# PostDoc offer

# *Model reduction, uncertainty quantification and data assimilation for spatio-temporal non-linear PDE systems: Application to flood models.*

Jerôme Monnier and Olivier Roustant

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## 1 Context

This postdoctoral project is funded by the Chair PILearnWater of the Toulouse AI Cluster ANITI, led by Jerôme Monnier and Olivier Roustant. The aim of the Chair is to investigate and develop algorithms for estimating continental-scale water flows (river networks), including extreme events such as floods and marine inundation in coastal regions. Our research program is presented on our website.

The present postdoctoral project takes place at the middle of the Chair life, and will address the whole complexity of our spatio-temporal problems. In that setting, the objectives are the following.

## 2 Objectives

- **To develop fast methods for computing sensitivity maps.** Sensitivity analysis quantifies the contribution of input variables to output uncertainty. When the output is spatio-temporal, this results in sensitivity maps, which are valuable for tracking the influence of input variables across space and time. The goal of this research axis is to build on the Chair's previous work and develop efficient methods for computing such maps, particularly within the framework of Gaussian process surrogate models.
- **To improve real-time prediction with data assimilation on the fly.** In real-time settings, as new data becomes available, it is desirable to update the reduced (surrogate) models accordingly. We aim to address this challenge by leveraging our expertise in both surrogate modeling and data assimilation. This will require to investigate dimension reduction techniques for spatio-temporal data too.
- **To apply the methodologies to flooding models.** In two previous internships, we successfully implemented basic spatio-temporal surrogate models using neural networks and Gaussian process models. We now intend to extend this work by incorporating the advances achieved during the post-doctoral project. This application, numerical flooding models on real-data set using our computational software DassFlow, will serve as a case study to illustrate and validate the methodological improvements.

## 3 Conditions and application agenda

- The duration of the post-doc is 1 year. It is expected to start on November 2026. The net salary is around €2.400 (with health insurance included).
- Send your application to Jérôme Monnier (`jerome.monnier@insa-toulouse.fr`) and Olivier Roustant (`roustant@insa-toulouse.fr`). The application file should include a CV, transcripts of Master's grades, and the contact details of two academic referees.
- Application files must be submitted by July 30, 2026.
- Interviews will be held before September 15.
- Results will be announced before end of September, 2026.

# References


[1] M. Allabou, R. Bouclier, P.-A. Garambois, and J. Monnier. Reduction of the shallow water system by an error aware POD-neural network method: Application to floodplain dynamics. *Computer Methods in Applied Mechanics and Engineering*, 428:117094, 2024.

[2] F. Amato, F. Guignard, S. Robert, and M. Kanevski. A novel framework for spatio-temporal prediction of environmental data using deep learning. *Scientific reports*, 10(1):22243, 2020.

[3] H. Boulenc, R. Bouclier, P.-A. Garambois, and J. Monnier. Spatially-distributed parameter identification by physics-informed neural networks illustrated on the 2D shallow-water equations. *Inverse Problems*, 41(3):035006, 2025.

[4] DassFlow. Data assimilation for free surface flows: Open source computational software. *GitHub repository*. `https://github.com/DassHydro`.

[5] Y. Sáo, O. Roustant, and G. de Freitas Maciel. Fast pick-freeze estimation of Sobol' sensitivity maps using basis expansions. *Reliability Engineering & System Safety*, 265:111504, 2026.