

## ***Interactive comment on “Modeling groundwater responses to climate change in the Prairie Pothole Region” by Z. Zhang et al.***

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### General Comments

This manuscript describes a land surface model linked to a basic groundwater model to investigate water table depth across the Prairie Pothole Region of North America. The coupled model is first used to represent recent conditions (2000 to 2013), then a future climate scenario. The manuscript addresses a relevant question regarding the hydrology of a large region, and presents a method that would be applicable in other regions. The findings are interesting and would be of interest to researchers working in smaller areas within the Prairie Pothole Region. The approach demonstrates how cold region processes can be considered in large scale models that include a basic

C1

groundwater component.

### Specific Comments

There are 3 specific comments that warrant more attention:

1) One finding of the study is that simulated water table depth is sensitive to parameterization of the soil properties, which were input from a global dataset. The authors indicate that replacing some of the default soil type parameters with more location-specific information improves the match between simulated and observed water table depth (lines 448-453). This is great to see; however, there is no indication of the difference to the future climate scenario and water budget. The net effect on the primary question (i.e. future climate) is needed for completion. How much does the REP approach change the conclusions regarding distribution of recharge under the future climate? Addressing this issue would help the authors convey how important the fine-scale properties might be.

2) The culling criteria for groundwater observation data may have been a bit ruthless. To end up with only 7% of the potential observation data seems quite aggressive. Whilst I don't disagree with the culling criteria, it would be helpful to have some additional points for spatial coverage that could be considered a “secondary” dataset (e.g. reported as supplemental material). To better understand (and accept) the culling procedure, some additional details are needed in lines 164-166. What is meant by a “sufficiently long record”? (provide an example or specify the timeframe). How were anthropogenic effects considered? Why was 7m selected as a cut off? Relaxing these criteria even just a little will increase the spatial coverage of your observation data.

3) Related to the culling criteria, we evaluated the Alberta groundwater observation well data in a comparison with GRACE (Huang et al. 2016, Hydrogeology Journal v24, 1663-1680). You might be able to use Table 1 from that paper to increase the number of observation records. Also, you might be able to incorporate the GRACE comparison to water level data into your discussion and conclusions.

C2

## Technical Corrections

L17: Typo “on groundwater recharge rates”

L21: Is “mismatch” really the correct term? What you’re describing is a parameter that is not represented in the model adequately. The resultant water table depth is mismatched, but the parameter is misrepresented.

L23: Type “delaying the time. . .”

L47: A reference for the general concept of recharge and frozen soil would be useful (e.g. Hayashi)

L61: Typo “discharge to rivers”

L64-65: Suggested edit “. . . snowmelt recharge to reach the water table, the previously upward water movement by capillary effect to reverse and move downwards, and allow the water table to rise to. . .”

L66: Suggest removing “and desiccates the soil”, as this starts to invoke ideas of seasonally varying parameters.

L76: Provide a reference for the 5-40mm/yr example.

L80: Typo “. . . this is challenging to represent in current. . .”

L85: Typo “suggested”

L97: Typo “groundwater models”

L128: What is meant by “groundwater evolution”? Do you simply mean water table dynamics?

L143: Typo “. . . from the WRF. . .”

L148: You might want to mention that most of the observation well data will be biased toward more permeable deposits (e.g. sand and gravel). Typically, provincial and state

C3

agencies don’t monitor low permeability formation.

L153: Alberta Environment and Parks

L164: Provide an example timeframe

L165: How was anthropogenic effect determined?

L259: Add “in the PPR” to the end of this sentence

L285-288: The model initialization process is unclear. Spin up times of 500 years and 4 years are mentioned here. Is the 4 yr period simply to account for grid size difference, and essentially following the 500 yr spin up in the previous model?

L317-318: Relation to Amazon with is not relevant and totally looks like self-citation here. The concept of infiltration response is pretty basic.

L321: By “out-of-the-box” do you simply mean “uncalibrated”?

L323: Instead of “further study” do you mean “preliminary study”, because later in the manuscript modified parameters are used (i.e. REP) Section 3.2 and 3.3: A little bit of set-up is needed here. Are the results presented averages over a certain period? What timeframe for the water budget components correspond to? (3 months)

L425: Typo “. . . in the locations of the observations well.”

L448-453: This section kinda teases the reader. How do the future scenario results look with the REP parameters?

L520: Typo “As a result. . .”

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C4