Review on "The diurnal evolution of oceanic boundary layer beneath early-frozen landfast ice in Prydz Bay, East Antarctica" by Hu et al. (2022), submitted to TC Discussions

September 15, 2022

The submitted manuscript describes a data set of ocean temperature, salinity and currents as well as thereof derived ice & ocean properties such as density and heat fluxes. The data record from the presented "integrated ocean observation system" (which contains an Acoustic Doppler Velocimeter, a CTD and a sea ice mass balance array) in Prydz Bay, Antarctica, spans about seven days in total and features measurements with a temporal resolution of 30 seconds to six hours.

Overall, I am missing clear focus points in the manuscript. Besides the comparatively high frequency of ocean temperature and salinity measurements and a fairly comprehensive description of the measurements and derived quantities, I find it hard to spot truly unique findings in the manuscript that would qualify for a swift publication in The Cryosphere. If the authors are able to better relate their measurements to other data sources / the larger scale context, together with a more profound discussion and evaluation of uncertainties & shortcomings, there might still be a chance to reconsider it after several major revisions. Please find my main remarks below under "General comments".

Language & grammar-wise (judging from a non-native English perspective), several parts of the paper (see "Specific comments" below) would most certainly profit from another round of thorough proofreading and rephrasing, especially in relation to overly long sentences and word order.

General comments

1) The presented time series of just seven days is particularly short, compared to other similar data sets in both hemispheres. How do you justify the significance of this data record? It is not 100% clear to me how this data set sets itself apart from any other. Further, you only mention an instrument malfunction at the very end of Ch.5, which is likely the cause for the short data record, right? Why is this not mentioned right at the beginning of your data description?!
2) The manuscript often mentions the apparent benefits of "minute resolution" measurements, without clearly differentiating between the different data sources. For instance, the SIMB measurements of vertical temperatures are only available four times a day (hence, imprinting on presented heat fluxes). Please revise the respective parts carefully.
3) The authors apparently decided to leave out a "traditional" chapter on the applied methodology to process and analyze the recorded data. Later in the text in the context of results (Ch.3.6), at least the heat flux calculations are explained. However, I consider these parts as misplaced. I would recommend a new separate chapter on methodical aspects & data processing prior to the results section. In this context, Chapters 3.6.1 and 3.6.2 could also be thoughtfully merged and at the same time streamlined to the most relevant aspects.
4) Almost all figures require a careful overhaul, be it due to the lack of proper labelling, low resolution images, non-barrier-free colormaps or "just" an insufficient / too short caption. You will find more detailed comments on all these below, right after specific comments to individual chapters.
5) There is no further information on the larger scale environmental conditions (sea ice cover, atmospheric / ocean reanalysis, etc.) at all. Even if you omit to directly relate these conditions to your own data, it would be extremely helpful to have those for a proper context.
6) Please pay attention on using a (relevant) number of digits after the decimal point. Often, there is unnecessary detail given, especially when the numbers end with ".0". In addition, try to be consistent throughout the manuscript.
7) You describe your results/measurements in past tense (e.g., "Figure 6 showed") → please use the present tense in that regard.

Specific comments *(incl. technical notes)*

Abstract

P.1, L.14: "COMPACT-CTD" → there is only an ACTD mentioned in the manuscript. Please explain, also why capital letters are used here.

P.1, L.16: Not all measurements are minute-resolution, right? SIMB → six-hourly

P.1, L.20: "the bulk …" → "a bulk"

Ch.1: Introduction

P.2, L.37: Fraser et al. (2021) would be another good reference here (DOI: 190.51.94/tc-15-5061-2021)

P.2, L.60: "the flux balance equation" → "a flux balance equation"

P.2, L.60: 8 psu salinity → salinity of the sea ice? More specific please.

P.2, L.62: Explain abbreviation "HIGHTSI" and give the respective reference

P.2, L.64: Again – "a residual" instead of "the residual"

P.2, L.65: Leave out ".0"

P.3, L.67: "there are few studies" →so there are some apparently?

