The importance of short duration wind events on intrusions of Circumpolar Deep Water onto Antarctic continental shelves

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Abstract

The core of the Antarctic Circumpolar Current that surrounds the Antarctic continent consists of Circumpolar Deep Water (CDW), which is a mixture of deep water from all of the world's oceans. This relatively warm, nutrient-rich water mass can be found near the continental shelf break around most of Antarctica. Transport of CDW onto Antarctic continental shelves is critically important for several physical and biological processes. 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 several locations. Understanding the mechanisms involved in bringing this water mass onto the continental shelf is important in trying to determine how climatic change will affect the basal melt of some ice shelves.

The location and spatial extent of some of these intrusions have been known for a while, but until recently, little was known about the frequency. Mooring data in Marguerite Trough, the major pathway for CDW intrusions into Marguerite Bay on the western Antarctic Peninsula (WAP) continental shelf, show an intrusion frequency of approximately 4 intrusions per month, with no apparent seasonality and with the typical duration being 1-3 days (Moffat et al., 2009). A 4-km resolution regional ocean/sea-ice/ice shelf model of the WAP coastal ocean forced by AMPS forecast winds shows similar intrusion behavior with 2-3 intrusions per month with a typical duration of 1-4 days. The model solutions have a significant correlation between the along-shelf break wind stress and the CDW flux through Marguerite Trough suggesting that intrusions are at least partially related to short-duration wind events. The mechanism for these events may be due to momentum advection of the more intense flow on the inner shelf (due to the wind), but there also may be other causes. A more detailed study of these processes will require smaller grid spacing to better resolve the vorticity generated at the trough entrance that may result in eddying behavior. Preliminary results from a mooring in a trough on the central Amundsen Sea continental shelf also show a strong correlation between the along-shelf break winds (ECMWF-Interim reanalysis in this case) and the along trough velocity, again showing the importance of high frequency local wind forcing on the CDW intrusions.