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Small-scale physiological feedback effects under elevated atmospheric carbon dioxide concentration simulated with REMO-iMOVE

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With a regional climate model fully coupled to a dynamic vegetation model, we investigate the small-scale (0.44°) dynamic interactions between vegetation and climate under elevated atmospheric carbon dioxide concentration. The regional climate model REMO was coupled to core features of JSBACH (Jena Scheme for Biosphere Atmosphere Coupling in Hamburg) to model the interactive response of vegetation to changes in both atmospheric parameters and atmospheric chemical composition.

With this coupled regional model REMO-iMOVE we conducted two experiments over
a model domain covering Europe in 0.44° horizontal grid resolution. Both experiments were driven by the results of a global model simulation of ECHAM5 with prescribed constant CO_2 concentrations of 696ppm. In the first experiment, the atmospheric CO_2 concentration was able to influence the radiation absorption in the atmosphere, as well as the plant physiology. In the second experiment, the effect of elevated CO_2 concentration was acting again fully to the radiation absorption, but only half on the plant physiological properties.

In the first experiment the effect of stomatal closure due to elevated CO_2 concentrations in the atmosphere is modeled. The second experiment is a reference experiment, only considering the radiative but not the physiological effects of CO_2. Compared to the reference, most areas show stomatal conductance to be reduced between 30 to 50% during the summer months with a latitudinal trend. In many regions, stomatal closure hinders plants to evaporate, which results in a decrease in latent heat flux and increase in near-surface temperature.

Based on this conceptual analysis and model simulations, some possible consequences of atmospheric island effects are demonstrated. We suggest, that while there is no experimental means of testing this phenomenon, it should be considered in models explicitly in order to better predict vegetation responses to climate change.