Wind Effects on Circumpolar Deep Water Intrusions on the West Antarctic Peninsula Continental Shelf

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Relatively warm Circumpolar Deep Water (CDW) can be found near the continental shelf break around most of Antarctica. Advection of this warm water across the continental shelf to the base of floating ice shelves is thought to be a critical source of heat for basal melting in some locations. Changes in either the temperature or quantity of CDW moving onto the continental shelf have been proposed as a possible mechanism for increases in the basal melt rate of the ice shelves in some areas. Along the west Antarctic Peninsula (WAP), the southern boundary of the Antarctic Circumpolar Current (ACC) is adjacent to the shelf break which is relatively close to several ice shelves, allowing the effects of cross-shelf break transport of CDW to have a rapid impact on the basal melting of the nearby ice shelves.

A high resolution (4 km) regional ocean/sea-ice/ice shelf model of the west Antarctic Peninsula coastal ocean is used to examine the mechanisms of CDW intrusions onto the continental shelf. In the WAP, the previous view (based on broad scale hydrographic surveys) was that there were 4-6 intrusions per year in the Marguerite Bay area. However, mooring data in Marguerite Trough, the major pathway for CDW intrusions into Marguerite Bay, shows a much higher intrusion frequency of approximately 4 intrusions per month with the typical duration being 1-3 days (Moffat et al., 2009). Examining fluxes of not only heat, but a simulated "dye" representing oceanic CDW, shows that the model has about 2 intrusions per month in Marguerite Trough with an average duration of 1-4 days. The model solutions have a significant correlation between the along shelf break wind stress and the cross shelf break dye flux through Marguerite Trough suggesting that intrusions are at least partially related to short duration wind events.

The effects of possible changes in the winds on the CDW transport and basal melt have also been examined. Instead of performing full climate downscaling simulations, simplified simulations were run where the winds were scaled by constant (stronger or weaker) factors. One additional simulation was run with an increased ACC transport, forced by increased temperature and salinity gradients in the ACC fronts on the model lateral open boundaries. Increases in winds and ACC transport led to increases in the amount of CDW advected onto the continental shelf. However, these did not necessarily lead to increased CDW flux underneath the nearby ice shelves and the basal melt underneath George VI Ice Shelf actually decreased with increased wind strength.