Geophysical Research Abstracts
Vol. 16, EGU2014-10451, 2014
EGU General Assembly 2014

A Bayesian fingerprinting analysis for detection and attribution of changes in extreme flows

Yeshewatesfa Hundecha (1), Bruno Merz (2), Rui A. P. Perdigão (3), Sergiy Vorogushyn (2), Alberto Viglione (3), and Günter Blöschl (3)

(1) Swedish Meteorological and Hydrological Institute (SMHI), Norrköping, Sweden, (2) Helmholtz Zentrum, Potsdam, Germany, (3) Vienna University of Technology, Institute of Hydraulic Engineering and Water Resources Management, Vienna, Austria

Fingerprinting analysis has widely been used in the detection and attribution problem within the climate community over the past several decades. In the approach, a field of certain observed climate indicator is represented as a linear model of a signal pattern (fingerprint) that is simulated by a climate model under external forcing plus a noise field, which represents a realisation of the internal climate variability. A scaling factor is introduced to adjust the amplitude of the signal pattern so that it matches the observations well. In the approach, the scaling factor is optimally estimated to maximise the signal-to-noise ratio, thereby increasing detectability of the signal due to a forced climate change.

Many of the fingerprinting analyses that are reported in the literature are framed on the classical statistical theory. Such an approach can give reliable results under the condition that the natural variability of the system and the uncertainties in the predicted signals under a given forcing can be quantified. If these uncertainties cannot be objectively estimated, interpretation of the results will mainly be guided by a subjective judgement. Recent analyses have made a shift towards a Bayesian approach, which provides a quantitative framework for the integration of subjective prior information on the uncertainties into the statistical detection and attribution problem. Hasselmann (1998) reviews the fingerprinting approach that is based on the classical statistical framework and presents generalisation of the approach to a Bayesian framework. Berliner et al. (2000) also presents a formal Bayesian fingerprinting analytical framework for the detection and attribution problem.

The potential applicability of the fingerprinting approach to the detection and attribution problem of extreme flows has been discussed in the opinion paper by Merz et al. (2012). Hundecha and Merz (2012) have also implemented an approach that is similar to the fingerprinting approach under the classical statistical framework to detect and attribute trends in the seasonal extreme flows to components of surface meteorological drivers.

We now propose to extend the work of Hundecha and Merz (2012) using the Bayesian fingerprinting approach as outlined in Berliner et al. (2000). We use the seasonal maximum flows at a few selected stations, where the seasonal extremes show significant trends. Analogous to the forced climate simulations, we use seasonal extreme flows simulated by a hydrologic model forced by synthetic climate variables generated by a weather generator using non-stationary distributions of the individual climate variables consistent with the changes in the distributions of the observational data. These simulated values are used to identify the changes in extreme flows, which are attributable to changes in the distributions of the climate variables. As a proxy to the natural variability, we use simulated seasonal extremes under a stationary climate by using constant distributions to the climate variables. Additional forcings, such as river works, can also be included if they can be readily available.

Berliner, L.M., Levine, R.A., and D.J. Shea (2000), Bayesian Climate Change Assessment, J. Climate, 13, 3805-3820.

Hasselmann, K. (1998), Conventional and Bayesian approach to climate-change detection and attribution, Quart. J. Roy. Meteor. Soc., 124, 2541-2565.

Hundecha, Y., and B. Merz (2012), Exploring the relationship between changes in climate and floods using a model-based analysis, Water Resour. Res., 48, W04512, doi:10.1029/2011WR010527.

Merz, B., Vorogushyn, S., Uhlemann, S., Delgado, J., and Y. Hundecha (2012), HESS Opinion,More efforts and scientific rigour are needed to attribute trends in flood time series'. HESS, 16,5,1379-1387.