

Response Framework on the Peer Reviewed Compiled Document - Stochastic Hydrology of the Great Lakes - A Systemic Analysis

The peer review comments on the stochastic hydrology products were provided to the principal investigators of the three studies included in the submission to address them in the manner they deem fit. The following approaches were received back:

1. Editor's Note and Context sections – responses are provided in this document for the specific comments. The Study chose to take the notes on general remarks from Mr. Paul Whitfield under advisement and no response is provided.
2. Parts 'A' and 'B' on Stochastic Modeling and Simulation of the Great Lakes System – the principal investigator, Dr. Laura Fagherazzi chose to combine the two parts and rewrote the entire report with new graphics into a single document. All comments provided by Dr. Thorsten Wagener and Mr. Paul Whitfield were acknowledged and addressed in the revised document.
3. The lead authors for Parts 'C' and 'D' addressed the review comments at two levels. They provided responses against each of the comments and the revised documents reflect the changes made in responding to the comments.

Generally, the reviewer's comments are noted in red font with italicized text and the response is in normal text in blue font.

Dr. Thorsten Wagener

No comments on the Editorial notes and context piece.

Paul Whitfield

Editor's note:

Page ii. "The peer review was conducted under the joint auspicious of National Academy of Sciences in the US and the Royal Society of Canada." – is this in fact true?

The Lake Ontario Study was indeed peer reviewed by the august groups. While the group was not directly charged with reviewing these reports, it was looked at while evaluating the Shared Vision Model (SVM). As the Editor's note was directly aimed for peer reviewers, this is now dropped as the original of revised documents are included in this submission.

Global page numbers are used throughout.

Page 2. The statement "The IJC, created by the Boundary Waters Treaty of 1909, has the responsibility to manage the shared waters between Canada and the United States." Is not consistent with my experience and understanding of the IJC.

The sentence in the context piece is in essence the main objective of IJC both in spirit and body. Noted below is a direct lift from the IJC's website.

"The Role of the International Joint Commission

Canada and the United States created the International Joint Commission because they recognized that each country is affected by the other's actions in lake and river systems along the border. The two countries cooperate to manage these waters wisely and to protect them for the benefit of today's citizens and future generations."

http://www.ijc.org/en/background/ijc_cmi_nature.htm)

Page 3. The section "Approaches and Products" is quite useful to help understand the perspective of the document, but it does not provide a sufficient description. While the pluses of choices that were made seem to be well noted, these choices also have minuses which are not described at all. The group has made choices, and I understand that they were unable to examine every potentiality. However, there are many places that a person who is not experience in these areas is not provided with sufficient detail. In each and every section it would be useful to state why a choice was made and the consequences. For example, they group chose NCEP variables, but does not provide the grid size, or acknowledge that the precipitation fields are known to be poor. They also chose Scenarios A1B and A2 for future climates without and if I understand correctly, the references have been previously published and the components of this are 'extractions' from those reports. It is unclear if the context section will persist past this review, but it should be, and the 'components' should come before the references.

There are three distinct parts to this comment. The first part was discussed in detail in a separate peer review submission for the climate change strategy and studies and explanations are captured in the reports and peer reviewed papers for example by Angel and Kunkel.

The second comment is about the fate of the context piece. The context piece was modified and will continue to be the front piece for all other documents.

We agree with the reviewer on positioning the components before references and the revised document reflects this change.

Seidou reference – extra text could be removed. Taesam should be T. and K1N6N5 is a postal code?

The editorial comment is acknowledged and these changes made in the revised submission.

Responses to the Review of Wagner and Whitfield on Section ‘C’ - *Stochastic Generation of Synthetic Residual Net Basin Supply for the Great Lakes System*, and Section ‘D’ – *Predictability of Climate Indices with Time Series Models*

Wagener

C1-The author’s state: “However, the ability of GCMs in reproducing ENSO is believed to be poor.” (p. 121) Please provide reference for this conclusion. Also, does the ability to reproduce ENSO not vary with GCM and with location?

⇒ Answer: During the study there has been a lot of discussion about whether or not a reliable ENSO signal could be extracted from GCM outputs. The consensus was that current versions of climate model still have trouble reproducing climate indices. Extracting ENSO values from GCM outputs is time consuming and we decided not to invest time given the uncertainties on the outcome. Yes, the ability to reproduce ENSO will vary with the GCM, but not with location.

C2-The third bullet on page 121 refers to scenario A3. I assume this is supposed to be A2? It would also be good to briefly mention the differences between the two scenarios.

⇒ Answer: It refers to scenario A2. The difference between A2 and a1B is explained in section IV.5 in the new version of the report.

C3-What is the general impact of ENSO on the lakes region? How much of the historical variability can be explained by ENSO?

⇒ Answer: the known impacts of ENSO in the region are the following:

- ✓ Impacts winter severity
- ✓ Impacts ice extents on the lakes
- ✓ Using NL-ARX with ENSO, we get the following Nash-Sutcliffe coefficients (section III.4):

LAKE	PREDICTOR	Nash (calibration)	Nash (validation)
SUP	ENSO Winter	0.6275	0.4075
STC	ENSO Winter	0.2548	0.2233
MHG	ENSO Winter	0.0784	0.2845
ERI	ENSO Winter	0.6214	0.3893
ONT	ENSO Annual	0.4186	0.3119

⇒ Since the Nash Sutcliffe coefficient is larger than zero, our model has a better explanatory power than assuming a constant mean.

