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The Cryosphere Discussions

Interactive comment on "Frazil ice growth and production during katabatic wind events in the Ross Sea, Antarctica" *by* Lisa De Pace et al.

Anonymous Referee #2

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General comments

This study has revealed extremely high ice production via underwater frazil ice formation and the importance of intense events of frazil ice production in the Antarctic polynyas, based on direct observation under PIPERS project. The finding is novel and the method/analysis are appropriate. The study demonstrates that process of underwater frazil ice formation should be properly considered in the polynya process. In addition, observed polynyas are the sites where dense water, precursor of Antarctic Bottom Water, is formed. Therefore, I have no doubt that the contents of the paper contribute to understanding of sea ice –ocean interaction and the Antarctic oceanography significantly. Therefore, I highly recommend that the paper should be published in "Cryosphere", but with moderate revision. The revising points are listed below.

Major comments

1. This study estimated ice production for each event and shows large variance of ice production ranging from 7 to 378 cm day-1. Although these estimates are very valuable, an important quantity is the averaged ice production or annual (monthly) ice production, which controls the formation of dense water and thus Antarctic Bottom Water. Therefore, it is desirable to infer the averaged ice production based on the two-weeks' PIPERS project. The authors took the median value of 26 cm day-1 as a representative ice production. This is better than taking the average of all the events, considering the very large variance. Even so, the median seems somewhat ad hoc way. More reasonable estimate of representative or average ice production may be possible. For example, if ice production can be related to atmospheric (and oceanic) conditions, more reasonable estimate of average ice production would be possible. Once average or monthly ice production can be inferred, then comparison or discussion with the previous satellite estimates would be possible. The present study probably suggests that the previous satellite estimation underestimated the polynya ice production.

2. Ice production has very large variance from 7 to 378 cm day-1. What are the key points (reasons) for this large variance? Brief statement for this is needed, because this seems very important part of this paper. Associated with this, as shown in Table 2, the life time is very short in the case of Stn.32. This is because Lm-o is very small. As such, the value of Lm-o has very large variance. What is the key factor for this?

Minor comments

3. Description in the paper is overall understandable. On the other hand, it is somewhat redundant and lacking in compactness. I think that the length of the paper can be reduced by 10-20%.

4. Line 362-363: Please describe the temperature trend and the starting location more specifically. Not easy to understand at this stage.

5. Line 378-379: Lf=330 kJ kg-1: What is the reference for this value? I think that use of Lf=334 kJ kg-1 is more appropriate by referring Martin (1981), which showed that frazil ice crystals do not retain any brine and thus Lf should be equal to that of freshwater. Although 330 and 334 is not so different, the basis of the value should be described in the scientific paper.

6. Line 380: Equation (2); Table 1: Conceˆtemp_ice is not understandable quantity. The total volume of frazil ice can be calculated by integration over the water column and this value can be represented by thickness of ice. This quantity is easier to understand. Heat loss occurs at the ocean surface, and thus a quantity per unit area is more meaningful than a quantity per unit volume. I know that ice production represented by thickness per day is introduced using Conceˆtemp_ice later in section 6. But integrated frazil ice thickness should be introduced at this stage. This comment is also applied to Conceˆsalt_ice (Equation 5).

7. Line 398: How did you determine the starting location from below the anomaly?

8. Line 417: Remove one of the double heat.

9. Line 489: How “t” is finally represented using the known quantities?

10. Table 2: How “the life time” is finally represented (by an equation)?

11. Figure 10: color at Stn.32 looks like purple, not red.

12. Regarding the estimate of average or annual (monthly) ice production, there have been several satellite (microwave) investigations for these polynyas (e.g., Comiso et al., 2011; Drucker et al., 2011; Nihashi and Ohshima, 2015; Tamura et al., 2016), because the satellite microwave can provide daily sea ice condition. For example, data set of monthly ice production from Nihashi and Ohshima (2015) is now in public, and can be downloaded from http://www.lowtem.hokudai.ac.jp/wwwod/polar-seaflux/. As well as comparison with the model studies as was done in section 6.2, comparison and discussion with these satellite studies would enhance the value of this paper.

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