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The Cryosphere
Discussions

Interactive comment on "Inconsistency in precipitation measurements across Alaska and Yukon border" *by* L. Scaff et al.

L. Scaff et al.

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From: Anonymous Referee #1 Received and published: 14 August 2015

General Comments This study compared precipitation observations along international borders to investigate the impact of gauge type biases on the distribution of precipitation. The use of observed and corrected precipitation, in my opinion, is an interesting topic worthy of exploring. This is particularly true for the documented gradient difference, which I found to be the most novel part of the manuscript. However, these results are limited by the very small sample size; a set of two groups. In addition, I found the manuscript lacking details in some locations, which may be helpful to prospective readers. For instance, the authors never comment on whether precipitation gradients

across the U.S.-Canada border should resemble the corrected or uncorrected gauge data results. Also missing was a brief description of how the Yang et al. (2005) corrections were applied. This is of interest since U.S. National Weather Service (NWS) stations do monitor surface winds, which may be necessary to evaluate wind related biases. Moreover, I recommend the manuscript be considered for publication pending minor revisions; however, I'm concerned about the impact of the study considering the small sample size.

Response: We greatly appreciate your time and comments, and we have improved the paper with the revision.

Specific Comments

1). The most interesting aspect of this study is the gradient differences between corrected and uncorrected gauge data. Unfortunately, this analysis is limited by the selection of a study area, which in my opinion is too narrowly focused on the Alaska and Yukon border. It is not clear in the manuscript why the southern region along the U.S. and Canada border was excluded. Do the authors expect differences along southern border to differ from the AK and Yukon comparison? Does the Yang et al. (2005) dataset not include stations along this border? Please explain.

Re: The main objective of this study is to examine and quantify the changes in precipitation gradient across the AK and YK border due to bias corrections of US and Canadian gauge observations. Many studies, including Yang et al., (2005), clearly show that the biases in gauge precipitation measurements are very high (up to 80-100%) for the cold regions, particularly in areas with light snowfall and high winds. Relative to the AK-YK border, this region are cold with more snowfall compared with southern US-Canada, meaning higher biases due to wind induced gauge undercatch, and thus significant changes and difference between measured and corrected precipitation across AK-YK border. This is the reason why our study specifically selected such a region, i.e. to focus on an area with the biggest problem in precipitation mea-

surements incompatibility. This study used data from 5 climate stations in 2 groups in the northern and central AK-YK regions. The selected stations very well represent climate gradient across the region, and the results from these sites are sufficient for the methodology development and demonstration of new knowledge in precipitation regime and distribution.

The data developed by Yang et al., (2005) include many climate stations along the southern US/Canada border. Since geography and climate conditions vary greatly along this long transect of several thousand kilometers, we expect to find different results from AK/YK transect. Our effort is ongoing to investigate precipitation measurements and data quality over the US/Canada border regions.

2). If known, could the authors consider providing some context to the reader as to what direction the precipitation gradient should be along the border. In other words, should we expect more to less, less to more, or the same amount of precipitation as you move across the border from the U.S. to Canadian?

Re: Simpson et al. (2005) studied temperature and precipitation distributions (with ANUSPLIN and PRISM interpolation methods) over the State of Alaska, with 54 precipitation stations for ANUSPLIN interpolation and over 500 stations for PRISM. The records lengths are variables, but most of them are between 1930-1990 in ANUSPLIN and 1960-1990 in PRISM. They found that monthly precipitation show a clear seasonal variability with the maximum in summer season and precipitation consistently increase from north to south. The mean monthly (12 months average) precipitation distribution across the AK-YK border shows a difference in central Alaska (5-15 mm) and Yukon (15-40 mm) in both interpolations, including the headwater of the Yukon basin, which is consistent with higher values in Yukon (relative to AK) as we presented in Figure 9 in the manuscript. The Brooks Range (foothills and summits) also have higher mean monthly precipitation (approx. 40 mm) relative to its surroundings (approx. 25 mm). Mean monthly precipitation along the northern coast and the south region of the Beaufort Sea shows relatively homogeneous values, less than 10 mm as the 12-month

average. These results are in general consistent with Serreze and Hurst (2000), who, based on monthly reanalysis and bias-corrected precipitation data over the large arctic regions, also identify a more dominant gradient north to south and a relatively homogeneous precipitation gradient along the coast of the Beaufort Sea compared with the increase in the Brooks Range.

