Methane Emissions

CH_4 emissions were released in May 2017 (CEDS v_05_18_2017) as gridded, annual estimates from 1970 – 2014, which are available on Earth System Grid Federation with other CEDS data. Emissions by country and sector will be released with the final version of this manuscript (and are also available on request).

Data sources and methodology

Default CH_4 emission factors for combustion sectors are calculated similarly to those for NO_X, CO, and NH_3 emissions, from the global implementation of the GAINS model (Klimont et al., 2016, 2017; Stohl et al., 2015). Default emissions for agriculture sectors (3B_Manure-management, 3D_Rice-Cultivation, and 3D_Rice-Cultivation) are taken from the UN Food and Agriculture Organization data base (FAOSTAT) (FAO, 2016), which are available from 1961 – 2014. Default fugitive petroleum and gas emissions are taken from EDGAR 4.2 emissions (EC-JRC/PBL, 2016) combined with ECLIPSE V5a (Stohl et al., 2015). Remaining non-combustion emissions are taken from EDGAR 4.2 (EC-JRC/PBL, 2016).

The default CH_4 emissions estimates are scaled to match to the following inventories: UNFCCC submissions for Annex I countries and the US GHG inventory (US EPA 2016) for the United States. Final methane emissions are just slightly lower than EDGAR estimates, shown in Figure 1.

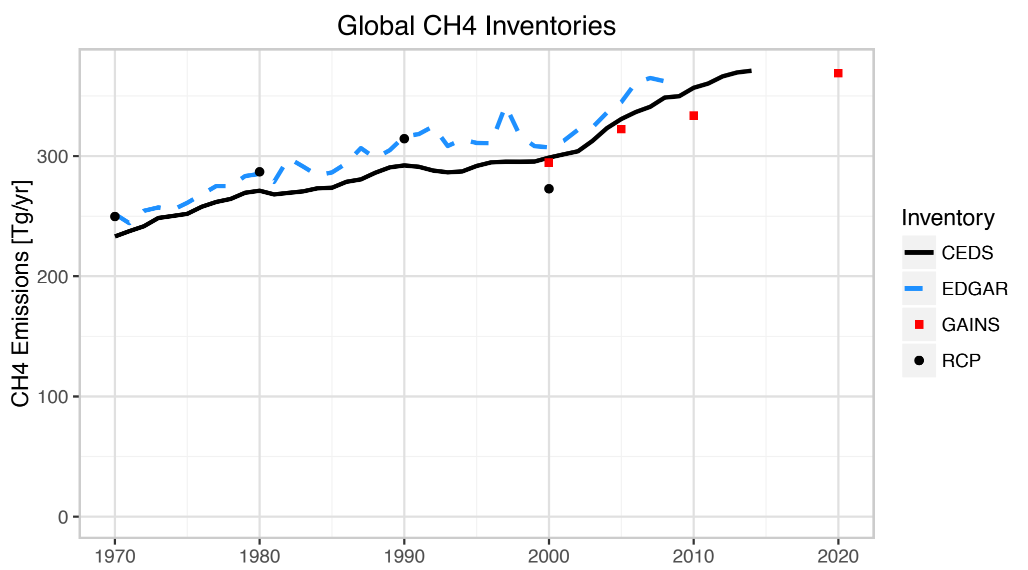

Figure 1 Like with like comparison of global CEDS emissions with EDGAR 4.2 , GAINS, and RCP for methane emissions.

Comparisons to Other Inventories

Globally, CEDS emissions range from 93% of RCP values in 1970 to 109% of RCP values in 2000 (Figure 1, Figure x). The CEDS values change more smoothly over time, without a dip in 2000. Because of our use of EDGAR and FAO defaults for most countries, overall CEDS CH4 emissions follow EDGAR values. CEDS energy emissions are consistently larger (22 – 58%) than RCP emissions. CEDS agriculture emissions are consistently 10-15% smaller than RCP estimates, except in 2000 (6% smaller) when RCP estimates dip an CEDS emissions flatten, due to our inclusion of FAO agriculture data.

Global CEDS emissions estimates are slightly smaller than to EDGAR 4.2 estimates, ranging from 94 – 98% the value EDGAR estimates. The similarity is because much of our methane emissions are either from EDGAR, or FAO (which uses similar methodologies) (Figures 1, 5). The largest differences can be found in 1B2 (fugitive petroleum and gas emissions) in Central and South America Africa, and the Former Soviet Union, as these default emissions also incorporate data from ECLIPSE and 3D (rice cultivation) in China, which is from FAO.

Methane from fugitive oil and gas is a third higher than the value from Larsen et al. (2015), but 12% smaller than Höglund-Isaksson (2015) (Figure 6). Overall energy sector production emissions are almost identical to Höglund-Isaksson, but 33% smaller than the global EPA estimates (comparing CEDS data with the available historical years for each of these data sets). These differences indicate the large uncertainty in fugitive methane emissions from fossil energy production and distribution.

