We are pleased that reviewer 1 considers the manuscript to be of relevance and of interest to ACP readers. We have addressed the specific comments raised by reviewer 1. Furthermore, then the ACPD manuscript has been proof-read by a fellow scientist with English as mother tongue. Below we have answered each of the questions by reviewer 1 and also provided a full list of changes due to both the proof reading and the requests from reviewer 2, especially with respect to a discussion of the national emission ceilings (NEC).

Referee 1

General comments from reviewer 1

The manuscript 'The effect of climate and climate change on ammonia emissions in Europe' models the affect of climate change in the form of increased temperature on ammonia emissions from a typical Dutch 1000 animal pig stable. Because higher temperature increases the ammonia volatilization, ammonia emissions are found to increase with increasing temperature. The manuscript recommends that chemical transport models should use dynamical methodology to simulate ammonia emissions, similar to the methods used to simulate biogenic volatile organic compound emissions.

The manuscript is of interest to ACP readers. Editorial issues need to be addressed before publication.

Answer to the general comment from reviewer 1:

We have made the analysis for a storage related to a typical Danish pig stable and not a Dutch stable. However, the difference in the management between a typical Danish and Dutch pig stable is minimal (Klimont and Brink, 2004), which is the information that is used in the GAINS model (e.g. Klimont and Winiwarter, 2011). This includes storage facilities (9 and 8 months) , housing time (343 days and 365 days) and how big a fraction of the manure that is applied to arable land (86% and 80%). In fact, this information was used to construct Table 2 in Skjøth et al (2011). It was also due to this information, that a storage associated to pig stable was chosen as example. They have the most uniform management in central to northern Europe, although even small differences in handling (e.g top loading vs bottom loading) is known to affect overall emission rate (Muck and Steenhuis, 1982). The editorial issues and the specific comments from the reviewer are addressed in the following.

Specific comments from reviewer 1

The English grammar and spelling of this manuscript needs to be rechecked. For example in the abstract, line 5-6 'to investigating the spatio-temporal . . .' should be changed to 'to investigate'. There are numerous examples of misuse of verb number throughout.

Answer to the specific comment from reviewer 1:

The manuscript has been proof read by a native English speaking scientist.

Specific comments from reviewer 1

In addition, throughout the manuscript, the authors unnecessarily state if a citation is from a high profile journal, i.e. 'Nature' or 'Nature Geoscience'. Journal names are listed as part of the full reference and that is sufficient. Such usage in the following lines should be removed

Answer to the specific comment from reviewer 1:

We have removed this type of referencing. We have provided a full list of the changes at the bottom of this reply.

Specific comments from reviewer 1

P23405, line 23

Answer to the specific comment from reviewer 1:

We have here referenced Sutton et al (2011) as the Nature commentary by Sutton et al. (2011). We have changed the writing according to the recommendation by the reviewer and removed the name of the journal.

Specific comments from reviewer 1

P23407, line 14

Answer to the specific comment from reviewer 1:

We have here referenced Arneth et al (2010) as in a review in Nature Geoscience by Arneth et al (2010). We have changed the writing according to the recommendation by the reviewer and removed the name of the journal

Specific comments from reviewer 1

P23417, line 15, In this line no actual papers are referenced only the journal Nature. It is necessary to reference the papers themselves.

Answer to the specific comment from reviewer 1:

We have changed the formulation from

"To our knowledge dynamical models for ammonia are not under development in global models, although several Nature papers have stated that the nitrogen issue is probably one of the biggest challenges humans will face in the future under an increased population load (Gruber and Galloway, 2008)."

Into

"To our knowledge, then all global models rely on fixed NH3 emission inventories such as those presented by Beusen et al., (2008). Dynamical models for ammonia emissions are currently not considered in global models such as Geos-Chem (e.g. Heald et al., 2012) , although a number of authors have stated that the nitrogen issue is probably one of the biggest challenges humans will face in the future under an increased population load (Arneth et al., 2010; Gruber and Galloway, 2008; Sutton et al., 2011)."

Specific comments from reviewer 1

P23419, lines 8 and 9.

Answer to the specific comment from reviewer 1:

We have removed “in Nature”

Specific comments from reviewer 1

In addition to superfluous usage of journal titles, the authors also refer to a scientific meeting on P23417, line 22-23 in a haphazard way. Many scientific meetings and conferences have sessions dedicated to the nitrogen cycle and ammonia emissions. If the authors feel it is necessary to cite the meeting, then some type of proceedings or abstract reference must be given.