C4: This section (C) of the report includes better explanations for figures than the previous Sections

⇒ Answer: Thanks- even more efforts are put in the explanations in the next version of the document.

C5: There is some repetition of text in this chapter (e.g. p. 137).

⇒ Answer: The text was completely rewritten and repetitions were removed.

C6: Why would the predictive variables not change in the future (p.139-140)? This is the general question with statistical approaches (e.g. for downscaling), but it would still be good to include a couple of sentences on this point.

⇒ Answer: The change in predictive variables was accounted for by using the outputs of CGCM3 instead of NCEP reanalysis data. The problematic assumption is that we assume that the relation between the predictand and the predictors will be valid in the future, while we just checked it for the present time.

C7: There are some problems with automatic referencing on page 146.

⇒ Answer: the text was rewritten and referencing carefully checked.

C8: The details (circles) on figures VII-1 and VII-2 are difficult to see. Similar comments can be made for later figures of the same type.

⇒ Answer: these details are visible in the original word document. I guess it is a question of PDF quality.

C9: There seems to be a tendency for the simulations of the lake levels to be too low for the low cumulative frequency and too high for the high cumulative frequency values (e.g. IX-2). Why is that?

⇒ Answer: yes, the generation model based on NCEP tends to overestimate high flows and underestimate low flows. We cannot explain why but mentioned it in the new version of the text (sections VII.2, and VII.3)

Comments on: D Predictability of Climate Indices with Time Series Models

The writing in this section is not as good. Should be read through another time by a native speaker.

⇒ This comment is a little different from the other reviewer's comment. We proof read the document once more at any rate. It was further edited by a native speaker.

Claiming that GCM output is not widely available is too simplistic a good starting point (p. 185). It is easy to access GCM outputs and even downscaled products are widely available. If the choice is for time series models, then that is fine, but this should not be based on such claims.

⇒ Even though the direct GCM outputs and downscaled products for current and future are available for current and future, retrospective predictions of those are rarely available. Therefore, without the retrospective predictions, one cannot check the performance of applied models. Nevertheless, we slightly remove the sentence not to confuse the reader accordingly.

I am not fully clear why a Kalman filter is necessary here? Please explain better.

⇒ Kalman filter was applied to the parameter estimation of the DLM model as well as prediction. This was explained in section 2.3.2 of Part D. One sentence is added right

after the Eq. (48) to enhance explanation.

Page 200: While a calibration/validation process is used, it is not clear to me why the authors did split up the time series according to when change actually occurred (as shown in section A)? Isn't the main question whether the model can reproduce changes in the mean? Wouldn't it make more sense to split the dataset into periods with different means and show that the models can actually reproduce change?

⇒ Basically, the main objective of this prediction study of the climate indices in Part D is to find the best stochastic time series model that has the best prediction capability of climate indices. This objective is different from the simulation study.

The x and y axes are missing on the figures on page 227.

⇒ The authors appreciate this specific comment. There was a mistake during the file conversion. All related figures are fixed in order not to miss x and y axes even after file conversion (Figures 6, 7, 8, 9, 18 and 19).

Whitfield

Page 120

C1: Line 2 'potential' performance of a given plan...

⇒ Answer: the sentence was corrected

C2: Line 4 - that are 'sufficiently' long enough...

⇒ Answer: the sentence was corrected

C3: Line 5 'sentence starting 'Historical observations...' it does not follow – if the historical data are not adequate, then assuming that longer stochastic series with the same statistical attributes as the historical data will be adequate is a large assumption. Needs additional explanation.

⇒ Answer: added 'Even though the statistical characteristics are the same, the synthetic series will contain more extreme values than the historical data and therefore will allow testing the system in more unusual flow conditions'

Line 6 - are 'often' too short... and the only remaining 'one' alternative is ...

⇒ Answer: the text was corrected

C4: line 12 the authors use 50000 in contrast to the earlier use of 55510 – were these actually done differently?

⇒ Answer: the mandate is to generate 50000 years of data. However, depending of the statistical methods a few more years of data are generated. For instance, a burning period of 50 years is needed for temporal disaggregation with SAMS, and is not mentioned in the report.

C5: Para 2 delete 'In this report'

⇒ Answer: the text was corrected

C6: There is a need to provide some evidence and reason for ENSO to be considered. The previous paragraph describe long time series, and this is a jump in logic to including ENSO.

⇒ Answer: added more explanations: 'Amadou et al. (2009) showed that there are nonlinear teleconnexions between most NBS components and climates indices like the North American Oscillation (NAO), the Pacific Decadal Oscillation PDO and the El-Nino Southern Oscillation (ENSO). It was therefore decided to develop...'

C7: Line 2 non-stationarity

⇒ Answer: the text was corrected

C8: Line 4 50000 synthetic yearly ENSO values were afterward generated ... – awkward wording – normally these would be the 'annual series' not yearly.

⇒ Answer: replaced by 'A 50000 years-long time series of synthetic annual ENSO values was afterward generated ...'

