



Antarctic ice-sheet melting provides negative feedbacks on future climate warming

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Anthropogenic greenhouse gas emissions are likely to affect climate for millennia, notably due to the large thermal inertia of the oceans and the long memory of the ice sheets. Archives of the past suggest noticeable Antarctic Ice-Sheet (AIS) melting contributions to sea-level changes during the last deglaciation and glaciation, illustrating the possibility of massive freshwater input into the Southern Ocean, which could have influenced the climate. Recent observations report an accelerated melting of the West Antarctic Ice Sheet. This ice melting may partly explain the observed freshening of the Ross Sea observed during the past four decades. Freshening also appears in the Antarctic Bottom Water (AABW) and could limit this deep-water formation in the future and affect climate. While none of the coupled climate models participating to the IPCC Fourth Assessment Report take into account the AIS melting, it is necessary to evaluate the potential effect of this melting on projected long-term global warming. Here we show by using a three-dimensional climate model, which includes a comprehensive representation of polar ice sheets, that AIS melting moderates warming in the Southern Hemisphere, by up to 10°C regionally, in a 4xCO₂ scenario of 3000 years. This behaviour stems from the formation of a cold halocline in the Southern Ocean, which limits sea-ice cover retreat under global warming and increases surface albedo, reducing surface warming. Furthermore, we show that AIS melting, by decreasing AABW formation, restrains the weakening of the Atlantic meridional over-

turning circulation, which is a new illustration of the effect of the bipolar oceanic seesaw. Consequently, it appears that AIS melting strongly interacts with climate and ocean circulation globally. It is therefore necessary to account for this coupling in future climate and sea-level rise scenarios.