Dear Reviewers,

We have made further revisions to the manuscript. The comments/corrections listed by the two reviewers are taken into account and corrected accordingly.

The main revisions include the following points:

(1) We have redrawn all the figures and corrected the minor errors as the reviewers figured out. Especially we added detailed decrepitations to the figures' captions to make the figures easily understood.

(2) To benefit the ice community, the observation dataset used in this study including CTD, SIMBA, and ADV are completely released publicly and the weblinks with DOI numbers are available in the "Data availability" Section.

(3) During the revision process, one new co-author was included and listed in the fourth place. He contributed more to the results analysis and language polishing. All the other co-authors have agreed.

(4) The language has been smooth by the professional native English expert, to ensure no more grammar and spelling issues.

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

Referee #1

General comments

1) As noted above, several parts of the manuscript were rearranged and changed quite noticeably. However, I feel that some of the new parts (such as Ch.4.2 or the addition of three different bulk approaches for the oceanic heat flux) are not so well connected to the rest of the manuscript. In other words – I am missing a clear and stringent "story line" on how each part of the study relates to one another. Maybe the authors can try to improve on this aspect.

Responses: Thanks for your comments. Indeed, it was hard to find a high relationship between our local observation and the large-scale pheromone, but the sea ice evolution and the large

circulation in Prydz Bay absolutely affected the seasonal cycle of local variables. Therefore, we decided to retain the 4.2 section, but narrowed this section, removed the original figure 13 and deleted the doubtable assumptions.

To make the "storyline" clearer, we added one paragraph as the first one in the Discussion section. "The minute-frequency annual observations of variables in the ice-ocean interface in this study provide a clear picture of how they varied on an hourly, daily or seasonal scale, and fill up the data gap in Zhongshan Station. As the relative studies in other regions, those variables may be affected by the short-term cycle of sub-glacial current (McPhee et al., 1996) and ocean tide current (Lei et al., 2010). To further enrich our analysis, the relationships between processes on the local scale and pan-Prydz Bay scale were discussed here."

2) Methods & results are again not consequently described in present tense throughout the manuscript. In addition, some numbers are still given with too many digits (e.g., heat fluxes). Please revise grammar / style.

Responses: Thanks for your advice. In the revised manuscript, we corrected these issues.

Specific comments (incl. technical notes)

Abstract

General: Too many brackets – please keep it concise & simple to increase readability. Plus, please check grammar/wording in order to avoid phrasing or sentences with little information.

Responses: Thank you for your suggestion. We revised them in the new version.

Ch.1: Introduction

P.3, L.66: "in the ice-ocean model parametrization" – what exactly do you mean here? One specific parametrization or should it be a more general statement?

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

In lines 79-81 of the new version:

"Direct observations of high-frequency ocean temperature, salinity, and velocity beneath landfast ice are important for filling the data gap of the ice–ocean interaction near the Chinese Antarctic Zhongshan Station and for more accurately understanding how the oceanic heat flux affects the growth of sea ice in Prydz Bay on the diurnal and seasonal scales."

P.3, L.70-73: Please revise – all sentences in past tense & beginning with "the"

Responses: Thanks for your advice. In the revised manuscript, we corrected these issues.

Ch.2: Data and Methods

P.3, L.83-94: Can give respective references to the individual instruments?

Responses: Thanks for the reviewer's suggestions. We added the references in the revised manuscript.

In lines 99-102 of the revised manuscript:

"A cable-type CTD sensor (model: ALEC ACTD–DF, Japanese JFE Advantech Co., Ltd.) (for more information, see https://www.xylem.com/siteassets/brand/sontek/resources/specification/sontek-argonaut-adv-brochure-s11-02-1119.pdf, last access: February 24, 2023) was deployed 2 m beneath the ice surface and 15 m from the shoreline."

In lines 104-107 of the revised manuscript:

"An ADV (model: SonTek Argonaut–ADV, the xylem company) (for more information, see https://www.analyticalsolns.com.au/product/conductivity_temperature_depth_logger_miniature_.html, last access: February 24, 2023) was deployed to observe the 3-D ocean velocity at 5 m below the ice surface and 5 m north of the CTD."

In lines 107-110 of the revised manuscript:

"A SIMBA (model: SRSL SIMBA) (for more information, see https://www.sams-enterprise.com/services/autonomous-ice-measurement/, last access: February 24, 2023) was deployed 5 m north of the ADV, which contained 240 temperature sensors at 2-cm intervals mounted on a thermistor string."

P.4, L.112-113: Reference missing for the ocean reanalysis

Responses: A web link was added to the revised manuscript in lines 131-135.

"The Operational Mercator global ocean reanalysis products, produced by the Copernicus-Marine Environment Monitoring Service (CMEMS), provide the daily and monthly ocean currents and mixed layer depth of the global ocean with a 1/12-degree spatial resolution and 3-hour frequency (for more information, see https://catalogue.marine.copernicus.eu/documents/QUID/CMEMS-GLO-QUID-001-030.pdf, last access: February 24, 2023)."

P.4, L.114: Please be more specific about the type of interpolation and grid format.

Responses: Thanks for the suggestion. We modified these sentences as follows:

"To facilitate comparative analysis, this study employed the nearest neighbour method to

interpolate the CMEMS products to the same projection and spatial resolution as the AMSR2 sea ice concentration."

Ch.3: Results

P.6, L172: "didn't change obviously" – please revise grammar

Responses: Thanks for your suggestion, and this sentence was modified as follows:

In lines 196-197 of the revised manuscript:

"The ice surface experienced no obvious changes during the cold season, therefore changes of the ice thickness mainly happened at the ice bottom."

P4, L.100: You reference a detailed discussion about Ice-Ocean interface detection in „Zhao Jiechen, Yang Qinghua, Cheng Bin, et al. Snow and land-fast sea ice thickness derived from thermistor chain buoy in the Prydz Bay, Antarctic. Haiyang Xuebao, 39(11), 115-127, https://doi.org/10.3969/j.issn.0253-4193.2017.11.011, 2017." However, this paper is only available in Chinese as far as I can see. Is there also a translated version available somewhere? Otherwise, are there alternatives?

Responses: Indeed, the original reference is only in Chinese and we added an English publication as a supplemental reference in the revised manuscript.

Tian Zhongxiang, Cheng Bin, Zhao Jiechen, Vihma Timo, Zhang Wenliang, Li Zhijun, Zhang Zhanhai. 2017. Observed and modelled snow and ice thickness in the Arctic Ocean with CHINARE buoy data. Acta Oceanologica Sinica, 36(8): 66–75, doi: 10.1007/s13131-017-1020-4

P.8, L.208/209: What do you mean with "a classic example of air–ice–ocean interactions"?

Responses: The original expressions are confusing and we delete this sentence in the revised manuscript.

In lines 232-233 of the revised manuscript:

"This event was accompanied by a concurrent increase in both the air temperature and ocean temperature, suggesting a heightened transfer of heat from both the air and ocean to the sea ice."

P.10, Fig.4: In addition to comments below – is this figure really necessary, given that the rose diagrams in Fig.5 already give the information on current velocities and directions? Fig.4 (panels a-c) doesn't really yield a lot of additional information (and fluctuations are quite hard to differentiate), and a note in the text on the smaller range of W-component values could well be

sufficient in my opinion.

Responses: Thanks for the suggestions and we deleted this figure in the revised manuscript.

P.12, L.270-272: Why this sudden shift to two digits?

Responses: Sorry for the miswriting. In the revised manuscript, we ensured the decimal format of the same variables is consistent throughout the entire text.

Ch.4: Discussions

P.17, L.352: "Several polynyas" → Do they have names / were these already part of earlier pan-Antarctic polynya inventories? In that regard, would you expect a noticeable influence of those polynyas (e.g., by salt release through new ice production) on the oceanic measurements at Zhongshan station?

Responses: Thanks for the reviewer's comments. We revised Figure 10 and marked these large polynyas in the new figure. The four larger polynyas are the Davis Polynya (DaP) and Four Ladies Bank Polynya (FLBP) on the east side, the Mackenzie Bay Polynya (MBP) and Cape Darnley Polynya (CDP) on the west side.