C9: Line 7 Sentence beginning 'Finally, noise was generated...' needs additional explanation as to why.

⇒ Answer: The statistical properties of the noise were optimized to reproduce the key statistical characteristics (temporal and spatial variability, cross correlations and temporal correlation) of historical annual NBS time series, as explained later in the sentence.

C10: Line 12 none of these three references are listed in the references section.

⇒ Answer: the references are updated at the end of the document

- ✓ Grygier, J.C., Stedinger, J.R., 1988. Condensed Disaggregation Procedures and Conservation Corrections for Stochastic Hydrology. *Water Resources Research*, 24(10): 1574-1584.
- ✓ Grygier, J.C., Stedinger, J.R., 1990. SPIGOT, A Synthetic Streamflow Generation Software Package, School of Civil and Env. Engr., Cornell University, Ithaca, NY.
- ✓ Lee, T., Ouarda, T.B.M.J., 2010. Multivariate Stochastic Simulation of Climate Indices with Empirical Model Decomposition R-1188, INRS-ETE, Quebec.

C11: Line 15 Sentence beginning "The resulting NBS sequences were finally with the ..." is not a sentence.

⇒ Answer: the resulting NBS sequences were finally routed

Page 121

C1: Paragraph starting on previous page. I do not think that the paragraph is very clear. Extracting ENSO from GCM's is not always possible as many GCM's do not resolve ENSO specifically. Need to clarify the differences between GCM outputs and NCEP reanalysis output. Technically, these are not 'data' but model outputs. The 'second model' is not adequately specified so understanding the outputs in the bulleted list is not sufficiently clear. The scenarios should be explained prior to their use in this list.

⇒ Answer: the text was completely rewritten. It now reads:
However, after several discussions with the study board, a consensus emerged on the fact that the ability of current GCMs in reproducing ENSO is poor. It was therefore decided to develop a second model which links annual NBS to a list of variables that could be obtained from climate models outputs for both present and future climate. The values of the predictors for current climate could be obtained from NCEP reanalysis which are gridded data sets that are obtained by assimilating climatic observations all around the world. Future values of the predictors will be obtained from climate change experiments (GCM runs using hypothetical emission scenarios). Only one GCM (the third generation of the Canadian general Circulation Model) and two emission scenarios (A1B and A2) were considered in this study because of the time constraints. More details on the selected emission scenarios will be provided later in the text.

C2: Sentence "These last three time series..." depends on the poor explanation given on the previous page. [120 line 15]. Perhaps it would be useful to add a figure that would explain both of these models better?

⇒ Answer: the text was completely rewritten, and a figure was added as requested to make it clearer.

C3: Paragraph 2 'The remainder report is organized...' is not a sentence. The English in this paragraph is particularly a problem.

⇒ Answer: The English was edited

C4: The section on scenarios in this paragraph is problematic. A1B and A2 are but 2 of 40+ equally probable scenarios. Why were these two chosen over the others? Using only two scenarios does not "account for climate changes."

⇒ Answer: explanation as to why these two scenarios were selected is added in the second paragraph

C5: 2nd last line on page "...chapters IX (), X, and ..."

⇒ Answer: The text was corrected

Page 122 Chapter II

C1: Paragraph 1 - more pointers without content or connection.

⇒ Answer: the pointers were removed

C2: Paragraph 2 – It would be useful is there was some consistency in the naming, acronyms, and order of the five lakes. When the reader faces different usages, it is [1] confusing; and [2] they seek to understand why the order, names, or acronyms are different.

⇒ Answer: the order of the lakes and the acronyms were made consistent

C3: Figure II-1 Caption is inadequate. The figure needs to have a legend to link the lines with the lakes. It would be useful to vary the line types as well as the colour to support greyscale and/or colour challenged readers.

⇒ Answer: A legend was added to the figure, an line types were changed. The legend was changed to '1900-2009 annual residual NBS for Lake Superior (SUP), Lake St-Clair (STC), Lake Michigan-Huron with Georgian Bay (MHG), Lake Erie (ERI), and Lake Ontario (ONT)'.
'

Page 123

C1: Table II-1 – Caption is inadequate, needs to show units, abbreviations, and other pertinent information that helps the table stand alone. Caption has spelling error. Lake order is different to text on page 122.

⇒ Answer: the caption is changed, units added, and lakes are referred with their full names, and lake order changed.

C2: Table II-2 – Caption is inadequate, needs to show units, abbreviations, and other pertinent information that helps the table stand alone. Lake order is different to text on page 122 and to the table immediately above it.

⇒ Answer: the caption is changed, units added, and lakes are referred with their full names, and lake order changed.

C3: The numbers in the table would be better without exponents [or at least use the same exponent for each case i.e. 003] to be consistent with the usage in the text. Need to explain

the units better.

⇒ Answer: The number format was changed

C4: Line 1. This is not sufficient. There should be some explanation as to why these attributes are felt to be important, how adequacy is assessed and the amount of tolerance.

⇒ Answer: the motivation for the choice of these statistics is presented. The method used to assess the performance of the generation procedure (qualitative assessment using boxplots) is also presented.

Page 124

C1: just before the table "... of the predictors depend of the stochastic sequence..." is not clear.

