

Master's Thesis Opportunity: Urban Atmospheric Inversion of Greenhouse Gas Emissions (Munich)

We offer a Master's thesis focused on tracing urban atmospheric greenhouse gas emissions in Munich, using state-of-the-art Bayesian methods for sparse inverse problems.

Over the last ten years, a novel greenhouse gas observation network has been established in Munich by our research group, composed of sensors distributed over the city. Coupling these concentration measurements with wind data enables the possibility to trace emissions back to their sources within the city. This process, known as atmospheric inversion, is crucial to validate official emission inventories and offers the potential to detect previously unknown point sources.

However, existing inversion methods are primarily designed for large-scale applications (e.g., at the national level) and are not directly suitable for the more complex urban environment. Therefore, there is a need to adapt and extend current methodologies to handle urban-scale inversions.

The research project is highly applied, hands-on and contributes directly to ongoing, active research.

Tasks

- Test and improve novel atmospheric inversion methods based on compressed sensing to estimate emission fluxes in Munich
- Apply advanced Markov Chain Monte Carlo (MCMC) methods to sample the posterior distribution of a Maximum A Posteriori (MAP) estimator, using a Laplace prior for sparse urban atmospheric inversions
- Model boundary conditions and background concentrations
- Adapt and evaluate methods that can handle noisy measurements, with a particular focus on robustness to transport errors (i.e., uncertainties in wind data)

Requirements

- Strong coding skills (e.g., Julia, Python)
- Solid mathematical background, especially in linear algebra, computational statistics, and compressed sensing

Interested students are encouraged to get in touch for further details.

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