Data assimilation system for estimating methane flows using satellite data

Marina Platonova
Novosibirsk State University, Novosibirsk, Russian Federation (gumoznaya@gmail.com)

This work is devoted to the urgent task of assessing regional flows of greenhouse gases from the Earth's surface according to satellite observations. The article presents the practical and theoretical results of the first year of study in the PhD program, later they will be included in the final dissertation. Flows will be estimated based on the observational data assimilation system for a three-dimensional model of diffusive transport of gas components in the atmosphere (MOZART-4). Model for Ozone and Associated Chemical Indicators, Version 4 (MOZART-4) is an autonomous global model for the transport of chemicals in the atmosphere.

The development of a modern system for the assimilation of real satellite data for assessing greenhouse gas sources is currently a very important theoretical and practical area in science. The ensemble approach is relevant and has great potential for using both stochastic and variational methods. In the process of implementation, this is an order of magnitude simpler, since there are no cumbersome matrix calculations using the model.

To solve the problem of estimating methane flows, the parameter estimation problem was solved: an algorithm for data assimilation was developed; the Kalman filter with the transformation of the local ensemble was used as the basis for it. Using an example of a model problem, an algorithm for estimating the concentration of a passive impurity and a parameter is developed. The case was also considered when only one parameter can be estimated in the assimilation system. In this case it is considered that at the forecasting stage the parameter does not change, and the calculations in accordance with the transport model are included in the operator $H$, for example, as in Feng (2009, 2017). $H$ is the observation operator; transfers predicted values to observation points (and observed variables). For example, for satellite methane data, $H$ includes:

- a) interpolation to the observation point;
- b) vertical averaging (using the middle core);
- c) if the observation data is obtained from a large time interval, then the operator $H$ also includes a forecast for the model in time.

Numerical experiments were carried out with model and real data. Using numerical experiments with the model, it was shown that a large problem (global) can be solved sequentially by subregion, independently in each subregion, which allowed the use of MPI and OpenMP.