⇒ Answer: the sentence was rewritten as: ' The class of F and the predictors used for each of the generated synthetic NBS series is given in the table below:'

C2: Table II-3. The caption is not complete. This is more that a list of generated synthetic NBS sequences. It would be useful if somewhere the distinction between 'series' and 'sequences' was made clear.

⇒ Answer: the caption was rewritten as 'Predictors and class of function F for each generated synthetic NBS '.

Page 125

C1: Once again, the technical level of the description provided makes this reviewer question who the intended readers of this report might be?

⇒ Answer: this is new material that can be found nowhere else. We believe it should be kept in the report, and mentioned as optional to the non technical reader

C2: End of step 2: ' ... and the desire is that the elements of Ω reproduce the temporal ...'

⇒ Answer: the sentence was corrected.

C3: Step 3: the wording needs to be improved, and the time period clearly linked to the availability of NCEP (1949-2008). There needs to be a better explanation of 'adding a constant to each lake's NBS' – it is not clear how this is done; and if this adjustment is made to overcome any difference then how can historical means be considered as a meaningful attribute to be reproduced?

⇒ Answer: At the end of the procedure, the historical mean is reproduced. However, the exact match is due to the correction

C4: Amadou et al 2009 [used several times] is not a listed reference. English in this paragraph is awkward. Net Basin Supply – which NBS is this?

⇒ Answer: the reference list was corrected. We are referring to the components NBS supply, and it was made clear in the text.

C5: Sentence beginning "50000 values of each of these six potential" is difficult to follow.

⇒ Answer: the sentence was cut in two in order to make it more readable.

In the following sentence should is the “NSO process” non-stationary oscillation or ENSO?

⇒ Answer: It refers to ENSO. The correction was made.

C6: Line 15 “It was therefore decide to develop a NL-ARXmodel...” is not sufficiently described to allow the reader to follow the reasoning.

⇒ Answer: More details are provided on the reasons for choosing NL-ARX models.

C7: Last sentence - spelling errors

⇒ Answer: the error is corrected

C8: Paragraph 2 “another Pointers paragraph”

⇒ Answer: The paragraph describes the content of the chapter.

C9: Paragraph 3 wording is difficult. Please explain why it is an ‘objective variable’

⇒ Answer: 'objective variable' is replaced by 'target variable'

Page 127

C1: Once again, the technical level of the description provided makes this reviewer question that the intended readers of this report might be?

⇒ Answer: we removed the unnecessary references to the sets of inequations.

C2: In 1. It seems odd to list “no non-linear transform” as a form of non-linear transform. And the double negative does not add to clarity.

⇒ Answer: changed “no non-linear transform” to "no transformation"

C3: In 2. Need to explain the ‘networks’. The link “in section 1” points to where? There needs to by some wording added to explain what this means in a practical sense.

⇒ Answer: an explanation of "network" is added to the text: “Function F is referred to as a network because it is the sum of several basis functions with different nodes and parameter. Each basis function can be seen as a node in a one layer network.

C4: In 3. Need to explain the ‘networks’. There needs to by some wording added to explain what this means in a practical sense.

⇒ Answer: see the answer to the previous comment

C5: In 4. Need to explain the ‘networks’. There needs to by some wording added to explain what this means in a practical sense.

⇒ Answer: see the answer to the previous comment

C6: “a set of inequations”?

⇒ Answer: Reference to inequations was removed from the text

Page 128

C1: Below the W equation there should be some explanation of ‘complex conjugate’ and ‘admissibility conditions’. Since the authors have included them the reader should be

informed of what this means in a practical sense.

⇒ Answer: we removed the reference to the admissibility condition. We kept 'complex conjugate' since it is a simple concept that should be known

C2: Figure III-1. Caption is inadequate. An alternate scale that transfer to grayscale would be preferable. Need to explain what the lines within the figure indicate and the boundary [no edge effects].

⇒ Answer: The figure was changed to grayscale. The text explains that 'Values are only plotted within a cone of influence (COI) where there are no edge effects on the calculation of the coefficients'.

Page 129

C1: Figure III-2. Caption is inadequate. An alternate scale that transfers to grayscale would be preferable. Need to explain what the arrows within the figure indicate and the boundary [no edge effects].

⇒ Answer: The caption is changed to 'Cross waveletpower of PDO autumn and the autumn runoff on lake Erie watershed.'

Page 130

C1: In this numbered list:

[2] Needs to explain the selection of a threshold.

⇒ Answer: In fact each value of the threshold is selected once to build one predictor. The text was changed to make it more explicit

[3] Needs to explain the basis for this selection.

⇒ Answer: A frequency is selected if the mean wavelet coherence for that frequency is above the threshold, and discarded otherwise

[4] Clarify this – perhaps in a practical sense this is all non-important components are ignored?

⇒ Answer: The text was changed to make it clearer: 'The lines of the wavelet coefficients matrix in A are set to zero for all the frequencies not selected at step 3 to ignore components for which the mean wavelet coherence is below the threshold'

[5] Equation 8 is referred to – the only equation 8 that is in this is on page 134? That equation does not provide the outcome described here.

⇒ Answer: reference to equation 8 is removed

[6] Needs further explanation.

