

Dear Reviewers,

We have made further revisions to the manuscript. The comments/corrections listed by the two reviewers are considered and corrected accordingly. Please see below our response (text in red) to the reviewer's comments point by point.

Thank you for your help!

Best regards,

The authors

## Review on Revision #1

### Special comments

1) Line 31 “long-term observations” change to “Cross-seasonal observations”.

**Responses:** Thanks for your advice. **In line 34 of the revised manuscript, we corrected it in the revised manuscript.**

2) Line 34-40: I don't think the climate and sea ice changes in the Arctic have anything to do with your study, as I said last time.

**Responses:** Thanks for your advice. **In the revised manuscript, we removed these descriptions.**

3) Line 90 “the second Chinese Antarctic scientific research station, which was established in February 1989 and has been operated year-round since its establishment” -- just delete it.

**Responses:** Thanks for your advice. **We have deleted these descriptions in the revised manuscript.**

4) The Operational Mercator global ocean reanalysis products: I do not believe that the reanalysis data of the ocean has the ability to solve the ocean processes under landfast ice with only <100 m from the shore, that having complex topographic features.

**Responses:** Yes, we agreed with the reviewer's opinion. **In fact, the Mercator ocean reanalysis was used to map the large-scale distribution of ocean temperature and current, not the small-scale. We made it clear in the revised manuscript as shown in Section 2.2.**

5) Line 199 and other texts: “The annual mean”: Actually, you don't have a year of observational data.

**Responses:** Thanks for your advice. We corrected it in the revised manuscript.

- 6) Line 202 “which are similar to previous observations”, Further comparison with the following study is necessary because the landfast ice near Zhongshan Station will be affected by the terrain and distribution of grounding icebergs.

Lin L, Lei R, Hoppmann M, Perovich D K, and He H. 2022. Changes in the annual sea ice freeze–thaw cycle in the Arctic Ocean from 2001 to 2018, *The Cryosphere*, 16, 4779–4796, <https://doi.org/10.5194/tc-16-4779-2022>, 2022.

**Responses:** Thanks for your advice. **In lines 200–202 of the revised manuscript**, we cited the related paper and revised it as follows:

“which are similar to the nearshore observations at Zhongshan Station in 2006 (Lei et al., 2010) and in 2012 (Zhao et al., 2019), but different to the offshore cases around this region, especially when grounded icebergs existed (Li et al., 2023) .”

The new reference is listed as follow:

Li, N., Lei, R., Heil, P., Cheng, B., Ding, M., Tian, Z., and Li, B.: Seasonal and interannual variability of the landfast ice mass balance between 2009 and 2018 in Prydz Bay, East Antarctica, *The Cryosphere*, 17, 917–937, <https://doi.org/10.5194/tc-17-917-2023>, 2023.

- 7) Line 210 “indicating the influence of the air–ice–ocean interactions on the ice evolution”: just delete it, it is a correct but meaningless discussion.

**Responses:** Thanks for your advice. We have modified the corresponding description in the revised manuscript.

- 8) Figure 2: It is best to provide both snow and ice thickness in-situ observation data. In addition, I do not believe that during some winter periods, there were no snow at all, and there was still 2-6 cm of snow.

**Responses:** Thanks for your advice. Unfortunately, the in-situ observations of snow and ice thickness were not available for us at this moment. According to the previous studies, the snow and ice thickness retrieved from SIMBA were reliable to demonstrate the snow and ice annual evolution (Zhao et al., 2021; Lei et al., 2022).

