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Biogeosciences Discussions

Interactive comment on "Seasonal Variability of Tropical Wetland CH₄ emissions: the role of the methanogen-available carbon pool" *by* A. A. Bloom et al.

Anonymous Referee #3

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General Comments:

The global methane cycle and the methane emissions from wetlands are topics of much current interest. Wetlands are the largest natural source but there is a significant uncertainty associated with the emission estimates. This paper makes an important contribution to this topic.

The paper extends previous work on methane from wetlands by the same authors (Bloom et al., 2010), primarily through the introduction of a time decay of the methanogen-available substrate in the parameterisation of methane release from wetlands. This is used to explain the observation that the maximum in the atmospheric

CH_4 column over the Amazon can occur some months prior to the peak in the water table (the measure used to characterise the 'wetland'). The parameterisation is then applied globally and used in the GEOS-CHEM atmospheric chemistry model. This work is highly relevant as many of the leading land surface models (e.g., the US Community Land Model (Riley et al., 2011), the Joint UK Land Environment Simulator (Clark et al., 2011), Orchidee (Ringeval et al., 2010), etc) generally use parameterisations of CH_4 release from wetlands which would scale with the wetland extent/fraction, all other factors being equal.

The paper draws heavily on the earlier work (Bloom et al., 2010) and the assumptions made there. A thorough reading of that paper and its supplementary material is a prerequisite to understand many aspects and implications of this paper. As an example, the conversion constant κ is introduced to relate the grid-square emission flux to the grid-square atmospheric column (page 393-394). This parameter effectively represents the effect of dispersion and other atmospheric processes. There is no information provided in this paper as to how κ or its uncertainty was derived. The authors should address the level of detail provided.

I would agree with Reviewer 1 that the authors should explore alternative hypotheses.

Specific Comments:

The Congo river basin (page 389, line 24) was also highlighted as one of the areas where the earlier paramterisation was less successful (the other being the Amazon considered here). There is however no further discussion of this basin in this paper.

As indicated above, the parameter κ is used to represent processes occurring in the atmosphere. Later on page 394, the uncertainty σ_κ in κ is stated to be $\pm$16%. What does this uncertainty represent?

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It is not completely clear whether the parameterisation developed here for the tropics was extended globally or the parameterisation developed by Bloom et al. (2010), amended to account for the temperature cut-off, was used for non-tropical regions. The implication of this work is that there is synchronicity of the peaks in the effective water height and the atmosphereic methane measurements. The decay constants will be lower (as there is likely to be a temperature control). There would be no decay and time lag. In the Supplementary Material to the previous paper, a weak correlation was observed between column CH_4 and equivalent water table height in Northern Amazonia, which the authors suggested was due to the effects of the intertropical convergence zone. Is this still seen?

There is a general lack of site-specific CH_4 flux data in the tropics (Table 3 of Riley et al. (2011) provides a list of the sites used to evaluate CLM). It would however be valuable to see how the parameterisation performs against site-specific measurements (or as suggested by the other reviewers, against more detailed parameterisations).

The paper by Bousquet et al. (2011) is not cited. In this paper, two top-down emission estimates derived using atmospheric inversion methods were compared with a bottom-up estimate from the Orchidee model. The top-down approach gave a global CH_4 source from wetlands of 165 Tg CH_4 per annum. For completeness, there is a recent paper in this journal (Ito and Inatomi, 2012) which also looks at global CH_4 emission estimates and their uncertainties.

Technical comments:
Page 393, What does ΔF in equation (4) represent? Presumably, by analogy with ΔS, this is the emission flux variability after the interannual trend has been removed.
Page, 394, line 4: the 'e.g Bloom et al' is not really an example of the methodology but is based on it. This should be replaced with 'as discussed' or 'see Bloom et al.'

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Page 398, line 21: the acronym ACTM (=atmospheric chemistry transport model) needs to be defined.
Page 405, Figure 1 caption: Timing (day of year) should be replaced with Timing (month of year) as the upper set of figures use 'month of year'.

References

Bloom, A. A., Palmer, P. I., Fraser, A., Reay, D. S., and Frankenberg, C.: Large-Scale Controls of Methanogenesis Inferred from Methane and Gravity Spaceborne Data, Science, 327, 322-325, 2010.

Bousquet, P., Ringeval, B., Pison, I., Dlugokencky, E. J., Brunke, E.-G., Carouge, C., Chevallier, F., Fortems-Cheiney, A., Frankenberg, C., Hauglustaine, D. A., Krummel, P. B., Langenfelds, R. L., Ramonet, M., Schmidt, M., Steele, L. P., Szopa, S., Yver, C., Viovy, N., and Ciais, P.: Source attribution of the changes in atmospheric methane for 2006–2008, Atmos. Chem. Phys., 11, 3689-3700, doi:10.5194/acp-11-3689-2011, 2011.

Clark, D. B., Mercado, L. M., Sitch, S., Jones, C. D., Gedney, N., Best, M. J., Pryor, M., Rooney, G. G., Essery, R. L. H., Blyth, E., Boucher, O., Harding, R. J., Huntingford, C., and Cox, P. M.: The Joint UK Land Environment Simulator (JULES), model description – Part 2: Carbon fluxes and vegetation dynamics, Geosci. Model Dev., 4, 701-722, doi:10.5194/gmd-4-701-2011, 2011.

Ito, A. and Inatomi, M.: Use of a process-based model for assessing the methane budgets of global terrestrial ecosystems and evaluation of uncertainty, Biogeosciences, 9, 759-773, doi:10.5194/bg-9-759-2012, 2012.

Riley, W. J., Subin, Z. M., Lawrence, D. M., Swenson, S. C., Torn, M. S., Meng, L., Mahowald, N. M., and Hess, P.: Barriers to predicting changes in global terrestrial methane fluxes: analyses using CLM4Me, a methane biogeochemistry model integrated in CESM, Biogeosciences, 8, 1925–1953, doi:10.5194/bg-8-1925-2011, 2011.

Ringeval, B., de Noblet-Ducoudré, N., Ciais, P., Bousquet, P., Prigent, C., Papa, F., and W. B. Rossow: An attempt to quantify the impact of changes in wetland extent on methane emissions on the seasonal and interannual time scales, Global Biogeochem. Cycles, 24, GB2003, doi:10.1029/2008GB003354, 2010.

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