In lines 396-399 of the revised manuscript:

"From May to October, ice floes completely covered Prydz Bay, except for several large polynyas (Fig. 10d), for example, Davis Polynya (DaP) and the Four Ladies Bank Polynya (FLBP) on the east side and the Mackenzie Bay Polynya (MBP) and Cape Darnley Polynya (CDP) on the west side (Hou and Shi, 2021; Nihashi and Ohshima, 2015; Williams et al., 2016)."

In lines 408-412 of the revised manuscript:

"The four large polynyas shown in Fig. 10d started to form in April, which led to the release of a large amount of salt through new ice production during their existence. As a result, the ocean mixed layer in the corresponding locations derived from Mercator global ocean reanalysis products exhibited obvious thickening from May to October (figure not shown). In addition, the thickening of the entire ice region in Prydz Bay contributed to the strengthened vertical mixing caused by the salt rejection as the sea ice continued to grow."

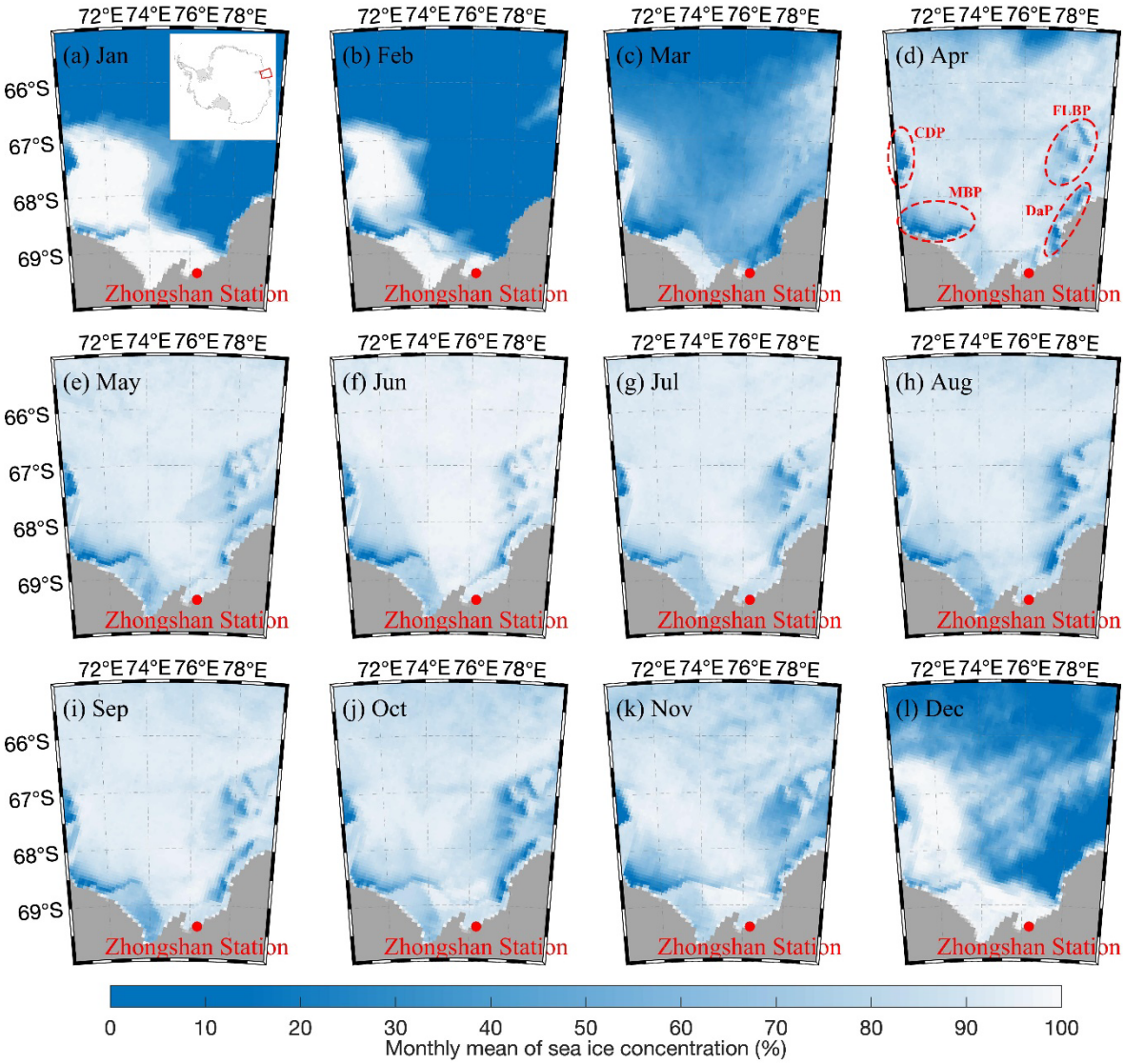

Figure 10. (a–i) Evolution of the monthly sea ice concentration in Prydz Bay from January to December 2021. The domain of Prydz Bay (70–80°E, 65–70°S) in Antarctica is shown in the right-top corner of (a). The sea ice concentration dataset was retrieved from the AMSR2 product provided by Bremen University (https://seaice.uni-bremen.de), with a spatial resolution of 6.25 km. The locations of four large Polynyas are marked in (d), i.e., the Davis Polynya (DaP) and Four Ladies Bank Polynya (FLBP) on the east side and the Mackenzie Bay Polynya (MBP) and Cape Darnley Polynya (CDP) on the west side.

Their references were listed as follows.

Hou, S. and Shi, J.: Variability and Formation Mechanism of Polynyas in Eastern Prydz Bay, Antarctica, REMOTE SENSING, 13, https://doi.org/10.3390/rs13245089, 2021.

Nihashi, S. and Ohshima, K. I.: Circumpolar Mapping of Antarctic Coastal Polynyas and Landfast

Sea Ice: Relationship and Variability, JOURNAL OF CLIMATE, 28, 3650–3670, https://doi.org/10.1175/JCLI-D-14-00369.1, 2015.
Williams, G. D., Herraiz-Borreguero, L., Roquet, F., Tamura, T., Ohshima, K. I., Fukamachi, Y., Fraser, A. D., Gao, L., Chen, H., McMahon, C. R., Harcourt, R., and Hindell, M.: The suppression of Antarctic bottom water formation by melting ice shelves in Prydz Bay, Nat Commun, 7, 1–9, https://doi.org/10.1038/ncomms12577, 2016.

P.17, L.355-360: Is that part referring to Fig.13? If that is the case, this reference is missing. Also, this Figure is poorly introduced (what it is showing, why, etc.). Can you add a few more words on that?

Responses: Thanks for the comments. Considering the comments from two reviewers, we finally decided to remove Figure 13 and narrowed the relevant descriptions.

P.18, L.362: "an obvious thick" – do you mean "thickening"?

Responses: Thank you. We have revised the corresponding language problems in the revised manuscript.

Other aspects

Data availability: You indicated that you plan to make the data available – that's great and I would certainly see that as a strong benefit, both in terms of reproducibility of your results as well as in terms of a data sustainability.

Responses: Thanks for your comments. We realize the importance of this dataset, which is really hard to collect in the field of Antarctica, therefore we decide to share these datasets publicly with the ice community. We have uploaded them to a public data website and received the DOI number.

The observation data are available from the Science Data Bank. The seawater temperature and salinity recorded from a cable-type CTD are publicly available at https://doi.org/10.57760/sciencedb.07693 (Zhao and Hu, 2023). The air-ice-ocean temperature profile derived from Sea Ice Mass Balance Array (SIMBA) is publicly available at https://doi.org/10.57760/sciencedb.07684 (Zhao and Hu, 2023). The 3-D current velocity 5-m beneath landfast ice recorded from an Acoustic Doppler Velocimeter (ADV) are publicly available at https://doi.org/10.57760/sciencedb.07692 (Zhao and Hu, 2023).

