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Southern Hemisphere cyclone development and transient moisture flux under recent and anthropogenic climate conditions

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This study investigates Southern Hemisphere (SH) cyclone development around Antarctica and the Southern Ocean and connected impacts on moisture flux under recent and future climate conditions. Therefore, the meridional component of moisture flux is divided into time-averaged and transient parts. Investigations are done with reanalysis data and the data of a multi-model ensemble for recent climate conditions and for a 21st century time period according to the IPCC SRES A1B scenario.

Cyclone development is analysed by means of an objective identification and tracking algorithm. Compared to ERA40 and NCEP reanalysis products the overall spatial distribution patterns of cyclonic activity are well represented in most of the models although a partly large underestimation of the number of tracks is observed in individual models. The investigation of the climate change signal at the end of this century shows a poleward shift of cyclone track density in all analysed models. The climate change pattern may vary from model to model in detail but in an ensemble mean perspective increasing track density is found south of about 55°S with significant positive changes up to 20% around 65°S. Furthermore a significant intensification signal related to the Laplacian of pressure is identified with maximum values in the east Pacific sector, the west Indic sector and the Australian sector of the Southern Ocean.

The transient component of the vertically integrated meridional moisture flux holds the main contribution compared to total flux. Former studies identify maximum values around 40°S located at the South Pacific, the South Atlantic and the South Indic Ocean. These characteristics are in accordance with all model simulations. Under recent climate conditions up to 94% of the transient component of the vertically integrated meridional moisture flux is located between surface and 500hPa. This relation decreases to 90% in a warmer climate and leads to a higher contribution of transient waves in the upper troposphere. The climate change signal of the transient component of the vertically integrated moisture flux shows significant higher values in the multi-model ensemble mean in nearly all regions of the southern ocean up to 45% in the Australian sector whereas the total column water vapour increases about 20%.

The transient moisture flux in the upper troposphere has a higher contribution under future climate conditions. Nevertheless the main transient flux occurs still in the lower to middle troposphere and thus can be connected to cyclonic activities. The diagnosis of detailed mechanisms to explain changes in transient moisture flux and cyclonic development is part of ongoing studies.