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Biogeosciences Discussions

Interactive comment on "SURFATM-NH_3: a model combining the surface energy balance and bi-directional exchanges of ammonia applied at the field scale" *by* E. Personne et al.

Anonymous Referee #2

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General comments

This paper presents a surface-vegetation-atmosphere transfer (SVAT) model that couples energy, water vapour and NH3 exchange. While the model parts dealing with NH3 exchange processes between the soil, vegetation and the atmosphere are largely based on previous models and thus show no great conceptual originality, it is the physical coupling to the energy budget of compensation points and resistances at various heights within the canopy profile that provides a step forward from previous approaches. The rationale and objectives of the paper are clearly laid out and overall the model description is adequate without being overly detailed, but minor inconsistencies must be resolved and many language/grammatical errors corrected.

Specific comments

The model framework presented is used as a tool to investigate source-sink relationships within the soil-grass system, and also to simulate net exchange fluxes. Although bioassays carried out during the Braunschweig campaign showed great emission potentials in BOTH soil and in the overlying leaf litter, the model framework only allows for one source at the 'soil surface'. If the soil emission potential is chosen as the driver of NH_3 emission from the bottom part of the canopy (S1), then the leaf litter is ignored, and vice versa. The bottom part of the canopy is thus presented as an Either/Or alternative (see p79, l2: soil or litter i.e. scenario S1 or S2), while NH_3 can clearly originate from both. The authors present the differences in flux between S1 and S2 but they never try to combine the two sources, or at least to discuss the possibility or challenges of a combined approach and a model investigation of the relative importance of both sources. One is left with the impression that S1 is sometimes justified, while at other times S2 seems more appropriate, but no effort is made to integrate both sources and provide a comprehensive framework. The sequential management of grassland, with successive growth, cut, fertilisation, is likely to lead to changing relative magnitudes of the soil vs litter emission potentials, but with potential concurrent contributions by both, and this must be accounted for if this model is to be used is larger-scale ATM, as is advertised in the introduction and conclusion.

One strong justification for the coupling of the energy budget and NH_3 exchange is the influence of a within-canopy vertical temperature profile on compensation points in different layers, with a doubling of Cp with every additional 5K. However, the paper shows no comparison of simulations between this model and other existing 2-layer models that use one single bulk canopy temperature (z0'), or a comparison to this model with the surface temperature gradient turned off for the sake of argument. Does the resolution of the energy budget with a view to simulating the vertical distribution of temperature actually greatly improve model performance? Could there might be compensating factors (e.g. higher temperature and enhanced emission in the upper layers, but higher humidity and increased deposition in the lower layers), resulting in little difference in the net canopy flux? A sensitivity analysis might help.

The model's acronym 'Surfatm-NH3' is rather heavy but at the same time not explicit enough, as the model does not only simulate NH3 exchange but also the energy partitioning and within-canopy profiles.

p75, l18: Is Dw in fact D_H in Eq. 1?

p76, l2: Why is R_litter included in R_bss ? R_litter is an additional resistance in series with R_bss, but the diffusional resistance through the litter is a different process than in the pseudo-laminar layer and should not be included conceptually in R_bf, even if this is identical numerically

p75, l18 and p76, l2 and l20: in R_bss of Eq.2, the molecular diffusivity of NH3 is taken into account in the Schmid number, and also in R_bf of Eq. 1, in the Di/Dw term. Why should another factor be implemented in line 20-21 to account once more for D_NH3 in the formulation of R_bss and R_bf? Note: the D_NH3/Dw correction is usually applied for stomatal resistance, but there seems to be no justification for it here.

p83, l21-22: there are clearly, occasionally, larger differences between modelled and measured Tsurf, up to more than 10K, and while the model does provide overall good estimates of Tsurf, there are periods of significant discrepancy so it may not be entirely truthful to state that 'the agreement .. is within 4°C'. Please re-phrase more accurately.

p86, l15: where does the 2000 s m-1 value come from? Was this fitted to make the nightly difference between modelled and measured G vanish? There is no reference in the text p76

p86, l23-25: 'the overestimation is linked with the presence of grass left on the field': why should the overestimation only occur on the first 3-4 days after the cut, and not later on, when the grass was left on the field for 7 days (as stated p 80, l15)?

