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Positive feedback between global temperature changes and atmospheric CO2 concentration in Earth System Model simulations over the last Millennium

Johann Jungclaus, Stephan Lorenz, Victor Brovkin, and Bjorn Stevens
Max Planck Institute for Meteorology, Hamburg, Germany (johann.jungclaus(at)zmaw.de)

A positive correlation between temperature and atmospheric concentration of CO2 is prominent in geological archives across interannual to Milankovitch time-scales. However, the magnitude of this positive carbon cycle – climate feedback is uncertain. Observation-based estimates of the atmospheric CO2 sensitivity to global temperature change depend on the choice of reconstruction and the period considered.

Here we present analyses of ensemble simulations over the period 800 AD to present carried out with the Max Planck Institute for Meteorology Earth System Model. The model consists of the atmosphere model ECHAM5 and the ocean model MPIOM. Modules for land surface (JSBACH) and ocean biogeochemistry (HAMOCC) are included to simulate an interactive carbon cycle. The combination of a multi-millennia control run, single-forcing experiments, and simulations using all natural and anthropogenic forcings allows for discrimination between internal variability and externally-driven climate change. Strong and coherent relations emerge between CO2 and the global surface temperature (SAT) in particular at decadal to centennial time-scales. The CO2 sensitivity to global temperature change is less than 4ppm/K in the control experiment. It gets higher (between 5 and 7 ppm/K) in the forced experiments. Analysis of the response to various forcing components will be presented.