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Interactive comment on "Rebuilding sources of linear tracers after atmospheric concentration measurements" *by* J.-P. Issartel

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The paper considers an important research topic on the pollutant source term reconstruction based on measurements of atmospheric concentrations. The author focuses on the deterministic approach, based on adjoint transport equations. The method, considered in the paper, is not generally new, and essentially it was suggested in Russian scientific literature much earlier, than the references in the Introduction chapter. The methods of adjoint equations for different inverse problems were developed by Marchuk and his Novosibirsk school in 70th and 80th. A dual description of measurements by the integral functional (1) was also used since 60th (Marchuk (1992) gives a detailed description of this approach).

However, the author gives a nice demonstration/application of the method and further

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original developments of the inverse technique for rebuilding sources. The idea of smoothing the visibility of measurements was discussed and used in several papers (e.g. Pudykevwicz, 1998; Baklanov, 2000), but in this paper the author gives an elegant way of the smoothing by introducing the concept of "illumination" and makes a critical analysis of possibilities of the approach.

The work was professionally well done, with careful analysis of the mathematical aspects. It is very pleasant that the author also tries to analyse the physical interpretation of the method and further develop practical aspects of the method use for rebuilding sources.

I certainly recommend the paper for publication.

However, there are several critical comments to the paper.

In the introduction a wide spectrum of pollutant/tracer sources is considered for the discussed approach, however, from my point of view, the deterministic approach is most suitable for short-term emissions or accidental releases, but for long-term emissions (e.g., CO, CO2, methane) the statistical approach is cheaper and more relevant.

It is a long discussion about the terminology, and I don't like to continue it. However, the interpretation of "retroplumes" is not completely correct, because the concentration is a state function, but the weight function in (1) is a function of measurement/sample distribution. Therefore, formally, it is not fully correct to interpret the adjoint operator as an operator of inverse transport of concentration. It is better, following Marchuk, to call it as a function of the representativity or value. Penenko (1982) for non-linear problems used sensitivity functions for functionals of measurements. The source could be really negative in some very special cases (e.g., active cleaning, filtering, etc.). However, the deposition, gravitation settling, decay or chemical transformation processes should be considered separately in the equations, but not in the source term. If to consider the deposition or sink, for example, in the source term, as it is suggested by the author, it will lead to additional uncertainties of the method and some noises, because the negative

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part of the source is distributed in space and is not localised. It seams that the author received the adjoint equation intuitively, based just on some logical constructions. However, if to follow the adjoint equation theory, suggested by Marchuk (1972), the adjont equations could be received for different formulations of the direct atmospheric transport problem, based on the Lagrange identity /duality relation/. For example, the deposition, decay or chemical transformation terms can be easily deduced in the adjoint equation as well. In this case, there is no reason to consider negative values of the source term.

The turbulent motions in general are not time symmetric. It is so in a simple case of the isentropic turbulence. In other case, the turbulent term in the adjoint equation could have other, more complex form.

The algorithm of the orthogonal projection, considered in Ch. 3, is well-known and can be found in textbooks on the matrix theory, so it is reasonable to make this chapter shorter or, at least, to give a reference. Modifications of this algorithm, considered in Chs. 4 and 5, are very interesting, because they improve the method for the considered problem. It would be better to emphasize and make this part of the paper more visible.

It would be nice to write a short conclusion chapter in the paper. The text should be checked and corrected once more (some mistyping, style, etc.)

P.S. I'll give full references mentioned above later, when I'll be back from vacation to my office.

Interactive comment on Atmos. Chem. Phys. Discuss., 3, 3171, 2003.