Supplement of The Cryosphere, 10, 2603–2609, 2016
http://www.the-cryosphere.net/10/2603/2016/
doi:10.5194/tc-10-2603-2016-supplement

The Cryosphere Open Access

Supplement of

Brief communication: Impacts of a developing polynya off Commonwealth Bay, East Antarctica, triggered by grounding of iceberg B09B

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Section 1. Model description

The model used here is based on the Rutgers version of the Regional Ocean Modeling System (ROMS) (Shchepetkin and McWilliams, 2005) that includes ocean/ice shelf and frazil ice thermo-dynamics (Galton-Fenzi et al., 2012; Dinniman et al., 2003). The horizontal and vertical grid is the same than presented in Cougnon et al. (2013). Without a dynamic sea ice model, the fine-scale polynya activity is resolved by forcing the surface of the model with monthly heat and salt from Tamura et al. (2016) data set that is based on sea ice concentration estimated with the Tamura et al. (2007) algorithm. This algorithm estimates thin ice thickness using Special Sensor Microwave Imager (SSM/I) observations and the European Centre for Medium-Range Weather Forecast Re-Analysis data (ERA-Interim). Water masses formed on the continental shelf in the model are controlled by the variability of the air/sea forcing as well as by the glacial melt water released from the local ice shelves. The model has been set up to compare the ocean and basal ice shelf melting changes post-calving compared with other years of similar heat and salt fluxes intensity within the MGP region. The year 2009 and 2012 are chosen for the pre- and the post-calving air/sea forcing simulations respectively, after analysing the monthly heat and salt fluxes averaged over the Mertz polynyna area for the period 1992 to 2013 (Figure S3). The year 2009 is representative to an average to strong sea ice production year in terms of heat and salt fluxes and 2012 was chosen in consideration of the fast ice and its representation of permanent features between 2010 and 2012 (A. Fraser personal communication). Fast ice is parameterised as in Cougnon et al. (2013) and Cougnon (2016), using an updated version of Fraser et al. (2012). Lateral boundary fields, including salinity, potential temperature and horizontal velocity, were relaxed to a climatology calculated from the monthly fields from the Estimating Circulation and Climate of the Ocean, Phase II synthesis (ECCO2) for the period 1992-2013 (Wunsch et al., 2009). It is important to note that salinity values used in the model are on the Practical Salinity Scale (PSS78) and are dimensionless. The total run time of the model simulation was 33 years for each simulation. This 33 year run includes a spinup phase of 30 years to reach equilibrium using a repeating loop of the climatology forcing. A climatology of the last 3 years of the run are used for the analyses.

Section 2. Selection of 2009 climatology

The choice of the year 2009 for the PRE simulation forcing was made after analysing the monthly heat and salt fluxes averaged over the Mertz Glacier Polynya (MGP) area for the period 1992 to 2013. The period from 2007 to 2009 was identified as a constant sustained period with a winter average (May to September inclusive) of about -164 W m^{-2}, while the average over the pre-calving period (1992-2009) is of -159±17 W m^{-2} (See Figure S3). Similarly, the salt fluxes averaged for 2007-2009 is of about 0.82 kg m^{-2}, while the averaged for 1992 to 2009 is of 0.82±0.1 kg m^{-2}. 2007 to 2009 can therefore be considered as being a representative period for the pre-calving MGP region. As a result, 2009 (the year closest to the calving) was chosen as the focus of the pre-calving simulation in this study to explore the general ocean conditions related to a stable ice geometry pre- and post-calving. Furthermore, given that only a single-year forcing is available for the post-calving simulation, a comparable single-year climatology is preferable for the pre-calving simulation. In the post-calving scenario, 2012 was chosen in consideration of the fast ice and its representation of permanent features between 2010 and 2012 (A. Fraser personal communication). In summary, the results from these simulations are not restricted to the year chosen for the forcing, they can be compared with other years of similar salt and heat flux intensity between 1992-2009.