The new references are listed as follow:

Zhao Jiechen, Yang Tao, Shu Qi, Shen Hui, Tian Zhongxiang, Hao Guanghua, Zhao Biao. 2021. Modelling the annual cycle of landfast ice near Zhongshan Station, East Antarctica. *Acta Oceanologica Sinica*, 40(7): 129–141, doi: 10.1007/s13131-021-1727-0

Lei, R, Cheng, B, Hoppmann, M, Zhang, F, Zuo, G, Hutchings, JK, Lin, L, Lan, M, Wang, H, Regnery, J, Krumpen, T, Haapala, J, Rabe, B, Perovich, DK, Nicolaus, M. 2022. Seasonality and timing of sea ice mass balance and heat fluxes in the Arctic transpolar drift during 2019–2020. *Elementa: Science of the Anthropocene* 10(1). DOI: <https://doi.org/10.1525/elementa.2021.000089>

9) “after sublimation in summer”: How do you tell if it's sublimation rather than melting.

**Responses:** Thanks for your advice. **In lines 215–216 of the revised manuscript**, we corrected it to “sublimation or melting in summer”.

10) Figure 3: The density of seawater does not make much sense, and the deviation of seawater temperature above freezing point should be given.

**Responses:** Thanks for your advice. We corrected these problems in the revised manuscript, and the figure was redrawn. The new figure and caption were shown as follows.

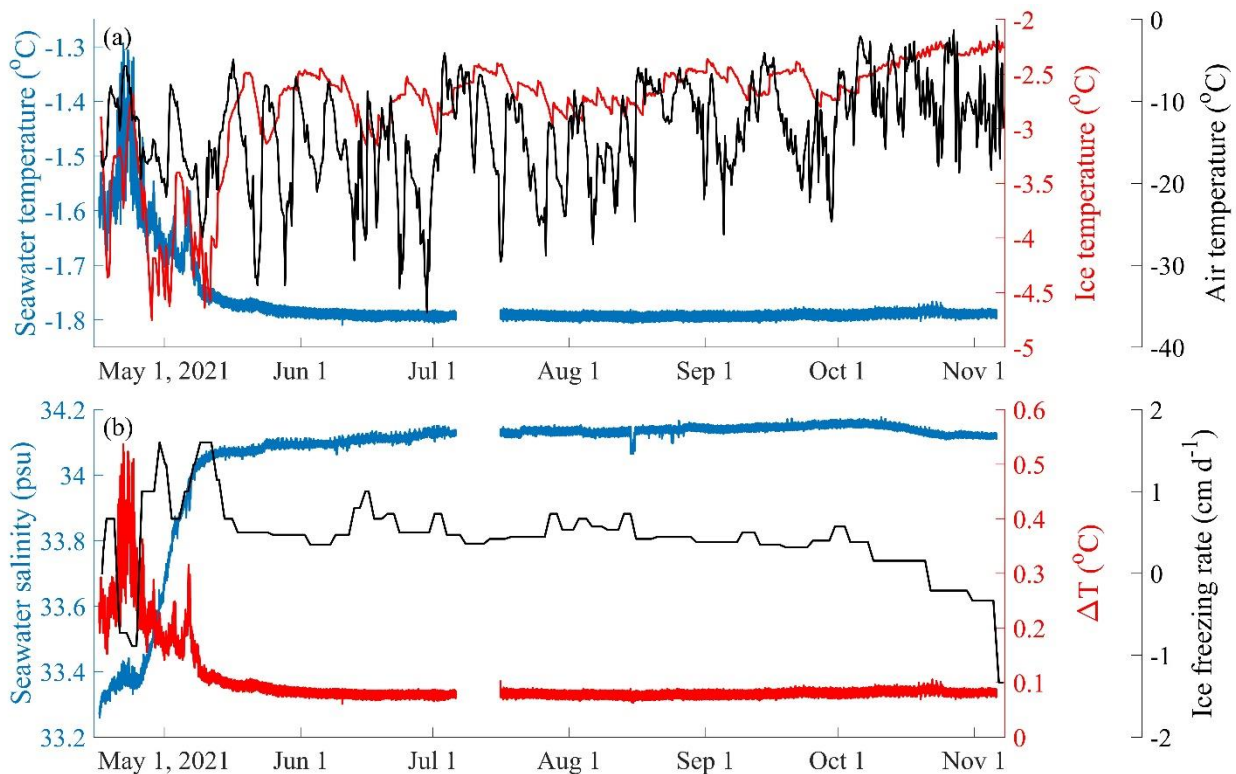


Figure 3. (a) The seawater temperature observed by the CTD at 2 m beneath the landfast ice surface (blue lines),