⇒ Answer: additional explanation was added in the text

[7] Figure 2-1 not shown [is this actually referring to III-3? The clarity of this text will need improvement.

⇒ Answer: the exact number of the figure is III-3. This is corrected in the text

C2: Overall, this description is not sufficient to provide a non-specialist reader with an adequate understanding of the process.

⇒ Answer: Figure III-3 is a graphical representation of the process (bullets 1 to 6) and the paragraph above it explains the figure.

Page 131

C1: Figure III-2. Caption is inadequate.

⇒ Answer: the caption was changed to 'Cross waveletpower of PDO autumn and the autumn runoff on lake Erie watershed.'

C2: Wording of the paragraph is awkward.

⇒ Answer: the paragraph was rewritten

C3: Table III-1 is it not 'Climate Index' and not "Climate indices". There should be some text explaining the basis of selection of these indices.

⇒ Answer: The caption was changed to 'Predictors considered in the study and their period of availability'

Page 132

C1: III.4 First bullet could be more clearly worded. Spelling error.

⇒ Answer: the section was completely rewritten

C2: Third bullet – is this the Nash-Sutcliffe coefficient? Is NS a good [robust] test in this case?

⇒ Answer: The Nash coefficient seemed to be a reasonable choice

C3: Table III-2. Caption is inadequate. Units? Undefined terms? In fourth column. What are the n's?

⇒ Answer: the caption is changed to 'Characteristics and performance of the best NL-ARX model for each lake'; The n's are the orders of the NL-ARX models

C4: Figures 3-4 to 3.8. The referencing of figures and tables is very messy and inconsistent in this section.

⇒ Answer: Figures 3-4 to 3-8 were removed from the document

NASH has not be adequately defined and the reader will have no basis to understand that 0.22 and 0.4 are to be compared to 1.0

⇒ Answer: hints on how to interpret the value of the Nash coefficient were added to the text

Page 133

C1: Figure III-4. Vary line types as well as colour. Caption inadequate. Where are the figures 3-4 to 3-8? Or III-5 to III-8? Spelling error in text. In the table below "III-4"

⇒ Answer: Figures 3-4 to 3-8 were removed from the document

Table III-4 is oddly split between two pages with the caption in the middle?

⇒ Answer: the formatting issues have been addressed

Page 134

C1: First line Table 3??

⇒ Answer: This formatting problem will be taken care of in the final version of the document.

C2: A second equation (7) is provided on this page?

⇒ Answer: Equations were renumbered

C3: The pseudo code section needs to be presented as such.

⇒ Answer: we believe this is the simplest way to present the method

Page 135

C1: Line 3 spelling error

⇒ Answer: corrected

C2: This reviewer is unsure of the usefulness of “A Matlab script which ...”

⇒ Answer: we replaced ‘Matlab script’ with ‘Computer code’

C3: Line 9 Table reference is incorrect and there is a spelling error

⇒ Answer: table reference was corrected.

C4: Paragraph 2 – table references incorrect. Some text to clarify; help the reader understand how to interpret ‘very close’ and ‘of the same order’

Previous comments regarding captions and table structure apply to III-5-III-7. .

⇒ Answer: captions and table structure were corrected

Page 135

C1: Need to add a summary to bring these many pointers to figures tables and text to give the reader a sense of what has been shown in this section.

⇒ Answer: A new table and more text were added to explain the comparison of the two variance-covariance matrixes (the one calculated with observations and the one calculated using simulated values).

Page 137

C1: The first paragraph is largely a copy for earlier in the document. It contains the same shortcomings. The two differences indicate at the end of the paragraph warrant more explanation.

Answer: text duplication was removed, and the differences are discussed at the beginning of chapter I.

C2: Paragraph 2. Reference to the table should be to a specific table IV-1? The period 1948-2009 is for the NCEP series; explain why the standardized period is for 1961-2009. Also it is not clear if the standardization is done over lake drainage or over the entire domain.

⇒ Answer: the standardization period is 1961-1990 and it is done over the lake drainage

C3: Further, the 25 variables are either extracted or calculated. The authors should indicate which are extracted and which are calculated. Also they might suggest why these 25 were selected.

⇒ Answer: Vorticity and divergence were calculated following DAI CGCM3 Predictors (2008) while other variables were calculated. The 25 variables are exactly the ones used in DAI CGCM3 Predictors (2008) because they have been specifically developed for

downscaling application. Reference: DAI CGCM3 Predictors (2008): Sets of Predictor Variables Derived From CGCM3 T47 and NCEP/NCAR Reanalysis, version 1.1, April 2008, Montreal, QC, Canada, 16 pp.

C4: Table IV-1. The caption needs to be more complete. While some readers might have a good sense of why these variables might be good predictors for a hydrological model [or a statistical model of hydrology] the average reader might not be clear on why these variables might be useful. Some additional information that would benefit the reader is needed.

⇒ Answer: a sentence was added in the text: 'Apart from the temperatures, all these variables are pressure and humidity related variables. They all affect precipitation either directly either by moisture redistribution'.

Page 139

C1: Paragraph 1. Needs an explanation of the advantages of these forms of smoothing and also address the fact that these are not independent [if in fact the original 25 could be considered independent].

