



## **Sensitivity to CO<sub>2</sub> of the Eocene climate - implications for ocean circulation and glaciation**

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Here we present an ensemble of fully coupled GCM simulations which investigate the sensitivity of several aspects of the Eocene climate system to CO<sub>2</sub>. We use the UK Met Office model, HadCM3L, and simulate more than 3000 years of climate for 4 CO<sub>2</sub> concentrations (1\*, 2\*, 4\*, and 6\* pre-industrial).

The ocean circulation in the Eocene simulations is diagnosed. In particular, there is a reversal in the direction of the deep Atlantic water transport, going from northward in the 2\*CO<sub>2</sub> simulation to southward in the 6\*CO<sub>2</sub> simulation, in agreement with some proxy data (Nunes and Norris, 2006). The switch is associated with the formation of Antarctic Deep Water, and is driven by increasing atmospheric air temperatures over Antarctica, enhanced by snow melt. The model results suggest that the changes in circulation are a possible consequence of elevated greenhouse gas concentrations, rather than a driver of elevated PETM temperatures.

Regarding permanent glaciation, which has recently been proposed as being present during the Eocene at high latitudes, we find that significant ice sheets are only compatible with the Eocene climate up to 2\* pre-industrial values. However, small glaciers could have existed at high altitudes at 4\* and 6\* CO<sub>2</sub>.