One-to-one interhemispheric coupling of millennial polar climate variability during the last glacial in the new EPICA Dronning Maud Land ice core

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Abstract:

The glacial and deglacial climate evolution in the North Atlantic region was characterized by rapid shifts from cold stadial to warmer interstadial conditions. In contrast climate in the Circum-Antarctic region (as recorded in ice cores from the Indian and Pacific Ocean sector of the Antarctic ice sheet) exhibited slower millennial changes with temperature amplitudes of up to 3 °C during that time. Absolute synchronization of Greenland and Antarctic ice core records using the global atmospheric change in CH_4 concentrations accompanying the DO events in the North showed a conspicuous phase relationship with the South starting to cool as soon as the longest DO events in the North set in. This bipolar seesaw pattern can be explained by the transport of heat and freshwater connected to the Atlantic Meridional Overturning Circulation (AMOC), where a stronger (reduced) AMOC leads to increased (decreased) drainage of heat from the Southern Ocean heat reservoir. To what extent this concept is also able to explain the shorter and less pronounced climate variability found in Antarctic ice cores, however, remained obscure. Here we report on the high-resolution climate record from the new EPICA Dronning Maud Land (EDML) ice core which represents the first direct South Atlantic counterpart to the Greenland records. Methane synchronized, high resolution EDML isotope temperatures $\delta^{18}O$ clearly show a one-to-one bipolar seesaw coupling also for all the shorter DO events, with the amplitude of the corresponding Antarctic warming being linearly dependent on the duration of the concurrent stadial in the north. Accordingly we propose a new nomenclature for these Antarctic Isotope Maxima (AIM) which reflects this one-to-one relationship. Parallel changes in mineral dust and sea salt aerosol concentrations point to concurrent climate changes in the Patagonian dust source as well as short term reductions of the sea ice cover in the Atlantic sector of the Southern ocean at the onset of the AIMs.