A novel model–data fusion approach to terrestrial carbon cycle reanalysis across the contiguous U.S

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NASA CMS CARBON MONITORING SYSTEM

Science Question

Can we use iterative model-data fusion to reconcile multiple data constraints about the terrestrial carbon cycle to produce "reanalysis" best estimates of ecosystem carbon budgets (pools and fluxes) across space and time?

Analysis

- Utilizes Landtrendr AGB (CMS15-Kennedy) and MODIS LAI for assimilation, Ameriflux for calibration and initial conditions, ERA5 as meteorological drivers, the SIPNET model for forward simulation, the TWEnF algorithm for assimilation, and PEcAn for the overall workflow. Validates against SoilGrids SOC, Ameriflux.
- Initial proof-of-concept product covers contiguous US (CONUS) from 1986-2018 with a 493 point irregular grid. Forecasts have subdaily resolution, Analysis occurs annually.

Results

- Product validates well against held out SOC and NEE data
- Assimilation captures uncertainties & covariance structure across pools and sites
- Lays foundation for adding additional constraints, increasing spatial extent and spatiotemporal resolution

Significance

Because reanalysis products reconcile multiple bottom-up data sources, with uncertainties, and estimate the full terrestrial carbon cycle (not just individual pools or fluxes), they have high potential value for MRV, for understanding the spatiotemporal variability in the terrestrial carbon cycle, for understanding the information contribution of different data sources, and as priors in atm inversions.

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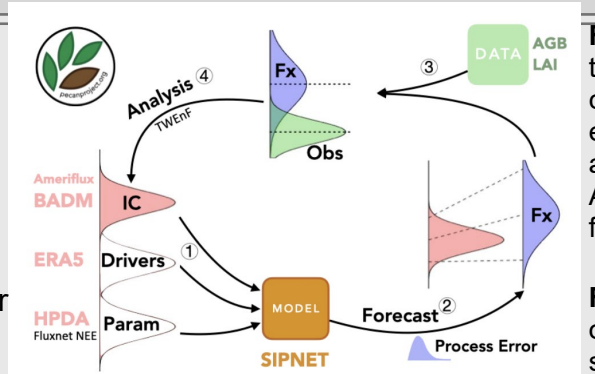

Figure 1: Iterative data assimilation workflow that (1) integrates uncertainty in model initial conditions, drivers, parameters, and process error to (2) produce probabilistic forecasts that are then (3) constrained by observed LAI and AGB, providing (4) updated initial conditions for the next forecast

Figure 2: Forecast and assimilation estimates of carbon pools and fluxes for an examples site (1 of 493)