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Hydrology and Earth System Sciences Discussions

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Interactive Comment

Interactive comment on "Daily reservoir inflow forecasting combining QPF into ANNs model" *by* Jun Zhang et al.

Jun Zhang et al.

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The authors would like to thank Referee #2 for his/her valuable and constructive comments. The review puts forth several specific comments and technical corrections. All technical corrections suggested by the reviewer will be adopted in revised manuscript. This is a short response to some of the specific comments.

Major issues:

Comment:

1) By using ANN, the authors have assumed that the system is nonlinear, hence it would be impropriate to use ACF and CCF for identifying the input variables. ACF and CCF are tools suitable for time series analysis and help to identify linear models. For nonlinear models, you should use trail and error of different variable combinations to

get the suitable past flow and rainfall inputs.

Response:

We agree with Referee #2 about that ACF and CCF are tools suitable for time series analysis and help to identify linear models, and trail and error is one valid method to decide the inputs of ANNs. However, Sudheer et al. (2002) provided a nice illustration of ACF and CCF for constructing artificial neural network rainfall-runoff models. Actually, in 1999, CCF was used to examine the contribution of rainfall to flow (Campolo et al., 1999). Further, Jain (2005) suggested that auto-correlation functions (ACF), partial autocorrelation functions (PACF) and cross-correlation functions (CCF) can be used to decide on the number of significant explanatory variables to be considered in the ANNs model. So, ACF and CCF, in our opinion, are also suitable for selecting inputs of ANNs model. Trail and error method is used to determine the nodes number in hidden layer of ANNs.

Comment:

2) Even for linear models, the authors misused the information from ACF and CCF. In Fig 2, the authors simply assumed only one past flow was needed in the model because it had the largest ACF. This is wrong. The past flow after that also has useful information to contribute (ACF=0.7).

Response:

The authors wish to thank Referee #2 for clarifying this misuse and we will correct it in revised version.

Comment:

3) There is no need to plot CCF for positive lags since there is no causal-effect relationship between the future rain and past flow.

Response:

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The CCF figure will be improved in revised version.

Comment:

4) The selection for ANN input variables is not convincing. On Page 127, there is no justification for including P(30) and Q(30) (why not P(5), P(10), ..Q(5), Q(10),...). If a forecast is done at time t, there must be Q(t) available, but authors only used Q(t-1) to predict Q(t+1). Q(t) mysteriously disappeared in the calculations. Also, it seems more rainfall inputs were added in ANN input nodes without justifications (Eq (1), two rainfall inputs, Eq(3) 5 rainfall inputs, why? If 5 rainfall inputs are needed, Eq(1) should add P(t-3), P(t-4), ...)

Response:

As the reply to Referee #1, considering our forecasting horizon is within mid-term including several days, mean values of observed rainfall and discharge of too long days are not necessary. Based on the basin characteristics, '30 days' was determinated by the forecasting operators in Fujian Power Grid by their experiences. This aspect will be deserved a further study.

The forecast time origin is 't', but Q(t) is not available at the forecasting time and it is one of forecasting objectives. Actually, the QPFs information is released at 08:00 a.m. every day as we described in the manuscript (see line 18, page 126, indicated hereinafter in this response by the convention 18/126). The forecasting is automatically carried out after this release in time and the forecasting results are delivered immediately to the 'operation department' of Fujian Power Grid Company for daily planning and scheduling of hydro-electric power system based on a multireservoir system optimal operation calculation. Because scheduling is for next 7 days including 't+0'-'t+6' while the QPFs information is for next 3 days including 't+0'-'t+2', we designed four models named model(t+0), model(t+1), model(t+2), model(t+3) to use different QPFs information for the forecasting. Forecastings for next 't+0'-'t+2' are based on model(t+0), model(t+1) and model(t+2) respectively. Therefore, the numbers of rainfall inputs for each model

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are different.

Comment:

5) Figures 7 and 8 are supposed to be for a flow forecasting system , but the presented results were only for hind-casting. They just look like past event analysis software (with both measured and model flow displayed). Generally, this part of the content is not useful to other readers and should be removed from the manuscript.

Response:

Figure 7 illustrates the auto forecasting module, the core module of web-based daily reservoir inflow forecasting system (WDRIFS) we developed for Fujian Power Grid. Figure 7 shows the auto forecasting interface in which the auto forecasting plans and the QPF information together with the observed data for following six days are listed in one table. Figure 8 checks the historical forecasting results in graphics mode by which the performances of ANNs models can be examined. 'Software implementation' section will be adjusted as an appendix in revised version.

Comment:

6) Although reservoir is mentioned many times in the paper, the methodology described is just a rainfall runoff modelling, so the description of how important of the reservoirs is not very relevant. It seems that cascade reservoir operations are not included in the calculations. This is wrong. At least the reservoir routing effect should be considered since its calculation is very easy and accurate. If some of the reservoirs are controlled by gates, they would have a huge impact to downstream flows.

Response:

Inflow forecasting for reservoirs with lead times of several days, from the viewpoint of power system, is significant to the operational planning and scheduling of power system in which hydropower plays an important role such as Fujian Power Grid system in China. Traditional, inflow forecasting for reservoirs is mainly based on historical flow

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and rainfall, and the forecasting results could not achieve the request of operational planning and scheduling, especially in terms of lead time. In this manuscript, the QPFs information is employed as an excessive input factor to improve the forecasting.

In this manuscript, the forecasting objective we focused on is interval inflow rather than total inflow of Shuikou reservoir. Impact from upstream reservoirs only affects total inflow and this impact should be considered in the multireservoir system operation phase, which is not within the scope of this manuscript.

Minor issues

Comment:

1) P127, it is confusing to use symbol 'i'; for two purposes: For every day t, four ML-PANNs models, namely Model(t+i) i=0, 1, 2, 3, are developed for the daily reservoir inflow forecasting with lead-times (represented by symbol i) varying from 1 to 6 days;

Response: All symbols will be examined and corrected to avoid confusion in revised version.

Comment:

2) It would be useful to include some further information on QPF (data spatial and temporal resolution, domain size, data availability). You may also compare QPF with rain gauge data to check their quality.

Response: We agree with Referee #2 and Referee #1 about that estimation of the QPFs may considerably influence the uncertainties in the inflow forecasts and this aspect is very interesting issue deserved investigation. But at present, information about QPFs for us is limited for several reasons. More relevant information will be added in revised version and more detailed analysis will be accomplished in a further study.

Comment:

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3) Although the English in the paper should be understandable by international readers, it is still desirable to have the manuscript polished to remove some non-idiomatic words.

Response: We will make a professional consultation about English expression and polish our manuscript. All incorrect usages and inappropriate expresses will be corrected in revised version.

Once again, we would like to Referee #2 for the valuable review.

References used in this response:

Campolo, M., P. Andreussi, and Soldati, A., River Flood Forecasting with a Neural Network Model, Water Resour. Res., 35(4), 1191-1197, 1999.

Jain, A.: Comment on 'Comparison of static-feedforward and dynamic-feedback neural networks for rainfall-runoff modeling' by Y.M. Chiang, L.C. Chang, and F.J. Chang, 2004. J. Hydrol., 290 (3-4), 297-311, J. Hydrol., 314, 207-211, 2005.

Sudheer, K. P., Gosain, A. K., and Ramasastri, K. S.: A data-driven algorithm for constructing artificial neural network rainfall-runoff models, Hydrol. Process., 16, 1325-1330, 2002.

Interactive comment on Hydrol. Earth Syst. Sci. Discuss., 6, 121, 2009.