Interactive comment on "Online coupled regional meteorology-chemistry models in Europe: current status and prospects" by A. Baklanov et al.

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General comment:

This is a very relevant and timely paper, which can be used by the scientific community for quite some time as a reference for on-line coupling of meteorology and climate. It pleases me to see the large author list which will ensure a solid foundation with respect to knowledge of in-line models that are in use today. Congratulations. I have a comment and suggestion concerning climate driven emissions, in particular ammonia. Ammonia and ammonia fluxes are highlighted several places in the manuscript and in the conclusion, and the authors propose improvements in relation to how on-line coupled models should handle ammonia emissions. This topic has recently been covered in another article. I will therefore suggest that authors consider the article with the title "Towards a climate-dependent paradigm of ammonia emission and deposition" by Sutton et al (2013) and in particular Figure 8 plus the most central studies that have been used to construct Figure 8. This figure suggests a new approach for handling ammonia emissions in atmospheric models. This is relevant for section 4.7.1 and section 7.2.1, where the latter is in the chapter "major challenges and needs".

Thank you for reviewing our manuscript and providing positive feedbacks.
We have incorporated all your comments and suggestions in the revised manuscript.
Please see below our point-by-point replies to the specific comments (in read), following your remarks, which we copied and kept in black.

Specific comment:

The basic concept in the new paradigm is that ammonia emissions cannot be known for sure, before the meteorology has been calculated! Therefore, scientists will cause uncertainty in ammonia emissions by fixing the ammonia emissions to the prescribed annual values (e.g. from EMEP or MACC) or by fixing the emissions to prescribed seasonal and daily profiles. This uncertainty can be substantial! A good example is ammonia emissions in relation to animal operations (e.g. housing or storage or application of manure). The emission from these operations is expected to increase exponentially with increasing temperatures. So identical activities in the agricultural sector (e.g. application of manure) will cause changed ammonia emissions when there is a change in weather or climate. This effect is in general not taken into account in official national inventories. To me, then the obvious solution to this problem is to include the calculation of ammonia emissions on-line coupled meteorology-chemistry models. Secondly, then there will be a redistribution of nitrogen in the atmosphere-biosphere system. This can be handled by a bi-directional model. The authors have correctly pointed this dependency out, e.g. in section 7.2.1. A bi-directional module will ensure the redistribution of the existing nitrogen within the model system which is mainly relevant for chemical simulations. And this redistribution can also be substantial! But the authors have missed the very important point that it is the dynamics of the meteorology that cause many of the variations and uncertainties of the emission of ammonia into the system. The authors partly cover this by the sentence on page 12581, line 17-18 where they state that the model improvements should include dependence on meteorology, agricultural practice and bi-directional exchange. In my opinion this statement is not enough. Instead the models should be allowed to deviate from prescribed emissions

in order to fully take into account climate and meteorology, which directly affects ammonia emissions and indirectly by affecting agricultural operations. It is my impression that a full dynamic implementation of ammonia emissions will cause a cascade of effects that needs to be explored with on-line models.

Suggestion:

I will suggest, that the authors consider if the paradigm by Sutton et al (2013) can be directly adapted by on-line models without modification or if the paradigm (including existing paramterisations) needs modifications to be usable by on-line models. If so, then I am asking for a few details on which parts of the paradigm (including parameterisations or data sets) that can be used directly and which parts that needs more work. Such recommendations will be valuable for the scientific community and the on-going work in both Europe and USA.

All suggested references including Sutton et al (2013), Bash et al (2013) and Pleim et al (2011) have been added. The subject has been linked more explicitly to the deposition section to stress the coupling with land use/vegetation/soil moisture, as they are also relevant for e.g. ozone or mercury. The importance of calculating ammonia fluxes online is highlighted more in the conclusions. We did not go into much more detail, since the direct relationship between emissions with meteorology does not only hold for ammonia but in fact for many more emission sources.

Reference:
Sutton et al (2013), Towards a climate-dependent paradigm of ammonia emission and deposition. Phil Trans R Soc B 368: 20130166. http://dx.doi.org/10.1098/rstb.2013.0166