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Carbon and water fluxes coupling in past and future climate model projections

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Terrestrial ecosystems currently act as a carbon sink by absorbing about one third of the anthropogenic CO_2 emissions. However, there are large uncertainties concerning the fate of this carbon sink under a changing future climate. Extreme events such as droughts and heat waves are expected to become more frequent and severe in some regions, which may reduce the terrestrial carbon sink and may even turn it into a source in some regions. A better understanding of the processes controlling these land-atmosphere CO_2 exchanges is therefore crucial in order to better constrain the carbon cycle response to future climate change.

The objective of this study is to compare different model estimates of seasonal terrestrial carbon fluxes over Europe and to infer the sensitivity of these fluxes to different environmental factors such as soil moisture and temperature. Past and future terrestrial CO_2 fluxes are analysed based on a set of Land Surface Models (LSMs), Dynamic Global Vegetation Models (DGVMs) and Earth System Models (ESMs) used in the framework of the CARBO EXTREME, TRENDY and CMIP5 projects. Overall, Gross Primary Production (GPP) and Net Biome Production (NBP) are highly correlated with soil moisture in Central Europe and in the Mediterranean region, while in Northern Europe these fluxes are highly correlated with temperature. Summer NBP in the Mediterranean region becomes positive (CO_2 source) when soil moisture decreases below around 1.3 standard deviation, while spring NBP becomes positive in Northern Europe when temperature is less than 2^oC. Our results also suggest a decrease in the terrestrial carbon sink over Europe during the 21^{st} century, but the role of soil moisture changes and variability in this decrease still remains uncertain.