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Regional frequency analysis conditioned on large-scale atmospheric or oceanic fields

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Many studies report that hydrologic regimes are modulated by large-scale modes of climate variability such as the El Niño Southern Oscillation (ENSO) or the North Atlantic Oscillation (NAO). Climate-informed frequency analysis models have therefore been proposed to condition the distribution of hydrologic variables on climate indices. However, standard climate indices may be poor predictors in some regions. This paper therefore describes a regional frequency analysis framework that conditions the distribution of hydrologic variables directly on atmospheric or oceanic fields, as opposed to predefined climate indices.

This framework is based on a 2-level probabilistic model describing both climate and hydrologic data. The climate dataset (predictor) is typically a time series of atmospheric of oceanic fields defined on a grid over some area, while the hydrologic dataset (predictand) is typically a regional dataset of station data (e.g. annual peak flow at several gauging stations). A Bayesian estimation framework is used, so that a natural quantification of uncertainties affecting hydrologic predictions is available.

A case study aimed at predicting the number of autumn flood events in 16 catchments located in Mediterranean France using geopotential heights at 500 hPa over the North-Atlantic region is presented. The temporal variability of hydrologic data is shown to be associated with a particular spatial pattern in the geopotential heights. A cross-validation experiment indicates that the resulting probabilistic climate-informed predictions are skillful: their reliability is acceptable and they are much sharper than predictions based on standard climate indices and baseline predictions that ignore climate information.