Answer to the specific comment from reviewer 1:

The particular meeting included also the production of a proceeding for the Journal “Proceedings of the Royal Society, Part B”. As co-authors we knew that the proceeding was underway, but we did not feel comfortable to cite a publication that was in preparation. The proceeding has now been submitted and the reference (Sutton et al 2011) can be replaced with the new reference (Sutton et al., 2012) that includes the proceeding.

Specific comments from reviewer 1

How good are the ammonia emission inventories? The authors claim that emissions can easily vary 20% within a country due to climatic considerations. What is the uncertainty in the emissions inventories themselves? Recent work by Heald et al, ACPD 2012, Walker et al, ACPD 2012, and Nowak et al., GRL 2012 show that emissions inventories can be off well more than 20 – 40%.

Answer to the specific comment from reviewer 1:

The quality of ammonia emission inventories varies considerably depending on geographical location. In general, the research on agricultural air quality is much behind in the US compared to in European countries such as Denmark, the UK and the Netherlands (Zhang et al., 2008). For ammonia, this can be shown in the differences between recent studies over Denmark and USA. In Denmark the uncertainty of the total annual emissions the uncertainty is assumed to be in the range of 5-10% (Geels et al., 2012), while recent investigations for California in the US suggest that the uncertainty of ammonia emission exceeds a factor of ten (Nowak et al., 2012). Among the main reasons to this uncertainty is the use of uniform emission factors and inadequate temporal resolutions (Zhang et al., 2008). Despite the relatively low uncertainty in the Danish inventories, this method, however, still relies on fixed statistics (at the farm level) such as typical N contents in the animal products and volatilization from the farms. Therefore the uncertainty on farm/field level is assumed to be in the range of 25-35% in Denmark (Geels et al., 2012). Earlier studies in the Netherlands have reported uncertainties to be in the range 50% to 250% on the farm level (Oudendag and Luesink, 1998). According to EEA the European ammonia emissions are estimated to be associated with an uncertainty of +/- 30% (http://www.eea.europa.eu/data-and-maps/indicators/eea-32-ammonia-nh3-emissions-1). Such uncertainties in both highly detailed areas (the Netherlands and Denmark) and less studies area (US) can be reduced by taking into account meteorological factors as it is done in this study. Furthermore, it is of major concern to close the knowledge gab in the nitrogen budgets (Reis et al., 2009). A study by de Vries et al (2011), show that there is up to a factor of two in difference in national scale emissions, such as the ones that are present in EDGAR (Beusen et al., 2008) and

EMEP(Vestreng et al., 2009). It highlights that a more comprehensive discussion of NH3 emissions and sources is needed. In our opinion, the one obvious approach is to take into account local meteorology before the actual emission is estimated.

To be included in section 4.1:

"The uncertainty related to the official gridded emission inventories varies considerably depending on geographical location. In general, the research on agricultural air quality is much behind in the US compared to in European countries like Denmark, the UK and the Netherlands (Zhang et al., 2008). In Denmark the uncertainty of the total annual emissions the uncertainty is assumed to be in the range of 5-10%, (Geels et al., 2012), while recent investigations for California in the US suggest that the uncertainty of ammonia emission exceeds a factor of ten (Nowak et al., 2012). According to EEA the overall European ammonia emissions from EMEP are estimated to be associated with an uncertainty of +/- 30% (http://www.eea.europa.eu/data-and-maps/indicators/eea-32-ammonia-nh3-emissions-1, accessed 14 november 2012). It is not clear if this estimate include the effect of meteorological parameters, but most likely this uncertainty can be reduced by taking the meteorological factors into account (e.g. Zhang et al., 2008) . "

Specific comments from reviewer 1

Is the problem for CTMs and CCMs that they do not account for climate change effects on ammonia emissions or that the ammonia emissions are not correct in the first place? I understand the use of one standard farm type for this modeling study. However, how realistic is it that pig stables are that similar throughout Europe? What information is there on European farming practices that can be referenced? It is unclear to me whether the bigger influence on future ammonia emissions is temperature increases or farming practices. I suspect that market forces influencing farming practices can easily affect ammonia emissions by 20 – 40 %. I also think the manuscript could do a better job in identifying the other factors to ammonia emissions, such as animal diet and the differences in ammonia emissions from different livestock. Nonetheless, this is an interesting manuscript and the authors do a nice job pointing out that temperature increases may cause an increase in ammonia emissions that is not being considered by current models. This is important information for policy makers to use in addressing the best farming practices to minimize future ammonia emissions.

