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Understanding the link between large-scale climate variability and regional hydrologic variability using weather patterns as intermediate variables

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Climate naturally follows specific modes of variability, quantified by some climate indices (e.g. North Atlantic Oscillation NAO, Southern Oscillation Index SOI, Atlantic Multidecadal Oscillation AMO, etc.). These modes of variability are due to large-scale climatic processes affecting large areas, and whose temporal scales range from a few months to a few decades.

The temporal variability of hydrological regimes depends on such modes of variability, as has been reported in several regions worldwide. However, this relationship is more difficult to observe in some other regions, for several possible reasons: (i) the large natural variability of hydrological regimes, especially in the extreme domain, might strongly restrict the ability to detect weak or moderate relationships; (ii) Standard modes of variability like the NAO, SOI, etc. might not be the most relevant for some regions.

This presentation explores an approach which, instead of directly seeking links between large-scale climate variability and regional hydrologic variability, decomposes the problem into two transitive “sub-problems” involving weather patterns as intermediate variables. Weather patterns are used to describe the atmospheric situation over a region as a categorical variable. As region-specific indices, they are potentially more explanatory than larger-scale indices like the NAO or SOI to explain the regional variability of hydrologic regimes. Consequently, two probabilistic models are derived: (1) a model to predict the frequency of weather patterns using large-scale climate indices (NAO, SOI, etc.) as predictors; (2) a model to predict the regional distribution of some hydrologic variable (e.g. number of flood events) using the frequencies of weather patterns as predictors.

A case study based on French flood data is used to illustrate the application of this approach. It shows that each sub-model has some predictive ability: for instance, the annual number of flood events can be predicted (to some extent) from the frequency of weather patterns; in turn, the frequency of weather patterns can be predicted (to some extent) from NAO and SOI values. However, much of this predictive ability is lost when attempting to directly predict the annual number of flood events from NAO and SOI values. The consequences of these findings and avenues for improvement will be discussed.