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Multiresolution Low Frequency Geometric and Statistical Evolution of Euro-Atlantic Geopotential Height Linked with Monthly Precipitation over Paris, France from NOAA 20CR reanalysis ensemble 1901-2012

Manuel Fossa (1), Nicolas Massei (1), Bastien Dieppois (2), Nicolas Lecoq (1), Matthieu Fournier (1), and Benoit Laignel (1)

(1) Normandie Univ, UNIROUEN, UNICAEN, CNRS, M2C, 76000 Rouen, France, (2) Centre for Agroecology, Water and Resilience, Coventry University, UK

NOAA 20CRv2 and NOAA 20CRv2c reanalysis represents a quantum leap in climate study analysis by providing a global, century long, gridded observational set with quantified uncertainty. For hydrology, the reanalysis allows studying the different phases of the water cycle. One important aspect of the cycle is how large scale climate field interact with local variables such as precipitation or discharge.
Several methods allow for characterization of those links either in terms of correlation or causal relationship. However, several challenges arise in describing those fields.
First, it has been shown by multiple studies that geophysical processes behave differently depending on the time/space scale considered. It prompts the necessity to look at the relationships at different time, and perhaps even spatial, scales. The necessity is particularly true for low frequency/large time scales as global climate models are shown to, at best, severely underestimate the variabilities greater than the annual time scale.
Second, since climate variables are associated with large spatial extension, their variabilities have a very important geometric component. Indeed, not only the intensity of the climate variable but also its spatial repartition i.e its shape will greatly influence the local variabilities. Thus, one is presented with the challenge of sparsely characterizing variabilities that are more than one dimensional.
Finally, NOAA 20CR should be used with caution as one of the strong point of the reanalysis is its quantified uncertainty by the presence of 56 members for the reanalysis ensemble. Taking the mean reanalysis as observation set quality data is risky. Thus consideration of the internal variability due to the probabilistic nature of the NOAA 20CR model must be taken into account. This brings another challenge by increasing the amount of data 56 fold.
The present study aims at tackling those 3 challenges by the following means:
- The variabilities in both climate and local variables are studied at different interannual and decadal time scales using Discrete Wavelet transform methods to decompose the signal into quasi-independent time scales.
- The geometric information is characterized without losing the global and local information by means of differential geometry and topological mappings resuming the information in low dimensional spaces.
- The uncertainty (i.e internal variability) in the NOAA 20CR ensemble is assessed using Continuous Wavelet Transform methods like Coherence and Wavelet clustering to assess the dispersion within the reanalysis ensemble.
This study tries to answer how geopotential height fields linked with discharge over the Paris Montsouris precipitation gauging station evolved from 1901 to 2012. It does so by taking into account the different low frequency time scales, characterizing the geometric and statistical evolution of the fields and discriminating natural variability from internal variability using the aforementioned methods.