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Assessing the Risk of Ecosystem Disruption in Europe using a Dynamic Vegetation Model driven by CMIP5 Regional Climatic Projections from EURO-CORDEX

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While the combination of warmer and drier mean climatic conditions can have severe impacts on ecosystems, extreme events like droughts or heat waves that break the gradual climate change can have more long-term consequences on ecosystem composition, functioning and carbon storage. Hence, it is essential to assess the changes in climate variability and the changes in frequency of extreme events projected for the future. Ecosystems could not be in a condition to adapt to these new conditions and might be disrupted. Here, the process-based dynamic vegetation model CARAIB DVM was used to evaluate and analyze how future climate and extreme events will affect European ecosystems.

To quantify the uncertainties in the climatic projections and in their potential impacts on ecosystems, the vegetation model was driven with the outputs of different regional climatic models (RCMs), nested in CMIP5 GCM projections for the EURO-CORDEX project: ALADIN53 (Météo-France/CNRM), RACMO22E (KNMI), RCA4 (SMHI) and REMO2009 (MPI-CSC) RCMs. These climatic projections are at a high spatial resolution (0.11-degree, $\sim$12 km). CARAIB simulations were performed across Europe over the historical period 1951-2005 and the future period 2006-2100 under RCP4.5 and RCP8.5 emission scenarios. We simulated a set of 99 individual species (47 herbs, 12 shrubs and 40 trees) representing the major European ecosystem flora.

First, we analyzed the climatic variability simulated by the climatic models over the historical period and compared it with the observed climatic variability. None of these climatic models can reproduce accurately the present natural climatic variability. Then, to assess the risk of ecosystem disruption in the future and to identify the vulnerable areas in Europe, we created an index combining several CARAIB outputs: runoff, mean NPP, soil turnover, burned area, appearance and disappearance of species. We evaluated the severity of change projected for these variables (period 2070-2099) relative to their current variability (period 1970-1999). Mean changes were considered severe if they exceed observed variability. The highest values of the index were found in southern Europe, indicating that the amplitude of the expected ecosystem changes largely exceeds current interannual variability in this area. This spatial risk index and the projections of potential shifts in species distributions are directly dedicated to current forest management to guide in planting or in assisted migration.