Geophysical Research Abstracts
Vol. 14, EGU2012-4743-1, 2012
EGU General Assembly 2012

Transition to a climate state qualitatively different from modern in NCAR CCSM simulations of the Eocene

R. Caballero (1), M. Huber (2), and J. Hanley (1)

(1) Department of Meteorology, Stockholm University, Stockholm, Sweden (rodrigo@misu.su.se), (2) Earth and Atmospheric Sciences, Purdue University, Indiana, USA

Recent paleoclimate proxy reconstructions indicate that global-mean surface temperatures in past warm climates may have been some 10-15°C higher than today. Little is known about atmospheric dynamics at temperatures this warm. In particular, is it possible that the general circulation may transition to a qualitatively different state at warm enough temperatures? We study this question in a set of simulations using NCAR's Community Climate System Model in both full- and slab-ocean configurations with a range of atmospheric CO_2 concentrations extending from preindustrial values (280 ppm) up to 8960 ppm (5 doublings). We find that the simulation at 4480 ppm CO_2 gives a remarkably good fit to recent surface temperature reconstructions of the early Eocene, and does not suffer from the classical 'low gradient' problem. We also find that the atmospheric general circulation in this and warmer simulations differs qualitatively from the modern regime in at least two major ways:

1) When equatorial surface temperatures exceed ∼33°C, the model undergoes a transition to equatorial superrotation, a state with strong annual- and zonal-mean westerlies on the equator. The transition is driven by zonal momentum convergence due to large-amplitude transient eddies on the equator. These eddies have a structure similar to the observed Madden-Julian Oscillation (MJO). The model's MJO variability is weaker than observed when simulating the modern climate but increases sharply with temperature, coming to dominate the tropical variability and mean state of the warmest climates.

2) Poleward atmospheric moisture transport across midlatitudes *decreases* with increasing temperature, the opposite behaviour to that at temperatures close to modern. We account for this non-monotonic behaviour in terms of a simple diffusive model of the oceanic storm tracks which suggests that it is due mostly to the drop in mean eddy amplitudes as temperature increases.