Discussion: Quantification of uncertainties in the assessment of atmospheric release source with application to the autumn 2017 ^{106}Ru event

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We thank Dr. Tichý for all his valuable comments, recommendations, and interest in the paper.

The manuscript presents interesting study based on estimation of atmospheric release from ambient concentration measurement coupled with atmospheric model. Few prior models of a release are presented, discussed and evaluated on Ruthenium 106 case from 2017. Here, there is consensus on release location and approximate release time-profile which makes this case very interesting and a playground for model testing. The manuscript is nicely written and clear to understand. What I lack is clarification and verification of some statements. I also recommend to extend conclusion (or discussion) by some suggestions and recommendations for future cases, see specific comments bellow. In sum, I would recommend the paper for publication after these clarifications.

Specific comments:

– p. 5, line 115: Although I understand the importance of lower values in measurements, there might be a good reason for high significance of higher values since they may bring more confident infromation wiht lower uncertainty, especially in case with spatialy and temporaly long transport.

  We agree that the fourth criterion results from a "multiplicative" consideration of the error distribution, which is not necessarily true. However, we believe that this simplification is relevant in the case where a limited number of hyperparameters are available to model $\mathbf{R}$. We have specified in the text that this criterion relies on this underlying simplification.

– Figure 2: I am curious whether similar results are obtained for latitude. Considering the dominant direction of the atmospheric transport is probably in longitude axis, it is maybe different in latitude axis. Please, comment.

  The difference in std for the latitude is indeed lower. We have chosen a special case where the difference is very important. Please see figure 1 for the difference between the latitude distribution with observation sorting algorithm (for two different threshold values) and without observation sorting algorithm. In most scenarios, and for most variables, the difference between the stds of reconstructed distributions with and without the application of the sorting algorithm is about 10 to 30 %.