the ice temperature at the bottom (red lines; defined as the mean temperature derived by the SMIBA sensor located 0.1 m above the bottom of the ice), and air temperature observed by the SIMBA at 1 m above the landfast ice surface. (b) The seawater salinity observed by the CTD (blue lines), the deviation of seawater temperature above freezing point ( $\Delta T$ , red lines), and the ice freezing rate at the bottom (black lines) observed by the SIMBA from April 16 to November 7.

**In lines 257–262 of the revised manuscript:**

“After acquiring the seawater salinity by CTD, the seawater freezing point was calculated with the observed seawater temperature and salinity, using the equation proposed by Millero (1978). The calculated freezing point decreases with the increase of the seawater salinity, from  $-1.83^{\circ}\text{C}$  in April to  $-1.86^{\circ}\text{C}$  in May, and then remained stable, with a mean value of  $-1.87^{\circ}\text{C}$  in the following seasons. Further, the deviation of seawater temperature above the freezing point was calculated ( $\Delta T$ , red lines in Fig. 3b), which increased quickly from  $0.15^{\circ}\text{C}$  to  $0.55^{\circ}\text{C}$  in April and decreased to around  $0.1^{\circ}\text{C}$  in the middle of May and maintained to November.”

11) Line 252-255 just remove it.

**Responses:** Thanks for your advice. In the revised manuscript, we redraw the figure and remove the lines of density, while we retain the text in the revised version.

12) Line 265 “the horizontal current exhibited a similar distribution in all three directions”: there are three directions for the horizontal current?

**Responses:** Sorry for the spelling mistake. We revised it in the new version.

**In line 273 of the new version:** “the horizontal current exhibited a similar distribution in the directions”.

13) Figure 4 “Please note that the percentage scales are different in the different sub-panels.”: use the same scale please.

