



Danish heathland manipulation experiment data in Model-Data-Fusion

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In ecosystem manipulation experiments (EMEs) the ecosystem is artificially exposed to different environmental conditions that aim to simulate circumstances in future climate. At Danish EME site Brandbjerg the responses of a heathland to drought, warming and increased atmospheric CO₂ concentration are studied. The warming manipulation is realized by passive nighttime warming. The measurements include control plots as well as replicates for each three treatment separately and in combination. The Brandbjerg heathland ecosystem is dominated by heather and wavy hairgrass.

These experiments provide excellent data for validation and development of ecosystem models. In this work we used a generic vegetation model ORCHIDEE with Model-Data-Fusion (MDF) approach. ORCHIDEE model is a process-based model that describes the exchanges of carbon, water and energy between the atmosphere and the vegetation. It can be run at different spatial scales from global to site level. Different vegetation types are described in ORCHIDEE as plant functional types.

In MDF we are using observations from the site to optimize the model parameters. This enables us to assess the modelling errors and the performance of the model for different manipulation treatments. This insight will inform us whether the different processes are adequately modelled or if the model is missing some important processes. We used a genetic algorithm in the MDF.

The data available from the site included measurements of aboveground biomass, heterotrophic soil respiration and total ecosystem respiration from years 2006-2008. The biomass was measured six times during this period. The respiration measurements were done with manual chamber measurements. For the soil respiration we used results from an empirical model that has been developed for the site. This enabled us to have more data for the MDF.

Before the MDF we performed a sensitivity analysis of the model parameters to different data streams. Fifteen most influential parameters were chosen to be optimized. These included parameters connected to photosynthesis, phenology, allocation of biomass and respiration. All three data streams were used simultaneously in the MDF. Before the MDF, the model had the tendency to overestimate the respiration and the aboveground biomass. After MDF the model simulations were closer to the observations, but its estimations for those variables that were not used in the MDF, such as, e.g., fine root biomass growth, did not improve greatly.

In these runs the vegetation of Brandbjerg site was described in ORCHIDEE as C3 grass, which had some characteristics that do not apply to a Danish heathland very well. The results suggest that a new plant functional type needs to be developed for ORCHIDEE in order to successfully simulate such ecosystem as Brandbjerg.