Research Program on Modeling Future Climate Change: Effects of Increased Atmospheric Carbon Dioxide and Other Climate Forcings

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Influence of the Continental Ice Retreat on Future Globabl Climate

The objective of this program is to study the potential impact of the continental ice retreat, including the melt of glaciers and mountain ice caps, and the Greenland and Western Antarctic Ice Sheets, on the future global climate with focus on the AMOC.

Recent results

Evidence from observations indicates a net loss of global land-based ice and a rise of global sea level. Other than sea level rise, it is not clear how this loss of land-based ice could affect other aspects of global climate in the future. Here, we use the Community Climate System Model version 3 to evaluate the potential influence of shrinking land-based ice on the AMOC and surface climate in the next two centuries, under the IPCC A1B scenario with prescribed rates of melting for the Greenland Ice Sheet, Western Antarctic Ice Sheet, and mountain glaciers and ice caps. Results show that the AMOC, in general, is only sensitive to the freshwater discharge directly into the North Atlantic over the next two centuries (Figure 1). If the loss of ice from the Western Antarctic Ice Sheet wouldn't significantly increase from its current rate, it would not have much effect on the AMOC. The AMOC slows down further only when the surface freshwater input, due to runoff from land-based ice melt, becomes large enough to generate a net freshwater gain in the upper North Atlantic. This further weakened AMOC does not cool the global mean climate, but it does cause less warming, especially in the northern high latitudes in general and in Europe in particular. The projected precipitation increase in North America in the standard run becomes a net reduction in the simulation that includes land ice runoff. But there are precipitation increases in west Australia in the simulations where the AMOC slows down due to the inclusion of land-based ice runoff.

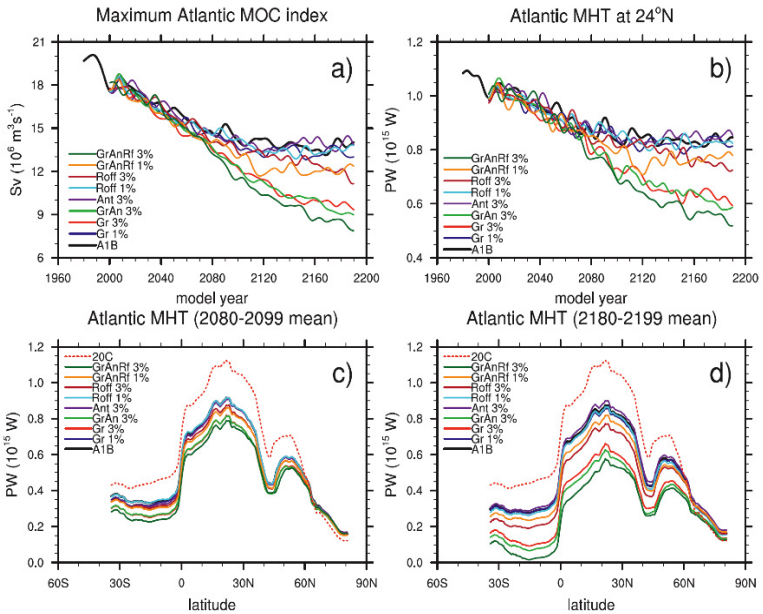

Figure 1. Changes of the MOC and MHT in the Atlantic. a) Time-evolving AMOC index; b) time-evolving Atlantic MHT at 24°N; c) the annual mean Atlantic MHT averaged over 2080-2099 for the sensitivity simulations and averaged over 1980-1999 (20C); d) the annual mean Atlantic MHT averaged over 2180-2199 for the sensitivity simulations and averaged over 1980-1999 (20C).