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Biogeosciences Discussions

Interactive comment on "Use and uncertainty evaluation of a process-based model for assessing the methane budgets of global terrestrial ecosystems" *by* A. Ito and M. Inatomi

Anonymous Referee #2

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In this study A. Ito and M. Inatomi present a comprehensive review of established process parametrisations for terrestrial methane emissions. They revisit parametrisations especially for methane emissions in wetlands and apply them as schemes in the VISIT ecosystem model. They find CH4 emissions within the range of previous estimates. Their calculations are very reasonable and presented in a well organised way. However, their findings are not groundbreaking and do not give new insights or constraints for the present day methane budget. I thus suggest to strentghten the review character of the paper by including most recent findings from similar studies, that have been conducted especially over the last two years. I thus would support a publication in Biogeosciences after a revision.

General points Several studies have assessed global methane emissions from terrestial ecosystems in a similar way, using either dynamic vegetation models, ecosystem models, observations or a combination of both. In the following I list a selection of additional references for a potential comparison with model results for the individual ecosystems: peatlands, i.e. bogs and fens (Wania et al., 2010, Spahni et al., 2011), inundated wetlands (Ringeval et al., 2010, Bloom et al., Science, 2010, Spahni et al., 2011, Hodson et al., 2011, Riley et al., 2011), saturated and non-saturated soil emissions (Bloom et al., Science, 2010, Ringeval et al., 2010, Spahni et al., 2011, Riley et al., 2011), rice paddy emissions (Spahni et al., 2011),upland soil uptake (Spahni et al., 2011), lakes, rivers and reservoirs (Bastviken et al., 2011). Of course there are even more studies that could be added.

Allthough these studies use similar or sometimes exactly the same parametrisations of the emission/uptake processes, the global net CH4 flux densities to the atmosphere are different in space and time (season, year). However, their total global emissions per year are very close to each other independent of their setup and parametrisations used. This implies that all studies somehow scale to the same global CH4 emissions in order to be compatible with the atmospheric CH4 budget inferred from top-down. I would thus argue that the different parameterisations (for wetland emissions at least), are not independet of each other. Thus my main critics is that total CH4 emission uncertainty and variablity from bottom-up process based estimates are greatly underestimated and arguable larger than +/- 18.9 Tg/yr as inferred for the calculated source total by Ito and Inatomi in this paper.

The authors correctly point out that the upscaling from natural ecosystem CH4 emissions from point based measurements is difficult, as it can vary with ecosystem and area, e.g. area and location of inundated wetlands. However, there is little discussion on these important uncertainties and how they affect the outome of the estimated total CH4 emission range. More detailed questions regarding these point are listed within the specific points below.

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Specific points p7034,l24: Please mention atmospheric water vapour in this context.

p7036,l1: Please add also some other newer models from the list above.

p7037,l26: So for CH4 the model is evaluated for one deciduous broadleave forest? Or have other sites been used to test CH4 fluxes? How well are other ecosystem represented for their annual CH4 flux, like inundated wetlands, peatlands, rice paddies? What about emission from lakes, are they included or validated? It is eligible to use straight forward model simulations, but more information on which CH4 flux were validated and which not would be very helpful.

p7038,l20: Was FP, the proportion of the decomposed organic carbon transformed into CH4, kept constant at 0.47 over space, time and ecosystems for the simulations?

p7040,l15: labelling for titles of CH4 uptake schemes seems to be irregular, "2.2" or "2.2.1"?

p7044,l1: The authors are right, there has been a big controversy regarding aerobic emissions from plants. But recent estimates have come down considerably, e.g. see Bloom et al., New Phytologist, 2010 suggest total sources of 0.2 to 1.0 Tg/yr. Another estimate you can find in an online reply to a comment by F. Keppler in Spahni et al., 2011 in this Journal: http://www.biogeosciences-discuss.net/8/221/2011/bgd-8-221-2011-discussion.html How does the aerobic plant emission parametrisation compare to these two upscalings?

p7045,l10: This is a very interesting approach for the ruminant livestock Ch4 emission estimate. Do animal density somehow correlate with model based pasture productivity, like e.g. grass NPP?

p7045,l25: "focused"

p7046,l18: Which parameters were varied, if at all, in the two schemes for the 576 simulatons?

