

The Cryosphere Discuss., referee comment RC1  
<https://doi.org/10.5194/tc-2022-185-RC1>, 2022  
© Author(s) 2022. This work is distributed under  
the Creative Commons Attribution 4.0 License.

## **Comment on tc-2022-185**

Anonymous Referee #1

---

Referee comment on "Attributing near-surface atmospheric trends in the Fram Strait region to regional sea ice conditions" by Amelie U. Schmitt and Christof Lüpkes, The Cryosphere Discuss., <https://doi.org/10.5194/tc-2022-185-RC1>, 2022

---

### **Summary**

This paper by Schmitt and Lüpkes focuses on two separate areas particularly affected by recent changes in sea ice concentration and air temperature: the Greenland Sea and the southwestern Nansen Basin. The authors use atmospheric reanalysis and satellite data to examine 1992-2022 trends in winter near-surface temperature, humidity, winds, and sea ice concentration (S.I.C.). The analysis is separated into periods of "on-ice" and "off-ice" winds, differentiated by wind direction in areas which are typically near or downwind of the winter ice edge. The analysis reveals a slight but significant increase in "off-ice" winds northwest of Svalbard, and shows that positive trends in air temperature and humidity during "off-ice" winds are amplified in the same region. In the Greenland Sea, similar but weaker positive trends are stronger further south and east during "off-ice" winds. The authors go on to examine S.I.C. trends, showing a strong decline sea ice cover in both study regions in line with previous studies, with interannual sea ice concentration variability negatively correlated with both temperature and humidity. They show that the spatial structure of the correlation between S.I.C. and temperature/humidity differs between on-ice and off-ice winds. In the discussion, the authors show that the observed trends are largely consistent with previous studies, and they argue that upstream sea ice loss is a cause for increased temperature/humidity trends in the study regions.

### **General comments**

The study has the worthwhile objective of disentangling the causes behind the strong trends in atmospheric temperature in some of the planet's most rapidly changing regions. While I think the manuscript contains several interesting findings and the analysis generally seems to be rigorous and well executed, I find that the study has some methodological shortcomings and – crucially – lacks for clarity.

The writing itself is generally good and clear, and individual results are laid out in an understandable fashion supported by useful figures. The introduction section provides a good introduction to the current knowledge of the region.

I found the analysis of trends and correlation to be interesting; while similar things have been documented elsewhere for this area, the extension to present date is apt and of wider relevance. It is also interesting to see the trends in humidity, which are significant and largely mirror the temperature trends.

As I understand it, the main objective of the study is to distinguish impacts on atmospheric temperature and humidity due to "regional sea ice changes" vs "other factors influencing atmospheric conditions". The separation between the two is done by looking separately at periods of "on-ice" and "off-ice" winds, defined by specific wind direction ranges. I was occasionally confused by this approach; it seems to me that much more space needs to be given to explaining the idea behind this method and what the implications of the observed differences actually are.

From what I understand, the authors look to separate temperature/humidity trends due to "effects of changing sea ice cover" vs "other factors" by which they seem to imply warm intrusions from the south. It is not obvious to me that the "on/off-wind" separation is a good way to do this (wouldn't it be easier to single out *southerly* winds, for example, or to look at heat transports directly?). Decreased regional sea ice cover presumably does not require "off-ice flow" to affect air temperature/humidity near the ice edge – I am sure the authors are aware of this, but I believe that they should lay out the motivation behind their methodology much more clearly. Moreover, it is not clear to me that the "off-ice" direction necessarily corresponds well to actual off-ice flow.

The manuscript lacks a thorough discussion of confounding variables, and I often had trouble with the inferred causality. For example, take the statement of L309: "*.. correlations for off-ice flow exceed -0.8 for both temperature and humidity and this S.I.C. changes in the upstream region can explain up to two thirds of the observed [temperature and humidity] variability..*". Would they get a different result if they replaced the WNB box with a box to the NW, or just used the same box as for the atmosphere? If not, what are the implications for this statement? And what about large-scale atmospheric warming or increased ocean heat; wouldn't that affect both variables? I understand that it is hard to pick apart the many interwoven mechanisms at play, but I am missing a more clear and thorough discussion of exactly what the authors have found.

I do not recommend the publication of this manuscript in its current form; my recommendation is that the paper undergoes major revisions, which I strongly suggest should include a comprehensive overhaul of the paper with the goal of making it much clearer to the reader why the particular approach was chosen, and what one should actually make of the results. I personally suspect that it might be beneficial to separate both the results and discussion into one section dealing with general trends/correlations and another dealing with the difference between on-ice/off-ice winds (although that would certainly not be the only way to go about it).

