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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Nudging technique for scale bridging in air quality/climate atmospheric composition modelling" *by* A. Maurizi et al.

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We thank the anonymous referee for starting the discussion on the paper. His comments are very interesting and worth a discussion.

We focus here on the main point raised: the lack of verification against data. It is our strong opinion that model experiments without verification hardly provide full answer to the ideas behind. Concerning this specific experiment, before confirming that the ideas developed here are verified and useful, an intensive analysis of performances against experimental data is needed.

However there are some considerations we would like to report here that can relax the above statement, at least for the present methodological study.

The frame we had in mind was the application of some technique to the problem of bridging the scales between a coarse resolution (e.g. global) and a rather finer resolution model (regional, local). In our picture we must assume that both models use appropriate emission data and are verified against data themselves and, most importantly, the higher resolution performs better than the low resolution. In fact, the focus of the nudging technique is not a matter of refining the resolution of a single model, for which limits of applicability of the approximations and parameterizations must be considered, but rather of matching two different models in their respective domain of applicability.

The original statement: "(...) this assumption relies on the consideration that once the input is known at any resolution, the quality of the solution of a discretised system of equations increases with increasing resolution" as noticed by the referee, is not correct in general, but actually it is not even needed in the context of the definition of the general idea.

It is worth spending few words on the assumption that the fine resolution model performs better than the coarse one. Sadly this is not true as a general statement for state-of-the-art models. Experiences in recent Projects (e.g. GEMS), where comparison of several models were performed, no clear evidence of quality increasing with resolution was found. This means that, happily, much room is left to research in the field.

In any case, the aim of our work was to present the general features of a new method rather than performing a validation. Providing a complete (though not definitive) assessment of the method, using therefore two different models, will require a greater effort. To simulate the picture above we used the same model at two different resolutions. The resolutions selected were well within the limit of applicability of the model and we thought that even a ratio of 5 between the two resolutions was enough to test the idea.

For the nudging technique to be meaningful it is necessary that the finer resolution simulation is closer to the data compared to the low resolution. Within the project Cityzen we performed an experiment that aimed at verifying the improvement against data with the nudging technique in a different region (BeNeLux) for a different year (2006). Results show that most of the times (> 80%): - HR-r is better than HR - HR is better than LR - LR-N is better than LR. Unfortunately, improvements are not significant (few percents). We're sure we could find a test case where the improvement is significant but a single test case study would not represent the real performance of the nudging technique.

We are confident that our model performs just like others (comparison performed over several years with data and other models in GEMS and Cityzen) so we don't think that the small increase of model performances with resolution is related to our specific model but is it of general "value".

As the reviewer also noted, the paper is missing an explicit evaluation of the variations outside the forcing area. This will be done running the HR simulation over an extended domain and the corresponding discussion will be added to the final version of the paper.

Careful attention should be paid to the choice of the emission databases. Emissions in the fine resolution area should be as accurate as possible. One possible weakness of our work is that the emissions were generated by a top-down approach: their spatial distribution was made finer using proxies like population, and so on. Thus, the fine resolution simulation do not benefit of a real increase in the emission details.

Based on the above arguments, we excluded the comparison with data choosing to present a pure methodological study on the nudging, making it available for further investigations also by other researchers. In case the paper will not be rejected in the present form, along with answers to other referee's comments, we will add a throughout discussion of all the above points.

Interactive comment on Atmos. Chem. Phys. Discuss., 11, 17177, 2011.