Authors' reply to interactive comment posted by Anonymous Referee #3 regarding the ESSD Discussion paper "Long-term weather, hydrometric, and water chemistry datasets in high-temporal resolution at the La Salle River watershed in Manitoba, Canada"

Dear Referee,

We appreciate your comments and suggestions to strengthen the manuscript. Please find below the answers to your comments.

General comments

1. Reviewer: *The manuscript describes a data set containing three subsets of data, namely (1) gap-filled and disaggregated meteorological data, (2) stream discharge data, and (3) stream chemistry data for nitrogen and phosphorous. (1) and (2) have been produced from readily available on-line data sources published by the Government of Canada, and (3) appears to be an original data set that has not been published before. (1) and (2) cover a long period (1990-2013), and (3) covers a relatively short period (2009-2015).*
   Authors: That is correct.

2. Reviewer: *The title and the map (Fig. 1) seem to suggest that the data set covers the entire watershed of La Salle River, but this is misleading.*
   Authors: The title of the manuscript has been modified for clarification, as per specific suggestion below. The map shown in figure 1 has been modified to further enhance clarity. The description of the shaded area has been modified from "Sub-catchment" to "Study area" to avoid any confusion.

3. Reviewer: *Stream discharge and chemistry data were collected at a gauging station located in the upper most part of the watershed, and the meteorological data were collected from meteorological stations located outside the watershed. The objective of this work is to produce an hourly meteorological data set to drive a physically-based hydrological model for this particular watershed lacking a suitable data set. The authors completed this task by interpolating, gap-filling, transferring, and disaggregating daily data collected at an assortment of meteorological stations in the region, but outside the watershed. This type of labour-intensive and time-consuming exercise is necessary when a researcher is forced to run a hydrological model for a watershed that does not have required data. However, the data quality is compromised, which in turn introduces a large degree of uncertainty in model simulation results.*
   Authors: The reviewer is absolutely correct and the authors agree with the statement above. However, it should be highlighted that long-term simulations

using sub-daily time steps are often hindered due to lack of sub-daily precipitation data[1] and even when sub-daily precipitation records can be obtained, data gaps are a frequent limitation[2] due to loss of older paper records or interruption of automated stations due to calibrations, malfunctioning, or relocation[3]. Thus, the approach used is one of the best available to generate such long-term datasets. The current dataset or closely related ones have been used in modelling exercises in this watershed at daily[4] and hourly[5] time steps, and while the results have inherent uncertainty, they furthered the understanding of important hydrological features in this area. Locations with high quality discharge and higher frequency water quality data that are characteristic of the Red River Basin are rare and often do not occur in close proximity to weather stations with ongoing monitoring. Stream flow in this region is driven primarily by snowmelt and accuracy of measurement of solid forms of precipitation in addition to suitable frequency of measurement is essential. Also, although automated gauges provide higher frequency of measurement, accuracy may be impacted by under catch at higher wind speeds and data from sites with this instrumentation generally only came online partway through the time period covered by this dataset. The uncertainty in the precipitation dataset is considered low due to i) manual measurement, and ii) the use of a Nipher gauge which reduces problems with snow under-catch. These aspects have been discussed in the revised manuscript.

4. Reviewer: *The journal website states that the aim of this journal is "publication of original research data, furthering the reuse of high-quality data of benefit to Earth system sciences". The review criteria contain: "Is the data set complete? Are the accuracy, calibration, processing, etc. state of the art?" Based on these, I am afraid the data set presented in the manuscript does not warrant publication in*

[1] Gaume, E., Mouhous, N., and Andrieu, H.: Rainfall stochastic disaggregation models: Calibration and validation of a multiplicative cascade model, Advances in Water Resources, 30, 1301-1319, http://dx.doi.org/10.1016/j.advwatres.2006.11.007, 2007.

[2] Kim, J.-W., and Pachepsky, Y. A.: Reconstructing missing daily precipitation data using regression trees and artificial neural networks for SWAT streamflow simulation, Journal of Hydrology, 394, 305-314, 10.1016/j.jhydrol.2010.09.005, 2010.

[3] Simolo, C., Brunetti, M., Maugeri, M., and Nanni, T.: Improving estimation of missing values in daily precipitation series by a probability density function-preserving approach, International Journal of Climatology, 30, 1564-1576, 10.1002/joc.1992, 2010.

[4] Yang, Q., Leon, L. F., Booty, W. G., Wong, I. W., McCrimmon, C., Fong, P., Michiels, P., Vanrobaeys, J., and Benoy, G.: Land use change impacts on water quality in three Lake Winnipeg watersheds, Journal of Environment Quality, 43, 1690-1701, 10.2134/jeq2013.06.0234, 2014.

