From time series analysis to hydrodynamic modelling in a complex hydrosystem: applications for the hydrodynamic characterization and modelling of a karst aquifer with sparse data (Oeillal spring, France).

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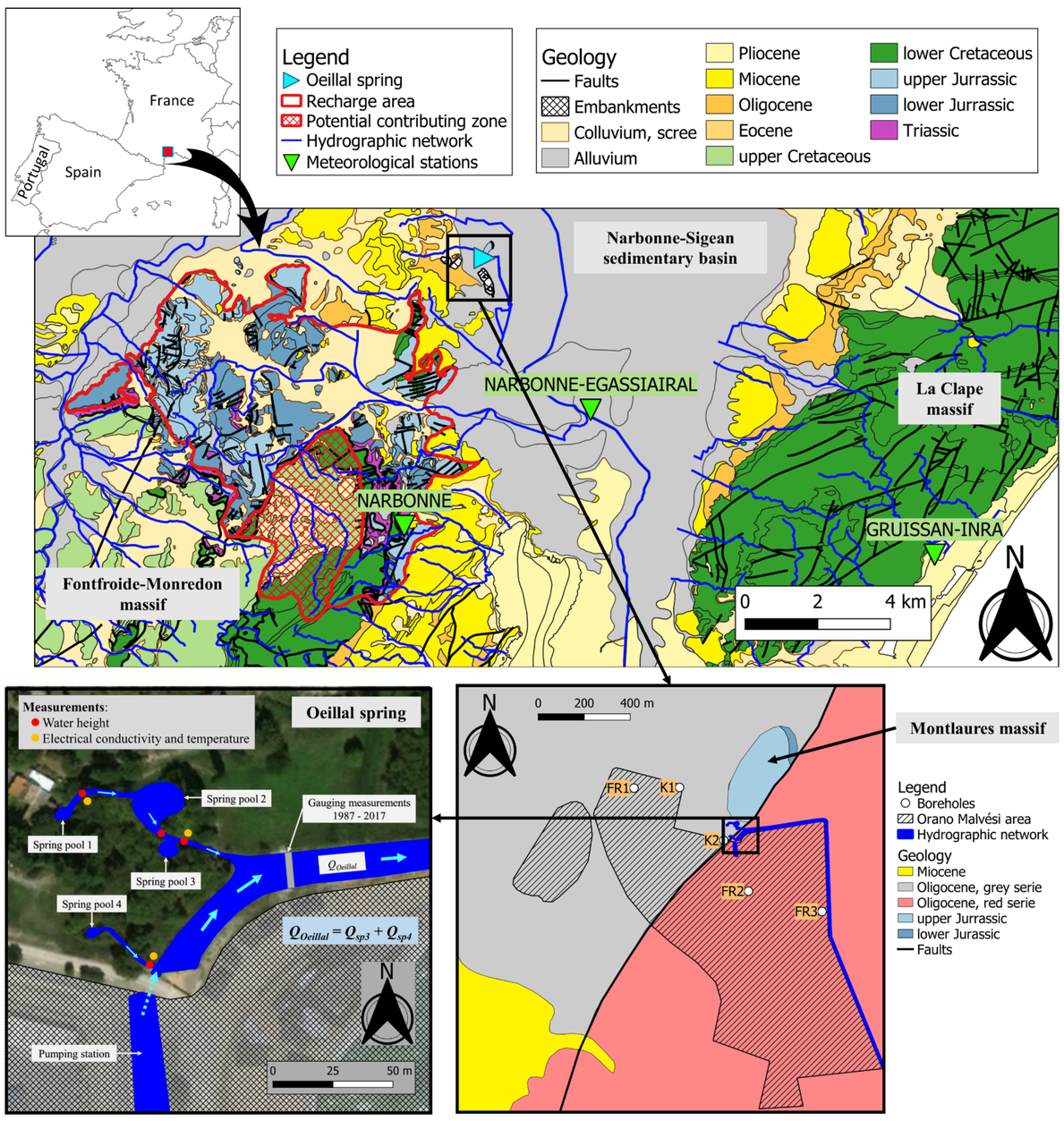
Objectives

The main objective is to adopt a suitable hydrodynamic modelling approach in a complex hydrosystem with sparse temporal sampling. Spring discharge has been measured irregularly on monthly time resolution for about 30 years. The dataset has been completed with high resolution monitoring over a 21 months period.

