(1) IMDAF - Inverse Modeling and Data Assimilation Framework

(2) ICMMG SB RAS - Institute of Computational Mathematics and Mathematical Geophysics, Siberian Branch, Russian Academy of Sciences, Russia
Alexey Penenko <a.penenko@yandex.ru>

(3) Available modes for the model runs: Research

(4) Components & processes: Atmosphere & Physical, Chemical

(5) Brief model description

IMDAF model provides common technological basis for various forward and inverse modeling applications. Basic theoretical elements are variational methods to connect measurement data to the model state functions and splitting schemes to treat multi-dimensionality (*Penenko et al., 2015; 2016*). Core components of the framework are: direct problem solvers for advection-diffusion-reaction models, inverse modeling algorithms and supporting classes to carry out numerical experiments with both synthetic and real data. Data assimilation is carried out by sequential solution of the inverse source problems with the incoming measurement data. Computational efficiency of the algorithm is achieved by the quasi-independent data assimilation on the separate splitting stages with the shared measurement data. The individual inverse problems for the splitting stages are solved with direct and iterative algorithms. Adjoint versions of the models are used as a part of the inverse modeling algorithms and to carry out the model sensitivity studies. The sensitivity operators, composed of the sets of adjoint problems, are used to solve the nonlinear inverse problems with Newton type algorithms and to study them with the SVD methods. The examples of the inverse modeling applications are: single column source reconstruction, concentration profiles reconstruction (*Penenko & Antokhin, 2016*), diffusion coefficient reconstruction and the chemistry transport model with integrated data assimilation capabilities (Fig.1), etc.

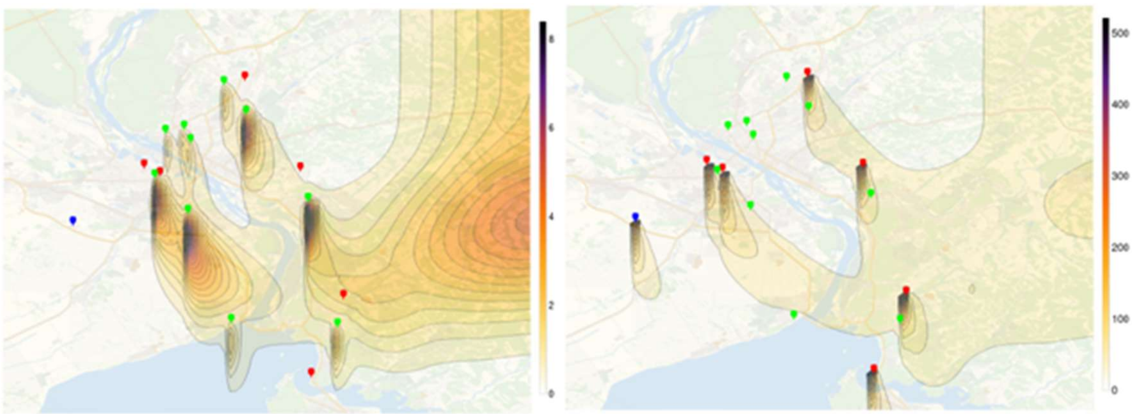

Fig.1: Concentration data assimilation result (left) for the synthetic measurement for a scenario (right) in the city of Novosibirsk. Sources are marked with red and blue dots. Measurement sites are marked with green dots. Measurements are taken every 30 min. Sources are unknown to the data assimilation algorithm.

References:

Penenko, A. V.; Penenko, V. V. & Tsvetova, E. A. Sequential data assimilation algorithms for air quality monitoring models based on a weak-constraint variational principle // Numerical Analysis and Applications, ***2016****, 9 , 312-325*

Penenko, V. V.; Tsvetova, E. A. & Penenko, A. V. Development of variational approach for direct and inverse problems of atmospheric hydrodynamics and chemistry // Izvestiya, Atmospheric and Oceanic Physics, ***2015****, 51, 311-319*

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