Application of Generalized Ensemble Filter for estimating terrestrial carbon budgets across the contiguous U.S

H Dokoohaki, Ann Raiho, B Morrison, S Serbin, M Dietze

In this study, we apply a new regionalized Sequential Data Assimilation (SDA) functionality within the PEcAn platform to address the problem of generating spatial and temporal ‘reanalysis’ budgets of carbon pools and fluxes and their uncertainties across the contiguous United States. Our SDA uses a formal-Bayesian model-data fusion approach to assimilate and reconcile a wide range of satellite, tower, and field observations across observed/unobserved state variables and sites. Our current retrospective analysis focuses on >500 sites within the contiguous US from 1980-present. Above ground biomass from Landtrendr and LAI observations from MODIS were sequentially assimilated into SIPNET ensemble forecasts of carbon pools for all 500 sites simultaneously. Data assimilation was performed by developing a Generalized Ensemble Filter (GEF) algorithm in a Bayesian framework by including an estimation of model process variance. The forecast mean, covariance and the likelihood function were transformed to tobit space to account for the left or right censored state variables. In addition, the prior for our process covariance matrix was assumed to be Wishart and prior shape parameters were stored and updated at each time step. This gave us the flexibility to not only relax the normality assumption behind the Kalman Filter family of data assimilation methods but also to estimate and propagate model process error over the assimilation period. A series of analyses on the spatial covariances of model-data residuals was also performed to study and inspect different localization schemes and inform the range parameters in those schemes. Additionally, we present the results of our overall analysis maps and time-series for the carbon budget of U.S. terrestrial ecosystems and their uncertainties, in terms of both carbon pools and fluxes. Finally, we explore large-scale patterns, and compare our bottom-up estimates to independent top-down inversion estimates to our results.