Reply to reviewer 2's comments:

The authors would like to thank the reviewer for his/her valuable comments, which helped to improve the quality of the manuscript. Kindly find below in blue our response point-by-point to the reviewer's inputs.

Pine Island Glacier is a major contributor to the loss of ice mass. Work to date has focused on understanding basal melting. The authors use 41 years of reanalysis data to investigate the role of Foehn winds in the surface mass balance at Pine Island Glacier. They characterise Foehn episodes over the satellite record and show that sublimation plays an important role in surface mass balance. Sublimation processes are not captured by existing remote sensing techniques and this article highlights an important contribution to ice mass balance that is currently not monitored.

The article is well-written and well-structured. It is an interesting article that provides a new aspect to our understanding of how Pine Island Glacier is changing in defining the role of Foehn winds in surface melting. My comments are largely related to improving the readability of the figures and the length of the article.

My one main concern is around confidence in the ERA5 dataset. The authors note that ERA5 does not have a sufficient spatial resolution to fully resolve smaller-scale flows. However, they also note that previous work has shown that moderate to strong Foehn events can be identified over the Antarctic Peninsula. Does this location of the AWS allow an assessment of the proportion of Foehn events at PIG that are resolved in ERA5? If this could be shown, it would lend more weight to the conclusions.
REPLY: We would like to thank the reviewer for raising this issue. We have now better justified in the text that the performance of ERA-5 is adequate both for the detection of Foehn events (lines 191-194) and the surface mass balance analysis (lines 219-226). Regarding the reviewer's last question, unfortunately we cannot use the AWS data collected by this station for assessment of Foehn events at PIG as it is located at the southern end of the Hudson Mountains north of the glacier, and therefore separated from the glacier itself (we have now highlighted its location in Fig. 1a).

There are several freely available modelling products that could be used in place of ERA-5 such as those listed below. We have explored this option but unfortunately none is adequate for this work.

- ➢ The Antarctic Weather Research and Forecasting (WRF) Mesoscale Prediction System (AMPS) model output is available for 2002-2016 (https://polarmet.osu.edu/AMPS/), but (i) the spatial resolution around PIG varies from 30 km in 2002 to 10 km to 2013-2016, and we know that the model-predicted temperature, moisture and wind fields at the near-surface are highly sensitive to the horizontal resolution in particular in stably stratified environments such as Antarctica, and (ii) not all the fields required for the surface mass balance analysis are available (e.g. the surface roughness length is not provided);

- ➢ The output of the Regional Atmospheric Climate Model (RACMO2) over Antarctica is also available (https://www.projects.science.uu.nl/iceclimate/models/racmo-archive.php) in particular for 1979-2014. However, the horizontal resolution of this product is the same as that of ERA-5 with a much reduced vertical resolution (40 instead of 137 levels), and it also does not employ data assimilation;

- ➢ Other modelling products, such as those obtained with the Modèle Atmosphérique Régional (MAR), the United Kingdom Met Office Unified Model (MetUM) and the Consortium for Small-scale Modelling and Climate Limited-area Modelling Community (COSMO-CLM^2), as detailed in

Mottram et al. (2021), are at spatial resolutions of 25 km or coarser, and only a handful of variables are provided, far fewer than those given in the AMPS model outputs.

For the case study (03-14 November 2011), we have conducted a high-resolution numerical simulation with the Polar version of the WRF model (PolarWRF) with two grids shown in Fig. R1a: an outer domain at 12 km that comprises the whole Antarctica and the adjacent Southern Ocean, and a 4 km grid over West Antarctica, our target region. The model physics configuration follows Zou et al. (2021) who investigated the role of Foehn effects on the surface melting at the Ross Ice Shelf. As seen in Fig. R1b, the PolarWRF has considerable biases when its predictions are compared to the observations at the Evans Knoll weather station located north of the glacier. In fact, the reanalysis dataset generally gives more accurate forecasts than those of PolarWRF. What is more, performing a 20 to 40 year run with this model configuration would take several months and also require more than 100 TB for storage, beyond our available resources.

