Geophysical Research Abstracts
Vol. 15, EGU2013-13909-1, 2013
EGU General Assembly 2013

Estimation of the Greenland ice sheet surface mass balance contribution to future sea level rise using the regional climate model MAR (Arne Richter Award for Outstanding Young Scientists Lecture)

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With the aim of estimating the sea level rise (SLR) coming from Surface Mass Balance (SMB) changes over the Greenland ice sheet (GrIS), we report future projections obtained with the regional climate model MAR, forced by outputs of three CMIP5 General Circulation Models (GCMs).

Our results indicate that in warmer climates, the mass gained due to increased winter snowfall over GrIS does not compensate the mass lost through increased meltwater run-off in summer. All the MAR projections shows similar non-linear melt increases with rising temperatures as a result of the positive surface albedo feedback, because no change is projected in the general atmospheric circulation over Greenland. Nevertheless, MAR exhibits a large range in its future projections.

By coarsely estimating the GrIS SMB changes from CMIP5 GCMs outputs, we show that the uncertainty coming from the GCM-based forcing represents about half of projected SMB changes. In 2100, the CMIP5 ensemble mean projects a SLR, resulting from a GrIS SMB decrease, estimated to be 4 ± 2 cm and 9 ± 4 cm for the RCP 4.5 and RCP 8.5 scenarios, respectively.

However, these future projections do not consider the positive melt-elevation feedback. Sensitivity MAR experiments using perturbed ice sheet topographies consistent with the projected SMB changes highlight the importance of coupling climate models to an ice sheet model. Such a coupling will allow to consider the future response of both surface processes and ice-dynamic changes, and their mutual feedbacks to rising temperatures.