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Assessing the impacts of present and future interannual climate variability on European ecosystems using a dynamic vegetation model

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Climate projections indicate changes in mean climate as well as in climate variability and frequency of extreme events for the end of the 21st century compared to present. Since many biological processes reach non-reversible thresholds (loss of ability to germinate, mortality, etc.) at some temperatures or soil water values, changes in climate variability have long-term consequences for ecosystem composition, functioning and carbon storage. The CARAIB dynamic vegetation model is used to evaluate and analyse how future climate variability will affect European ecosystems. We examine the impacts of climate change and associated drought episodes on primary productivity (NPP) as well as on fire intensity. CARAIB is driven by the ARPEGE/Climate model and three regional climate models from the European Union project ENSEMBLES (KNMI-RACMO2, DMI-HIRHAM5 and HC-HadRM3Q0 models) forced with the IPCC A1B emission scenario. We analyse the interannual climate variability simulated by those climate models and compare it with the observed climate variability (CRU TS 3.0 historical climate dataset) over the period 1961-1990. None of these climate models can reproduce accurately the present natural climate variability. Therefore, the present NPP interannual variability simulated by CARAIB using climate outputs from the climate models differs from the one obtained with observed climate. For instance, the NPP interannual variability obtained with the ARPEGE/Climate model is significantly overestimated in some parts of Europe, especially in the Mediterranean region, in France, in northern Germany and northern Poland, in the Balkans and in Ukraine. Since discrepancies between modelled and observed current climate variability may also affect NPP variability calculated for the future as well as the intensity and the frequency of severe drought periods and wildfires, comparing the terrestrial ecosystem evolutions obtained with a range of climate models allows to improve the assessment of climate change impacts on ecosystems in the future. Anyway the trend between the present and the future is expected to be more robust. The NPP interannual variability increases in the future with the four climate models as a result of more frequent and more severe soil water stress episodes in southern and Central Europe. The projected climate changes are also likely to induce increased fire risk in the Mediterranean region but also in Central Europe and Russia.