

## ***Interactive comment on “A long-term Northern Hemisphere snow cover extent data record for climate studies and monitoring” by T. W. Estilow et al.***

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Received and published: 13 April 2015

The authors wish to thank three anonymous referees for their helpful comments and time spent reviewing the manuscript. Detailed responses to comments from Anonymous Referee #1 follow:

[Comment] The manuscript does not provide a sufficiently clear account of uncertainties. There are some publications specifically to this issue (e.g. Brown and Robinson, Northern Hemisphere spring snow cover variability and change over 1922–2010 including an assessment of uncertainty, doi:10.5194/tc-5-219-2011 . . . at least one of

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the authors knows that paper well anyway). So please provide some assessment of uncertainties (in addition to that fact that you mention that the october trend is very probably spurious).

[Response] We have added mention of the suggested reference to the revised manuscript, and expanded the long-term trends section (4.2) to provide an assessment of uncertainties.

Specific Points

[Comment] The dataset qualifier is only given in the abstract of the article. I think that technically the abstract should not contain additional information that is not given in the main body of the article. so please consider providing the DOI also in the main body of the article.

[Response] The DOI has been added to the main body of the revised manuscript.

[Comment] P. 670, L. 18: "The annual and interannual variability of the cryosphere are characterized by changes in hemispheric sea ice and snow cover extent. . .": Glacier and ice sheet (surface) mass balance also has substantial (inter) annual variability (but OK, it's less directly visible)

[Response] This section of the revised manuscript includes a more comprehensive definition of the cryosphere.

[Comment] P. 670, L. 20: "They are important factors in detecting climate change". Rather: "important indicators of climate change"?

[Response] Revised text to use the suggested improved terminology.

[Comment] P. 670, L. 22: "According to IPCC Assessment Report 4 (Anisimov et al., 2007; McBean et al., 2005). . ." I suggest citing the AR5 (why should one cite the AR4 today for something that has been known for long?), plus some very old modeling studies that show this (possibly even go back to Manabe & Wetherald 1975, or Manabe

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& Stouffer that is cited a bit later).

[Response] The section has been reworked, resulting in omission of the AR4 citation.

[Comment] P. 670, L.25. polar amplification. Today, people rather speak about Arctic Amplification.

[Response] Good suggestion, but we have removed reference to Arctic Amplification as a result of rewriting the introduction.

[Comment] P.671, L. 14. Bates & Privette give their maturity matrix in supplementary information that is a bit hard to find (in particular the link provided in their article to the supplementary information does not work). Could you please say in a few words what the value of 3 in that matrix means for the different aspects? By the way, level 3 means that changes to the data can be subject to some moderate changes if I understand correctly. Could you please be a bit more specific on what kind of changes might be expected in the future, what is planned, etc.? (besides monthly updates of course)

[Response] The text has been revised, removing "score of level three or higher" in favor of a description of the CDR's maturity. For reference the maturity matrix is available here: [http://www1.ncdc.noaa.gov/pub/data/sds/cdr/Guidelines/Maturity\\_Matrix\\_Template.xlsx](http://www1.ncdc.noaa.gov/pub/data/sds/cdr/Guidelines/Maturity_Matrix_Template.xlsx) We will ask NCDC if they can make this document more easily accessible (e.g. assign a DOI). The revised manuscript will briefly describe possible changes in terms of the Maturity Matrix.

[Comment] There is quite some redundancy between section 2 (Historical description) and 3 (Data set description). For example, the information about the 89x89 grid already appears in section 2. There is some possible contradiction concerning the 42% threshold. Section 2 gives the impression that this was derived from a "comparison between the two datasets" (P. 672, L.20), that is, probably from some statistic analysis, while Section 3 (P.674, L.20) states that the 42% threshold is used in an automated

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process. This is not clear to me

[Response] Sections reworked to provide a clearer description.

[Comment] In section 2, a graphic summarizing the main phases of the history of this data set (sort of a timeline) might be useful.