Figures & tables

Several figures were noticeably modified or even exchanged completely, so additional and some of the previous comments (which still apply unfortunately!) on all figures below:

Fig.1:

1) The photo in panel (b) is not planar as indicated on the map in panel (a), which leads to several hic-ups regarding the length-scale. Also, it seems that the distances/marked locations of the ACTD, ADV etc. are way closer together than the 30m indicated in panel (c), judging from the Ski-Doo on the right side of the photo. Please reaffirm.
2) Indicate a reference for the Worldview-2 satellite image in (a)

Responses: Thanks for the suggestions. The panel (c) really confused the readers, therefore we decided to delete this subplot and retain panels (a) and (b). The distance of 30 m is a wrong estimate, and we talked to the field observer and corrected this description to "about 5 meters" in the new version. We added a web link reference for the satellite image: https://worldview.earthdata.nasa.gov.

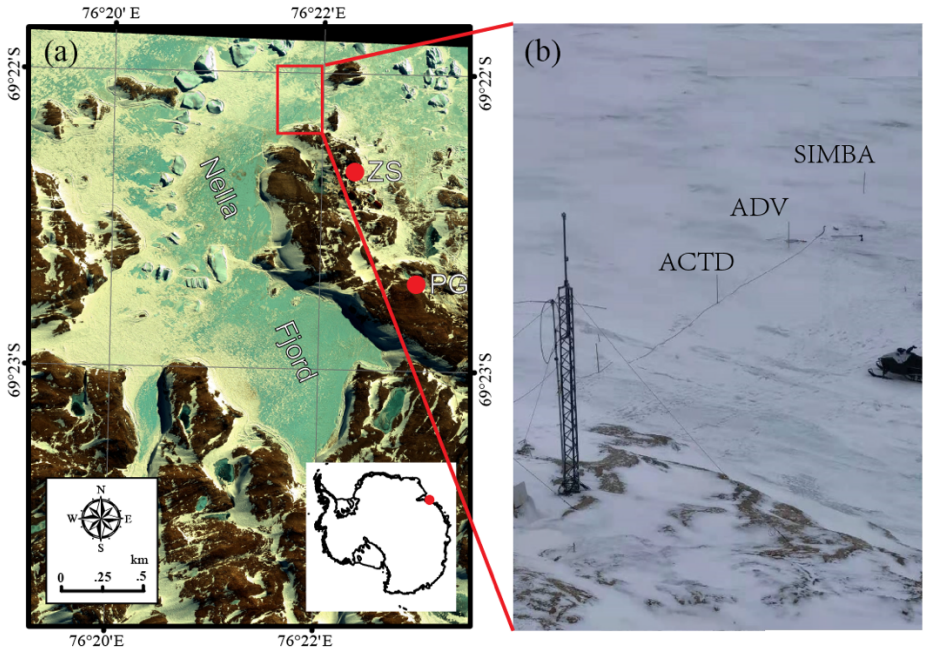

Figure 1. (a) Satellite image of the observation site in Nella Fjord near Zhongshan Station, modified from the WorldView–2 multi-bands image taken on October 20 2012 (https://worldview.earthdata.nasa.gov); (b) Photo of the observation site shot down from a 30-m high slope on April 12, 2021, by Jinkai Ma, one of the co-authors. The photo is not planar as the red box in (a) because of the angle of the shot. The distances among ACTD, ADV and SIMBA were about 5 meters.

Fig.2:

1) Panel (b): Vertical gradient (note the spelling mistake) □ add “of temperature” or use “Vertical temperature gradient”
2) It is not mentioned in the caption that this is a contour plot based on a limited number of measurements (four times daily); none of the axis explained
3) Please also note the year on the time axis
4) Colormap not suited for readers with color vision deficiencies; better examples & background for instance here https://zenodo.org/record/5501399 or here https://tos.org/oceanography/assets/docs/29- 3_thyng.pdf

Responses: The figure was redrawn as the reviewer suggested. The new figure and caption were shown as follows.

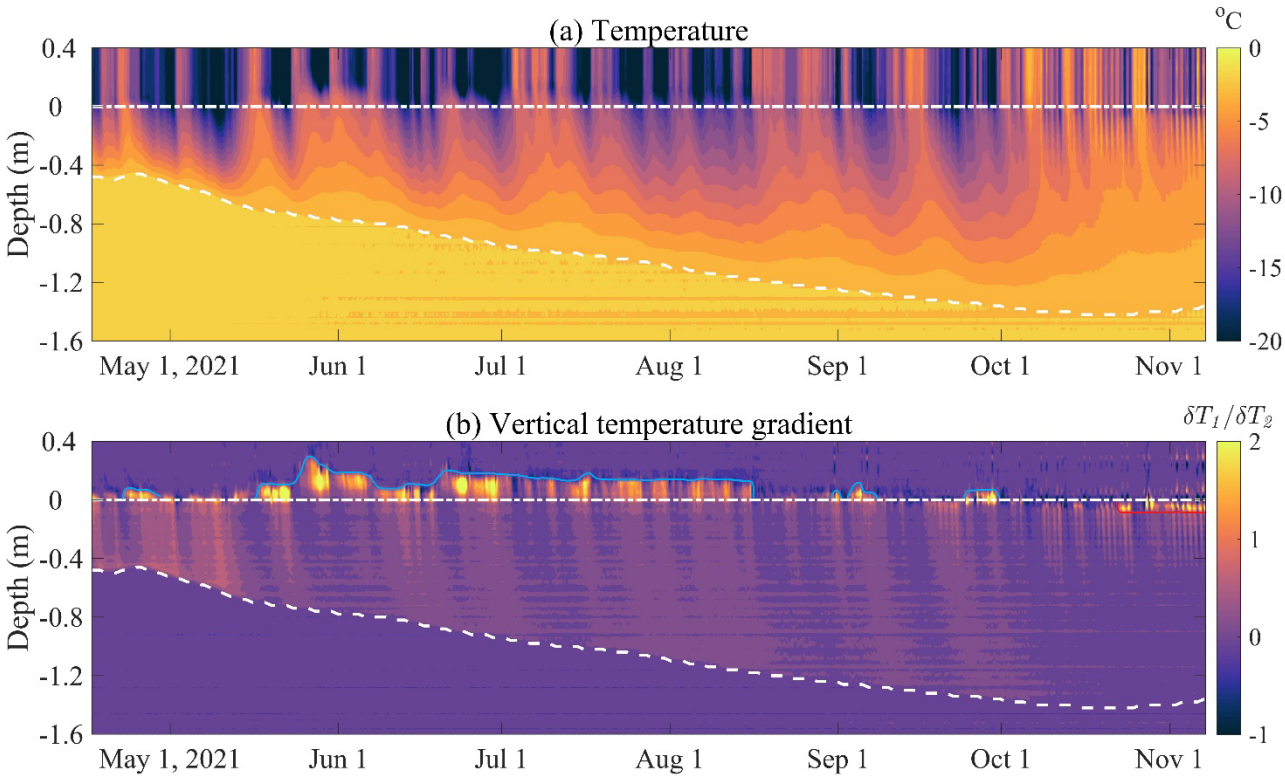

Figure 2. (a) Temperature profiles and (b) vertical gradient of the temperature profiles recorded by the SIMBA every 6 hours during April–November 2021. The white dashed line and dotted lines in (a) and (b) represent the bottom of the ice and the initial ice surface, respectively. The blue lines and red lines in (b) represent the snow surface and new ice surface after sublimation in summer.

Fig.3 (formerly 3-5):

1) Pay attention to grammar & spelling in the caption
2) Please also note the year on the time axis

Responses: The figure was redrawn and the language errors were corrected. The new figure and

caption were shown as follows.

