We are grateful for the constructive comments from the Reviewer. We have addressed all the comments and questions raised by the reviewer 2. In our response the comments have been marked in black and our responses have been marked in blue. Furthermore, the manuscript has been checked by a native speaker.

Some attention to the English is required throughout – I have not identified all errors in the specific comments below so suggest a final revision by a native English speaker.

The language has been carefully checked by a native speaker.

Specific comments:

P1 L15 Define CTM

Defined.

P1 L22 Define NWP

Defined.

P1 L30 change 'was compared' to 'were compared'

Changed.

P4 L1 What is the WRF model (and subsequently WRF-Chem and WRF-ARW)?

WRF (Weather Research and Forecasting model) and WRF-ARW (The Advanced Research WRF) was used interchangeably in the text. We have clarified this and now only WRF is used. WRF-Chem is a chemical transport model (WRF coupled with chemistry). Reference to WRF-Chem was removed from this sentence.

Modified text:

Page 2025, lines 8-11

We will connect the model directly with the meteorological calculations from the Weather Research and Forecasting model (WRF, Skamarock and Klemp, 2008) according to the vision of Sutton et al. (2013).

P5 L5 'stables' is often used as a term for livestock housing by non-native English speakers in Europe; however, in English, stables is normally understood to refer specifically to housing for horses. Please change the term here and elsewhere in the manuscript to 'livestock housing' or similar.

The term was changed to "livestock housing".

P5 L7 What are the units for the various parameters in Eq. 1 (and 2 on following page). I have to admit to not fully understanding the subsequent description of the derivation of the functions – is the function an emission value itself, or a multiplier to be applied to the emission input data. Perhaps this description could be expanded slightly to aid understanding.

The units have been explained:

$E_i(x,y)$ [kg ha^{-1} year^{-1}]

$Epot_i(x,y)$ [unitless]

$T_i(x,y)$ [ºC]

$W_i(x,y)$ [m s^{-1}]

The description has been expanded for clarity:

Page 2026, line 11; new text:

The individual functions are distributed into two groups: Gaussian functions for short term emission sources and annual functions. Both groups respond to the environmental variables wind speed and temperature. The Gaussian functions are linked to a crop growth model developed by Olesen & Plauborg (1995). The crop growth model uses accumulated temperature sums to determine the timing of the maximum value of the individual gauss functions.

2027, lines 15-17 (modified and expanded text)

Here, μ_i is the mean value for the parameterized distribution. This means that μ_i (given in days or hours) corresponds to the time of the year when the Gaussian function obtains its maximum value. This is the optimal time for the farmer to apply manure according to crop growth. Therefore, the value of μ_i depends on the results from the crop growth model which vary from cell to cell over the entire model grid. σ_i is the spread of the Gauss function, which here parameterizes the amount of time that all farmers carry out this specific activity in each grid cell. A large σ_i means that the emission from the corresponding activity takes place during most of the year, while a small σ_i means that emission takes place during a few weeks. Here *t* is the actual time of the year. The temperature correction Tcorr and the emission potential $Epot_i(x,y)$ (calculated in the preprocessing) is given in eq. (3).

$T_{corr} = e^{(0.0223*t(x,y))}$ for i= 8, 9, 10, 11, 12, 13

$T_{corr} = 1$ otherwise

$Epot_i(x,y) \neq 1$ for i= 8, 9, 10, 11, 12, 13

$Epot_i(x,y) = 1$ otherwise

P6-7 It would be good to include some introduction as to why these 4 specific scenarios are being modelled.

We agree with the Reviewer. We have included some introduction (please see below). We have also changed the order of scenarios as it was suggested by Reviewer 1 (It concerns all figures and tables related to the scenarios).

Page 2028, line 10

The annual gridded NH_3 emissions were then used to construct 4 scenarios termed FLAT (1), DEFAULT (2), POLREGUL (3) and NOFERT (4) (Table 2). Applying the scenarios DEFAULT and FLAT shows the advantage of implementation of the dynamic emission model (DEFAULT) instead of using a constant emission profile (FLAT). This step is especially important for the area of Poland, as the dynamic approach at high spatial and temporal resolution has not been used before and because Poland is a large country where the variations in the climate cause changes in crop growth throughout the country, thereby affecting agricultural activity. Then, by replacing the default setup in the dynamic model with Polish regulations (POLREGUL) we wanted to provide some outlines for the users of this or similar models concerning the expected range of changes in ammonia emission. This is considered particularly important due to the expanding use of this open-source model. These differences in emissions are caused by variations in agricultural practice in different countries, which are caused by both climate (thus affecting agricultural activity) and national regulations. A detailed description of the POLREGUL approach is provided below. In the fourth scenario (NOFERT) we wanted to show the sensitivity of the dynamic model in respect to application of manure and fertilizers, mainly in respect of spring ammonia emission peak, thereby demonstrating that the implementation of the method should carefully assess national regulations on manure application for optimal performance of the model.

