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Bipolar teleconnection on millennial and orbital time scales: a modelling perspective

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High latitude paleoclimate records reveal a number of features which are still poorly understood. Considerable confusion was caused by observed phase lead of the Southern Hemisphere both on millennial and orbital time scales. Another apparently surprising fact is the lag of CO2 behind Antarctic temperature. These findings led some workers to the conclusion that the Southern Hemisphere is the primary driver of climate changes both on millennial and orbital time scales. The latter is, obviously, in a conflict with the classical Milankovitch theory. Using results of long-term transient simulations with a climate model of intermediate complexity I will argue that many features of bipolar paleoclimate records can be explained as a result of the influence of three major factors: changes in meridional Atlantic heat transport, carbon dioxide concentration and orbital forcing. In particular, on the orbital time scale, combination of these factors causes a considerable lead of the Southern Hemisphere temperature both during deglaciation and glacial inception, which does not contradict to the primary role played by the Northern Hemisphere forcing. On the millennial time scale, apparent lead of the Southern Hemisphere can be explained by the well-known mechanism of “bipolar seesaw”. The latter, however, is often understood too simplistic. In fact, the temperature changes in the high latitudes of the Northern Hemisphere are controlled by the oceanic heat transport from mid to high latitudes, while the Southern Hemisphere temperature changes result from changes in interhemispheric ocean heat transport and CO2 concentration. The overall conclusion is that the understanding of bipolar teleconnections requires extensive use of the comprehensive Earth system models.