Projection of the Antarctic surface mass balance by 2100 using MAR

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Abstract

While the next IPCC report on the Antarctic Ice Sheet (AIS) contribution to sea level rise will be based on CMIP5 models, the new generation of CMIP6 models suggests an even stronger warming for the end of the century. This study investigates the sensitivity of the Antarctic surface mass balance (SMB) components to different intensities of global warming.

Results

Projected SMB changes (2075-2099) vs the historical period (1980-2005)

Evaluation over the historical period (1980-2005)

Significant anomalies due to different atmospheric circulations and humidity patterns between the GCMs and ERA5.

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Data availability

Time-series evolution of the anomalies of the SMB over the Antarctic ice sheet including the ice shelves and only over the grounded ice (A) and its main components (Runoff and Snowfall) over the whole Antarctic ice sheet (B) compared to 1980-2003. A 21-year running mean has been applied to the original annual values.

While both grounded and ice shelf SMB are projected to increase in MAR(NOR) with a similar rate, the SMB simulated by MAR(ACC) suggests a decoupling between the ice shelves and the grounded starting around 2045.

Despite a similar increase in snowfall for both simulations, the strong increase in runoff over the ice shelves in MAR(ACC) will nearly compensate the increase in snowfall.

Introduction

While the next IPCC report on the Antarctic Ice Sheet (AIS) contribution to sea level rise will be based on CMIP5 models, the new generation of CMIP6 models suggests an even stronger warming for the end of the century.

Conclusion

In the context of global warming, the Antarctic SMB is projected to increase due to enhanced snowfall. However, projections based on a stronger warming reveal a significant increase in runoff that compensates the increase in snowfall.

The significant increase in melt, especially over the ice shelves could lead to more numerous ice shelf collapses through hydro-fracturing processes before the end of this century.

Methods

Model

We use the polar-oriented Regional Climate Model MAR(v3.10) to downscale 6-hourly GCM outputs.

Simulations (1980-2099)

MAR(NOR): MAR forced by NorESM1-M using RCP8.5 Representative of a moderate warming

MAR(ACC): MAR forced by ACCESS1.3 using RCP8.5 Representative of a mean CMIP6 warming

MAR(CN): MAR forced by CNRM-CM6 using SSP58.5 Representative of a strong warming

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