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Is Antarctic Glaciation an Important Component of Earth System Sensitivity?

A. Goldner (1), M. Huber (1), and R. Caballero (2)

(1) Purdue University, Earth and Atmospheric Sciences, Lafayette, Indiana, United States (agoldner@purdue.edu), (2) Bert Bolin Center for Climate Research and Department of Meteorology (MISU), Stockholm University, Stocklholm, Sweden (rodrigo@misu.su.se)

Here we compare the sensitivity of climate to the presence or absence of Antarctic glaciation in Eocene and modern future contexts in slab ocean configuration using the Community Earth System Model (CESM1.0) from the National Center for Atmospheric Research (NCAR). Simulations show that adding the Antarctic ice sheet into late Eocene climate on average has a 0.3 K global cooling effect. This is in contrast to the near-future simulations which show a 0.8 to 1.2 K change, this is despite the fact that the surface albedo perturbation is similar in all cases. The increased surface albedo and decreased absorbed radiative flux at the surface is offset by a negative cloud forcing feedback which acts to warm the Eocene glacier simulations. This cloud forcing mechanism does not occur in the future simulations as significant global cooling occurs. Additional late Eocene simulations where the height and surface albedo are increased over Antarctica produce an enhanced negative cloud feedback response in comparison to the late Eocene simulations where only the surface albedo was changed.

The results from this study have two major conclusions. 1) Within this model the radiative impacts induced by the Antarctic ice sheet does not significantly cool the planet at the Eocene/Oligocene Transition (EOT) and that other factors like declining atmospheric CO_2, changes in orbital cycles, and oceanic/atmosphere interactions are more important in regulating the temperature transition at the EOT. 2) Modern understanding of climate ice albedo and cloud feedbacks may not always be directly applied to past climate where boundary conditions and climate feedbacks may have been different than today. The implication of these results is that estimating paleoclimate sensitivity from even the grossest forcings will be made challenging by uncertainties in feedback processes.