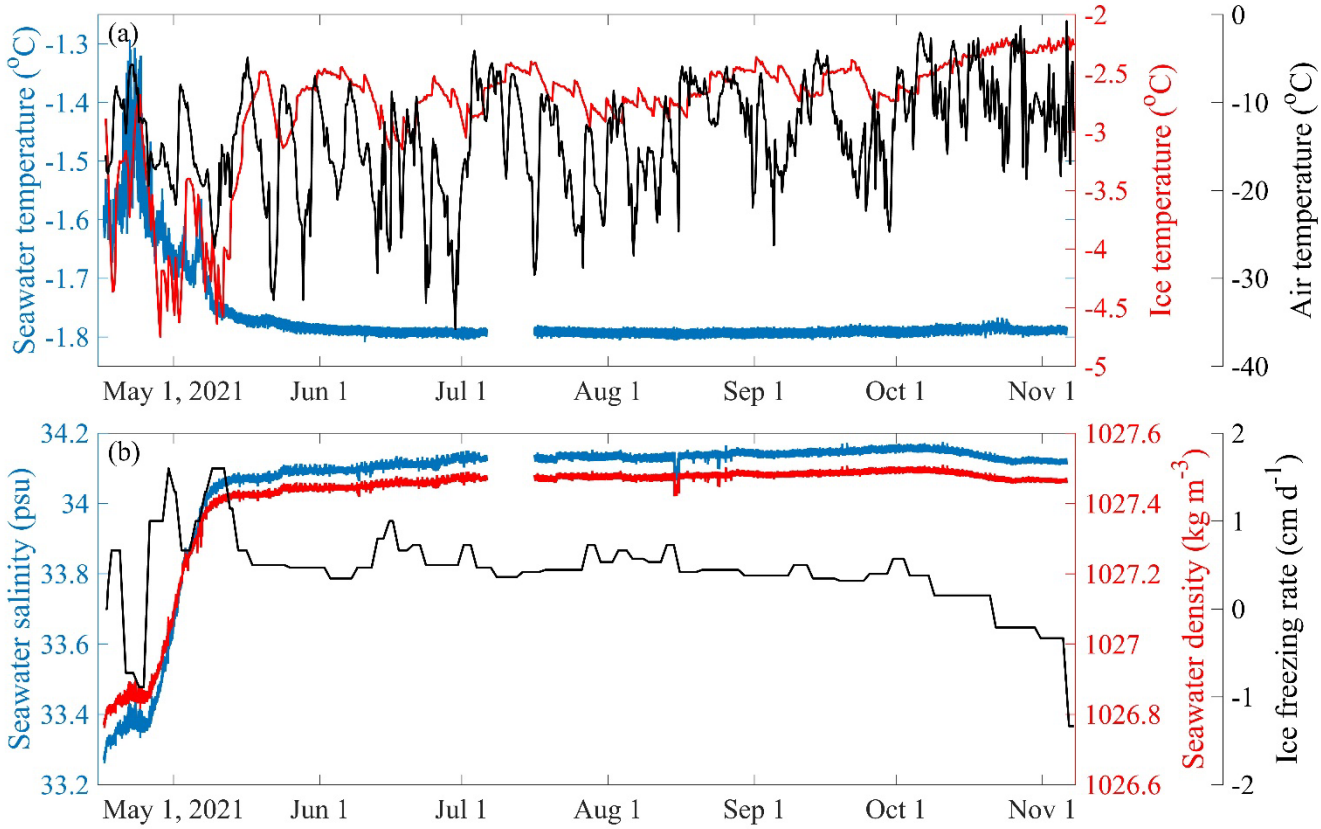

Figure 3. (a) The seawater temperature observed by the CTD at 2 m beneath the landfast ice surface (blue lines), the ice temperature at the bottom (red lines; defined as the mean temperature derived by the SMIBA sensor located 0.1 m above the bottom of the ice), and air temperature observed by the SIMBA at 1 m above the landfast ice surface. (b) The seawater salinity observed by the CTD (blue lines), the seawater density calculated from the observed temperature and salinity (red lines), and the ice freezing rate at the bottom (black lines) observed by the SIMBA from April 16 to November 7.

Fig.4 (formerly 6):

1) As in previous three figures: The reason for a differentiation between now 2 minutes and 1 hour average values is not mentioned in the text. Either note that this is purely for visualization purposes, or justify in the text why you decided to illustrate it like that.
2) Please also note the year on the time axis
3) Caption/panels (a) to (b): add "-component" and/or explain abbreviations

Responses: Thanks for the suggestion. as your earlier suggestion, this figure was removed from the revised manuscript.

Fig.5 (formerly 7):

1) I would recommend to choose another symbol for "Current speed" than "s". "V" is probably more common and intuitive.
2) Caption: Too short; please be a bit more descriptive on what the sub-panels depict, on the location of measurements and the displayed quantity & unit.

Responses: Revised as the reviewer suggested. The new figure and caption were shown as follows. When we revised this figure, we found the wrong direction was displayed in the original figure. We confirm that this issue doesn't affect other results and conclusions of this study. The corrected figure was shown as follows:

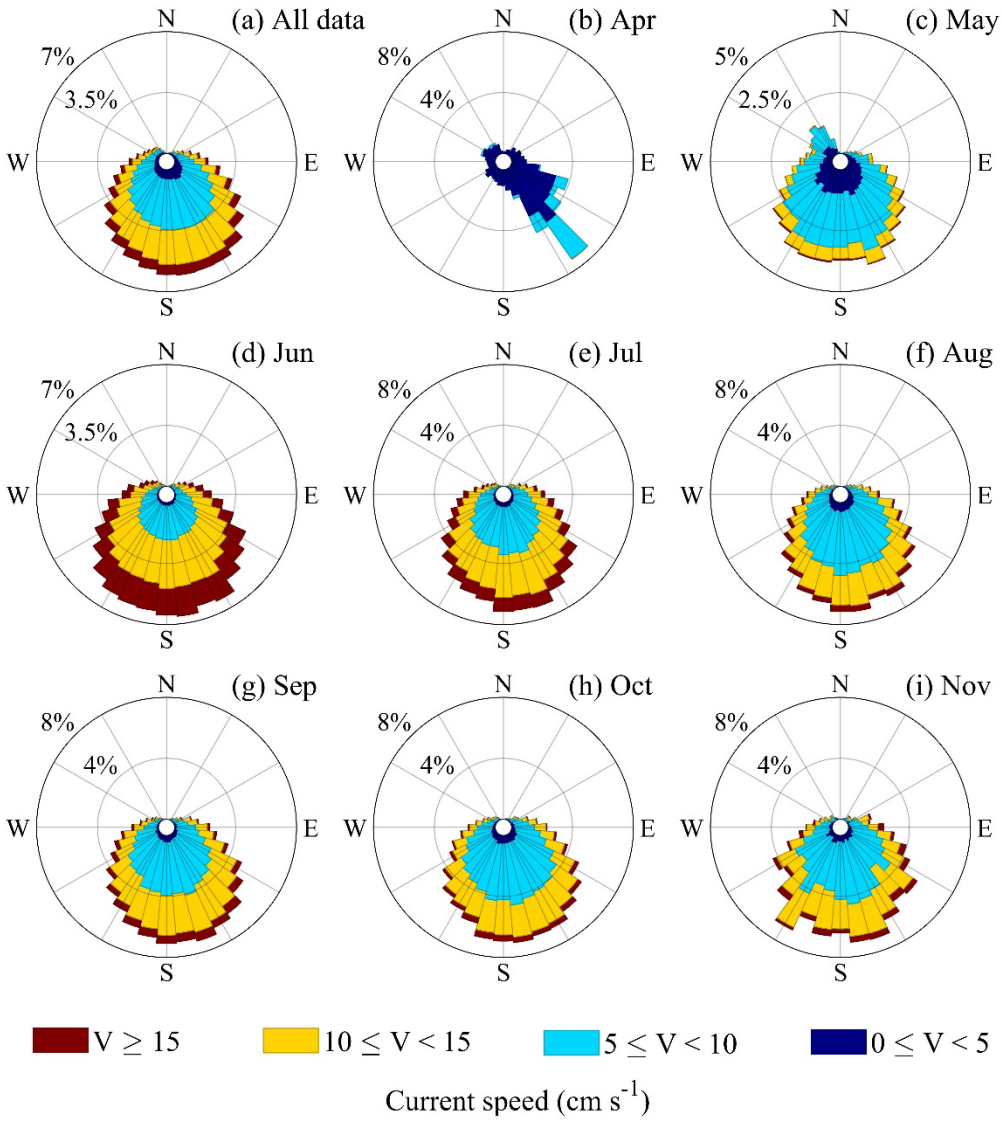

Figure 4. Roses diagram of the horizontal current speed with a 2-minute resolution for (a) the total time series and (b-i) different months. The different colours represent the different ranges of the current speed. Due to technical issues, only 8 days were available in April and 20 days in May. Please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

Fig.6 (formerly 9):

1) Indicate the reference layer / position in the caption
2) It's sensible heat flux, not "specific"
3) Please also note the year on the time axis

Responses: Revised the caption as the reviewer suggested. About the specific heat flux, we confirmed it in many previous studies. In this equation, we think oceanic heat flux represented the term sensible heat flux.

