Session: C24 Poster: T203B

Joint uncertainty assessment and statistical merging of multiple model and remote-sensing data records for biogeochemical modeling

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Satellite remote sensing and coupled climate models provide a wealth of land surface climatic data records whose reliability varies temporally, spatially, and among state variables. Whereas certain state variables are reliable in specific regions, they may be poorly constrained by available observations and model representation in many areas. These data are often used as required inputs for global hydrology and biogeochemical models, resulting in land parameter simulation uncertainty. We developed an approach that exploits synergistic information from three or more independent datasets to estimate land parameter relative uncertainty and statistically combine the datasets into a single state variable record using total least squares and Kalman filter methods. This approach is applied to obtain improved simulations and soil moisture information using surface soil moisture retrievals from the Advanced Microwave Scanning Radiometer (AMSR-E), GMAO MERRA (Modern Era Retrospective-Analysis for Research and Applications) global reanalysis, precipitation and evapotranspiration products from the Tropical Rainfall Monitoring Mission (TRMM) and Moderate Resolution Imaging Spectroradiometer (MODIS). A primary check on this approach is that the merged data product is of greater accuracy than the individual input datasets relative to benchmark observations (i.e. ground stations) and that the spatial patterns of estimated errors are well correlated with the benchmark. These criteria were evaluated using soil moisture observations from the global flux tower network and we find an overall significant median improvement in correlation (R2) of 15 % and 0-30 % range of improvement among sites. The estimated soil moisture uncertainties agree with the flux tower observations and also reflect expected spatial gradients with vegetation biomass and other environmental factors. The resulting soil moisture dataset is being used to guide development of carbon modeling and data assimilation products for the Soil Moisture Active Passive (SMAP) Mission.