⇒ Answer: The averaging was actually done to include more variables in the search. The fact the variables are not independent is now mentioned in the text.

C2: Table IV-2 IV-3 and IV-4– Are these tables referred to within the text? Does the numbering [1-7] indicate the best to least explanatory models? Also, the caption should explain how the encoding in the table can be interpreted. Some parts are likely to do with watershed areas, but “SUP_c3alp5_vna JUN(Y+1) to JUN(Y+1)” is not very informative.

⇒ Answer: Captions are now made more informative. All the variables in a given column are included in the regression model of that lake

C3: Figures IV-1 and 2. Are these referred to in the text? Captions need to be more complete. While there are places where acronyms for the Lakes are useful, it seems odd to refer to Lake SUP.

⇒ Answer: the figures were removed

Page 142

C1: Text and table mix reference systems. It would be useful to indicate that the expectation for the residuals is that they should be zero. The problem is that the reader does not have a context for the numbers in the table – is say -121 cms large or small?

Answer: the values of bias were checked and corrected. The relative bias (mean of the residuals divided by the mean observed NBS) is provided.

C2: Last paragraph – table and chapter references inconsistent. 3rd from last line – spelling error correlation

⇒ Answer: references and typos were corrected

Page 143

C1: Need to note that the V-COV of the residuals is an order of magnitude larger than those of the fitted model in table IV-9.

⇒ Answer: there is not such difference in the VCOV coefficients. The numbers in the tables

are now written to the same format.

C2: A summary at the end of this chapter would be a useful addition

⇒ Answer: the last paragraph in the new version of the text briefly summarize the findings

Page 144

C1: Comments made earlier about using one GCM and two scenarios apply to this first paragraph as well. What are the relevance of the statements about the model structures; and the role of governments in running GCM's? It is probably more realistic that the GCMs are run on super computers that are primarily used for weather forecasting supported by government. How is the popularity of a GCM measured?

⇒ Answer: the entire section was deleted

Page 145

C1: These two paragraphs are largely repetitions of earlier text. The first contains additional unnecessary text. The use of an average of grid cells as predictors seems at odds with the extensive literature on downscaling. The suggestion that standardized series have the 'appropriate scaling' is debatable. 2nd paragraph needs more explanation. The numbers in this paragraph do not agree with those elsewhere in the report [other sections]. This 'chapter' at it exists could simply be deleted; it is largely a repeat of text used earlier, and provides no additional information. With the addition of some information it could provide the reader with some context about GCM's and their use.

⇒ Answer: the chapter was deleted and relevant sections were moved to chapter IV

Page 146

C1: Delete the 1st paragraph. The second paragraph seems to be in an incorrect location. The authors should be careful to put the information about ENSO and PDO into proper context. How much precision is added by including these indices in the models. The third paragraph is inconsistent with earlier material that suggests that a stochastic model is the one alternative. Need to specify how 'sustainability' is being used in this investigation.

The text of these paragraphs needs attention to the use of articles.

⇒ Answer: Paragraphs 1, 2 and 3 were deleted

C2: Last paragraph "Reference not found" is second to last line. Two sentences beginning "To check whether ..." are awkward.

⇒ Answer: The sentence was rewritten

Page 147

C1: Table VI-1. Caption is not complete. Most of the footnote should be in the caption.

⇒ Answer: the footnote was deleted and the information transferred the caption

Page 148

C1: Paragraph 2. Needs more explanation of how the comparison is made and why Weibull was used.

The following section starting "In Section VII.1 ..." is another case of a set of pointers that

simply lists items [pointers]. The text about the main conclusion is useful and similar text should be added in many places in the entire report. However, the reader is left to their own interpretation of 'fairly well reproduced' and 'well reproduced'.

⇒ Answer: This chapter was entirely rewritten. The motivation for calculating CDFs using Weibul Probability Plots) are presented. Quality measures are introduced and all the results were interpreted based on these measures.

Page 150

C1: None of the figures in this chapter seems to be discussed except being mentioned in the list on page 149. The following comments apply to the first occurrence and each clone that follows.

⇒ Answer: all the figures in the text are discussed now.

C2: Figure VII-1 the x-axis should list all the pairing and not leave it to the reader to guess the missing labels on the x-axis.

⇒ Answer: complete labels were added to the figures

C3: Figure VII-2 this form is 3x4 and later [VII-8] the form is 4x3. Each component should have a label.

⇒ Answer: Labels were added to each component. There only one form now (four lines and 4 columns)

C4: Figure VII-5 Is this the best way to present this information? What are the units? The observed data is only a single point and being compared to model output with wide confidence intervals. It would be interesting for the authors to provide some interpretation that would assist the reader in interpreting this specific figure.

⇒ Answer: Figure VII.5 is now commented.

C5: Figures VII-6 and.... Caption is not correct the observed data is a + and not a o

⇒ Answer: The caption is now corrected

Page 156

C1: It would be useful at the end of this section to provide an interpretation of whether or not the 'validation' is acceptable

⇒ Answer: A section was added to conclude about the overall performance of the generation procedure

Page 157

C1: The comments that were made on pages 149-156 apply to this section as well.

