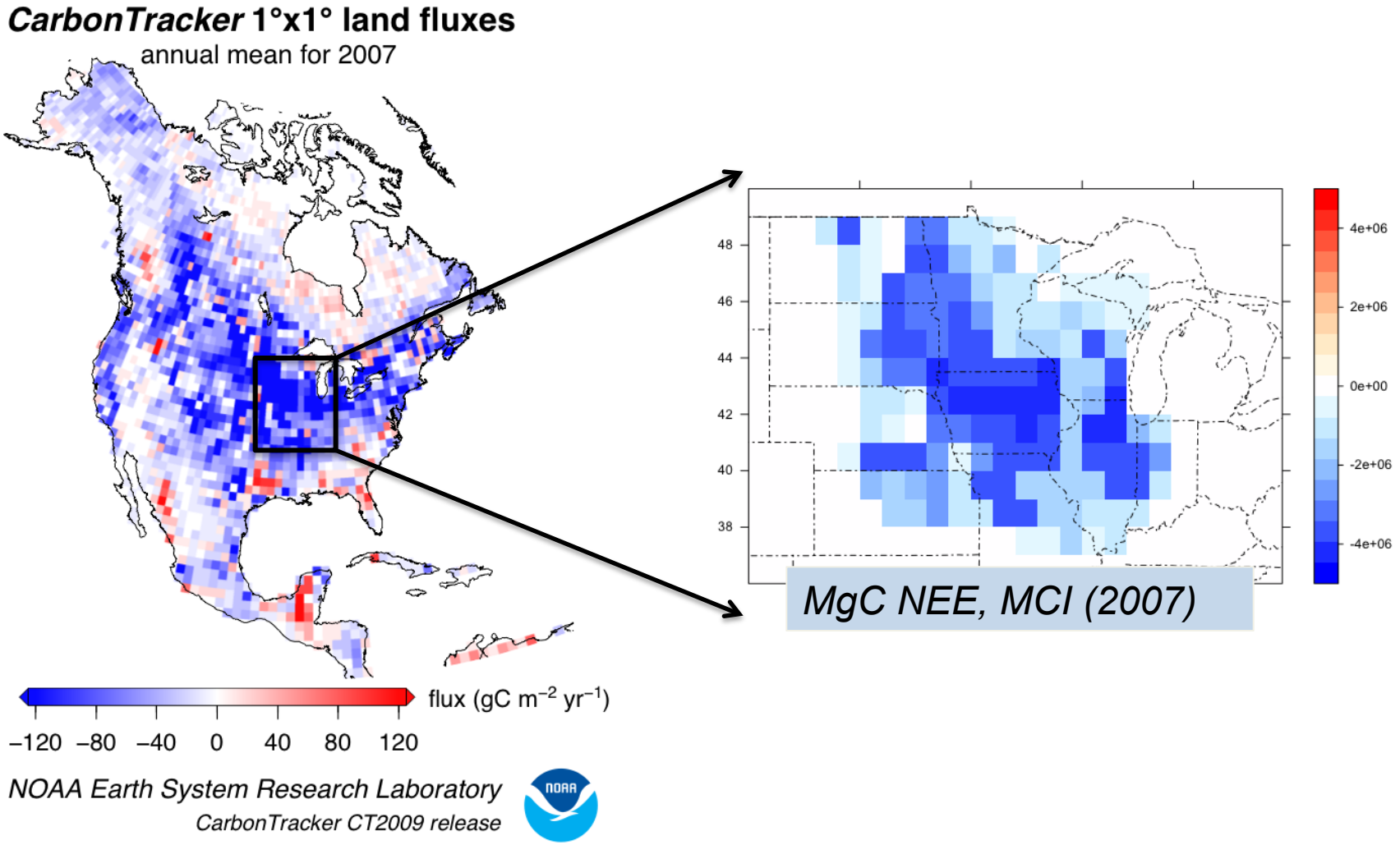
– $\mathbf{w}^{(t)} \sim (\mathbf{0}, R^{(t)})$: transport uncertainty and measurement error

– $\mathbf{v}^{(t)} \sim (\mathbf{1}, \Sigma)$: a priori uncertainty in beta, spatially correlated