Answer to the specific comment from reviewer 1:

It is considered a general problem that the ammonia emission are inaccurate and their accurate characterization has been highlighted as a major challenge in air quality modelling (Zhang et al., 2008). We have here used storage for pig stables as such storage facility are relatively uniform between most of the countries in central to Northern Europe, although even small differences in handling (e.g top loading vs bottom loading) is known to affect overall emission rate (Muck and Steenhuis, 1982) It is correct that the management practice vary a lot across Europe and that future changes in this will have a huge impact on the ammonia emission. But this does not justify the neglection of meteorology and climate (e.g. Zhang et al., 2008). It has previously been shown that change in management (due to policy or market forces) can change emission to a very large degree (Skjøth et al., 2008). The activity data and the emission factor related to each activity (stable type etc.) should at the national scale reflect this. Currently we apply data from the GAINS system (Klimont and Winiwarter, 2011). Our focus here is on the uncertainty due to meteorological parameters only. We believe that it is beyond the scope of this paper to include a comprehensive analysis of all the factors that impact the ammonia emissions in Europe. Here we refer to studies of emission factors such as Webb and Misselbrook (2004) . We have in table 2 tried to make an

overview of how sensitive main agricultural categories are in order to emphasize that results of this study will have impact on most of the categories, not only the storage facility used in the analysis.

We therefore suggest to add following sentence to line 22, page 23415

“Management practice varies a lot across Europe and that future changes in this will have a huge impact on the ammonia emission. One example is the differences in handling the loading of the manure into the storage (e.g. top loading vs bottom loading) which affects the overall emission rate (Muck and Steenhuis, 1982). But this does not justify the neglection of meteorology and climate (e.g. Zhang et al., 2008).”

And following to line 16, page 23419:

“The approach we have chosen here can be expanded to cover many different agricultural production methods and as such provide information to policy makers that address farming practice in relation to future ammonia emissions.”

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List of changes that have been made to the manuscript:

Page 23404, line 3: Changed from “variations” into “variation”

Page 23404, line 5: Changed from “to investigating” into “to investigate”

Page 23404, line 6: Removed “the”

Page 23404, line 8: Changed from “storage” into “storage facility”

Page 23404, line 9: Changed from “Danish standard” into “standard Danish”

Page 23404, line 9: Changed from “the emission” into “emissions”

Page 23404, line 10: Changed from “category” into “would”

Page 23404, line 12: Changed from “the emission” into “emission”

Page 23404, line 13: Changed from “points” into “point”

Page 23404, line 14: Changed from “with 20% by changing” into “by 20% for different”

Page 23404, line 15: Changed from “Largest” into “The largest”

Page 23404, line 16: Changed from “like” into “such as the”

Page 23404, line 16: Changed from “will in general” into “may”

Page 23404, line 18: Changed from “the emissions with” into “emissions by

Page 23404, line 19: Changed from “along country borders” into “between neighbour countries”

Page 23404, line 19: Changed from “UK” to “the UK”

Page 23404, line 21: Changed from “issue” into “factors”

Page 23404, line 23: Changed from “with” into “made with”

Page 23404, line 27: Added “Finally, the climate penalty on ammonia emissions should be taken into account at the policy level such as the NEC and IPPC directives.”

Page 23405, line 4: Changed from “fast” to “rapidly”

Page 23404, line 5: Changed from “its acknowledgement” into “ it was recognised”

Page 23404, line 8: Changed from “Ammonia is emitted from” into “Sources of ammonia include”

Page 23405, line 17: Removed “with”

Page 23405, line 23: Removed “Nature”

Page 23405, line 24: Changed from “to acidification” into “to the acidification”

Page 23405, line 26-27: Changed from “In Europe, more than 90 % of the emitted ammonia” into “More than 90 % of the ammonia emitted in Europe”

Page 23406, line 5: Changed from " manure in the field" into "manure spreading on fields"

Page 23406, line 5: Changed from "follows the changes in air temperature and wind velocity from " into "varies from"

Page 23406, line 9: Changed from "to have higher" into "to give higher"

Page 23406, line 9: Removed "then

Page 23406, line 13: Changed from "cause variations" into "cause the temporal variation"

Page 23406, line 20: Changed from:

"These gridded emission inventories are often based on national emission factors" into "These gridded emission inventories are often based on national emission factors combined with gridded activity data like e.g. animal numbers ."

