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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.

Anonymous Referee #1

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General comments

In this work it is proposed to use the nudging technique to force a low-resolution chemical-composition model simulation with a high resolution run. The idea is interesting and it is well illustrated. The authors performed a sensitivity analysis through a numerical experiment and concluded that the approach is promising but further investigations on some main issues are needed. I feel that a weakness of the paper lies in the fact that the approach used has not been verified against observed data. In fact, the low-resolution (LR) results are tested only versus the high-resolution (HR) outputs. The changes are supposed to be 'improvements' since the LR-N run is more similar to the HR one than a no-nudged LR. The main results are that (1) with the forcing through the HR-r nudging there is a visible improvement of the LR-N performance in the core

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area; (2) the effect of the nudging is recorded also in the outer areas: this is expected to be positive but a clear statement is not made. This last is a delicate issue and should be somehow verified, since it might happen that a 'local nudging' spoils the simulation in the outer region of the larger domain with a not-realistic forcing towards the local conditions themselves. In particular the Po valley is a rather critical region, on the topographical, meteorological and air quality viewpoints. Therefore a special care has to be taken when applying here the nudging technique. The work in its present form risks to appear just like a numerical test, while the intention of the authors is clearly to pursue a wider scope. To apply the proposed technique at least to a case study would make the work more complete, more quantitative and would rise the possibilities of its definitive publication. Also, more discussion on some of the obtained results would improve the understanding of the proposed approach. In the following, some detailed remarks and suggestions are listed.

Specific comments

1) Introduction, Page 1. The two-way nesting is not used that seldom, at least in the meteorological frame: refer for this to the literature on atmospheric regional-scale models.

2) Introduction, Page 2. About: " (. . .) 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." This is sensible but not fully convincing, since the discretised system of equations may be built on the basis of approximations and hypotheses that do not hold anymore at smaller scales and higher resolutions.

3) Section 2, Page 2. Please, explain what was actually done 'by conservatively remapping' the HR fields to obtain the final forcing term HR-r. Also, briefly illustrate the 'variety of reasons' for which HR-r should perform better than HR when compared to data. This would help the reader to better understand the rationale of the approach without having

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to read the referenced article.

4) Section 4, Page 3. Please, specify the height of the first model level above the ground. Maybe in Section 3 the authors could give the detail of the vertical grid also. It would be worth to try interpreting the different effect that the nudging has on the different species and its dependency on the season.

5) End of Subsection 4.1, Page 3: please provide the time scales that are discussed, for the O3 production and the 'mixing time' in the Po Valley. How was this last defined and/or estimated?

6) Beginning of Subsection 4.2, Page 3: "The usefulness of the nudging technique is summarised in the ability to influence the simulated concentrations outside of the forcing area." As said before, the assumption that the nudging technique is successful when it influences the simulated concentrations also outside of the forcing area is a critical aspect and should be discussed as such. It is not automatic that the outer-region effect is surely positive and that it would lead to " (. . .) an overall improvement of the skill of the low resolution run also outside of the forcing area" (as in the general part of Section 4).

7) Subsection 4.2, Page 4. Here also it would be worth to try interpreting the results (as partially done only in the Conclusions): the nudging's different effect on the different species, the dependency on the season, the possible role that the meteorology could play.

8) Conclusions, Page 7. After recalling the main results, the possible limitations of the proposed method should be discussed in a deeper way, before passing to the speculative idea of applying it to couple two different models.

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