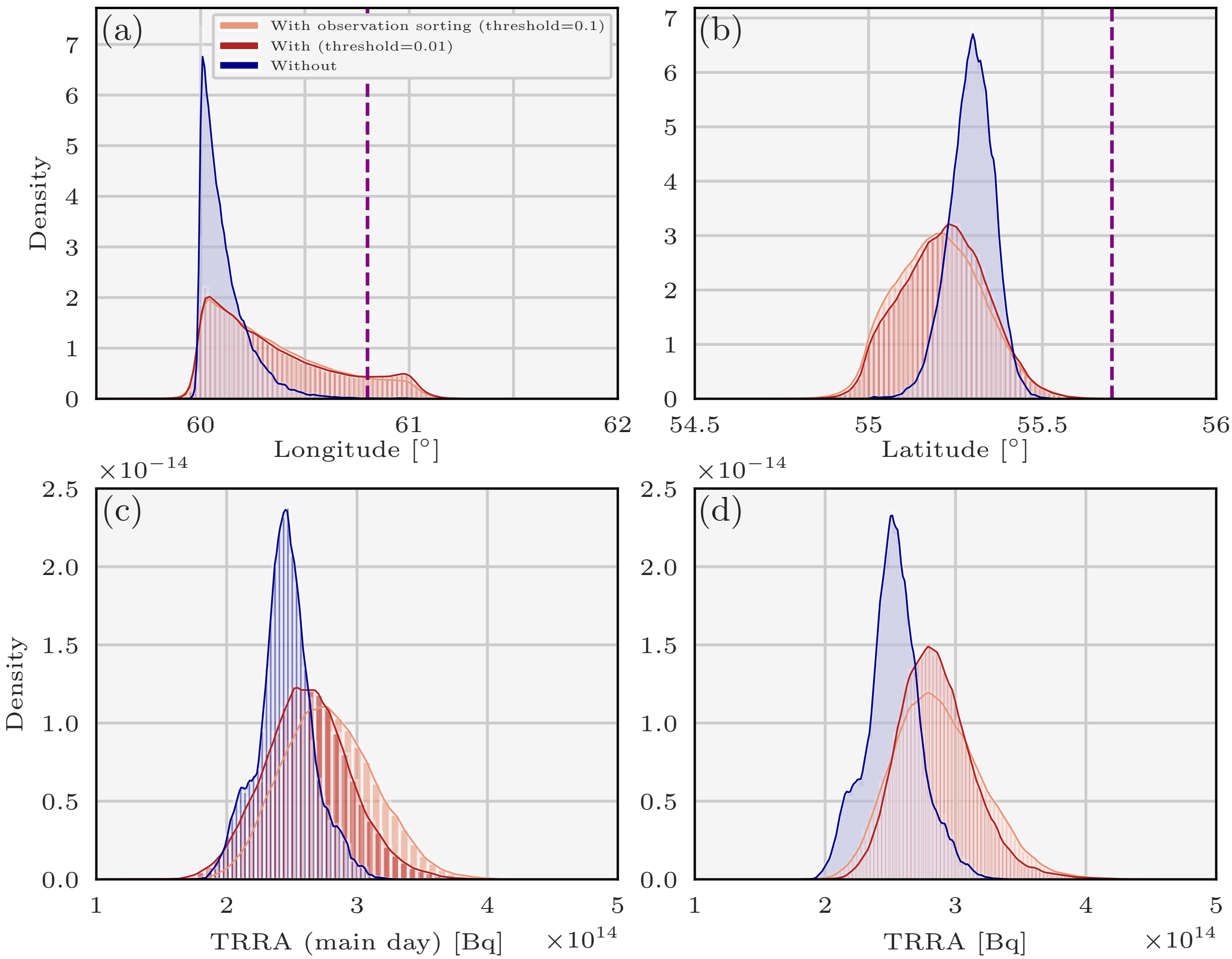

Figure 1. Density of the variables describing the ^{106}Ru source for a log-Laplace likelihood with threshold $y_t = 0.1\,\mathrm{mBq.m^{-3}}$ of the Ruthenium source sampled with the enhanced ensemble of observation operators using the parallel tempering method with or without the help of the observation sorting algorithm. When applied, the threshold of the observation sorting algorithm is $\epsilon_d = 0.1\,\mathrm{mBq.m^{-3}}$ or $0.01\,\mathrm{mBq.m^{-3}}$.

– p. 14, line 375: Regarding temporal profiles of the estimated release, what is exactly the time-resution of the posterior, is it one day? Is it possible to plot the release profiles somehow, e.g. using medians or similar? Did you estimate some significant activity also in other days except 25th and 26th September?

The release is estimated as a vector of daily release rates. Each release rate on each day between the 22nd and the 28th is estimated as a 1D variable. We plot the evolution of the release rate (using medians and variances) on figure 2. No significant activity is estimated in other days except for the 25th or 26th as described in our first paper (Dumont Le Brazidec et al., 2020). There is however an exception in the case with the enhanced ensemble of observation operators, with a log-normal likelihood of threshold 3mBq.m^{-3} (the coordinates of the source distribution is displaced and so is the release.)