Page 23406, line 25: Changed from "variations in ammonia emissions" into "variation in ammonia emission"

Page 23407, line 1: Changed from "Netherlands" into "the Netherlands"

Page 23407, line 2: Changed from "if" to "whether"

Page 23407, line 3: Changed from "needs" into "need"

Page 23407, line 3: Changed from "emissions" into "emission data"

Page 23407, line 4: Changed from "and accuracy" and that the accuracy"

Page 23407, line 4: Changed from "are" into "is"

Page 23407, line 4: Changed from "factors" into "areas"

Page 23407, line 6: Changed from "The regional variations of" The effect of regional variation in"

Page 23407, line 14: Removed ""in Nature Geosci."

Page 23407, line 14: Changed from "involve" into "involves"

Page 23407, line 21: Changed from "alone due to the temperature" into "due to the temperature alone"

Page 23407, line 28: Changed from "an" into "a"

Page 23407, line 29: Changed from "model Skjøth" into "model by Skjøth"

Page 23408, line 5: Changed from "are studying" into "study"

Page 23408, line 7-8: Changed from "amount and temporal" into "the amount and the temporal"

Page 23408, line 8: Changed from "Similarly we" into "Similarly, we also"

Page 23408, line 9: Deleted "also"

Page 23408, line 15: Changed from "from" into "on"

Page 23408, line 19: Changed from “16” into “16.67”

Page 23409, line 2: Changed from “have been” into “were then”

Page 23409, line 2: Changed from “an” into “a”

Page 23409, line 2: Changed from “data have been” into “were”

Page 23409, line 5: Changed from “16” into “16.67”

Page 23409, line 5: Changed from “in” into “of”

Page 23409, line 5: Changed from “sliding” into “running” and similar later in the text

Page 23409, line 6: Changed from “has been” into “was”

Page 23409, line 6: Changed from “has been” into “was”

Page 23409, line 24: Changed from “Model use” into “Model uses”

Page 23409, line 26 to Page 23410, line 4: Changed from :

“The emission model also use an inventory of gridded NH3 emissions (e.g. EMEP, EDGAR or national inventories), in combinations with information on agricultural activities. On European scale the inventory is based on a redistribution of the officially reported EMEP emissions and national numbers for a distribution of agricultural activities that contributes to the overall ammonia emission load. These numbers are obtained from Table 2 in Skjøth et al. (2011) to provide a gridded estimate for all 15 source categories.”

Into:

“The emission model also use an inventory of gridded NH3 emissions (e.g. EMEP, EDGAR or national inventories), in combinations with information on agricultural activities. In the current setup the officially reported EMEP emissions on 50 km x 50 km grid resolution have been redistributed directly into the applied model domain with a resolution of 16.67 km x 16.67 km. Afterwards the gridded totals have been divided into different agricultural categories that are present in the emission model. This distribution is obtained from Table 2 in Skjøth et al. (2011) as it provides the national split between the different categories. The final result is a gridded estimate for all 15 source categories.”

Page 23410, line 8: Changed from “emissions” into “emission”

Page 23410, line 11: Changed from “in each” into “for each”

Page 23410, line 15: Changed from “in each” into “for each”

Page 23410, line 21: Changed from “of the” into “in”

Page 23410, line 22: Changed from “storage” into “storage facility”

Page 23410, line 24-25:Changed from “the standard storage to be a storage related to a pig stable facility with 1000 animals with the same production” into “a storage facility related to a pig farm with 1000 animals that uses the same production”

Page 23410, line 26:Changed from “(Skjøth et al.,2004)” into “Skjøth et al., (2004)”

Page 23410, line 27: Removed ”the”

page 23411, line 3:Changed from " from storage that is associated to” into “from a storage facility associated with”

Page 23411, line 7: Changed from “calculations above, but for” into “above calculations for”

Page 23411, line 11-12 Changed the sentence from:
“Figure 2 show maps of gridded annual emission of NH3 from storage facilities for the years 2007 and 2010.”
Into:
“Fig. 2 shows maps of gridded annual emission of NH3 from our test storage facility for the years 2007 and 2010 if it was placed at any location in the model domain and exposed to the local meteorology during the study years.”
Page 23411, line 26: Changed from “UK” into “the UK”

Page 23412, line 11-12: Changed from:

“In Table 1 the maximum and minimum emission rates within the countries are given for the warm years 2007, 2047 and 2087.”

