Geophysical Research Abstracts
Vol. 14, EGU2012-6677-1, 2012
EGU General Assembly 2012

Comparison of three methods for the optimal allocation of hydrological model participation in an Ensemble Prediction System

D. Brochero (1,2), F. Anctil (1), and C. Gagné (2)

(1) Université Laval, Chaire de recherche EDS en prévisions et actions hydrologiques, Department of Civil and Water Engineering, Quebec, Canada, (2) Université Laval, Computer Vision and Systems Laboratory (CVSL), Department of Electrical Engineering and Computer Engineering, Quebec, Canada

Today, the availability of the Meteorological Ensemble Prediction Systems (MEPS) and its subsequent coupling with multiple hydrological models offer the possibility of building Hydrological Ensemble Prediction Systems (HEPS) consisting of a large number of members. However, this task is complex both in terms of the coupling of information and of the computational time, which may create an operational barrier. The evaluation of the prominence of each hydrological members can be seen as a non-parametric post-processing stage that seeks finding the optimal participation of the hydrological models (in a fashion similar to the Bayesian model averaging technique), maintaining or improving the quality of a probabilistic forecasts based on only x members drawn from a super ensemble of d members, thus allowing the reduction of the task required to issue the probabilistic forecast.

The main objective of the current work consists in assessing the degree of simplification (reduction of the number of hydrological members) that can be achieved with a HEPS configured using 16 lumped hydrological models driven by the 50 weather ensemble forecasts from the European Centre for Medium-range Weather Forecasts (ECMWF), i.e. an 800-member HEPS. In a previous work (Brochero et al., 2011a, b), we demonstrated that the proportion of members allocated to each hydrological model is a sufficient criterion to reduce the number of hydrological members while improving the balance of the scores, taking into account interchangeability of the ECMWF MEPS.

Here, we compare the proportion of members allocated to each hydrological model derived from three non-parametric techniques: correlation analysis of hydrological members, Backward Greedy Selection (BGS) and Nondominated Sorting Genetic Algorithm (NSGA II). The last two techniques allude to techniques developed in machine learning, in a multicriteria framework exploiting the relationship between bias, reliability, and the number of members of the probabilistic prediction. To compare the results of the simplified scheme with respect to the 800 original members and the techniques used in the selection criteria we use a weighted criterion in which each score in the selected ensemble of hydrological members is normalized from the division by the corresponding score in the initial 800-member HEPS, placing each component on the same scale.

Performance is based on the application of the member selection to a neighboring basin, providing a rigorous test. In general, we see that there is a relationship between the quality of the ensemble prediction and the number of hydrological members that represent different scenarios, as well as the complex balance between the bias represented by the mean ignorance score and the reliability represented by the error in the reliability diagram.

Although intuitively attractive and simpler to implement, member elimination based on correlation is detrimental to the system reliability and consistency. Both BGS and NSGA II provide high performance simplifications. However, the NSGA II is more descriptive than BGS, since it provides the Pareto front of selections, which leaves the modeller the choice of the weight allocated to the different characteristics assessed in the probabilistic forecast.

References

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