

Author Response: Reviewer 2

Dear reviewer,

Thank you for your positive feedback and recommendations for improving the manuscript. We appreciate the detail with which you have reviewed. We have provided point-by-point responses to your technical corrections below. Your comments or concerns are in black and our responses are in red, with italics used to highlight specific changes in the manuscript. The updated manuscript will be uploaded once permission is granted by our editor, where changes will be marked in red to highlight the changes.

Many thanks,
Jenny Turton, on behalf of all authors.

Editor comment:

Inconsistent use of LCIS or Larsen C.

We have now changed all instances of LCIS to Larsen C, as we use Larsen A and Larsen B in the same format.

Throughout: review tenses- some mixture of present and past to describe the same data.

We have now reviewed the manuscript and made changes throughout to ensure consistency.

L14: 100 km away

Changed.

L17-18: previous attempts to quantify

Changed.

L39-40: Marshall et al. (2006) proposed that a trend towards... events on the eastern side of the AP leading to increased surface melt.

Thank you for this clarification. The sentence now reads:

Marshall et al. (2006) proposed that a trend towards an increasingly positive Southern Annular Mode (SAM) index in the late 1960's led to a strengthening and southward movement of the circumpolar westerly winds. This increased the flow of air over the AP, and consequently led to an increase in the number of föhn events on the eastern side of the AP, leading to increased surface melt.

L51: be localised but intense

Changed.

L52: 100 km (separate number and units here and elsewhere)

Changed. We have reviewed the manuscript and made all necessary changes.

L54: föhn frequency is highly variable from season to season over LCIS

Changed, thank you.

L77: However, these have focused on a number of...

Changed.

L94: ... model driven by...

Changed.

Ln 101-: Meteorological observations spanning January 22, 2009 to December 31, 2012 (at AWS2 and AWS3) and February 19, 2011 to December 31 (AWS1) were analysed in this study. For this latter...

Changed, thank you.

L103: Observations were collected...

Changed.

L104: hourly values were derived

Changed.

L111: In order to compare..., and following..., we compute

Changed, thank you.

L116: ... as outlined in Sect. 2.2

Changed.

L118: We used a previously published and validated SEB model, in conjunction with AWS data input, to compute the surface energy balance and its components at AWS2 and AWS3 (citations).

Changed as suggested.

L119: Daily averages, derived from the SEB model's hourly output, are analysed in this study.

Changed, thank you.

L120: only a brief overview of the SEB model

Changed.

L121: delete 'The model is required...'

Removed.

L162: Eq. (4) was used to calculate melt from AMPS data:

Changed.

L166: melting the surface (i.e when positive)

Changed.

L181: (although föhn...)

Changed, thank you.

L189: AP mountains (not a proper name)

Changed.

L190: In certain seasons

Changed.

L192: ..., and more frequently in summer closer to the foot of the mountains (AWS1; Table 2)

Changed.

L194: ... and the relative humidity decreases at least 19 %

Changed, thank you.

L195: Delete Table 2 summarizes... it's introduced earlier in line 191.

Deleted.

L205: ... to the observationally-derived SEB

Changed.

L207: model identified 214 melt days at AWS2, compared to 289 for AMPS (Table 3)

Changed.

L219: AMPS is therefore better able to represent the occurrence of melting... as opposed to melting on...

Changed.

L241: AMPS will simulate temperatures at or near 0 °C, leading to an overestimation of the total number of melt days. An overestimation...

Changed as suggested, thank you.

L245: reduced overestimation is a bit awkward, smaller positive bias?

Thank you for the suggestion. We used '*smaller positive bias in...*'

L246: Emelt, alongside lower air temperatures (see Kirchgaessner et al. 2019)

Changed.

L252: Formatting LWnet

Corrected.

L257: ...observations and AMPS that melting...

Changed.

L258: typically report p-value ($p < 0.01$) rather than 99% confidence level. What test was used?

We have now reported the p-value. It was the t-test, we have now made that clearer.

L264: with over 40 six-hourly melt events...

Changed.

L270: annually-averaged differences... in a subset of the observed SEB components. -Why only some? If only tau is not tested, simply state that you show SEB components, and specific in table that you omit tau.

Changes made as suggested.

L281: this could bias... be more specific than 'this'

We have now written '*the seasonal magnitude of SW↓ could bias...*'

L282: As shown in table 2 and in Turton et al. (2018), föhn days are not evenly distributed seasonally or interannually.

