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Predictability of soil moisture and river discharge over France for the Spring season

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Water resources are unevenly distributed in space and time. Water resource managers thus need decision support tools, such as seasonal forecasts of river flows or soil wetness, in order to anticipate the future water availability for hydropower, water supply or irrigation purposes. A first evaluation of an hydrometeorological seasonal forecasting suite has recently been performed over France for the Spring season (March-April-May period) with a one-month lead-time (Céron et al, 2010). The hydrometeorological suite Safran-Isba-Modcou has been driven by the DEMETER atmospheric seasonal forecasts. Results showed the feasibility of hydrological forecasts over the 1971-2001 period and scores were better for hydrological than atmospheric variables in four large river catchments.

In the present study, the sources of predictability of the hydrological system were studied in a comprehensive way over the whole of France over the period 1960-2005, which corresponds to the availability of the ENSEMBLES seasonal hindcasts (Weisheimer et al, 2009). The hydrological forecasts were compared to a reference run of the Safran-Isba-Modcou hydrometeorological model driven by meteorological observations. In order to test the impact of the relative importance of the land surface initial state and the atmospheric forecast, two experiments were set up. In the first one (called Random Atmospheric Forcing, RAF), the initial state of the hydrological system on the 1st February was given by the Safran-Isba-Modcou reference run. A 9-member ensemble of atmospheric forcings was built using 9 randomly chosen years of the climatology. In the second experiment (Random land surface Initial States), the atmospheric forcing came from the Safran reanalysis. The members differed only by their initial state, randomly chosen in the Safran-Isba-Modcou climatology. Scores were calculated on soil moisture and river flows forecasts over France, respectively over a 8-km grid and at more than 900 hydrometric stations. These experiments allowed us to highlight that hydrological predictability in Spring mainly depends on snow cover over mountains, whereas it primarily depends on atmospheric forcing (mostly temperature and total precipitation) over the plains. The Seine river basin makes exception as the predictability mainly comes from the initial state of its large aquifer that sustains surface flows.

Finally, the hydrometeorological suite has been forced with the 1960-2005 seasonal hindcasts of the Météo-France ARPEGE model from the ENSEMBLES simulations (Weisheimer et al, 2009). Scores similar to the RAF experiment were obtained, suggesting that atmospheric forecasts could be improved.

Céron J-P, Tanguy G, Franchistéguy L, Martin E, Regimbeau F and Vidal J-P, 2010. Hydrological seasonal forecast over France : feasibility and prospects. Atmospheric Science Letters, 11, 78-82. DOI: 10.1002/asl.256

Weisheimer A, Doblas-Reyes FJ, Palmer TN, Alessandri A, Arribas A, Déqué M, Keenlyside N, MacVean M, Navarra A and Rogel P, 2009. ENSEMBLES: A new multi-model ensemble for seasonal-to-annual predictions—Skill and progress beyond DEMETER in forecasting tropical Pacific SSTs. Geophysical. Research. Letters, 36, L21711. DOI:10.1029/2009GL040896.