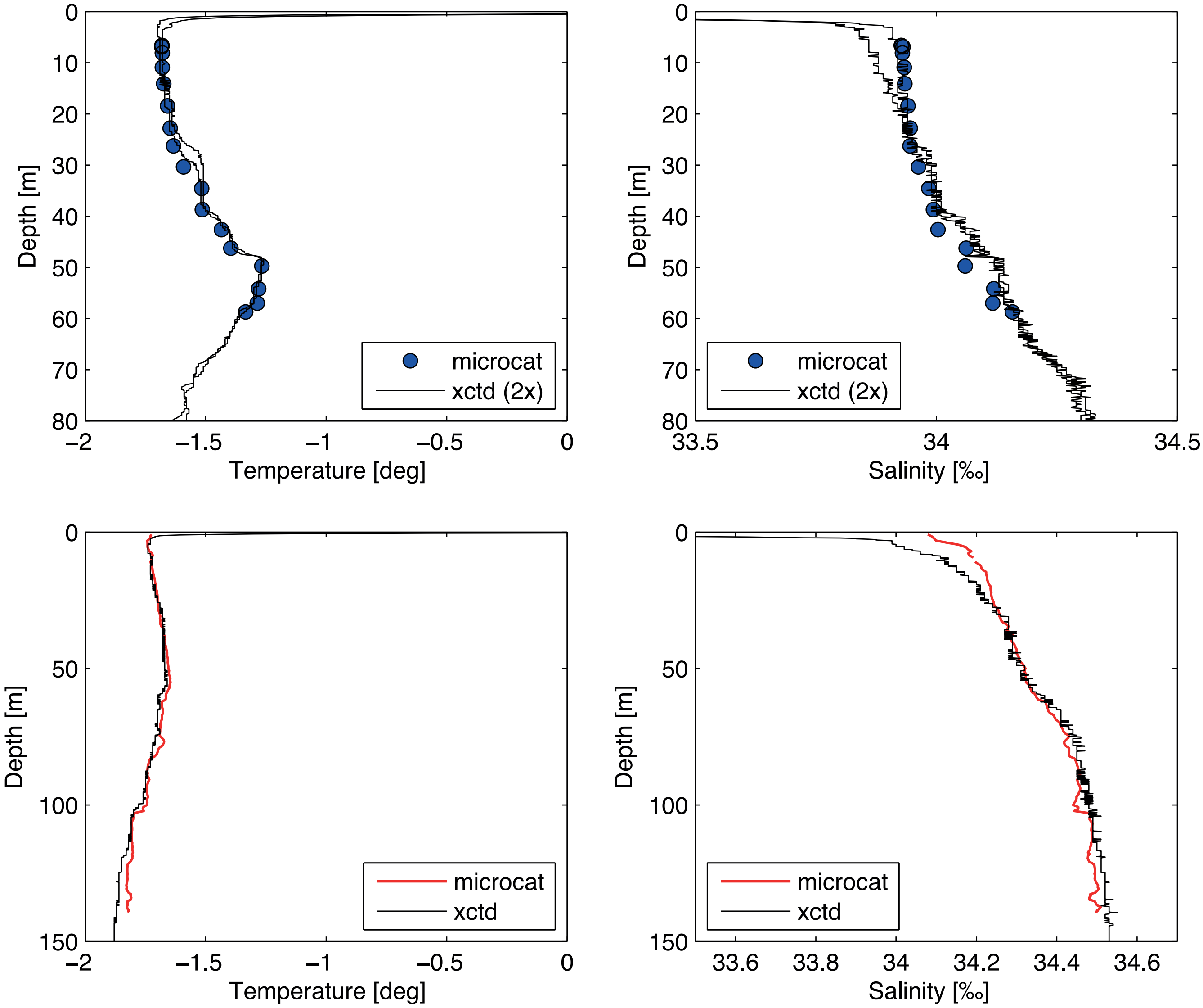

Figure S1. Comparison between XCTD and microcat temperatures (ºC) salinities (‰)

