

# ***Interactive comment on “Constraining sector-specific CO<sub>2</sub> and CH<sub>4</sub> emissions in the United States” by Scot M. Miller and Anna M. Michalak***

## **Anonymous Referee #2**

Received and published: 10 November 2016

### General Comments:

This is a helpful summary of recent work to estimate methane and CO<sub>2</sub> emissions from the US and should be published with minor revisions. The scope of the review should be stated in the introduction. For example, many studies aimed at understanding CO<sub>2</sub> uptake by terrestrial vegetation are evidently out of scope, even though biological CO<sub>2</sub> sequestration may significantly offset US CO<sub>2</sub> emissions.

Discussion of the quality of satellite data required for anthropogenic flux estimation and trend estimation would be helpful. The measurement requirements to detect anthropogenic CO<sub>2</sub> plumes are described in the 2010 NRC Report, Verifying Greenhouse Gas Emissions, and in publications de-

cribing the notional CarbonSat mission as well as in the CarbonSat report ([http://esamultimedia.esa.int/docs/EarthObservation/SP1330-1\\_CarbonSat.pdf](http://esamultimedia.esa.int/docs/EarthObservation/SP1330-1_CarbonSat.pdf)).

Also it should be noted that the current generation of satellite sensors are not designed to provide comprehensive global mapping and are therefore not ideally suited for urban and point/source estimation. OCO-2 and GOSAT were designed for global carbon cycle science rather than emissions monitoring. How does the uncertainty in e.g. the Kort et al. analysis of Los Angeles emissions using GOSAT compare with the requirements for useful urban trend detection (e.g., something like a 10% reduction in emissions over 10 years) ?

It would be useful to see more discussion about where existing inventories and/or inversions agree and where they disagree. For example, how do the Schneising et al SCIAMACHY fugitive methane emissions estimates for North America compare with those from aircraft campaigns?

Finally, some more discussion of transport modeling errors would be useful. To what extent do uncertainties in simulated transport limit top-down flux estimation? What type of work is needed to address transport uncertainty?

Specific Comments:

page 2, line 20: Are there any regulations targeting CH<sub>4</sub> emissions from agriculture? Perhaps worth mentioning here that agriculture is a large source of CH<sub>4</sub> even if not regulated yet.

page 3, line 9: “meteorically” sounds sensational

page 3, line 15: Perhaps briefly discuss biological CO<sub>2</sub> sinks and potential for deliberate sequestration, along with concomitant need for verification of such reservoirs. Also could mention challenges of accounting for emissions from CH<sub>4</sub> wetlands, as well as CH<sub>4</sub> emissions related to anthropogenic interference in the hydrological systems (emissions from reservoirs). Something about co-location of cows and oil and gas

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perhaps also worth mentioning here.

page 4, line 1: I don't see a reference for EDGAR inventory in this list of references for global efforts, though it is frequently used.

page 4, line 10: For the example of coal gasification, how is energy lost in conversion of coal to gas taken into account? It seems like this should count as emissions from coal.

page 4, line 28: First mention of EDGAR, but I don't see any reference. Perhaps add a url.

page 5, first paragraph: Perhaps mention for which years these products are available and how often they are updated (or not updated).

page 5 line 8: instead of "rigorous" consider "detailed"

page 5 line 14: repeated use of "EFs" results in confusing long sentence. Consider simplifying e.g., "...much higher EFs that result in higher emissions that are much more consistent..."

page 5, various lines: over-use of the word "leverage" in this section

page 5, line 26: The Andres et al. effort is also government-sponsored

page 5, line 31: "these omissions" since threshold plus ag exemption

page 6, line 20: it would be helpful to define what is meant by on-road measurements, i.e. are these all ground-based mobile using public (or private) roads?

page 6, line 25: Smokestack measurements of CO2 are not used in the EPA inventory?

page 7, line 2: Marcellus not Mercellus

page 7, line 20: Could you also include agricultural CH4 emissions in Figure 1?

page 9, line 10: Mays and Cambaliza both Indianapolis.

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page 9, paragraph beginning on line 31: A limitation is that most of these studies use data from a single campaign and provide only a snapshot of emissions. Some of the studies used tracers such as ethane to estimate contribution of landfills, etc. I think this is worth mentioning here.

page 11, line 33. The verbiage “run an atmospheric transport model once per source sector” is confusing. Zhao et al. and Jeong et al. used STILT-WRF, so they generated footprints from a single WRF run. Suggest simply eliminating the phrase “once per source sector”, since details of how the transport model is run may vary.

equation 5:  $x[i]$  not defined.

page 12, line 28: Technicality: SCIAMACHY is not a satellite. It is the name of a sensor on the Envisat satellite.

page 13, equation 6: A limitation of the GIM as implemented in the cited references is that the betas are spatially constant whereas in reality relationships between activity data and emissions may vary spatially or temporally.

page 14, line 10: Radiocarbon measurements show that respired biogenic CO<sub>2</sub> is significant even in winter.

page 15, line 15: It should be mentioned that in order for satellite measurements to be useful for understanding and tracking urban emissions, they must not only detect the presence of a large urban area but also be sufficiently sensitive to measure trends.

page 15, line 24: Limitations of the ASCENDS concept should be mentioned. For example ASCENDS will provide limited spatial coverage, infrequent revisits, and will low signal to noise for urban signatures.

page 15, line 30: Revised launch date needed for TROPOMI.

page 16, line 11: More recently than what?

page 16, line 22: The description of current radiocarbon sampling could be improved.

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More specificity is needed, especially regarding the temporal density of samples in the current network compared to what is recommended by Basu et al.

page 17, line 2: Impact of disequilibrium fluxes on estimated emissions can be mitigated if major urban areas have both upwind and downwind sampling.

page 17, line 17: Typo “now markets and”.

page 17, line 18: Detlev Helmig’s lab at INSTAAR has been measuring ethane in whole air samples from the NOAA global network for many years (<http://www.nature.com/ngeo/journal/v9/n7/abs/ngeo2721.html>). There is also a new instrument that is now being used to measure ethane from whole air samples North American tall towers and aircraft.

page 18, lines 15-20: Repeated use of “far more”. Not quantitative.

page 18, line 25: Perhaps should point out that intensive measurement campaigns provide only a snapshot and, unless repeated, provide no information about how emissions may vary over time.

page 19, line 13: I don’t think it is helpful or fair to single out Environment Canada for criticism (especially since focus of this review is US emissions), though your general point about data not being readily accessible is valid. CO<sub>2</sub> data from Environment Canada through 2015 is available from the GLOBALVIEWplus\_v2.1 ObsPack available here (<http://www.esrl.noaa.gov/gmd/ccgg/obspack/data.php>). Hopefully a similar product will be available soon for CH<sub>4</sub>.

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