P.3, L.75: please give a reference for the "modified Stefan's law", or explain briefly

P.3, L.77: "Based on *measurements* of…"

P.3, L.77: Please explain abbreviations in the text; as they are used for the first time here

P.3, L.78-80: Can be left out → phrasing in its current form

Ch.2: Observations

P.3, L.82: Coordinates misplaced; move to beginning of next sentence

P.3, L.84: Reference for the landfast ice cover duration?

P.3, L.86-88: Are these own observations or is the reference missing?

P.3, L.91-96: Please indicate reference papers/reports for the respective measurement devices (could also be moved to a table in general; together with other instrument characteristics)

P.4, L.101: "every five days" → in a seven-day data record, it is sufficient to call that "twice"

Ch.3: Results

P.4, L.112-114: Please revise this sentence to improve grammar

P.4, L.114: Be careful with the use of the word "significant", as this usually refers to a statistical significance. If there are no statistics involved here, please try to use a different wording.

P.5, L.120: You write that the ice-water interface was determined by a simple threshold (freezing point temperature of sea water). Can you elaborate more on that topic, especially how you handled noisy data and the given uncertainty for the IMB temperature measurements?

P.5, L.123: "observed in the field" → do you mean direct measurements, for instance by a drill?

P.5, L.125: "in consequence" → a consequence

P.5, L.131: "the ACTD"

P.5, L.131: “2m below the ice surface” → how thick was the ice at this position?! I would assume that at least platelet ice could fairly quickly become a problem for CTD measurements at this depth…

P5, L.134: with “about 0.1m above the ice bottom” – do you mean the lowest 10cm? Please rephrase

P.6, L.138/139: Check grammar and sentence breaks

P.6, L.139/140: Please be more precise here. Which temperature gets warmer, and compared to what/when? Plus: “more heat”, not “more heat flux”

P.7, L.147/148: Did you mix up smallest & largest deviation?

P.7, L.148: Add “mean” or “average” before “ocean salinity” and replace “remained at”

P.8, L.157: Remove “internationally recognized”

P.8, L.158-166: Multiple remarks; Please elaborate in more detail why you used this particular equation, i.e., why you consider it as suited for your observations in Prydz Bay. Further, please do not just copy the denoted symbols from the source publication without explaining them first together with the respective units (t, S, rho). Also, be more precise and consistent with the indexing, for instance in case of salinity (ice or water salinity?).

P.8, L.168 & 170: Be careful when referring to a “trend”, as this is again mainly used in the context of statistical analysis.

P.8, L.171: Check grammar & sentence breaks

P.9, L.180: “u-component” and “v-component”; check grammar after “It can be seen”

P.9, L.182: “ROSE analysis” is not the correct wording. It’s “just” a diagram.

P.10, L.186: Please explain what you mean by “compound current”

P.10, L.187: Please give a proper reference / data citation for the data set from the Bureau of Meteorology, Australia and introduce the abbreviation that you are using later in the text

P.13, L.222/230: “the reference layer” is only explained towards the end of the sub-section. It would be useful to have this part earlier in the text in order to avoid confusions. Also, please indicate which measurement device(s) are used for your calculations. Further, can you comment on / discuss the effect of snow on top of the sea ice when you calculate your heat fluxes?

P.13, L.229-233: Please rephrase & avoid repetitions of “and”

P.14, L.240-242: List references for the used constants

P.14, L.262: Again, careful with “significant”

P.15, L.277: Please explain w’ and T’ explicitly

P.16, L.296: check grammar / word order

P.16, L.300-303: check grammar / word order

P.16., L.312/313: Again, careful with “significant”

Ch.4: Discussions

P.18, L.326: How does this compare to a climatology or model results?

