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Association of high and low frequency components to high and low transmissivity zones of a synthetic karst system

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Karst systems present particular hydrography and hydrology, and are characterized by a non-negligible spatial heterogeneity of hydraulic parameters (such as rock permeability, storage coefficient…). The dual character of karst flow system is widely recognized and stems from the existence of different types of porosities within karst aquifer, which determine the prevailing type of flow. Unfortunatelly, the only information that can be obtained at the output of a karst system is the flow rate at the resurgence. Numerous works in the past decades have used and proven the usefulness of time-series analysis and spectral techniques applied to spring flow, precipitations or even physico-chemical parameters, for interpreting karst hydrological functioning. The main issue of this work is to determine how the hydrodynamic signal can be related to physical phenomenon and to the karst system hydraulic properties and how the climatic signal is deformed by karst system.

Physics-based modeling is particularly suitable for sedimentary areas, but not for karst systems which present discontinuities (fractures, conduits and caves). In order to address this issue, we undertake an empirical approach based on the use of both distributed and physics-based models, and on synthetic systems responses. The flow differential equations resolved by MARTHE, the first computer code used in this study, and developed by the BRGM, allows karst conduits modeling. A forward modeling of flow through several simple, constrained and synthetic cases in response to precipitations is undertaken: we arbitrary chose a single-conduit reference model and two different karst network geometries, according to Palmer's classification.

These three modeled domains allow us to observe how the statistical and spectral characteristics of flow at the outlet are sensitive to changes in conduit geometries. From signal processing on these simulated spring responses, we can quantify the delay effect imputed by network complexity, and we are also able to break down the output signals into high and low frequency flow components. By summing part of them, we can recompose two signals: one attributed to the higher transmissive zones (conduit) and another associated to the lower transmissive zones (matrix).

Future steps will be using another computer codes, one based on a conceptual approach and one based on a double-continuum approach and allowing turbulent conduit flow.