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Discussions
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Interactive comment on "Brief Communication: Evidence of a developing Polynya off Commonwealth Bay, East Antarctica, triggered by grounding of iceberg" *by* C. J. Fogwill et al.

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We thank each of the reviewers for their detailed reviews, and in light of their comments and suggestions have updated our manuscript as outlined in the following paragraphs. The reviewers raise two key issues. Firstly, they request more details of the model, and question suitability of 2009 climatology in driving the pre-calving simulation. Secondly, they raise questions over the apparent contradiction between our observations and model simulations. In our resubmission we address these points directly, with an expanded model description and climatological analysis (within the main text, and the supplementary information), and perform further analysis of the trends in circulation and sea ice production off Commonwealth Bay in the model simulations that support

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our assertion that a polynya has developed in the lee of iceberg B09B. In addition, we have reformatted the figures within the main body of the text in line with the reviewer's comments, and include additional figures in the supplementary files to address the reviewer's specific comments as outlined in the paragraphs below. Again, we wish to thanks the reviewers for their detailed comments that have substantially strengthened this Brief Communication in the Cryosphere.

[1] Although this paper speculated the local DSW formation in the lee side of B9B from the T-S profiles (Fig.1 B and E), T-S profiles in the Mertz SW region (Fig.1 D and G) have also a similar structure. There is a possibility that DSW is advected from the east.

Response: 1. We appreciate the reviewer's point in regards to advection of water masses from the East, but our modelling argues against this hypothesis. This can be seen in Figure 1 and is discussed in the text with our vertically integrated velocity profile suggesting little advection from the East due to the blocking effect of B09B.

[2] Showing a summer image in Fig. 1A is misleading. Polynyas in winter and spring have different roles. While winter polynya plays a role in high sea ice and DSW productions, spring polynya is a sea ice melting area. It seems to me that showing winter sea ice concentration or sea ice production is a direct way to indicate an active formation region of sea ice and DSW.

Response: 1. Figure 1 was provided for context, not necessarily to show the polynya activity per se.

[3] The ocean model failed to reproduce the ocean properties. The observation (Fig. 1 B) shows an increase in summer salinity, but model does not. The temperature profiles are also different between the two.

Response: We acknowledge that this difference has not been fully explored in our original manuscript therefore in our updated manuscript we add the following text to section 3.2: The numerical simulations pre- and post-calving indicate a change in oceanographic conditions in the area of the B09B iceberg, demonstrating the development of a polynya area in the lee of B09B post-calving. The modelled sea-ice production (Tamura et al 2016) within the Mertz Glacier polynya decreases and is restricted to an area closer to the coast. On the other hand, sea-ice production in the lee of the B09B iceberg post-calving is shown to increase markedly (Figures 2A and B).

The modelled ocean circulation for December shows that pre-calving, a westward coastal current carried water masses from the Mertz polynya and Commonwealth Bay areas towards the Commonwealth Bay NW XCTD positions (red squares on Figures 2A and B), forming a stratified water column with warm and fresh surface water (Figure 2C). The cold and salty water mass simulated pre-calving at the NW Commonwealth Bay XCTD positions is advected from the Mertz polynya and Commonwealth Bay post-calving. Modelled water column stratification is stronger in winter when there is sea-ice production. The model simulates a relatively warm layer at around 150 m depth (-1.18 ËŽC) in July pre calving (Figure 2D). From 250 m to the ocean floor there is a cold (-1.92 ËŽC) and salty (34.67) water mass that originates from the advection of HSSW from the Mertz polynya and Commonwealth Bay.

Post calving, the coastal current is blocked by the B09B iceberg, associated with a decrease in sea ice production within the Mertz polynya; little HSSW is advected into the area of the Commonwealth Bay NW XCTDs. The model average for December shows a stratified water column in summer, due to the advection from the north of a relatively warm water mass in summer. However, the water column post calving at the Commonwealth Bay NW XCTDs is entirely homogeneous in potential temperature (-1.90 ËŽC) and salinity (34.54), illustrating an active polynya that locally produces HSSW capable of being convected to the sea floor in winter. The model does not simulate an increase in salinity post-calving, but the seasonality illustrates the potential of a polynya developing in the lee of the B09B iceberg to locally form HSSW dense enough to sink to the sea floor, as inferred from the trends in the summer observations. It should be noted that our model simulations do not show the current evolution of the impact of the calving, but rather simulate the ocean conditions for two stable ice geometries, before and after the Mertz calving, thus can not be directly inter-compared to our XCTD data. However, the trends indicated from our regional model simulations provide valuable insights into mechanisms driving the circulation changes triggered as a response to the grounding of B09B off Commonwealth Bay.

[4] There are no pronounced differences in ocean velocity. In first place, how can you speculate the polynya activity from ocean velocity? I expect that a (bottom) salinity field is more suitable to show the activity before and after the relocation of B9b.

Response: We now present the vertically integrated horizontal velocity together with the changes predicted in sea ice production which demonstrate the changes in ocean circulation together with the changes in sea ice production post grounding of B09B.

[5] Figure 1 should be revised. It is too small to see. Larger area which covers the Adelie Depression and the MGT is preferable. Please add bottom contour, grounding line, and ice front line to easily understand the regional configuration. I expect that active sea ice production near the B9B is on the Adelie Bank, not the Adelie Depression. If so, it seems to be difficult for the local water to be dense enough and to be exported from the Adelie Sill (where is the main pathway of DSW formed in the Adelie Depression).