Into

“In Table 1 the maximum and minimum emission rates within the countries are given for the warm years 2007, 2047 and 2087, where we have excluded those grid cells in the Alpine region that does not contain built-up and agricultural land by using the Corine Land Cover data set (European Commission, 2005).”

Page 23412, line 20: Changed from “country like Germany” into “country such as Germany,”

Page 23412, line 23: Changed from “storage” into “storage facility”

Page 23412, line 24: Changed from “storage” into “storage facility”

Page 23413, line 2: Changed from ”existing” into “present day”

Page 23413, line 7: Changed from ”storage in a pig production” into “storage facility on a pig farm”

Page 23413, line 10: Changed from ”emission” to “emissions”

Page 23413, line 10: Changed from ”to” to “with”

Page 23413, line 10: Changed from ”depending” to “depending on”

Page 23413, line 16: Changed from ”storage” to “a storage facility”

Page 23413, line 17: Added

“Furthermore, mountain areas such as the alpine region also show large variations. Here it should be noted, that this area is particular sensitive to the meteorological data set and that the chose grid resolution might be to coarse for an accurate assessment in that region.”

Page 23413, line 18: Changed from ”such as the ones that are” to “, such as those”

Page 23413, line 18: Changed from ”amount” to “number”

Page 23413, line 28: Changed from ”in the emissions” into “in emission”

Page 23413, line 18: Changed from ”for UK” into “for the UK”

Page 23414, line 1: Changed from ”storage” into “a storage facility”

Page 23414, line 2: Changed from ”amount” to “number”

Page 23414, line 7: Changed from ”on” to “at a”

Page 23414, line 9: Added following section:

“The uncertainty related to the official gridded emission inventories varies considerably depending on geographical location. In general, the research on agricultural air quality is much behind in the US compared to in European countries like Denmark, the UK and the Netherlands (Zhang et al., 2008). In Denmark the uncertainty of the total annual emissions the uncertainty is assumed to be in the range of 5-10%, (Geels et al., 2012), while recent investigations for California in the US suggest that the uncertainty of ammonia emission exceeds a factor of ten (Nowak et al., 2012). According to EEA the overall European ammonia emissions from EMEP are estimated to be associated with an uncertainty of +/- 30% (http://www.eea.europa.eu/data-and-maps/indicators/eea-32-ammonia-nh3-emissions-1, accessed 14 November 2012). It is not clear if this estimate includes the effect of meteorological parameters, but most likely this uncertainty can be reduced by taking the meteorological factors into account (e.g. Zhang et al., 2008)

Page 23414, line 12: Changed from ”European scale or global scale” to “a European or global scale,”

Page 23414, line 15: Changed from ”the” to “this”

Page 23414, line 16: Added following section:

“In Europe the emission of NH3 is regulated through the National Emission Ceiling directive (NEC 2001/81/EC), where the countries have agreed on legally binding emissions ceilings to be met in 2010. An evaluation made by the European Environment Agency in 2012 (Acid News 2012, No 1, March 2012) show that only two countries fail to meet the NH3 directive limits. It is, however, expected that the current review of the EU policy will lead to stricter emissions ceilings in the future in order to improve the protection of the human health as well as the environment. For the evaluation of such international agreements a harmonized emission reporting from the countries is crucial and the climate dependent uncertainty described in this paper complicates the evaluation of the NH3 celling. Furthermore the fact that a given agricultural activity will lead to larger emission in a warmer country or year than in a colder country/year, in spite of using identical production methods, could lead to a discussion on the fairness of the used approach with emissions ceilings. Our results indicate for example that the emissions from our test storage in 2010 in North-western Europe were lower than in 2007. Thereby it would be easier for countries in this region to meet the ceiling for 2010.”

