Geophysical Research Abstracts
Vol. 18, EGU2016-14968, 2016
EGU General Assembly 2016

A Cascade Approach to Uncertainty Estimation for the Hydrological Simulation of Droughts

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Uncertainty poses a significant challenge in environmental research and the characterisation and quantification of uncertainty has become a research priority over the past decade. Studies of extreme events are particularly affected by issues of uncertainty. This study focusses on the sources of uncertainty in the modelling of streamflow droughts in the United Kingdom. Droughts are a poorly understood natural hazard with no universally accepted definition. Meteorological, hydrological and agricultural droughts have different meanings and vary both spatially and temporally, yet each is inextricably linked.

The work presented here is part of two extensive interdisciplinary projects investigating drought reconstruction and drought forecasting capabilities in the UK. Lumped catchment models are applied to simulate streamflow drought, and uncertainties from 5 different sources are investigated: climate input data, potential evapotranspiration (PET) method, hydrological model, within model structure, and model parameterisation. Latin Hypercube sampling is applied to develop large parameter ensembles for each model structure which are run using parallel computing on a high performance computer cluster. Parameterisations are assessed using a multi-objective evaluation criteria which includes both general and drought performance metrics. The effect of different climate input data and PET methods on model output is then considered using the accepted model parameterisations. The uncertainty from each of the sources creates a cascade, and when presented as such the relative importance of each aspect of uncertainty can be determined.