Geophysical Research Abstracts
Vol. 16, EGU2014-10418, 2014
EGU General Assembly 2014

Continued global warming after CO_2 emissions stoppage

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Recent studies have suggested that global mean surface temperature would remain approximately constant on multi-century timescales after CO_2 emissions are stopped. Here we use Earth system model simulations of such a stoppage to demonstrate that in some models, surface temperature may actually increase on multi-century timescales after an initial century-long decrease. For example, global mean surface temperature may increase by 0.6°C after a carbon emissions stoppage at 2-degree. This increase occurs in spite of a decline in radiative forcing that exceeds the decline in ocean heat uptake—a circumstance that would otherwise be expected to lead to a decline in global temperature. The reason is that the warming effect of decreasing ocean heat uptake together with feedback effects arising in response to the geographic structure of ocean heat uptake overcompensates the cooling effect of decreasing atmospheric CO_2 on multi-century timescales. Our study also reveals that equilibrium climate sensitivity estimates based on a widely used method of regressing the Earth's energy imbalance against surface temperature change are biased. Uncertainty in the magnitude of the feedback effects associated with the magnitude and geographic distribution of ocean heat uptake therefore contributes substantially to the uncertainty in allowable carbon emissions for a given multi-century warming target.