Page 23414, line 18: Changed from ”then” to “the”

Page 23415, line7: Changed from “been studied” to “been previously studied”

Page 23415, line17: Changed from “storage” to “storage facilities”

Page 23415, line21: Deleted ”and up”

Page 23415, line 22: Added following sentence:

“Management practice varies a lot across Europe and that future changes in this will have a huge impact on the ammonia emission. One example is the differences in handling the loading of the manure into the storage (e.g. top loading vs bottom loading) which affects the overall emission rate (Muck and Steenhuis, 1982). But this does not justify the neglection of meteorology and climate on the emissions (e.g. Zhang et al., 2008). To our knowledge…”

Page 23415, line26: Changed from “emissions” to “emission”

Page 23415, line28: Changed from “the” to “the model”

Page 23416, line10: Changed from “affect the emissions pattern” to “affects emission patterns”

Page 23416, line11: Changed from “affects pigs” to “affect pig”

Page 23416, line13: Changed from “storage” to “a storage facility”

Page 23416, line14-15: Changed from “Europe due to variations in production methods” into “central and northern Europe”

Page 23416, line16: Changed from “storage from” to “storage facilities at”

Page 23416, line16: Changed from “the emission” to “emissions”

Page 23416, line17: Changed from “barn is” to “barns are”

Page 23416, line17: Changed from “cattle is” to “cattle are”

Page 23416, line20: Changed from “storage” to “a storage facilities”

Page 23416, line26: Changed from “yr” to “years”

Page 23417, line2: Changed from “amount” to “number”

Page 23417, line8: Changed from “ensures” to “provides”

Page 23417, line 10: replace “should also include” with “use”

Page 23417, line 14: replace “both may” with “may both”

Page 23417, line 14-17: Changed sentence into: “To our knowledge, then all global models rely on fixed NH_3 emission inventories such as those presented by Beusen et al., (2008). Dynamical models for ammonia emissions are currently not considered in global models such as Geos-Chem (e.g. Heald et al., 2012), although a number of authors have stated that the nitrogen issue is probably one of the biggest challenges humans will face in the future under an increased population load (Arneth et al., 2010; Gruber and Galloway, 2008; Sutton et al., 2011).”

Page 23417, line 20: Replaced “(Hertel et al.,2011)” with “(Hertel et al.,2012)” and moved the reference to the end of the sentence.

Page 23417, line 26:Replaced “(Sutton et al., 2011a) with (Sutton et al., 2012)

Page 23417, line 27: Replaced “(2011a)” with ”(2012)”

Page 23418, line 1: Changed “from” with “on”

Page 23418, line 2: Changed “combines” with “combine”

Page 23418, line 12: Changed “studies suggest,” with “study suggests”

Page 23418, line 13: Changed “affects” with “affect”

Page 23418, line 18: Changed “Similarly” with “Similar”

Page 23418, line 21-22: Changed “when they” with “which”

Page 23418, line 24: Changed “emissions” with “emission”

Page 23419, line 1: Changed “led” with “lead”

Page 23419, line 2: Removed “an”

Page 23419, line 7: Removed “in Nature”

Page 23419, line 9: Removed “in Nature Geosci.”

Page 23419, line 9: Changed “despite nitrogen” with “despite the fact that nitrogen”

Page 23419, line 10: Removed “then”

Page 23419, line 11: Changed “remains” with “remain”

Page 23419, line 12: Changed “on” with “to”

Page 23419, line 13-16: Changed from

“Therefore evaluations of future abatement strategies for ammonia need to take the possible effect of a general temperature changes into account as well as the associated cascade of effects in the nitrogen cycle, which is initiated with the emission.”

Into: “In relation to the NEC directive and a new emission celling for ammonia is should for example be evaluated if the use of a specific target year is desirable. If the target year (currently 2010) is a year with above/below average temperatures in a given region it will be harder/easier to meet the ceiling. In a future climate with a general warming trend and potentially more frequent extreme years then this issue will be even more relevant. The analysis and subsequent negotiations leading to a revised NEC directive should somehow include the climate sensitivity of NH3 emissions.”

Page 23419, line 16:

“The approach we have chosen here can be expanded to cover many different agricultural production methods and as such provide information to policy makers that address farming practice in relation to future ammonia emissions.”

Other technical corrections: In general we have changed “storage” to “storage facilities” and corrected UK and Netherlands into “the UK “and “the Netherlands”.

