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Variational data assimilation schemes for transport and transformation models of atmospheric chemistry

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The work is devoted to data assimilation algorithm for atmospheric chemistry transport and transformation models. In the work a control function is introduced into the model source term (emission rate) to provide flexibility to adjust to data. This function is evaluated as the constrained minimum of the target functional combining a control function norm with a norm of the misfit between measured data and its model-simulated analog. Transport and transformation processes model is acting as a constraint. The constrained minimization problem is solved with Euler-Lagrange variational principle [1] which allows reducing it to a system of direct, adjoint and control function estimate relations. This provides a physically-plausible structure of the resulting analysis without model error covariance matrices that are sought within conventional approaches to data assimilation.
High dimensionality of the atmospheric chemistry models and a real-time mode of operation demand for computational efficiency of the data assimilation algorithms. Computational issues with complicated models can be solved by using a splitting technique. Within this approach a complex model is split to a set of relatively independent simpler models equipped with a coupling procedure. In a fine-grained approach data assimilation is carried out quasi-independently on the separate splitting stages with shared measurement data [2]. In integrated schemes data assimilation is carried out with respect to the split model as a whole. We compare the two approaches both theoretically and numerically. Data assimilation on the transport stage is carried out with a direct algorithm without iterations. Different algorithms to assimilate data on nonlinear transformation stage are compared.
In the work we compare data assimilation results for both artificial and real measurement data. With these data we study the impact of transformation processes and data assimilation to the performance of the modeling system [3].

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References:

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