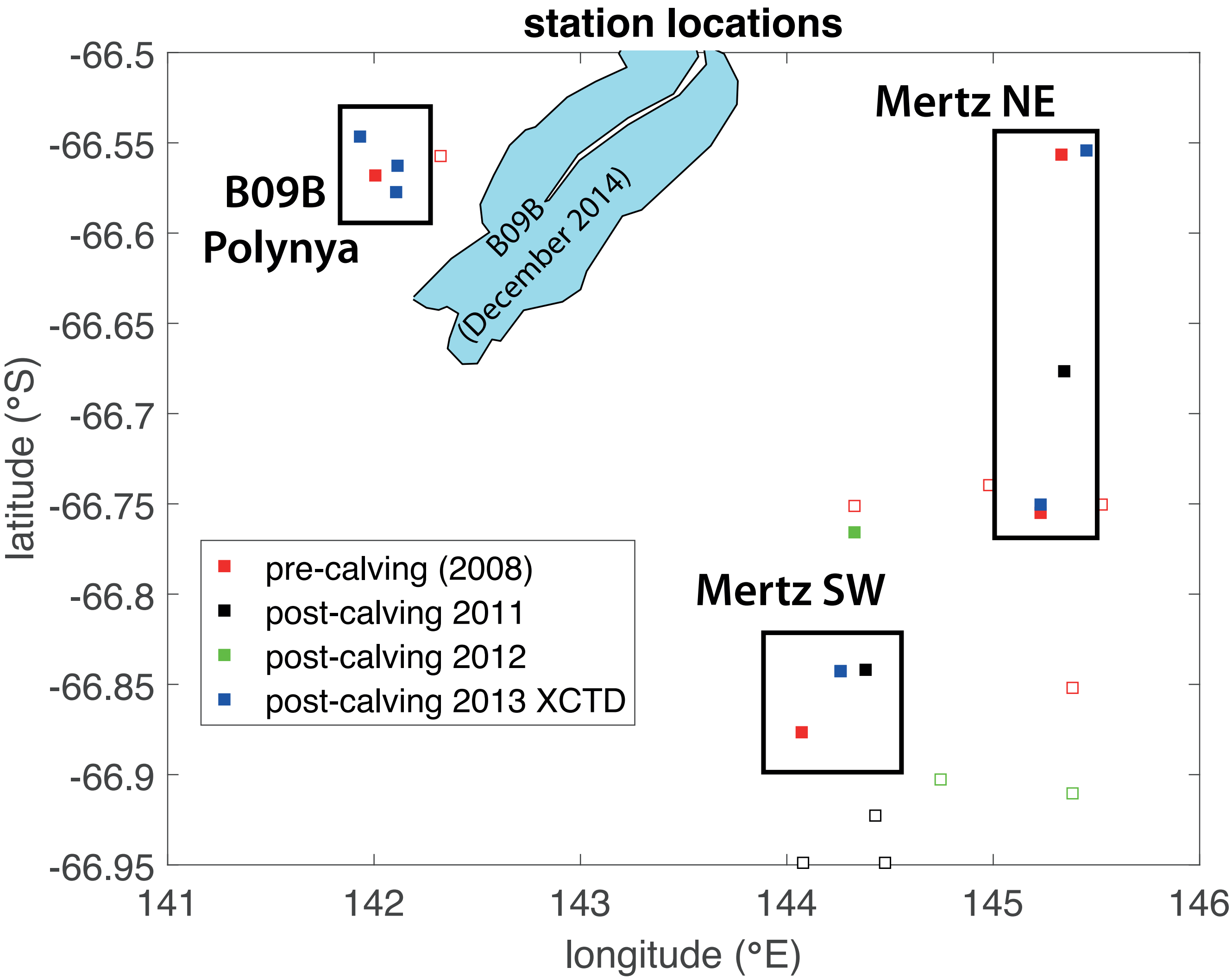

Figure S2. CTD and XCTD station locations used in inter-comparison

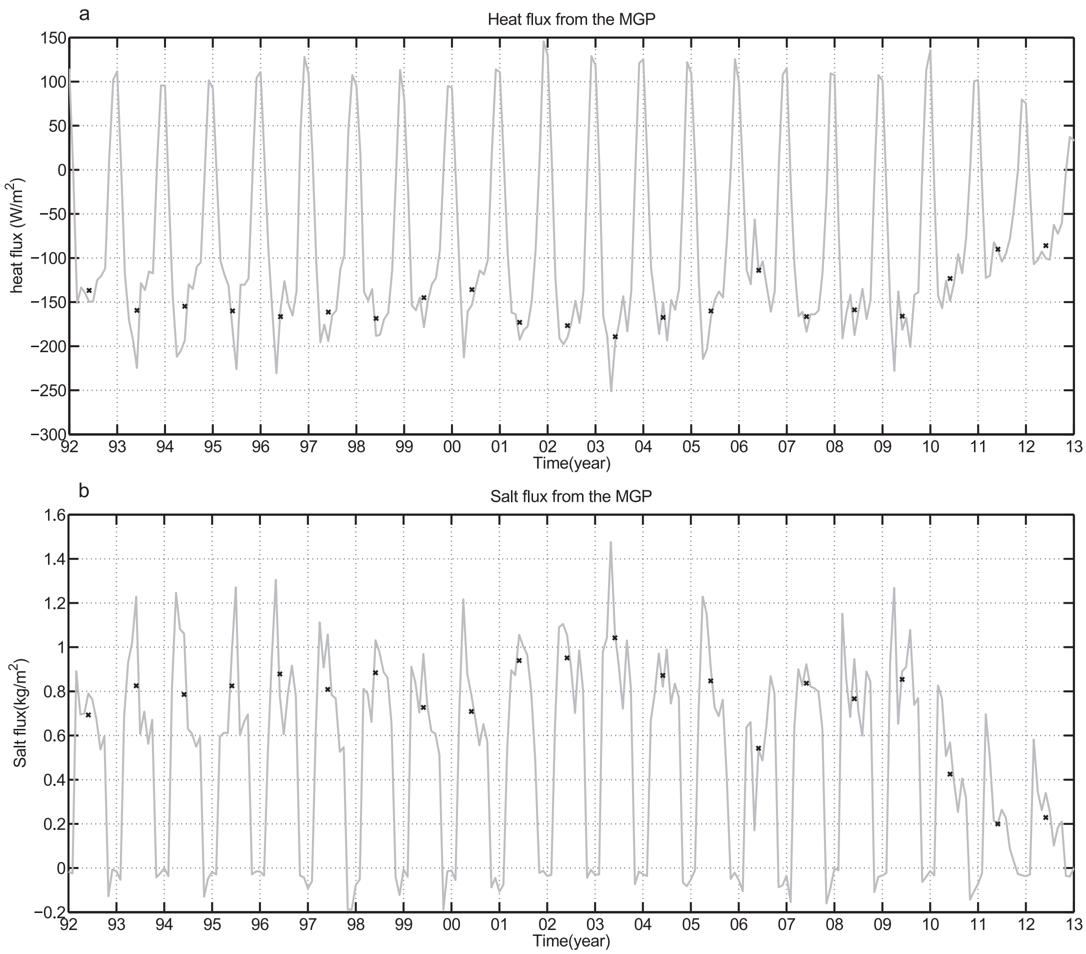

Figure S3. Monthly surface heat (a) and salt (b) fluxes averaged over the Mertz Glacier Polynya (MGP) from Tamura et al., (2016) data set used in the model, with winter time averages (May to September inclusive) shown with crosses (Cougnon 2016).