**Responses:** Revised as the reviewer suggested. The new figure and caption were shown as follows.

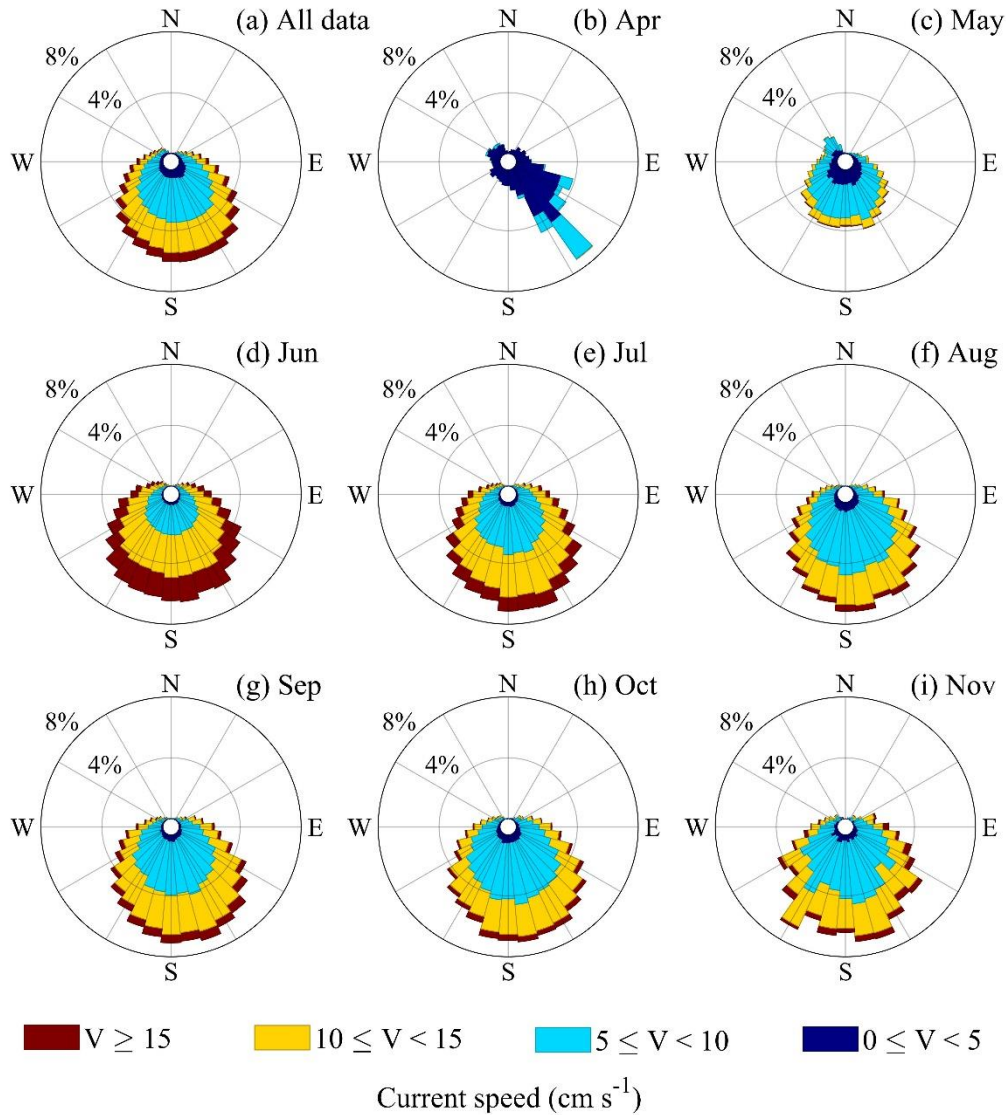


Figure 4. Roses diagram of the horizontal current speed with a 2-minute resolution for (a) the total time series and (b–i) different months. The different colours represent the different ranges of the current speed. Due to technical issues, only 8 days were available in April and 20 days in May.

14) Line 285 “but a practical value is more realistic in the  $F_c$ ”: it is in the  $F_I$ ?

**Responses:** Sorry for the misleading. We revised this description in the new version.

**In line 292 of the new version:** “but a practical value is more realistic in the  $F_I$  calculation”.

When we checked the Fig. 5, we found that the notation of  $F_I$ ,  $F_c$  and  $F_s$  in the original figure was inverted when drawing the figure, but it will not affect the final oceanic heat flux calculation result.

**In lines 297–304 of the new version,** the description errors only appear in this paragraph and have been corrected. We confirm that this issue doesn’t affect other results and conclusions of this study.

The corrected figure was shown as follows:

