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European BVOC emissions: A model comparison, and future emission trends from European forests.

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Plants emit a broad spectrum of biological volatile organic compounds (BVOCs) that play multiple roles in plant protection. These emissions are important in atmospheric chemistry, as a major source of non-methane atmospheric hydrocarbons, and also constitute a potentially large loss of carbon assimilated through photosynthesis. Any future changes in such emissions, either climatic or anthropogenic induced, could represent a potentially large feedback in the climate system. The predicted extent of European emissions under future climate change and the effect of such emissions on the predictions of terrestrial ecosystem models are investigated here. Previous approaches to modelling regional emissions have used a top down approach, linking emission models to dynamic vegetation models. Here, a more detailed bottom up approach is used, considering individual species emission factors, and using the process based forest growth model Gotilwa+.

Three emission models, ranging from purely empirical based algorithms, to process based models linked to leaf photosynthetic characteristics, were applied and compared to predict the emission of Isoprene and Monoterpenes. These models were coupled to the Gotilwa+ terrestrial biogeochemical ecosystem model to scale leaf emissions to the landscape level. Present day forest distributions were considered, with individual basal emission rates for the 80 dominant European tree species.

Simulation results run over currently forested areas in Europe on a 1'x1' pixel resolution show that BVOC emissions, though often an overlooked element of terrestrial ecosystem models, can play a significant role in the processing of carbon produced by photosynthesis. The level of this effect is shown to depend on the model applied and environmental conditions experienced. Total emission levels of Monoterpenes over Europe were predicted to increase under climate change, due both to the predicted expansion of the modelled Monoterpene emitting species and the response of emissions to environmental drivers. No change in the predicted emissions of Isoprene was observed. The debated inclusion of a CO_2response is examined and shown to have a potentially large effect on predicted future European emission rates. Results are compared with and without land use change to separate the response to a changing climate from changes in emission rates which are due to changing land use.

This work shows that the inclusion of emission processes can be of particular importance both in making accurate predictions on forest ecosystem responses to climate change scenarios, and in modelling global emission levels in dynamic global vegetation models, and should be incorporated into any such modelling attempt.