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Early Eocene's climate and ocean circulation from coupled model simulations

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While proxy data provide a snapshot of climate conditions at a specific location, coupled atmosphere-ocean models are able to expand this knowledge over the globe. Therefore, they are indispensable tools for understanding past climate conditions. We model the dynamical state of atmosphere and ocean during the Early Eocene and pre-industrial times, using the coupled atmosphere-ocean model ECHAM5/MPIOM with realistic reconstructions of vegetation and CO_2. The resulting simulated climate variables are compared to terrestrial and oceanic proxies.

The Early Eocene climate is in the global mean warmer ($\sim$13°C) and wetter ($\sim$1 mm/d) than in pre-industrial times. Especially temperatures in the Southern Ocean, the Greenland Sea and Arctic Ocean raise by up to 25K, being in accordance with surface temperature estimates from terrestrial and marine proxy data. The oceans are hereby rendered ice-free, leading to a decrease of polar albedo and thereby facilitating polar warming. This leads to a by 5K diminished equator-to-pole temperature gradient.

Warmer temperatures as well as changed bathymetry have an effect on ocean dynamics in the Early Eocene. Although deep-water formation can be found in the Greenland Sea, Weddell Sea, and Tethys Sea, it is weaker than in the pre-industrial run and the resulting circulation is shallower. This is not only visible in water transport through sea gates but also in the Atlantic Meridional Overturning Circulation (AMOC), adopting its maximum at 700m depths in the Early Eocene, while maximum transport is reached in the pre-industrial control run at 1200m. Albeit a shallow and weak thermohaline circulation, a global ocean conveyor belt is being triggered, causing a transport from the areas of subduction through the Atlantic and Southern Oceans into the Indian and Pacific Oceans.