

This is very interesting work. However, I am confused about the relationship between the “emissions factors” shown in Fig. 10 and the “methane intensities” shown in Fig. 13.

I believe Fig. 10 shows:

$$EF_{oil} = \frac{m_{ch4,oil}}{M_{oil}} \quad (1)$$

$$EF_{NG} = \frac{m_{ch4,NG}}{M_{NG}} \quad (2)$$

where m is mass flux emitted to atmosphere determined from this work’s TROPOMI + EDGAR posterior, and M is mass sent to market determined from the bottom-up EIA inventory.

Then is Fig. 13 methane intensity:

$$MI = \frac{m_{ch4,oil} + m_{ch4,NG}}{M_{NG}} = EF_{oil} \left(\frac{M_{oil}}{M_{NG}} \right) + EF_{NG} \quad (3)$$

or does methane intensity have an additional term, such as:

$$MI = \left[EF_{oil} \left(\frac{M_{oil}}{M_{NG}} \right) + EF_{NG} \right] + \frac{m_{flared}}{M_{NG}} \quad (4)$$

where m_{flared} is methane emitted to the atmosphere not as methane but as combustion products, determined from VIIRS satellite using Elvidge (2016) methodology? In other words, does the emissions factor count only the methane that escapes flaring, whereas the methane intensity counts even the methane that gets combusted during flaring?

E.g. why does Iraq have much smaller emissions factors than Turkmenistan in Fig. 10, but much larger methane intensities in Fig. 13? Is it just because Iraq has a larger ratio (M_{oil}/M_{NG}) shown in Fig. 11? Or is it additionally because Iraq has a larger (m_{flared}/M_{NG}) shown in Fig. 12b?

The present manuscript suggests methane intensity follows Eq. 3 in some sections and Eq. 4 in others. The abstract suggests Eq. 3, because it doesn’t mention VIIRS and says “the methane intensity in most countries is considerably higher...[reflecting] incomplete flaring of gas.” The figure captions also suggest Eq. 3. Fig. 10 caption says “Emission factors for upstream activity...The emissions factors represent the amount of methane emitted per unit of oil or gas produced, following the definition of IPCC (2006).” Which is very similar language to Fig. 13 caption “The methane intensity is defined as the amount of methane emitted from oil/gas upstream activities per unit of methane gas produced.”

But the main text of section 3.4 (sentences beginning on lines 536, 548) and the inclusion of Fig. 12b suggests Eq. 4.

I recommend you explicitly define Eq. 3 (or similar) explicitly in the manuscript, and reword the sections that appear to contradict that equation.

It’s also difficult to determine these equations from the citations. IPCC (2006) and Elvidge (2016) are cited but missing from the references. Which section of IPCC (2006) defines the emissions factor? The methane intensity is defined in OGC (2021), but that source is also unclear, as p. 17 of that source seems to count emissions sources fugitive leaks, venting, and flaring, but does not distinguish complete flaring from incomplete flaring.