A new terrestrial biosphere model for combining optical, and active/passive microwave observations into a consistent view of the terrestrial carbon cycle in a variational assimilation system.

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We report on the development and application of the new DALEC & BETHY (D&B) model that is performed within ESA's Land surface Carbon Constellation (https://lcc.inversion-lab.com) study. This new community model is designed to simulate a range of satellite and in-situ observations through dedicated observation operators. A suite of observation operators allows the simulation of solar induced fluorescence, Fraction of Absorbed Photosynthetically Active Radiation, Vegetation Optical Depth from passive sensors, the slope of the backscatter-incidence angle relationship of an active sensor, and surface layer soil moisture – and thus the assimilation of those data streams. To our knowledge, the D&B assimilation framework will be the first to combine such a large and diverse array of observational constraints moving beyond site scale to regional applications. D&B builds on the strengths of each component model in that 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. We present an evaluation of the model performance against a range of in-situ observations at two well-instrumented sites at which field campaigns are carried out: (1) Sodankylä, Finland, located in a boreal evergreen needleleaved forest biome and (2) Majadas de Tietar, Spain, located in a temperate savanna biome. The model performance will also be assessed against a range of satellite observations for approximately 500 km x 500 km regions around each site. The model is embedded

into a variational assimilation system that adjusts a combination of initial pool sizes and process parameters to match the observational data streams. For this purpose the D&B assimilation system is provided with efficient tangent and adjoint code. This variational data assimilation system is an ideal framework to assess the consistency between the data sets assimilated into the model, the data sets used to drive the model, the data sets used for validation of the model, and the process understanding implemented in model. We will show initial data assimilation experiments at site scale.