Biogeosciences Discuss., 12, C6900–C6905, 2015
www.biogeosciences-discuss.net/12/C6900/2015/

Biogeosciences
Discussions
Open Access

Interactive comment on "Estimate of changes in agricultural terrestrial nitrogen pathways and ammonia emissions from 1850 to present in the Community Earth System Model" *by* S. N. Riddick et al.

Anonymous Referee #2

Received and published: 22 October 2015

GENERAL Global models need emission inventories. The problem it is difficult to obtain all information needed to make them. One has always to make some (crude) assumptions to make such an inventory. This is not an easy task. For that reason, this article is welcomed. It is of course also easy to criticize such work as one always can find some special examples for a country, which give other results.

I hope that I have interpreted the paper correctly, as it is sometimes difficult to read.

As far as I can find out from the paper, the authors are bypassing the use of animal housings and storage systems. They argue that the emission factors for spreading are not significantly different than for housing+storage (p. 15958, line 11). As far as I can find out from this formulation the authors take the emission after spreading as being representative for the whole system housing -> storage -> spreading. This is, however, not true as e.g. the emission of housing + storage is of the same order as for spreading and belongs to the SAME amount of manure. For that reason, as far as I can see, the emission should be about twice as high as the authors calculate. Moreover, they do not differentiate between spreading of manure and grazing/being in a feedyard. There are large differences in emission factors for broad spreading and grazing, which they apparently are not familiar with. For the above reason, I recommend that the paper should not be accepted, although the description of emission after spreading can be useful.

The units for all variables in the equations should be given (otherwise, it is difficult to check whether the equations are correct or sometimes how a Henry's law coefficient is defined).

DETAILED COMMENTS Title: should also contain the words ruminants and mineral fertilizer? Maybe N_r could be defined in the beginning. p. 15953 line 9: I am not sure that Paulot et al. (2014) have derived emission factors explicitly as a function of temperature.

p. 15954 line 23: "relation between" is written here twice.

p. 15955 and Fig. 1: the model. Remark: It is much better to have a model where all processes are taken into account and for which is then possible to make checks that the mass balance is kept.

Fig. 1 (model). The fate of Nr emitted to the atmosphere is described by the CAM-chem model. If the model grid is large enough (a few hundred km's) it could be assumed that the amount of NH3 that is emitted is deposited in this area (mainly as dry deposition of NH3 and wet deposition of NHx) as the atmospheric residence time is of the order of one day.

BGD

12, C6900–C6905, 2015

p. 15958. line 28. Why is it that only ruminants are chosen? (Potter et al., 2010 include also the excretion from pigs and poultry). Give the error made in the emissions because of this choice.

p. 15958. line 9. It is assumed that manure is continuously spread onto fields, bypassing the use of housings and storage facilities. It is then mentioned that the emission factors for NH3 emissions from spreading are not significantly different from them from housing and storage (I guess this must be housing plus storage) and that for that reason the emission after spreading is used instead. This need to be discussed into more detail and I do not think that this assumption can be justified and this is crucial for the method. Indeed the emission from housings + storage facilities can be of the same order as after spreading (in e.g. kg NH3/kg manure), but the important thing is both emissions belong to the same amount of manure (the manure is first deposited in the housing, is and subsequently transferred to the storage facility, and is then is being spread). If the emissions from housing + storage and the emissions from spreading were equal, the total emission from the whole system would almost be twice as large as the emission from spreading alone, and, as far as I can see, this is not taken into account and will lead to an underestimation of the calculated emission by a factor of two. An example: let us assume that a fraction of 0.2 of the 1 kg of N in manure entering the housing is emitted in housing (+ storage). Then 0.2*1 = 0.2 kg N has been emitted. Then 0.8 kg N is left when the same manure is spread. Let us assume that again a fraction of 0.2 of N present is emitted after spreading (= 0.2*0.8 = 0.16 kg). Then 0.2 + 0.16 = 0.36 kg of the N originally entering the housing is emitted. Therefore, although the fraction emitted is about the same for housing (+storage) as after spreading, the total emission is almost twice as high.