[5] Cordeiro, M. R. C., Wilson, H. F., Vanrobaeys, J., Pomeroy, J. W., Fang, X., and The Red-Assiniboine Project Biophysical Modelling, T.: Simulating cold-region hydrology in an intensively drained agricultural watershed in Manitoba, Canada, using the Cold Regions Hydrological Model, Hydrol. Earth Syst. Sci., 21, 3483-3506, 10.5194/hess-21-3483-2017, 2017.

this journal, even though it is a useful data set for the authors' own research project. I will elaborate more in my specific comments below.

Authors: The source datasets with the best quality available in the region were used and targeted collection of water quality data at this site was undertaken because of lack of higher frequency data in similar watersheds. However, available weather data were not ideal for high frequency simulation (particularly rainfall) and challenges with missing records are typical of other weather stations regionally. The authors sustain the argument (discussed in the answers below) that the dataset is highly valuable to further understanding of hydrology and nutrient transport in the region due to i) the inclusion of higher-resolution water chemistry measurements not previously available in the area, ii) the state-of-the-art methods used to reconstruct the weather datasets and deal with the inevitable limitations (e.g. gaps) in such long-term time-series, and iii) the value-added processing in the hydrometric data that identifies and removes records with high degree of uncertainty. In short, the authors are confident that all three datasets are important not only for their own research efforts but for the broad scientific community in the region.

Specific comments

1. Reviewer: *Title. The data set was generated for running a hydrological model for the upper most reach of the La Salle River. I would suggest "the upper La Salle River watershed" for the title.*

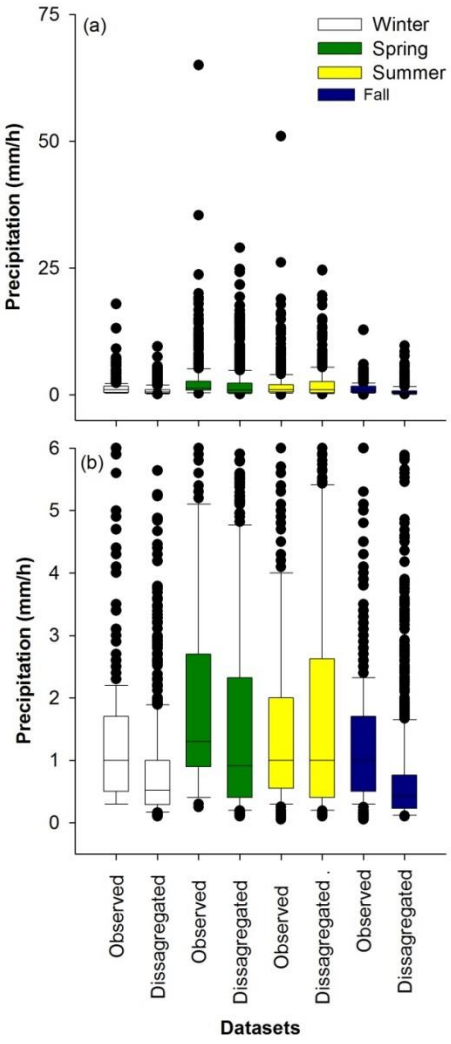
   Authors: the title of the manuscript has been modified, as suggested.

2. Reviewer: *Line 140-149. For high-resolution (i.e. hourly) hydrological modelling, the most important meteorological variable is precipitation. Unfortunately, that is the weakest component of this data set. Firstly, it is well known that precipitation data reported by the Government of Canada meteorological stations have systematic bias, especially for solid precipitation influenced by wind-induced undercatch (Mekis and Vincent, 2011, Atmosphere-Ocean 49:163-177). Therefore, the standard practice for high-quality research in Canada is to use the adjusted and homogenized dataset published by the Government of Canada (http://ec.gc.ca/dcchaahccd/default.asp?lang=en&n=9AA530BE-1). The meteorological stations used by the authors do not have the adjusted and homogenized data, and hence, the original data likely have a substantial bias in precipitation. Secondly, the "high-temporal resolution" (i.e. hourly) precipitation data were obtained by disaggregating daily data set, which compromises the data quality further. The resulting data set may provide required model inputs for this particular case study, but its value to a broader research community is limited.*

