Review: Satellite quantification of methane emissions and oil/gas methane intensities from individual countries in the Middle East and North Africa: implications for climate action

ACP Chen et al. January 2023

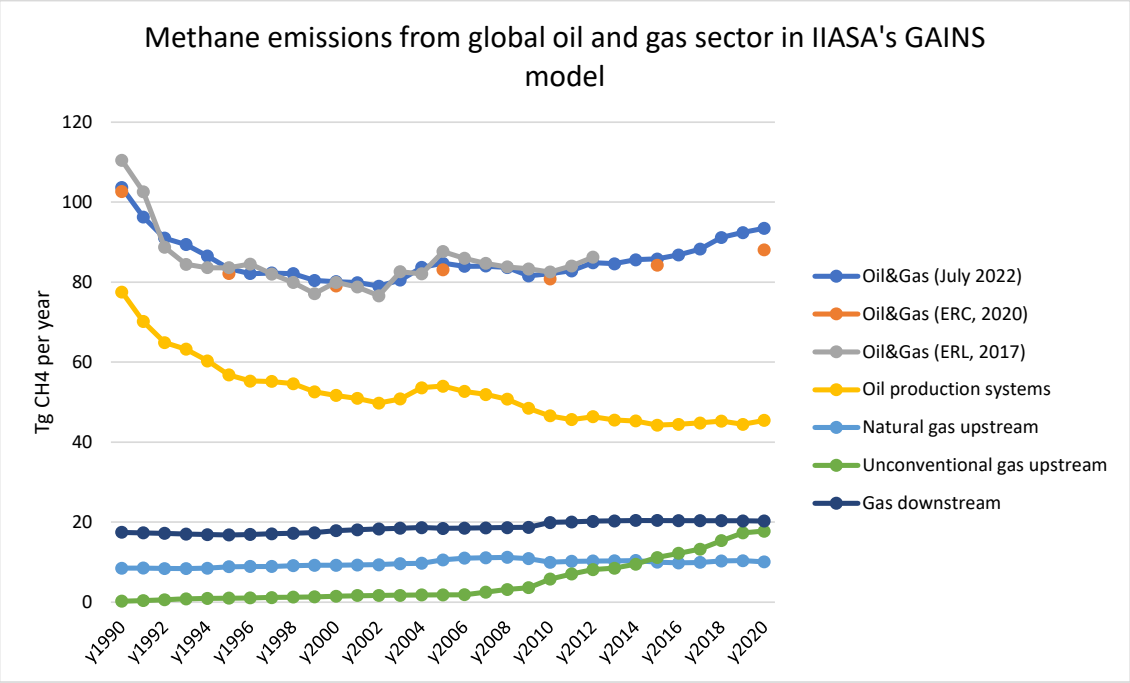
This is a very interesting and highly policy relevant paper which provides important new insights into the attribution of methane emissions to sector sources in the previously little studied region of the Middle East. I am not an expert on inverse modelling myself but rather on bottom-up modelling and mitigation strategies and will therefore limit my comments to these aspects of the paper. As a bottom-up modeller I find it very encouraging that the quantification of methane emissions using top-down methods (satellites and surface flask measurements) is now narrowing down to the country and sector level. This paper is a good example of this. The paper is well written and easy to follow and I support publication but have a few questions and remarks.

As far as I understand, the authors identify the individual source sectors using prior distributions of emissions from bottom-up inventories complemented with a spatial pattern identifying the type of activities on the ground. To me it is not completely clear how this very fine resolution to individual source sectors was made and how the individual source sectors were identified, e.g., between upstream oil, upstream gas, midstream gas, and downstream gas. I would wish for more clarity on this.

I find the Table 2 very interesting to compare with bottom-up estimates. In this context, I wonder if it would be possible to further split the "Gas" column by upstream and downstream emissions? On p. 10 row 404, I was surprised to see such high emissions from midstream gas transmission from offshore platforms in Saudi Arabia. I would not expect such high emissions from offshore pipelines due to oxidation in the water column, but it refers perhaps to on-shore storage facilities?

I'm intrigued that top-down monitoring now confirms the importance of management practices and technology status for emissions from the oil and gas sector. And also that these are much more important determinants for methane emissions than production quantity or number of wells drilled. It should however be acknowledged that differences in management practices is something that the bottom-up model community has attempted to capture through e.g., simulation of associated gas flows using country-specific information on gas recovery and venting/flaring rates https://iopscience.iop.org/article/10.1088/1748-9326/aa583e. These results are of course much cruder and more uncertain than the results you now put forward in this study.

Changes primarily in management practices, with increases in recovery of associated gas and increased flaring rather than venting of unrecovered gas in several countries are primary reasons why methane emissions from IIASA's GAINS model https://iopscience.iop.org/article/10.1088/2515-7620/ab7457 show a declining trend over time for methane emissions from global oil production:



Hence, not all bottom-up inventories rely fully on activity metrics coupled with constant default emission factors. Some try to find methods to better reflect variations in management practices and technology status as well. The recent advancements in top-down technologies have however brought us a big step forward in better understanding the sources of methane emissions, like the Chen et al. study nicely shows. We now need to feed this knowledge into improved methods for bottom-up inventories, which are likely to remain the primary basis for political negotiations on mitigation targets, at least in the foreseeable future (or until we have the technology to continuously monitor site-level methane emissions globally).