Authors' response to the referee comment of Y. Wu on "A process-based model for ammonia emission from urine patches, GAG (Generation of Ammonia from Grazing): description, validation and sensitivity analysis"

We thank the reviewer for their comments. Our answers followed by our modifications of the manuscript are provided point-by-point below.

Comment: *"However, some of these assumptions [in the model] might be invalid in the real world, such as no capillary forcing when soil moisture reaches field capacity, which is the dominant diving forcing for water movement in unsaturated soil."*

Our answer: We thank the reviewer for noting that there are possible consequences of the simple handling of the water movement in the soil. However, the simulation of water movement, including the effect of capillary force, diffusion of water in the soil as well as the concentration of TAN and urea within the moving liquid is very complex. Shorten and Pleasants (2007) published a system of partial differential equation describing these processes, which could be a basis for further development of GAG. Nonetheless, incorporating this model (or any other model of soil water movement) to GAG would require such an extensive modelling work that is beyond the scope of our current study.

Change to the manuscript:

In response to this point, we add the following paragraph to page 10088 after line 25:

"In addition, a limitation of the calculation of the water budget is that GAG does not account for the water movement in the soil, including the effect of capillary force, diffusion of water in the soil as well as the concentration of TAN and urea within the moving liquid. However, the simulation of these processes is very complex. Shorten and Pleasants (2007) published a system of partial differential equations describing these processes, which could be a basis for further development of GAG."

Comment: *"Soil temperature, an important factor for ammonia emission from urine patches, was not discussed in the model."*

Our answer: The model does take into account the effect of the soil temperature, as an input parameter based on measurements, on the compensation point in the model soil pores, as well as for the urea hydrolysis rate (Eq. 18 and 26, respectively). We tested the sensitivity of the model to soil temperature (Table 5) and described the results in Section 6.

Comment: *"To my understanding, water film and plant cuticle are two different materials, and their resistance to ammonia emission are also different. So, Equation 8 might not represent both."*

Our answer: We also thank the reviewer for noting this point. The cuticular exchange of ammonia is strongly linked to the presence of a water film on the leaf surface (Flechard et al., 1999). This can form even well below the water vapour saturation, as a result of condensation of water vapour facilitated by hygroscopic particles on the plant surface (Burkhardt et al., 1999). Thus, the single resistance used in ammonia exchange models

(e.g. Nemitz et al., 2000, 2001, Burkhardt et al., 2009) to describe the non-stomatal (cuticular) pathway includes the effect of the water film too.

Change to the manuscript:

To clarify the role of the cuticular resistance in ammonia exchange we will extend the following sentence on page 10068 starting in line 10:

"The cuticular resistance (R_w) describes the effect of the water film, forming on the waxy leaf surface, on the NH_3 absorption."

with the following:

"The cuticular exchange of ammonia is strongly linked to the presence of a water film on the waxy leaf surface (Flechard et al., 1999). This can form even below the saturation point for pure water vapour, as a result of condensation facilitated by hygroscopic particles on the plant surface (Burkhardt et al., 1999). Therefore, the cuticular resistance (R_w) describes the effect of this water film on NH_3 absorption."

References

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