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Interactive comment on "An improved mechanistic model for ammonia volatilization in Earth system models: Flow of Agricultural Nitrogen, version 2 (FANv2)" *by* Julius Vira et al.

Anonymous Referee #2

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This paper describes a process based model FAN (Flow of Agricultural Nitrogen), which evaluates the NH3 emissions interactively within an Earth system model for use in the Community Earth System Model (CESM). The paper is an advancement to FANv1. However, FANv2 largely inherits its parameterizations for chemical and biological processes from FANv1 but adds a more detailed description of the processes which transport TAN within the soil. The updated version (FANv2) includes 5 more detailed treatment of both physical and agricultural processes, which allows the model to differentiate between the volatilization losses from animal housings, manure storage, grazed pastures, and from application of manure and different types of mineral fertilizers. The FANv2 model is connected to the interactive crop model within the land component

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Discussion paper

of CESM, which determines the amount and timings of fertilizer applications for major types of crops. The model is first evaluated at local scale against experimental data for various types of fertilizers and manure, and subsequently run globally to evaluate present-day NH3 emissions.

The authors i.e. Vira, Hess, Melkonian and Wieder are all highly regarded. They have made a very good attempt at advancing the science of estimating the science of ammonia emissions from agricultural soils. Moreover, they have compared their model output to measured values; and extended the analysis to global prediction.

I believe the manuscript needs to address my concerns before I will recommend it for publication. Major Comments:

1. The manuscript is very lengthy; and a lot of the modeling framework background should be shortened.

2. The assumptions made in the manuscript need to be explained and or justified. For example pg 3, line 30 "the soil below the topmost layer is treated as a sink—–and all the N transport below 2 cm layer is assumed to be permanently unavailable—-" needs to be justified.

3. Most of the References are old i.e. prior to 2015. More recent references i.e. 2018 and 2019 should be provided and their results discussed.

4. Pg 4, line 2 The role of microbial activity is not simulated. This is a very important component of the N biogeochemical cycling and needs to be addressed.

5. Pg 2, line 33 "In this study FANv2 is run globally within the CLM for the six-year period 2010–2015 to simulate the present-day NH3 emissions, which are then compared with existing global and regional inventories". This is fundamentally incorrect since ammonia emissions and thus ammonia concentrations calculated for 2015 will be different from present-day i.e. 2019 or 2020.

6. Pg 4, Eq 2. The rates are all first order. This assumption needs to both be explained

and justified.

7. Pg 5, Line 2. "The diffusion and leaching fluxes are not evaluated for the available and resistant organic N". This reviewer does not understand what is being suggested.

8. Pg. 23, Figure 5 b. Model results and observations do not agree well. This needs to be explained in detail.

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