Review of "Improved methods for PCA-based reconstructions: case study using the Steig et al. (2009) Antarctic temperature reconstruction", by O'Donnell et al.

Summary: This paper makes a thorough and relevant critique of the Steig et al. Antarctic temperature reconstruction. One particularly pertinent aspect of O'Donnell et al.'s results is that they are consistent with two recurring, informal comments by the community that have emerged in the wake of the Steig et al. paper:

1) That the significant warming over East Antarctica suggested by Steig et al. is questionable in light of the raw station records, which do not indicate warming (confirmed by O'Donnell et al.).
2) That the broader warming that extends beyond the Antarctic Peninsula and over West Antarctica, the key finding by Steig et al., appears to be robust. While O'Donnell et al. show a smaller region of warming over West Antarctica than Steig et al. (e.g., Fig. 3), they show that it stretches to as far as the WAIS divide, including over one very key area where glacial wastage has been more prominent than in any other region of Antarctica – the Pine Island/Thwaites glacier drainages.

There are some minor comments, expanded upon below, that I ask be considered by the authors. These are aimed at the following:
1. Placing the results into the context of the existing literature.
2. Addressing the fact that the O'Donnell et al. results are much more similar to the Steig et al. results than is reflected in the current discussion. For example, according to Tables 3 and 4, most of the regionally averaged annual and seasonal trends from the two new O'Donnell et al. reconstructions are not statistically different from those of the Steig et al.
3. Adding emphasis to the very important result of O'Donnell et al. confirming that statistically significant warming is occurring during summertime across the entire continent and all of its sub-regions (see Table 4 – the result is robust across all three reconstructions). This is important because summertime is the only season in which melt occurs, and therefore the summer temperature increases have the potential to cause enhanced melt, with consequences for the mass balance of Antarctica and sea level rise. This key finding is arguably more important than the main objective of the study (the critique of S09), so it warrants mention in the abstract and discussion in the text.

Recommendation: Accept for publication, after addressing the minor comments below

Minor Comments:
1. While it is important to note, as the authors do, that their trend is half that of Steig et al. (0.11 C/decade versus 0.20 C/decade), it is also noteworthy that:
a. The trend, in addition to being significant (as the authors note) is not statistically different than the Steig et al. trend based on the bounds of uncertainty (0.11 +/- 0.08 C/decade vs 0.20 +/- 0.09 C/decade).
b. Even at half the magnitude of Steig et al., O'Donnell et al.'s West Antarctic trend is still equivalent to 0.55 degrees of warming over the past 50 years, a number that is approximately consistent with the global mean rate of warming over the same period.
c. That the region of warming over West Antarctica, while smaller than Steig et al. found, covers a key region where glacial recession has been most prominent: the Pine Island and Thwaites glacial drainages (e.g., Rignot et al. 2008, Nature Geoscience). While the wastage of these glaciers has been attributed primarily to regional ocean warming 'eating away' at the ice where it terminates into the ocean, it is possible that enhanced surface melting may be helping to lubricate the base of these glaciers, as studies over Greenland have already shown.

2. O'Donnell et al. provide a very nice critique of the S09 methodology and provide an extensive description of their own technique, which is very commendable. However, the authors make little effort to support their results based on the extensive literature that has examined Antarctic temperature variability in the context of physical forcing mechanisms such as large-scale forcing (i.e, the SAM and ENSO), and regional sea ice variability. For example, the seasonality of the spatial temperature trends in West Antarctica that O'Donnell et al. show is more-or-less consistent with the annual and seasonal of the sea ice extent/area/concentration trends in the Bellingshausen/Amundsen (decreasing) and Ross (increasing) Seas (e.g., Liu et al. 2004, GRL, Fig. 1a; Cavalieri and Parkinson, 2008, JGR Oceans), but the authors make no mention of this. Additionally, the O'Donnell et al. results are largely consistent with newer studies suggesting that the influence of the SAM is strongest in East Antarctica and is less prominent in West Antarctica (e.g., Neff et al. 2008, GRL). This would partially explain why the warming is weaker in East Antarctica and is stronger in West Antarctica, given the impact of the SAM on Antarctic surface temperatures (e.g., Marshall 2007, Int. J.

Climatol). I recommend that the authors dedicate slightly more effort to tie their results to some of the existing literature. I'm not suggesting an extensive literature review, rather that the authors briefly place their results into the context of the existing literature. This will also help to strengthen the author's critique of S09, as S09 drew heavily on the existing literature to support their results.

3. Table 3: I assume these trends span 1957-2006. If so, please state this in the caption.

4. Table 3: Your trends for West Antarctica for RLS and E-W in this Table (0.05+/- 0.8 and 0.04+/- 0.08) are different from what you discuss in the text (0.10+/- 0.07 on page 22 and 0.11+/- 0.08 on page 26). Is this a typo?

5. Table 4: Similar to comment #3, are these trends for 1957-2006? If so, please state in the caption.

6. Table 3: Assuming that the trends for West Antarctica in this table are a typo (see comment 4 above), both the RLS and E-W trends for Continental, East Antarctica, and West Antarctica are not statistically different from those of S09. This is an important statistical aspect to point out in the discussion, as it objectively demonstrates that the reconstructions in relative agreement.

7. Table 4: Similar to comment #6, the continental trends among RLS, E-W, and S09 are not statistically different in Spring, Summer and Fall, nor are the East Antarctic trends for the same 3 seasons, nor are the West Antarctic trends for summer. As for comment #6, this should be discussed in the text.

8. One of the most important results of this paper – and something that was not pointed out by S09 – is that there is statistically significant warming in summer across the entire continent, and in every region. This is a robust result among all three reconstructions (RLS, E-W, and S09). Considering that summer is currently the only season in which melt occurs over continental Antarctica, this is by far the most important season to by monitoring for warming trends due to the potential impact of enhanced melting on the mass balance of Antarctica (and subsequently sea level rise). This key result should be mentioned not just in the discussion, but also in the abstract.

9. S09 presented results from two AVHRR reconstructions – one that used 'trended' AVHRR, and another that used detrended AVHRR data. Even though S09 focused primarily on the 'trended' version, they included discussion of the detrended version, including presenting the continent-average 1957-2006 trend from the 'S09-detrended' reconstruction in the main body of the text: 0.08 C/decade (not statistically different from zero). O'Donnell et al mention the S09-detrended reconstruction briefly in a footnote on page 3, but they do not mention the resulting S09-detrended 1957-2006 trend anywhere in the text. Considering that the O'Donnell et al continent-average trends for 1957-2006 (both RLS and E-W) are in relatively close agreement with the result from S09-detrended (0.06, 0.05, and 0.08 respectively), and that the S09-detrended result was included in the S09 paper, the S09-detrended result merits discussion by O'Donnell et al. An additional reason that the S09-detrended reconstruction deserves mention is because the good agreement between RLS, E-W, and S09-detrended suggests that potential problems with AVHRR data may have had a first-order influence on the 'S09-trended' results, in addition to S09's statistical assumptions that are the main subject of the O'Donnell et al. critique.