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Hydrology and Earth System Sciences
Discussions

Interactive comment on "Physics-inspired integrated space-time Artificial Neural Networks for regional groundwater flow modeling" *by* Ali Ghaseminejad and Venkatesh Uddameri

Anonymous Referee #2

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The manuscript presents an integrated space-time approach for predicting one-year ahead groundwater head at multiple locations using artificial neural networks. The idea is certainly interesting and relevant for the scope of the Journal. The document is well written and the area of investigation is of extreme relevance, given the strong depletion characterizing the Southern High Plains since predevelopment.

I have only minors comments, that the authors can find below:

0- Title: considering the experiment 'physically inspired' might be a little bit of a stretch. Methodologically, the study is purely a data-driven modeling exercise with the introduction of a spatial component (the coordinates and of the neighboring wells) in the input

set.

1- In the introduction, some of the most recent applications of hybrid data-driven models including a spatial component are missing:

Among them, Varouchakis et al., 2019:

Varouchakis, E. A., Theodoridou, P. G., & Karatzas, G. P. (2019). Spatiotemporal geostatistical modeling of groundwater levels under a Bayesian framework using means of physical background. Journal of Hydrology, 575, 487-498

This citation can be of particular relevance since it partially addresses the 'Two-stage (ANN + interpolation) models for predicting spatiotemporal variability of groundwater levels are conceptually intuitive and pragmatic. However, this approach has limited fidelity to the groundwater system it intends to model.' issue presented by the authors.

Another recent application of spatial integration in data-driven groundwater modeling in a similar case study is constituted by Amaranto et al., 2019:

Amaranto, A., MunozâĂŘArriola, F., Solomatine, D. P., & Corzo, G. (2019). A spatially enhanced dataâĂŘdriven multimodel to improve semiseasonal groundwater forecasts in the High Plains aquifer, USA. Water Resources Research, 55(7), 5941-5961.

Furthermore, it is worth mentioning how Mohanty et al., (2014) developed a model for the forecasting of GW level at multiple sites:

Mohanty, S., Jha, M. K., Raul, S. K., Panda, R. K., & Sudheer, K. P. (2015). Using artificial neural network approach for simultaneous forecasting of weekly groundwater levels at multiple sites. Water Resources Management, 29(15), 5521-5532.

2 - Overall, the methodology is well presented but could benefit from the integration of an additional section, or a flowchart, explaining how the different methodological steps are interconnected to each other.

3-In the case study description, one could find interesting a comparison between the

southern portion of the High Plains Aquifer (or Ogalalla) and the remaining part. In this regard, it would also be worth mentioning some hydro-meteorological aspects that are afterward used in contextualizing results (low recharge rate etc).

4- Point comments:

Line 11 'Incorporation of spatial variability was more critical then capturing groundwater level persistence'. Not very clear

Line 256: were deemed sufficient based on autocorrelation analysis. Would be nice to see some values

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