Replacements in the reference list:

The references

Hertel, O., Reis, S., Skjøth, C. A., Bleeker, A., Harrison, R., Cape, J. N., Fowler, D., Skiba, U., Simpson, D., Jickells, T., Baker, A., Kulmala, M., Gyldenkærne, S., Sørensen, L. L., and Erisman, J. W., Nitrogen processes in the atmosphere in: The European Nitrogen Assessment: Sutton, M., Howard, C. M., Erisman, J. W., Billen, G., Bleeker, A., Grennfelt, P., Grinsven, H., and Grizzetti, B., Eds., Cambridge, 177-207, 2011.

Langner, J., Engardt, M., Baklanov, A., Christensen, J. H., Gauss, M., Geels, C., Hedegaard, G. B., Nuterman, R., Simpson, D., Soares, J., Sofiev, M., Wind, P., and Zakey, A., A multi-model study of impacts of climate change on surface ozone in Europe, Atmos. Chem. Phys. Discuss., 12, 4901-4939, 2012.

Sutton, M., Milford, C., Nemitz, E., Riddick, S., Dragosits, U., Blackall, T., Tang, S., Flechard, C., Vieno, M., Reis, S., Misselbrook, T. H., Coheur, P., Clarisse, L., van Damme, M., Ngadi, N., Bouwman, L., Skjøth, C. A., Geels, C., Dentener, F., and de Vries, W., Toward a climate-depend paradigm of ammonia emission and deposition Invited presentation at the Royal Society for the meeting concerning the Global Nitrogen Cycle, London, 5-6 Dec 2011.

Has been replaced with

Hertel, O., Skjøth, C. A., Reis, S., Bleeker, A., Harrison, R., Cape, J. N., Fowler, D., Skiba, U., Simpson, D., Jickells, T., Kulmala, M., Gyldenkærne, S., Sørensen, L. L., Erisman, J. W., and Sutton, M. A., 2012, Governing processes for reactive nitrogen compounds in the atmosphere in relation to ecosystem, climatic and human health impacts: Biogeosciences Discuss., **9,** 9349-9423.

Langner, J., Engardt, M., Baklanov, A., Christensen, J. H., Gauss, M., Geels, C., Hedegaard, G. B., Nuterman, R., Simpson, D., Soares, J., Sofiev, M., Wind, P., and Zakey, A., A multi-model study of impacts of climate change on surface ozone in Europe, Atmos. Chem. Phys., 12, 10423-10440, 2012.

Sutton, M., Reis, S., Riddick, S., Dragosits, U., Nemitz, E., Theobald, M. R., Tang, S., Braban, C. F., Vieno, M., Dore, A. J., Mitchell, R. F., Wanless, S., Daunt, F., Fowler, D., Blackall, T., Milford, C., Flechard, C., Loubet, B., Massad, R. S., Cellier, P., Clarisse, L., van Damme, M., Ngadi, N., Clerbaux, C., Skjøth, C., Geels, C., Hertel, O., Wichink Kruit, R. J., Pinder, R. W., Bash, J. O., Walker, J. D., Simpson, D., Horvath, L., Misselbrook, T., Bleeker, A., Dentener, F., and de Vries, W., 2012, Toward a Climate-Dependent Paradigm of Ammonia Emission & Deposition Submitted to Proceedings of the Royal Society, Part B, November 2012.

Additions to the reference list:

Heald, C. L., Collett Jr, J. L., Lee, T., Benedict, K. B., Schwandner, F. M., Li, Y., Clarisse, L., Hurtmans, D. R., Van Damme, M., Clerbaux, C., Coheur, P. F., Philip, S., Martin, R. V., and Pye, H. O. T., Atmospheric ammonia and particulate inorganic nitrogen over the United States: Atmos. Chem. Phys., **12,** 10295-10312. 2012

Muck, R. E. and Steenhuis, T. S., Nitrogen Losses from Manure Storages: Agricultural Wastes, **4,** 41-54, 1982

Zhang, Y., Wu, S. Y., Krishnan, S., Wang, K., Queen, A., Aneja, V. P., and Arya, S. P., Modeling agricultural air quality: Current status, major challenges, and outlook: Atmos. Environ., **42,** 3218-3237, 2008

Changes to figures and tables:

Removed the dot Tange on the maps in Figure 2 and Figure 3

Updated Table 1 with new numbers for Switzerland so that the minimum numbers are “145.4”, “187.6” and “215.2”, respectively. Afterwards we have removed the digits.

Added following to the caption “Note that minimum numbers for Austria, Italy and Switzerland should be treated with caution due to the dependency of the meteorological data set that were used in the calculations.”