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Interactive Comment

Interactive comment on "Inverse modelling-based reconstruction of the Chernobyl source term available for long-range transport" *by* X. Davoine and M. Bocquet

X. Davoine and M. Bocquet

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Thank you very much for your comment, which raises an important question.

Your are right in saying that it is difficult to compare inversions using Gaussian hypotheses and inversions using the MEM principle based on another a priori probability law for the source.

We felt compelled to add this comparison in the manuscript so that is made obvious that there are significant differences in the outcome.

The Gaussian approach (least-square or 4D-Var) has one parameter, which is the mass scale m. In this case, parameter $\sqrt{\chi}$ represents the same degree of freedom as the mass scale m. For the MEM approach used in the paper, these two parameters represent two degrees of freedom.

In the Gaussian case, in addition to m, one could add a mean value (the *first guess* of data assimilation), as you suggested. In the case of a positive law, there is no way to escape given a non-zero value to this parameter (essentially $m\gamma$), which is why there is such a difference of treatment with the Gaussian approach (this is not an arbitrary choice). But remember that γ is given a very small value so that the mean is very weak ($\gamma = 10^{-9}$), so that where there is not enough information in an area, the algorithm prefers to set the solution to zero in this area.

The corresponding idea, in the Gaussian case, is to set the average to 0. Still, if one ascribes a small value to this parameter in the Gaussian case, this won't barely change the solution. There would still be areas where the solution is negative.

Nevertheless to give a fair treatment to the Gaussian approach, we should have optimised the parameter m, in the same rigorous way we did for the MEM approach.

This is what we have checked, and we will update the manuscript accordingly. The optimal parameter is $m/\sqrt{\chi} = 4.5$. Then the result is similar to what was shown (with a total release activity of $1.09\,10^{18}$ Bq, instead of $1.66\,10^{18}$ Bq), but the negative areas are reduced. If one lowers m even more (it is then not anymore an optimal parameter), then the negative areas diminished significantly. But so does the total mass....For $m/\sqrt{\chi} = 1$, only $6.37\,10^{17}$ Bq are recovered, which is lower than twice less than the *true* value.

We will enhance and clarify the comparison Gaussian prior / positive laws priors. The corresponding L-curve will also be given.

Best regards,

Marc Bocquet

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