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Simulating the impact of abrupt AMOC changes on vegetation and carbon stocks with the ORCHIDEE/IPSL models

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The last glacial period has been punctuated by two types of abrupt climatic events, the Dansgaard-Oeschger (DO) and Heinrich (HE) events. These events, recorded in Greenland ice and in marine sediments, involved changes in the Atlantic Meridional Overturning Circulation (AMOC) and led to major changes in the terrestrial biosphere. Here we use the dynamical global vegetation model ORCHIDEE, forced off-line by the IPSL_CM4 general circulation model, to simulate the response of vegetation to abrupt changes in the AMOC strength, with a focus on western Europe where many pollen records are available to compare with. We investigate the impact of a collapse and recovery of the AMOC, at different rates, obtained by adding freshwater fluxes in the North Atlantic.

ORCHIDEE simulates correctly the regression of forests and expansion of grasses over Europe in response to the cooling induced by a collapse of the AMOC, with a lag of about 200 years between climate and vegetation. The lag for a gradual recovery of the AMOC is of the same order of magnitude. A run with a rapid shift of the AMOC from 0 to 30 Sv within 150 years, mimicking the warming phase of a DO event, does not exhibit a strong impact of such an hyperactive AMOC on the European vegetation compared to the glacial control state. Simulating the impact of an HE event thus appears easier than simulating the abrupt transition towards the interstadial phase of a DO. We also present the impact of the different AMOC changes on the carbon stocks at global scale.