

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

Received and published: 5 November 2011

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 strengthen 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.

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General points Several studies have assessed global methane emissions from terrestrial 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.

Although 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 independent of each other. Thus my main criticism is that total CH₄ emission uncertainty and variability 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 outcome of the estimated total CH₄ emission range. More detailed questions regarding these points 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 broadleaf forest? Or have other sites been used to test CH₄ fluxes? How well are other ecosystems 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 simulations?

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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 fertilizer (see e.g. Kai et al., 2011). Is this considered in the VISIT estimate? How were the areas of Monfreda et al. separated from the inundation data set by Prigent et al. ? Is there an 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 assumption 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?

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