Given this, the only option available to us is to use reanalysis data, with ERA-5 selected due to its higher spatial and temporal resolution compared to the other ones available. In addition, and as noted above and seen in Fig. R1b, for the fields used in the Foehn identification algorithm and in the surface mass balance analysis, the reanalysis performance is good and hence it is suitable for this work. We hope the reviewer understands our decision to stick with ERA-5 in this study.

(a) (b)

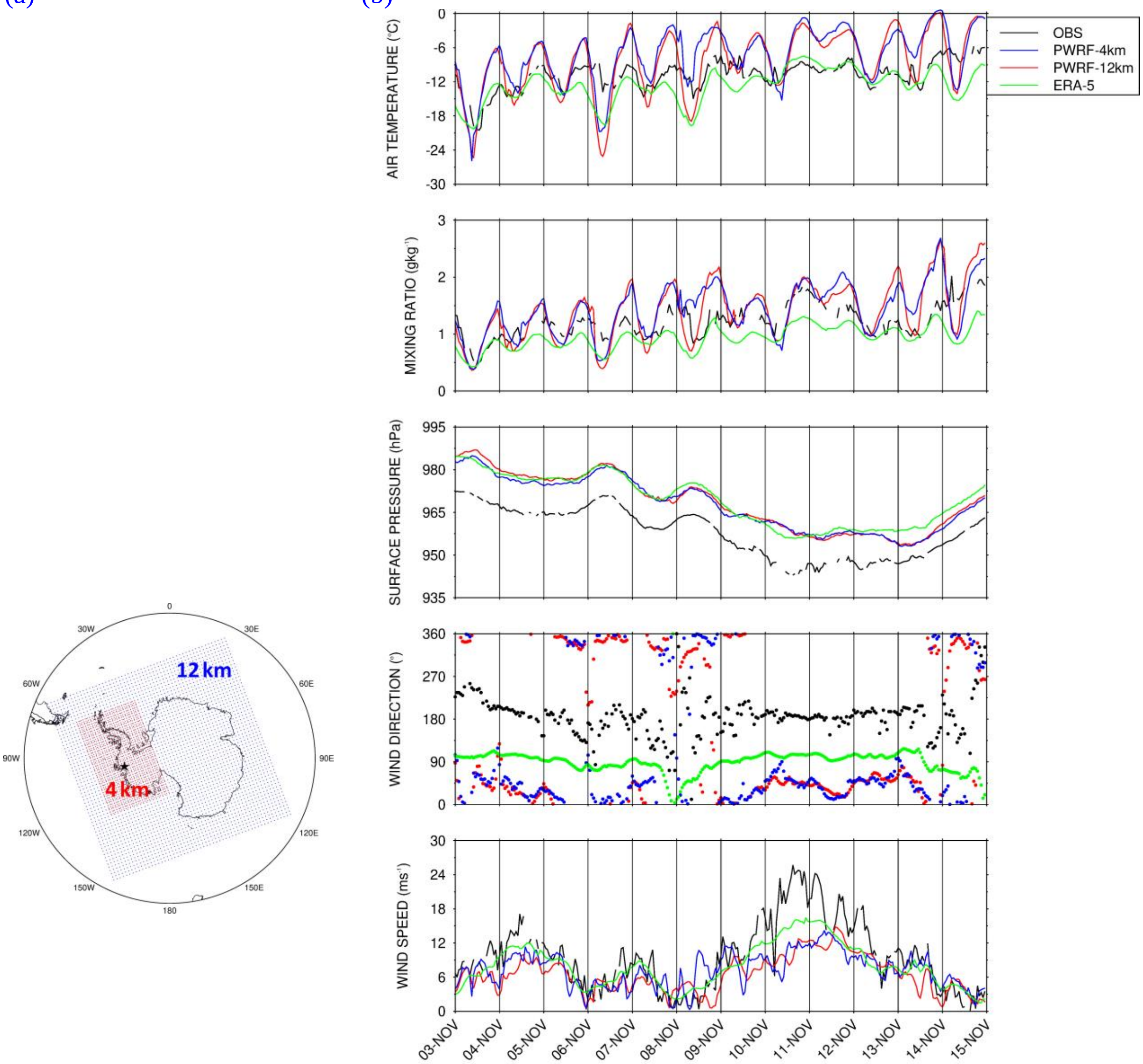

Figure R1: (a) Spatial extent of the 12 km (blue) and 4 km (red) domains used in the PolarWRF simulation. The star gives the approximate location of the Pine Island Glacier (PIG). (b) Observed (black) and predicted by ERA-5 (green) and PolarWRF's 12 km (red) and 4 km (blue) air temperature (ºC), water vapour mixing ratio (g kg^{-1}), surface pressure (hPa) and 10-m horizontal wind direction (º) and speed (m s^{-1}) at the Evans Knoll weather station (74.85ºS; 100.404ºW), located just north of PIG. The values shown for the model and re-analysis data are those at the closest grid-point to the location of the station.

It is a long article, and the authors might consider some of the following suggestions to reduce the length of the article:

REPLY: We agree that the article was very long and took steps to shorten it. In particular, we have (i) reduced the number of words in the Introduction by about 25% and removed 10 references; (ii) simplified the discussion on the trends that are not statistically significant and took out all references to it in the

Discussion and Conclusions section; (iii) shortened some of the paragraphs in the results section where we went overboard in the comparison of the findings at PIG with those reported in the literature at other sites around Antarctica. We believe the paper is more readable now and would like to thank the reviewer for his/her comments that made that possible.

1. Introduction - you later show that SAM does not play a large role in the weather conditions at PIG, so perhaps you don't need to include the details on SAM in the introduction (lines 116-121).
REPLY: Agree, we have moved the discussion of SAM to section 4 where it is next mentioned with respect to the large-scale circulation patterns that favour the occurrence of Foehn at PIG (lines 434-436). Following a suggestion by another reviewer, the paragraph the sentences the reviewer is referring to were part of was fully removed in the revised version of the paper.

