technische universität dortmund

fakultät statistik

Juniorprofessur Environmetrics

Improving algorithms for estimating spatial mean environmental conditions from non-uniformly distributed and noisy data

Bachelorthesis
Supervision: JProf. Dr. Nils Weitzel, Environmetrics group
12.01.2026

Short description

Even in the era of big data, inferring spatial mean environmental conditions from sparse observations remains a major challenge in environmental sciences, because observational networks quickly shrink back in time. (Unknown) spatial non-stationarities of environmental fields can make standard geostatistical techniques invalid for this estimation. This has led to the development of a number of ad-hoc algorithms without a formalized statistical model and comprehensive testing in simulation studies. This project aims at formalizing, testing, and improving existing algorithms for reconstructing spatial mean surface temperatures and forest cover. Potential thesis topics include

- Formalizing the statistical models underlying the algorithms and implement appropriate inference methods
- Testing the ability of various bootstrapping methods to provide calibrated confidence intervals
- Develop and test new semi-parametric models that combine domain knowledge about spatial non-stationarities and geostatistical models

Key concepts/prerequisites

- Experience with functional or spatial data (e.g. Gaussian processes)
- Experience with bootstrapping methods
- Programming skills in R or python
- Interest in working with environmental datasets

Key references with example algorithms

- Baudouin, J.-P., Weitzel, N., May, M., Jonkers, L., Dolman, A. M., and Rehfeld, K.: Testing the reliability of global surface temperature reconstructions of the Last Glacial Cycle with pseudo-proxy experiments, Clim. Past, 21, 381–403, https://doi.org/10.5194/cp-21-381-2025, 2025.
- Dallmeyer, A., Kleinen, T., Claussen, M., Weitzel, N., Cao, X., and Herzschuh, U.: The deglacial forest conundrum, Nat Commun, 13, 6035, https://doi.org/10.1038/s41467-022-33646-6, 2022.