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Modelling short term variability in carbon and water exchange in a Dutch pine forest

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Vegetation is not static but continually varies, within a year (phenology), between years (interannual variability (IAV)) and over longer time scales. Observed short term variability in carbon and water exchange is not well understood, and not well parameterized in Dynamic Global Vegetation Models (DGVMs). To better understand this variability, a detailed one site analysis of daily carbon and water fluxes with the DGVM and ecosystem model LPJ-GUESS is combined with extensive on site flux measurements between 1997 - 2009 in a Dutch pine forest (Loobos, coord: 52°10'04N, 05°44'38E, dominant species: Pinus sylvestris).

IAV at the site cannot be readily explained from environmental variables, and the model is not able to simulate the observed IAV at the site due to a yearly underestimation of Gross Primary Production (GPP) and actual evapotranspiration (AET). This is attributed to a lack of understanding and hence parameterization of short term physiological processes: 1) the response of vegetation to drought and 2) a stronger photosynthesis response of pine trees at mid latitude during winter compared to that of boreal forests (i.e. no dormant phase). For example, modelled estimates of GPP and AET reveal a strong sensitivity to available soil moisture on warm and dry summer days.

Different mechanisms to simulate water uptake by plant roots are tested against each other, to investigate the response of vegetation during warm periods with low precipitation. The temperature response of photosynthesis during winter periods is compared to measured data to improve modelled winter fluxes.

These results shed an interesting light on the process based model LPJ-GUESS and its ability to simulate carbon and water exchange at such a particular site. By identifying the key processes involved in IAV at Loobos we get one step closer to understanding its ecosystem dynamics and towards options for a more complete mechanistic approach in DGVM parameterization.