Study area : karstic hydrosystem associated with Oeillal spring (Narbonne, France)

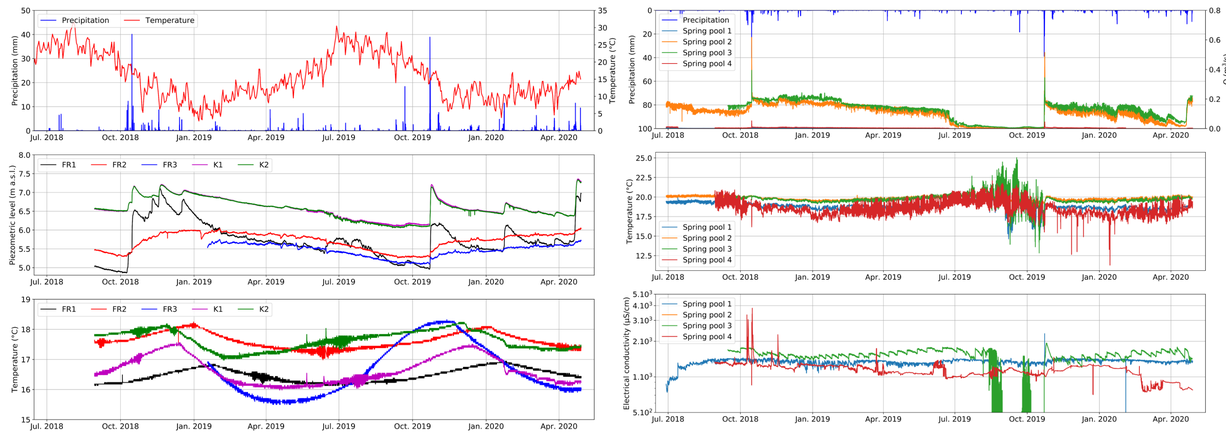
Geological settings over the study area (modified from [1] and [2])

The Oeillal spring drains water from the Jurassic calcareous formations (Fontfroide-Montredon and Montlaures massifs). The higher piezometric level in the Montlaures calcareous formations is at the origin of an upward vertical leakage towards the Oligocene sediments. It mays influence the hydrodynamic behavior at the Oeillal spring.



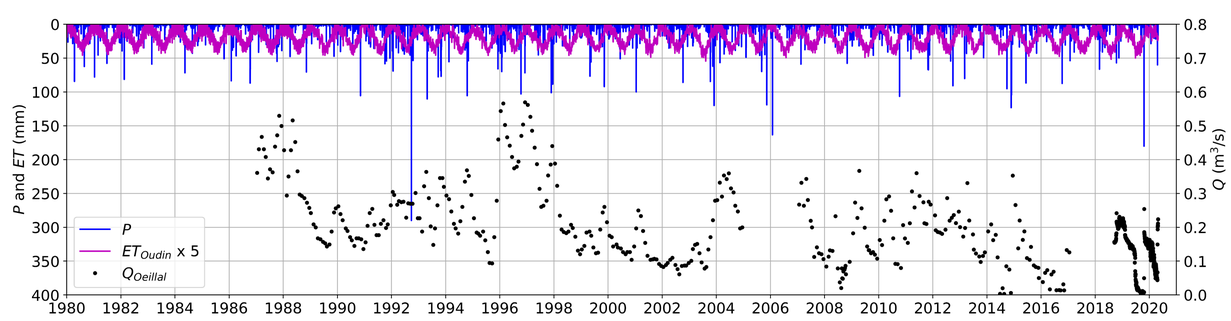
Field monitoring and data

The karst spring outflows at 4 spring pools equipped with a CTD probe. Moreover, the area is monitored with piezometric and temperature measurements that allow characterizing each of the main geological formations near the Oeillal spring. Though gauging measurements started more than thirty years ago (1987), continuous monitoring is available on one complete hydrological cycle, only.