Response: please see our response to point [3]

[6] More detail of the model configuration is required in section 2.2

Response: We have added further detail of the model setup to the text supported in detail in the supplementary information, as outlined in point 13 to Reviewer One.

[7] There are several sentences throughout the manuscript to speculate the impact on AABW. I don't think that emphasizing the connection to AABW at many place is important because this paper examined only the polynya near one large iceberg without showing the relative importance in the total DSW and AABW production. Some of them

should be removed.

Response: We recognise the reviewers point here and have addressed this throughout our revised manuscript.

Furthermore, we have addressed each of the minor comments highlighted by Reviewer One in the text of our updated manuscript.

We thank the reviewers for their input and detailed comments. Dr Chris Fogwill on behalf of the co-authors.

Interactive comment on The Cryosphere Discuss., doi:10.5194/tc-2016-19, 2016.

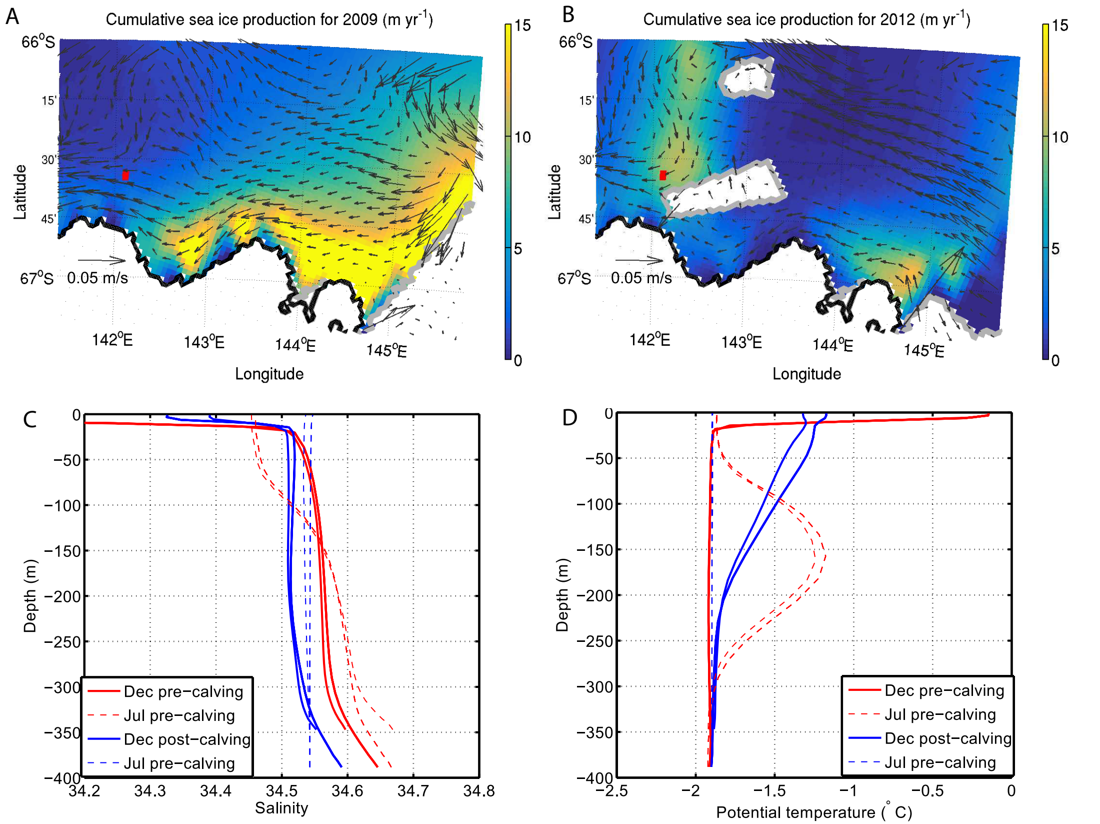

Fig. 1. Upper panels: Cumulative sea ice production (m/yr) for the two years of forcing for A pre- (2009) and B. post- (2012) calving simulations, overlaid with the vertically integrated horizontal velocity (

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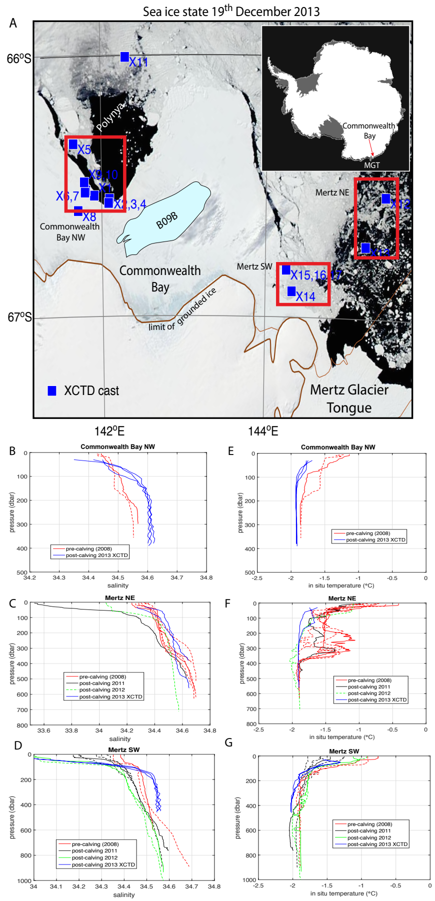

Fig. 2. Updated location and observation Figure