**Dear Dr Jourdain and three anonymous reviewers,**

**Thank you for taking the time to review our paper. We submit a revised version which we believe is substantially improved thanks to changes made in response to the suggestion of the editor and reviewers. We summarize the key changes in response to the editor's comment and detail further changes below. A document with track changes is also included. Our response to each of the reviewers' comments was detailed in the interactive discussion.**

Editor comment

*Your manuscript was initially submitted to The Cryosphere in August 2021 and rejected a few months later by another editor. A revised manuscript was submitted in February 2022 as a new submission, and I accepted to be the editor for this re-submission.*

*In the initial review, Reviewer #2 requested "moderate revisions" while Reviewer #1 and #3 both recommended to reject the manuscript. In the second review, both Reviewer #1 and Reviewer #2 have evaluated the revised manuscript, and I again had to ask the point of view of a third reviewer because Reviewer #1 recommended to reject the manuscript while Reviewer #2 was satisfied by the revisions, to the exception of one point that had not been addressed. The new Reviewer #3 basically recommends that the authors take the previous comments into account. So in total, we received three rather negative reviews of your manuscript, and one rather positive.*

*I agree with Reviewer #2 that a detailed description of the Amundsen Sea Polynya would be interesting for the community, so I have decided to send the manuscript back for major revisions. Nevertheless, I do not consider that your previous revisions were sufficient, and I will reject the manuscript if you don't make substantial modifications to address the concerns raised by these reviewers. More specifically, I expect that you provide at least :*

*- A quantitative investigation of the links between the wind characteristics (including its direction and possibly cumulative values) and the polynya area.*

**We have substantially improved this aspect of the paper by producing and analyzing a new figure (Fig. 8) that shows a wind rose (wind direction and speed) for times when the active polynya area *does not* increase and for when it *does* increase. This demonstrates the importance of a stronger easterly component in the growth of the polynya. We also include a new supplementary figure (Fig. S3) that is a scatter plot of wind direction and increase in polynya area for all days when the active polynya area increases.**

**This is discussed in the re-written results section on winds at lines 519-532, and alluded to in the discussion, conclusion and abstract.**

*- More details about the image processing (e.g. calibration and correction for incidence angle).*

**More detail on image processing is now given on lines 158-161:**

*"Google Earth Engine applies a series of pre-processing steps to Sentinel-1 images (https://developers.google.com/earth-engine/guides/sentinel1): 1) application of orbit file, 2) GRD border noise removal, 3) thermal noise removal, 4) radiometric calibration and 5) orthorectification. Images are also converted to decibels (dB)."*

**And lines 165-167:**

*"SNAP was used to crop the images, apply radiometric correction (gamma-nought), apply a Lee (7 x7) speckle filter and perform ellipsoid correction and map projection, projecting to an Antarctic polar stereographic projection. Images were also converted to decibels."*

**Although incidence angle normalization can be done and is appropriate for some studies, particularly of quantitative variations in backscatter, true 'correction' for incidence angle cannot be done. Given the combination of factors taken into account when visually, qualitatively analysing the SAR imagery, we do not believe it is necessary here. Studies may opt to limit images to a narrow range of incidence angles, but we believe that would be a bigger limitation than including a wider range while covering more of the study area. However we agree the fact that incidence angle influences backscatter should be acknowledged, and is now stated on lines 183-185:**

*"Incidence angle also influences backscatter and should be considered in a quantitative study of backscatter. Although its effect should be acknowledged, it is not generally considered a significant impediment in the ability to qualitatively analyse dynamics for this study's purpose, with visual analysis dependent on a number of factors."*

*- Comparisons between the passive microwave and SAR derived polynya areas. Comparing the areas from SAR and SIC in the case of Fig. 2 would be useful, but extending the comparison to a few dates or time windows in Fig. 5 and 6 (if really not possible for the entire period) would be more convincing.*

**We manually estimated active polynya area in SAR imagery on the nine dates in 2020 when the whole 'ASP study area' used for the estimations using SIC (in Figs. 5-6) was covered by SAR. We include this comparison as a new supplemental figure (Fig. S1). We also add the following on lines 231-239:**