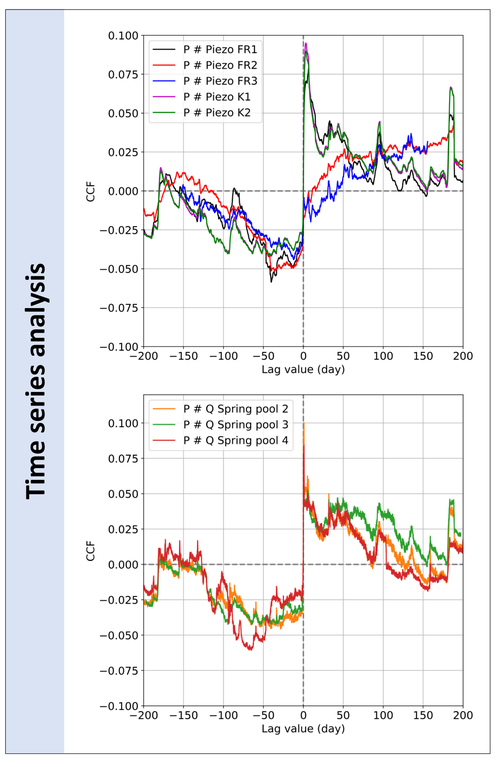
The data available for rainfall-runoff model calibration consists in:

- continuous daily precipitation and temperature (for estimation of evapotranspiration through the Oudin's formula [3])
- sparse temporal gauging measurement from 1987 to 2017 and high resolution CTD measurement since June 2018.



Calibrating a hydrodynamic model with such sparse temporal data constitutes a major challenge and a necessary step to attempt estimation of global change effects on the groundwater resource over the study area.

Modelling approach



Field data
Gauging measurement over 30 years
High resolution monitoring over 21 months
(boreholes + CTD at spring pools)

Time series analysis
AutoCorrelation Function (ACF)
CrossCorrelation Function (CCF)
Recession analysis
Multiscale mass balance

Hypotheses

Rainfall-runoff model calibration
Lumped, semi-distributed or distributed

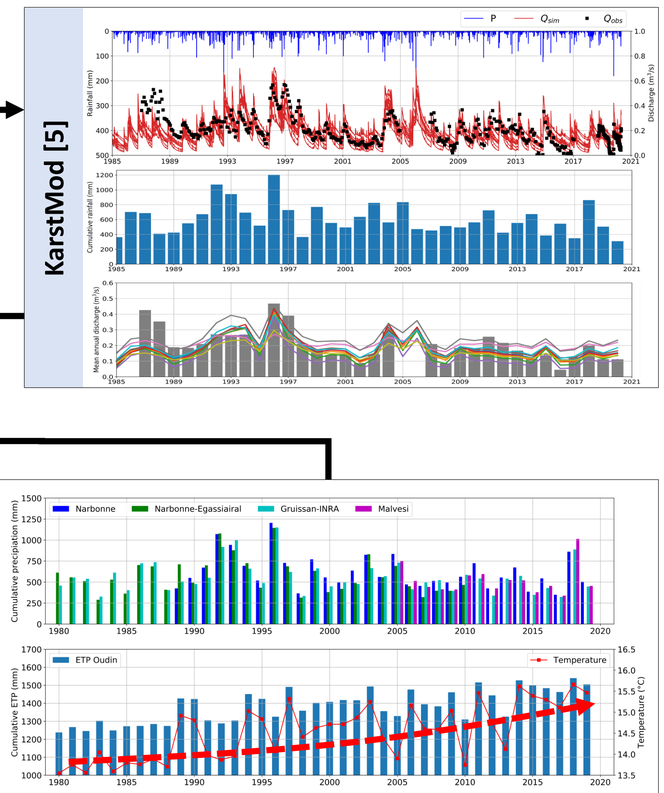
Hydrodynamic behavior

Physico-chemical data
can be implemented as conditioning data or posterior validation data

Hydrodynamic model
The model is calibrated using several performance criteria

Running scenarii
Climate change [4]
Local water supply
Inversion of leakage effect ? (aquifer vulnerability)

Decision support tool for sustainable management of local water resources



References:

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