Radiative forcing of the physiological CO_2 response

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Theory and observations indicate that plant stomatal conductance decreases in response to increase in the atmospheric CO_2. This physiological CO_2 response causes reduction in the evapotranspiration and modification of the global hydrological cycle, affecting the global radiative fluxes and climate sensitivity. While this biogeophysical mechanism is included into all comprehensive Earth System Models, its radiative forcing has not been isolated from the other biospheric feedbacks. To evaluate the scale of its radiative forcing, we performed two sensitivity experiments with the CMIP6 version of the MPI Earth system model (MPI-ESM1.2-LR). In addition to the standard 4xCO_2 simulation, in which both climate and carbon cycle respond to an instantaneous 4-fold increase in CO_2, we performed the 4xCO_2rad simulation in which biogeochemistry and plants were not affected by elevated CO_2. We analyse changes in outgoing radiation and surface temperature using the Gregory et al. (2004) approach for radiative forcing, and compare results with- and without physiological CO_2 response. Rescaling to the doubling of the CO_2 concentration, stomatal conductance response increases equilibrium climate sensitivity of the model by ca. 10%, and its radiative feedback is estimated at 0.14 W/m^2/K. This suggest that the magnitude of this positive biogeophysical feedback is comparable with the magnitude of biogeochemical (climate-carbon) feedback.

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