Our results show a monthly mean precipitation amounts across the north regions from 150 mm to 300 mm for yearly total, (c.f. Fig. 7 in the manuscript), with higher (gauge measured) precipitation in Yukon than Alaska. After the bias corrections, the precipitation difference across the border is smaller, and even more the horizontal gradient changes the sign between Barter and Komakuk stations. These results are in agreement with the last above mentioned works. In the central region (c.f. Fig. 9 in the manuscript) the measured precipitation is slightly higher in Yukon, which is also consistent with Simpson et al., (2005). The gradient also becomes smaller after the bias corrections.

We have included part of the information above in the revised manuscript.

3). I recommend the authors provide some additional details on how U.S. and Canadian gauge data were corrected at the daily scale. For instance, what surface wind speed data was used to correct National Weather Service (NWS) station gauge data if they are not equipped with sensors to monitor surface winds. Is it from nearby stations? If so, how far apart are the two sensors (anemometer and precipitation gauge)? Do the Canadian stations monitor surface winds? If not how far are those nearby measurements?

Re: We have provided additional details regarding bias corrections in the revision. The text below is a summary:

The bias corrections were done Yang et al. (2005) for more than 4000 northern stations above 45N, including the US and Canada, on a daily time scale. Gauge measured precipitation, temperature, and wind data were used for this task. For the US stations,

wind data from the standard height was reduced to the gauge level of the NWS 8-in gauge. Wind speeds and directions were measured at the Canada climatic network; the same approach was applied to estimate the wind seed at the gauge height on precipitation days. The corrections were done only for those stations with wind data. There are many stations in the US without wind info and this is a challenge to gauge bias corrections. It has been recommended to measure wind speed and direction at the gauge height for the operational networks, so as to reduce the uncertainly in precipitation bias corrections.

Technical Comments

1). On page 3711 line 10, the acronym “P” has not been defined yet; please do so here.

Re: We replaced the acronym P for the word "precipitation".

2). On page 3712 line 23, replace “in” with “into”

Re: The change was made.

3). On page 3713, the sentence beginning on line 2 with “The observations have . . .” is confusing. Please describe exactly what the researchers’ have done to the gauge data that follows U.S. and Canadian national standards. I suspect this sentence may not be necessary?

Re: Agree, the sentence is not necessary. It was deleted.

4). On page 3713 line 7, the National Climatic Data Center (NCDC) has just recently changed its name to the National Centers for Environmental Information (NCEI). While urls are in the process of being updated, the old links will be preserved into the future. Recommend referring to the new name: National Centers for Environmental Information (formally National Climatic Data Center).

Re: Thank you for the information. The name of the Center was changed and the link

updated.

5). On page 3713 line 21, suggest revising sentence from “yearly precipitation data across the border station pairs” to “yearly precipitation data from the selected border station pairs”.

Re: The sentence was modified as suggested.

6). On page 3713 line 23, drop the “s” on periods.

Re: The "s" was deleted.

7). On page 3713 line 23, may want to consider briefly explaining what is meant by double mass curves. Such a description could be pulled from the summary and conclusion section where it is currently described in better detail.

Re: More detail of the DMC was included in this section.

8). The use of three acronyms for precipitation throughout the results section was slightly confusing: P, Pm and Pc. Perhaps P is not really necessary. To me, P was synonymous with Pm?

Re: It is true that we had many acronyms for different types of precipitation, so we decided to write out completely "precipitation" for total precipitation or for the general term, and keep Pm to indicate “Measured Precipitation” in comparison to Pc, which is “Corrected Precipitation”.

9). On page 3714 line 17, add an “s” to “word”; “In other words, . . .”

Re: We included the "s".

10). On page 3715 line 21, use the Pm acronym for “measured P” Pc for “the corrected values”.

Re: We replaced the words for the acronyms, to be consistent.

11). On page 3716 line 23, you may want to consider replacing the second use of the

term “correction” with “bias”?