2. Less emphasis in the introduction on Foehn processes around Antarctica and instead focus on an introduction to the important details in and around Pine Island Glacier. Similarly in section 3, the Foehn events at Pine Island Glacier are extensively compared to Foehn events elsewhere. Some of the details from other locations can be more concisely presented and the focus kept on what is happening at Pine Island Glacier.
REPLY: We agree with the reviewer and have followed his/her suggestions. In the Introduction we now focus more on PIG, while the multiple references to Foehn events elsewhere in Antarctica in section 3 have been substantially shortened. We believe both sections are now easier to follow.

3. Lines 334-345 there is a long discussion about trends. With the amount of variability in the signals, the timeseries is too short to identify a trend. Consider just pointing out the small trends and low statistical significance.
REPLY: We have shortened the referred paragraph reducing the number of words by a quarter as we agree we were placing a strong emphasis on trends that are not statistically significant (lines 321-327).

Minor comments

1. Figure 1a: it is very difficult to differentiate between the thick and thin purple lines - perhaps consider using two colours. I find the purple quite hard to read on the dark green so maybe a different colour scheme would also help here. Perhaps you could show the location of the Evans Knoll AWS on Figure 1a. It would also help to orient the reader if you could show the location of the outline for Figures 3 and 4 on this figure - I don't think they are the same as the red box shown?
REPLY: We would like to thank the reviewer for his/her comments regarding Fig. 1a. We have updated the plot accordingly, by (i) improving the easiness of visualization of the solid contours (now drawn as dashed and solid cyan lines), (ii) giving the location of the Evans Knoll weather station (green circle), (iii) highlighting the domain used for plotting in Figs. 3-4 (red dashed rectangle).

2. Figure 2a and b: I found it tricky to relate the yellow boxes to the red axis and it took me a while to work out how to read these graphs. Consider using the same colors for the bars and/or adding a legend as you do in Figure 2c.
REPLY: We have updated both panels to make it easier to interpret the results. Following the reviewer's suggestion, we have added a legend and now the bars have the same colour as the respective axis, with the error bars drawn in black.