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Key Points:
- Warm but modified CDW floods the continental shelf of the Bellingshausen Sea
- A cyclonic trough circulation that carries heat toward the coast is detected
- The mCDW flows westward at the shelf break, suggesting the Antarctic Slope Current

Supporting Information:
- Supporting Information S1
- Table S1
- Figure S1
- Figure S2
- Figure S3

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Circulation and meltwater distribution in the Bellingshausen Sea: From shelf break to coast

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Abstract West Antarctic ice shelves have thinned dramatically over recent decades. Oceanographic measurements that explore connections between offshore warming and transport across a continental shelf with variable bathymetry toward ice shelves are needed to constrain future changes in melt rates. Six years of seal-acquired observations provide extensive hydrographic coverage in the Bellingshausen Sea, where ship-based measurements are scarce. Warm but modified Circumpolar Deep Water floods the shelf and establishes a cyclonic circulation within the Belgica Trough with flow extending toward the coast along the eastern boundaries and returning to the shelf break along western boundaries. These boundary currents are the primary water mass pathways that carry heat toward the coast and advect ice shelf meltwater offshore. The modified Circumpolar Deep Water and meltwater mixtures shoal and thin as they approach the continental slope before flowing westward at the shelf break, suggesting the presence of the Antarctic Slope Current. Constraining meltwater pathways is a key step in monitoring the stability of the West Antarctic Ice Sheet.

1. Introduction

The Southern Ocean has experienced substantial changes since the last century, including warming throughout the water column [*Gille*, 2008] and freshening of bottom water [*Rintoul*, 2007; *Aoki et al.*, 2005; *Purkey and Johnson*, 2013]. Close to the Antarctic coast, remote observations have shown that basal melt has become the leading process for ice shelf thinning [*Pritchard et al.*, 2012] and mass loss [*Rignot et al.*, 2013] in Antarctica. Significant glacier thinning was observed as a consequence of the ice shelf loss [*Wouters et al.*, 2015]. However, the link between ocean warming and accelerated ice shelf basal melt is less clear, mainly due to the lack of observations at high latitudes and the complicated, bathymetrically influenced continental shelf circulation.

Various studies have addressed the oceanic forcing on ice shelf basal melt. In the central Amundsen Sea, persistent flow of warm Circumpolar Deep Water (CDW) has been observed on the continental shelf [*Arneborg et al.*, 2012; *Wåhlin et al.*, 2013; *Walker et al.*, 2013]. There is strong evidence that shelf water here includes a modified CDW-meltwater mixture [*Wåhlin et al.*, 2010; *Nakayama et al.*, 2013]. Measurements in the vicinity of ice shelves allow estimations of basal melt rates, such as the Pine Island Ice Shelf [*Jenkins*, 1999; *Dutrieux et al.*, 2014; *Nakayama et al.*, 2013]. There are also detailed studies of the Wilkins Ice Shelf and George VI Ice Shelf in the Bellingshausen Sea [*Padman et al.*, 2012; *Jenkins and Jacobs*, 2008]. In the western Bellingshausen Sea, hydrographic data are limited, although these measurements indicate that warm CDW found over the continental slope in this region is both warming and shoaling over the past two decades [*Schmidtko et al.*, 2014].

Warm CDW may enter the Bellingshausen Sea through the Belgica Trough and the Latady Trough to access the ice shelf cavities (Figure 1). Many ice shelves occupy the coast of the Bellingshausen Sea, all of which show positive basal melt rate [*Rignot et al.*, 2013] and volume loss in the last two decades [*Paolo et al.*, 2015]. The ice shelves east of 80°W have been relatively well studied and monitored [*Jacobs et al.*, 1996; *Jenkins and Jacobs*, 2008; *Padman et al.*, 2012]. Less is known about the circulation and melting of the two ice shelves west of 80°W. For example, although the Venable Ice Shelf covers a smaller area, its basal melt rate is higher than that of the more extensive Wilkins Ice Shelf [*Rignot et al.*, 2013]. Numerical simulations have shown high concentration of melt water in the Belgica Trough from Bellingshausen Sea ice shelves [*Nakayama et al.*, 2014],