CarbonTracker (*NOAA ESRL*) Inversion Estimates for Annual NEE 2007



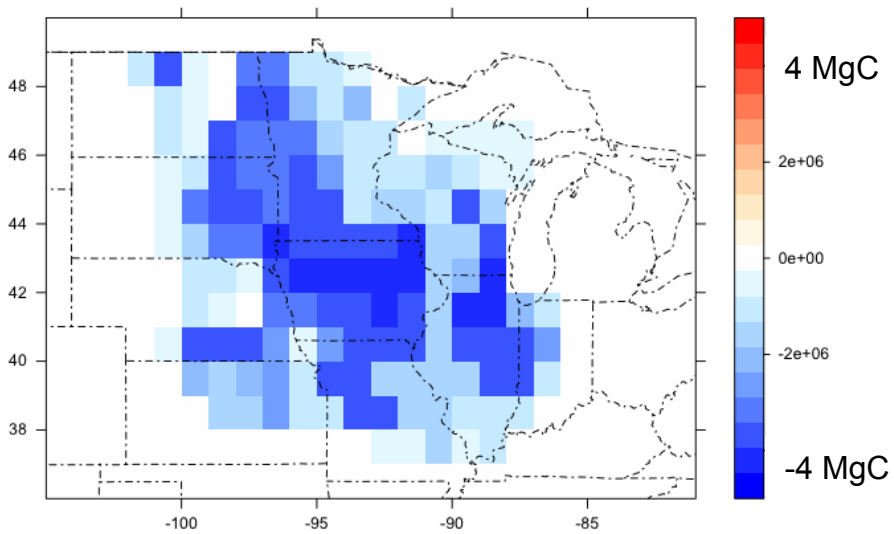
CarbonTracker (*NOAA ESRL*) Inversion Estimates for Annual NEE for the MCI 2007



MCI Carbon Flux Estimates

CarbonTracker

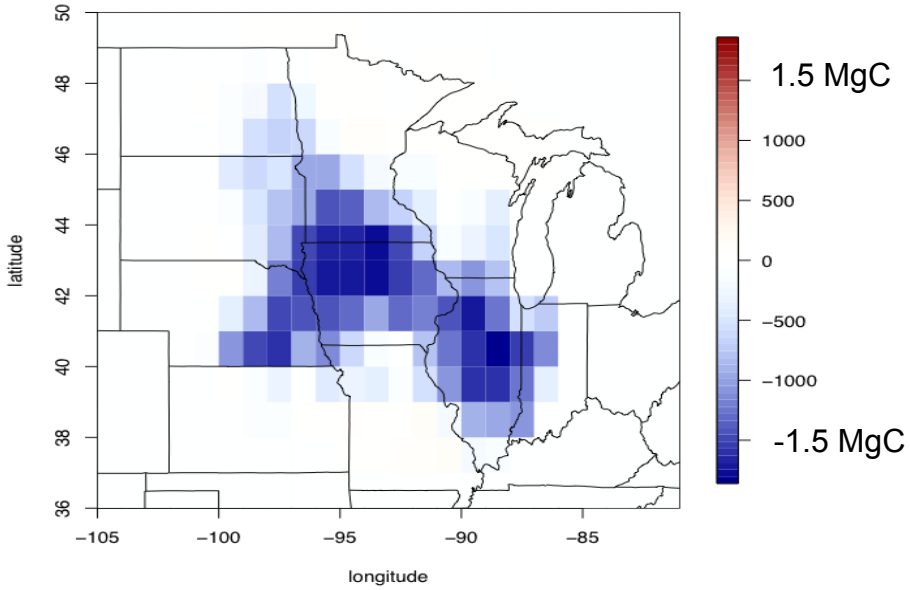
1. ***Posterior*** estimate of CO_2 fluxes
2. Global model using coarse ecoregion inversion scheme
3. DOES NOT USE local Ring2 data



Carbon Sink: 318 TgC NEE, MCI (2007)

