Large-scale, low-frequency hydrological variability of climate-sensitive catchments over France : regional classification and links to North-Atlantic atmospheric circulation variability.

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Introduction

Characterizing and understanding long-term variations in hydrological characteristics is a key issue for climate change-related hydrological investigation, in order to distinguish “natural” variability and trends from anthropogenic forcing.

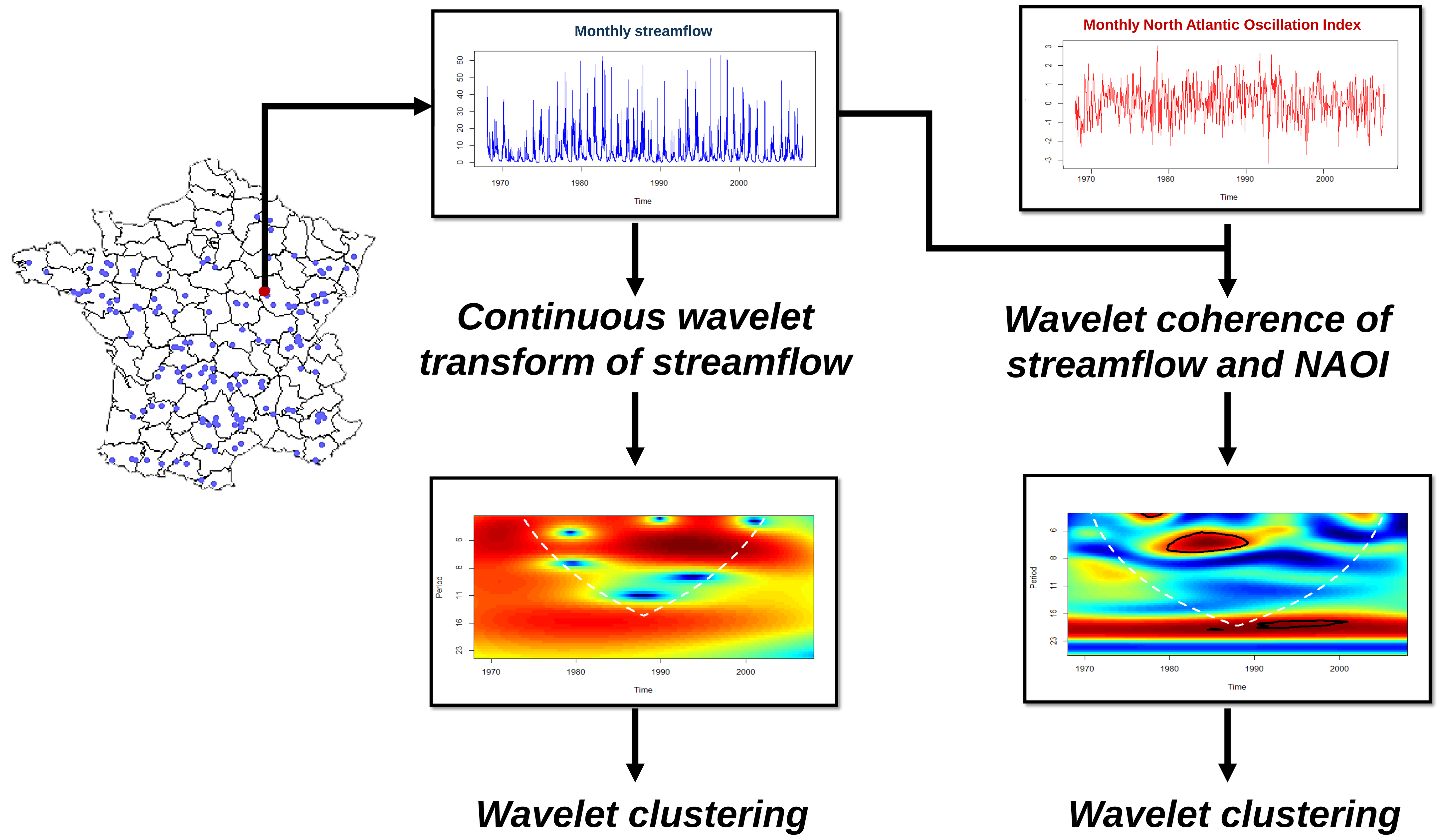
In this study we investigated the **spatial distribution of hydrological variations over France, focusing on low-frequency variability** (interannual to multidecadal time-scales).

The **two hypotheses to be tested concerned the possibility of distinguishing spatial patterns** based on 1- the low frequency variability of streamflow, 2- the statistical linkages of streamflow with large-scale circulation taking the winter-months NAO index (NAOI) as a reference.

