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Amplification of Rossby waves in the circumpolar trough – implications for Antarctic weather and climate

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Precipitation is the most important positive component of the Antarctic mass balance, which has been given increasing attention recently in discussions of climate change, since its response to global warming can considerably influence sea level change. A possibly increased precipitation in a warmer climate could mitigate sea level rise by storage of larger amounts of water in the Antarctic ice sheet. Thus knowledge of the Antarctic precipitation regime is highly important. The exchange of heat and moisture between high and mid-latitudes depends strongly on the state of the circumpolar westerlies. Amplification of Rossby waves in the circumpolar trough during the negative phase of the Southern Annular Mode (SAM) (corresponding to a decreased pressure gradient between mid- and high Southern latitudes and thus weaker westerlies) can lead to extreme precipitation events in both coastal and interior Antarctica, combined with considerable warming in the interior regions. Here we use ECMWF Interim Reanalysis data to investigate two weather situations related to amplification of Rossby waves in the Atlantic sector that led to extreme precipitation/warming and a hurricane-force storm, respectively. Both situations are associated with a strong northerly flow, thus advection of warm, moist air. In one case, lee cyclogenesis east of the Andes was followed by a strong intensification of the southeastward moving cyclone at the sea ice edge, where usually the highest baroclinicity is found. The cyclone caused wind speeds up to 32m/s at the German Antarctic wintering base Neumayer. The second case brought precipitation amounts that represented 60% of the total annual accumulation within 10 days at Neumayer. The northerly flow continued across the South Pole to the Pacific part of the Southern Ocean and led to substantial warming at South Pole and other inland stations. The behavior of SAM in a changing climate and its connection to ENSO variability, which is highly complex and nonlinear, is not fully understood yet. A systematic change of SAM to the negative (positive) phase could lead to higher (lower) precipitation and warming (cooling) of continental Antarctic.