The Cryosphere Discuss.,
https://doi.org/10.5194/tc-2019-65-RC2, 2019

The Cryosphere Discussions

Interactive comment on "The surface albedo of the Greenland Ice Sheet between 1982 and 2015, and its relationship to the ice sheet's surface mass balance and ice discharge" *by* Aku Riihelä et al.

Jason Box (Referee)

jbox.greenland@gmail.com

Received and published: 31 May 2019

notes on comments: a.) io = "instead of" b.) Comments refer to page then line number using X Y

General Remark The study has a lot of value by presenting an expanded (in time and process) treatment of AVHRR albedo over Greenland. The article makes several major analyses, the fourth of which I am not sure should be kept because of its very wide scope, complexity and limited finding.

Major critique A.) The fourth major analysis should be more clearly explained or re-

moved*, that with lag analysis, basin scale examination of hypothetical meltwater lubrication of ice dynamics. The study already has a lot of substance. Adding the lagged result only to confirm earlier studies is a bit much. 12 9-16 reinforces that the study is taking the empirical albedo relation too far. 1 24-27 recommend removing this part of the study as it does not directly examine melt-induced flow acceleration while much has been evaluated more directly on this topic. See SWIPA 2017 chapter 6 https://www.amap.no/documents/doc/snow-water-ice-and-permafrost-in-the-arctic-swipa-2017/1610 *7 6-11 difficult to follow

B.) Discussion of this study vs Stroeve (2001) Stroeve, J.: Assessment of Greenland albedo variability from the advanced very high resolution radiometer Polar Pathfinder data set, J. Geophys. Res.-Atmos., 106, 33989–34006, doi:10.1029/2001jd900072, 2001. How does this study square with Stroeve (2001, see Fig 4 etc) who found decreasing trends 1981-1998? 8 29 "majority of the albedo decrease signal originates after 2000" but Stroeve 2001 found a decrease before 2000 9 19-26 bringing in Stroeve 2001 agreement/disagreement seems important here Stroeve found NAO resonance, as one would expect. What about this study?

C.) conclusions... 16 12 "The albedo decrease of the northeastern and eastern margins was initiated during the 1982-1999 period"... you offer a mechanism for the west but what about the east...any idea the cause? It should be either/and atmospheric circulation or sea ice -related.

D.) A direct comparison between albedo data sets: CLARA-A2-SAL and MODIS MOD10A1 seems warranted. How well do they agree in the overlapping period?

General comments 7 16 agree with "empirically suitable threshold albedo of 0.58"... compositing with many PROMICE years yields 0.56 (unpublished) Recommend to not use abbreviation "GrIS". Instead, use "Greenland ice sheet" until it (very quickly) becomes obvious the study is on Greenland, afterward, use "ice sheet". Should title have "mass balance" io "surface mass balance and ice discharge" 1 9 "driven in part by " io

“primarily driven by “ 1 13 “We then subtract ice discharge from the mass change estimates from the GRACE satellite mission to estimate surface mass balance” io “We then correct the mass balance estimates observed by the GRACE satellite mission with state-of-the-art ice discharge” 1 23 “rapid surface mass” io “rapid mass” 2 31 “examining the role of albedo” io “both highlighting and confirming the dominant role of surface melt” would seem to improve the statement by making it not a conclusion placed in the intro of the paper and otherwise clarifying that albedo is the predictor variable here. 4 1 “uppermost areas” io “innermost parts” 4 1 - 4 8 . . .Fig 3A in Box, J.E., D. van As, K. Steffen, 2017. Greenland, Canadian and Icelandic land ice albedo grids (2000-2016), Geological Survey of Denmark and Greenland Bulletin, 38, 53-56 available from http://www.geus.dk/DK/publications/geol-survey-dk-gl-bull/38/Documents/nr38_p53-56.pdf supports the idea that 2012 was not anomalously low AND that variability is small (in the Summit GC-Net example; max-min = 0.03) in the dry snow area‘ 4 12 “$\sim$0.02 increase of the GrIS albedo” io “$\sim$0.02 overestimation of the GrIS albedo” . . . it was a real climate event so the measurement is not an overestimation 8 25 I expect some readers/reviewers will dislike excluding 92 and 93. Yet, I think it’s not too questionable as long as you’re clear. Here, better I think would be “externally forced” io “less reliable” 8 25 “largely remained stable” discuss relative to Stroeve 2001 8 31 “may be”? Seems more testing needed to address this hypothesis. 9 1 “is” io “may be”. . . see/cite Box, J.E., D. van As, K. Steffen, 2017. Greenland, Canadian and Icelandic land ice albedo grids (2000-2016), Geological Survey of Denmark and Greenland Bulletin, 38, 53-56 9 5 “rarely examined” “the ice sheet’s albedo was primarily stable” see Fig 9c and related discussion in the following where from 1988-1999 eastern Greenland has the largest AVHRR albedo decrease. Some discussion of that seems warranted. Box, J.E., D.H. Bromwich, B.A. Veenhuis, L-S Bai, J.C. Stroeve, J.C. Rogers, K. Steffen, T. Haran, S-H Wang, 2006: Greenland ice sheet surface mass balance variability (1988-2004) from calibrated Polar MM5 output, Journal of Climate, Vol. 19(12), 2783–2800. 9 28-34 geolocation errors were attributed in the following study for the relatively noisy ice margin trends. See Box, J.E., D.H. Bromwich, B.A.

