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Hydrology and Earth System Sciences
Discussions

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

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Kurkute et al. produced high-resolution WRF simulation of RCP8.5 over two large watersheds in Canada. They evaluated the model performance and projected the futuree water budget. The topic of the study is interesting and timely, considering the local/regional assessment of climate change impacts. However, some issues within the manuscript require substantial improvement and further work. 1. The introduction is not well-designed and consistent with arguments. I could not find any clear research gap and authors did not talk about the novelty of this study. Each paragraph of this section stands alone, and there is no flow of information. Above all, this section is

wordy and in the end, I lost my mind to extract what they tried to do. I understand (after reading section 2) that dynamical downscaling was one of the important tasks they did; however, it is hard to get this message. Describing only evapotranspiration and precipitation as a water budget component is not enough in the introduction. Most importantly, how do you connect this paragraph with the previous and later paragraphs? I feel like this information here is redundant. Please maintain a continuous flow of information to tell a clear story. Please clearly mention what research gap you are trying to fill up. Is it only high-resolution data? Producing P, ET, Soil moisture and moisture flux spatial maps cannot be a significant contribution to science.

We thank the reviewer's great effort to provide constructive critiques and advice to improve the presentation of the manuscript. We acknowledge that the context of the research was not properly presented in the first version of the paper. Here we have revised the introduction of the paper to tell the story in a more coherent and meaningful way in the context of previous researches on the water balance and moisture fluxes in Mackenzie and Saskatchewan river basins. The description of uncertainties in evapotranspiration and precipitation observation is now put into the context of the difficulty in closing the water budget in observation. We also added a paragraph to describe the research gap we want to fill: 1. using a convection permitting model for the first time to delineate and compare the water budget in the two important basins and their subtle differences.;2. to show the projected changes in the water cycle in the two basins in a high-resolution simulation. The main focus of the paper is the water budget and moisture flux, the spatial maps are supplementary to the basin averaged statistics to show the difference in P,ET, soil moisture and moisture flux divergence in different months surrounding the growing season. We hope that's helpful for readers that are interested in the spatial distribution of future changes in each component.

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2. There are many ways available to evaluate the climate model performance (please

see IPCC working group 1, Chapter 9, 2013). The quantitative assessment is important; however, it is not convincing enough to draw a conclusion. The authors presented results (e.g., Figs. 2 & 3) at the temporal scale for the entire study area of 2560 km * 2800 km. I would say this is oversimplified. Then what is the point of doing high-resolution modeling, if you plot a single graph for the entire study area? Assessment at the spatial scale is imperative here. The authors need to support the assessment statistically. There are many performance metrics available in the literature.

We thank the reviewer to raise the question about model evaluation. We are fully aware of the importance of model evaluation. We have conducted temperature and precipitation in another paper [Li et al. 2019]. Unluckily, due to the lack of large-scale trustworthy observation dataset for other components (e.g., ET, SWE), it is difficult to conduct evaluations for these components. Since the focus of the paper is the moisture budget over the two main basins, we mainly conducted basin averaged analysis. However, our research shows that even for the basin averaged statistics, such as basin moisture flux convergence, high-resolution matters to more realistically represent the sharp orographic precipitation processes and convections. We did show detailed spatial distributions of water cycle components in section 3.3 for current and future climate (Figs. 9-12).

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3. The results section is also wordy. I would recommend reducing the length of the paper. For example, what is the necessity of writing the first sentence of Section 3 ('Figure 2 presents the surface water budget in MRB')? This manuscript can be shorten to half of its current length without destroying the quality.

We thank the reviewer for pointing out the wordiness of this section. We have removed

many sentences/phrases that are considered redundant.

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4. Please, use different notation instead of 'Q' in the equation (4) as it creates confusion with the runoff of equation (3).

We have changed the notation for moisture flux to "MF". Now, Q only stands for runoff.

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5. Please use the same y-limit for all figures so that readers can easily compare results. Fonts are not readable in Figures 9-12. These figure titles need more description (e.g., what temporal scale you covered for these figures?). Thank you.

We thank the reviewer for these suggestions on improving the figures. We have made the adjustments accordingly and added descriptions in the caption.

References:

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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