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Biogeosciences Discussions

# *Interactive comment on* "Grazing related nitrous oxide emissions: from patch scale to field scale" *by* Karl Voglmeier et al.

**Anonymous Referee #2**

Received and published: 13 December 2018

General comments: The manuscript "Grazing related nitrous oxide emissions: from patch scale to field scale" uses scaled chamber N2O fluxes and eddy covariance N2O flux measurements to estimate field scale N2O emissions from dairy cow grazing systems in Switzerland. The authors used an established Lagrangian stochastic model to scale up chamber measurements from excreta and "background" fluxes. The scaling approach results are interesting and show the challenges of quantifying whole-farm N2O fluxes. The authors used gap filling approaches to fill gaps in their eddy covariance N2O flux dataset but there was not much discussion about the gap filling results. My suggestion is that this discussion should be expanded. In addition, it would be important to include more details in the methodology on the EC and chamber measurements and scaling approaches (see specific comments). Some sentences in the



text are difficult to understand, so the writing requires further work. I also noticed some grammar mistakes in the text. I recommend the authors to perform a thorough review of the manuscript to correct these mistakes before resubmitting the manuscript.

Specific comments

Page 1

L9 – replace "the emissions" by N2O emissions

L10 – replace "variability" by "variabilities" and "and therefore emissions" by "so N2O emissions"

L11 – replace "of two grazing systems" by "for two grazing systems"

L12 – replacing "season 2016" by "season of 2016". In addition, I suggest including the number of dairy cows for each herd.

L15 – "Excreta patches and background surfaces on the pasture were identified manually". I suggest to be more specific here by saying that urine patches were identified based on the soil electric conductivity.

L20 – "(960 $\pm$ 219 g N2O-N, or 25 %)" This number is a little confusing. What does the 25% represent and shouldn't the emission units be expressed in per area?

L29 – replace "In the atmosphere, nitrous oxide" by "Nitrous oxide". In addition, include the appropriate citation for this sentence.

L30 – replace "it has a strong potential" by "N2O has a strong potential". I noticed that the replacement of nous by pronouns in some sentences throughout the text can compromise the clarity of those sentences. I suggest the authors to be as direct as they can in their sentences for the sake of clarity.

L31 – replace "to fertilization" by "to nitrogen fertilization"

Page 2

L1 – “especially by cows”. Are you referring specifically here to dairy cows? If so, please specify.

L2 – “excreta from the animals” replace by “from animal excreta”

L3 – replace “often even exceeds” by “often exceeds”

L3 to L5 – “Directly applied on a pasture soil. . .” this sentence is awkward and needs to be reworded.

L11 – “previously (Cardenas et al., 2010) and urine patches of cattle have exceptionally high loading” rates” by “previously (Cardenas et al., 2010). Urine patches of cattle have exceptionally high N loading rates”

L17 – replace “(e.g. EF of 0-14% of applied urine N, n=40; Selbie et al., 2015) and many of those studies measured the” by “(e.g. EF of 0-14% of applied urine N, n=40; Selbie et al., 2015). Many of those studies measured the”. In addition, give some examples of the “many of those studies”.

L18 – replace “conditions and thus these results are questionable with regard to” by “conditions making these results are questionable with regard to”

L20 – “these emissions” which emissions?

L20 - “(e.g. Arriaga et al., 2010)” provide more examples of studies and more the citation to the end of the sentence.

L21 – “For this purpose forage” replace by “For this purpose, forage”

L22 – “can be fed as a supplement to N rich grass and this subsequently leads to less” replace by “can be used as a feed supplement with N rich grass leading to less”

L24 – “real practice conditions”. Do you mean real management conditions?

L23-24 – “experiments. . . are very rare”. Cite some of the existing ones.

L26 – “a small scale” replace by “on a small spatial scale”



L26 –“and to attribute them to certain emission drivers” this statement needs to be reworded for clarity.

L30 – “by integration over a larger domain”. Integration of what? Do you mean fluxes? Larger domain than chambers?

L30 – “It was already applied”. What is “it”? The EC technique? If so, replace “it” by “The EC technique”

L32 – “(intensive – extensive, different crops, land / lake, . . .)” replace by “(intensive – extensive, different crops, land / lake, etc.)”

