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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Technical Note: A novel approach to estimation of time-variable surface sources and sinks of carbon dioxide using empirical orthogonal functions and the Kalman filter" *by* R. Zhuravlev et al.

Anonymous Referee #2

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The technical note presents a promising and interesting method for estimation of carbon dioxide (CO2) emissions analyzing the ground-based network of CO2 data (75 stations) as employed in previous inverse studies such as TransCom-3. The described inverse method is based on the decomposition of CO2 fluxes into a discrete set of empirical orthogonal functions (EOF) using variability of emissions as pictured by the Carbon Tracker database. The statistical optimization of EOF's amplitudes by the surface CO2 data was performed by Kalman filtering in the NIES chemistry-transport model.

The authors remarked that "it is desirable to determine the minimum number of EOFs

to reasonably accurately represent CO2 emissions". They performed this exercise using the Carbon Tracker emission database. This task can help to answer on the question: "how many regional sources (sinks) can be identified for the assumed level of uncertainty of emissions or "accuracy of the decomposition" (10% case is illustrated in this paper, Figure1) of the time-variable a priori. Figure 2 of this note indeed provides a good summary plot illustrating relationship between "number of regions" (EOFs) and decomposition errors (in %) for the Carbon Tracker database.

As a reviewer and reader of the technical note that describes the novel approach, I was looking for illustrations that can help to evaluate the proposed method using the synthetic data and "known" true emission fields. However, the authors discussed only the illustrative comparisons (Figure 3) between their EOF method and traditional "regional" inversion.

I would recommend to add results of so-called simulator experiments with synthetic CO2 data and "prescribed" true emissions to illustrate the main attractive features of the EOF approach. These features are listed in the abstract and conclusions but they are not substantially illustrated in the manuscript. It is worthy to note that using different dimension of the synthetic data (from 75 stations to 1000 data points) this paper can easily address the question of observability of derived EOFs by the current and prospected surface networks of CO2 observations.

My specific comments are as follows:

Abstract. 1) Please open abbreviation "NIES"; 2)As benefit of the proposed method against "traditional" regional inversion,I recommend highlighting the consistent way for definition of set of EOFs that capture "variability" of emissions

1. Introduction. Some discussions on the variational adjoint methods for inversion of emissions can be added. (T. Kaminski, P. J. Rayner, M. Heimann, and I. G. Enting. On aggregation errors in atmospheric transport inversions. J.Geophys. Res. , 106:4703–4715, 2001).

2. Methodology (or Method and Results). It would be better to insert sub-sections:

2.1 Determination of EOF; 2.2 Constraining EOF by data in NIES transport model; 2.3 Experiments with synthetic data, accuracy of inversion; 2.4 Observability of derived EOFs; 2.5 Comparison with regional inversions.

I recommend to put a brief model description (with reference to Maksutov et al., 2008) in the context of 2.2 and eliminate Appendix A.

3.Conclusions. This section with discussions of Fig. 3 and 5 reminds me discussion of results. It would be better to state a major promise of the proposed approach and discuss the future plans for applications with different data sets.

I understand the point and suggestions made by the first reviewer about considering the revised version of this manuscript as a research paper. However I would still designate this manuscript as a technical note rather than a research paper. Clarifications of the technical details would be more beneficial to the community. An addition of the “simulator” experiments and some discussion of the observability of derived EOFs can also benefit to this technical note that proposes a very interesting and promising approach for estimation and selection of observable CO2 sources and sinks.

Interactive comment on Atmos. Chem. Phys. Discuss., 11, 1367, 2011.