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Modelling the risk of ecosystem disruption in Europe with a dynamic vegetation model

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What will be the European ecosystem responses to future climate? With unprecedented speed and extent, the projected climate change might lead to a disruption of terrestrial plants functioning in many regions. In the framework of the EcoChange project, transient projections over the 1901-2100 period have been performed with a process-based dynamic vegetation model, CARAIB DVM (Dury et al., 2011, iForest 4: 82, 99). The vegetation model was driven by the outputs of four climate models under the SRES A1B scenario: the ARPEGE/Climate model and three regional climate models (KNMI-RACMO$_2$, DMI-HIRHAM5 and HC-HadRM3Q0 RCMs) from the European Union project ENSEMBLES. DVMs are appropriate tools to apprehend potential climate change impacts on ecosystems and identify threatened regions over Europe. CARAIB outputs (soil moisture, runoff, net primary productivity, fire, etc.) were used to characterise the ecosystem evolution. To assess consequences on biodiversity, the evolution of 100 natural common European species (47 herbs, 12 shrubs and 41 trees) has been studied year-to-year over the 1901-2100 period.

Under the combined effects of projected changes particularly in temperature and precipitations, CARAIB simulates important reductions in the annual soil water content. The species productivities vary strongly from year to year reaching during the driest years values much lower than present-day average productivities. According to CARAIB, a lot of species might go beyond their water tolerance very frequently, particularly after 2050, due to more intense summer droughts. In the northern part of Europe and in the Alps, with reduced temperature variability and positive soil water anomalies, NPP variability tends to decrease. Regions with more severe droughts might also be affected by an increase of the frequency and intensity of wildfires. With this background, the species distributions might be strongly modified at the end of the century. 15% of tree species and 30% of herb and shrub species (respectively 30% and 60% if the CO_2 fertilization effect on species is not taken into account) might experience a loss of 30% or more of their current distribution. Proportions of new species appearance were also studied. Southern Europe might suffer important species extinction while the more suitable climate conditions in northern Europe might lead to a gain in species diversity.