Re: We modified the word as suggested.

12). On the same sentence as earlier (comment 11), consider replacing “besides” with “apart from”.

Re: We modified the word as suggested.

13). On page 3716 line 29, the sentence may read better as “Eagle and Dawson regions with border station mean temperature and wind speed within a degree Celsius and meter per second respectively”.

Re: We modified this sentence to make it clearer.

14). On page 3717 line 27, please invert “respectively” and “for Pm and Pc” so the sentence reads “. . . 347 mm for Pm and Pc respectively.”

Re: The word "Respectively” was deleted and improved the text for a better understanding.

15). On page 3718 line 2, I believe the numbers 88 and 139 should also be inverted?

Re: Thank you for noting this typo, the numbers were corrected and verified in the calculations. We also extended this phrase a bit more for a better understanding.

16). On page 3720 line 21, please provide a bit more information on how the instrument has changed. For instance, was a new Nipher gauge installed?

Re: We found the evidence of anemometer issue, which was fixed by 1980/08/28. This may affected the corrected precipitation values. Maybe other changes have been done, but no other record of them was found.

17). On page 3720 line 22, the sentence beginning as “Both stations. . .” seems a bit odd. For instance, what is the cumulative precipitation increase of 3% in reference to; Pc compared to Pm? You may also want to identify on figure 11 where exactly 1204

and 1352 mm are on the x-axis (i.e. add a line to the graph)?

Re: The phrase was modified and the figure was corrected. The x axis was not long enough, so it couldn’t show the whole curve.

18). On page 3711 line 11, the reference for Leeper et al. 2014 should be 2015?

Re: Yes, the year is 2015. It was corrected in the new version of the manuscript.

19). On pages 3714 line 27, 3716 line 10, and 3723 line 29 there are references to Yang et al. 1998, which according to the cited references should be identified with either an “a” or “b”.

Re: The references were updated.

20). On page 3722 line 27, should the Searcy and Hardison Clayton, 1960 inline reference be Searcy and Clayton, 1960?

Re: Yes, the reference was modified. However, the last name of the second author is Hardison, so the reference is now: (Searcy and Hardison, 1960). This paragraph was moved to the “Study Area, Data and Methods” section.

21). On page 3722 line 20, replace “the” with “a”? “It is very clear from this study that a. . .”.

Re: The text was modified.

22). On page 3722 line 23, you could omit “and cold” since the sentence is already talking about snowfall; cold conditions are already implied.

Re: The sentence was improved.

23). On page 3726 line 21, I could not seem to find an inline reference for Yang 2014.

Re: The inline reference was removed.

24). On page 3724 line 10, since “national networks” is not referring to a specific net-

work so you may want to remove word “the”? So the sentence reads: "...precipitation measurements at national networks.

Re: The word was changed.

25). Figure caption 1 should read “Study area and locations of selected. . .”?

Re: The word was added.

Re: Please, find the revised manuscript attached as a supplement document.

References:

Searcy, J. and Hardison, C.: Double-Mass Curves, United States Department of the Interior, Washington DC., 1960.

Serreze, M. C. and Hurst, C. M.: Representation of mean arctic precipitation from NCEP-NCAR and ERA reanalyses, J. Clim., 13(1), 182–201, doi:10.1175/1520-0442(2000)013<0182:ROMAPF>2.0.CO;2, 2000.

Simpson, J. J., Hufford, G. L., Daly, C., Berg, J. S. and Fleming, M. D.: Comparing maps of mean monthly surface temperature and precipitation for Alaska and adjacent areas of Canada produced by two different methods, Arctic, 58(2), 137–161, 2005.

Yang, D., Kane, D., Zhang, Z., Legates, D. and Goodison, B.: Bias corrections of long-term (1973–2004) daily precipitation data over the northern regions, Geophys. Res. Lett., 32(19), L19501, doi:10.1029/2005GL024057, 2005.

Please also note the supplement to this comment:
http://www.the-cryosphere-discuss.net/9/C2221/2015/tcd-9-C2221-2015-supplement.pdf

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Interactive comment on The Cryosphere Discuss., 9, 3709, 2015.