Understanding the Mid-Brunhes Transition in surface and oceanic climates based on model simulations

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The Mid-Brunhes Transition (or Mid- Brunhes Event) (MBT) is characterized by systematical changes in the intensity of the interglacials and in the atmospheric CO2 concentration around 430 ka BP. The interglacials after this date are generally stronger and have higher CO2 concentration than those before. To understand this climatic transition, I performed a series of climate simulations with the model LOVECLIM and using factor separation technique to quantify the individual roles of insolation and CO2 to the interglacial climates of the past 800,000 years.

My results show that CO2 plays a dominant role on the variations of the annual mean temperature of both the Globe and the southern high latitudes, whereas, insolation plays a dominant role on the variations of tree fraction, precipitation and of the northern high latitude temperature and sea ice. As far as surface climate is concerned, the MBT appears to be significant only in climate variables dominated by CO2, but not obvious in those dominated by insolation. This explains why the MBT occurs mainly in the southern hemisphere but not obvious in the northern one, a model result which is in line with proxy data observations.

However, in response to insolation changes only, feedbacks between sea ice, temperature, evaporation and salinity caused vigorous pre-MBT Antarctic Bottom Water formation and Southern Ocean ventilation. In parallel, strong Westerlies increased the pre-MBT overturning in the Southern Ocean via an increased latitudinal insolation gradient created by changes in eccentricity during austral winter and in obliquity during austral summer. The stronger bottom water formation led to a cooler deep ocean during the older interglacials. These insolation-induced results are unexpected, because there is no straightforward visible systematic difference in the astronomical parameters between the interglacials before and after 430 ka ago. Rather than being a real "event", the apparent MBE appears in my results to originate from the complex response of the climate system to the astronomical and insolation forcings prevailing before and after 430 ka BP.

Related publications:

Yin Q.Z and Berger A., 2010. Insolation and CO2 contribution to the interglacial climate before and after the Mid-Brunhes Event. Nature Geoscience 3 (4), 243-246.

Yin Q.Z. and Berger A., 2012. Individual contribution of insolation and CO2 to the interglacial climates of the past 800,000 years. Climate Dynamics 38:709–724.

Yin Q.Z., 2013. Insolation-induced Mid-Brunhes Transition in the Southern and Deep Oceans. Nature, DOI 10.1038/nature11790.