

Site-level uncertainty arising from climate data in estimations of gross primary productivity

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Process-based models estimate vegetation growth and productivity with uncertainties that are, to some extent, inevitable. These uncertainties arise not only from the model structure but also the input data. Among the several types of input data, climate forcing contributes the largest uncertainty in the simulated gross primary productivity (GPP) [Jung *et al.*, 2007]. For regional and global simulations, gridded climate data are required for climate forcing. Such climate inputs involve biases with respect to observation data and lead to errors in simulations of GPP and leaf area index (LAI). To investigate the uncertainties in GPP arising from climate forcing data using reanalysis data, we conducted simulation experiments using three climate forcing datasets.

For the simulation experiments, we used a prognostic model: the Biophysical and Ecophysiological Processes-based Model for Predicting Phenology and Productivity (BE4P). This model is forced by sub-daily simple climate variables and predicts GPP and LAI at daily steps. Using this model, we simulated seasonal changes in GPP and LAI at 30 flux tower sites encompassing various biomes and climate zones (Experiment C). To run this model, measured climate data at each site were derived from FLUXNET. Next, we repeated the simulations at the selected sites using NCEP/NCAR reanalysis data (Experiment R). Lastly, we replaced the reanalysis data with the bias-corrected data and conducted simulations in the same manner (Experiment R-BC). The bias correction was done using CRU monthly data as references. The estimated seasonal change in GPP and LAI in Experiment C agreed with the observed data at most sites. In Experiment R, the estimated GPPs were higher than those in Experiment C at most sites. The bias of the annual GPP was highest (~25%) for the deciduous broadleaf forest sites, which was comparable to the results using a different model [Barman *et al.*, 2014]. The higher bias was attributed to higher levels of solar radiation and precipitation in the reanalysis data compared to the measurements. In Experiment R, some sites showed similar or even lower GPP, whereas the estimated growth period was longer compared to Experiment C. Less soil water content during the growth period contributes to suppressing the productivity. This negative effect on vegetation growth and productivity surpassed the positive effect of the longer growth period, which suggests that the estimated GPP varies in response to soil water content during the growth period. In Experiment R-BC, the biases of the GPP and growth period were ameliorated. In conclusion, the reanalysis data can cause significant biases in the estimated GPP through light and water conditions, and a correction using gridded forcing data would help to reduce these biases.

References

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