

## ***Interactive comment on “Assessing the nonlinear response of fine particles to precursor emissions: development and application of an Extended Response Surface Modeling technique (ERSM v1.0)” by B. Zhao et al.***

**Anonymous Referee #1**

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The paper presents an extension of RSM to ERSM, to manage emission reductions from multiple variables/geographical domains. In my opinion at this stage there are some issues to be modified in the paper, to improve readability and comprehension of the work.

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INTRODUCTION At page 5053 (line 20) and page 5054 (line 5) it is stated that "...number of scenarios required to build the RSM depends on the variable number via an equation of fourth or higher order...". This depends on the family of models chosen  
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for RSM. I.e., in machine learning theory, other approaches exist with different requirements in terms of number of simulations. Please try to extend this part. Also, in surrogate modelling, various steps could be implemented to reduce the number of required simulations (apart from the family of models chosen). Please try to extend this part, commenting also this issue.

At page 5054 (end of Introduction) you should clearly state the advantages of ERSM in comparison to RSM...I think pros mainly refer to the possibility to use (in comparison to RSM) an increased number of variables/geographical areas, but it is not clearly stated.

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METHODOLOGY In general, I find this part of the paper (important, because it presents the ERSM approach) quite complex/obscure. I suggest the authors to re-structure this section, because now it is quite complex to follow how the model is identified, and how the various equations interact. I.e. a diagram/flow chart of the required steps/equations to be used could be quite beneficial.

At page 5056 (line 10) the number of simulations required for RM is presented (30 and 50 scenarios) but no explanation for this is provided. There is indeed a citation, but I would suggest authors to better integrate/explain this part.

Some assumptions are presented (pag 5058, line 5; pag 5059, line 1-5) in the paper, to justify some of the choices done by the authors in the equation implementation; I would suggest to better explain why these assumptions are taken, and which are their implications.

At pag 5061 (line 27) authors say that 663 scenarios are required...again, please specify how this number is computed. I think this number depends on the number of variables/geographical areas chosen. But if this is the case, it means that this ERSM approach is really in my opinion too demanding in terms of CTMs simulations (600 simulations is really a huge number, in my opinion). Also, the set of CTM simulation

is quite strictly dependent on some assumptions (choice of geographical areas, choice of variables) that could be quite uncertain starting a new study...if these assumptions changes due some further analysis, one should recompute the CTM hundreds of simulations? Please clarify this point.

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RESULTS AND DISCUSSION It seems to me the paper deals with analysis on January and August periods...please explain how one (if possible) could extend this analysis to the full year (i.e. to analyses possible structural emission reductions).

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CONCLUSIONS I would discuss (in the conclusions, or somewhere in the paper) issues about - how to deal with meteorology variability in this approach - how uncertain is the model identification - as already said, the limitations of this approach (need of hundreds of simulations, that depend on assumptions on geographical areas/variables, etc...).

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FIGURE I would keep, as an example, only Figure 3 (Figure 4-5 in my opinion are not needed).

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Interactive comment on Geosci. Model Dev. Discuss., 7, 5049, 2014.