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Influence of Antarctic Ice Sheet Lowering on Southern Hemisphere Climate

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It has long beeen recongnized that the Earth's climate system is influenced by the configuration of large-scale topography which plays a significant role to characterize the dynamical and thermodynamical aspects of the climate/weather. The impact of changes in the Antarctic Ice Sheet (AIS) topography on the climate system may be usefully investigated on the basis of coupled climate experiments, designed to inter-compare the nature of the atmospheric and oceanic circulation under modern conditions and those conditions induced by anomalous AIS topographic forcing. This approach provides an unique opportunity to study the importance of changes in the AIS topography in amplifying global climate features in the time-space domain. Furthermore, it may contribute to the understanding of the climate occured in the transition from Eocene to Oligocene (between 30 and 35 Million years ago) during the onset of the Antarctic ice sheet. In order to investigate the climate response to changes in the AIS topography, two model simulations have been performed with the SPEEDO (Speedy-Ocean) coupled model. A modern simulation driven by present day boundary conditions (MOD) and a second experiment which includes modification in the AIS topography (AIS). In this simulation the height of the Antarctica ice sheet is lowered by 25%. This modification reduces the top of the Antarctica ice sheet by approximately 700-1000 m. The new topography configuration may characterize the transition during the middle and late Miocene (15 million years ago).

The results show that oceanic changes between both simulations are evident in the Southern Ocean with values as higher as 4°C in the AIS simulation as compared to the CTR. These changes are more pronounced in the Atlantic and Indian oceans which is in close agreement with the weakening of the wind stress, and enhanced southward advection. Moreover, reduced AIS also leads to weaker zonal windstress between 40°S-60°S which feeds back the initial warming tendency. Modification of the AIS topography induces substantial modification in the AABW but not in the NADW differently of what is expected based on the interhemispheric seesaw assumption. In this sense, one may conclude that the dynamical and mechanical effects of the Antarctic ice sheet topography are crucial to determine past, present and future climates.