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Southern Hemisphere Cyclone Development and its Impacts on Net Precipitation under Recent and Anthropogenic Climate Conditions

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This investigation studies Southern Hemisphere (SH) cyclone development around Antarctica and the Southern Ocean and its impacts on poleward moisture transport. Therefore, the meridional component of moisture flux is divided into time-averaged and transient parts that makes the main contribution compared to total flux. Net precipitation (P-E) is calculated by means of the divergence of the vertically integrated moisture flux. Hence, this study identifies the contribution of cyclonic activity to net precipitation within the Antarctic Circle (66°33'S). For this purpose, data of ERA40 reanalysis and a multi-model ensemble is analysed. This is done for recent climate conditions and for a 21st century time period according to the IPCC SRES A1B scenario.

Investigations of cyclone development are done by means of an objective identification and tracking algorithm. Compared to ERA40 the spatial distribution patterns of cyclone track density are well represented in most of the models. Analysis of the climate change signal at the end of this century shows a significant poleward shift of the track density in all analysed models. Furthermore cyclonic intensity related to the Laplacian of pressure reveals an increasing signal with maximum values in the east Pacific sector, the west Indic sector and the Australian sector of the Southern Ocean.

The climate change signal of the transient component of the vertically integrated moisture flux shows a significant increase in the multi-model ensemble mean. Maximum values are identified in the regions of maximum cyclonic intensification up to 45% in the Australian sector whereas the total column water vapour increases about 20%.

The net precipitation in the Antarctic Circle is slightly overestimated by the multi-model ensemble mean compared to ERA40. The transient flux divergence, i.e. net precipitation related to cyclonic activity holds more than 90% of total flux divergence in all simulations. The climate change signal shows an increase in the warmer climate about 12% in the multi-model perspective, whereas transient fluxes are the main contributor to these changes.