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Interactive Comment

Interactive comment on "An inverse modeling method to assess the source term of the Fukushima nuclear power plant accident using gamma dose rate observations" *by* O. Saunier et al.

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General comments

The presented paper is of significant scientific and practical interest since it addresses an important question of how gamma dose rate measurements could be used in source inversion procedure following an accidental event at nuclear power plant.

Even though the problem of usage of gamma dose measurements in source inver-

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sion process had been addressed previously in several works and some of them used also variational approach (e.g., Tsiouri et al, 2012) to my opinion the most important contribution of this paper is in addressing the question of nuclide composition and in successful application of the presented method for the Fukushima case. Therefore the presented paper could be considered as the most advanced study available up to now in this field (source inversion with gamma dose measurements).

Specific comments

Some questions also arise from reading the paper.

1. It is clear that gamma dose rate measurements are most important for operational real-time source inversion. Therefore it is not clear how to choose automatically (in the real-time) the regularization parameters (λ_1, λ_2). The hyperparameter estimation method which is cited in the paper may be not suitable in a real-time since according to Winiarek et al. (2012), p. 2949 "the result of this estimation is very sensitive to the context and is also computationally demanding".

2. I believe the authors should say some more about particular dose rate calculation method which they used. For instance in the work of Tsiouri et al. (2012) results of source inversion appeared to be sensitive to particular dose rate calculation method (see discussion on p. 39 of the quoted work).

3. As far as I understood from the paper the release height had been uniformly distributed through the first 2 model layers (between 0 and 160 m AGL). Were the model results sensitive to this assumption?

4. It is stated in the paper that "the number of constraints must be at least equal to the number of radionuclides to be used for the evaluation of the release rate". May be there is small ambiguity and the number of constraints should be by 1 less than the number of radionuclides since when there is only 1 radionuclide there are not constraints (on radionuclide ratios)?

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5. There is very large uncertainty (5 orders) in ratio of the released Xe-133 to the released Cs134 (equation 11). Isn't this explained by the mentioned in paper volatility of noble gases? If this explanation is true don't authors think that it could be possible to use time-dependant restrictions on radionuclide ratios in such case (i.e., the more time after release happens the less could be upper bound of the noble gases)?

6. The logic in the last par. of the p. 15582 is not clear. The authors write that the sensitivity tests had been performed for $0 < \lambda_2 < 10^{-8}$ and revealed that the results are insensitive to that parameter but than they choose the value of $\lambda_2 = 10^{-12}$ which is far out of range of the sensitivity tests. Were the results with $\lambda_2 = 10^{-12}$ still insensitive to the value of λ_2?

7. Also in the same paragraph the meaning of the following sentence is not clear: "This result suggests that it is sufficient to reduce the dimensions of the inverse problem, thereby reducing the influence of the regularization term". Wasn't the dimension of the inverse problem already reduced at Step 2 (previous subsection)? What is meant by reducing the dimension of inverse problem here?

8. It is difficult to agree (par. 2 at p. 15574 and in other places) that $\sigma_b = 0$ means 'no prior knowledge of the source term'. It is more logically to consider that no prior knowledge of the source term is equivalent to the absence of the regularization term (or what is the same - to infinite diagonal values in matrix B) while $\sigma_b = 0$ means presence of prior source term having zero value. This mixture of terminology could be misleading.

References

1. Tsiouri V., Kovalets I.V., Andronopoulos S., Bartzis J.G., 2012. Emission rate estimation through data assimilation of gamma dose measurements in a Lagrangian atmospheric dispersion model // Radiation Protection Dosimetry. – Vol. 148, No. 1, pp. 34–44 (http://rpd.oxfordjournals.org/cgi/content/full/ncq592?ijkey=GAoAnw7zBtzhGXZkeytype=ref

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2. Winiarek, V., Vira, J., Bocquet, M., Sofiev, M., and Saunier, O.: Towards the operational estimation of a radiological plume using data assimilation after a radiological accidental atmospheric release, Atmos. Environ., 45, 2944–2955, 2011.

Interactive comment on Atmos. Chem. Phys. Discuss., 13, 15567, 2013.