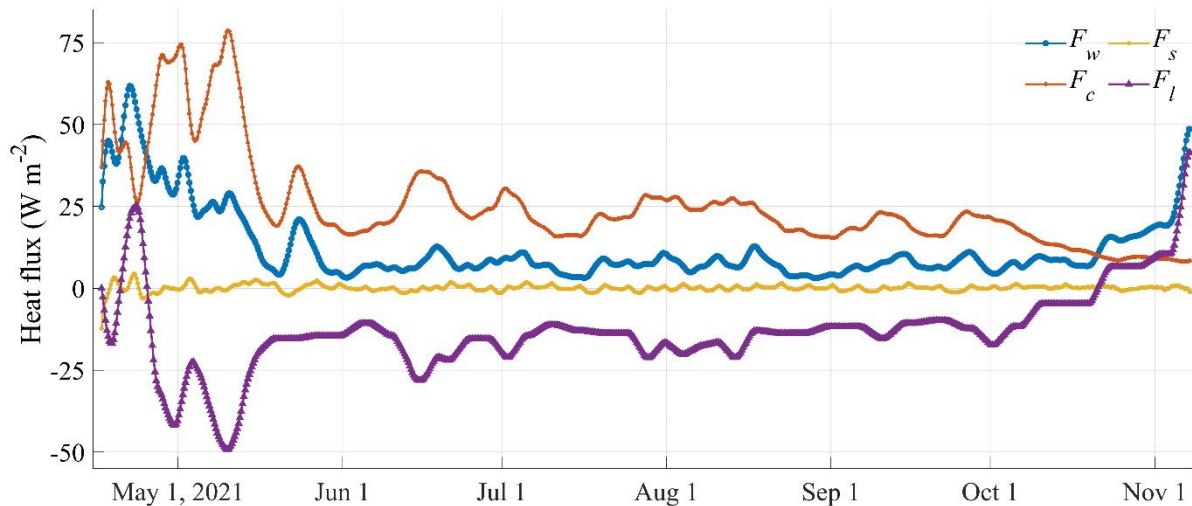


Figure 5. Conductive heat flux ( $F_c$ ), latent heat flux ( $F_l$ ), specific heat flux ( $F_s$ ), and oceanic heat flux ( $F_w$ ) were estimated using the residual method and a reference layer located 0.2 m above the bottom of the ice. The time interval is 6 hours.

15) Table: remove it because it give the information repeated from the above figure.

**Responses:** Thanks for your advice. In the revised manuscript, we removed this Table.

16) Line 351 “and fill up the data gap” -- change to “fill up the knowledge gap”

**Responses:** Thanks for your advice. In line 357 of the revised manuscript, we revised this description in the new version.

17) Line 487 “such as ice thickness radar, ocean temperature chains, and ice salinity gauges”:

Actually, I don't know what are the ice thickness radar and ice salinity gauges.

**Responses:** Thanks for your advice. In line 493 of the revised manuscript, we revised this description in the new version.

## Referee #2

### General & specific comments:

1) In Ch.2.1 & 2.2: You listed weblinks as references for the individual instruments. Firstly, I would assume that the journal will require to move these to the reference section, i.e., in a more appropriate format. Secondly, as “references” I rather had published studies or reports in mind that contain/list technical specifications, data formats & examples, etc., but in case those do not exist, weblinks could be sufficient.

**Responses:** Thank you for your suggestion. Unfortunately, we have not been able to find studies or reports that include/list technical specifications, data formats, examples, etc., so the web link is listed directly here as a reference to the instrument parameters.

2) Fig.1 (caption): “False-colour satellite image (...)”

**Responses:** Thanks for your advice. **In line 121 of the revised manuscript,** we revised this description in the new version.

3) L.127: “Advanced Microwave Scanning Radiometer 2 (AMSR2)” (use capital letters)

**Responses:** Thanks for your advice. **In lines 126–127 of the revised manuscript,** we revised this description in the new version.

4) L.339: “...which provide more details and insights for the readers and communities...” – instead of addressing different persons/groups here (I would omit this phrase), try to focus on the benefits in terms of resolvable processes that are enabled by using/showing this higher temporal resolution. In other words, more details of what and compared to what exactly?

**Responses:** Thanks for your advice. We revised this description in the new version.

**In lines 345–349 of the new version:** “Compared to the higher temporal resolution (6 hours for the residual method and 2 minutes for the bulk methods) in this study, the estimation based on the traditional borehole observations may produce great errors within a short time window (Lei et al., 2010). Therefore, this high-frequency observation can more accurately capture the subtle changes of oceanic heat flux in the short term, and better analyze the annual evolution of the ice–ocean interaction.”.

5) L.351: “relative studies” → do you mean “related studies” here? I haven’t read this wording yet, but it could certainly be correct as well.

**Responses:** Thanks for your advice. **In line 357 of the revised manuscript,** we revised this description in the new version.