SiB-CROP

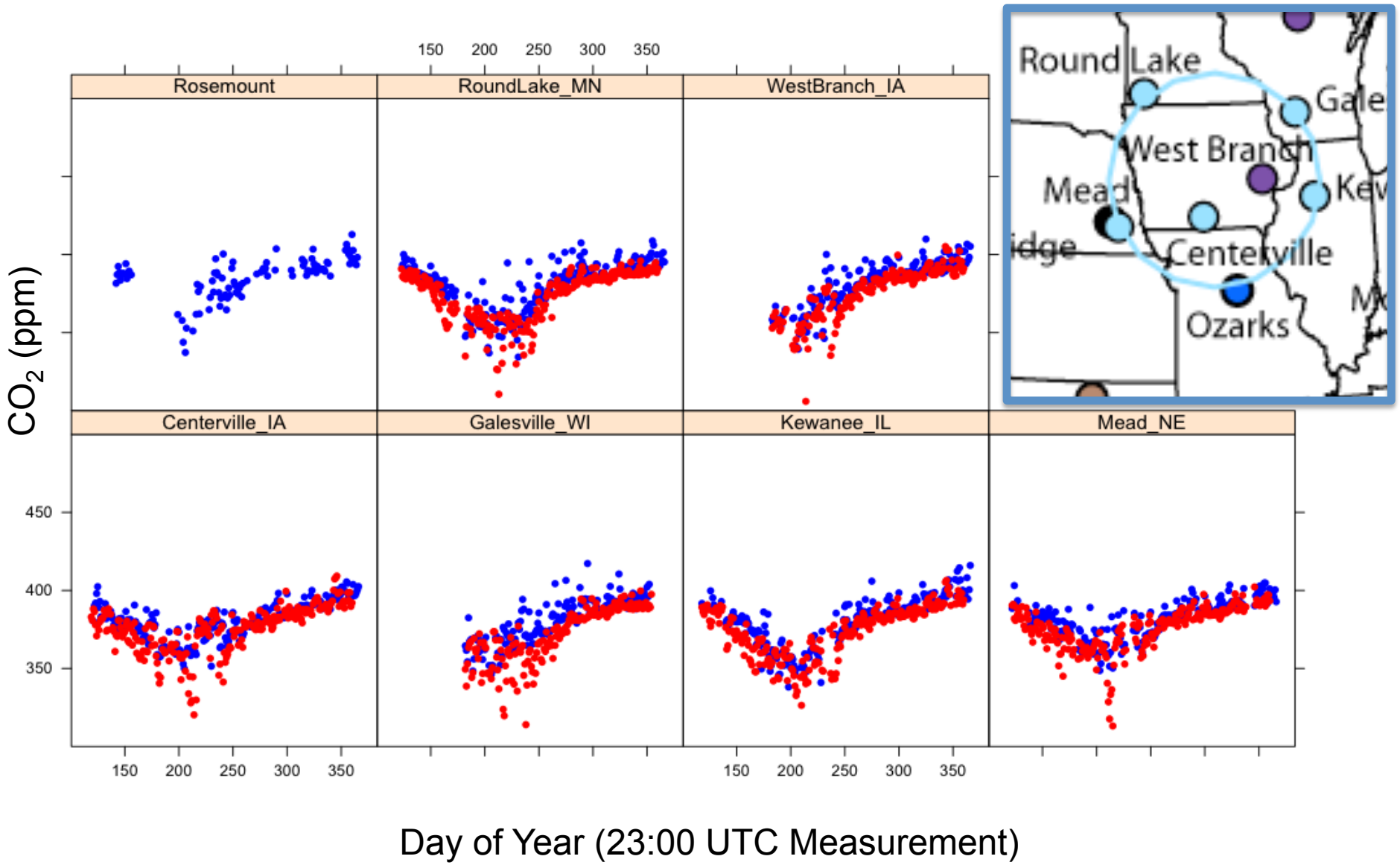
1. ***Prior*** estimate of CO_2 fluxes
2. Phenological crop model (E. Lokupitiya 2009) based upon NASS and AgCensus crop data