⇒ Answer: the chapter was rewritten and the comments addressed in the new version

C2: In figure VIII-1 the circle is not very visible.

⇒ Answer: it is visible in the word document. It's a question of PDF printing quality

C3: In figure VIII-2 [and VIII-6] the observed data is not a o but an x.

⇒ Answer: the caption was corrected

C4: Figure VIII-8 needs units. The mixture of y-axis scaling is not useful; better to use one scale to show seasonal variation.

⇒ Answer: The unit was added to the caption. The figure will be recalculated and sent to the IJC (at the time of the correction the author is out of town)

C5: It would be useful at the end of this section to provide an interpretation of whether or not the 'validation' is acceptable.

⇒ Answer: Quality criteria were introduced in the new version of the document and the acceptability of the validation is discussed.

Pages 162 to 169

C1: These chapters [IX and X] start with a list and a few plots with no interpretation and not summary and insufficient guidance to the reader regarding do-it-yourself interpretation.

⇒ Answer: all the plots are now commented and a summary was added to the end.

Page 170.

C1: Figure XI-1 is too small to be legible. A line [instead of dots in each] for the observed would be better. The caption should explain the manner in which these box and whiskers are constructed as it is different to previous.

⇒ Answer: Each box corresponds to a different period and observed cannot be connected with a line. The figure was made bigger on a landscape page.

Page 174.

C1: An interpretation and a summary is needed for this chapter.

⇒ Answer: an interpretation and a summary were added to the chapter.

Page 175

C1: A summary for this section is needed.

⇒ Answer: at the end of the chapter a short summary is presented

C2: References

Could not find where Torrence et al 1998 was cited.

There were several citations in the text that are not listed here:

Amadou et al 2009.

Stedinger et al 1995

Salas et al 2006

Lee et al 2011

⇒ Answer: the reference list was updated

These chapters [IX and X] start with a list and a few plots with no interpretation and not summary and insufficient guidance to the reader regarding do-it-yourself interpretation

⇒ Answer: the chapters were rewritten and each plot interpreted

Pages 162 to 169

Part D Predictability of climate indices with time series models

General comments

This Part was the best well written of the four parts. While it is clearly written, it perhaps overstates the case for climate indices by relying on in preparation manuscripts and insufficient references to existing literature on climate indices and the Great Lakes.

Specific comments

Page 184

It seems odd to have separate acknowledgements in each section of this report.

⇒ Each section is the independent report and has different contribution to complete.

Executive summary

The objective of this study is to project future climate indices that affect the Great Lakes system Net Basin storage.

⇒ The authors appreciate this reviewer's specific comment. The sentence was improved accordingly.

Line 7 Need to explain how much prediction improvement the 'most significant teleconnection' provides.

⇒ We think it is too specific to explain in the executive summary.

Page 185

Paragraph 1 the climate system is teleconnected to the hydrology; the indices are a measure of the climate system.

⇒ The sentence was improved accordingly.

Last sentence – awkward. I am not sure what is intended.

⇒ One example of the association between climate indices and Great Lakes region is discussed in the sentence.

Paragraph 2

...these climate indices can be used to improve predictions of the ...

⇒ The sentence was improved accordingly.

Last two sentences. This is not true. The outputs from GCM's are widely available to the general community, and while doing your own GCM would be very expensive, using the output from the available ones is not. Since this is not prohibitive, the authors should consider why predicting the indices in the manner suggested would be better than outputs of GCMs; particularly considering that these physically based models do not always resolve ENSO or PDO.

⇒ Those sentences were removed from the other's review.

Paragraph 3 Last sentence – what is the value of stating this?

⇒ The sentence was required since one might argue why only linear based time series

models are applied in the current study. Furthermore, we tested a number of different time series models. We think this is important to inform it to readers.

Paragraph 4 this reviewer finds it difficult to understand how the PDO has a larger signal than the AO, NAO, or AMO on this region. The literature upon which this is based and any supporting analysis would be a useful [and a necessary addition]. How much improvement in the prediction is being gained?

⇒ Even if the other climate indices such as AO, NAO, or AMO indicate the closer climate system (Atlantic) than PDO (Pacific), those indices are temporally too random to be employed for the future prediction. Specific application was done by the other reports. Please refer the other sections.

Page 187

These sections are nicely written and relatively easy to follow to a semi-expert. However, consider who the readers of this report will be. I think that it would be useful to add a 'layman' summary to make the material more accessible to the readership. Perhaps the matrix math can be removed. State clearly the intention, the context, the process and the assumptions. Also some commentary about whether these are met or not would be helpful. We leave this comment to the editors of this report.

In the ARMA section, the authors should comment on whether or not it is reasonable to assume that NBS, ENSO, and PDO are stationary.

⇒ We considered that was out of scope for this section.

Page 188

References to Aikake (1974) and Hurvich and Tsai (1989) were not included in the reference list.

⇒ The authors appreciate this reviewer's specific comment. The reference was added accordingly.

AIC is mentioned in an earlier section of this report, but not explained until here.

⇒ We don't see any problem with that because AIC is one of major mathematical term used in the current section.

Section 2.2 GARCH.

Why do these sections not follow the order in which they were introduced in paragraph 3 on page 185?

⇒ Paragraph 3 on page 185 was modified accordingly.

