The European terrestrial biosphere affected by the 2005 and 2003 climate anomalies: comparative analysis of processes and spatial patterns

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Keywords

Interannual variability, climate extremes, carbon and water fluxes, ecosystem modelling, remote sensing

Abstract

The 2003 and 2005 (and 2006) climate anomalies over Europe were quite different both in terms of spatial patterns and in terms of climate variables affected. These differences lead to quite contrasting responses of the terrestrial biosphere functioning with respect to both, thespatial patterns, the processes involved (e.g. respiration, photosynthesis) and the dominating climate factors (temperature, water balance). On this topic an integrated paper grant was given by the CarboEurope project SC.

We present a detailed integrated, comparative analysis of these two 'natural experiments' from eddy flux tower, ecosystem modelling and remote sensing perspectives. We find consistent descriptions of spatial anomaly patterns between modelling and remote sensing approaches: While in 2003 central Eastern and Western Europe were strongly affected, in 2005 strong reductions in modelled productivity and observed fPAR were found over the Iberian peninsula and around the Caspian Sea. These patterns are also reflected by the point observations via eddy flux towers (where available). According to the process modelling and the eddy data separated into gross primary productivity and terrestrial ecosystem respiration,

the anomalies in NEE were largely driven by changes in productivity rather respiration, except for the Baltic region where no models indicated strong positive respiration anomalies but no eddy flux towers exist. Modelling experiments indicate that memory effects with respect to soil water storage do exist, i.e. the productivity may depend also on the hydrological patterns during the previous year depending on whether soil water was restored or not.

Preliminary analysis of the year 2006 indicates that with similarly high temperatures and little summer rainfall, but a hydrologically different spring in 2006 forest productivity was less affected while severe reductions in shallow-rooted grass and croplands occurred. Overall, from the analysis we conclude that water-carbon interactions are very - and maybe increasingly - important for the understanding of carbon balance inter-annual variability.