Carbon SINK: 81 TgC NEE, MCI (2007)

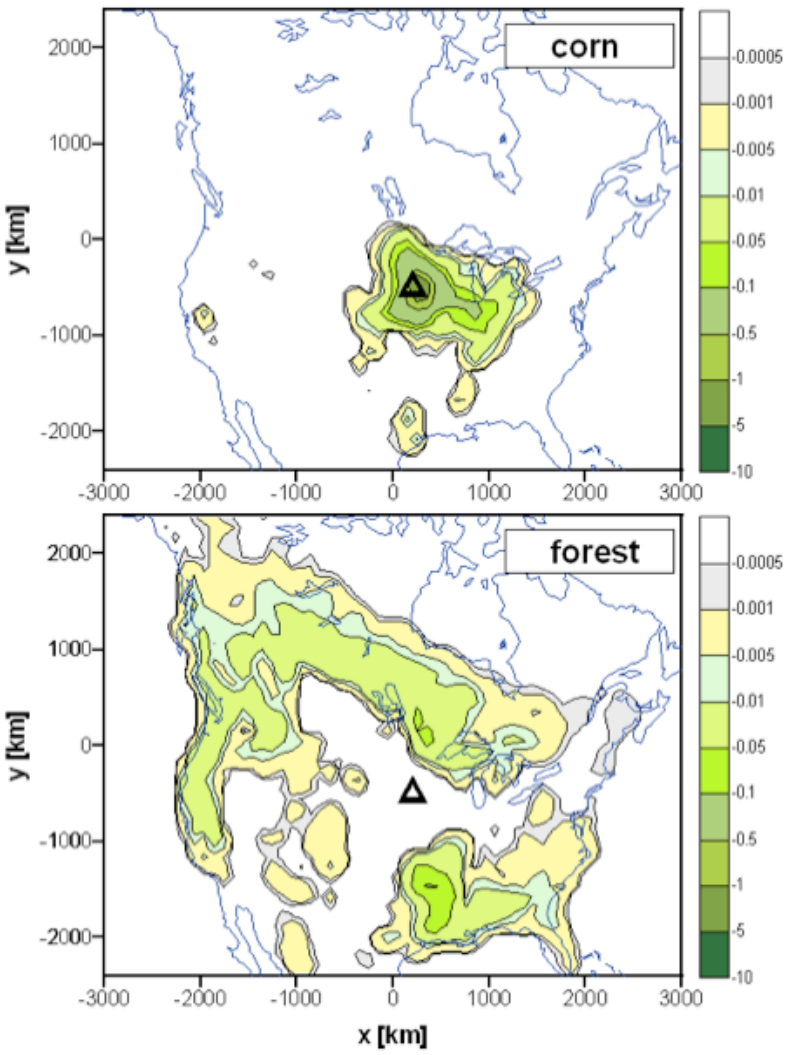
Initial Simulation of CO_2, April – September 2007
(0 meters to 5000 meters above terrain)