*"To further compare the identification of active winter polynya as identified using SIC data with the SAR imagery, we manually identified active polynya in the SAR imagery for the nine days in 2020 when SAR imagery covers the whole ASP study area (green box in Fig. 1b). The results of the comparison can be seen in Fig S1 and generally show good agreement. Note that even if the method was perfect there would be a discrepancy because the measurements are taken at different times of day and significant changes in active area can occur in hours due to movement of ice, freezing or a mixture of processes. There is also an element of human error in the manual measurement. Of the nine cases, the area was identified as higher using SIC data in five cases and using SAR data in four cases, suggesting that neither approach leads to a systematic over-estimation."*

*I agree that this study does not have to investigate biogeochemistry (which is just a motivation for this study) or AABW formation (which is not relevant for the Amundsen Sea). I agree that the term "active polynya" could be more suitable than "open polynya" as long as it is clearly defined and contextualised based on the reviewers' concerns.*

**We have changed the term from 'open' to 'active' polynya when referring to the winter. We have also made additions/changes at the following lines to add clarity and detail.**

**Added on lines 147-148:**

*"Qualitative visual analysis allows us to identify dynamics that are not easy or possible to identify and/or describe with quantitative data."*

**Lines 169-176, expanded from:**

*"Qualitative analysis was carried out by visually analyzing the time-lapse videos and images of interest, noting changes in the state of the polynya and ice in the region. Visual analysis is possible because of the distinct backscatter signals and texture of open water and different types of sea ice. Numerous previous studies have noted the ability to observe polynya activity and visually identify polynya opening and the drift of ice with SAR imagery and Senti-nel-1 in particular (e.g. Hollands and Dierking, 2016; Dai et al., 2020)."*

to

*"Qualitative analysis was carried out by visually analyzing the time-lapse videos and images of interest, noting changes in the state of the polynya and ice in the region. Visual analysis is possible by analyzing changes in the backscatter signal's texture, pattern and tone and because of the distinct backscatter characteristics of open water, older icepack and different types of thin sea ice. The motion of the ice between images also helped in the identification of polynya events. Numerous previous studies have noted the ability to observe polynya activity and visually identify polynya opening and the drift of ice with SAR imagery and Sentinel-1 in particular (e.g. Hollands and Dierking, 2016; Dai et al., 2020; Moore et al., 2021). Visual qualitative analysis of SAR imagery also forms an important part of, for example, the Environment Canada's production of sea ice charts (Environment Canada, 2005)."*

**Added lines 181-183:**

*"although it may also form in a 'swirl' or other forms. Open ocean may also appear bright during high winds, but it is typically clear from the pattern, tone and texture, and the context of the image whether it is an area of ice-free open ocean, or an area of pack ice or active polynya."*

**Added lines 218-220:**

*"It is also noted that the SIC data is known to underestimate SIC where there is thin ice, but as we define an active polynya as including thin ice, this is not likely to lead to substantial misclassification of active polynya areas."*

**Added line 252:**

*"Automated detection of active polynya area in winter using SAR is not yet possible to our knowledge."*

**Amended lines 282-283:**

*"The temperature of the water surface (TS, in K), was assumed to be at the freezing point of seawater (T0 in K),…"*

**Amended and added lines 358-373:**

*"Mean daily and annual wind speed and vector winds were calculated from hourly ERA5 reanalysis wind products. Hourly zonal (u ) and meridional (v) components of vector winds at a height of 10 m were obtained from ERA5 for a region adjacent to the Dotson Ice Shelf and iceberg chain where the polynya typically forms, identified in Fig. S2. Hourly wind speed (V ) in ms-1 and wind direction (θ) in degrees were calculated as*

$V = (u^2 + v^2)^{1/2}$ (11)
*and*
$\theta = \tan^{-1}(v/u)$ (12),

*respectively. Daily averaged vector wind fields superimposed on maps of daily averaged wind speed were plotted for the whole study area for the period 1 November 2016 to 31 December 2020 and are included as supplementary video Video S3. A wind rose (Fig. 8) showing the wind speed and direction at times when the active polynya both did not and did increase in area during winter (2017-2020) was also produced for the smaller area (shown by Fig. S2) where the polynya forms from. A map of annual mean vector wind field superimposed on a map of annual mean wind speed was plotted in Fig. 9 ."*

**Added lines 364-366:**

*"A wind rose (Fig 8) showing the wind speed and direction at times when the active polynya increased in area during winter (2017-2020) was also produced for a smaller area where the polynya forms from, shown by Fig. S2."*

**Added line 604:**

*"and are often associated with a stronger easterly component in winds close to the iceberg chain"*

**Added to Figs. 2-3: a decibel scale.**

**Best regards,**
**Dr Grant Macdonald, on behalf of all authors.**