The new figure and caption were shown as follows.

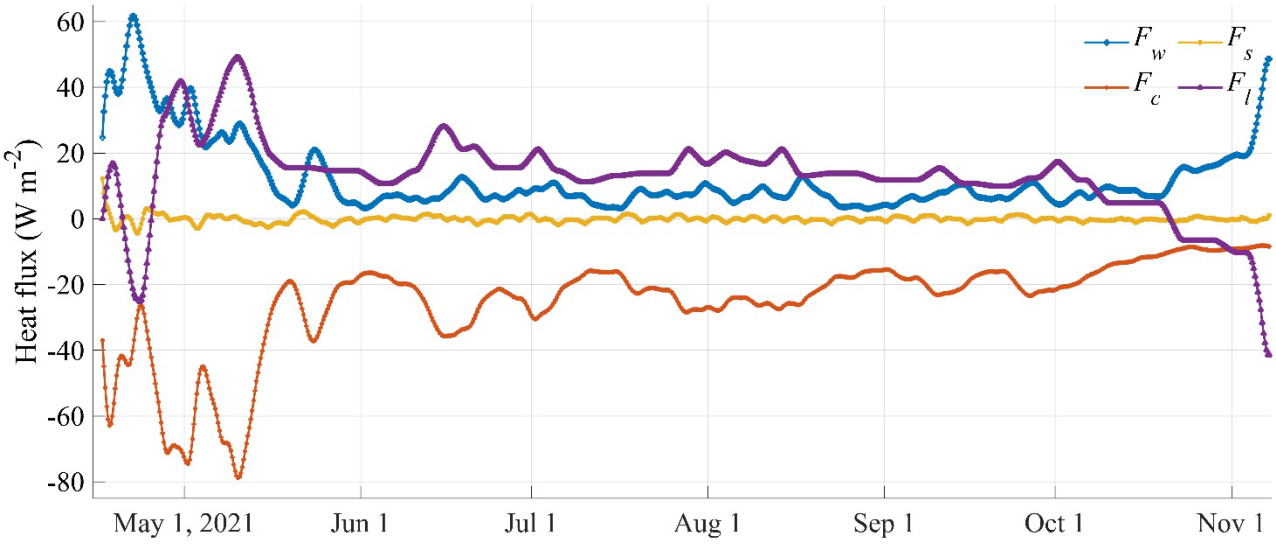

Figure 5. Conductive heat flux (F_c), latent heat flux (F_l), specific heat flux (F_s), and oceanic heat flux (F_w) were estimated using the residual method and a reference layer located 0.2 m above the bottom of the ice. The time interval is 6 hours.

Fig.7 (formerly 10):

1) Hourly and monthly mean values?
2) Please indicate what the error bars stand for. I assume +/- 1 standard deviation?
3) Please also note the year on the time axis
4) Be a bit more descriptive in the caption – it's a bit short on information.

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

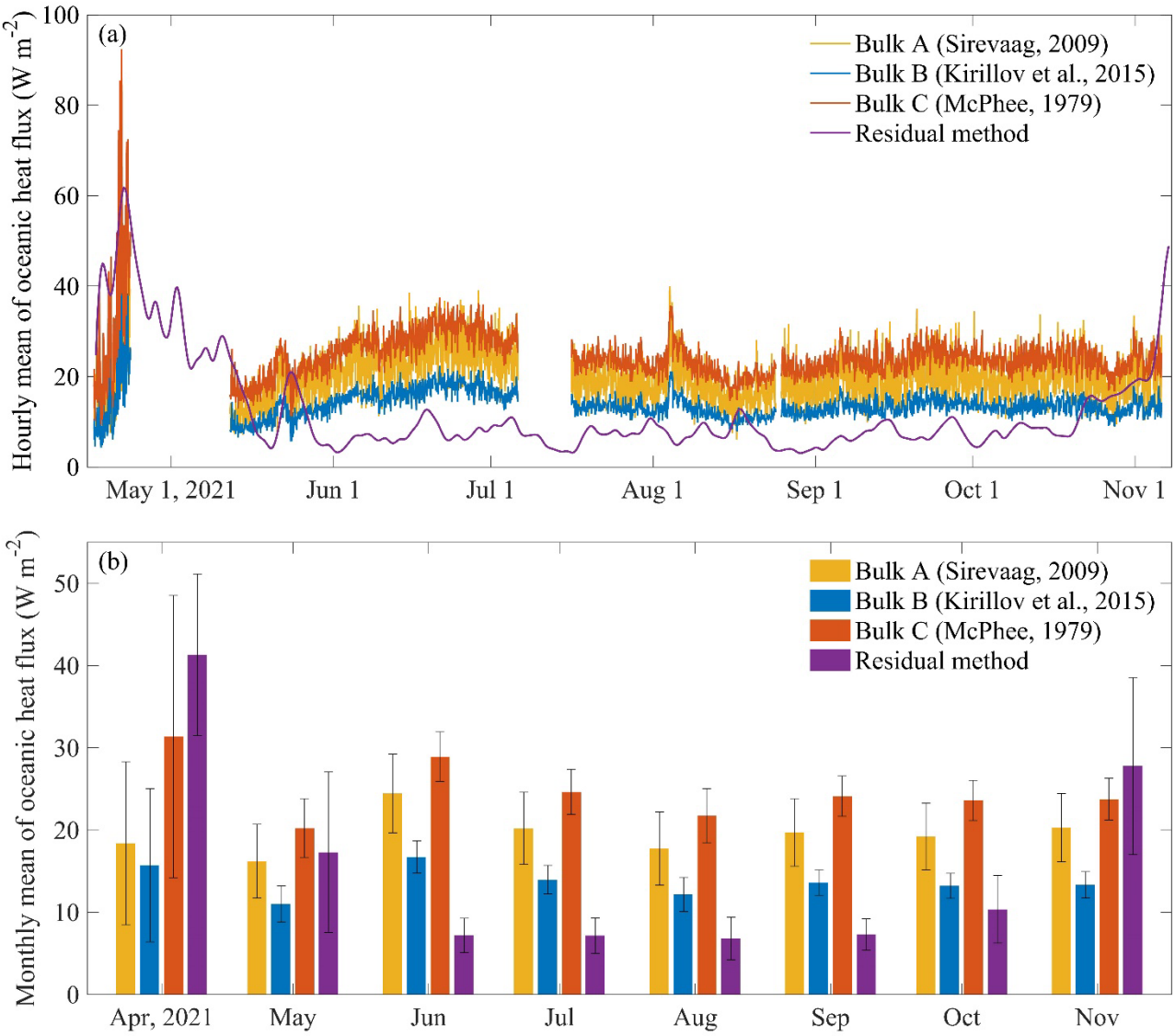

Figure 7. Hourly mean F_w was calculated by three bulk parameterization methods and 6-hourly mean F_w was calculated by the residual method (a) and monthly mean F_w (b). The error bars in (b) stand for ±1 standard deviation of hourly mean values.

Table 2 (formerly 1):

1) Add what +/- indicates (likely standard deviation?)

Responses: Revised as follow.

"Table 2. Inter-comparisons of mean ± standard deviation of oceanic heat flux (W m^{-2}) calculated by different methods."

Fig.8 (formerly 11):

1) Please also note the year on the time axis

2) What is the temporal resolution of the displayed data?

