

(62-210426-A) **Midwest U.S. Croplands Determine Model Divergence in North American Carbon Fluxes**

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Terrestrial biosphere models are key to understanding continental-scale patterns of biospheric carbon fluxes. However, individual models disagree on whether temperate forests or croplands dominate the growing-season net carbon uptake over North America. Evidence from novel photosynthetic proxies has cast doubt on the “strong forest, weak cropland” carbon uptake patterns simulated by most models. To glean robust space-time patterns of North American carbon fluxes from widely divergent model estimates, we need to leverage regional-scale (10^3 – 10^5 km²) constraints from carbon dioxide (CO₂) atmospheric observations in model evaluation. Here, we evaluate a large suite of terrestrial biosphere models and data-driven models by examining how well the atmospheric signals resulting from their carbon flux estimates capture the space-time variability in atmospheric CO₂, as is observed by a network of tall towers over North America.

Models with gross or net carbon fluxes that are consistent with the observed CO₂ variability share a salient feature of strong growing-season carbon uptake in Midwest U.S. croplands. Conversely, the remaining models place most growing-season uptake in boreal or temperate forests. Differences in model explanatory power depend mainly on the simulated timing of peak uptake in croplands rather than the distribution of seasonal cycle amplitudes of fluxes across biomes. Our results suggest that improved model representation of cropland phenology is crucial to robust, policy-relevant estimation of North American carbon exchange.

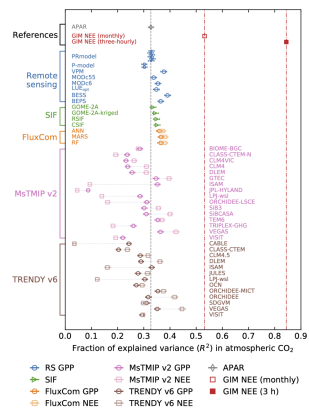


Figure 1. Fraction of variance (R^2) in atmospheric CO₂ explained by modeled carbon fluxes (GPP and NEE), solar-induced chlorophyll fluorescence (SIF) data products, and the absorbed photosynthetically active radiation (APAR) during 2007–2010, with error bars showing 95% confidence intervals obtained from bootstrapping. For each model with both GPP and NEE estimates, data points that denote R^2 values of GPP and NEE of that model are linked by a thin dashed line. The vertical lines denote R^2 values of three references (from left to right): APAR and monthly and three-hourly geostatistical inverse estimates of NEE (GIM NEE).

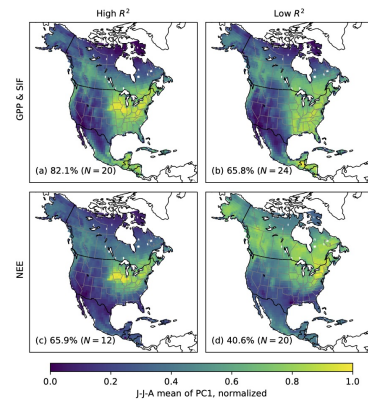


Figure 2. The June–July–August (JJA) mean patterns of the extracted first principal component (PC1) among (a) GPP and SIF models of high R^2 , (b) GPP models of low R^2 , (c) NEE models of high R^2 , and (d) NEE models of low R^2 , where models of high R^2 and of low R^2 are separated using the R^2 value of APAR (0.327) as a threshold. Percentage numbers represent the fraction of variance in each group explained by the PC1, whereas N indicates the number of models in each group. For both GPP and SIF (a) and NEE (c), models with high R^2 show common features of strong summer uptake in the mid-continental cropland region.