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Interactive comment on "The Global Methane Budget 2000–2017" *by* Marielle Saunois et al.

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The emission estimates for the decade of 2000-2009 in Saunois 2016 have larger ranges than in Saunois 2019. I think, if the GCP condenses all information that exists, there should be at least a table explaining which studies were left out and why as supplementary information.

A major problem with the bottom-up budget is that it is so much larger than the top-down estimate. The border between wetlands and other fresh water systems is very fuzzy and more discussion is required. Historically wetlands have been classified as bogs, fens, swamps, floodplains, and shallow lakes (Bartlett 1993). For example lake Chapala, Mexico's largest lake, has a maximum depth of 2 m, is it a wetland or a lake? Is a floodplain to be considered a wetland or a freshwater system? For example, in the Amazon inundation can vary for several meters. Furthermore, in the Eastern Amazon,

emissions tend to be larger at as river flow starts to decrease in August and September (Devol 1988, Beck 2012, Ringeval 2014, Basso 2016). This seasonal maximum is not capture by any of the WETCHIMP models, which instead show a maximum between January and April (Ringeval 2014). Ringeval (2014) were able to reproduce a seasonal cycle of CH4 emissions from the Amazon mainstream that was more similar to observations by using output from a hydrology model to identify floodplains. Furthermore, from your description it seems you classify as wetlands as saturated soils and fresh water systems can be lakes, rivers, reservoirs. Early studies, e.g. Devol (1988, 1990), Bartlett (1988, 1990), Tathy 1992, Keller 1994 and Melack (2004) made measurements both over saturated soils, emergent plants and open water. These early studies were used to calibrate many models, for example, in Spahni (2011), the LPJ-Bern model was calibrate to match the seasonal cycle from an inverse modeling estimate. Furthermore, DelSontro et al. (2018) has very high emissions but is stratification and transport within a lake were not taken in consideration. For example, lakes in East Africa are highly stratified and anoxic below the mixed layer but the amount of emissions estimated by DelSontro (2018) is difficult to bring in agreement with satellite CH_4 cartographies (e.g. Frankenberg, 2011). they do not emit high quantities of methane continuously due to the same stratification of the water column. Is the future of CH4 emission modeling the merging of dynamic vegetation models with hydrology models?

With respect to the soil sink, your estimates are based on published model estimates. However, in these models, the sink strength depends on atmospheric mixing ratio (often a global constant value). For example, in the Curry (2007) model, the flux *j* is

$$j = C_0 * g_0 * r_w * r_c * \sqrt{D * k}$$

where C_0 [ppm] is the CH_4 mixing ratio and g_0 is a conversion factor from ppm to mass units. Taking this into account, the sink becomes much larger may become much larger and changes in time in proportion to the atmospheric abundance. Furthermore, both Ridgwell (1999) and Curry (2007) had use the ideal gas law to set the g0 parameter to 610 and 578 assuming a pressure of 100 kPa and temperatures of 0°C and 15°C

respectively. By determine the g0 per gridcell based on monthly temperatures and pressure, the g0 ranges between 320 and 750.

Additionally, there are important contribution from Hackstein (1994, 1996, 2006) concerning potentially large emissions from wild terrestrial vertebrates and three arthropod taxa apart from termites.

In the future, it would be useful to also have estimates of the year-to-year variability for wetlands and OH in order to understand what drove the observed year-to-year variability of the growth rate.

References

Bartlett, K. B., Crill, P. M., Sebacher, D. I., Harriss, R. C., Wilson, C., Melack, J. M. (1988). Methane Flux From the Central Amazonian Floodplain. Journal of Geophysical Research-Atmospheres, 93(D2), 1571–1582. http://doi.org/10.1029/JD093iD02p01571

Bartlett, K. B., Crill, P. M., Bonazi, J. A., Richey, J. E., Harriss, R. C. (1990). Methane Flux From the Amazon River Floodplain - Emissions During Rising Water. Journal of Geophysical Research-Atmospheres, 95, 16773–16788. http://doi.org/10.1029/JD095iD10p16773

Bartlett, K. B., Hariss, R. C. (1993). Review and Assessment of Methane Emissions From Wetlands (Vol. 26, pp. 261–320). Presented at the Chemosphere.

