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The Cryosphere Discussions

Interactive comment on "Greenland ice sheet albedo feedback: thermodynamics and atmospheric drivers" *by* J. E. Box et al.

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comment: My only substantive suggestion is for the authors to try to provide (in the main text) a slightly clearer picture of why the accumulation area albedo feedbacks are of opposite sign when derived with the two different methods (paired anomalies and bulk). The chief explanation for the accumulation area negative feedback derived using detrended paired anomalies is that more snowfall in warmer years increases albedo. In section 5.4 (p.21) the long-term albedo decline (which drives positive bulk feedback) is partially attributed to "Reduced summer snowfall rates sustained low albedo, maximizing surface solar heating, progressively lowering albedo over multiple years." Is this statement true for the accumulation area? If so, it seems inconsistent with the physical explanation drawn from the paired anomaly analysis. If not, please indicate

that it only applies to the ablation zone. Does the negative albedo feedback derived from paired anomalies break down after 2007, when Greenland experienced anomalously low snowfall and warm temperatures, or does the detrending process eliminate this signal? The supplemental material nicely shows differences in the paired anomaly analysis with and without detrending. A concise summary of why these approaches produce different feedback signs would benefit the main text.

response: It's a good suggestion to add more text to make a "clearer picture of why the accumulation area albedo feedbacks are of opposite sign when derived with the two different methods". Further, reviewer 2 charges that the anomaly-based feedback assessments are "second order" which I agree with. So, the text now spends time to be clear that the feedback we're teasing out is hidden but is found in anomaly space. In the abstract and elsewhere throughout the paper, the anomaly feedback is referred to repeatedly as "second order". Sure, why not! Now, thanks to you we also include the bulk feedback. A new paragraph in the Conclusions section reads:

The feedback we've teased out is found in anomaly space. While there can be no doubt that the strong negative albedo sensitivity found in the ablation area that when combined with downward shortwave data produces a high correlation and spatially coherent region of "positive feedback", the much shallower trend in the accumulation area is no doubt less intuitive. Yet, given the positive accumulation area correlation between snowfall and temperature, a physical mechanism is available to explain this second order damping without which complete melting over the entire ice sheet surface may already be observed. The significance testing yields some confidence that the second order damping feedback evident over the accumulation area is real. The damping feedback is not preventing the accumulation area net radiation from approaching positive values. The accumulation area negative albedo anomaly feedback is clearly not strong enough to fully damp out the effects of warming. There is an overall albedo decline. Yet, hidden in the interannual anomalies is evidence of this damping feedback.

comment: Section 5.6 states: "The bulk albedo feedback necessarily includes negative

values only where temperature trends are negative." The bulk albedo feedback should also be negative in situations where there is albedo increase in the presence of positive temperature trend. Please either correct this statement or clarify the methodological restriction.

response: I have clarified by inserting your text that reads:

“The bulk albedo feedback should also be negative in situations where there is albedo increase in the presence of increasing temperature trend.

comment: p12: I suggest using different notations for the "Delta" albedo and temperature terms defined in equation 6 (feedback A) and referred to for the bulk feedback (feedback B, bottom of p.12), since they refer to different quantities.

response: This is a good point. See the revised Equation 6 that now uses the prime symbol (‘) to indicate anomaly space. The bulk albedo feedback has the Delta without the prime, as it did before.

comment: I suggest cleaning up section 4.5. For example, "insolation" appears to be mistakenly used instead of net shortwave flux. (This may also be true in the abstract).

response: net shortwave flux now replaces “insolation”

comment: Some of the figure and table captions (e.g., table 3, figure 5) could be expanded for clarity.

response: I have made some minor additions to table 3, figure 5 captions.

Interactive comment on The Cryosphere Discuss., 6, 593, 2012.