a priori LPDM-SiB-RAMS to Obs. Comparison

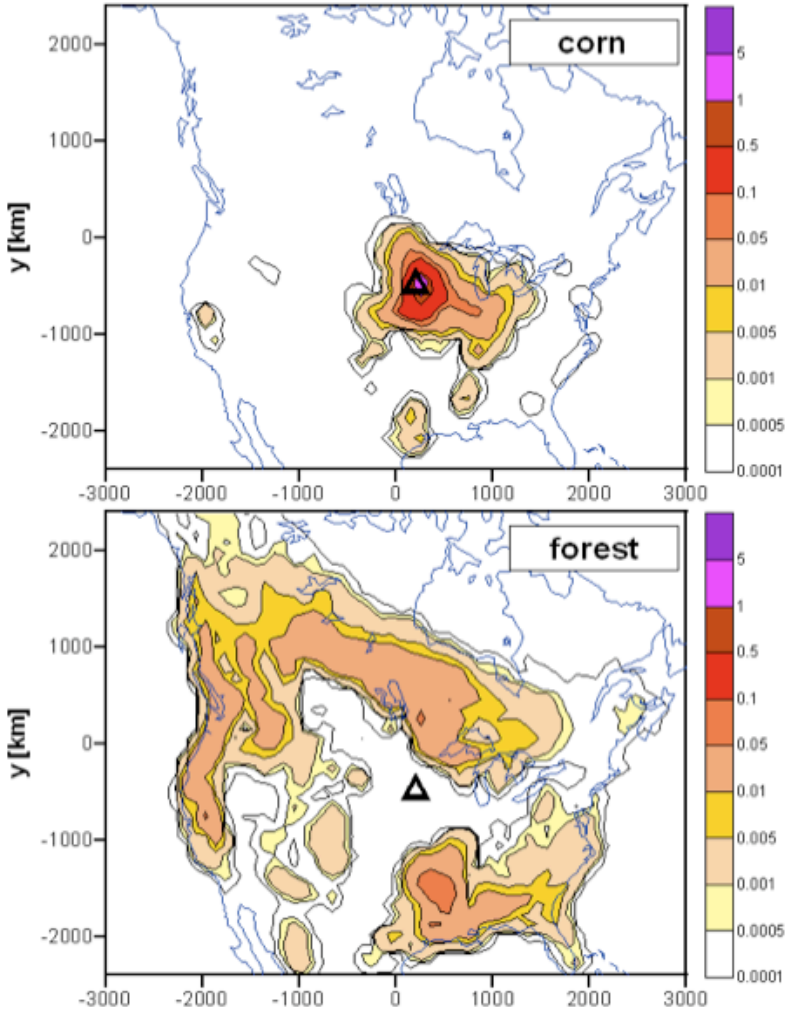


Biome Mean Contributions (ppm) to Round Lake station CO_2 , June-August

GPP



Respiration



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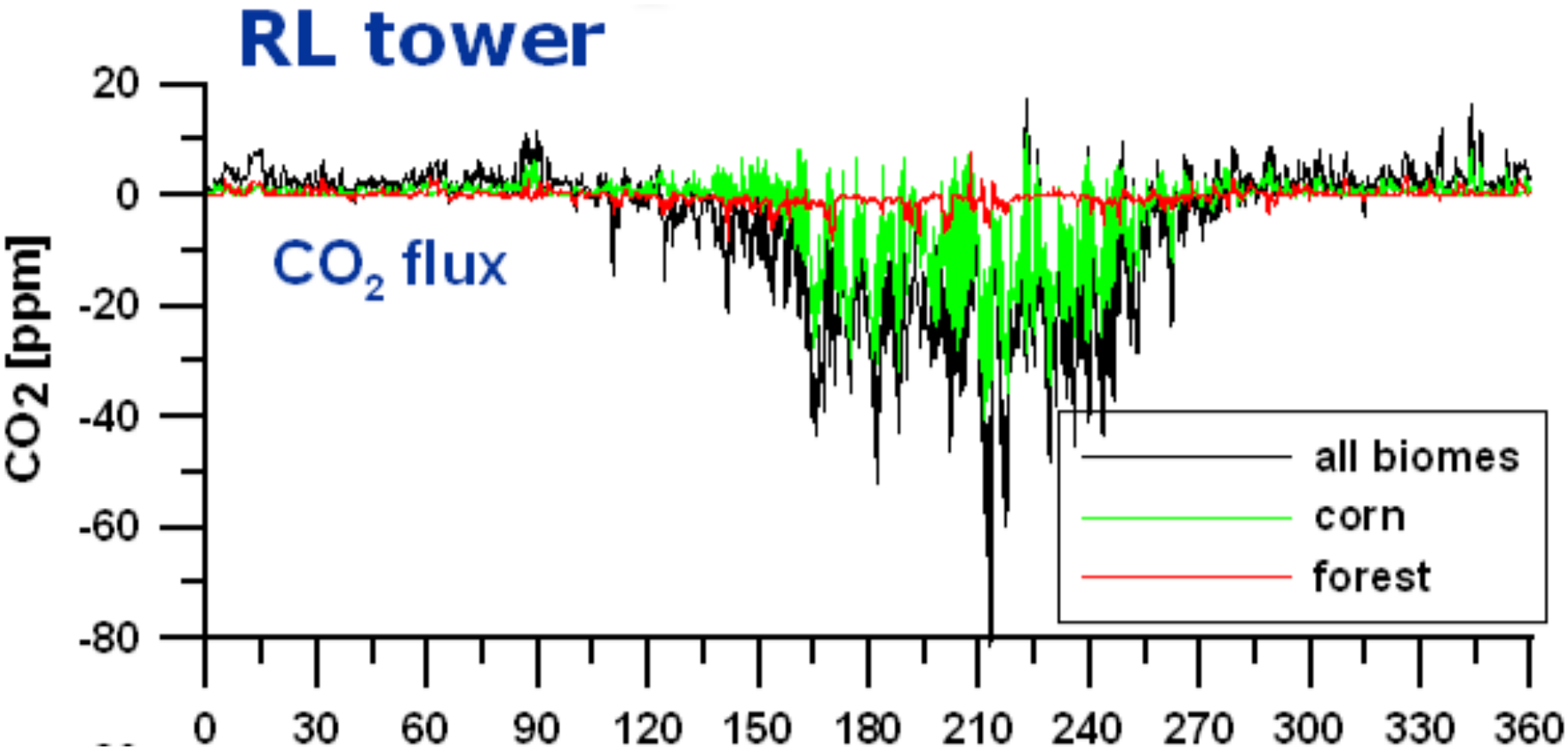
Biome Contributions to a tower's CO_2 Round Lake station, June-August



