Response of basal melting in Antarctic ice shelves to climatic forcing under the last glacial maximum and CO2 doubling climates

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Basal melting of the Antarctic ice shelves is an important factor in the retreat of the marine Antarctic ice sheet, but little consensus exists on how the basal melting rate is affected by climatic forcing.

The Antarctic Ocean and basal melting of Antarctic ice shelves under the last glacial maximum, along with equilibrium CO2 doubling climate are investigated using a circumpolar ocean model with an ice shelf cavity forced by outputs of a climate model. Identical present-day topography is applied in these experiments to understand the role of climatic forcing. We show that basal melting rate increases as the climate warms, but it is much larger in the CO2 doubling climate than in the LGM despite the close magnitude of global radiative forcing.

The model results indicate that the difference in basal melting results from the difference in water mass formation in the shelf seas. Sea ice production in the Antarctic coast forms cold, saline and dense water in the shelf seas, and this water mass prevents intrusion of warm subsurface water originating from the Southern Ocean. Our model analysis shows that under warmer climate such as CO2 doubling climate, basal melting rate increases by intrusion of warm subsurface water due to decreased sea ice production, together with warmer water in the subsurface Southern Ocean.

These results imply that sea ice prodution and associated cold and saline dense water formation should be considered as an important mechanism which influences the rate of basal melting beneath ice shelves, by modulating the intrusion of warm Southern Ocean subsurface water onto continental shelves and beneath ice shelves.