The influence of föhn winds on annual and seasonal surface melt on the Larsen C Ice Shelf, Antarctica
-review, 8/18/20

The manuscript by Turton et al. examines observational and model evidence of föhn wind impacts on surface processes across the Larsen C ice shelf. Aggregating model output and weather records from automated weather stations (AWS), the authors quantify the frequency of föhn events and their association with surface melt, teasing apart the underlying relationship between the two by examining surface energy balance. Differences in these variables between föhn and non-föhn periods are examine across seasons and years. Mean annual patterns are also present, which provide an overview föhn impacts on the region.

While akin in spirit to other publications examining the impact of föhn winds on the Larsen Ice Shelves, this manuscript distinguishes itself by examining a long-term observational weather record in context of model output to tease apart general relationships between föhn winds and surface melt. Other studies have tended to focus on specific events and shorter time-periods. As such, this study fills a niche in the field. Another point of novelty is the detailed evaluation of AMPS and its ability to resolve the relationship between föhn occurrence and melt across seasons and years. Identification of strengths and weaknesses in the model provides great insight than can further model development, and inform future studies using model output to examine these regional wind patterns.

The manuscript is overall well-written, logically organized, and the major conclusions of the study (namely the importance of spring föhn events for seasonal / annual melt amounts / patterns) are well supported by the data presented. There is some repetition in the results, owing to the structure of the manuscript which repeatedly highlights the importance of föhn for melts in different seasons (apart from winter), and years. However this is more a stylistic point and does not detract from the scientific findings of the paper.

I highlight below a number of technical points regarding the writing, with edits meant to clarify the text. While technical corrections are needed, the manuscript is scientifically sound and will contribute significantly to the field once published.

Technical corrections:

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

L14: 100 km away
L17-18: previous attempts to quantify
L39-40: Marshall et al. (2006) proposed that a trend towards... events on the eastern side of the AP leading to increased surface melt.

L51: be localised but intense...
L52: 100 km (separate number and units here and elsewhere)
L54: Fohn frequency is highly variable from season to season over LCIS
L77: However, these have focused on a number of....

L94: ... model driven by...
L101-: Meteorological observations spanning January 22, 2009 to December 31, 2012 (at AWS2 and AWS3) and February 19, 200 to December 31, 2012 (AWS1) were analyzed in this study. For this latter...
L103: Observations were collected...
L104: hourly values were derived
L111: In order to compare..., and following..., we compute
L116: ... as outlined in Sect. 2.2
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 3 (citations).
L119: Daily averages, derived from the SEB model's hourly output, are analyzed in this study.
L120: only a brief overview of the SEB model
L121: delete "The model is required..."
L162: Eq. (4) was used to calculate melt from AMPS data:
L166: melting the surface (i.e. when positive)
L181: (although föhn...)

L189: AP mountains (not a proper name)
L190: In certain seasons
L192: ..., and more frequently in summer closer to the foot of the mountains (AWS1; Table 2)
L194: ... and the relative humidity decreases at least 19 %
L195: Delete Table 2 summarizes... it's introduced earlier in line 191
L205: ... to the observationally-derived SEB
L207: model identified 214 melt days at AWS2, compared to 2918 for AMPS (Table 3)
L219: AMPS is therefore better able to represent the occurrence of melting... as opposed to melting on...
L241: AMPS will simulate temperatures at or near 0 ºC, leading to an overestimation of the total number of melt days. An overestimation...
L245: reduced overestimation is a bit awkward, smaller positive bias?
L246: Emelt, alongside lower air temperatures (see Kirchgaessner et al. 2019)
L252 Lwnet (Formatting)
L257: ...observations and AMPS that melting...
L258: typically report p-value ($p<0.01$) rather that 99% confidence level. What test was used?
L264: with over 40 six-hourly melt events...

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 specify in table that you omit tau

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

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

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

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?]

L307: Hsen <- subscript

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

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

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

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

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

L393-394: you make the same point at the close of numerous paragraphs (see p15 L 333, 346, 356, 361, 403. Review the manuscript to see if some of these points could be condensed / aggregated to avoid repetition

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

L502: the three AWS locations.

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

L513: As a result, values of melt energy currently derived from AMPS cannot be trusted...

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

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

->Change legend to show AWS2

Figure 3:

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

-increase point size in figure, hard to see

-Emelt-> formatting

Figure 4:

-colorbar labels too small, hard to read
Figure 5: Are these means? I would appreciate seeing error bars on this figure

Tables
-for tables, add confidence intervals / sd to measurements
Table 2:
-caption: ... AMPS, following Turton et al. (2018)
-... for example, DJF 2012 spans December 1, 2011 to February 29, 2012)
-center AWS2 (%). Use parentheses or brackets, but be consistent in figures and tables

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.
-melt amounts is too vague. Cite specific entry
-the same for both AWS and AMPS as a result of the föhn identification criteria (see Methods)

Table 4:
-superscript and subscripts on Variable
L294: Differences were not assessed for tau, derived from average SW and SWtop, owing to small sample size

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

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

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