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Climate transitions and state-dependent climate sensitivity in NCAR CAM3 simulations over a broad range of radiative forcing

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We explore the climate sensitivity of the NCAR CAM3 model coupled to a slab ocean in a set of simulations spanning a broad range of atmospheric CO_2 concentrations using both modern and Eocene configurations. We find that in both configurations, climate sensitivity increases sharply above a certain temperature threshold which is associated with major changes in the atmospheric general circulation. Application of an offline 'partial radiative perturbation' feedback diagnostic scheme shows that the increase in sensitivity is largely due to cloud feedbacks. To further test the robustness of this sensitivity behaviour to uncertainty in cloud and convective parameterizations, we repeat the simulations using an alternative parameter setting specifically chosen to optimize the fit of modern simulations to observations. We find that this alternative setting produces similar results as the standard setting but with an overall higher sensitivity. Finally, noting that one of the Eocene simulations gives a remarkably good fit to proxy-reconstructed early Eocene surface temperatures, we discuss the opportunities for estimating climate sensitivity from deep-time proxy data and the associated difficulties.