Methodological approach

The analysis was based on a subset of 152 streamflow records climate-sensitive catchments for the period 1968-2008. Records are from the French database “Banque Hydro”. Streamflow was first converted to specific discharge in order to remove the spatial scale effect induced by catchment area.

The methodological approach was based on **univariate and bivariate continuous wavelet analysis** of streamflow records, **associated to a multivariate wavelet clustering approach** *(Rouyer et al., 2008)* of local wavelet spectra and wavelet coherence (NAOI/streamflow). Wavelet clustering was then performed on the wavelet spectra of mean monthly, annual high and low flow of specific discharge.



Records have been divided according their wavelet spectrum. Classification is based on the presence or absence of change in frequency over time (including discontinuities), variation type (increase or decrease) and amplitude change.

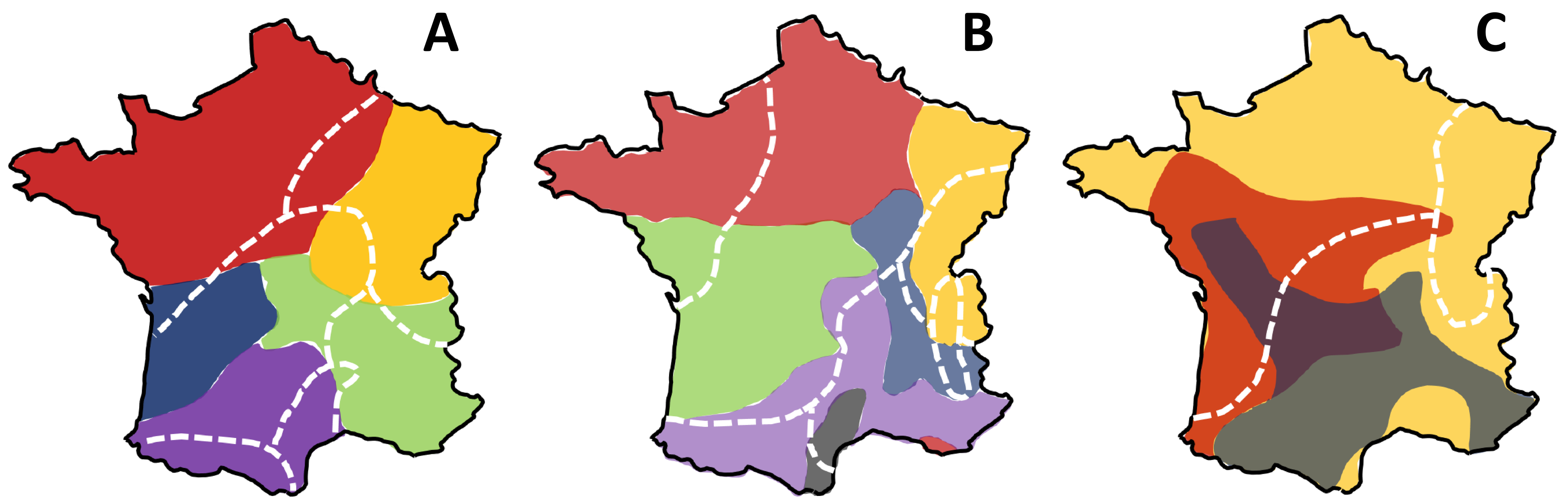
Results and discussion

Univariate wavelet clustering based on monthly streamflow records **allowed the identification of well-defined spatial patterns** through three clusters: western stations subject to oceanic influence, eastern stations subject to continental climate and stations located in the southern part of France (Mediterranean area).

More clusters were found for mean and annual high flow than for low flow. This could be explained by a more direct influence of meteorological conditions/atmospheric circulation (high precipitation events and storms) on mean streamflow and high flow. On the other hand, low flows are most of the time related to ground water flow from aquifers which generally act as low frequency filters and may buffer high-amplitude and intense precipitation events.

Mean and high flows showed **coherence with NAOI for 4-5 yr, 7-10 yr and 15-17 yr fluctuations**; this was not the case of low flows.

In any case wavelet clustering based on the linkages between streamflow and circulation showed **well-defined clusters, which were to some extent similar to those previously identified based on streamflow only.**



Comparison of groups determined for coherence between streamflow and NAOI (color) and groups from the regionalization based on streamflow records (dotted line)
A : Annual high flow, B : Monthly mean flow, C : Annual Low flow

The differences between the results from the two approaches can be related to the fact that other large-circulation patterns than NAO or other physical processes are involved to explain the low-frequency variability observed in streamflow, even for a relatively small area such as conterminous France.

Literature Cited
Rouyer T., Fromentin J. M., Stenseth N., & Cazelles B. (2008) Analysing multiple time series and extending significance testing in wavelet analysis, Marine Ecology Progress Series, 359, pages 11-23