Especially in Europe emission from storage facilities and after spreading have been reduced, making the emission from housings relatively more important. The temperature regime and ventilation regime in housings and storage facilities are also different from that on open land, leading to another emission behaviour. Moreover, processes as leaching do not take place in housings and hopefully not in storage facilities. When talking about ruminants grazing is important and that is not addressed here, although later in the article is referred to some experiments where emission during grazing is measured. During grazing most of the TAN is in the urine and urine is entering the soil at a larger speed than e.g slurry (mixture of faeces and uring). For that reason, the emission during grazing is usually much lower than during broad spreading (without using any reduction technique). See e.g. Hutchings, N.J. et al. Atmos. Environ. 35, 1959-1968.

p. 15958. line 11: Manure is not excreted in the storage facility, only in the housing.

p. 15959. Potter et al. (2010) give in their publication the N produced in manure by all domestic animals. Why are the calculations in this publication only for ruminants?

p. 15959. line 11: Use import from other areas instead of lateral transport.

p. 15959. line 27: It is assumed that a fraction of 0.5 of the nitrogen excreted is urine and is directly available to the TAN. Data for Europe (EMEP/EEA (2009) EMEP/EEA emission inventory guidebook 2009, Animal husbandry and manure management.) indicate that this fraction should be somewhat higher, of the order of 0.6.

p. 15960. If I look at equation (2) and (5) I can see that N_resistant is transformed to N_TAN, but at p. 15960 line 9 it is stated that N_resistant is resistant to forming TAN. This should be made clearer (not everybody is an agricultural scientist and this can be confusing).

p. 15960. It is not clear to me what happens with the N that is subject to mechanical loss. Does the model some bookkeeping of this? (without tracking this it is impossible to have a check on the mass balance).

p. 15964, section 2.2.6 Equations should be given for Ra and Rb. I guess that the friction velocity is part of the equation. The question is then: how is the friction velocity derived for different types of vegetation?. No information is given on that. It is men-

BGD

12, C6900–C6905, 2015

Interactive Comment

tioned “We compute average values of Ra and Rb for each CLM soil column”. It should be mentioned what is done here. It is not clear to me, e.g. if every vegetation type has its own NH3 (g) concentration or not. It is e.g. not clear if first the Ra values are averaged and then the Rb values. What should be done is averaging the fluxes, not Ra and Rb values. It is mentioned that a low atmospheric concentration of 0.3 microgram/m3 is adopted, but that does not play a role as the NH3(g) concentration is usually very large. This statement is, however, not completely true. In the two or three-dimensional world the concentrations downwind are rather high, which leads to a somewhat lower emission rate as one would expect. It is mentioned that the NH3 concentration in the future will be calculated with the CAM-model. This is, however, not so simple as it might look like. First, the vertical resolution of such a model should be very high in order to calculate near ground NH3 concentration correctly, or other methods should be used to model the vertical concentration profile implicitly. Moreover, one should realize that concentrations in agricultural areas and nature areas within one grid element are different. It is stated that it will be assumed that f_capture is set to 0.6 in the future. This part, however, is not described in Fig. 1, as it is not part of the model presented here. So maybe leave out, or at least state that it is not part of the model discussed here. In order to be consequent, one should not set this to a constant factor. The factor 0.6, however, is not constant at all and depends on many factors, e.g. also on the size of the grid element used in the model. (see e.g. Asman, W.A.H. (1998) Atmos. Environ. 32, 415-421). The dry deposition of NH3 should be modelled in the same way as the emission is, e.g. from Ra, Rb, a surface concentration etc. In addition, here it should be taken into account that different PFTs exist within one grid element. If the dry deposition of NH3 is discussed here, it could be useful to mention that one of the removal pathways is through wet deposition (of NHx = NH3 + NH4).

p. 15966. It could be that eq. (12) is not correct. It looks like there is a K_H too much in the denominator. See e.g. Génermont and Cellier (1997) , Agric. For. Meteorol. 88, 145-167. The equation depends also on how K_H is defined.

BGD

12, C6900–C6905, 2015

p. 15968. line 24. It could maybe nice to get some information on the assumptions made by Holland et al. (2005). It looks like it is only data set. A cow in 1850 is not producing as much N as a cow in 2015. Is that taken into account by Holland et al. (2005)?

p. 15970. The article it is assumed (p. 15958. line 9). It is assumed that manure is continuously spread onto fields, bypassing the use of housings and storage facilities. In section 3.1 the model is compared with measurements, but none of these measurements refer to emission after spreading. It are measurements during grazing and from feedyards. So this data cannot be used to test the model. Data after spreading of manure can be found in Sogaard et al. (2002) Atmos. Environ 36, 3309-3319. There are more data obtained since then. Sogaard et al. (2002) also indicated that other factors such as wind speed were important in Europe. It was e.g. shown that the emission rates in northern Europe were as high as in southern Europe. The effect of increase of the emission rate due to higher temperatures in southern Europe was apparently compensated for by the lower wind speeds in southern Europe. So if possible more factors should be taken into account. The same type of effect can be expected for fertilizer.

Fig. 2: Busink must be Bussink.

Interactive comment on Biogeosciences Discuss., 12, 15947, 2015.