POSTDOCTORAL RESEARCHER IN EARTH SCIENCE
(m/f/d, 100%, TVL-E13, temporary for the duration of 2 years)

Dr. Anneli Guthke, leader of the research group on **statistical model-data integration at the Stuttgart Center of Simulation Science (SC SimTech)**, seeks an enthusiastic postdoctoral researcher for the project "**UNI-BENCH: Diagnostic benchmarking of hybrid hydrological models**". Contribute to advances in hybrid modeling in Earth Science and beyond!

The project & your career perspective:

In the Earth Sciences, we rely on models that simulate the behavior of the natural system, to deepen system understanding, for operational forecasting, or predicting previously unobservable conditions as under climate change. The hydrological community traditionally uses physics-based or conceptual models that represent our process understanding. In cases of data abundance, deep learning methods have shown impressive prediction skill. Yet, they are criticized for their lack of interpretability and of physics consistency, which limits their acceptance and applicability to problems of societal relevance. To merge the best of two worlds, variants of physics-informed machine learning are being developed in an ever-increasing speed. Building on the findings and methods from the UNITE project, the goal of this project is to develop a model evaluation space consisting of three axes (performance, interpretability, and process consistency), equipped with universal anchors for benchmarking, and formulated in the universal language of information theory. UNI-BENCH shall help ensure that hybrid models perform well for the right reasons, such that we can confidently promote their use in science and practice. While the project will focus on rainfall-runoff modelling, we expect UNI-BENCH to be valuable for a wide range of disciplines and societal challenges that rely on trust in dynamical models. Hence, we see this Postdoc position as a great building block for a successful academic career, benefitting from a clear research vision for the time-frame of two years, offering fantastic networking opportunities world-wide and deepening skills relevant in various fields that bridge between physics and machine learning.

Your tasks (supported by a diverse team of experts):

- Extend the UNITE toolbox for efficient estimation of information-theoretic quantities towards transfer entropy, ideally in Python (alternatively in MATLAB or R)
- Develop and implement a mapping between Artificial Neuronal Network (particularly LSTM) components and a process model based on a well-instrumented and modelled catchment in Belgium
- Design and test meaningful universal benchmarks to create trust in the hydrological consistency of hybrid models on the same case study
- Demonstrate and evaluate the developed methods on hybrid hydrological models for large-sample data sets such as CAMELS-DE
- Collaborate closely with Dr.-Ing. Uwe Ehret at the Karlsruhe Institute for Technology (KIT) in Karlsruhe, Germany, Ass.-Prof. Daniel Klotz at the Interdisciplinary Transformation University Austria (IT:U) in Linz, and Prof. Hoshin V. Gupta at the University of Arizona/USA
- Publish research results in high-ranked open-access journals
- Present and discuss research results at international conferences

Your qualifications (don't hesitate to apply – enthusiasm can compensate some gaps):

- Very good PhD degree in hydrology, geosciences, environmental engineering, computer or data science, or related fields
- Demonstrated interest in research questions focused on at least one of the following: physics-based or data-driven modelling, model training and evaluation, model diagnostics, interpretability/explainability
- Previous experience in at least one of the following: coding algorithms, model building (physics-based, conceptual or data-driven), model calibration/uncertainty assessment, application of information-theoretic concepts
- Previous experience in at least one programming language common in quantitative fields (e.g., MATLAB, R, Python, Julia, or C++)
- Proficient English skills (spoken and written, C1 level); German skills are an asset (B1/B2 level)

We offer (looking for anything else? Ask us!):

- Internationally renowned expertise in environmental/hydrological modelling, hybrid modelling, uncertainty quantification and information theory
- An inspirational and supportive research environment at the Cluster of Excellence SimTech embedded in the SC SimTech and KIT with ample networking opportunities
- Membership in the Graduate Academy of the SC SimTech
- Three-month paid research stay at the University of Arizona/USA
- One-month paid research stay at the Interdisciplinary Transformation University Austria in Linz
- A nationally and internationally well-connected research group
- Fully funded conference visits (within Europe and overseas)
- A growing interdisciplinary and intercultural team
- Coaching to support further steps in your academic/professional career

The University and the Cluster of Excellence:

The University of Stuttgart represents outstanding, world-renowned research and first-class teaching in one of Europe's most dynamic industrial regions. As a reliable employer, the university supports and promotes the academic careers of its researchers. It is proud of its employees, who currently come from over 100 different countries. The university is a partner for knowledge and technology transfer and focuses on multidisciplinarity.

The Cluster of Excellence EXC 2075 "Data-integrated Simulation Science" (EXC SimTech) and the Stuttgart Center for Simulation Science (SC SimTech) constitute a long-standing prime example of establishing and structurally supporting interdisciplinary research. SC SimTech serves as the institutional backbone of the ongoing EXC 2075. The SC SimTech, including the EXC 2075, is an interdisciplinary research center with more than 200 scientists of different ages, gender identities, nationalities and different subject areas, jointly performing research towards a common goal: We target a new class of modeling and computational methods based on available data from various sources, in order to take the usability, precision and reliability of simulations to a new level.

Diversity and work-life balance:

At the University of Stuttgart and the Cluster of Excellence EXC 2075, we actively promote diversity among our employees. We have set ourselves the goal of recruiting more women scientists and employing more people with an international background, as well as people with disabilities. We are therefore particularly pleased to receive applications from such people. Regardless, we welcome any good application. Women who apply will be given preferential consideration in areas in which they are underrepresented, provided they have the same aptitude, qualifications and professional performance. Severely disabled applicants with equal qualifications will be given priority.

As a certified family-friendly university, we support the compatibility of work and family, and of professional and private life in general, through various flexible modules. We have an employee health management system that has won several awards and offers our employees a wide range of continuing education programs. We are consistently improving our accessibility. Our Welcome Center helps international scientists get started in Stuttgart.

Application procedure:

Please apply via the career portal of the University of Stuttgart "JoinUs" and submit your complete application, including one-page motivation letter, academic CV, one letter of reference, as well as academic certificates, **until September 21st, 2025**. The starting date is negotiable. If you have any questions regarding this application, please contact us via anneli.guthke@simtech.uni-stuttgart.de.

Information in accordance with Article 13 DS-GVO on the processing of applicant data can be found here.