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

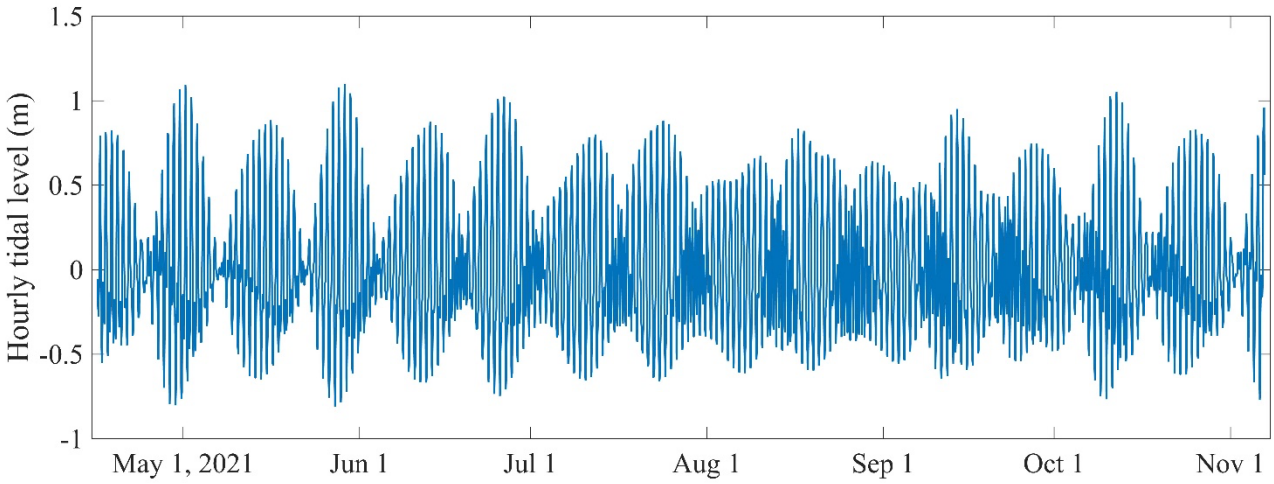

Figure 7. The tidal oscillations were constructed using the harmonic analysis method (Pan et al., 2018) and the harmonic constants of E et al., (2013). The temporal resolution of this dataset is 1 hour.

Fig. 9:

1) Please properly sort the legend in panel (b) and clearly indicate heat fluxes and current components
2) Also (b): It's hard to depict any differences in the lower percentage-range. Can you try to improve this?

Responses: We redraw this figure as the reviewer suggested. The new figure and caption were shown as follows.

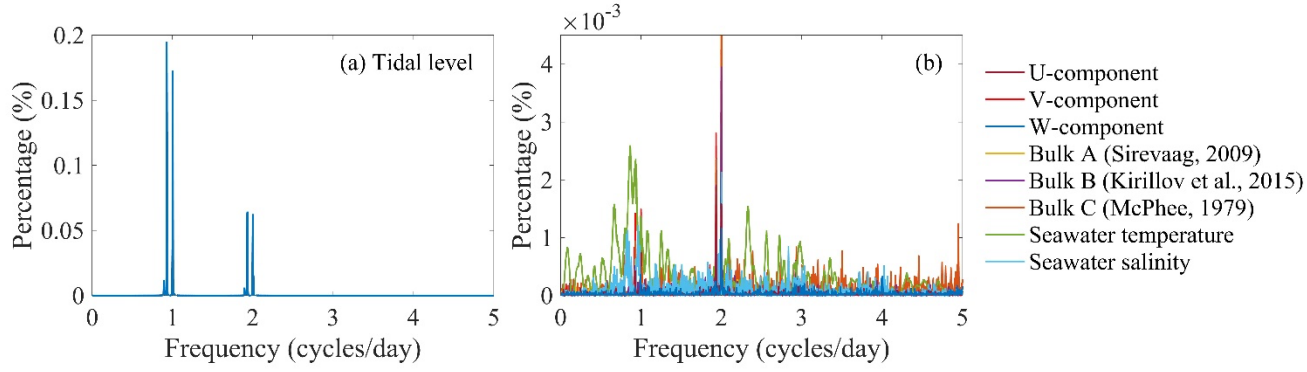

Figure 8. (a) The results of the spectral analysis of the tidal oscillations and the observed ocean variables, and (b) the calculated F_w. The periodogram method was used to detect the periodicity (Welch, 1967).

Fig.10:

1) Caption: add unit of tidal-level bins

Responses: Revised and redraw this figure. The new figure and caption were shown as follows.

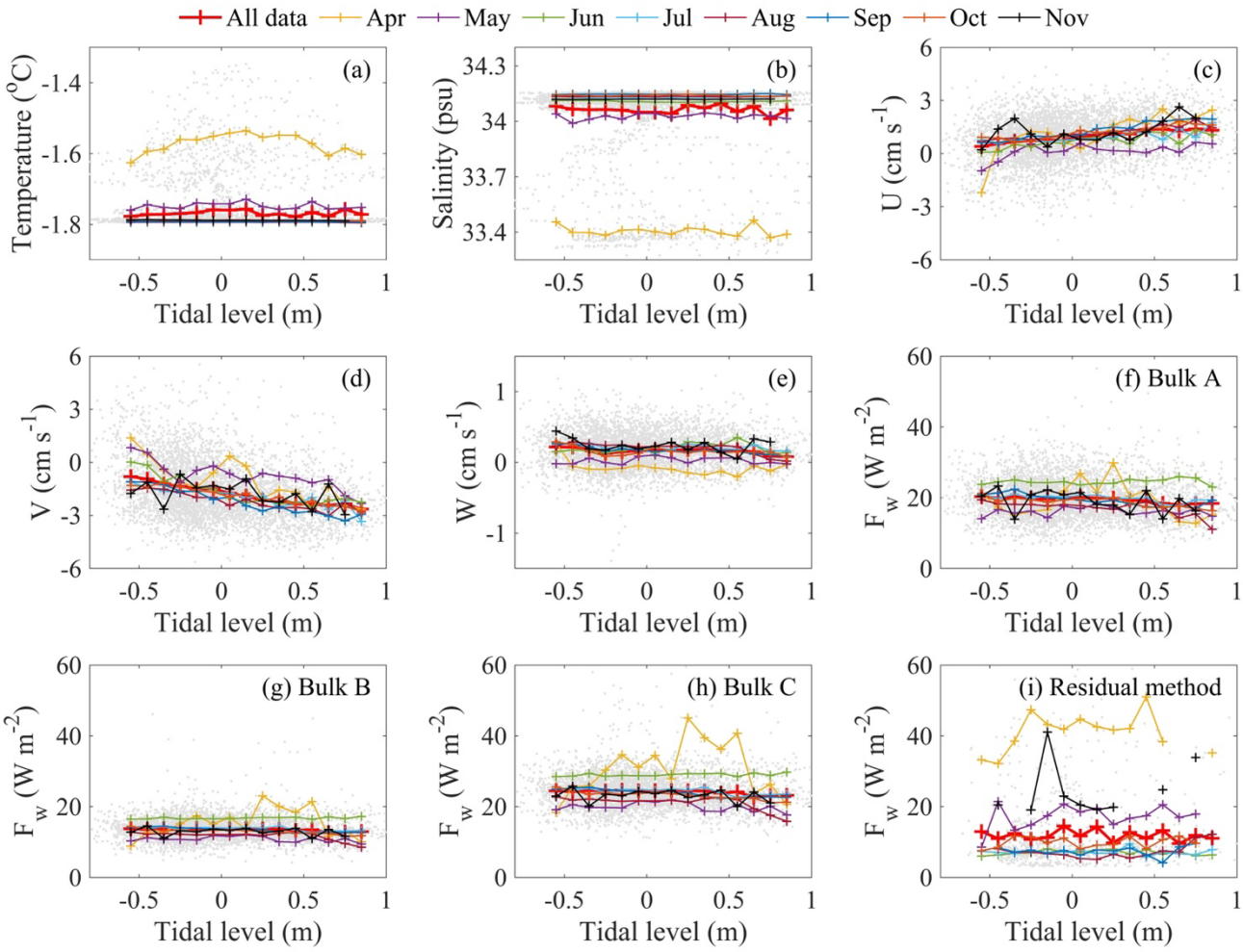

Figure 9. Scatter plots of the tidal level versus the oceanic variables: (a) seawater temperature, (b) seawater salinity, (c) U-component velocity, (d) V-component velocity, (e) W-component velocity, and (f–i) F_w from the Bulk A, B, C, and residual methods. The grey dots are the hourly mean values of the variables, and the different lines represent the monthly mean values for 0.1 m tidal level bins.