I recognize that the mechanism the authors invoke is somewhat complex, and that I may be missing important aspects out of ignorance. If that is the case, I hope the authors take my input as motivation for providing a clearer framing of the study in a future version of the manuscript.

### **Specific comments**

The authors need to explain more clearly how their methodology of looking at trends/correlations during different wind directions relates to main objective of the study (separating effects of regional sea ice loss vs "other effects"/southerly heat transport). Perhaps some sort of schematic could be helpful?

--

The study relies on the separation between "on-ice" vs "off-ice" winds. These are defined as specific wind direction ranges for the two regions. In my opinion, this choice needs to at least be justified more clearly. For example, would not winds from the NW be more directly "off-ice" at the WNB ATM box than those from the NE? And area the "WNB ICE" box and "fetch line" actually upwind of the "WNB ATM" box during off-ice winds per this definition?

It is possible that all of this would be more obvious to a reader more intimately familiar with the region than I am. However, I think it might be helpful in this respect to show some context at the start of the paper; e.g., wind roses with temperature and/or humidity, distribution of temp/hum as functions of wind direction, or map plots of the mean wind/temperature fields during on/off-ice winds might help setting the stage.

--

It should also be made explicit, or at least discussed in more detail, whether off-ice winds cause a *redistribution* of heat/moisture within a larger region, or whether this is a mechanism that has caused net increases in heat/moisture in the Barents/Fram Strait area. It was not clear to me from e.g. the trend/correlation difference plots (Fig 3ef, 4cf, 10ef, 11cf) whether the positive/negative regions actually balance out.

--

I think the authors need to state more clearly whether the differences between trends during "off-ice" and "on-ice" wind conditions are actually statistically different. Does Table 2 indicate that they are *not*? If so, how does that impact the conclusions?

--

Throughout the manuscript, there needs to be a clearer differentiation between trends/effects that are attributed specifically to "off-ice flow" vs to other effects/"general trends".

One specific example:

From L5 in the abstract ("During off-ice flow.."): It seems necessary here to include the corresponding temperature changes during the other wind directions.

Another example:

Red markers in Figure 9 show the relationship between air temperature NW of Svalbard as a function of WNB S.I.C./polynya length. How different would this figure look if you only included "on-ice" winds?

--

L129: The formula by Steiger 1980, or a brief description of what it is, should be included.

--

Figure A1: I am a little confused as to why the SD of sea ice concentration is shown here. Why not just show the actual (winter average) concentration?

--

Great that the study looks at two different reanalysis products, this strengthens the analysis. Figure 5 shows apparent striking systematic differences in both temperature and humidity – it would be useful if the authors could briefly comment on possible reasons for this (different height levels? known biases?).

--

In general, I found the figures to be nicely made and helpful. I would suggest a few modifications:

- Add scale bars to the maps (helps to interpret statements like “500 km downstream”, etc).
- Clearly label the boxes – e.g. GRB (ICE), GRB (ATM) or similar; it is at times difficult to follow which is which.
- Label the Odden Ice Tongue somewhere in Figure 1. The Odden ice tongue should also be indicated in Fig. 4.
- Revise the colormaps such that warm colors correspond to warm temperatures etc (this would make especially Figures 3/4 a bit more intuitive). Figures 3/10 and 4/11 should at least have the same color showing the same sign of temp/hum change.

--

The area NW of Svalbard where trends are most affected by off-ice winds (e.g. Fig. 3ab, Fig3ef) seems to correspond roughly to the Yermak Plateau, which from what I understand is an area where the upper ocean is particularly warm and loses a lot of heat and moisture to the atmosphere. Could this play a role in the mechanism that the authors invoke? (Note: I don't expect the authors to go into detail, but I think it warrants a mention).

### **Technical/minor**

The manuscript should be gone over for clarity. Below are a few specific instances where I think changes are warranted:

--

L20-22: Meaning is unclear.

--

L147 and onward: "trends of the frequencies" – I find this use of "frequency" confusing (others may not).

--

L142. "Westerly to northerly": If this refers to the 30-60 degree window, this phrasing seems inaccurate.

--

L173: "time series of trends" – meaning unclear.

--

I would advise being careful with the use of "as for"; to me, this reads as "with regard to". (Ex. L189, L245, L280).