The Cryosphere Discussions

The Cryosphere Discuss., referee comment RC2
https://doi.org/10.5194/tc-2021-250-RC2, 2021
© Author(s) 2021. This work is distributed under
the Creative Commons Attribution 4.0 License.

Referee comment on tc-2021-250

Anonymous Referee #2

Referee comment on "Evolution of the Amundsen Sea Polynya, Antarctica, 2016–2021" by Grant J. Macdonald et al., The Cryosphere Discuss., https://doi.org/10.5194/tc-2021-250-RC2, 2021

GENERAL COMMENTS

I think the manuscript's topic fits nicely within the scope of the journal. As far as I know, this manuscript is unique (i.e. original) in its detailed description of Amundsen Polynya, providing far more information than earlier publications. The study is also scientifically significant given the regional importance of the Amundsen Polynya, either in terms of sea ice production (4th in Antarctica) or for its role in phytoplankton production and atmospheric CO2 uptake. The methods and analyses were generally sound except in one particular analysis for which I proposed verifications and improvements (see "Specific comments: Major"). I thought the manuscript was structured in a straightforward/predictable manner and that the writing (and choice of references) was generally appropriate. Overall, I believe the manuscript has the potential to become a valuable addition to "The Cryosphere".

RECOMMENDATION

Unless my co-reviewers identify major flaws that I've missed, I think the manuscript will be acceptable for publication *after* moderate revisions are made (see specific comments below).

SPECIFIC COMMENTS: MAJOR

(1) Lines 521-522: "Daily mean wind speed at the polynya site and polynya area during the winter period has a weak but significant positive correlation"

Are you sure that these are the two variables (wind speed versus polynya area) you should be comparing together?
I would have tried to compare the winds against the *change* in polynya area, i.e. d(area)/dt.
A gust of winds would presumably correlate with a change in area (d(area)/dt), not the actual area.

Another related comment is that you are using wind *speed* and ignoring the wind's direction.
Wouldn't the wind direction matter, e.g. in distinguishing between an opening (area increases) or a closing (area decreases) of the polynya?

(2) Lines 529-531: "The mean wind direction throughout the ASP study area is approximately southerly. While this direction corresponds to the direction in which the polynya sometimes forms northward off the Dotson Ice Shelf, it does not correspond to the more typical westward formation off the iceberg chain."

Could you please expand on this in your "response to the reviewers", and demonstrate that the "southerly mean wind direction" isn't a plotting artefact or an error in the postprocessing of ERA5's winds? Although I haven't specifically worked with years 2016-2020, the area just north of the Getz and Dotson ice shelves usually shows mean winds blowing from the southeast or from east-southeast. In contrast, Figure 9 shows winds blowing from the south or from south-southeast.

A few thoughts and suggestions:

---A wind blowing from the south or from the south-southeast would imply that the `v' wind component is larger (in absolute terms) than the `u' wind component. Can you go back to the original ERA5 results (meaning before doing any sort of processing) and confirm that this is what you are truly seeing in ERA5's u,v wind components? (We are particularly interested in the region just north of Getz and Dotson ice shelf, i.e. the ASP).
---If you select one single location (latitude = something, longitude = something) where ERA5 winds are defined, please verify that the 'u' value and the the 'v' value (in the original ERA5 files) are quantitatively consistent with the arrow's direction shown at that particular location. If they don't quantitatively match (using the basic trigonometric relations), then there is an error in the plotting or the postprocessing.
---Since wind direction is important in Figure 9, shouldn't we add longitudes and latitudes to orient the reader who is not particularly familiar with the Amundsen Sea?
---Please clarify whether the statement about the "southerly" mean wind direction (Line 529) is specific to a time of the year, and if so, what time of the year exactly? This is a confusing thing, considering that Figure 8 is representative of April-October, Figure 9 is representative of November-December, and we just don't know about Line 529.

SPECIFIC COMMENTS: MODERATE

(3) Lines 90-91: "...such as Antarctic bottom water formation and global thermohaline circulation..."

The Amundsen Sea doesn't produce Antarctic bottom water. You must be confusing the Amundsen with another location in Antarctica (maybe the Ross Sea?). You have to remove this passage because it simply doesn't apply to the Amundsen Sea.

(4) Lines 301-302: "Additionally, the total SIC for each day was calculated by calculating the sum of all percentage SIC values in the study region. These total SIC values should only be considered useful for analyzing relative changes in SIC"

By defining "total SIC" in this particular way, you are making it unecessarily difficult to compare your results with past/future studies, because the value obtained will be intimately tied to your grid resolution (the latter being an arbitrary choice).