Fig.11:

1) Unit of sea ice concentration missing (colorbar)
2) Caption: reference missing; resolution of product not given
3) (Small) overview map of Antarctica would help to geographically locate this area

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

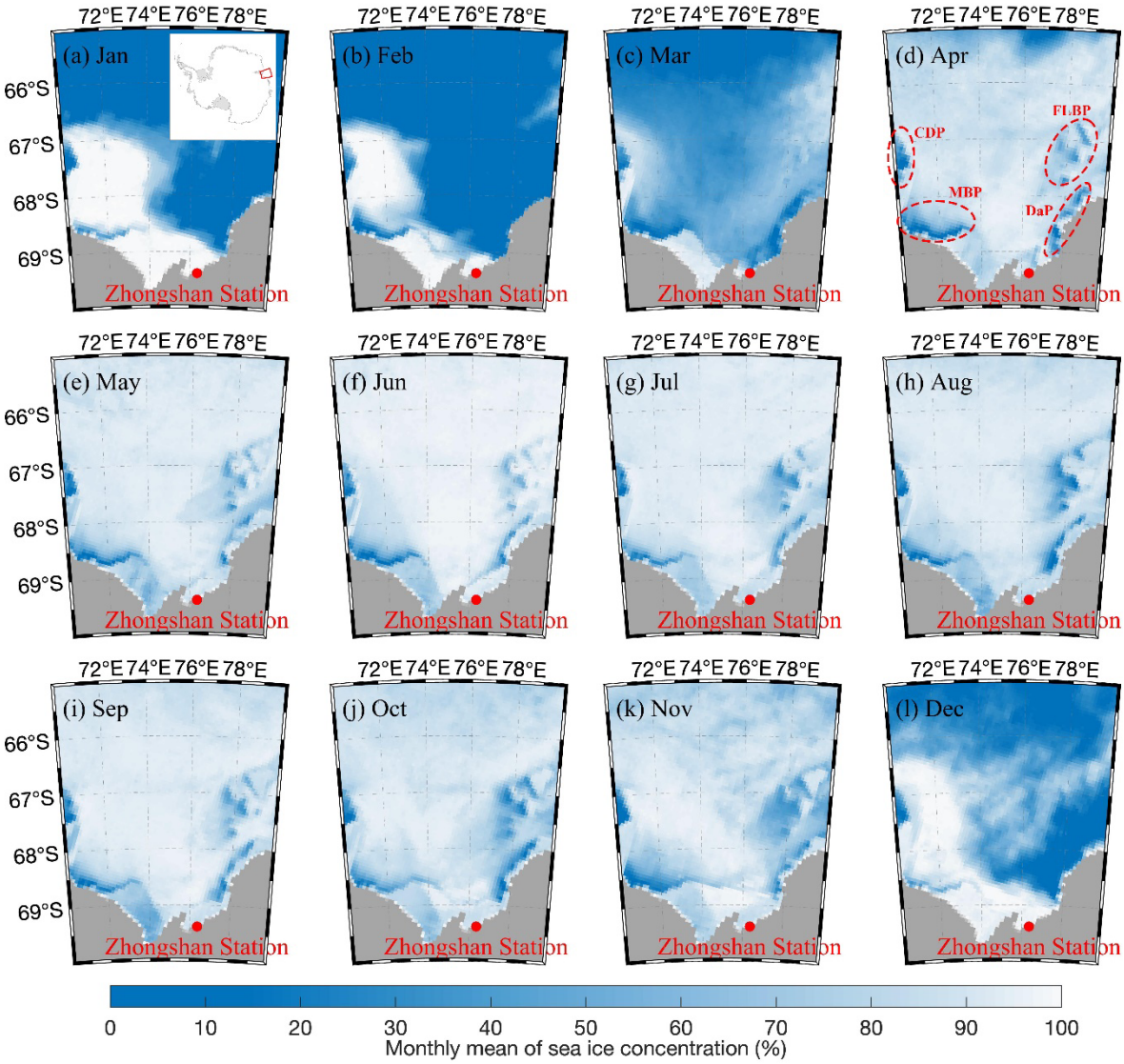

Figure 10. (a–i) Evolution of the monthly sea ice concentration in Prydz Bay from January to December 2021. The domain of Prydz Bay (70–80°E, 65–70°S) in Antarctica is shown in the right-top corner of (a). The sea ice concentration dataset was retrieved from the AMSR2 product provided by Bremen University (https://seaice.uni-bremen.de), with a spatial resolution of 6.25 km. The locations of four large Polynyas are marked in (d), i.e., the Davis Polynya (DaP) and Four Ladies Bank Polynya (FLBP) on the east side and the Mackenzie Bay Polynya (MBP) and Cape Darnley Polynya (CDP) on the west side.

Fig.12:

1) Percentage of what? A reference area / mask (if yes, what is the spatial extent of that area?)? That is neither mentioned in the text nor indicated here (caption, sub-panel or previous Figure).
2) What is the grey line with rose shading?? Again, not in caption!

Responses: Revised as the reviewer suggested. We added a detailed description in the caption. The new figure and caption were shown as follows.

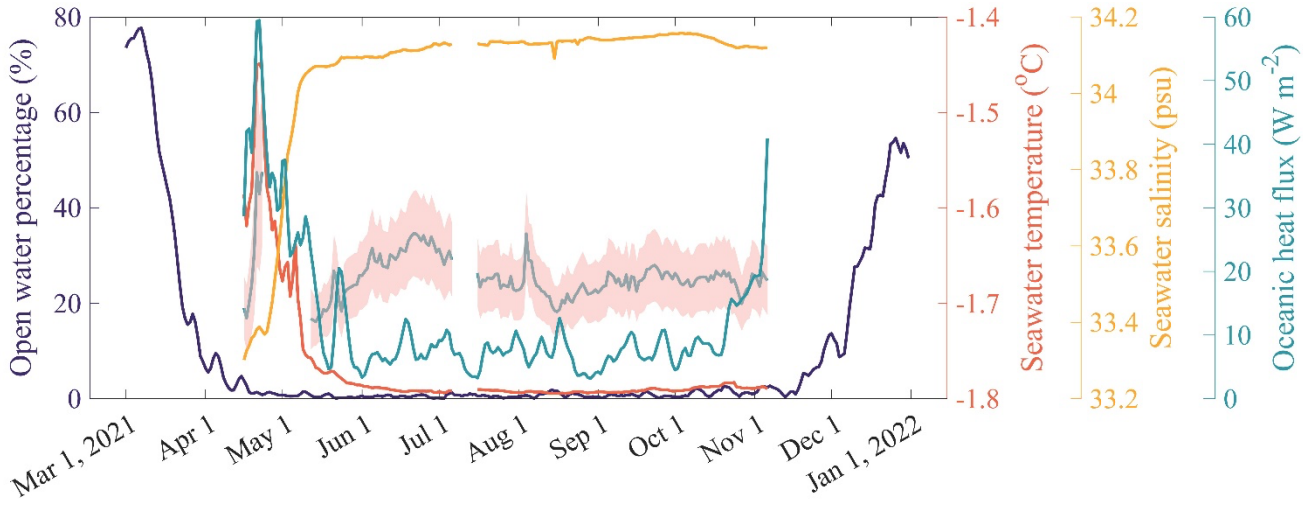

Figure 11. The time series of the daily percentage of open water (purple lines) relative to the domain of Prydz Bay (shown in Fig. 10) and the seawater temperature (red lines), seawater salinity (yellow lines), mean oceanic heat flux from the Bulk A, B, and C methods (grey lines with rose shading), and the oceanic heat flux from the residual method (green lines). The open water area was defined as the sum of the grid cells where the sea ice concentration was less than 15%. The rose shading indicates ±1 standard deviation.

Fig.13:

1) Colormap not suited for readers with color vision deficiencies; better examples & background for instance here: https://zenodo.org/record/5501399
2) What is "Density ocean mixed layer thickness"? I.e., what does "density" refer to (check grammar)?
3) What are the white shadings? Interpolation gaps or some other data features outside the colormap range?
4) Caption: reference missing; resolution of product not given

Responses: Thanks very much. Considering the comments from two reviewers, we narrowed this section, and removed the original figure 13, but retained the analysis text connected to this figure.

Referee #2

General comments:

1) During field deployment, how to ensure that the attitude change of ADV did not affect the

current measurement, or how to eliminate the influence during data processing?

