

# **Assessment of near 0°C temperature and precipitation characteristics across Canada**

Mekis et al

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This paper develops a climatology of near 0°C conditions across Canada. This is an interesting and timely contribution and with some improvements will merit publication. There are three specific concerns that will need attention if the paper is to be published: better context setting, a more clear presentation about the sample window, and the use of appropriate statistical methods for trends in count/proportion data. I have also made some specific suggestions for changes in the text.

## **Major improvements**

1. One of the issues in dealing with the occurrence of zero temperatures in a country as diverse as Canada is making the context of the data clear. This is important as the audience of this journal is international. Across Canada, zero can be a high, medium, or low temperature. This is inferred in Figure 1 but I am of the opinion that the 'context setting' would be better if the mean annual temperature was added to Figure 1, and contours of mean annual temperature added to Figure 2. Mapping of permafrost distribution might be an alternative to mean annual temperature. As well, this additional context might better support the apparently arbitrary spatial divisions made in the manuscript. There are several specific places in the text where the reader could be reminded of this context.
2. A key assumption is that a window from -2 to 2°C is an appropriate criteria for 'near zero conditions'. While I would agree that the window needs to be wider than only exactly zero, I do think this deserves a more thorough and robust presentation. Is there literature available that supports or suggests how the width of the window should be set? With precipitation, surface air temperature is not necessarily the determinant of frozen forms. I am not asking that another window be considered, rather I would like to see more about the thinking that went into the selection of such a window. I would like to see some justification/discussion for the window being symmetrical about zero; an event that drops into the window but never reaches zero might produce the same count as an event that warms into the window without ever exceeding zero, but have quite different precipitation characteristics.

3. Statistical methods. While Mann-Kendall and Sen Slopes are widely used for continuous variables they are not appropriate for count and proportion data. These data types are normally dealt with using logistic regression.

Frei, C. (2013), trend R package, version 1.5.1.  
<http://www.iac.ethz.ch/edu/courses/master/electives/acwd>.

Jung, R. C., M. Kukuk, and R. Liesenfeld (2006), Time series of count data: modeling, estimation and diagnostics, *Computational Statistics & Data Analysis*, 51(4), 2350-2364.

Schmidli, J., and C. Frei (2005), Trends in heavy precipitation and wet dry spells in Switzerland during the 20th Century, *International Journal of Climatology*, 25, 753-771.

Weller, E. A., and L. M. Ryan (1998), Testing for trend with count data, *Biometrics*, 54, 762-773.

### **Detailed comments**

Line 12-13 consider adding 'snowmelt' and permafrost here.

Lines 14-15. Consider stating positively. "The study develops a Canada-wide perspective on near 0°C conditions using hourly temperature and precipitation type observations from 92 climate stations for the period 1981 to 2011."

Line 26 "In cold regions, such as Canada, both environmental ..."

Line 28. This seems to be not parallel, delete 'that affects open water evaporation'

Lines 30-34. Could be clearer and maybe more simple. The real issue is that changes in episodes of near freezing increase the frequency of river ice-jams and ice-jam flooding, increase the depth and duration of ground ice that affects winter feeding of caribou and other species, increases the frequency of ice layers in snowpacks that increases the frequency of avalanches and poses a risk to skiing ...

Line 35 "Many regions of Canada have experienced...". My view is that it is better to be specific about which country in an international journal.

Line 49 insert "for Canada" after 'freezing precipitation'.

Line 51 "Two recent articles,"

Line 56 replace 'its' with 'freezing precipitation'

Line 57-58 "A recent study identified the impacts of extreme weather on critical infrastructure in Europe..."

Line 62-63. This is a place where the 'context setting' could be improved. Here, a mention of mean annual temperature in relation to zero bears mention.

Lines 73 to 78. I don't think that this text is totally accurate. The access to the archive that is available publically does not allow downloading the complete daily or hourly data for a station. Rather, one must follow the line to [Get More Data](#) and then use alternative code to get the data through wget, Cygwin, or hombrew.

Line 79 Remove 'is fraught with' as the dangers are being specified.

