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Assimilating optical remote sensing data to improve biome parameterization on different scales

M. Probeck (1), H. Bach (2) and W. Mauser (1)

(1) Department of Earth and Environmental Sciences, Chair for Geography and Geographical Remote Sensing, University of Munich, Germany, (2) VISTA GmbH - Remote Sensing in Geosciences, Munich, Germany (m.probeck@iggf.geo.uni-muenchen.de / FAX: ++49-89-21806675)

In this study, the information content of two LANDSAT-TM scenes is assimilated into the regional ecosystem model PROMET-V, with the objective of deriving improved biome-specific parameters (i.e. light use efficiency and water use efficiency) on the regional scale. These parameters are scale-invariant and thus are used for upscaling to the global-scale earth system model BETHY in order to allow enhanced forecasts of terrestrial carbon fluxes. The process-based dynamic ecosystem model PROMET-V is capable of modelling fluxes and balances of matter, energy and information on a regional scale, as well as of using remote sensing data for model initialisation and update. It was parameterized and run for the Alpine Foreland test site (3844 km^2) southwest of Munich, Germany, on a 50m-grid and a daily time step, to simulate plant growth, water and nutrient fluxes and their spatial patterns and interactions over a 1-year time period. For this, the model needs the input variables albedo and fAPAR for each time step. These variables are crucial for modelling the surface and canopy energy budget. They are normally extracted from literature values and attributed to each land use class. But they can also be provided spatially distributed through the inversion of optical remote sensing data. However this is only possible for those moments in time, where satellite acquisitions are available - a realistic temporal interpolation is not possible by using simple statistical tools. Canopy reflectance models can be used to simulate the temporal evolution between the acquisitions using the outputs of an ecosystem model. In this study, PROMET-V provides land surface-, soil- and vegetation-properties, particularly distribution of LAI, fraction of brown leaves and surface soil moisture. From these temporally dynamic variables and additional static, land use-specific parameters, the temporal courses of albedo and fAPAR are simulated using the 4-stream Soil-Leaf-Canopy radiative transfer model SLC, which is an extension of the canopy reflectance models SAILH and GeoSAIL. The two variables are assimilated into PROMET-V, replacing the literature-based standard courses. Spatially distributed forest crown coverage and LAI data sets are derived by applying the inverted SLC radiative transfer model to the LANDSAT-TM scenes. By default, in PROMET-V forests are modelled assuming a full crown coverage, i.e. as an ideal forest. By considering the derived crown coverage data, the spatial heterogeneity and temporal development of forest stands improves significantly. The LAI data sets contain valuable information regarding the cutting status of the predominant land use class meadows. They are used for assessing the parameterisation of grassland management in PROMET-V. By performing sensitivity studies, two extensive and three intensive meadow classes with different management and fertilisation practice are derived, best representing the measured LAI value range. By applying thresholds, every meadow pixel is assigned to one of these meadow classes. Thus, meadows are modelled with much more appropriate management plan, showing more realistic and spatially distributed cutting dates. By assimilating optical remote sensing data, the parameterisation of the regional scale model PROMET-V is significantly improved, leading to a more precise calculation of ecosystem variables and subsequently also to a better calculation of biome-specific parameters, both in magnitude and spatial representation. A use of these improved parameters in the global-scale earth system model BETHY shows promising first results.