Basso, L. S., Gatti, L. V., Gloor, M., Miller, J. B., Domingues, L. G., Correia, C. S. C., Borges, V. F. (2016). Seasonality and interannual variability of CH4 fluxes from the eastern Amazon Basin inferred from atmospheric mole fraction profiles. Journal of Geophysical Research-Atmospheres, 121(1), 168–184. http://doi.org/10.1002/2015JD023874

Beck, V. (2012). Determination of the methane budget of the Amazon region utilizing airborne methane observations in combination with atmospheric transport and vegeta-

tion modeling. (C. Gerbig K.-U. Totsche, Eds.). Max Planck Institute for Biogeochemistry, Jena.

Curry, C. L. (2007). Modeling the soil consumption of atmospheric methane at the global scale. Global Biogeochemical Cycles, 21(4), –. http://doi.org/10.1029/2006GB002818

Devol, A. H., Richey, J. E., CLARK, W. A., King, S. L., Martinelli, L. A. (1988). Methane Emissions to the Troposphere From the Amazon Floodplain. Journal of Geophysical Research-Atmospheres, 93(D2), 1583–1592.

Devol, A. H., Richey, J. E., Forsberg, B. R., Martinelli, L. A. (1990). Seasonal dynamics in methane emissions from the Amazon River floodplain to the troposphere. Journal of Geophysical Research (ISSN 0148-0227), 95, 16417–16426. http://doi.org/10.1029/JD095iD10p16417

DelSontro, T., Beaulieu, J. J., Downing, J. A. (2018). Greenhouse gas emissions from lakes and impoundments: Upscaling in the face of global change. Limnology and Oceanography Letters, 3(3), 64–75. http://doi.org/10.1007/s101150200013

Frankenberg, C., Aben, I., Bergamaschi, P., Dlugokencky, E. J., van Hees, R., Houweling, S., et al. (2011). Global column-averaged methane mixing ratios from 2003 to 2009 as derived from SCIAMACHY: Trends and variability. Journal of Geophysical Research, 116(D4), D04302–. http://doi.org/10.1029/2010JD014849

Hackstein, J. H. P., Stumm, C. K. (1994). Methane Production in Terrestrial Arthropods (Vol. 91, pp. 5441–5445). Presented at the Proceedings of the National Academy of Sciences of the United States of America. http://doi.org/10.1073/pnas.91.12.5441

Hackstein, J. H. P., van Alen, T. A. (1996). Fecal methanogens and vertebrate evolution. Evolution, 559–572.

Hackstein, J. H. P., Alen, T. A., Rosenberg, J. (2006). Methane Production by Terrestrial Arthropods. In H. König A. Varma (Eds.), Soil Biology: Intestinal Microorganisms

of Soil Invertebrates (Vol. 6, pp. 155–180). Berlin/Heidelberg: Springer-Verlag Berlin. http://doi.org/10.1007/3-540-28185-1$_7$

Keller, M., Stallard, R. F. (1994). Methane emission by bubbling from Gatun Lake, Panama. Journal of Geophysical Research, 99(D4), 8307. http://doi.org/10.1029/92JD02170

Melack, J. M., Hess, L., Gastil, M., Forsberg, B., Hamilton, S., Lima, I., Novo, E. (2004). Regionalization of methane emissions in the Amazon Basin with microwave remote sensing. Global Change Biology, 10(5), 530–544. http://doi.org/10.1111/j.1529-8817.2003.00763.x

Ringeval, B., Houweling, S., van Bodegom, P. M., Spahni, R., van Beek, R., Joos, F., Röckmann, T. (2014). Methane emissions from floodplains in the Amazon Basin: towards a process-based model for global applications. Biogeosciences, 11, 1519–1558. http://doi.org/10.5194/bg-11-1519-2014

Saunois, M., Bousquet, P., Poulter, B., Peregon, A., Ciais, P., Canadell, J. G., et al. (2016). Global Methane Budget 2000-2012. Earth System Science Data, 8, 697–751. http://doi.org/10.5194/essd-8-697-2016

Spahni, R., Wania, R., Neef, L. (2011). Constraining global methane emissions and uptake by ecosystems. Biogeosciences.

Tathy, J. P., Cros, B., Delmas, R., Marenco, A., Servant, J., Labat, M. (1992). Methane Emission From Flooded Forest in Central Africa. Journal of Geophysical Research-Atmospheres, 97(D6), 6159–6168.

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