Interactive comment on “Sensitivity model study
of regional mercury dispersion in the atmosphere”
by Christian N. Gencarelli et al.
Anonymous Referee #1
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The manuscript reports the model results of a number of carefully crafted sensitivity simulations under different scenarios of mercury emission inventory (AMAP and EDGAR) and chemical oxidation (O3, OH and Br) of elemental mercury in air, using WRF/Chem-Hg and CMAQ-Hg. The model results and data interpretation are presented in a organized fashion; and the conclusions are useful for better understanding of the chemical transport of mercury at regional scale. There are a few minor points that can be explained in more detail. I recommend the manuscript be accepted for publication after clarifying the points or providing the discussion of the following:

P4L27. The authors claim that the deposition parametrisation does not have an effect on the ratio of simulate dry to wet deposition. This is somewhat surprising and should be clarified.

We think the referee may have misread the sentence,
“The differences in deposition parametrisations does have an effect on the ratio of dry to wet Hg deposition however.”
We purposefully used “does have” rather than “has” in order to emphasize the fact that the dry to wet deposition ratio changes, as is clearly stated in the sentence that follows,
“While dry and wet deposition are almost equal in the WRF simulations (wet 49%, dry 51%), the dry deposition in CMAQ is more than twice the wet (69% dry and 31% wet), see Table 3, Fig. 3 and Fig. 4 for details.”

We have therefore left the text unchanged.

Figure 5. The authors rank the ratios from high to low. Discussion should be provided regarding what causes the spatial difference should be provided.

This is an interesting suggestion. Unfortunately it was not possible to identify obvious spatial patterns, although in the stations located around the Baltic Sea a general overestimation of WD measurements by the model is noted.
Generally for GEM atmospheric concentrations there is a general underestimation in the WRF model simulations and an overestimation in CMAQ model simulations.
For wet deposition values the CMAQ model tends overestimate the observations, especially in Scandinavia, England and at Longobucco. On the other hand the WRF model has different characteristics: in Scandinavia the observations are always overestimated when compared to the rest of the domain, in the BASE2 experiment the greatest overestimation occurs while in the ANTSPEC experiment there is a general underestimation almost everywhere (given the lack of RGM emissions it is not surprising that the deposition is lower in this experiment).

These comments were added to section 3.1.
according

It appears that (1) the variability of simulated concentration does not match the variability of observed concentration, and (2) the simulated wet deposition grossly underestimate the observed values. (Figures 6 and 7). Discussion regarding the reasons should be provided.

(1) It is normal that the ratio is not equal between measurements and model values, otherwise the ratio should always be 1 (perfect agreement). But a fairly accurate agreement consists in having

the ratio within the range of uncertainty in the literature (dashed lines in figure 5: 30% for the GEM air concentrations, figure 5a, and factor 5 for wet deposition, figure 5b)
(2) Regarding the wet deposition in the estimation of these fluxes many more factors are involved (e.g. estimation of rainfall, coalescence efficiency), which increase the inaccuracies between observed and modeled values. In fact the literature range of the uncertainty is much larger.

With these suggestions the comments to Figure 5 have been expanded

It is somewhat disappointing that the authors paid little attention to the simulated concentration of gaseous oxidized mercury, considering the experiment on the oxidation mechanism of gaseous elemental mercury. Discussion around this topic is of scientific interest and should be provided.

We initially planned to only discuss the model results which in part can be compared with the observations. Considering that we do not have enough RGM measures to harmonize the discussion, we avoided including these results. However these results have been added in section 3.3 and the maps in figure 10 now show the average concentrations of modelled RGM for the main experiments (BASE, ANTSPEC and BASEc) and the ratio with respect to the sensitivity runs.

After such an expansive modelling assessment, the authors may want to provide a synthesized conclusion regarding regional model configuration (chemistry, emission, etc.) for atmospheric modelling.

A more extensive description of the models and the differences between them was added in Section 2.1, as suggested also by Referee #2.