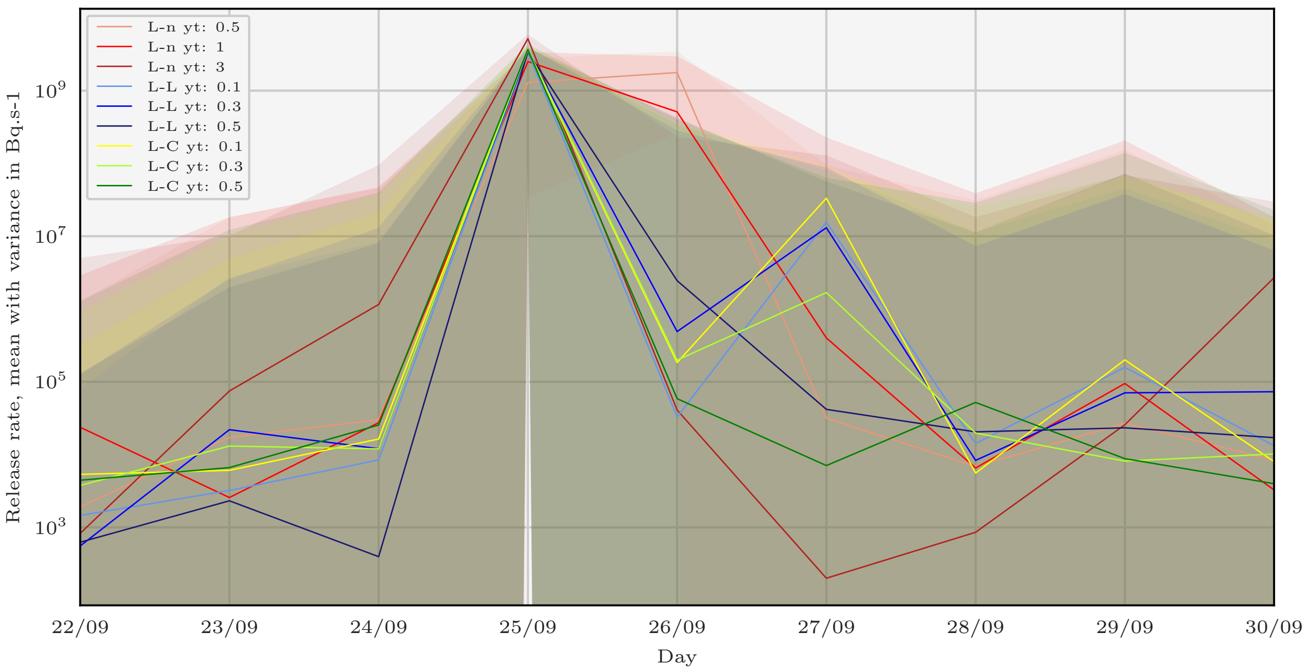

Figure 2. Evolution of the release rate of ^{106}Ru for several likelihoods with several thresholds sampled with the enhanced ensemble of observation operators using the parallel tempering method with the observation sorting algorithm. Line represents the median. Area with less opacity represents the area between the mean added to the standard deviation and the mean minus the standard deviation.

- p. 17, line 398: Could you please clarify the choice of reference source in [60, 55] while Ozyorsk (near where the plant is located) is located at 60°43' E 55°45' N and modelled spatial resolution is 0.5 degree? Shouldnt it be closer point [61.5 55.5]? Or maybe you have different numbering, please, clarify.

  We used the source of the Saunier et al. (2019) retrieved using inverse problem methods instead of the Mayak facility as reference.

- In general, I lack discussion and recommendation what settings should one choose when situation similar to the Ru-106 case occur in the future and, let say, one location and one total of the release need to be reported. Also, are your findings rather general, or case specific?

We believe the most trustworthy results are to be found in the Figure 7 where all methods are applied at once. If one had to give a single location, it must be at the peak of most longitude distributions (60 degrees) and latitude distributions (55.15 degrees). For what concerns the release magnitude, the total of the release posterior distribution maximum is around 300-350 Tbq. But the beauty of Bayesian results is that we have access to a full range of possibilities instead of a single optimum!

Furthermore, we believe that the methods that we exploit are rather general. Each of them can be applied on any type of accidents.

Technical corrections:

- p. 3, line 63: S should be defined in term $\mathbf{y}_S$, probably Sth obsevation

  We are not sure to understand. S goes for simulation if this is the question (with $\boldsymbol{y}$ being the observations vector, $\boldsymbol{y}_S$ is the predictions vector or simulated observations vector).

- Eq. (2): the $\mathbf{x}$ is used as the source term previously while $\mathbf{q}$ it is used here. Please, clarify whether they are the same of have different meanings.

  x is the ensemble of variables describing the source that we want to sample and q is the source term : the vector of release rates. q is included in x.

- Eq. (5a-5c): norm with two indexes in subscript should be defined (although clear for many readers, for many may not).

  The definitions have been added. Thank you.

- p. 5, line 141: "Secondly, a location term appears..." I am not sure what you mean by this statement, please, clarify.

  We have clarified this sentence.

- p. 6, line 163: there sould be (5c) instead of (6), probably.

  This is not the original definition of the log-Cauchy cost. We have added a threshold term to the log-Cauchy definition in this equation.

- Figure 8: there are missing labels (a) - (f) in subplots.

  This has been added. Thank you for all your comments.

Thank you a lot for these interesting comments.

References

Dumont Le Brazidec, J., Bocquet, M., Saunier, O., and Roustan, Y.: MCMC methods applied to the reconstruction of the autumn 2017 Ruthenium-106 atmospheric contamination source, Atmospheric Environment: X, 6, 100 071, https://doi.org/10.1016/j.aeaoa.2020.100071, 2020.