L33 – “for one system is preferable” replace by “for each system is preferable”

Page 3

L2 – “to understand the contributions” replace by “to estimate the contributions”

L2 – “of the single emission sources” replace by “from single emission sources”

L4 – “emissions of two” replace by “emissions from two”

L5 – “diet for the cows” replace by “cows’ diet”

L6 – The word fast should not be capitalized.

L8 to 9 – “We aimed at a better understanding of the quantity of the overall pasture emissions, the different emission sources and the reduction of corresponding uncertainties”. This sentence is awkward and needs to be reworded.

L12 to 13 – provide the experimental period.

L13 – “detail in Voglmeier” replace by “detail by Voglmeier”

L14 – “annual average rain amount”. Is snow also included in the total amount? If so, replace the word “rain” by “precipitation”.

L15 to 16 – “(about 20 % clay, 35 % silt and 16 45 % sand” there is no need to show

this since this soil texture data are shown in Table 1.

L16 – “Soil measurements were performed. . .”. Can you be more specific?

L18 – “the last renovation of the field in 2007” replace by “the last field renovation in 2007,”

L19 to 20 – “the fertilization rate was in the order of 120 kg N ha-1 20 per year between 2007 and 2015”. Can you please specify the fertilization timing?

L23 – “12 cows per system.”. Please reference figure 1.

L24 – “with additional maize silage”. Was this silage offered to the cows in a different area? Did the silage supplementation influenced the time in which the cows spend in the grazing system?

L30 – “X indicating both systems”. I suggest using M or G instead of X to avoid confusion.

Page 4

L7 to 8 – “July and made a grass cut on the 22nd of June necessary” replace by “July and requiring a grass cut on June 22nd ”

L15 – “For the comparison with the field-scale EC”. Which comparison? Be more specific.

L25 – “to perform chamber measurements attributable to distinct surface conditions” replace by “to estimate N2O emissions from different surface sources”.

L30 to 31 – “GS3 probe 31 (Meter Group, US” replace by “soil probe (GS3, Meter Group, US)”.

Page 5

L1 to 2– “Conductivity values exceeding a threshold of 0.15 mS cm-1 1 2 were marked as possible urine patches for further chamber measurements.” It is important to explain



how this electric conductivity threshold was established.

L 3 – “Exemplary” replace by “Time series of”

L10 – “taken mainly during dry soil conditions” Can you provide the soil water content associated with “dry soil conditions”?

L18 – “The gas 18 was sucked through” replace by “The gas 18 was drawn through”

L18 – “a 40 m 1/4" PA tube allowing”. Use metric units do express the dimensions of the tubing. Does 1/4” refer to the internal diameter of the tube? Please specify. What does “PA” stand for?

L19 – “The sample flow rate Q was typically around 8 l min-1 19”. Did you use a mass flow controller to keep the flow rate constant?

L21 – “foam material to avoid uncontrolled air exchange”. Was the chamber covered with some insulating material? What was the typical temperature differences within and outside the chamber during these measurements?

L21 to 22 – “The chamber was also equipped with a GMP343 (Vaisala, FL) CO2 probe to measure the soil respiration.” Do you show this CO2 data? If not, I suggest excluding this sentence.

L22 to 23 – “The increase in concentration after placing the chamber on the soil was recorded every three seconds for a time period of about 90 seconds.” For your chamber flux calculations, did you take into account the time necessary to purge this long tube right after the sampling line was connected to the analyzer?

Page 6

L2 – “(slow chamber volume exchange and short measurement time)”. Can you provide an average value for the chamber volume exchange?

L13 to 14 – “a thermocouple for air temperature measurement within the chamber, a

GS3 probe (see Sect. 2.4.1) and a ML3 Thetaprobe (Delta-T Devices Ltd, UK) for soil moisture and temperature observations (c. 0-5 cm and 0-10cm depth, respectively)." This sentence is a little confusing and needs to be reworded.

Page 7

L4 – "were fenced to avoid unwanted animal contact". Can you provide the area of the fenced area around the tower?

L9 – Does this sonic anemometer infers the air temperature based on the sonic temperature or it has its own temperature sensor?

