Geophysical Research Abstracts
Vol. 21, EGU2019-13438, 2019
EGU General Assembly 2019

Study on influence of the prior source term to linear inverse problem for atmospheric source term determination

Ondřej Tichý, Václav Šmídl, Lukáš Ulrych, and Radek Hofman
Institute of Information Theory and Automation, Czech Academy of Sciences, Prague, Czech Republic (otichy@utia.cas.cz)

The linear inverse problem is often formulated as $\mathbf{y} = M\mathbf{x} + \mathbf{e}$ (Seibert, 2001), where $\mathbf{y}$ is the the vector of observations, M is the source-receptor-sensitivity (SRS) matrix, $\mathbf{x}$ is the unknown source term, and $\mathbf{e}$ is the model residue. The key task is to estimate the source term $\mathbf{x}$. The measurements $\mathbf{y}$ are typically in the form of concentrations or gamma dose rates. The SRS matrix M is computed using an atmospheric transport model coupled with meteorological data. Since the inverse problem is ill-conditioned and subject to many errors, some form of regularization is required. A commonly used regularization is the knowledge of the prior source term, also known as a first guess. The result is thus influenced by this choice, which may be a drawback in cases when very uncertain or limited information is available to construct such prior.

In this contribution, we are going to investigate the influence of the prior source term on the posterior estimate of the source term. We considered the conventional optimization approach with loss function (Eckhardt et al., 2008) as well as probabilistic method LS-APC with automatic selection of the tuning parameters (Tichý et al., 2016). To study the influence, it is necessary to have a dataset with ground truth source term, therefore, we show the results on a twin simulation study as well as on real data from the controlled tracer experiment ETEX. Specifically, we use the original release as a prior source term, and compare results with those using inaccurate prior obtained by shifting, scaling, and blurring of the ground truth. Using this approach, stability and reliability of the estimated source term based on corrupted prior source terms and selected regularization parameters can be quantified and compared for different methods. We show that the LS-APC method is more robust when little information is available, but the conventional method can give good results when it is well tuned.

Citations:

Eckhardt, S., Prata, A. J., Seibert, P., Stebel, K., and Stohl, A.: Esti- mation of the vertical profile of sulfur dioxide injection into the atmosphere by a volcanic eruption using satellite column mea- surements and inverse transport modeling, Atmos. Chem. Phys., 8, 3881–3897, https://doi.org/10.5194/acp-8-3881-2008, 2008.

Seibert, P.: Iverse modelling with a lagrangian particle disperion model: application to point releases over limited time intervals, in: Air Pollution Modeling and its Application XIV, Springer, 381–389, 2001.

Tichý, O., Šmídl, V., Hofman, R., and Stohl, A.: LS-APC v1.0: a tuning-free method for the linear inverse problem and its ap- plication to source-term determination, Geosci. Model Dev., 9, 4297–4311, https://doi.org/10.5194/gmd-9-4297-2016, 2016.