DAAD GSSP - Stipendienausschreibung

Advisor(s):
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Research group / department:
Chair of Stochastic Simulation and Safety Research for Hydrosystems (LS^3)
Institute for Modelling Hydraulic and Environmental Systems (IWS)
and Stuttgart Centre for Simulation Technology (SC SimTech)

Space-Time Geostatistics for Opportunistic Rainfall Data

Keywords:

Introduction / Background:
The accurate estimation of precipitation is of fundamental importance for understanding and modelling hydrological processes as well as designing and planning for extreme rainfall events. Precipitation is highly variable in space and time, though. Its accurate estimation, especially for intense local events, is still a scientific challenge. Weather radars provide high resolution spatial and temporal rainfall estimates, yet their measurements can suffer from several error sources, e.g. the measurement height above ground or attenuation due to intense rainfall.
One fairly new approach to improve rainfall quantification is the use of so-called opportunistic sensors (OS) such as commercial microwave links (CML) or personal weather stations (PWS), i.e. sensors that were not designed to provide high-quality rainfall data or any rainfall data at all. The potential of OS Sensors for improving rainfall estimates has be shown by Bárdossy et al. (2021) and Graf et al. (2021). However, these studies have used daily or hourly rainfall data. For certain cases such as flooding events in small catchments of flash floods in urban areas, this temporal resolution is not sufficient since these processes may take place on sub-hourly time scales. Hence, there is a need of improving and evaluating the performance of OS data with sub-hourly temporal resolution.

Research goals:

One research goal is the development of interpolation methods for high temporal resolutions. With increasing temporal resolution, the spatial estimation of rainfall fields has to be considered as a spatio-temporal problem where the advection of the rainfall field has to be accounted for by considering previous time steps. This requires new approaches for the variogram estimation as since high temporal resolution rainfall datasets are typically “zero-inflated”, i.e. the have large amounts of 0mm rainfall measurement. Additionally, phenomena such as the "dry drift" (Schleiss et al., 2014) or the influence of anisotropy of the precipitation fields need to be investigated.
Another focus will be put on the evaluation of weather radar data with OS during extremes extreme events to answer the question how good OS rainfall data can capture such events. For this, a comparison with gauge-adjusted weather radar data products form the German Weather Service DWD is required. Rainfall maxima of such gauge-adjusted radar products at the locations of the gauges should be captured well in these radar products. However, a comparison of radar extremes with those of OS in close vicinity and at a greater distance from

the supporting DWD gauges may help to identify potential weaknesses of capturing extremes with the radar data.

Research Environment:
This research will be embedded into the Chair of Stochastic Simulation and Safety Research for Hydrosystems (LS^3) at the IWS, Faculty of Civil and Environmental Engineering. Depending on qualification of the candidate, a formal association of the project to the SC SimTech and the Cluster of Excellence in Data-Integrated Simulation Science is possible and advisable.

References:

Bárdossy, A., Seidel, J., & El Hachem, A. (2021). The use of personal weather station observations to improve precipitation estimation and interpolation. Hydrology and Earth System Sciences, 25(2), 583–601.

Graf, M., El Hachem, A., Eisele, M., Seidel, J., Chwala, C., Kunstmann, H., & Bárdossy, A. (2021). Rainfall estimates from opportunistic sensors in Germany across spatio-temporal scales. Journal of Hydrology: Regional Studies, 37, 100883.

Schleiss, M., Chamoun, S., & Berne, A. (2014). Nonstationarity in Intermittent Rainfall: The "Dry Drift". Journal of Hydrometeorology, 15(3), 1189–1204

Prerequisites:

- MSc in hydrology, environmental sciences, hydrogeology, water management (or similar) or in data sciences, statistics, applied mathematics.
- Skills in programming (e.g. python, matlab, julia)
- Skills at scientific writing and presentation
- Ability to work independently and in a team
- Willingness to learn new concepts and methods
- Experience (e.g., coursework, thesis work) in hydrological modelling or in machine learning is desirable
- Willingness to contribute to the goals and culture of the research group