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Climate feedbacks in response to changes in obliquity

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The feedbacks involved in the response of climate to a reduction of Earth's obliquity are investigated in the GFDL CM2.1 coupled model. A reduction in obliquity increases the meridional gradient of the annual mean insolation, causing a strengthening of the atmospheric and ocean circulation which transport more heat poleward. The heat transport does not balance the direct obliquity forcing completely and additional local radiative fluxes are required to explain the change in equilibrium energy budget. The surface temperature generally increases at low latitudes and decreases at high latitudes following the change in the insolation. However, in some areas, the sign of the temperature change is opposite to the forcing, indicating the strong influence of feedbacks. These feedbacks are also responsible for a decrease in the global mean temperature despite the fact that the change in the global mean insolation is close to zero. The processes responsible for these changes are increases in the ice fraction at high latitudes and the global cloud fraction, both of which reduce the absorbed solar radiation. A reduction in the global greenhouse trapping, due to changes in the distribution of the water vapor content of the atmosphere as well as a change in the lapse rate, has an additional cooling effect. Among these feedbacks, clouds and lapse rate have the larger contribution, with water vapor and surface albedo having a smaller effect. The implications of the findings presented here for interpretation of obliquity cycles in the paleoclimate record are discussed.