

Interactive comment on “Snow on the Ross Ice Shelf: comparison of reanalyses and observations from automatic weather stations” by L. Cohen and S. Dean

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We are grateful for the reviewer's comments, which have really helped to improve the manuscript. Our response to general comments is followed by the responses to specific remarks (reviewer's comments are numbered followed by our responses denoted by » and proposed changes to text in quotes).

General Comments:

Since the primary aim of this work is to present a methodology to use the ADG measurements on synoptic timescales and to assess the strengths and weaknesses of these measurements as a proxy for precipitation, we think that the use of the two re-

C1008

analyses datasets is sufficient for this manuscript. We use ERA-Interim and NCEP-2 specifically because they are the most widely studied and used reanalyses products. We think that we did not make this very clear in the manuscript and have therefore reworded several paragraphs, particularly in the Introduction and Conclusions sections.

In regards to the second general comment, we agree that there needs to be further discussion of why ERA may perform better than NCEP and have added a new paragraph in Section 3.2 discussing the differences in model resolution assimilation that affect reanalyses precipitation. There is also a new figure (Fig 3 – included in Supplemental file) and discussion in Section 4, which illustrates the differences in moisture and circulation between ERA and NCEP.

Finally, we definitely agree that it is very important to remind readers that snow accumulation measurements are only a proxy for precipitation (since this is one of the main challenges of using these data) and have added text in the Introduction section to make this point more clearly. We also made sure the terminology “accumulation” and “precipitation” is used clearly throughout the text. The new text at the last paragraph of Sec. 1 (Introduction) reads:

“As snow accumulation records are a proxy for precipitation, using them to compare to precipitation is not straightforward. The ADG measurements on the Ross Ice Shelf provide a new dataset of high temporal resolution, ground-based accumulation observations which may provide an important source of measurements to assess modeled precipitation on synoptic timescales.”

Specific comments:

1. In line 9 on page 1246 – this sentence says that the AWS measurements have been widely used in many studies. This is true for all but the ADG measurements. The ADG measurements are relatively new on the AWS, and have not been as widely used.

» Agreed that the ADGs are relatively new additions to the AWS network, but they have

been used pretty widely in previous studies throughout Antarctica (e.g. Braaten, 1997, 2000; Qin et al., 2004; Eisen et al., 2008; Reijmer and van den Broeke, 2003; Thiery et al., 2012; Noone et al., 1999; Reijmer et al., 2002; Helsen et al., 2007). Changed the beginning of the sentence from “These instruments ...” to “ADGs ...”

2. Line 2, page 1247 – in reference to Table 1. Most of these sites (particularly Nascent, Ferrell, Windless Bight, and Mary) have had operating ADGs on site for much longer than Table 1 implies (see Knuth et al. 2010, Table 3, as referenced in the paper). Knuth et al. lists some stations being available as early as 2005. Did the ADG instrument stop operating on the AWS between the Knuth et al. time period and this study? Or was the time period chosen to be shorter for this study? If so, why? Please make this clearer in the text.

» The data used by Knuth et al. (2010) in 2005-2006 is not readily available and is not continuous through to 2008. Added new text to make this more clear (1st paragraph, Sec. 2): “Though there are some measurements prior to 2008, continuous, year-round snow accumulation measurements are only available since 2008.”

3. It would be useful to show a figure where the model grid points and the locations of the AWS are overlaid so that we can visually see the proximity of the grid points to the AWS sites. It would also be useful for the authors to comment on the representativeness of the grid points and the AWS locations (especially given that they can be a large distance – 100 km – away). For example, if the grid point used to compare to the Ferrell site is actually located over the Ross Sea, is this really an appropriate comparison?

» Agreed. Changed Figure 1 to include locations of model gridpoints and included further discussion of the distances between AWS and gridpoints in Sec. 3.2 (last paragraph): “Most of the gridpoints are relatively close to their respective AWS, and all are less than ~100 kilometers from the AWS. Stations located in the region that has the highest topographic gradient (near the TAM) are closest to their respective gridpoints, which helps minimize differences due to orographically induced precipitation. Smaller

C1010

topographic features such as Ross Island and Roosevelt Island are not resolved topographically in either of the reanalyses, and thus, localized precipitation due to these features is not expected to be reproduced. For large-scale, synoptically-driven precipitation events, the distances between gridpoints and AWS will not affect the timing or amount of precipitation considerably.”

4. Figures 2 and 4 are too small. I could hardly read them on the page (especially Figure 4). It might be better to split each of these to display on two pages instead.

» Unfortunately the figures were formatted for an A4-portrait-sized page, but not for the TCD page format. Since the format for final TC manuscript is A4, we will keep them in their current format and make sure they are formatted to full page.