For example, assume that SIC=100 over a certain geographical area, and that this area is covered by 4 grid points (with the resolution you've chosen). The "total SIC" for this area will be 400. Then, in two years from now, another researcher does a similar analysis and selects a resolution that's twice finer than the one you chose. The same geographical area is now covered by 16 grid points, and the "total SIC" is suddenly 1600.

I'd suggest normalizing the "total SIC" by the total number of grid points within the study region. This way, the number coming out of your analysis isn't so dependent on the arbitrary choice of resolution. Another benefit is that the numbers you'll obtain will be much smaller and less cumbersome. Right now, lines 581-583 are discussing numbers having 7 digits, and that's a bit awkward.

(5) Line 311: "Daily wind speed and direction at the site of the polynya, ERA5's hourly 'u' and 'v' wind products were processed for a region..."

The sentence makes it sound like these variables are peculiar to ERA5, but they really aren't. Please use the formal terminology to present what u,v are:

"Daily zonal (u) and meridional (v) components of the winds at a height of 10m were obtained from ERA5 and processed for a region..."

I also note a confusion between "monthly" (Line 308), "Daily" (Line 311), and "Hourly" (Line 313). This is terribly confusing for the reader. Please state exactly what you've downloaded from ERA5 (monthly? daily? hourly? It has to be *one* of the three), and then correct these sentences as necessary.

SPECIFIC COMMENTS: MINOR

(6) Line 50: Why is "Carbon Dioxide" capitalized? This looks unusual.

(7) Lines 107-108: "Westward coastal currents prevail in the area (St-Laurent et al. 2019)..."

"St-Laurent et al." is only a modeling study. I think it would be good to also cite an observational study with actual measurements of the coastal current: Kim et al. 2016, Estuarine, Coastal and Shelf Science, https://doi.org/10.1016/j.ecss.2016.08.004
(Same comment for Line 674 of the manuscript.)

(8) Line 124: The acronym EOS isn't defined. Please define what EOS stands for, or remove the acronym.

(9) Figure 1a: To give the reader some context, please add to Fig.1a the climatological northward extent of the sea ice cover in Summer and in Winter. Such climatologies are available at, e.g., https://nsidc.org/data/NSIDC-0192/versions/3
Having this information will help the reader understand how you chose the extent of the red box. Without this information, the geographical extent of the red box appears arbitrary.

(10) Line 224: "Following Cheng et al. (2017) the daily net heat flux, Q (in W/m2), of a pixel was estimated by..."

Shouldn't it be: "of a *ice-free* pixel"?

(11) Line 235: L_o = epsilon sigma T_0^4 (Equation 2)

Why use T_0 (the freezing point of seawater) in Equation 2? Since Equation 2 is the black body radiation of the ocean surface, then Equation 2 should use T_s (the temperature of

the water surface), not T_0.

It's acceptable to assume, later on, that T_s is approximately equal to the freezing temperature, but Equation 2 should nevertheless be written as a function of T_s (not T_0) in order to make physical sense.

Similarly, line 241 should read:
T_s ~= T_0 = 273.15 - 0.0137...
rather than:
T_0 = T_s = 273.15 - 0.0137...

(12) Lines 256-259: The symbol for pressure is "Pa", not "pa". Please correct throughout the paragraph.

(13) Line 274: Acronym GDAL isn't defined. Please define what GDAL stands for, or remove the acronym.

(14) Line 282: The letter "i" in "rho_i" should be a subscript (compare with Line 280 where it is correctly typed).

(15) Lines 289-290: "Caution should be used when interpreting the absolute numbers produced by the ice production model, particularly because the input data is modeled climate data..."

Are you referring to ERA5 as "modeled climate data"? ERA5 is an atmospheric reanalysis, which is very different from "modeled climate data". For one thing, an atmospheric reanalysis assimilates historical measurements, while a "climate model" doesn't.

(16) Lines 318-319: "wind direction was plotted using the 'matplotlib' function 'quiver'"

The results shouldn't depend on the choice of the graphics software. If this is relevant to the results, then explain in what ways it is relevant. If it's not relevant, then remove the passage.

(17) Figure 4,5,6: Can we make the curvers a bit thicker, so that their color is more apparent and makes it easier to distinguish one curve from another? Also, would it be

possible to make these figure labels less pixelated, or larger so that the pixelation doesn't show as much?

(18) Line 575: "SIC for the broader ASP region on two days in 2017"

Please clarify why you picked these two specific days, and what they represent? Presumably the top figure represents some kind of minimum? And what about the bottom figure?

(19) Line 676: "(Koo et al., in review)."

You aren't supposed to cite studies that haven't been accepted for publication. Most journals will systematically remove such references at the copy-editing stage.

(20) There is something wrong in the caption of Figure S1:
"The figure covers background figure and area is the same as Fig 1b.".
Please correct as needed.