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Atmospheric Energy Budget Changes During 3000 Year CO_2 Forced GCM Experiments

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Two fully coupled GFDL climate models (CM3 and ESM2M) have been run into equilibrium after a doubling of CO_2. CM3 reached an equilibrium surface temperature (ECS) of 4.7 K, while ESM2M reached an ECS of 3.4 K. The difference between the ECS values can mainly be attributed to the shortwave cloud feedback being positive in CM3 and almost zero in ESM2M. Due to these differing cloud responses CM3 experiences an increase in downward solar radiation at the surface, while ESM2M experiences a decrease. These differences in the surface energy budget response also impact the global perception, which increases by 30% more per Kelvin warming in CM3 compared to ESM2M.
We found that the ECS of both models to be greater than the estimates in IPCC-AR5. This is caused by climate sensitivity increasing in time. Most of this increase was found to occur within the first century after CO_2 concentrations were held fixed, but in the case of ESM2M there are notable changes over the first 1000 years. For both models at the surface, the change in downward shortwave radiation was most impacted by the varying climate sensitivity. These results suggest in a warming climate that not all variables in the global energy budget will scale linearly with global surface temperature change.