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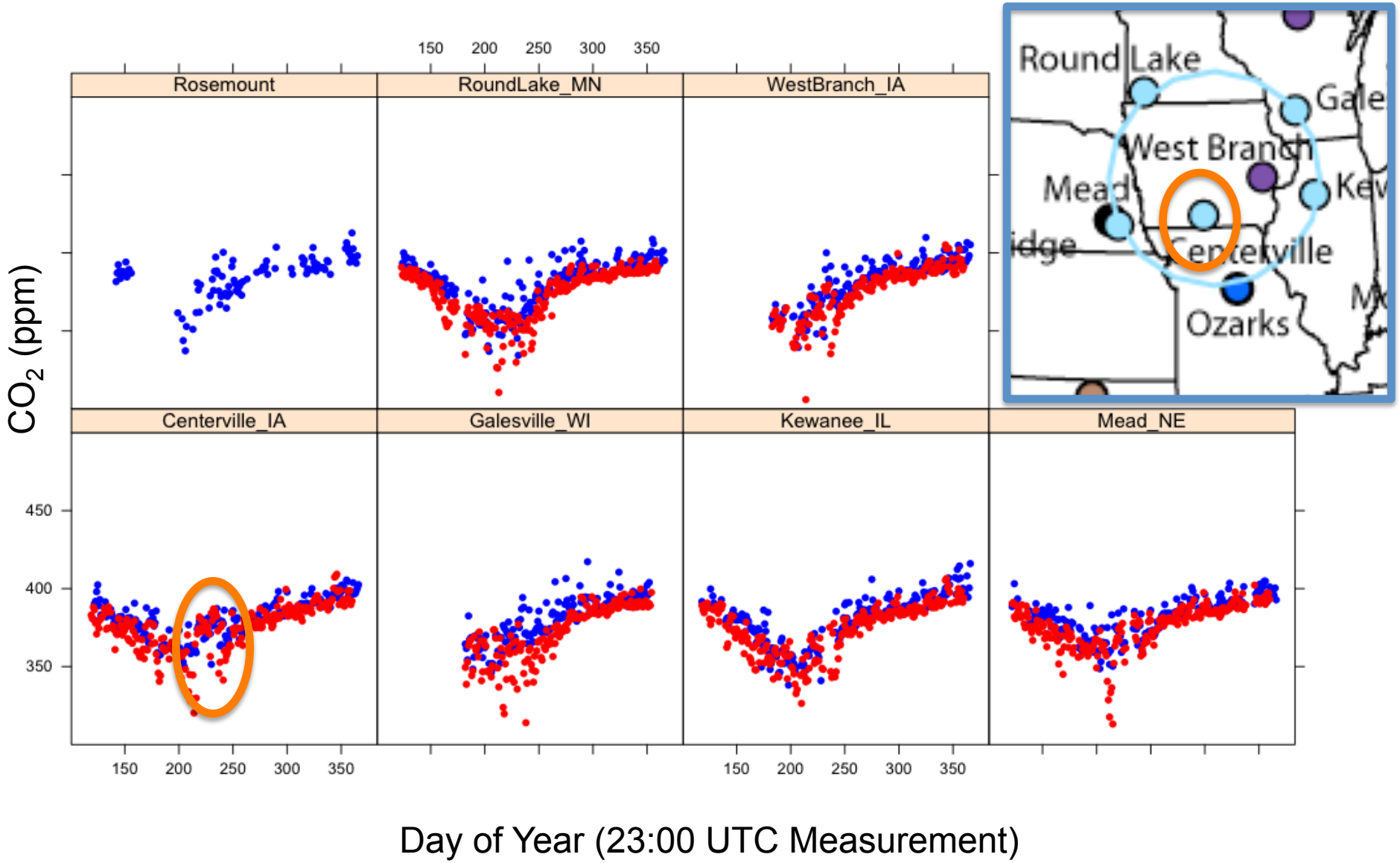
