Assessing Surface Water and Groundwater Interactions Using Long-Term Hydrological and Time-Lapse Seismic Data in the Orgeval Critical Zone Observatory

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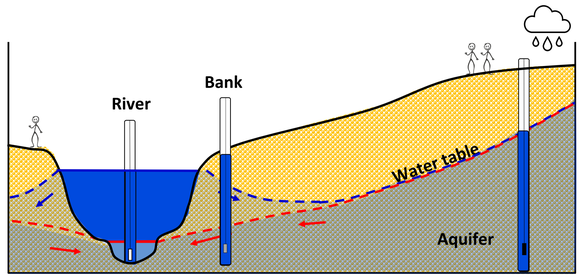
1. Motivations

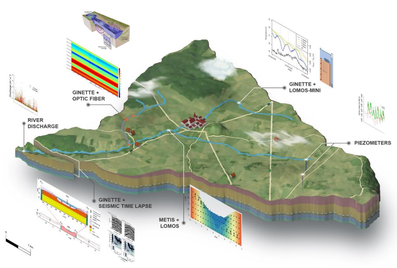
Groundwater (GW) systems exist in dynamic balance with the climate and human pressure, connecting interfacing zones of recharge and discharge with multiple feedbacks. These interfaces are composed of various morpho-sedimentary units with highly contrasting geometries and lithologies. GW recharge and SW-GW exchanges cannot be directly measured.



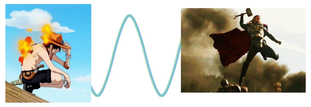
→ Quantifying Water Fluxes at Interfaces:
- **Determining Hydrofacies Distribution?**
- **Defining Initial and Boundary Conditions?**
- **Calibration of Variables?**

Orgeval Critical zone observatory

- Long-term experimental observatory and research site
- Area of 46 km2
- Representative of rural areas with intensive cereal farming

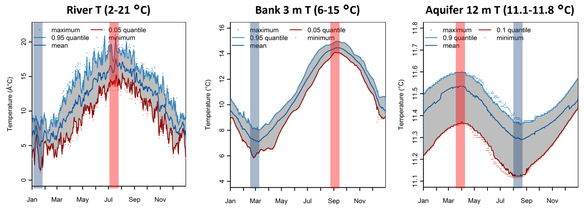


2. Methods



Seismic : Combined P-wave first arrivals and surface-wave dispersion measurements and inversion
→ VP/VS or Poisson's ratio estimation = **Water table depth !!**
→ related to strong water content contrasts

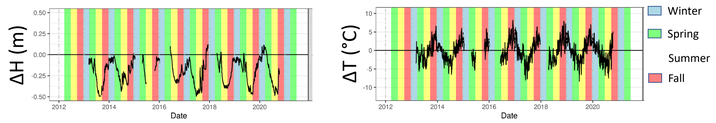
Heat as a tracer :



3. SW-GW exchanges: Dangeard et al. 2021 (WRR)

→ a. Streambed : Heat as a tracer

Aquifer-river

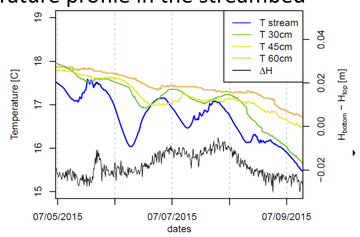


Physical parameters

$$\mathbf{y} = \begin{cases} n: \text{porosity} \\ \lambda_s: \text{Thermal conductivity } (W\ m^{-1}\ K^{-1}) \\ c_s: \text{Heat capacity} (J\ Kg^{-1}\ K^{-1}) \\ k: \textit{hydraulic conductivity } (m\ s^{-1}) \\ \rho_s: \text{solid density} (Kg\ m^{-3}) \end{cases}$$

