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Towards global pattern-oriented evaluation of land surface models using global fields of carbon, water, and energy fluxes derived from upscaling of eddy covariance measurements

M. Jung (1), M. Reichstein (1), E. Tomelleri (1), C. Beer (1), D. Baldocchi (2), N, Gobron (3), D. Papale (5), and FLUXNET members (6)

(1)) Biogeochemical Model-Data Integration Group, Max-Planck-Institute for Biogeochemistry, Jena, Germany (mjung@bgc-jena.mpg.de), (2) Biometeorology Laboratory, University of California Berkeley, USA, (3) European Commission – DG Joint Research Centre, Institute for Environment and Sustainability, Global Environment Monitoring Unit, Ispra, Italy, (4) Biogeochemical Systems Department, Max-Planck-Institute for Biogeochemistry, Jena, Germany, (5) Forest Ecology Laboratory, University of Tuscia, Viterbo, Italy, (6) www.fluxdata.org

The current FLUXNET database (www.fluxdata.org) of CO2, water and energy exchange between the terrestrial biosphere and the atmosphere assembles data from more than 250 sites, encompassing all major biomes of the world and being processed in a standardized way. Using a model tree ensemble (MTE) approach, we show that most of the variability of biosphere-atmosphere exchanges of carbon, water and energy fluxes can be explained by vegetation/respective remote sensing information, and climate. By applying these generalized empirical functions to the globe using a harmonized global remote sensing FAPAR product derived from SeaWiFS, MERIS, and AVHRR sensors, and meteorological fields we present monthly resolved and spatially explicit hindcasts of terrestrial ecosystem fluxes and its uncertainties from 1982-2008. We evaluate our estimates using artificial experiments and against independent data at regional to global scale lending support to the validity of our upscaling approach. Our product represents a new global data stream that helps understanding the variability of the terrestrial carbon cycle. This data stream is fully independent from and complementary to global land surface models and can be integrated into inverse modelling and data-assimilation approaches.

We propose a strategy of pattern-oriented evaluation of global land surface models (LSMs) by capitalizing on the FLUXNET database and the upscaling methodology. The approach is based on using the same meteorological and land cover forcing data as the LSM in generating the global flux fields which removes confounding effects due to inconsistent driver data while achieving flux estimates at the same scale and spatio-temporal domain as the LSM. Subsequently, time series decomposition and dimensionality reduction techniques are applied to both the LSM simulations and the FLUXNET upscaling based fields to extract prominent patterns in both. These patterns are further compared and analysed to diagnose discrepancies between LSM simulations and empirical upscaling. We will discuss advantages and challenges of this evaluation approach in comparison to classical model evaluation strategies.