Interactive comment on "Estimating ice phenology on large northern lakes from AMSR-E: algorithm development and application to Great Bear Lake and Great Slave Lake, Canada" by K.-K. Kang et al.

Anonymous Referee #1
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We would like to thank the anonymous referee #1 for thoughtful and helpful reviews of this paper

Referee comment: *The paper addresses an important issue - monitoring ice phenology over Great Bear and Great Slave lakes in Canada using AMSR-E data.*

General comments 1: *The paper is quite long with many tables and figures, and extensive use of acronyms does not make it easier to read. In some cases (Page 3134, lines 17 and 18) acronyms are introduced (MRB and NWT) even if they are not used at all later in the paper. I would suggest to keep acronyms when it is necessary, but also to use more often here and there some human language.*

→ We agree with the comment. All acronyms were adjusted but the commonly used ones remain in the main body of the text. We feel that the number of tables and figures in the manuscript is appropriate and reducing them further would weaken the manuscript. We had already gone through this exercise before something the paper.

General comments 2: *A more thorough justification of the choice of 18.7 GHz channel is needed. Several other ice algorithms (Artist Sea Ice etc) successfully use 85 GHz channel from SSM/I and 89 GHz from AMSR-E by correcting weather influence using other channels. Why not use the similar approach as it is will dramatically increase the spatial resolution and minimize land contamination of the radiometric signal?*

→ We have added some more justification for the choice of 18.7 GHz in section 5.2.

Although 89.0 GHz (3.5 × 5.9 km) from AMSR-E can be good for estimating sea ice concentration due to its finer spatial resolution, AMSR-E 18.7 GHz is better for defining ice phenology variables such as freeze-onset and melt-onset because this frequency has longer penetration depth, allowing less lake ice surface scattering. In addition, brightness temperatures (T_B) at 89.0 GHz are much more sensitive to surface roughness induced by winds during the

open water period compared to the lower frequency channels. As clearly shown in Figure 2, variations in T_B at 89 GHz are large during this period. This makes the estimation of FO and ice-off dates, in particular, difficult with the thresholding approach presented in this paper.

General comments 3: *Have the authors considered combining different channels at different polarizations to improve the ice/water detection? A table showing differences in defining ice phenology dates using different channels would help to substantiate and justify the choice of 18.7 GHz channel. Also, the discussion on potential possibility to estimate ice concentration could be useful.*

→ Yes, we did experiment with different frequencies and polarizations such as 89 GHz, 36.5, 18.7 GHz polarization difference (for ice-on dates and ice-off dates). However, values from polarization difference resulted in the estimation of late ice-on and ice-off dates compared to only using single H-pol. Although there may be some potential for estimating ice concentration with our algorithm, this topic is beyond the scope of this paper. However, we did add a sentence in the conclusions section about this topic as a line of future research.

General comments 4: *An important issue is the fact that both lakes go through spring and fall overturning (when the lake water temperature reaches the temperature of maximum density at +4_C). This is not mentioned in the paper and some conclusions are not correct in this respect. For example, I agree that the large amount of heat accumulated in the lake will result in later freeze-up onset (P.3144). However, after the overturning the whole water column has the same temperature and, contrary to what is stated on pages 3144-3145, freeze duration (FD) will depend only on air temperature variability after the overturning (no memory effect whatsoever whether it was a warm of cold summer before the overturning).*

→ We concur with this comment. We inserted a sentence about fall overturning on pages 3145 (after the first paragraph) and in section 7 (conclusion).

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General comments 5: *There is a lot of tables and I would suggest to add at least one graph showing some of the results from Tables 6-8 or just from Table 8 to illustrate the interannual variability of ice phenology and may be even some possible trends (by adding some historical data before winter 2002/2003) to put the results in the larger climatic context.*

→ We prefer to retain Tables 6-8 instead of making a new figure and we feel that this level of the historical interannual variability of ice phenology is beyond the scope of this paper. Furthermore, one cannot calculate (or draw conclusions from) trends with only 8 years of data.

Page-by-page comments

P3132, Line 5 - is "mimicked" an appropriate expression?

→ Yes.

P3138, line 11 - quick look or quick-look?

→ We changed quick-look in the manuscript.

P3140, line 26 - please explain what is meant here by clear, black and snow ice

→ Most text has been removed to address Reviewer #2's comment" However, we provide one of our previous references for further details.

P3166, Figure caption - - please indicate the meaning of numbers in brackets after "Ice Season" and "Ice-free Season".

→ Numbers after both "Ice Season" and "Ice-free Season" indicate value of number of days. We indicated this in Figure 2 caption.