Water resources forecasting by combined hydrogeophysics data and model

Workplace: Fontainebleau
Date of publication: November 2023
Type of Contract: postdoctoral
Starting date: beginning 2024 (the exact date can be discussed)
Contract Period: 24 months
Functions: Postdoctoral position
Proportion of work: Full time
Desired level of education: Doctorate.

The GWSBound Project invites applications for a postdoc position in numerical modelling at Geoscience laboratory of Mines Paris (PSL University) in France.

Overview of the project.

Groundwater (GW)'s strategic importance for water, energy, and food security is growing in the face of ongoing climatic changes and human uses. Precisely quantifying water resources is a critical concern, essential for ensuring sustainable yields and maintaining water quality. Components of the water balance are difficult to obtain, both in terms of accuracy and budget closure, especially at the subsurface boundaries of the GW. The GW subsurface boundaries such as the GW recharge and river- GW exchanges cannot be directly measured. Consequently, it is necessary to model these fluxes, as they are dependent on the boundary conditions and spatial description of the hydrodynamic parameters, which are largely unknown and estimated via model calibration.

The GWSBound ANR project is to provide monitoring and predictive tools of the spatiotemporal variability of the GW subsurface boundaries under the global change by the uses of innovative hydrogeophysic methodologies, such as seismic (Bodet et al., 2014; Dangeard et al., 2021; Pasquet et al., 2016; Solazzi et al., 2021) **and temperature-based approaches** (Cucchi et al., 2018; Kurylyk et al., 2019; Mouhri et al., 2013; Rivière, 2019; Tabbagh et al., 1999). In this goal, we will develop and use High-Performance numerical model and tools to process geophysical and hydrogeological data.

Team.

The GWSBound team involves partners from Mines Paris with the scientific coordinator, *A. Rivière*, whose expertise includes hydrodynamic modelling: theory, physical processes within the critical zone, design and parameterisation of numerical models, field surveys and databases; *A. Gesret*, specialist in geophysical inversion: probabilistic approaches, estimation and propagation of uncertainties; N. Desassis and D. Renard, specialists in geostatistics and spatial statistics: mostly with the SPDE approach and development of computing libraries. It benefits the expertise of geophysicists from Sorbonne Université: *L. Bodet*, expert in field seismic experiments, combined interpretation of geophysical and geotechnical data, information processing, wave propagation and mechanical properties of media; and assistance from the OSU ECCE TERRA with *S. Pasquet,* critical zone geophysicist, specialist in geophysical methods, field measurements, combined interpretation of geophysical and hydrogeological data. As for numerical modelling, the project is be supported by specialists from GET: *R. Martin* and *B. Plazolles,* seismic wave propagation and multiple data (seismic, gravity, electrical methods) imaging, inverse problems, data processing (deep learning), numerical modelling and high-performance computing.

Activities.

The postdoctoral researcher will have the following responsibilities:

1. Develop, test, and validate the combined forward models. The initial phase involves enhancing the Ginette code through the creation of patch-based data structures and the implementation of parallel algorithms, with the overarching goal of minimizing communication costs. Following these improvements, Ginette will be effectively coupled with the poroelastic and wave propagation codes (SPECFEM2D/3D, 2D/3D code SEISMIC_CPML) developed by the GET team in a manner that ensures numerical efficiency.
2. Create synthetic cases for sensitivity analysis of different heterogeneity configurations and hydrogeological regimes on hydrothermal and seismic wave responses. The geostatistical approach (gstlearn) and a priori information known on the Orgeval CZO will be used to build the synthetic cases.
3. Conduct sensitivity analysis using probabilistic and deep learning tools to reduce the number of parameters and estimate uncertainties.
4. Develop the workflow for combined hydrogeological and geophysical inversion.

The forthcoming year will witness the implementation of this technique at the outlet of the Orgeval Critical Zone Observatory, overseen by a doctoral candidate.

Skills and Qualifications:

We eagerly welcome candidates who share our interest in studying the evolution of water resources within the context of climate change. If you have a passion for numerical programming and wish to apply these skills in the field of water resources, we invite you to apply and join our research team. To excel in this role, candidates should possess the following qualifications:

- **Strong programming skills:** Fortran2018, Python, Julia; Rust or C++. Proficient in high-performance and parallel computing.
- **Physical and Mathematical Background**: Having a physical or mathematical background is advantageous.
- **Teamwork and Communication**: Effective teamwork and communication skills are essential for collaboration within our research team. Proficiency in written and verbal English is required, as it will be the primary language for communication and documentation.

Application contents.

- Cover letter describing the applicant's research experiences and interests.
- Curriculum vitae including a summary of education and research experience, publication list, involvement in research grants, etc.
- Names, addresses, emails, and phone numbers for three academic referees

References.

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