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An analysis of the decadal variability of Carbon fluxes in three evergreen European forests through modelling

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With several sites measuring mass and energy turbulent fluxes for more than ten years, the CarboEurope database appears as a valuable resource for addressing the question of the determinism of the interannual variability of carbon (C) and water balances in forests ecosystems.
Apart from major climate-driven anomalies during the anomalous 2003 summer and 2007 spring, little is known about the factors driving interannual variability (IAV) of the C balance in forest ecosystems.
We used the CASTANEA process-based model to simulate the C and W fluxes and balances of three European evergreen forests for the 2000-2007 period (FRPue Quercus ilex, 44°N; DETha Picea abies, 51°N; FIHyy Pinus sylvestris, 62°N).
The model fairly reproduced the day-to-day variability of measured fluxes, accounting for 70-81%, 77-91% and 59-90% of the daily variance of measured NEP, GPP and TER, respectively. However, the model was challenged in representing the IAV of fluxes integrated on an annual time scale. It reproduced ca. 80% of the interannual variance of measured GPP, but no significant relationship could be established between annual measured and modelled NEP or TER.
Accordingly, CASTANEA appeared as a suitable tool for disentangling the influence of climate and biological processes on GPP at mutiple time scales. We show that climate and biological processes relative influences on the modelled GPP vary from year to year in European evergreen forests. Water-stress related and phenological processes (i.e. release of the winter thermal constraint on photosynthesis in evergreens) appear as primary drivers for the particular 2003 and 2007 years, respectively, but the relative influence of other climatic factors widely varies for less remarkable years at all sites.
We discuss shortcomings of the method, as related to the influence of compensating errors in the simulated fluxes, and assess the causes of the model poor ability to represent the IAV of the annual sums of NEP and TER.