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Spatio-temporal variability of land-atmosphere carbon and water fluxes: Coming to grips via integration of FLUXNET, earth observation data and biogeochemical modeling?

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Whether we will achieve fundamental advancement in our understanding and diagnostic as well as prognostic capabilities concerning the terrestrial biogeochemical cycles and feedback with the climate system will critically depend on how successfully we extract and combine information inherent in ecosystem model formulations and various data sources [e.g. land-atmosphere flux observations from FLUXNET, ecosystem state variables (inventories), atmospheric CO2 concentrations, Earth Observation data]. Each of the sources of information has its specific advantages, shortcomings and uncertainties, that have to be formally stated in any reliable model-data fusion or data-assimilation system. In this presentation we review those data and model properties with special emphasis on eddy covariance CO2 and water fluxes and remote sensing data in combination with diagnostic and process-oriented modelling. We show that FLUXNET data, albeit confined to individual sites, but being deployed as a growing network, is already gaining pseudo-spatial characteristics over parts of the globe, that e.g. allow regionalized analyses of inter-annual variability of carbon and energy fluxes. Remote sensing then constitutes a powerful complementary means for a high-resolution wall-to-wall up-scaling from flux sites, while process-based models are the only options for prognostic studies. In this context we present situations where ecosystem models can be falsified and subsequently improved (only) by multivariate constraints using the FLUXNETwork ecosystem and Earth Observation data. We conclude with combined flux tower, remote sensing and modeling views on the terrestrial biosphere's response to the climate anomalies 2003 and 2005 over Europe and parts of Asia.