Authors: While precipitation is a prominent variable for the hydrologic response of any watershed, all the variables included in the dataset are important from a model setup standpoint since they are all required to run simulations or to assess the results. Regarding the systematic bias in under-catch, the authors acknowledge it but would like to discuss a few important aspects that led to the choice of the data presented in the paper: (1) the closest station with adjusted and homogenized data is in Portage La Prairie, whose distance from the study areas is 2.5 times larger than the Marquette station. As discussed in section 3.1 of the manuscript, proximity was considered the most important criteria for selecting the weather station because of the inherent spatial variability of precipitation (this discussion has been added to the revised manuscript); (2) the under catch bias in the prairies is much lower than that in other regions such as the Artic and Atlantic Canada. For example, the case studies investigated by Mekis and Vincent (2011)[6] indicates that the underestimation in Saskatchewan (6.8%), , is much smaller than that in Newfoundland (20.8%) and Nunavut (30.4%), which could be considered substantial, as pointed out by the reviewer; and (3) some process-based models such as the Cold Regions Hydrological Model (CRHM) are able to correct for the under-catch effect. Regarding the downscaling process, the limitations are again acknowledged but this aspect does not limit the importance of the dataset for the scientific community. There is a large number of modelling studies using synthetic datasets derived from downscaled products generated either from observations or from GCMs. While the claim was never made that the quality of these datasets are comparable to those derived from actual observations or measurements, the authors argue that approaches such as downscaling are the only alternative to locations where data does not exist. A particularity of the study area is that much of the precipitation (as much as 30%) takes place in solid phase since it is a cold region. This increases the importance of the accuracy of the snowfall dataset since cold-region hydrology and modelling studies in areas where runoff and stream discharge are snowmelt-driven are often hindered by lack of data. It also highlights the importance of uncertainty in snowfall measurements, which was considered small in the present dataset due to the reasons discussed in the answer to General Question #3. A comparison of the properties of the disaggregated precipitation dataset to actual hourly precipitation from Portage La Prairie indicates that the downscaling process was able to capture the major properties of precipitation in all different seasons. The datasets have been compared through boxplot graphs, which are included in the revised paper and are pasted below for reference. As the figure shows, the downscaling process was able to capture the small, moderate, and large precipitation events (except the

[6] Mekis, É., and Vincent, L. A.: An overview of the second generation adjusted daily precipitation dataset for trend analysis in Canada, Atmosphere-Ocean, 49, 163-177, 10.1080/07055900.2011.583910, 2011.

very large ones). The median and interquartile range were generally were represented for all the seasons, indicating that most of the events in the region are of small magnitude. This aspect alone also reduces the relative importance of the under-catch effect, since a 6.8% difference in events smaller than 2 mm/h could be considered negligible.



3. Reviewer: *Line 156. The original air temperature, humidity, wind speed, and solar radiation data sets were missing 27 to 37% of data, and the authors had to fill these data gaps using an assortment of gap-filling techniques. Again, this is a necessary procedure for hydrological modelling, but it compromises the data quality and increases the uncertainty in model results*.
Authors: Long-term data series usually contain gaps and sound techniques based on the literature were used to address this issue. Widely used hydrological models such as SWAT acknowledge and even make provision for data gaps through

weather generators. Thus, the limitation of the dataset is not out of the ordinary and should not hinder the use of the dataset.

4. Reviewer: *Line 194. Data gaps in hourly wind speed data were filled using the data from Winnipeg. This was the only option available, but using the data from a station located so far away can severely compromises the data quality as wind speed has large spatial and temporal variability.*
   Authors: As for the previous questions, this is acknowledged, but the value of the dataset still warrants its publication, despite the limitations, as discussed in previous answers.

5. Reviewer: *Line 228. If I understood correctly, the authors took daily precipitation data from the Marquette station and disaggregated the data using hourly data from the Portage Southport Airport. However, the latter appears to have hourly data set for air temperature, humidity, and wind speed, but no precipitation. The precipitation data for this station are only reported as daily values. It is not clear how the authors disaggregated precipitation data, and most importantly, how they validated the accuracy of the procedure.*
   Authors: As discussed in the paper, hourly precipitation records from the Portage Southport Airport station were only available from 2004. Due to the short record length, this station was screened out. The description of parameter estimation for the Bartlett-Lewis rectangular pulses rainfall model used for downscaling is presented in section 3.3. Model assessment was done but not presented in the original submission. It is now presented through a figure showing the comparison of the precipitation properties of both observed and disaggregated datasets (reproduced in the answer to specific question #2 above).

6. Reviewer: *Line 279-380. The Aims and Scope of the journal states that: "Articles in the data section may pertain to the planning, instrumentation, and execution of experiments or collection of data. Any interpretation of data is outside the scope of regular articles". Therefore, I believe that this section is outside the scope of the journal.*
   Authors: This section does not attempt to interpret the data but only to describe the major features of the major variables and to contextualize them to the surrounding physiography. A similar structure has been used in articles recently published by ESSD describing high-frequency environmental observations[7]

[7] Garel, E., and Ferreira, Ó.: Multi-year high-frequency physical and environmental observations at the Guadiana Estuary, Earth Syst. Sci. Data, 7, 299-309, 10.5194/essd-7-299-2015, 2015.