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Modulation of the bipolar seesaw in the Southeast Pacific during Termination 1

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A well-dated and high resolution sea surface temperature (SST) record form the SE-Pacific (Ocean Drilling Project Site 1233 located within the northernmost Antarctic Circumpolar Current (ACC) off southern Chile (41°S)) provides new evidence on the timing and interhemispheric climate pattern during the termination of the last ice age (T1). Deglacial warming off southern Chile starts at ca. 18.8 kyr BP with a ˜2-kyr-long increase of nearly 5°C until ca. 16.7 kyr BP. Thereafter, temperatures remain comparatively stable until the beginning of a second warming step of ca. 2°C between ca. 12.7 and ca. 12.1 kyr BP. A comparison of our SST record to different Antarctic ice-core records suggests a general correspondence in the major temperature trends, particularly the two-step warming over T1. However, the deglacial warming as documented in Antarctic ice-cores is substantially more gradual than observed in our SST record where most of the initial warming occurs over a time-interval of only ca. 1200 years (18.8 to 17.6 kyr BP).

The timing of both the initial and the second warming step in our data, suggests that the SST response in the mid-latitude Southeast Pacific occurred quasi instantaneous to the starting slowdown of the Atlantic meridional overturning circulation consistent with the concept of the bipolar thermal seesaw. The occurrence of an "immediate" and

high amplitude response in our SST record requires a rapid transfer of the Atlantic signal to the SE-Pacific without involving the thermal inertia of the Southern Ocean that contributed to the substantially more gradual deglacial temperature rise seen in Antarctic ice-cores. The most plausible mechanism for this rapid transfer is a seesaw induced change of the coupled ocean-atmosphere system of the ACC and the southern westerly wind belt.

Model simulations suggest that in addition to the seesaw induced changes, SE-Pacific temperatures respond to orbital and greenhouse gas forcing, however, in a more gradual manner and distinct from the two-step warming observed in our proxy record. This two-step pattern is also apparent in the CO2 record from the Dome C ice-core and the correspondence of the deglacial pattern in SE-Pacific SST and the CO2 record is remarkable. Both the initial warming (ca. 5°C) and the second major warming step during the NH YD (ca. 2°C) in our SST record coincide with the most significant increases in CO2 (ca. 35 ppmv and ca. 15 ppmv). Assuming that our record largely reflects shifts of the coupled ACC/westerlies system, this concurrence is consistent with the previously suggested important role of such latitudinal shifts in controlling atmospheric CO2 contents.

Taken together, our results underline the importance of the superposition of seesaw related processes with other external forcings such as orbitally-induced seasonal variations of incoming solar radiation and atmospheric CO2 that were unique to T1. These processes involve regional and hemisphere-wide feedbacks through the southern westerly wind belt and the ACC system.