P.19, L.355/356: check grammar / wording

P.19, L.362: Only one sentence that relates to your own measurements? There is for sure more to discuss in the context of other studies, as well as the general context of the measurements in a large-scale and/or climatological sense.

Ch.5: Conclusions

P.20, L.366-371: Please rework this part (grammar, past tense, wording)

P.20, L.374: These are already the conclusions, and I still don't know how exactly snow and ice thicknesses were estimated. Please explain early in the manuscript.

P.20, L.387: "increased to twice" → doubled?

P.21, L399: "equipment malfunction" → ?? See general comment. Why is this only mentioned at the very end?

Other aspects

Data availability: "data available on request" – please consider putting your data on a public repository. Additional benefit: You'll get a proper citable DOI.

Competing interests: Check grammar!

References: L.477 & 479 – this is the same author, right? Check references for consistency.

Figures & tables

Fig.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.
- Data source and reference for the satellite image in (a) missing
- Check grammar in the caption
- Panel (c) would need a slightly better resolution (likely compression-artefacts?)

Fig.2:

- Units missing next to the colorbars
- Panel (b): Vertical gradient (btw: note the spelling mistake) → add "of temperature"
- It is not mentioned in the caption that this is a contour plot based on a limited number of measurements (four times daily)
- Please also note the year on the time axis, plus time zone (UTC? local?)
- Caption: Not mentioned how the ice surface & bottom were derived (algorithm or manually); none of the axis explained
- Colormap not suited for readers with color vision deficiencies; better examples & background for instance here: https://zenodo.org/record/5501399

Fig.3-5:

- The differentiation between 2min and 1hour average values is nowhere 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.
- Units missing in sub-panel headers (after mean/std)
- Please also note the year on the time axis, plus time zone (UTC? local?)
- In general: Anomalies in the sub-panels (b) to (i) not discussed in the paper, so either leave them out (e.g., combining the upper panels of Fig.3-5) or discuss them adequately
- Caption: Spell out / explain abbreviations

Fig.6:

- As in previous three figures: The differentiation between 40s and 10min average values is nowhere 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.
- Please also note the year on the time axis, plus time zone (UTC? local?)
- Panel (c): Add "horizontal current speed"
- Caption/panels (a) and (b): u-component / v-component
- Caption: Spell out / explain abbreviations

Fig.7:

- I would recommend to choose another symbol for "Current speed" than "s". "V" is probably more common and intuitive.
- Percentage values: why decimal values / not rounded?
- Caption: Spell out / explain abbreviations

Fig.8:

- Right y-axis: Water level anomaly?
- Left y-axis: Unit missing
- Vector-arrows: are you sure these are 2min values and not 5min?
- Caption: Spell out / explain abbreviations

Fig.9:

- Please also note the year on the time axis, plus time zone (UTC? local?)
- Please indicate the instrument from which these fluxes where derived

Fig.10:

- Caption: 2min/1hour averages, not results
- Please indicate what the error bars stand for. I assume +/- 1 standard deviation?
- As in previous figures: The differentiation between 2min and 1h average values is nowhere 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.
- Please also note the year on the time axis, plus time zone (UTC? local?)
- (b) → use different colors than in (a) and previous figures

Table 1:

- Check wording
- Add what +/- indicates

Fig.11:

- Please also note the year on the time axis, plus time zone (UTC? local?)
- Spell out abbreviations and give appropriate references
- Explain "harmonic constant calculation" (it is not in text). What exactly is merged here?!
- Are these hourly values averaged values? Then please indicate the respective standard deviations (by error bars, shading or similar).

Fig.12:

- First of all, the figure is generally hard to assess and not very intuitive. 3D plots are fancy, I know, but 2D plots might be more familiar to many potential readers.
- The caption mentions the 3D-evolutiomn of ocean velocity and direction – only, where exactly is the velocity? I see temperatures, directions, Dates (again, time zone etc. missing), salinities…but no velocities! Please explain.
- The axis-labels are generally too small