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Interactive comment on "Bayesian Network Model for Flood Forecasting Based on Atmospheric Ensemble Forecasts" *by* Leila Goodarzi et al.

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We would like to express our sincere gratitude for the insightful comments. Please see below the responses to the comments, on behalf of the authors.

Comment 1:

"I have doubts about the reliability of those approaches compared to traditional methodologies, specifically the use of post-processing ensemble weather forecast as input of a distributed or lumped hydrological model. Usually, hydrological models are calibrated and validated for a long enough time-period, which ensure that they capture a wide range of hydrological conditions, including episodic floods. In this case, on the other hand, they were used 14 flood events to train and verified a BN and an ANN. Consid-

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Discussion paper

ering the large number of parameters those approaches include, a good performance and accuracy is expected. Under such circumstances, however, the risk of generating over parameterized models is significant. Although I recognize that flood events are statistically rare, it is important to demonstrate that the BN is able to capture a larger number of floods events."

Response 1:

The data sample is relatively small due to the following reasons: 1) NCEP (GFS - FNL) data are not available for some historical storms. 2) During the above-mentioned period, a small number of actual flood events occurred in the study area, since the basin is located in a semi-arid region. Considering the relatively small sample size, we proposed using the BN that is less sensitive to small data set size in comparison with ANN. We are aware that using a BN instead of a hydrological model does not remove the need for data, and we agree that data about flood events are scarce by nature. However, the number of parameters of a BN is not that high compared to distributed hydrological models. Our study is a proof of concept at the current stage that flood warnings can be done by evaluating hydrological pre-conditions and meteorological ensembles by a trained BN instead of a hydrological model. We do not yet promise that the method works in general, and further work must be done, thus we recommended future tests in the conclusions. We discussed our results accordingly. However, with the limitations described, the validation of the BN is given by the proof of better performance than the ANN. A very useful advantage of BN is that there are no minimum sample data sizes needed to perform the analysis, and BN take into account the complete data set (Myllymaki et al., 2002). In addition, Kontkanen et al. (1997) demonstrate that BN can show good accuracy of prediction even with rather small data set and Zhang and Bivens (2007) showed that BN is less sensitive to small data set size in comparison with ANN. The above paragraph will be added to paper.

Comment 2:

"Perhaps a suggestion to overcome such limitations is to analyze a longer period of time to incorporate a larger number of flood events, and using observed rainfall instead of ensemble weather forecast (which are difficult to implement) to test whether the BN performs adequately."

Response 2:

The purpose of this study is to develop a flood warning based on Atmospheric Ensemble Forecasts. BN model's input are Atmospheric Ensemble Forecasts and in case of using the observed rainfall, we have only a deterministic forecasting not the ensemble forecasting and that is why we didn't use the observed rainfall in our study. A BN trained against observation would not be comparable with the training against forecast ensembles. In the outlook of the article, we propose other steps to increase the confidence in the BN by increasing the lead time in large watersheds, using different cumulus schemes, etc.

Comment 3:

"It is well known that atmospheric models have acceptable skill scores for up to 4-5 days. Increasing the lead time will provide an opportunity for testing the use of BN for a larger number of cases."

Response 3:

Increasing the lead time will provide new cases but in this case we have two different sources of error: one is the different lead time (the accuracy of the numerical weather prediction would not be comparable to a single day lead time) and another source is the BN model, so we cannot realize the source of the error. In other words, we cannot determine that the forecasting error is because of the high lead time or the proposed BN model. Also, our study is conducted in a small basin, where a lead time of one day is considered sufficient and adequate. Longer lead times are more important for large watersheds, but there is a different ratio between meteorological and hydrological

effects. Thus, our method is designed for, and limited to, smaller headwater basins with short lead time. We will make this clearer in the final manuscript.

Once again, we wish to express our highest appreciation to the reviewers for their comments. We provided a first study of a new method in flood warning, which still has some limitations and much further work is required to get more insights and knowledge about general applicability. We hope the manuscript will suit the Journal Natural Hazards and Earth System Sciences and we are happy to provide a revised manuscript. We thank you for your continued interest in our research.

Yours sincerely

The Authors

References:

Li, J., Chen, Y., Wang, H., Qin, J., Li, J., & Chiao, S. (2017). Extending flood forecasting lead time in a large watershed by coupling WRF QPF with a distributed hydrological model. Hydrology and Earth System Sciences, 21(2), 1279-1294. Myllymaki, P., Silander, T., Tirri, H., and Uronen, P. (2002). B-Course: a web-based tool for Bayesian and causal data analysis. Int. J. Artif. Intell. Tools 11 (3), 369–387, doi: 10.1142/s0218213002000940. Kontkanen, P., Myllymaki, P., Silander, T., and Tirri, H. (1997). Comparing predictive inference methods for discrete domains. In: Proceedings of the sixth International Workshop on Artificial Intelligence and Statistics, Ft. Lauderdale, USA, 311–318. Zhang, R. and Bivens, A.J. (2007). Comparing the use of bayesian networks and neural networks in response time modeling for service-oriented systems. In: Proceedings of the 2007 workshop on Service-oriented computing performance: aspects, issues, and approaches (pp. 67-74). ACM.

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