Changed, thank you.

L286: ... conditions are small and non-significant.

Changed.

L299: The mean annual sensible heat values [do you mean fluxes?], observationally derived during föhn days for AWS2 and AWS3, are very similar... However, at AWS1, sensible heat fluxes are slightly smaller [than?].

Changes made as suggested. This section now reads as: '*The mean annual average sensible heat fluxes, observationally derived during föhn days at AWS2 and AWS3, are very similar (23.0_W_m⁻² and 24.2_W_m⁻² respectively) (Table 4). However, at AWS1 sensible heat fluxes are slightly smaller (19.7_W_m⁻²) than the other locations due to the...*'

L307: Hsen needs subscript

Changed, thank you.

L316: ...during föhn conditions, although the differences with non-föhn conditions...

Changed.

L323: ...whereby fewer clouds during föhn conditions lead to reduced downwelling flux of long wave...

Changed.

L343: ... this section focuses solely on AWS2 data... Mean annual melt from 2009-2012

Changed, thank you.

L369: the largest increase in... is associated with springtime föhn events.

Changed.

L379: ... was significantly lower during föhn conditions than... ($p < 0.05$; Table 5)

Changed.

L393-394: you make the same point at the close of numerous paragraphs (see P15 L333,346,356,361,403). Review the manuscript to see if some of these points could be condensed/aggregated to avoid repetition.

Thank you for highlighting these repetitions. The repeated sentences have been removed from L333 and L346. These points have been condensed in L356. As L361 serves as a summary paragraph before the next section of results, we have left this in. We have removed the repeated sentence on L403 also.

Discussion

L483: Perhaps a stylistic point, but I would avoid starting the discussion with caveats, or lists of data you did not have. I would highlight the data and interesting results in context and in relationship to your hypothesis. (e.g starting with L488 Here...), and move the discussion of data availability farther down.

We have now re-structured the start of the discussion to take this into account. The start of the discussion now focuses on highlighting the new available data. The data limitations are discussed in paragraph 3 now instead.

L502: the three AWS locations.

Changed.

L503: ... the contradicting results of Kuipers...

Changed.

L 513: As a result, values of melt energy currently derived from AMPS cannot be trusted...

Changed.

Figure 1: I'd list the panels in reverse order, c (more general) -> b -> a

As we have changed the order of the panels, we have subsequently updated the citation to match this. Please check the new figure to ensure that you are satisfied.

Figure 2: The daily, observationally-derived melt energy Emelt at AWS2 (red) and from AMPS (black) for 2009-2012.

Changed.

Figure 3:

-at AWS2 during... b) summer (DJF)... Changed.

- increase point size. Changed and marker shape altered for clarity.

- Emelt formatting. Changed.

Figure 4: Colorbar labels too small, hard to read.

Figure 5: Are these means? I would appreciate seeing error bars on this figure.

They are mean values yes, we have altered the figure caption to better reflect this. Please note, Figure 5 has been altered following reviewer #1s suggestion, and is now called Figure 4 in the text. Error bars were not added, as SD has been added to tables instead.

Tables:

-for tables, add confidence intervals/sd to measurements

SD has now been added, thank you.

Table 2:

-caption: ...AMPS, following Turton et al. (2018). Changed.

-... for example, DJF 2012 spans December 1, 2011 to February 29, 2012). Changed.

- center AWS (%). Use parentheses or brackets, but be consistent in figures and tables.

Changed.

Table 3: From observationally-derived data at AWS2, alongside AMPS model output interpolated to the same location... The total number of melt days... occurring with föhn and non-föhn periods are indicated for 2009-2012. Changed

- Melt amounts is too vague. Cite specific entry. **Specific entry given.**
- The same for both AWS and AMPS as a result of the föhn identification criteria (see Methods). **Changed.**

Table 4:

-superscripts and subscripts on variable.

Table 4 was removed as the information was included in the original Figure 5 (now Figure 4).

-L294: Differences were not assessed for tau, derived from average SW and SWtop, owing to small sample size.

Changed, thank you. Although this information is no longer in the table caption, but in Figure 4 caption.

Table 5: * indicates... (remove The)

Changed.

Table 6: Summertime daily-averaged values of ... *indicates... t-test... and ** at the 99% confidence... **Changed.**

-formatting of variables. **Changed.**

Table 7: for all dates, comma after numerical day (e.g November 23, 2009)

Checked throughout manuscript and changed, thank you.