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p7046,l20: Ringeval et al. 2010 showed that total annual CH4 emissions must be considered as a non-linear combination of wetland area and CH4 flux density. Thus does the wetland area vary from year to year? The Prigent data is available for the years 1993-2000. How was this data set combined with the wetland and lake data set by Lehner and Döll? Are lakes and rivers included? A study by Bastviken et al., 2011 shows that lakes might make up a big part of the methane budget of up to 103 Tg/yr. How does that fit within the VISIT estimate?

p7046,l26: Since the 1980 CH4 emissions from rice paddies are estimated to have gone down, even with increasing rice paddy area and rice production. The decline in rice CH4 emissions is explained by an increased use of ferilizer (see e.g. Kai et al., 2011). Is this considered in the VISIT estimate? How were the areas of Monfreda et al. seperated from the inundation data set by Prigent et al. ? Is there a overlap?

p7047,l5: "Kirschbaum" instead of "Kirchbaum"

p7048,l7: Here it is mentioned: "We expected that the distribution of the total budget produced by these simulations would reveal the range of estimation uncertainties caused by variability in the base data and evaluation schemes." As outlined in my general point I think the uncertainty is greatly underestimated. This assumptions certainly needs more justification. How were the 576 combinations achieved? Is each combination equally probable?

p707,Figure 7: Is the global CH4 emission pattern roughly compatible with the atmospheric CH4 concentration gradient? How does it compare to other budgets constrained by satellite or inversions (Bloom et al, Science, 2010, Spahni et al., 2011)?

p707,Figure 8: There is hardly a trend in CH4 emissions from wetlands over the last century. Are CH4 emissions affected by a CO2 fertilisation effect?

References Bastviken, David, Lars J. Tranvik, John A. Downing, Patrick M. Crill, and Alex Enrich-Prast, Freshwater Methane Emissions Offset the Continental Carbon Sink,

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Science 7 January 2011: 331 (6013), 50. [DOI:10.1126/science.1196808]

Bloom, A. A., Lee-Taylor, J., Madronich, S., Messenger, D. J., Palmer, P. I., Reay, D. S. and McLeod, A. R. (2010), Global methane emission estimates from ultraviolet irradiation of terrestrial plant foliage. New Phytologist, 187: 417–425. doi: 10.1111/j.1469-8137.2010.03259.x

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, doi:10.1126/science.1175176, 2010.

Hodson, E. L., B. Poulter, N. E. Zimmermann, C. Prigent, and J. O. Kaplan (2011), The El Niño–Southern Oscillation and wetland methane interannual variability, Geophys. Res. Lett., 38, L08810, doi:10.1029/2011GL046861.

Kai, Fuu Ming, Stanley C. Tyler, James T. Randerson & Donald R. Blake, Reduced methane growth rate explained by decreased Northern Hemisphere microbial sources, Nature 476, 194–197, (11 August 2011), doi:10.1038/nature10259

Pickett-Heaps, C. A., Jacob, D. J., Wecht, K. J., Kort, E. A., Wofsy, S. C., Diskin, G. S., Worthy, D. E. J., Kaplan, J. O., Bey, I., and Drevet, J.: Magnitude and seasonality of wetland methane emissions from the Hudson Bay Lowlands (Canada), Atmos. Chem. Phys., 11, 3773-3779, doi:10.5194/acp-11-3773-2011, 2011.

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

Spahni, R., Wania, R., Neef, L., van Weele, M., Pison, I., Bousquet, P., Frankenberg, C., Foster, P. N., Joos, F., Prentice, I. C., and van Velthoven, P.: Constraining global methane emissions and uptake by ecosystems, Biogeosciences, 8, 1643-1665, doi:10.5194/bg-8-1643-2011, 2011.

Wania, R., Ross, I., and Prentice, I. C.: Implementation and evaluation of a new methane model within a dynamic global vegetation model: LPJ-WHyMe v1.3.1, Geosci. Model Dev., 3, 565–584, doi:10.5194/gmd-3-565-2010, 2010b.

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