

## ***Interactive comment on “Multi-satellite sensor study on precipitation-induced emission pulses of NO<sub>x</sub> from soils in semi-arid ecosystems” by J. Zörner et al.***

**Anonymous Referee #1**

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Review on manuscript acp-2016-93. Multi-satellite sensor study on precipitation-induced emission pulses of NO<sub>x</sub> from soils in semi-arid ecosystems By J. Zörner, M.J.M. Penning de Vries, S. Beirle, H. Sihler, P.R. Veres, J. Williams, and T. Wagner.

The topic of the paper is about a top down approach to determine soil NO<sub>x</sub> emissions provoked by first rains after a long period of drought. Satellite data from three different instruments are used to retrieve NO<sub>2</sub> Vertical Column Densities, as well as other parameters necessary to interpret soil NO<sub>x</sub> emissions variability. The study is global, but focuses on semi arid regions, and specifically on the Sahel region. This study shows that increases in NO<sub>2</sub> VCDs are explained by soil NO<sub>x</sub> emissions at the beginning of the rain season. Corresponding fluxes are calculated and are in the range of literature

C1

values.

General comments

The paper is totally within the scope of ACP. The idea that pulsing emissions occur on very dry soil after the first rain is not new, but it is presented and demonstrated in a very comprehensive way including three different satellite instruments. Biases and possible misinterpretations of satellite data are ruled out and the conclusions are convincing.

The results are correctly presented; the figures illustrate the results in a clear way. The paper is well written, regardless of some minor corrections. I recommend this paper to be published in ACP, after minor corrections and improvements.

The principal missing points concern: - a calculation of the budget at the seasonal scale in TgN for the Sahel. The evaluation of NO fluxes from soils is a good point, but it would have been interesting to know the overall budget at the regional scale. All the necessary information is available (fluxes, area) for this calculation. If this calculation cannot be provided please explain why precisely.

- References on soil NO<sub>x</sub> emissions are a bit old, except Hudman et al. (2012). New references could be included, see suggestions below.

- Too little explanations are given on processes responsible for soil NO<sub>x</sub> emissions. References are suggested below.

- The Western Sahel is not included in the study, the reasons why are not clear and must be detailed.

Specific comments

Abstract. The abstract gives a clear idea of what is presented in the paper.

Introduction Line 7, page 2: NO<sub>x</sub> is also removed by NO<sub>2</sub> deposition on vegetated surfaces.

C2

Line 23 page 2: explanations of nitrification and denitrification processes are a bit confused. Please refer to Pilegaard et al., Phil Trans. R. Soc., 2013.

Line 31 page 2: you should also mention HONO emissions from semi arid soils, see Oswald et al., Science 341, 1233, 2013. "N-fixing microbial species occur": not clear enough

Line 6 page 3: Soils emission depend also on pH, N content (not only N input).

Line 8 page 3: In the Sahel, the presence of cattle is an important provider of organic fertilization. This should be mentioned. See for example Delon et al. (2010), already referenced in your paper.

Line 11 page 3: Add some recent publications of pulsing. Such as Kim et al., Biogeosciences, 9, 2459–2483, 2012, Wang et al., Volume 6(8), Article 133, Ecosphere, 2015.

Line 6 page 4: Section 3 is mentioned, but sections 1 and 2 should be mentioned first.

Line 7 page 4: "This approach..." should be "In section 4, this approach..."

Line 10 page 4: precise which governing parameters you refer to.

Line 11 page 4: "also" is not at the right place in the sentence.

Line 19 to 26 page 4: the way of presenting the different points ((i) (ii) (ii)) is not easy to read. Making proper sentences would be more readable.

Line 19 page 6: "Relative fluxes": relative to what?

Line 27 page 6: reformulate sentence beginning with "The data sources..."

Line 13 page 7: Sentence beginning with "The Moderate..." is difficult to understand. Please reformulate

Line 17 page 7: Specify "others". Specify the time period and the time resolution used.

### C3

Line 5 page 8: the time period is précised here, it should be précised earlier.

Line 16 page 8: "in the Sahel and shorter" should be "in the Sahel to shorter periods"

Line 20 page 8: precise that background level is precipitations < 2 mm during 60 days.

Line 3 page 9: Mention that fig 3 will be described below in the Results paragraph.

Line 15 page 9: Ad "the" between "Although" and "best". This sentence is confusing, in the sense that you write that analysis cannot be not in the Tropics, Northern America, Europe, South Asia? Please explain.

Line 23-24 page 9: Sentences need to be reformulated.

Line 2 page 10: Transports are mentioned to explain NO<sub>2</sub> VCDs enhancements. Neither transports nor industries and traffic were mentioned in the introduction as possible sources. Why should transport explain enhanced emissions at the first day of rain?

Line 7 page 10: the dry season in the Sahel lasts nearly 8 months. Was the month of July tested as part of the months when the first day of rain occur? Sometimes when the wet season is late, the first day of rain occurs only in July. See Lebel et al., Journal of Hydrology 375 (2009) 52–64.

Line 14 page 10: add "next" after "gradually with the start of the..."

Line 19 page 10: Why did you exclude the western Sahel of the studied zone?

Lines 22-25: this paragraph should be in the methodology section.

Line 24 page 10: You mean that for a period less than 2 months, the N enrichment is not sufficient? Can you give references for that?

Line 11 page 11: smaller instead of smallest.

Line 25 page 11: the expression "dry phases" is not understandable here. It is only understandable once reading the following sections. May be a word or two to explain could be useful.

### C4

Lines 27-30, page 11: do you think the enhancement of HCHO the day before Day0 has a link with air moisture? What are the processes that may be involved?

Lines 6-7 page 12: industrial activities and strongly fertilized agriculture are hardly found in the Sahel even in the Southern part. You mean may be the southern part of West Africa?

Line 9 page 12: low nitrogen input and nitrogen content. The role of cattle should be developed in this paragraph. Mineral fertilizers are not widely used in the Sahel, while organic fertilization plays a non negligible role in sNOx emissions. See for example Schlecht and Hiernaux, Nutrient Cycling in Agroecosystems 70: 303–319, 2004.

Line 20 page 13: a short conclusion of possible under or overestimation of cloud effect on NO2 VCDs should be useful.

Line 9 page 14: “,thus,” may be removed from the sentence.

Line 22 page 14: “at” instead of “on” the same latitude.

Line 16 page 15: “largest” instead of “larger”.

Line 3 page 16: specify “Eastern” Sahel, because the analysis has not been made in Western Sahel.

Line 5 page 18: As indicated in Aghedo et al., Atmos. Chem. Phys., 7, 1193–1212, 2007, anthropogenic pollution is not likely to reach sahelian latitudes.

An important added value could be brought here to this paper. As mentioned in the general comments, the budget over the whole studied area (i.e. Eastern Sahel) could be calculated in TgN for the studied period.

Conclusions Lines 7-13: difficult to follow with this a) to e) way of presenting the ideas. Proper sentences would be more readable.

Line 15 page 18: “maximum amount of precipitation”? do you mean the 2 mm thresh-

C5

old? In that case it is the minimum amount.

Line 17 page 18: “shown” instead of “showed”.

Line 20 page 18: again see Oswald et al., 2013, where laboratory measurements made on semi arid soils are presented.

Technical corrections Line 11 page 3: “lab” should be laboratory

Line 13 page 6: Upper case to begin the paragraph is needed.

e.g. throughout the text should be in italics.

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Interactive comment on Atmos. Chem. Phys. Discuss., doi:10.5194/acp-2016-93, 2016.

C6