Geophysical Research Abstracts
Vol. 12, EGU2010-4929, 2010
EGU General Assembly 2010

Comparison of the performance and reliability of 18 lumped hydrological models driven by ECMWF rainfall ensemble forecasts: a case study on 29 French catchments

Juan Alberto Velázquez (1), François Anctil (1), Maria-Helena Ramos (2), and Charles Perrin (2)
(1) Chaire de recherche EDS en prévisions et actions hydrologiques, Université Laval, Génie civil, Québec, Canada (francois.anctil@gci.ulaval.ca), (2) Cemagref, Hydrosystems and Bioprocesses Research Unit, Antony, France

An ensemble forecasting system seeks to assess and to communicate the uncertainty of hydrological predictions by proposing, at each time step, an ensemble of forecasts from which one can estimate the probability distribution of the predictant (the probabilistic forecast), in contrast with a single estimate of the flow, for which no distribution is obtainable (the deterministic forecast).

In the past years, efforts towards the development of probabilistic hydrological prediction systems were made with the adoption of ensembles of numerical weather predictions (NWPs). The additional information provided by the different available Ensemble Prediction Systems (EPS) was evaluated in a hydrological context on various case studies (see the review by Cloke and Pappenberger, 2009). For example, the European ECMWF-EPS was explored in case studies by Roulin et al. (2005), Bartholmes et al. (2005), Jaun et al. (2008), and Renner et al. (2009). The Canadian EC-EPS was also evaluated by Velázquez et al. (2009). Most of these case studies investigate the ensemble predictions of a given hydrological model, set up over a limited number of catchments. Uncertainty from weather predictions is assessed through the use of meteorological ensembles. However, uncertainty from the tested hydrological model and statistical robustness of the forecasting system when coping with different hydro-meteorological conditions are less frequently evaluated.

The aim of this study is to evaluate and compare the performance and the reliability of 18 lumped hydrological models applied to a large number of catchments in an operational ensemble forecasting context. Some of these models were evaluated in a previous study (Perrin et al. 2001) for their ability to simulate streamflow. Results demonstrated that very simple models can achieve a level of performance almost as high (sometimes higher) as models with more parameters. In the present study, we focus on the ability of the hydrological models to provide reliable probabilistic forecasts of streamflow, based on ensemble weather predictions. The models were therefore adapted to run in a forecasting mode, i.e., to update initial conditions according to the last observed discharge at the time of the forecast, and to cope with ensemble weather scenarios. All models are lumped, i.e., the hydrological behavior is integrated over the spatial scale of the catchment, and run at daily time steps. The complexity of tested models varies between 3 and 13 parameters. The models are tested on 29 French catchments. Daily streamflow time series extend over 17 months, from March 2005 to July 2006. Catchment areas range between 1470 km2 and 9390 km2, and represent a variety of hydrological and meteorological conditions. The 12 UTC 10-day ECMWF rainfall ensemble (51 members) was used, which led to daily streamflow forecasts for a 9-day lead time.

In order to assess the performance and reliability of the hydrological ensemble predictions, we computed the Continuous Ranked probability Score (CRPS) (Matheson and Winkler, 1976), as well as the reliability diagram (e.g. Wilks, 1995) and the rank histogram (Talagrand et al., 1999). Since the ECMWF deterministic forecasts are also available, the performance of the hydrological forecasting systems was also evaluated by comparing the deterministic score (MAE) with the probabilistic score (CRPS). The results obtained for the 18 hydrological models and the 29 studied catchments are discussed in the perspective of improving the operational use of ensemble forecasting in hydrology.

References

Bartholmes, J. and Todini, E.: Coupling meteorological and hydrological models for flood forecasting, Hydrol. Earth Syst. Sci., 9, 333–346, 2005.

Cloke, H. and Pappenberger, F.: Ensemble Flood Forecasting: A Review. Journal of Hydrology 375 (3-4): 613-626, 2009.

Jaun, S., Ahrens, B., Walser, A., Ewen, T., and Schär, C.: A probabilistic view on the August 2005 floods in the upper Rhine catchment, Nat. Hazards Earth Syst. Sci., 8, 281–291, 2008.

Matheson, J. E. and Winkler, R. L.: Scoring rules for continuous probability distributions, Manage Sci., 22, 1087–1096, 1976.

Perrin, C., Michel C. and Andréassian,V. Does a large number of parameters enhance model performance? Comparative assessment of common catchment model structures on 429 catchments, J. Hydrol., 242, 275-301, 2001.

Renner, M., Werner, M. G. F., Rademacher, S., and Sprokkereef, E.: Verification of ensemble flow forecast for the River Rhine, J. Hydrol., 376, 463–475, 2009.

Roulin, E. and Vannitsem, S.: Skill of medium-range hydrological ensemble predictions, J. Hydrometeorol., 6, 729–744, 2005.

Talagrand, O., Vautard, R., and Strauss, B.: Evaluation of the probabilistic prediction systems, in: Proceedings, ECMWF Workshop on Predictability, Shinfield Park, Reading, Berkshire, ECMWF, 1–25, 1999.

Velázquez, J.A., Petit, T., Lavoie, A., Boucher M.-A., Turcotte R., Fortin V., and Anctil, F. : An evaluation of the Canadian global meteorological ensemble prediction system for short-term hydrological forecasting, Hydrol. Earth Syst. Sci., 13, 2221–2231, 2009.

Wilks, D. S.: Statistical Methods in the Atmospheric Sciences, Academic Press, San Diego, CA, 465 pp., 1995.