Note: I found it interesting how much space is devoted to GARCH when the most important models [Part B] are not adequately explained].

Page 191

Why is only GARCH(1,1) used? Is an equation [16] an 'illustration'?

⇒ GARCH(1,1) is already an very complicate model. We tried higher order GARCH but no better results were found. The sentence was corrected accordingly.

Page 194

While propositions are important in a statistics paper are they useful in this report? The language alone will exclude some readers.

Page 196

Note: I found it interesting how much space is devoted to DLM when the most important models [Part B] are not adequately explained].

⇒ For the two comments above, DLM model was a little difficult to explain the procedure of parameter estimation and prediction with short sentences.

Paragraph 2 ‘cutting-edge’ is colloquial. Wording of this paragraph is particularly awkward.

⇒ The word “cutting-edge” was removed accordingly.

Numbered list:

[1] Was IMF defined previously? It might be useful to have a table of acronyms somewhere early in the report as searching for definitions in a 200+ page report is problematic.

⇒ IMF was defined there accordingly.

[2] Need to better explain subjective criteria. A reader would not have sufficient information to understand without resorting to reading the original reference.

⇒ We do not waste too much space for explaining EMD-NSOR method since the prediction results showed that this method was not useful for predicting the current short-term climate indices as mentioned in the result section.

Page 197

Bullet [4] “One of the k time indices is selected”. This nomenclature is difficult as we are reading about a time series of a climate index that itself has a time index.

⇒ The sentence was improved accordingly.

Page 198

Paragraph 1 the point has already been made about the issue of teleconnection. Here, the authors are using a reference to an in preparation manuscript as the sole reference for selecting ENSO and PDO.

⇒ We chose to insert this sentence to remind the importance of teleconnection between the Great Lakes system and climate indices.

Paragraph 2 This is not sufficiently clear, and does not show the logic for selecting this one ENSO index over the many that are available. Including text about “the fundamental tropical atmospheric bridges” as a support is not convincing. Why should that one index be better or best?

⇒ We totally agree with this reviewer’s comment. The part was removed accordingly.

A note on the PDO: the first principal component of Mantua et al is not consistently the leading PC. It switches on occasion to PC2 for periods of time – see “Victoria Mode” which makes it problematic if you model only PC1. See Fleming 2009 Can J Physics.

⇒ The authors appreciate this reviewer’s elaborate comment. The sentence was changed as ‘the principal component’.

Page 199

Paragraph 1

Another change in the style of pointing to tables and figures.

⇒ This must happen during the file conversion.

Line 5 delete 'evident'

⇒ The sentence was improved accordingly.

The last three sentences are awkward and do not seem to follow logically.

⇒ We do not think that was awkward. As shown in the last sentence, we also tested all the possible combinations, but the combination of ARMA(4,0) and another model is the most useful one. We tried to explain it in a logical manner. Please let us know how we can improve it specifically if needed.

Paragraph 2

Perhaps "We tested many models, but only the following are presented:"

⇒ No, this is not exactly what we meant.

Page 200

Paragraph 1 last sentence. Where is this 'section 2'??

⇒ We meant section 2, mathematical description of applied models. The sentence was improved accordingly.

Paragraph 2 it would be better to state that correlation and RMSE were used to assess the models rather than simply being 'estimated'.

⇒ The sentence was improved accordingly.

Paragraph 3 "Out of all, EMD-NSOR model was the least performing one" is awkward. 'The EMD-NSOR model had the poorest performance.'

⇒ The sentence was improved accordingly.

Paragraph 5 ends with ".."

⇒ The sentence was improved accordingly.

Page 201

Interesting that ARMA(28,0) had lowest AIC. What is the resolution of AIC that is important? Table 6 should only small percentage differences.

⇒ We tried all the possible lags for ARMA models. The order of ARMA was selected with AIC.

Section 5.2. There are data quality issues with the PDO index in the early years that should be noted.

⇒ Those issues are already well known in climate science. It seems out of scope to discuss in the current study.

Page 202

Is it necessary to present the same information in tables and figures?

⇒ Tables can show specific values and Figures can illustrate overall behavior of the model performance.

Summary. The first sentence is arguable in general, and has not been adequately shown for NBS. The authors should consider alternatives such as skill scores when assessing their 'predictions'.

⇒ The sentence was improved accordingly.

Tables:

Captions could all be improved. The use of bold and italics needs to be explained.

⇒ Only bold was used for the name of each column and row. We don't think further explanation is necessary.

Figures:

Figure 4 Is this not a 'smoothed' spectral density as indicated in the second part of the caption? How much smoothing?

⇒ The graph was drawn using the equations in the Salas's book (Salas et al. 1980). The smoothing function of Parzen (1967) was employed for smoothing. The sentence was improved accordingly.

Figure 5

The individual components should be labelled [Jan:Jan] etc.

⇒ There are no individual components. All the monthly data are illustrated in one panel. For example, $X(t)$ and $X(t+1)$ is the datasets of Jan-Feb, Feb-Mar, Mar-Apr..... etc.

Figure 6-9

These all should have x and y axes with appropriate scales.

These same comments apply to the second set of plots.

⇒ Those are modified accordingly.