[Response] This is a good suggestion. We plan to incorporate such a figure in a forthcoming publication that will explore more in-depth analysis of the CDR. The revised manuscript reduces the number of figures.

[Comment] In section 3, you might consider including the very useful Data Flow Diagram that is available from the NOAA data set web site (attached here for your convenience)

[Response] While we agree the diagram is useful, we would like to avoid republishing technical details that are available in NCDC documentation. The authors feel this diagram represents a level of detail beyond the scope of this publication.

[Comment] Section 3: It is not clear to me how mountain regions are treated. Are they treated as snow-covered as soon as there is snow somewhere on the mountain tops in the pixel?

[Response] Snow extent area observed within pixels must meet minimum thresholds before the pixel is recorded as snow-covered, regardless of terrain within the pixel.

[Comment] P. 674, L. 22: Is there any hope the missing months can be recovered from other satellite sources? (probably not, we are talking about data from the 60s and early 70s)

[Response] We are unaware of any available imagery that would permit mapping the missing months from early in the satellite era. Given that the missing months occurred during the warm season, there is not even the possibility of using station observations to provide anything but extremely limited spatial coverage to determine whether snow

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cover is present in high latitude regions.

[Comment] P.674, L.26 and Figure 3: Strictly speaking, the January maximum is not apparent from the figure, because December and February are not shown.

[Response] To help improve clarity, the caption in the revised manuscript has been modified to remove the text "each quarter".

[Comment] P. 675, L1: "The CDR product includes refinements to the NH SCE CDR grid." This is a bit confusing. To me, the new data set version is NH SCE, and it's a NOAA CDR. . .

[Response] Good point. This text has been revised to explain the original NOAA grid has been refined in the CDR product.

[Comment] P.675, Line 4 and following: The grid business with the change from 89x89 to 88x88 grid points is also somewhat repetitive

[Response] In the revised manuscript, the definition of the CDR grid section (3.3) has been reduced and rewritten.

[Comment] P. 675, L. 25 and following. What are the reasons for large errors in three longitude and latitude coordinates? I would imagine these coordinates to come from a simple formula that is either right or wrong.

[Response] Three pixels in row, column space that are located near the pole were associated with incorrect latitude and longitude coordinates. We don't have the specific reasons for the errors, however these original coordinates were calculated by NOAA in the late 1990s. Due to their location over the ocean, the incorrect coordinates did not affect snow cover extent analysis.

[Comment] P. 676, Line 6. "SCE area values have been calculated in a consistent manner for over two decades" Maybe specify these are the last two decades (if I understand correctly)

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[Response] This sentence has been revised to improve clarity, per the reviewer's suggestion.

[Comment] P.676, Line 18: How trustworthy is the August 1968 minimum? It immediately follows a missing month. Could it be affected by missing data?

[Response] August 1968 is based on 5 weeks of snow charting. The preceding month (July 1968) is not calculated because 4 weeks (July 2 – July 29) are missing.

For comparison, lowest ranked values are all in August: 1968 (2,088,745 km<sup>2</sup>), 2011 (2,241,236 km<sup>2</sup>), 1988 (2,314,353 km<sup>2</sup>), 2012 (2,315,425 km<sup>2</sup>), 2009 (2,323,542 km<sup>2</sup>)

[Comment] P. 676, bottom: Does that interpretation of a step change in 1987 hold statistically, for example if a change point analysis was used ?

[Response] We have performed a change point analysis to verify the results of the Robinson studies. Snow years from 1967 (starting September 1966) to 2014 (ending August 2014) were analyzed. Missing months (August-September 1966, July 1968, June-October 1969, July-September 1971) were replaced with period of record means.

Results of the analysis indicate a significant change occurred between 1975 and 1986, with a confidence level of 95%. Mean snow extent for the Northern Hemisphere changed from 25.9 to 24.8 million sq. km.

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Interactive comment on Earth Syst. Sci. Data Discuss., 7, 669, 2014.

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