Line 93. Missing from the text is a link describing the 'regions' in Figure 2 as being based upon provincial boundaries and not climatology. A bit of text is needed to support the selected nine representative stations. I would be of the opinion that Vancouver is not representative of British Columbia, so using 'nine stations selected from the Environment and Climate Change Canada regions shown in Figure 2.

Line 95-98. This is a key point in the paper and I think a bit more detail is needed to support using a window from -2 to 2°C.

Line 103-105 I found this text to be difficult to follow, perhaps this revision is clearer: A total of 21 indicators were considered. The first four indicators are associated with the near 0°C temperature condition without any consideration of precipitation. To assess precipitation during near 0°C conditions, a further thirteen precipitation type indicators were computed (Table 1). In addition, the combination of temperature and precipitation type provides an additional four indicators. These include the annual average hours with any or all of these precipitation type conditions; the annual average hours with only freezing rain; the percentage of time in which any precipitation (from the 12 types) occurred; and the percentage of time that freezing rain alone occurred. Freezing rain is highlighted, these rather than other frozen precipitation, since freezing rain often results in major impacts.

Line 114-115. This seems to be an opinion. Could it be supported using the work of others?

Lines 120 onwards. It seems that sometimes figures are "Figure x" and "Fig x" used interchangeably.

Line 123 Cordillera

Lines 137 to 143. The presentation is awkward. It seems things have been left out. What variable and which figure is being considered? What is meant by: "In contrast, here are now three general areas of low values."

Lines 228-234. This text is unclear. For example in line 230. "Only Toronto (Fig. 5c) shows both of these trends to be statistically significant." It is not clear what the two

trends are since only one figure is cited and it cannot be determined for the preceding sentences. It would be better to phrase this so that Toronto follows so the focus is on the trends. "Both of these trends (Figure 9c and Figure 5c) are significant at only one location, Toronto."

In section 5 the text contains insufficient links to Figures and in many places literature citations are required.

It the ongoing reference is to Figure 9 then where does Whitehorse fit?

Whitehorse shows significant earlier spring cessation and St. John's shows significant later autumn onset (Fig. 9d).

Cambridge Bay (**Figure 9b**) experiences near 0°C conditions in every 'warm season' month (Fig. 9b) so the onset of near 0°C in the spring and its cessation in the autumn were considered; neither showed statistically significant trends.

Lines 237 -243. Please indicate which figures are being referred to.

Lines 246-248. This text warrants literature support. Once a lake is frozen it no longer serves as a heat sink.

Line 255 sentence starting "Temperature changes with chinooks..." would be better as "Temperature changes during Chinooks..." and warrants literature support.

Lines 256-257. Is this from the literature?

Lines 263-267. Literature support?

Line 275 "... the Atlantic region is often buffeted by large storms..."

Line 332 Use "Canada" instead of "the entire country"

Line 345 delete "In addition, ocean temperatures near Canada tend to often be near 0°C during the cold season especially". My view is that this doesn't add to the conclusion nor was it thoroughly covered in the manuscript.

Line 347 Is this conclusion supported earlier in the manuscript?

Line 369 It seems odd to state "It is not associated with a conference."

Table 1

In line 7 "12e" is listed, but there is no explanation of what "12e" refers to?

In line 20 this is a 13<sup>th</sup> pptn indicator?

A general comment on the Figures; I find this colour palette difficult. The yellow disappears and the shades of blue cannot be distinguished. Consider using a different colour palette.

Figure 1. Consider adding a vertical line indicating mean annual temperature.

Figure 2. Add contours of mean annual temperature or permafrost.

Figure 6. Consider removing “Total =” from each case in the legend as this is clear from the caption. Consider changing lines types as well as colours.

Figure 7. My opinion would be that this would be better presented as a table. The reader cannot make even simple comparisons between places and precipitation types.

Figure 8. Consider changing the symbol type between cases in addition to colour.

Figure 9. This might be clearer if the blue points were labelled “temperature near zero” and the red points as “precipitation at temperatures near zero”. I wonder if it would be better to make the blue points larger and overlay the red points directly without an offset. This to make the conditional “precipitation if temp is near zero” directly obvious.