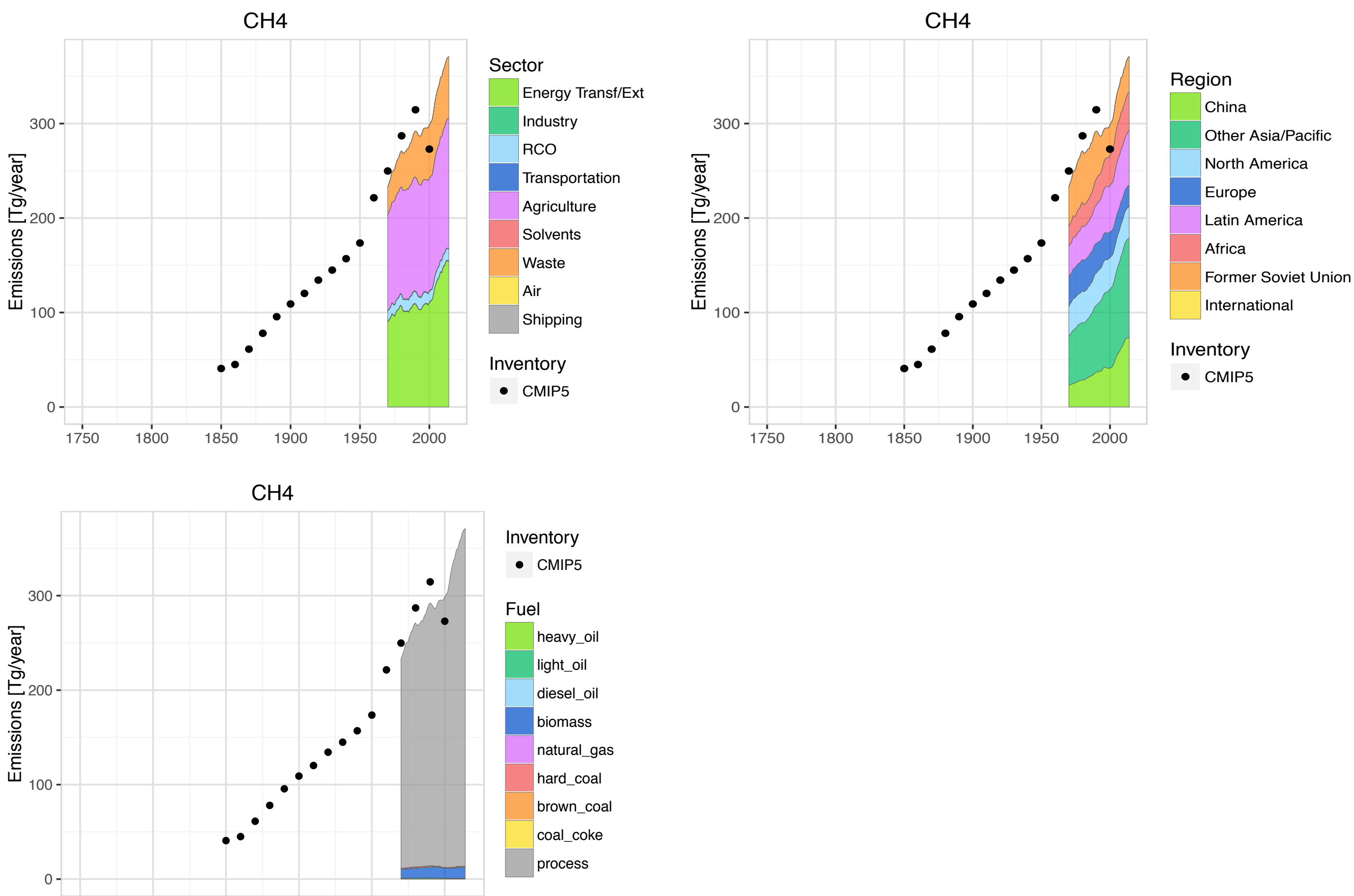

Figure 2 CEDS methane emissions estimates by aggregate sector, region, and fuel compared to Lamarque et al. (2010). For a like with like comparison, these figures do not include aviation or agricultural waste burning on fields. 'RCO' stands for residential, commercial, and other.

