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Geoscientific Model Development Discussions

Interactive comment on "WETMETH 1.0: A new wetland methane model for implementation in Earth system models" *by* Claude-Michel Nzotungicimpaye et al.

Anonymous Referee #1

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Summary:

The WETMETH model represents some advances in modelling science, although one of its "novel" components (vertical methane production) is also in other models. Even though WETMETH is to be included in an Earth system model, its detailed validation is highly skewed to the middle and high latitudes. More detailed validation needs to be undertaken in tropical regions. The scheme also needs a more thorough justification and calibration of its methane production optimal temperature formulation.

The manuscript is generally well-written and constructed, with appropriate figures and tables.

Model design, validation and calibration:

The manuscript describes the three pathways by which methane is produced by methanogens in the soil, with the main pathways utilising either acetate or CO_2. Root exudates provide a large source of acetate, but it is unclear from the WETMETH model description that any of the soil carbon pools include root exudates. If root exudates are included in a soil pool, does this pool have a fast enough turnover time appropriate for their decomposition, or is it combined with other compounds which have slower decomposition rates?

An optimal temperature for methane production is included in WETMETH, with the model being particularly sensitive to the value it is assigned. The formulation used is taken from Wu et al 2016, which is calibrated using data from mid and high latitudes bogs and fens. It is also based on the optimal temperature for soil CO_2 production.

Methane production via the acetoclastic pathway is not dependent on CO_2 availability however. So is it valid to use the same optimum temperature for methane production? Also is this optimum temperature value used equally valid in the tropics where one might expect soil microbes to be acclimatized to higher temperatures?

The model produces very different latitudinal patterns in flux per unit area to other estimates (Figure 11b, page 24), which could be due to the optimum temperature. This is especially the case over the tropics where the authors acknowledge that the overestimation of wetland area may be compensating for the low flux intensity, resulting in an overall flux which is more comparable to other estimates. This optimal temperature parameterization and the value chosen needs more justification, analysis and discussion.

The detailed validation of WETMETH is skewed towards the extra-tropics. There is insufficient validation against available tropical methane measurements. The assessment of tropical fluxes is made by comparison against other models from (climate model) grid to regional scales. This issue is highlighted by the fact that WETMETH produces very different flux rates per unit area in the tropics relative to other models (see above). Adequate validation over the tropics is of particular importance because tropical wetland methane emissions dominate the global wetland budget, and WETMETH is intended for use in Earth system models.

Specific comment:

The manuscript states: ". . ..particularity of WETMETH among relatively simple models is that the model accounts for. . .. . . a depth-dependent representation for methane production" (page 27 line 620). The addition of a vertical dependent methane production is not entirely novel within models of similar complexity (e.g. Comyn-Platt et al 2018).

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