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Interactive comment on "Is Shale Gas a Major Driver of Recent Increase in Global Atmospheric Methane?" *by* Robert W. Howarth et al.

Anonymous Referee #2

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This study represents a novel, valuable contribution to the ongoing discussion of the causes of the renewed growth in observed methane concentrations in the atmosphere. In my opinion it is very appropriate for the Ideas and Perspectives of this journal. I have one major question and one major suggestion, both below, along with several minor comments that I believe would improve the paper.

General comments

1) I have tried at some length, but I cannot understand equation 1. Figure 3A shows the weighting used by Worden et al, whereas Figure 3B has the new weighting used here. My understanding is that equation 1 converts the results of Worden et al shown in Fig 3A into the new division of Fig 3B. It makes sense to neglect biomass burning here as that's assumed to be the same in both. I don't understand, however, why

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the Worden et al estimate for biogenic (left side of equation 1) would be equal to the redistributed sum including the total CG term. For example, if there were no shale gas production (SG=0), this equation should maintain the Worden et al results, but it seems to me it doesn't as the CG*DA-CG term would still be there. Should not the 'CG' in that equation actually represent the change in CG in the reweighted values compared with the Worden et al value rather than the entire CG emissions? Then the equation would represent the revised biomass term, the shift due to the additional SG term, and the decreased allocation to CG, which should sum to the total of the original biomass plus CG from Figure 3A.

2) In addition to using isotopic data to identify the source of the recent increase in observed methane concentrations, the other information that previous studies have used is the geographic location of observed trends. This can help determine if the source is likely tropical (and hence probably biogenic) or from Northern Hemisphere mid-latitudes (and hence more plausibly with a substantial fossil share). This paper doesn't address this issue, and while it doesn't contribute new knowledge in this area it would be good for the reader to have a short discussion of results from this line of inquiry and how those compare with the conclusions drawn here. For example, Nisbet et al claim their box model suggests much of the increase is from tropical or Southern latitudes. The Rice et al study (already cited) found conflicting results, however. Similarly, at least some studies using satellite observations have suggested that increases are largely at mid-latitudes (e.g. Schneising et al; Turner et al).

Additional References: Nisbet, E. G., et al. (2016), Rising atmospheric methane: 2007–2014 growth and isotopic shift, Global Biogeochem. Cycles, 30, 1356–1370, doi:10.1002/2016GB005406.

Turner, A. J., et al., Geophys. Res. Lett., 43, 2218, 2016.

Additional comments:

P1, L22: UNFCC should be UNFCCC

P1, L29: This is the first mention of Fig 1A. This has an error in the y-axis labels, which show 1880 where it should be 1800.

P2, L1: There should be a space before the delta symbol, here and hereafter (e.g. P2,L21; P3,L18, etc.).

P3, L25: How are the 61 data points weighted, all the same? It there is uneven sampling, is it necessary to weight by geographic location to avoid bias (e.g. giving equal weight to the three regions mentioned previously)?

P4, L25: In the text reading DA-CG, the 'A-CG' portion should be subscript.

P5, L20-21: Should say something like 'estimated based on satellite observations' rather than 'as measured from satellite data' as the satellite cannot measure any specific source of methane emissions, only total methane concentration.

P8, L34-P9, L1: The text here states that "the model scenarios presented in the IPCC report emphasize reducing carbon dioxide emissions first, and these scenarios begin to reduce methane emissions only after 2030." This is incorrect. The scenarios are designed to achieve long-term targets at least cost, and as methane reductions are often very cost-effective these occur fairly rapidly in most scenarios. For example, Figure SPM.3a shows methane emissions relative to 2010 in the 1.5C scenarios, and the midpoint of the range is about a 40% decrease by 2030. Reductions are indeed typically larger and more rapid for CO2, but methane drops quite substantially early on.

P8, L1-L2: The phrase 'This may reflect the belief of the IPCC authors that methane emissions are dominated by biogenic sources' is not an appropriate way to describe characteristics of the scenarios in the SR1.5. The scenarios do not reflect beliefs of the authors, but rather results from integrated assessment models that the authors analyzed. Language such as "This may reflect an overestimate of the fraction of methane emissions attributed to biogenic sources in the underlying integrated assessment models" would be much better.

P9, L7-11: Some related calculations were shown in Shindell, D., J. S. Fuglestvedt, W. J. Collins, The Social Cost of Methane: Theory and Applications, Faraday Disc., 200, 429-451, doi: 10.1039/C7FD00009J, 2017, which could be noted here.

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