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The implication of input data aggregation on upscaling of soil organic carbon changes - a case study with CENTURY model

Balázs Grosz (1), Rene Dechow (1), Frank Ewert (2), Thomas Gaiser (2), Holger Hoffmann (2), and Gang Zhao (2)

(1) Thünen Institute of Climate-Smart Agriculture, Braunschweig, Germany (balazs.grosz@ti.bund.de), (2) Institute of Crop Science and Resource Conservation, University of Bonn, 53115 Bonn

Soil organic carbon models which have been extensively tested and calibrated for field scale applications in the past are now increasingly used for larger scale estimations. In large scale applications, recent data availability and limited computational capacity requires adequate aggregation of the model input and model initialization. Method and level of driver aggregation in up scaling studies are sources of uncertainty and might bias the aggregated model outcome. The suitability of up scaled model results using aggregated driving data depends on both the sensitivity of the model on these model drivers and the scale of interest describing the desired aggregation level of the model output.

The implications of driver aggregation schemes have been examined in a scaling exercise within the joint research project MACSUR (Modelling European Agriculture with Climate Change for Food Security). In this study, meteorological driving data and data on soil properties on several aggregation levels have been used to calculate the soil organic carbon change of agricultural land use in North Rhine-Westphalia with the bio-geo-chemical model CENTURY. The model couples processes determining crop growth, soil organic matter and nutrient dynamics.

In the aggregation study meteorological data and soil properties from a NUTS 2 region in Germany (North Rhine-Westphalia) from 1980 to 2010 were prepared on 6 aggregation levels corresponding to grid cells in 1x1km, 10x10km, 25x25km, 50x50km, 100x100km resolution and spatial means on federate state level. Upscaling exercises have been conducted by combining several aggregation levels of soil properties and weather data.

Results show that the aggregation of meteorological data has little impact on modeled soil organic carbon changes although model uncertainty increases slightly with decreasing scale of interest from NUTS 2 (federal state) level to smaller grid cell size. Contrary, the aggregation of soil properties result in high uncertainty ranges constraining the predictable scale of interest to the coarser resolution using a higher resolution aggregation level.