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Quantifying carbon-cycle and climate feedbacks

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When a radiative forcing is imposed on the climate system, for instance due to changes in atmospheric CO2 concentration, the system responds in various ways which affect its radiative balance, such as changes in black-body cooling to space, surface albedo and cloudiness. These radiative terms jointly determine the steady-state temperature change for a given radiative forcing. When carbon dioxide is emitted into the atmosphere from combustion of fossil fuels, the carbon system is affected in various ways which lead to release or uptake of carbon in terrestrial reservoirs and the ocean, such as through changes in respiration, primary productivity and solubility. These processes jointly determine the change in CO2 concentration. Some of them depend on climate change, some on CO2 concentration. Climate and carbon constitute a coupled system, and their feedbacks can be expressed in formally similar ways. The coupled system determines the covariation of temperature and CO2 due to non-CO2 forcings, such as insolation. The climate-carbon interaction can be viewed as a feedback either on the carbon system or on the climate system. The carbon system may be approximated as a steady state on multi-century timescales, but on decadal timescales it cannot; this suggests a need to find different metrics and experiments for quantifying its behaviour in the coming century.