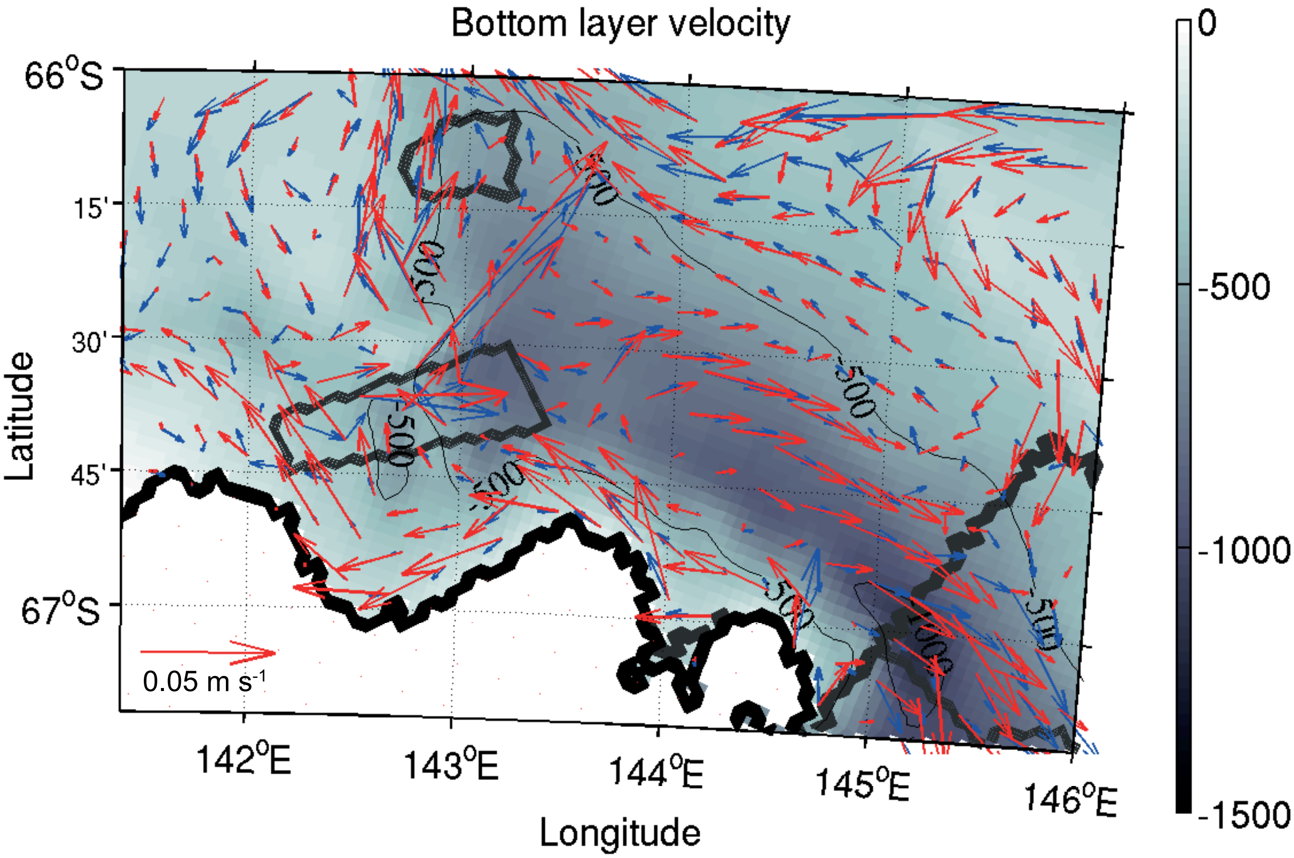

Figure S4. Time averaged horizontal velocity at the bottom layer of the model (m s-1) for the pre-calving (red) and post-calving (blue) simulations, for extended Commonwealth bay/Mertz Polynya area. Note vastly decreased post-calving westwards flow from Mertz Polynya. The grey contours outline the ice mask used in the model for both simulations and the black contour outlines the coastline. The bathymetry of the model (m) is shown at the background.

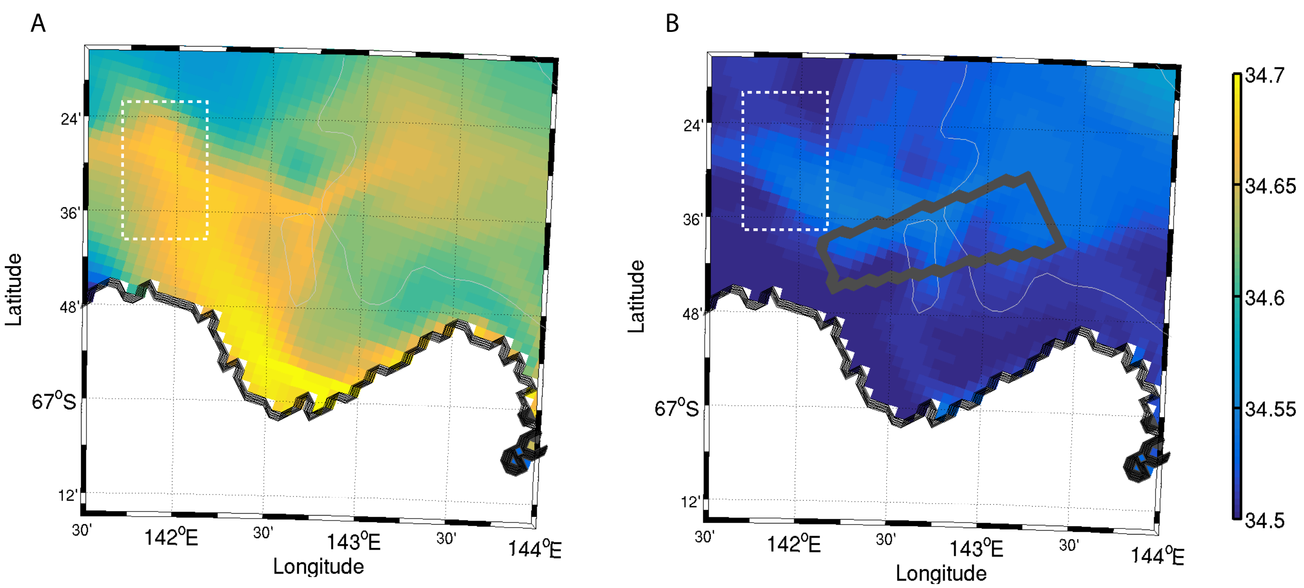

Figure S5. Simulated bottom salinity within the Commonwealth Bay area averaged for winter (June, July, August), for A. pre- and B. post-calving simulations. The outline of B09B can be seen in light grey, and the location of Commonwealth Bay NW area (white box).

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