Comment on tc-2021-393

Anonymous Referee #2

Referee comment on "Thickness of multi-year sea ice on the northern Canadian polar shelf: A second look after 40 years" by Humfrey Melling, The Cryosphere Discuss., https://doi.org/10.5194/tc-2021-393-RC2, 2022

Review of 'Sea-ice thickness on the northern Canadian polar shelf: A second look after 40 years' by H. Melling.

Summary

The paper focuses on long-term changes of multi-year sea ice thickness in the Canadian Arctic archipelago. As historical record of multi-year ice thickness in this area, the author exploits ice thickness measurements obtained from in-situ drill-hole surveys in 1970s. For ice thickness representing recent years the author uses ice draft measurements obtained from moored ice profiling sonar in Penny Strait from 2009 to 2010. To compare thickness record obtained from different seasons and locations, the author applied a simple ice growth model to the latter and made a comparison of multi-year ice thickness between two periods. The author concluded that no significant change of multi-year ice thickness has occurred in this area in the last 40 years. The paper also describes statistics of hazardous sea ice in Penny Strait by analyzing time series of ice thickness/draft measurements obtained from the ice profiling sonar in 2009/2010.

The data processing methodology of ice draft gained from ice profiling sonar is solid and reliable, whereas the comparison between the two periods (1970s and 2009/2010) seems to me a bit tricky. Since the recent multi-year ice thickness is represented by data from

one-mooring site with short period (2009-2010), I would suggest the author to provide more careful examinations to strengthen the conclusion of this study.

Major points

Since the manuscript focuses on long-term changes of multi-year ice thickness, sea ice growth estimates by climatological forcing may be problematic. I would rather suggest to use specific forcing from 2009/2010. I think it is also important to argue to what extent 2009/2010 forcing represents mean state of recent decade.

Discussions appeared in lines 364 – 394 are plausible, whereas the discussion ignores long-term changes of forcing fields (I don't mean the forcing field in the north of Canadian Archipelago has changed, but I would like to point out that this is not examined here and therefore the argument is not very convincing). I think some additional works described in the minor points below may help to strengthen the author's argument.

Minor point

Section 1.

- Line 47: It would help readers if the location and area of Sverdrup Basin is annotated in Figure 1.

- Line 65: Bathurst Istand and Norwegian Bay could be also highlighted, otherwise readers have to take time to find them in the map.

- Line 93: Queen Elizabeth Islands could be also annotated in Figure 1.

- line 93-94: "..; cut off the supply and the waters between …": I don't understand the meaning of this sentence. Could it be described/explained differently?

Section 2.

- Figure 3: I suggest showing the units in Figure 3 (e.g, 22" steel float) in m or cm following International System of Units (SI), since I'm afraid many readers may not familiar with inch unit.

- Line 137: 88.3° □ 88.3° N

- Line 143-145: I suggest to mark the position of the mooring in Figure 1 or another large-scale map. I would suggest to show this in a closer map showing bottom topographic features, e.g., maps covering the area shown in Figure 5.

Section 3.

- I would suggest to show coastline on top of the image, if possible. It helps to identify sea ice covered area.

- Figure 6: The star in figure 6 denotes the location of the mooring?

- Line 252: Why 0.75 m is used as a threshold to identify multi-year ice? Is the result sensitive to this choice? I would suggest to provide reference for this choice.

- Line 257 – 261: Is it possible to annotate these features in Figure 8, which helps reader to understand the temporal changes of ice type.

Section 4.

- Line 286 – 292: Why the author applied climatological data to derive the ice growth rate? I suppose that a calculation using the data from 2009-2010 could provide more accurate estimate that takes into account specific condition during the observation period. I have a concern on this point since the ice growth rate is used to estimate lines shown in Figure 11, 12 and 13, and therefore gives as a basis of the arguments thereafter.

- Line 289: I suggest to mark Resolute Bay and Eureka on Figure 1 or in a map showing the mooring location, otherwise readers have to look for them in a google map.

- Line 296 – 300: How much uncertainty should we expect from the procedure described here? Is the uncertainty significantly small compared to the difference of thickness from 1970s discussed later?

- Line 314 – 316: How is the numbers shown here sensitive to the assumption (half populated by multi-year ice)? Is the 'half populated by multi-year ice' the ice situation in the comparison period (1970s)? I have a concern on this point since the result summarized in Figure 12 and 13 may depend on this assumption. If the assumption is changed, e.g., 40%, 60% populated by multi-year ice, how these changes affect the results?

- Line 317: "the area north-west of Penny Strait" is ambiguous. I would suggest to show tracks of 1970s survey in a map for clarity.

- Line 318: The standard deviation of each mean thickness in the 1970s should be also

shown in Figure 12.

- Line 373 – 394: Though the mechanism of thick ice formation described here is plausible, it is not shown that mechanical forcing on ice pack has not been changed since 1970s. In order to strengthen the argument, I suggest to show that statistics of wind forcing (e.g., strength, variance) has not been changed between the two comparison period or to show statistics of buoy tracks (e.g., onshore drift speed) has not been changed.

- Line 431: Table 4 □ Table 3.

- Line 455: 'commo n' □ common

- Line 461 – 462: 'ice' is repeated before and after the bracket.

Section 5.

- Line 473: This sentence seems to me a bit strange. Probably colon or semicolon could be used to split the sentence.

- Line 485 – 486: I do find neither an analysis nor time series supporting this sentence in this manuscript.