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Interactive comment on "Circumpolar polynya regions and ice production in the Arctic: Results from MODIS thermal infrared imagery for 2002/2003 to 2014/2015 with a regional focus on the Laptev Sea" *by* Andreas Preußer et al.

Anonymous Referee #3

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General comments

Coastal polynyas play a crucial role in altering a variety of physical, biological and chemical processes at the boundary between the atmosphere and the ocean. In the case of Arctic Ocean, polynya ice production is a key component for understanding the maintenance and variability in ocean stratification (cold halocline) and ice-ocean interaction, as well as the seasonal sea-ice mass budget. This paper provides the circumpolar mapping of polynya area (POLA) and its ice production (IP) in the Arctic Ocean, with fine spatial resolution of about 2 km. This resolution is much finer than

the previous mapping with satellite microwaves. The authors have accomplished the creation of the dataset of POLA and IP by treating massive amount of 143000 MODIS data, with well-refined procedures. As well, the paper provides 14-year dataset of POLA and IP, which will be the basic data for understanding of drastically changing Arctic Ocean. The paper is overall logical, well-organized, and the presentation/writing is refined. Although the results might have some bias arising from that the calculations were made only for clear-sky and nighttime conditions, this is mainly because of limitation of satellite (MODIS) data. I think that the authors have done a best to create the circumpolar data set with a high spatial resolution. I believe that the paper surely contributes to the community of Arctic and climate sciences. But there still remains some points that should be improved, all of which are minor ones. Some figures can be a bit improved for clarity (see comments 7, 8, 12, 14, 15 for details). In brief, the paper should be published in Cryosphere after a minor revision. The specific points are the followings.

Specific comments

1. MODIS clear-sky data can be obtained rarely in the polar cloudy condition. Thus most of researchers including me think that it is difficult to obtain seamless (daily) surface dataset from the MODIS data. For example, in investigation of landfast ice (Fraser et al., 2012, J. Climate) from MODIS, data set was made only for 20-day interval because of cloudy condition. At first I could not believe the average coverage fraction of 70-80% per day (Table 1) in this study. However, if the MODIS image can be obtained for one area several tens of times per day, composite of clear-sky portion could offer the daily data. I guess this is the case and explain why such high fraction of coverage is possible. If this is true, the authors should clearly explain why such high fraction of coverage is possible. For example. How many times per day can MODIS cover a certain area? What percentage can we obtain the cloud free scene? I think that such explanation enhances the creditability of this study.

2. Although the MODIS data provide high resolution data set, POLA and IP can be

obtained only in clear-sky condition. The atmospheric condition and accordingly surface heat flux in clear-sky condition would be different from those in cloudy condition. Thus it is likely that POLA and IP obtained all from clear-sky condition have some bias compared to those from cloudy condition or pure average irrespective of atmospheric condition. I understand that evaluation of such bias is not easy and no further analysis is needed. But more discussion or clear statement of such bias should be made in the revision. At least such drawback should be stated in conclusion section.

3. Similarly, POLA and IP can be obtained only in nighttime and thus POLA and IP obtained all from nighttime likely have some bias compared to those from daytime or pure average. Although a brief statement was made in page 9, it may be better to evaluate such bias even in a brief way. For example, difference in heat budget on thin ice for nighttime and daytime under a typical wintertime condition can be evaluated.

4. The study does not include the results of October and April when the polynya activity starts and continues, which is one of the drawback of this study. According to Iwamoto et al. (2014), for example, these two months provide 10-30 % of total annual ice production (IP). Particularly in NEW, Laptev, Archipelago, IP becomes maximum in October. Such drawback should be stated in IP section and conclusion.

5. Abstract: "Overall, our study contains the most accurate characterization of circumpolar polynya dynamics and ice production to date". This statement is ambiguous and overvaluing. The authors should state more specifically in what points this study provides the most accurate characterization? Probably, high spatial resolution is strong selling point. On the other hand, this study still has the drawback of data gap by cloud.

6. P3, L15-16: "west of Novaya Zemlya is excluded in our investigations due to a variety of potential ambiguities originating from ocean heat fluxes": I understand the situation. But, as described in the textbook by Martin (2001, Polynyas. In: Encyclopedia of Ocean Sciences. vol 3. Academic Press,), the Novaya Zemlya polynya is one of the most active polynya, and other studies (e.g., Iwamoto et al., 2014) includes the Novaya

Zemlya polynya in their tables. Similar situation by the effect of ocean heat also occur in the polynyas of Storfjorden, Franz-Josef Land. Why only the Novaya Zemlya polynya is excluded?

7. In some figures (Figs. 4, 7, and 8), coast lines are not visible.

8. P6, Figure 3: The scale in the right bottom should be enlarged.

9. P7, L14-20: I understand the former part of this paragraph, but I do not understand well that why a pixel-wise persistence index (PIX) becomes the ratio between the total number of MODIS swaths that feature thin-ice and the total number of swaths that feature clear-sky conditions.

10. P7, L25-28: "a probability of thin-ice occurrence is derived using a weighted composite of the surrounding days", "by a weighted average of the surrounding six days". Please describe the weight (function) specifically.

11. P9, L19-24: This paragraph is hard to understand. How does the coverage-correction (CC) carry out the extrapolation? What's mean by "the additional SFR areas (COV4)".

12. P15, Figure 7: Most of the IP area are colored by nearly same color, blue, implying the production of 0.8-2.5 m. These high frequency ranges should be better resolved using stronger color gradient to discriminate the difference.

13. P17, L7-9: "a tendency towards a diminishing fast-ice extent", "retreating-behavior of fast ice": Which part corresponds to these features? It is better to describe the location of these areas specifically.

14. P18, Figure 9: The inset map at the upper right is not effective at all. Rather, range of Fig. 9 (Laptev Sea area) should be indicated in Fig.1 with the name of Island.

15. P19, Figure 10: This is not usual Hovmoeller plot. Hovmoeller plot is generally used to see the spatial vs. temporal variations to examine the propagation character-

istics. There is no temporal continuation in the vertical direction of Fig.10 and thus the contours should not be used in the vertical direction. This figure should not be drawn as Hovmoeller plot. The contours can be used in the lateral direction (seasonal evolution). I propose the following figure. The polynya area ratio (strength) is represented by the contours and color in the lateral direction (seasonal evolution) separately for each year. Then such horizontal long graphs are lined up in order from 2002 to 2015. Namely the contour procedure is only used for the lateral direction when compared to the original Fig.10.

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