Geoscientific
Model Development
Discussions

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Interactive comment on "Uncertainty in Lagrangian pollutant transport simulations due to meteorological uncertainty at mesoscale" *by* W. M. Angevine et al.

Anonymous Referee #1

Received and published: 2 September 2014

1 General

The paper addresses the relevant issue of quantification of uncertainty in mesoscale modelling and atmospheric transport modelling. It makes a limited contribution which is, though, well defined and the underlying analysis appears to be well designed.

2 Specific remarks

1. A major part of the paper deals with uncertainties of meteorological parameters in the WRF output. This makes sense, but it should also be reflected in the title, which only mentions uncertainty in transport simulations.

2. The issue of uncertainty estimation through ensemble techniques in meteorological and transport modelling is vast and it is clear that a piece of work as this here can only cover some limited aspects. Therefore, it is important that the limitations of this study are clear communicated. This would for example include climatic region, season, receptor points compared with observations (e.g., only limited set of surface data, not representing specific features such as topography, coastal, etc.). Furthermore, with respect to the tracer simulation, the spatio-temporal release pattern is important (results could be quite different for point sources). There may be more such aspects. In general, a complete error description has to include also the spatio-temporal covariance patterns – not that I am expecting this study to deliver it, but it deserves to be mentioned.

3. Meteorological parameters are evaluated one by one, without looking at the error covariance between them, which obviously could impact the transport. Also vertical motion is not considered.

4. The main results are presented almost exclusively as spreads / standard deviations / RMSE normalised by the mean value of the quantity under consideration. Even if partly regions with "low values" are left white in the plots, such a ratio is obviously sensitive to this normalising value in the denominator. The authors themselves dismiss a potentially important result (comparison of model error to ensemble spread for CO) as not robust. It would be very useful to show and discuss also absolute values. Scatter plots (double-log), probably the most common form of presenting model-observation or model-model concentration values,

should also be included.

5. Page 4604, line 20: While backward runs *may* be used to invert measurements for finding source emissions, neither are backward runs necessary for this purpose, nor is this their sole application.

6. Please avoid the wording "NWP model or reanalysis" – reanalyses are produced by NWP models. What you mean is probably operational NWP model output or reanalyses.

7. In this paper, "FLEXPART" is used for the WRF version of this Lagrangian model, which is a branch-off from the main version running with ECMWF or NCEP global data. I think it would be more clear to use the designation "FLEXPART-WRF".

8. At first (p. 4605), mesoscale simulations are defined as resolving features of 10 km in size. Then we are told that simulations were done with 12 km grid spacing. This is a contradiction, as such simulations will resolve only features larger than 24-48 km. One should also note that ECMWF now produces 0.125 degree output – corresponding to the WRF simulations used. If it is still possible for a revised version to include ECMWF fields into the comparison, it would be very valuable.

9. As runs were reinitialised daily, I presume that no grid nudging was done. Please state that clearly, and also explain the rationale for this approach (what about discontinuities between runs and how they affect transport simulations?).

10. Of course, soil moisture is an important parameter. However, one should keep in mind that also soil temperatures could be an issue.

11. On page 4614, line 20, rank histograms are introduced through a reference. Please explain this quantity sufficiently well to let readers understand you results without having to look up this reference.

12. I found the meaning of the columns in Table 7 not easy to comprehend. Please try to improve description. Each column should be explained in the caption, referring to it by number or by quoting its column head. Do not use abbreviations such as "std.dev." in the caption. On the other hand, some information such as details about data points can be replaced by links to previous explanation or the text.

13. Figure 1: The size ratio between the maps and the colour bar is disproportional. One of the maps, e.g. the station map, should show the mean CO emission field rather than terrain, as the distribution of the emissions is quite relevant for understanding the results.

14. Figures 2 and 3: Please make sure that the observations are clearly distinguishable from the simulations (e.g. thicker line).

15. Finally, GMD has a data policy – however, it seems this policy is not applied. At least there should be a statement on data availability.

Interactive comment on Geosci. Model Dev. Discuss., 7, 4603, 2014.