P7 L8 It is not clear here whether you mean 20% of all manure, which equates with all slurry, or 20% of slurry bein applied to grassland. Please clarify.

We have clarified the sentence:

Page 2028, lines 17-19

In Poland the solid and slurry fractions of the manure is applied differently due to national regulations. Solid manure goes into annual crops as only slurry is allowed on grasslands. Between 10% and 20% of the slurry fraction is applied to grassland, which covers about 25% of the entire agricultural area.

P11 L9-10 Values are presented for the grid square (5x5km) containing the Jarczew station?

Yes, values are presented for the grid square. It has been clarified in the text:

Page 2033, line 12-13

The seasonal variation of emission (POLREGUL run) for different agricultural categories for the grid representing Jarczew station is shown in Fig. 3.

P11 L15-17 Does this sentence apply generally for Poland or specifically for this grid square containing the Jarczew station? If it is a general statement for Poland, can anything be said about the spatial variation in large pig farms and cattle farming?

It is a general statement for Poland. It was clarified in the text. Pig and cattle farming in Poland is highly fragmented. There are many small farms in southern part of the country with a low number of cattle, between 2 and 10 (Litwińczuk and Grodzki, 2014). Dairy farms are, located in the north-eastern and central Poland, where the specialisation in milk production results in high animal numbers at each farm. Cattle kept for meat production are usually kept in herds of 25 and are farmed in north-eastern Poland. The highest concentration of pig farming as well as the largest farms are in central part of Poland (GUS, 2011).

P13 L11 I don't see any Fig. 8 – is it missing? And what is the RIP tool?

Figure 8 is attached in the Biogeosciences Discussion paper. Please see page 2061. RIP (which stands for Read/Interpolate/Plot) is a Fortran program used for visualizing output from gridded meteorological data sets.

We have expanded a description of the RIP tool:

Page 2032, lines 9-10

RIP version 4.5 (Stoelinga, 2009), which is a is a Fortran program used for visualizing output from gridded meteorological data sets, was implemented to get 36 h backward trajectories for the Jarczew station.

P14 L6-8 But data presented here show the opposite to what is being said in this sentence i.e. the data here show moving from the DEFAULT to POLREGUL gives a decrease in spring emissions.

We agree with the comment. We wanted to emphasize here the range of changes, which could be expected due to an application of national practice into the dynamic model. A scale and character of changes will vary between countries and depend on local infrastructure and practice.

We clarified it in the text:

Page 2036, line 27

The scale and character of changes between POLREGUL and DEFAULT simulation with the dynamic ammonia model will vary between countries and depend on local agricultural infrastructure and practice.

References:

Litwińczuk, Z. and Grodzki, H.: Stan hodowli i chowu bydła w Polsce oraz czynniki warunkujące rozwój tego sektora, Przegląd Hod., 6/2014, 1–5, 2014.

Olesen, J. E. and Plauborg, F.: MVTOOL Version 1.10 for Developing MARKVAND, Danish Institute of Plant and Soil Science, Research Centre Foulum, 1-64, 1995.

Skamarock, W. C. and Klemp, J. B.: A time-split nonhydrostatic atmospheric model for weather research and forecasting applications, J. Comput. Phys., 227, 3465–3485, doi:10.1016/j.jcp.2007.01.037, 2008.

Stoelinga, M.: A Users ' Guide to RIP Version 4 : A Program for Visualizing Mesoscale Model Output, Univ. Washingt., 1–82, 2009.

Sutton, M. A., Reis, S., Riddick, S. N., Dragosits, U., Nemitz, E., Theobald, M. R., Tang, Y. S., Braban, C. F., Vieno, M., Dore, A. J., Mitchell, R. F., Wanless, S., Daunt, F., Fowler, D., Blackall, T. D., Milford, C., Flechard, C. R., Loubet, B., Massad, R., Cellier, P., Personne, E., Coheur, P. F., Clarisse, L., Van Damme, M., Ngadi, Y., Clerbaux, C., Skjøth, C. A., Geels, C., Hertel, O., Wichink Kruit, R. J., Pinder, R. W., Bash, J. O., Walker, J. T., Simpson, D., Horváth, L., Misselbrook, T. H., Bleeker, A., Dentener, F. and de Vries, W.: Towards a climate-dependent paradigm of ammonia emission and deposition., Philos. Trans. R. Soc. Lond. B. Biol. Sci., 368(1621), 20130166, doi:10.1098/rstb.2013.0166, 2013.