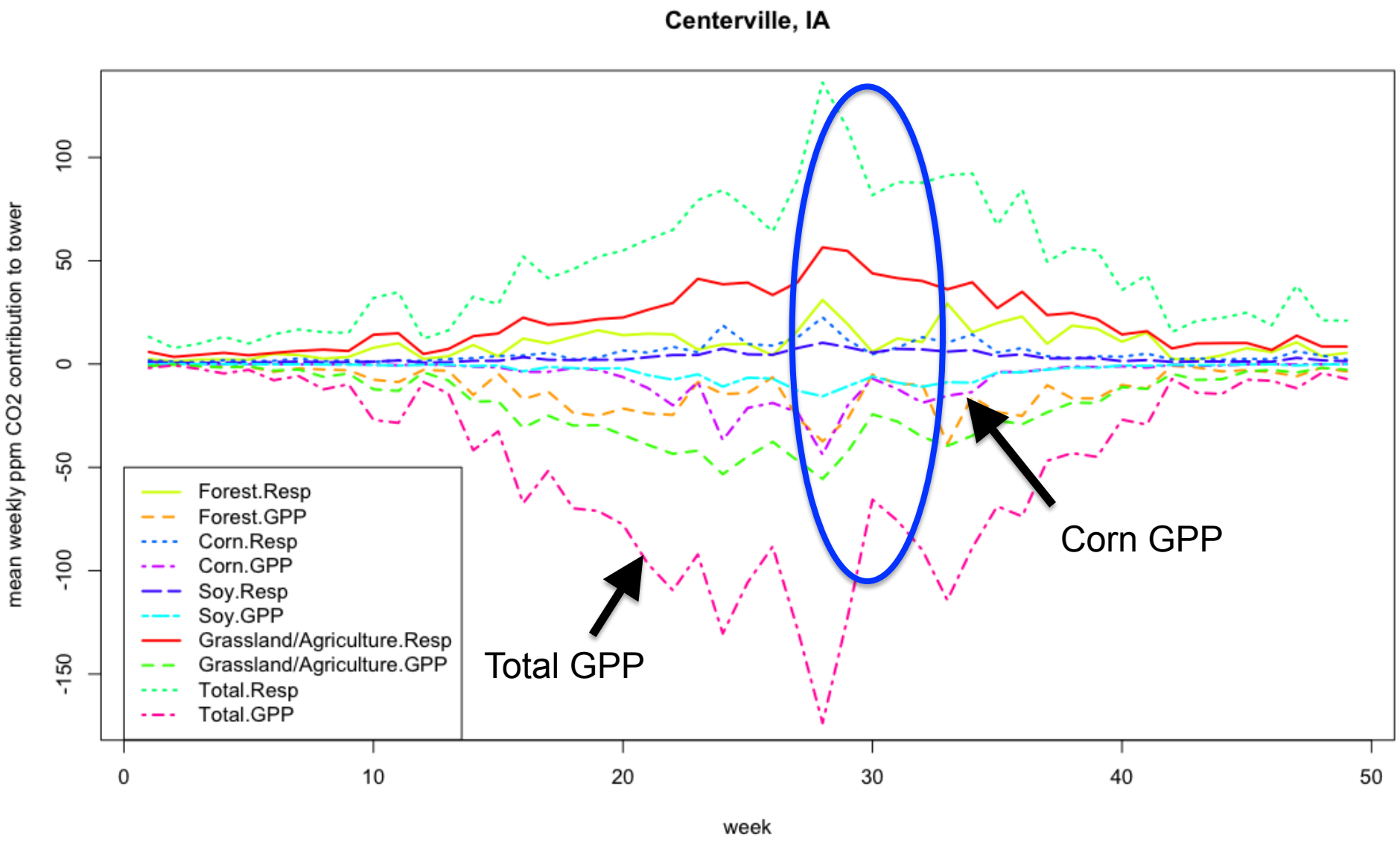
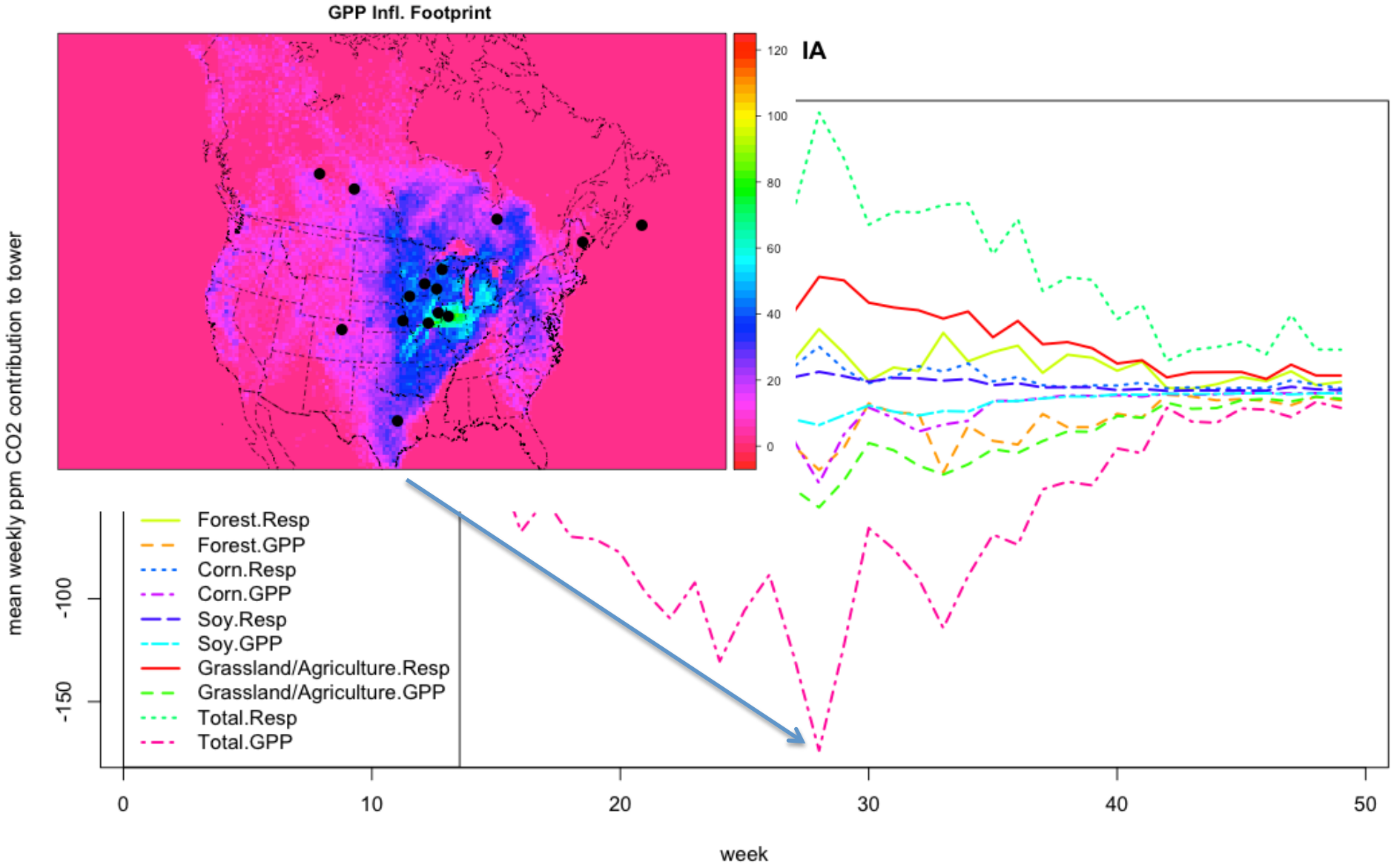
a priori LPDM-SiB-RAMS to Obs. Comparison