Veenhuis, L-S Bai, J.C. Stroeve, J.C. Rogers, K. Steffen, T. Haran, S-H Wang, 2006: Greenland ice sheet surface mass balance variability (1988-2004) from calibrated Polar MM5 output, Journal of Climate, Vol. 19(12), 2783–2800. 10 7 “where the trend signal originates” io “where they are expected to be more robust” 10 10 “larger” io “faster” 10 21 “earlier” io “faster” 10 25 the “increases in winter snowfall” finding is very interesting AND is related to the GRACE correlation because when there is snowfall, mass is added and albedo increases. So, be sure to make that point. The following may be relevant if you want to discuss more about how increasing snowfall may be from climate change. https://iopscience.iop.org/article/10.1088/1748-9326/10/11/114008/meta Further Box et al. (2013) find a climate change signal, an increase in snowfall with NH Air T, N Atlantic Air T, etc. Comparison of Greenland accumulation history with northern hemisphere air temperatures suggests a 6.8% (or 51 Gt) per degree C climate sensitivity (Box et al., 2013). See Box, J. E. 2013. Greenland ice sheet mass balance reconstruction. Part II: Surface mass balance (1840-2010), Journal of Climate,Vol. 26, No. 18. 6974-6989. doi:10.1175/JCLI-D-12-00518.1 15 20-26 Including discussion of Rajewicz and Marshall, 2014; McLeod and Mote 2016 is warranted. e annual frequency of extreme high pressure ‘blocking event’ days that deliver warm air onto western Greenland peaked in 2010 and 2012 (McLeod and Mote, 2016). Greenland mass loss accelerated between 2003 and 2012 primarily due to increasing surface meltwater runoff (-6.3$\pm$1.1 Gt/y2) driven by persistent southerly flow across the western ice sheet (e.g. Rajewicz and Marshall, 2014; McLeod and Mote, 2016). McLeod, J.T. and T.L. Mote, 2016. Linking interannual variability in extreme Greenland blocking episodes to the recent increase in summer melting across the Greenland ice sheet. International Journal of Climatology, 36:1484-1499. Rajewicz, J. and S.J. Marshall, 2014. Variability and trends in anticyclonic circulation over the Greenland ice sheet, 1948–2013. Geophysical Research Letters, 41:2842-2850.

16 20 “A notable exception to the widespread albedo decrease was” io “A notable exception was”

Figures Fig 2, 4,6 Increase text size. In Fig 4 a tiny a, b, c. . . text is problematic. Figs 3-5 would be an improvement to zoom in to the island of Greenland in each map Fig 4 inset trend map too small? The analysis is v interesting and deserves highlight. May be too many maps compressing the results too much. Remove the grey area. Fig 5 units per day? Small number, multiply to get per month? Fig 7 sorry but I think this analysis does not add sufficiently to the study.

Interactive comment on The Cryosphere Discuss., https://doi.org/10.5194/tc-2019-65, 2019.