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Evolving patterns of surface heat fluxes influence global radiative feedback strength

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In most climate models, after an abrupt increase in radiative forcing, the magnitude of the climate feedback parameter decreases with time. We demonstrate how the evolution of the pattern of surface warming and ocean heat uptake – moving from a more homogeneous toward a more high latitude enhanced pattern – influences not only regional but also global climate feedbacks.

We bridge the gap between complex fully coupled models and highly simplified aquaplanet models: We force a slab ocean model (including realistic topography, spatially varying mixed layer depth, sea ice, and seasonal varying solar insolation) with scaled patterns of ocean heat uptake derived from a coupled ocean-atmosphere general circulation model. We also introduce a new method to quantify feedback strength using this scaled heat flux forcing.

Our results show that steady-state results from the slab-ocean approximate transient results from the dynamic ocean configuration. Small scale, regional pattern of ocean heat uptake and release are sensitively reflected in the the cloud radiative response, which decreases the magnitude of the climate feedback parameter. Thus, the ocean strongly affects atmospheric temperatures through both heat uptake and through influencing atmospheric feedbacks. This highlights the challenges associated with reliably predicting transient or equilibrated climate system states from shorter-term climate simulations.

Rugenstein, Caldeira, Knutti, 2016: *Dependence of global radiative feedbacks on evolving patterns of surface heat fluxes*, GRL