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21st century Antarctic surface mass balance downscaling from global circulation models

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Most of the IPCC-AR4 Atmospheric Global Circulation Models (AGCM) predict an increase of the Antarctic Surface Mass Balance (SMB) during the 21st century that would mitigate global sea level rise. Present accumulation and predicted change are largest at the ice sheet margins because they are driven by snowfall, which mostly comes from warm, moist air arising over the land slopes. The coastal belt is also where complex processes of sublimation, melt and redistribution by the wind occur. Thus, high-resolution modelling (5 to 10 km) is necessary to adequately capture the effects of small-scale variations in topography on the atmospheric variables in this area, but limitations in computing resources prevent such resolution at the scale of Antarctica in full climate models. We present here a downscaling method leading to 10-km SMB resolution for century time-scales over Antarctica. We compute the effect of the fine topography on orographic precipitation and on boundary layer processes that lead to melt and sublimation. We show that the surface mass balance downscaled from ERA-Interim is in good agreement with field measurements for the last 40 years. We then display the SMB downscaled from LMDZ4 AGCM outputs (~60-km resolution), and show that the downscaling improves the agreement between present modelled and observed SMB. Finally, we present hi-resolution features of the Antarctic SMB evolution during the 21st century downscaled from LMDZ4 for different scenarios oand discuss the effect of the resolution on the Antarctic SMB contribution to sea level change. The downscaling model is a powerful tool that will be applied to others climate models for a better assessment of future sea level rise.