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p89, l25: 'the stomata are absorbing most of the NH3 ..': I would tend to disagree with this statement. It is likely that the non-stomatal resistance Rw was much lower than the stomatal resistance Rs, especially with a reduced LAI, and thus non-stomatal surfaces would be the preferred pathway, but this depends on relative humidity and is easily verified in the model.

p90, l17: 'the weight of the stomatal AND NON-STOMATAL LEAF SURFACE sink is reduced by the cut'

p96, Appendix C, l5-20: It is not clear whether Gs is calculated with a vertical profile of Rg or PAR, taken into account the attenuation of incoming radiation within the canopy, and then integrated vertically using an LAI profile ? Is this what is implied by eq. C2?

p103, References: the 2 references to Sutton et al 2008 are identical. The missing ref is to Sutton et al 2008, overall synthesis of the Braunschweig experiment

p112: It would be useful to show a comparison of relative humidity, modelled and measured, at the top and at the bottom of the canopy, as is done for temperature. This is critical for the weight of the non-stomatal sink.

Typographical corrections / language errors

p72, l10: change 'climatic' to 'meteorological'

p72, l24: ' a key process OF the Earth's biosphere..'

p72, l25 'global scaleS..'

p73, l11: delete 'Indeed', as this sentence is no logical consequence or follow-up of the previous

p74, l4: change 'depend exponentially on' to 'increase exponentially with'

p74, l5: change to '.., and to be controlled by stomatal resistance like any other gas'

p74, l20: move 'separately' after '..the soil layer' p75, l7: remove the quotes (”) of cuticular, or use another term (e.g. ’non-stomatal’) if cuticular is deemed not adequate

p77, l2: change ’photosynthetycally’ to ’photosynthetically’

p77, l20: ’.., THE cuticular resistance R_wf(NH3) is set to vary according..’

p79, l14: ’OperatiON of the model’

p 80, l4: Delete ’And’ at the start of sentence

p80, l9: change the 1st ’across’ with ’along’

p81, l9: change ’are index’ to ’area index’

p81, l12: it might be useful to change ’Gamma_s’ to ’Gamma_stom’ throughout the paper to avoid confusion with soil, for the sake of clarity.

p81, l16 and l17: the reference to the synthesis paper by Sutton et al. (2008) is missing. The paper listed in the reference list is the strategy and implementation paper by Sutton et al., but this reference is provided twice, while the synthesis paper is absent.

p82, l1: it is ’Fig. 3’

p83, l3: ’fluctuation method’: do you mean ’eddy covariance method’ ? Please change

p83, l8: change ’the 29 May’ to ’29th May’

p83, l8: ’the grassland cut led TO increased total heat flux and soil heat conduction’

p83, l22: delete ’and so the’ and insert brackets around ’(foliage temperature)’ and ’soil surface temperature)’

p 83, l25: ’it can be underlineD’

p83, l27: change ’which raise’ to ’of’

p84, l10: ’continued FOR A few days’

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p84, l18: change ’most close’ to ’closest’

p84, l26: ’ S1 tendS to underestimate’

p84, l27: ’S2 tendS to..’

p85, l15: insert ’and ’ between Gamma_soil and Gamma_litter

p85, l26: ’startS to give..’

p85, l27: ’agreeS very well..’

p86, l7: change ’was used to have a closing ..budget’ to ’ was used to close the ..budget’

p86, l16: change ’almost decreases’ to ’suppresses’

p86, l20 ’close to the measured TEMPERATURE OF top green leaves’

p87, l6: change ’multiplicate’ to ’multiply’

p87, l16: ’dependent ON temperature’

p87, l21’ DynamicS of the exchange’

p88, l20: ’the role of the ground surface exchange IS enhanceD as IS the influence ..’

p89, l1: ’emission potential should take into account the degradation on the soil surface and the dilution or leaching with SOIL WATER in order to IMPROVE the simulated results’

p89, l9: ’may be considered TO depend ..’

p89, l14: ’BEaring in mind..’

p90, l19: same as above

p90, l24: change ’smaller’ to ’lower’

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p90, l26: change 'small' to 'low'

p91, l7: 'the fertilisation induces an increasE of the NH3 fluxes'

p91, l10: 'the NH3 emissions .. 7 June ARE typical .. emissions and ARE well reproduceD by the litter emission scenario'

p107, footnote: 'used to extrapolatE '

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