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Changes in southern hemispheric polar amplification over the past 5 million years revealed by climate modelling

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Knowledge on polar amplification is important to relate high latitude climate records to global mean temperature changes. Several studies have pointed out that the strength of polar amplification in the Northern Hemisphere varies considerably due to the presence of large ice sheets and more sea ice during colder climate conditions. As a result, the polar amplification in the Northern Hemisphere decreases for warmer climates. In this study, we address the fact that these changes in the Northern Hemisphere also affect the polar amplification in the Southern Hemisphere. We study the Southern and Northern Hemisphere amplification together over the past 5 million years with the CLIMBER-2 intermediate complexity model. Radiation, land ice extent and height, and greenhouse gases are prescribed as forcing. We find that in contrast to the reduction in polar amplification in the Northern Hemisphere, polar amplification in the Southern Hemisphere increases for warmer climates. The amplification decreases in the Northern Hemisphere from 2.7 during glacial conditions to 1.6 for a pre-industrial climate, which is line with other climate simulations. Over the same CO_2 range the southern hemispheric polar amplification increases from 1 to 1.6. This is caused by the fact that the atmospheric transport needed to balance the radiation surplus in the equatorial region needs to be compensated by relatively stronger transport of energy in Southern direction while the transport in Northern direction reduces. This reduction in Northern direction is driven by less (land and sea) ice resulting in a smaller meridional gradient in Northern direction and hence a smaller atmospheric transport. As a consequence, the traditional scaled (with LGM temperature) Dome C record needs to be corrected with a maximum of 0.6 degrees half-way glacial and interglacial conditions, if it is to be interpreted as global mean temperature change indicator. While this changes the amplitude, the phasing of temperature records from the Southern Hemisphere remains unaffected.