Atmospheric
Chemistry
and Physics
Discussions

Interactive comment on "**Inverse modelling of the Chernobyl source term using atmospheric concentration and deposition measurements**" *by* **Nikolaos Evangeliou et al.**

Anonymous Referee #1

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General Comments:

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The manuscript under review presents an inversion analysis using the FLEXPART model of radio-isotopes of Cs and I, emitted after the Chernobyl nuclear power plant accident, using an expanded set of measurements (including deposition) to estimate the source term.

The source estimates were evaluated using a Eulerian transport model, and systematic uncertainties are quantified with sensitivity tests.

The authors address scientific questions within the scope of ACP, with valid scientific

methods and assumptions. Overall, the description of experiments and calculations are sufficiently complete and precise. The language and presentation can be somewhat improved (see specific comments below).

Specific Comments:

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1. On the choice of re-analysis dataset - isn't ERA-Interim more suitable as a primary database due to the higher resolution and 4D-Var assimilation? Also, see point 6 below on how it was decided which dataset gives better results. Can't the uncertainty be additionally quantified using an independent reanalysis dataset to drive the inverse model (e.g. NCEP)?

2. Though there is indeed uncertainty about the gas/particulate fraction of Iodine-131 emitted at Chernobyl, it's not well advised to model the radionuclide in the particulate form. Atmospheric measurements have revealed a gaseous/total atmospheric ratio of ∼80% (Ring of Five). This could significantly impact atmospheric residence times and deposition patterns. Thus a quantification of the uncertainty impact on the final emission estimate is required.

3. Section 3.3: When dealing with priors as an ensemble are they simply numerically averaged or do their individual uncertainties used to weight (as is more appropriate)?

4. Section 3.4: The i) magnitude, and ii) doubling of deposition over concentration uncertainties seems arbitrary, and should be better motivated.

5. Section 3.5: Doesn't nudging the dynamical model to ERA-Interim (used in the inversion) limit it's potential as an independent check of the emission inventory improvement?

6. Section 4.1: It is not clear if comparison of ERA-40 and ERA-Interim was and selection of the "proper" using RMSE was done selectively for certain "previously inaccurate" regions only. Perhaps the text can be reworked to be made clearer?

Technical corrections:

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Abstract: l.2 The present paper -> This paper l.6 the real magnitude -> the magnitude l.10 Remove "because radioactivity is a sensitive topic for the public and attracts a lot of attention" l.17 give such kind of -> provide available l.25 Please rephrase sentence "The results were of the present inversion were confirmed using an independent Eulerian model, for which deposition patterns were also improved when using the estimated posterior releases" to make meaning more clear

Section 2: p.4 l.33 good estimations -> estimates p.4 l.17 largest -> bulk of the p.4 l.31 supposedly -> reportedly

Section 3: p.5 l.20 bomb -> weapon

Section 4: Rename section 4.1 to "Meteorological datasets results comparison" p. 14 l.12: May 3rd, 4th and 5th -> May 3-5 (and similarly elsewhere...) p. 14 l.14: Chapter 2? p.15 l.8: less -> lower p.16 l.12: is the main advantage of -> improvement by

p.18 l.23-27: No need to list all countries (and country codes) here. Please remove and reference for brevity.

p.19 l.7-9: Rephrase sentence: "Unfortunately, considering that 131I has a lifetime of only about 8 days, it was impossible to gather any observations of 131I deposition over Europe" -> "observations of 131I deposition over Europe are unavailable, due to the short half-life"

Figure 1: The uncertainty bands of the different priors are unintelligible. This Fig is not necessary and can be removed. Priors per radionuclide can be broken into individual figures and provided in a Supplement.

Figure 5: Why are only 3 emission heights levels plotted, and not all calculated?

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