



Assimilation of soil moisture observations to constrain carbon fluxes in the Terrestrial Carbon Community Assimilation System (TCCAS)

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One of the key research questions in terrestrial carbon cycling is concerned about how to advance our understanding of the processes underlying terrestrial CO₂ fluxes and subsequently reduce related uncertainties in an integrated approach exploiting both observations (satellite and in situ) and modelling. Here, we demonstrate the synergistic exploitation of remotely sensed soil moisture observations together with additional observations from passive microwave and optical sensors for an improved understanding of the terrestrial carbon and water cycles. As such, the Terrestrial Carbon Community Assimilation System (TCCAS), an activity funded by the European Space Agency within its Carbon Science Cluster, has been developed. TCCAS has at its core the community terrestrial ecosystem model D&B that is based on the well-established DALEC and BETHY models, and thus building on the strengths of each component model. In particular, it combines the dynamic simulation of the carbon pools and canopy phenology of DALEC with the dynamic simulation of water pools, and the canopy model of photosynthesis and energy balance of BETHY. A suite of observation operators allows the simulation of surface layer soil moisture as well as solar-induced fluorescence, fraction of absorbed photosynthetically active radiation, and vegetation optical depth from passive microwave sensors. TCCAS employs a variational assimilation system (making use of efficient tangent and adjoint code) that adjusts a combination of initial pool sizes and process parameters to match the observational data streams. The system is applied to two ICOS sites and regions around these sites: Sodankylä, Finland, representing a boreal forest biome, and Majadas de Tietar, Spain, representing a temperate savanna biome. The model performance is assessed against independent observations at site scale as well as at approximately 500 km x 500 km regions around each site. We find that the assimilation of soil moisture in combination with the three other data streams has a profound impact on simulated ecosystem function and carbon fluxes at both sites/regions.

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