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Quantifying the effect of biogeochemical feedbacks on global climate change

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The purpose of this project is to quantify the spatial distribution and uncertainties related to the effect biological feedbacks have on the growth rate of anthropogenic gasses in the atmosphere. Large increases in CO_2 and other greenhouse gasses over the last 250 years due to anthropogenic activities have had a measurable effect on the earth's global mean surface temperature. Natural terrestrial and marine processes have reabsorbed large proportions of the anthropogenic CO_2; however the future role that these negative feedbacks will be able to play remains uncertain.

As a first step towards developing a spatially explicit global reduced-complexity model of coupled biogeochemical-climate feedbacks, a zero-dimensional model is developed to determine the change in global mean temperature with respect to a change in CO_2 concentration over time. The change in CO_2 concentration is a function of various processes. In this study we focus on industrial and land use emissions, terrestrial uptake, and marine uptake. The change in CO_2 concentration is related to its radiatively equivalent change in solar irradiance and used in calculating the global mean temperature change. The mode is tested by comparing the output temperature and atmospheric CO_2 values to historical data. Predictions of variation in global mean temperatures over the next 200 years are made under various assumptions concerning emission rates and sink activities.

The model can be expanded in various ways. The contribution of different regions to the terrestrial and oceanic sinks can be made explicit. This allows analyses of the effect and relative importance of a variation in CO_2 exchanges in each region on the

global climate feedback. The climate response to variation and relative contribution of each of the processes involved in the feedback cycle can also be investigated. Processes such as respiration, permafrost melt, fire, seawater stratification, etc. can be included. Feedbacks occur due to surface fluxes of different gasses, not only CO_2, therefore changes in concentrations of various gasses in the atmosphere can be investigated, as well as the interaction between these gasses. The consequences of different assumptions concerning the responses of greenhouse gas fluxes to climate and the responses of climate to GHG forcing will be investigated. A key source of knowledge for these parameterisations will be the various projects taking place across the GREENCYCLES network. These analyses will quantify the climate response to a range of biogeochemical feedback processes, and their contributions to uncertainties in the evolution of the earth system over the next couple of decades.