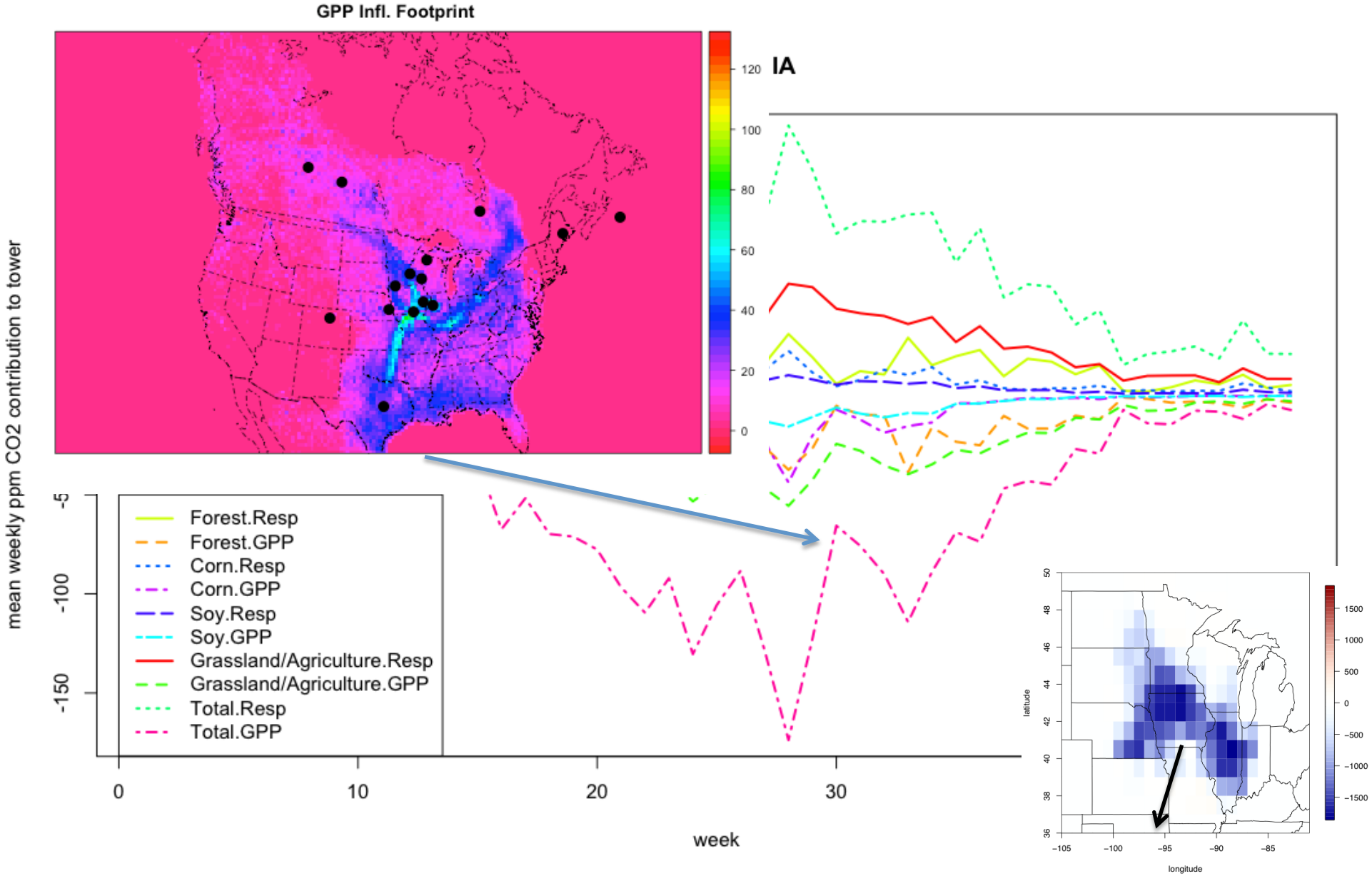
Particle-based decomposition of surface flux biome-specific contributions to CO_2



Particle decomposition into biome contributions



Particle decomposition into biome contributions



Initial Conclusions

- Variations in LPDM-based CO_2 shows promise
- need to further investigate sensitivity in LPDM which causes large source of CO_2 in inverse estimate of annual NEE ("touchdown" vs. "layer" method)

Looking forward…..

- Test sensitivity over selected tower subsets in MCI
- Test sensitivity over various crop flux reductions
- Repeat for 2008 and 2009 in order to capture inter-annual variability