L10 – replace "sucked" by "drawn"

L11 – Please provide the pore size of the filters

L16- "The sample frequency of the EC system was generally 10 Hz". Does this mean that there was variation in the sample frequency? Why is that?

L18-19 – This sentence is awkward and needs to be reworded.

L22 – "The approach is based on. . ." What approach are you referring to?

L24 – 500 data points?

L24 – replace "double rotation" replace by "double coordinate rotation"

L28 – "several seconds". Provide the typical time lag value and its standard deviation.

L31 – "a time window of 0.61 seconds". How was the number determined

Page 8

L1 – "In order to minimize the effect of non-stationarities in the time series, the 30 min flux was finally calculated as average over six 5 min subinterval flux values.". I wonder what would be the effect of this averaging approach on the low frequency spectral losses of their EC system. Furthermore, if you are already screening the data for non-



stationarity (page 8 L24) why to estimate fluxes for these short time intervals?

L7 – "half-hourly damping factors". Do you mean dampening factor?

L9 – "damping factors" see comment above

L10 – "damping effect" see previous comment

L11 – "EC flux measurements were taken" replace by "The EC flux was measured"

L19 – replace "which often result" by ", which often resulted"

L20 – delete the word "necessitate"

L21 – replace "like" by "for example"

L22 – replace "power break down" by "power outage"

L22 to 23 – replace "a data loss" by "data losses"

L24 – "(280o - 25o; 97o – 195o)" replace by (wind dir. = 280o - 25o and wind dir. = 97o – 195o)

L28 – "It was driven". What is "it" referring to?

Page 9

L15 – "and it has to be checked". What is "it" referring to?

L18 – ", it is based on" replaced by ", based on"

L19 to 21 – Place the variable definitions after the equation.

L22 – "80' 000 trajectories were released backwards in time" replaced by "80,000 fluid particles were released backwards in time". Also, what is the time scale of this simulations? 30-min periods?

L24 – "systematic uncertainty". Do you mean "accuracy"?

Page 10

L1 – I think section 2.6 is out of place. It should come after section 2.7.

L2 – what is the datalogger model used in this study?

L6 – In this section, it would be important to provide the spatial resolution of the grid used for upscaling the chamber fluxes. More details are also necessary on how the authors went from the output of Eq. 2 to the scaled fluxes. Did you generate digital maps of source emissions and then overlapped these maps with a footprint map? What was the software used to do these calculations?

L13 – "patches, . . .)" replace by "patches, etc.)"

L15 – "Upscaling FB measurements to the EC footprint was performed" replace by "FB measurements were up scaled to the EC footprint"

L16 – replace "contribution" by "contributions"

Page 11 L3 – "Upscaling to the paddocks" replace "Upscaling fluxes to the paddocks"

L10 – "Occasional negative individual flux values". What is the detection limit of this EC system? I think this would be an important variable to know to interpret these fluxes.

Page 12

L3 - "Fluxes of background and dung patches were significantly smaller". Did you perform a statistical test to support this statement?

L 4 – "Especially fresh deposited urine patches with excreta ages below 3 days were able to emit more than" replace by "Freshly deposited urine patches under 3 days old could result in N2O emissions larger than"

L26 – "exponential decrease" replace by "exponential function"

Page 14



L25 – "the variations were less pronounced". Which variations were less pronounces.

Page 15

L 19 – "The good agreement btween the two independent approaches" provide a statistical index to support this statement.

L20 – replace "incl." by "including"

L28 to 29 – This sentence is a little confusing and needs to be reworded.

L21 – "significant sytem difference". Over which period of time and shouldn't this difference be expressed per area?

Page 16

L3 to 4 – "e.g. N2O emissions related to the maize production. . .". Could you include values in the literature typical emission factors for corn silage production? These data would allow a fair comparison between the two grazing systems.

L9 – "They are based on". Specify who are "they".

L18 – "looking only at" replace by "looking only into"

Page 17

L18 – "lead to increased soil" replace by "leads to increased soil"

L23 – "emission optimum". What does the word "optimum" mean here? Low N2O emissions?

Page 18

L14 – replace "prohibited" by "prevented"

Page 25

L2 – "N of the Swiss dairy" replace by "N provided by the Swiss dairy"

Page 28

Table 5 – “EC integral system emission EC”. Do you mean: Integral EC flux system emission?

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