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Interactive comment on "Assessment and Projection of Water Budget over Western Canada using Convection Permitting WRF Simulations" *by* Sopan Kurkute et al.

Sopan Kurkute et al.

yanping.li@usask.ca

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This study set up a high-resolution convection-permitting (CP) Weather Research and Forecast (WRF) model and applied this model to two large basins in Canada to evaluate the performance by comparing the simulated surface water budget and atmospheric moisture balance with three reanalysis datasets. Results show that High- resolution WRF in both river basins has much lower residual term of water budget compared with the reanalysis data. Additionally, the historical and future surface water budget and atmospheric moisture balance in study basins were investigated by the high-resolution WRF model. Admittedly, authors did a lot of

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work. Unfortunately, this manuscript read like a technical report not a paper due to lack of a scientific question. Even as a technical report, the organization of this manuscript still needs a substantial improvement and many details also needs to be supplemented (see below specific comments). Therefore, I am afraid that I can't recommend publication of the manuscript in HESS, at least in this version.

We thank the reviewer for providing helpful comments on improving our manuscript. Based on the two reviewer's comments, we have added the research context and the scientific questions we want to answer in the introduction. We hope with the revision and new organization of the manuscript the paper has been significantly improved.

Specific comments: 1. P6 Lines 4-6 ("This simulation was forced ..... (Dee et al., 2011))."), there are three reanalysis datasets collected in this study. Why do we only use ERA-Interim to force the WRF model?

We compared the water balance in WRF and the three reanalysis datasets. We only conducted the WRF simulations using only one set of reanalysis (ERA-Interim) because of the computation cost for a high-resolution convection-permitting climate simulation with a large domain. That is also part of the reason the pseudo-global warming method is used for future projection.

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2. P6 Lines 6-7 ("Tests showed that . . .. . .and the WRF domain"), this sentence reads abrupt. How to understand it? What are the tests? Why do we need the tests? Please provide more details for broader audi- ences.

We thank the reviewer to point out this abrupt sentence. Here, we tried to de-

scribe the setup of the WRF model without going into much detail. Instead of giving partial details that seems abrubt, we now decide that it is a better way to refer the readers to the model simulation evaluation/description paper [Li et al. 2019]. We now refer to the technical detail paper at the beginning of this section and hope the flow of the paper is improved by doing so.

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3. P6 Equation (1), this equation is confused. Does "ERA-Interim" represent one variable or two?

The ERA-Interim refers to all the essential variables that are modified including the air temperature, geopotential height, specific humidity, wind vector, soil moisture, soil temperature, etc. We now have emphasized this description right after the equation 1.

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4. P7 Lines 5-7 ("Reanalysis products . . .. . . play important roles"), this sentence is too long to understand. Please rewrite it.

This subsection has been removed and merged into the previous section per the comment 5. In the revised paper, the evaluation of the model control run WRF-CTL is referred to the evaluation paper Li et al. [2019].

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5. P7 section 2.3, why do we need this section? No efficient information is provided. After reading this section, I still don't know how to evaluate the WRF simulation in this study.

This subsection has been removed. Instead, we have provided the evaluation of the

precipiation and temperature of WRF-CTL simulation in the reference Li et al. [2019].

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6. P7 Lines 16-17 (“The sparse availability . . .. . . (Mesinger et al., 2006).”), there are two “over Canada” in this sentence and please delete the redundant one.

Thanks for pointing out this repeatedness. We have now revised away the redundant "over Canada".

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7. P9-10, “Q” in this study rep- resents two variables (i.e., runoff and the vertically integrated moisture flux). It is very confusing and please revise.

Thanks for noting this duplication in the representation of variables. We have changed the notation of vertically integrated moisture flux to "MF". Now, Q only stands for runoff.

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8. Fig.2-3, what do the “EVAP”, and “APCP” represent? They aren’t described in the text.

We thank the reviewer for catching this omission. "EVAP" stands for evapotranpiration and "APCP" stands for accumulated precipitation. We have added these descriptions in the captions of Figures 2 and 3.

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9. Fig. 6, what does the “MFLUX” mean? It isn’t also described in the text.

We thank the reviewer for catching this omission in the figure caption. "MFLUX" represents vertically integrated moisture flux convergence. We have added the definition in the caption of Fig. 6.

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10. There are lots of “WRF-CTL” and “WRF-PGW” in this manuscript. What are the meanings of them?

"WRF-CTL" is the control/retrospective climate simulation and "WRF-PGW" is the pseudo-global warming (PGW) simulation. We have added these definitions in the model simulation description in section 2.

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11. P26 Lines 15-16 (“For the surface water budget . . .. . . reanalysis datasets”), Even the high-resolution WRF has a significantly lower residual than the reanalysis datasets, does it mean the performance of WRF on simulating individual variable (e.g., runoff or evapotranspiration) is better than the reanalysis datasets? Or does it mean the simulated individual variable is closer to the real value. If not, how do we trust the following analysis?

We thank the reviewer for raising this question. As noted before, in the revised paper WRF-CTL’s performance on T and P is evaluated in Li et al. [2019]. Due to the crude representation of the land surface in these reanalysis datasets, WRF’s runoff and ET are better overall . Though WRF-CTL has a wet bias in MRB and SRB producing more runoff than observation, it should be noted the WRF runoff includes both surface runoff and underground runoff (drainage), which is different from what station gauge measures (surface runoff, stream flow).

Reference:

Li, Y., Li, Z., Zhang, Z., Chen, L., Kurkute, S., Scaff, L., and Pan, X.: High-resolution regional climate modeling and projection over western Canada using a weather research forecasting model with a pseudo-global warming approach, Hydrol. Earth Syst. Sci., 23, 4635–4659, https://doi.org/10.5194/hess-23-4635-2019, 2019.

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