Responses: Thank you for your suggestion. The ADV field observation system included the ADV probe, about 5 kg weight and two 5-m length Stainless steel cables, about 10 kg weight, therefore the ADV field system was a total of 15 kg weight. Considering the large weight, the ADV was believed to move less in terms of attitude underwater, and maintained at 5-m depth beneath the ice surface, even if it was affected by the tide and current.

However, the ADV may rotate underwater. A compass sensor was designed inside ADV to record the rotation and tilt, with the same frequency of velocity during the deployment. Furthermore, to avoid the problem of compass failure in Antarctica, we used two Stainless steel cables to deploy the ADV and kept the physical X-axis of ADV heading in the geographical East direction (90°).

Based on the records of the compass sensor and the user's settings, The program designed inside ADV automatically converts the velocity data into three geographical directions (eastward, northward, and upward). During the entire study period, we found that the largest heading changes of the physical X-axis were about 6°, accounting for less than 2% of the full circle (360°), indicating that the ADV's orientation changes were not significant and had little effect on the velocity observation.

2) 4.2 It is difficult to say that there is a direct connection between the changes in large-scale sea ice and marine environmental conditions and the local air-ice-sea interaction at the landfast ice close to the shore. Although some parameters have synchronous seasonal changes, it can only consider that the seasonal change patterns of these parameters are consistent, rather than the dynamic mechanism. In addition, it is difficult to support some of the author's assumptions in terms of the data and analysis given, thus I suggest deleting this section or only retaining some simple qualitative analysis.

Responses:

Thanks for the reviewer's suggestions. The discussion of large scale and local interaction was suggested by another reviewer. In fact, it was hard to find a high relationship between our local observation and the large-scale pheromone, but the sea ice evolution and the large circulation in the Prydz Bay were absolutely affected the seasonal cycle of local variables. Therefore, we decided to retained this part, but narrowed this section, removed the original figure 13 and deleted the doubtable assumptions.

Special comments:

1) Line 12: “The ice–ocean interaction is one of the main drivers of sea ice mass balance in the Polar Regions” --This is very vague for the study of sea ice thermodynamic process. You should emphasize the importance of high-frequency observation and high-precision estimation of ice-sea heat exchange for assessing the role of ocean heat flux in the mass balance of landfast ice.

Responses: Thank you for your suggestion. We revised this description as follows:

In lines 14-15 of the revised manuscript:

“High-frequency observations of the ice–ocean interaction and high-precision estimation of the ice–ocean heat exchange is critical to understanding the thermodynamics of the landfast ice mass balance in Antarctica.”

2) The magnitude heat flux, seawater density: One decimal place is enough.

Responses: Thank you for your suggestion. We unified and modified the decimal places of the value in the revised manuscript. In the revised manuscript, we ensured the decimal format of the same variables is consistent throughout the entire text.

3) Line 25 “showed a typical period of 0.5 days” change to: showed a typical half-day period.

Responses: Thank you for your suggestion. We unified the description of values in the revised manuscript.

4) Introduction: You highlight the importance of landfast ice, and oceanic heat for ice mass balance, but miss the importance of high-frequency observation and high- precision estimation of ice-sea heat exchange. You also can give some successful cases (i.e., MOSAiC) on the estimation of oceanic heat flux under the ice based on similar observation strategy.

Responses: Thank you for your suggestion. We added one latest reference on sea ice mass balance and heat fluxes using dataset from MOSAiC in the revised manuscript.

“Lei, R., Cheng, B., Hoppmann, M., Zhang, F., Zuo, G., Hutchings, J. K., Lin, L., Lan, M., Wang, H., Regnery, J., Krumpen, T., Haapala, J., Rabe, B., Perovich, D. K., and Nicolaus, M.: 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, 000089, https://doi.org/10.1525/elementa.2021.000089, 2022.”

5) “global warming has been becoming more and more significant,”: In fact, it is not correct,

such as the hiatus of temperature rising.

Responses: Thank you for your suggestion. We made the necessary modifications to this portion of the information.

6) Line 76 “the second Chinese Antarctic scientific research station, which was established in February 1989 and operated year-round from then on” -- I don’t think the history of Station is a useful information for your study.

Responses: Thank you for your suggestion. The station information can give the reader background knowledge of why we can carry out the winter observations at this station. So, we decide to retain this sentence.

7) Line 105 “when he worked as the wintering team member in Zhongshan Station”: it is also useless information.

Responses: Thank you for your suggestion. We deleted this description in the revised manuscript.

8) Line 166 “The 4.8 m long SIMBA temperature chains recorded the vertical temperature profiles of air–snow–ice–ocean every 6 hours.” moved to the section of method.

Responses: Thank you for your suggestion. In the revised manuscript, we have moved the corresponding description to the method section. **In lines 110-111 of the revised manuscript.**

9) Line 186 “indicating the influence of short-term weather systems on ice evolution.”: The main impact should be the increase of heat content of ocean, not the increase of air temperature. The response of sea ice growth to changes in air temperature has some hysteresis.

Responses: Thank you for your suggestion. We incorporated your suggestion and made modifications to this part. **In lines 209-210 of the revised manuscript.**

10) Figure 2: change the sensor number to depth relative to sea level or ice surface please.

Responses: Revised.

11) Line 206: “which attributed to the snow isolation effect on ice and ocean.” -- Cannot only attributed to the snow isolation effect.

Responses: Thanks for the reviewer’s suggestion, and this sentence was deleted in the revised manuscript.

12) Ocean density, salinity-- would be better “seawater density and salinity”.

Responses: Thank you for your suggestion. Compared with "ocean", "seawater" may be more appropriate to describe the observation data of the site, which has been revised in the revised manuscript.

13) Figure 5: How to explain the changes in current direction distribution and magnitude from April to May?

Responses: The reason for the significant changes from April to May in Figure 5 was the length of the available data, only 8 days in April and 20 days in May, due to technical issues. We explained it in the caption of Figure 4 in the revised manuscript.

“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. Please note that the percentage scales are different in the different sub-panels.

”

14) Line 308 “methods were consistent with the previous studies but based on a higher temporal resolution”: It is difficult to say that the difference is tens of watts is “consistent”. It can only be said that the seasonality of oceanic heat flux given by different methods is consistent. The quantitative difference may be related to specific methods and environmental parameters of the given year. In addition, the estimation of oceanic heat flux at the ice bottom based on the residual energy method will produce great errors in a short time window.

Responses: Thank you for your suggestion. We restructured this part as follows in the revised manuscript.

In lines 336-341 of the revised manuscript:

“In this study, the average oceanic heat flux calculated using the residual method and the bulk methods are consistent with those of previous studies on the seasonal scale, and the quantitative difference may be related to the specific methods and environmental parameters for the given years. In this study, we utilized a higher temporal resolution (6 hours for the residual method and 2 minutes for the bulk methods), which provide more details and insights for the readers and communities, while the estimation of the oceanic heat flux at the bottom of the ice based on the residual method may produce great errors within a short time window (Lei et al., 2010).”

15) “E et al., (2013).”: It is from Huang et al. (2013). Right?

Responses: This reference is E et al., (2013), the first author is E Dongchen, from Wuhan University, China.

16) “PSD peaks”: what is the PSD here?

Responses: “PSD (power spectral density)”, we have made this part clearer in the revised manuscript.

In lines 357-359 of the revised manuscript:

“In this study, the periodogram method (Welch, 1967) was used to detect the periodicity of the long time-series observation data. Power spectrum analysis of the signal revealed that the tidal oscillations exhibited two peaks.”

17) Figure 9: “The results of spectral analysis”: the result is very strange for me? How to obtain such probability distribution?

Responses: Thank you for your comments. The method used for the results in Figure 8 is detailed in the previous reply.

This study used the Periodogram method to detect the periodicity of long time-series observation data. The Periodogram is a method of estimating the Power Spectral Density (PSD) of a signal and is primarily used to estimate the power distribution of a signal at different frequencies to detect whether there is a clear periodicity in the signal. If a signal has periodicity, then the power at certain specific frequencies will be much higher than at other frequencies. These frequencies are the signal's periodic frequencies, and their power density reflects the periodicity of the signal.