Data

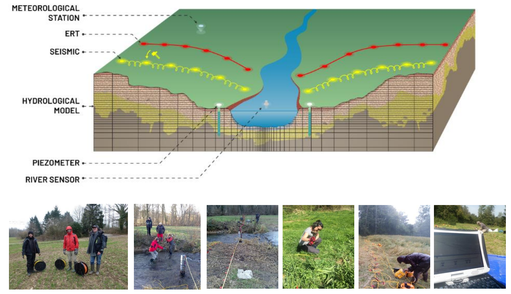
Temperature profile in the streambed

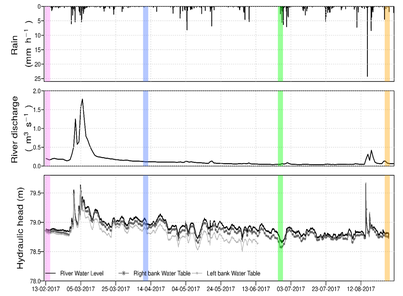


Estimation of the streambed parameters

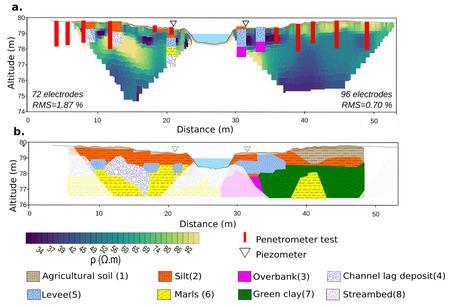
- Hydrothermal Code : Ginette (Rivière, 2012)
- + Bayesian inversion (Cucchi et al., 2018)

→ b. River corridor

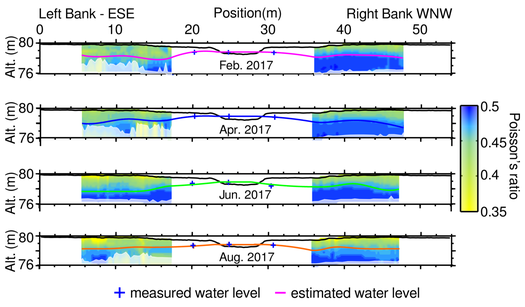




→ c. Hydrofacies distribution

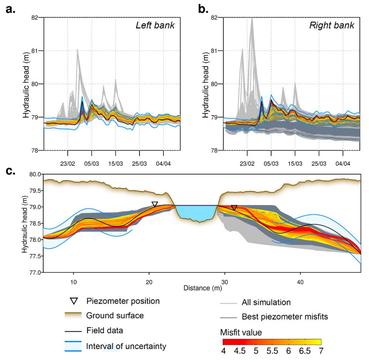


→ d. Water table image

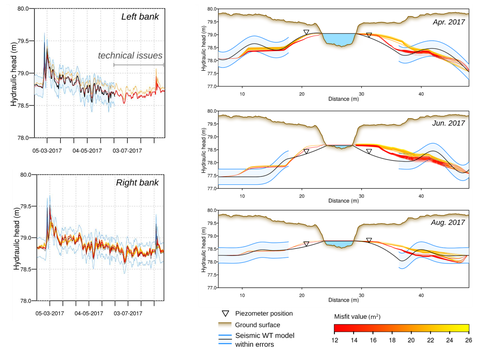


→ Geophysical models provide **initial+boundary conditions to calibrate and validate** the hydrogeological model & to **perform fully integrated 2D** river corridor modeling

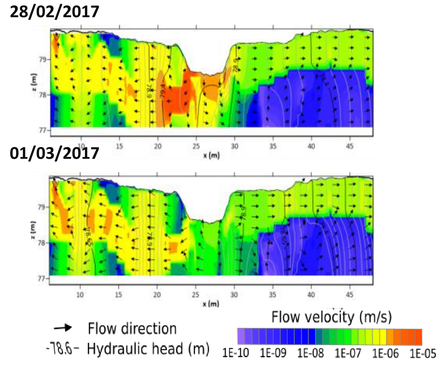
→ e. Calibration

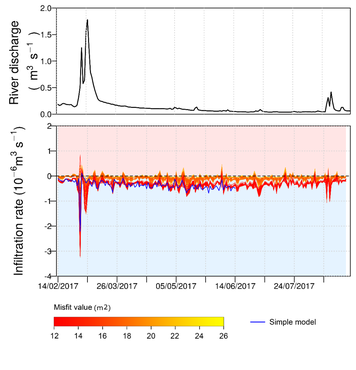


→ f. Validation



→ g. Simulations





5. Next steps

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1. GW recharge

2. Characterizing the Propagation of Uncertainty from Geophysical Data to the Models
   → Probabilistic Joint Inversion Approach;

3. Exploring the Consideration of these Geophysical Models as 'Inputs' to Hydrogeological Models
   → Propagation of Uncertainties from Geophysical Models
      → to Petrophysical Relationships;
      → to Hydrogeological Models...

4. Combining Hydrogeological Simulations with Geophysical Simulations
   → Achieving More Reliable Calibrations

→ Thermal Seismic Coupling!!
We are currently seeking candidates for the following positions:
- **1 Postdoctoral Researcher**
- **1 PhD Candidate**

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