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Comment on acp-2021-671

Lena Höglund-Isaksson (Referee)

Referee comment on "Methane emissions in the United States, Canada, and Mexico: evaluation of national methane emission inventories and 2010–2017 sectoral trends by inverse analysis of in situ (GLOBALVIEWplus CH₄ ObsPack) and satellite (GOSAT) atmospheric observations" by Xiao Lu et al., Atmos. Chem. Phys. Discuss., <https://doi.org/10.5194/acp-2021-671-RC1>, 2021

GENERAL:

I find this paper very interesting because it manages to shed considerable additional light on many of the big questions about the discrepancy between bottom-up and top-down estimates of methane emissions from North American sources. Without being an expert on inverse modelling myself (but rather bottom-up modelling), I still note that the authors make important improvements in the methodology that are additional to previous studies, i.e., using both satellite and in-situ observations, using a log-normal error function which better represents the high tail emission distributions that are typical for the oil and gas sources, and using an improved prior for wetlands, which does not overstate wetland emissions as has previously been a problem. These improvements seem to lead to results that better explain the total contribution from anthropogenic sources and their attribution to individual source sectors. The paper is also well written and easy to follow and I support publication but would like to see one major concern addressed and a few minor revisions, as listed below.

MAJOR CONCERN:

Authors are able to show that anthropogenic CH₄ emissions are substantially underreported in all three countries USA, Canada, Mexico, and in particular for the US. They conclude that in particular emissions from oil production are underreported by a factor of 2. Looking at the trend 2010-2017 for the US, they conclude that CH₄ emissions appear to have peaked in 2014 and thereafter slightly declined with the overall trend for the period still slightly increasing. This is in contrast to US official reporting to the UNFCCC, where emissions decline steadily over the period. The authors attribute the increases they find to oil production and landfill, while emissions from gas production are said to decline (and livestock and coal mining stay flat). Given that according to EIA, US shale gas production increased by 227% (from 165 to 540 bcm) over this period while oil production increased by a more modest 71% (and other natural gas production declined

by 39% from 493 to 300 bcm), I am not convinced about the authors' split in attribution between oil and gas sector emissions. I wonder if the inversions can really make this distinction between oil and gas sources as fields in the US are often producing both oil and gas? If authors are not able to do this split in a robust manner, then I would **recommend the authors not to report oil and gas sector emissions separately, because from a policy point of view this matters a lot**. If there is a risk that authors are wrong about their conclusions here and that in reality it is a strong increase in methane emissions from shale gas production that is picked up (and not oil), then you risk sending the completely wrong signal to policy-makers (i.e., "fix oil but don't worry too much about gas production", when it could be that the real problem is the shale gas). So if there is uncertainty regarding this, then report oil and gas emissions together and leave it to further research to figure out this split in more detail.

MINOR CONCERN/EDIT:

p.11 row 387: write out the acronym DOFS.

p.14 row 530: It is suggested that the downward correction for offshore operations can be referred to that methane from offshore oil platforms is piped onshore and inefficiently flared. Another possible explanation could be that when methane leaks happen at the seabed, methane oxidises to CO₂ in the water column before reaching the surface and therefore emissions are considerably lower during offshore production. Could this be an explanation here?