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Effects of climate data aggregation on regional net primary production (NPP) modelling

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Abstract:

In ecosystem modelling studies, data are often collected at a small scale but are used in models to predict ecosystem responses e.g. net primary production (NPP) at coarser scale, using data aggregation. The data aggregation causes errors that are difficult to predict, because of model complexity and our limited knowledge of the spatial heterogeneity underlying our aggregated input values. Input aggregation thus adds to the uncertainty associated with model predictions. One way of reducing uncertainty related to input aggregation error is to evaluate models at different resolutions for areas where high-resolution input data are available. The objective of this study was the quantification of the aggregation error on modelled NPP introduced by climate data aggregation. Therefore, climate data at 1 km x 1 km resolution (>30 000 grid cells) were used as baseline to simulate NPP with 11 different crop and biogeochemical models for the federal state North Rhine-Westphalia (Germany). These results, for 29 year monocultures of wheat and maize cropping systems, respectively, were compared with simulation results using aggregated climate data for four resolutions (10, 25, 50, 100 km grid cell side length). The aggregation effect is represented by the maximum differences between the NPP, averaged for wheat and maize cropping systems over the growing season, simulated for the five different resolutions. Input data aggregation had little impact on NPP of 29 year averages (0.5 – 7.8 % for wheat and 0.3 – 10 % for maize), while the climate data aggregation effect was higher for single years; up to 9 % and 13 % for wheat and maize, respectively, gradually decreasing to low effects for averages over 10 year periods or longer. The scale effect differed among models and shows only a minor impact (2%) for an ensemble run.

Keywords: net primary production, NPP, scaling, extreme events, crop modelling, climate, data aggregation