5. Line 20, page 1251 – I don’t understand the meaning of the sentence: “Accumulation events can be seen as stepped increases in height while decreases in height (in the ADG records only) indicate the effects of ablation, compaction, or sublimation”. . . Why wouldn’t decreases in height in the reanalyses also be due to ablation, compaction, or sublimation? Please clarify.

» This sentence was an attempt to remind readers that even though the accumulation and precipitation are plotted together in Fig. 2 they are not showing the same thing (ie. there are no decreases in reanalyses plots because it is only precipitation). Changed the text in these sentences (first 3 sentences of section 4) to make this more clear: “Figure 2 shows each station’s ADG accumulation record along with the ERA and NCEP precipitation. Snow accumulation and precipitation events are seen as stepped increases in the plots. Decreases in accumulation seen in the ADG records indicate the effects of ablation, compaction, or sublimation and are not accounted for in the reanalyses plots, which show only positive changes due to precipitation. Though negative accumulation processes are very important for surface mass balance, they are not considered in this study as we are simply attempting to identify precipitation events.”

C1011

6. Figure 3 – which gray box corresponds to which dataset?

»Changed Figure 3 (now Fig. 4) to make this more clear (coloured boxes now correspond to coloured lines).

7. There is another coincident event early on in the Ferrell record – it would be useful to see a comparison between the two (Ferrell's coincident event and Margaret's outlined in Figure 3).

»Though the event shown in Fig. 3 (now Fig. 4) is a large one, it is typical of the many coincident events in these records, which is why we use it as an example. The coincident event early on in the Ferrell record looks very similar. We've added text here to make this point more clear: "Figure 4 shows a close-up of six days in the ADG, ERA, and NCEP records for Margaret station (corresponding to the grey box in Figure 2). The figure illustrates the characteristics typical of most of the coincident events identified in all of the stations. The highly stepped nature of ADG accumulation events is clear, as is the more broad nature of reanalyses events. The duration of events are different for each dataset but the events overlap in time (or are within 24 hours as discussed in Section 3.3) as illustrated in Figure 4."

8. How are coincident events being defined? Is there a duration over which the three datasets must coincide within some sort of snow threshold?

»Yes, as described in Sec. 3.3, an event is defined by accumulation/precipitation rate greater than the cutoff value, and events which are within 24 hours are considered "coincident". Changed some text here (Sec. 3.3 and in Sec. 4) to make this more clear: "An event is defined for each dataset as the period of time that the accumulation/precipitation rate remains above the cutoff value (ADG: 5 mm snow day⁻¹; reanalyses: 0.5 mm w.e. day⁻¹), and only events lasting longer than 6 hours are considered. Coincident events are then determined by identifying the reanalyses events which overlap in time with or are within 24 hours of an ADG event." "The duration of events are different for each dataset but the events overlap in time (or are within 24 hours as

C1012

discussed in Section 3.3) as illustrated in Figure 4."

9. Why are reanalysis events longer than ADG events? This was mentioned briefly on page 1252, but was never discussed further or expanded upon.

»Added text here (4th paragraph in Sec. 4) to expand on this point since it is an interesting feature of the reanalyses products: "The greater duration of reanalyses events as compared to the ADG events is seen throughout the datasets. The mean duration of coincident events for all ADG events is 27 hours, while the mean durations for ERA and NCEP are 65 and 61 hours respectively. While this may indicate that the cutoff value for the reanalyses data is too low, increasing the cutoff value to a much higher value (2 mm w.e. day⁻¹) decreases the average duration of events to 48 and 46 hrs for ERA and NCEP respectively, which is still much longer than the ADG events and decreases the number of events by ~60% for both ERA and NCEP. That the reanalyses-derived events are much longer in duration than the ADG-derived events indicates that this is likely a result of the parameterization of synoptically-driven precipitation in reanalyses forecast models and is worth further investigation."

10. The authors should watch their use of the word "significant". Sometimes it's used appropriately (such as when they discuss the significance on page 1254 within a 90% level), but sometimes it's not quantified, and it's not clear if their discussion is actually statistically significant. This word is used many times throughout the paper.

»Agreed. Made changes throughout the manuscript (at P1244 L10, P1244 L14, P1250 L9, P1252 L1, P1252 L22, P1252 L27, P1252 L28, and P1253 L5).

Technical corrections:

1. Line 22, page 1248: "accumulations" should be "accumulation"

»Done

Please also note the supplement to this comment:

C1013

<http://www.the-cryosphere-discuss.net/7/C1008/2013/tcd-7-C1008-2013-supplement.pdf>

Interactive comment on The Cryosphere Discuss., 7, 1243, 2013.

C1014