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A model study on the relation between Southern Hemisphere Annular Mode and Antarctic Peninsula summer temperatures

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One of the regions on earth with the largest warming over the last 50 years is the Antarctic Peninsula region, where near-surface temperatures have increased by more than 3.5°C. A summer warming on the north-eastern (Weddell Sea) side of the orographic barrier of the Peninsula has led to the collapse of the northern sections of the Larsen Ice Shelf. Together with this observed warming, the summer Southern Hemisphere Annular Mode (SAM) has increased. The goal of this work is to improve our understanding of the effect of a strengthening of the westerlies on the local meteorological conditions in the mountain range on the Peninsula. We have studied whether part of the observed summer warming can be explained by this effect. As a tool we have used the regional atmospheric climate model (RACMO) at 14 km grid spacing. This model is driven at its lateral boundaries by fields from RACMO at 55 km grid spacing, which is in turn driven by ERA-15 re-analyses. The 7-year integration (1987-1993) is subdivided into two composites: the nine summer months with the highest values for the SAM index, as defined by the University of Washington, are compared with the nine summer months with the lowest SAM index. The results clearly support the hypothesis that the dramatic summer warming in the north-eastern side of the Peninsula is due to the interaction of the strengthening of the westerlies and the orographic barrier. During high SAM months, the relatively warm air is able to flow over the barrier and downslope föhn winds occur at the lee side. Modelled cloud cover and liquid and ice water content is found to increase on the windward and decrease on the lee-ward side of the barrier. The region of strongest sensitivity to the SAM is where ice shelf collapse has taken place and does not extend over Larsen-C.