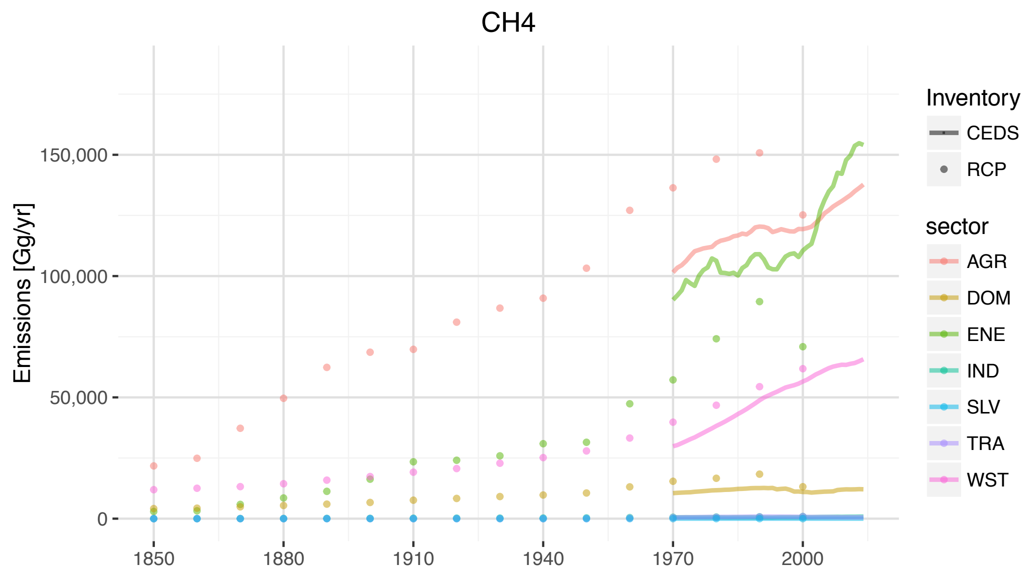

Figure 3 Comparison of RCP and CEDS methane estimates globally (top) and by aggregate sector as defined by the RCP data (bottom). For a like with like comparison, these figures do not include aviation or agricultural waste burning on fields. Sectors shown include agriculture, domestic (residential and commercial), energy, industrial, solvents, transportation, and waste.

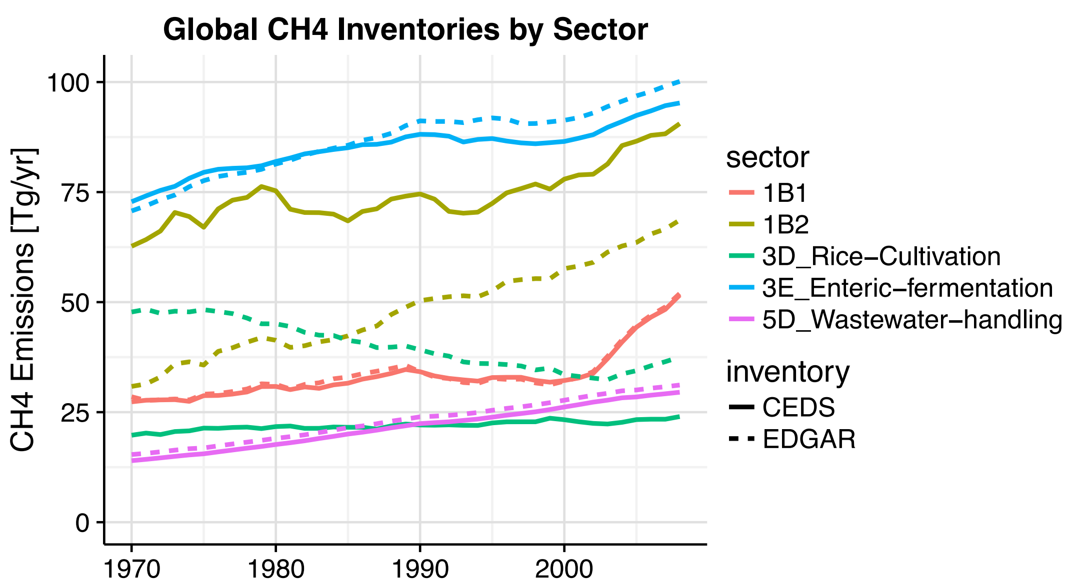

Figure 4 CEDS compared to EDGAR emissions for select diverging sectors.

Supplementary CH4 Emissions Extension to 1850

The May 2017 CEDS release for CH_4 emissions only extend from 1970 – 2014 because of additional data needs for consistently estimating emissions for earlier years.

Because a few modeling groups have requested emissions back to 1850, so we will also produce a "rough cut" supplementary extension of CH_4 emissions back to 1850 by scaling with RCP/CMIP5 historical CH_4 estimates (Lamarque et al. 2010). These pre-1970 estimates were generated by scaling the CEDS 1970 estimates back by aggregate sector at the 26 sub-region level of the RCP/CMIP5 data from Lamarque et al. 2010. While these emission estimates are not fully consistent with the other CEDS emissions, they provide a longer time series, albeit with some additional uncertainty, for groups that would like to have this data.

Note that we have already identified some potential biases in this extended dataset. The waste sector is 30% of total anthropogenic CH4 emissions by 1850. This appears to be due to scaling in the earlier data back in time by population. This is an overestimate of anthropogenic CH4 emissions from this source at that time since landfills and wastewater treatment plants, which create the anaerobic conditions conducive to CH4 emissions, did not start to come into widespread use until around 1930. However, as noted in the main paper, the earlier CMIP5/RCP emission estimates did not distinguish between biomass and coal combustion. Methane emissions from biomass combustion are much larger than those from coal combustion, which means that methane emissions from the residential sector are underestimated in this extrapolation. A rough estimate indicates that these two effects are of similar (and offsetting) magnitude. Further work is necessary to better refine historical CH4 emissions.

Additional Figures

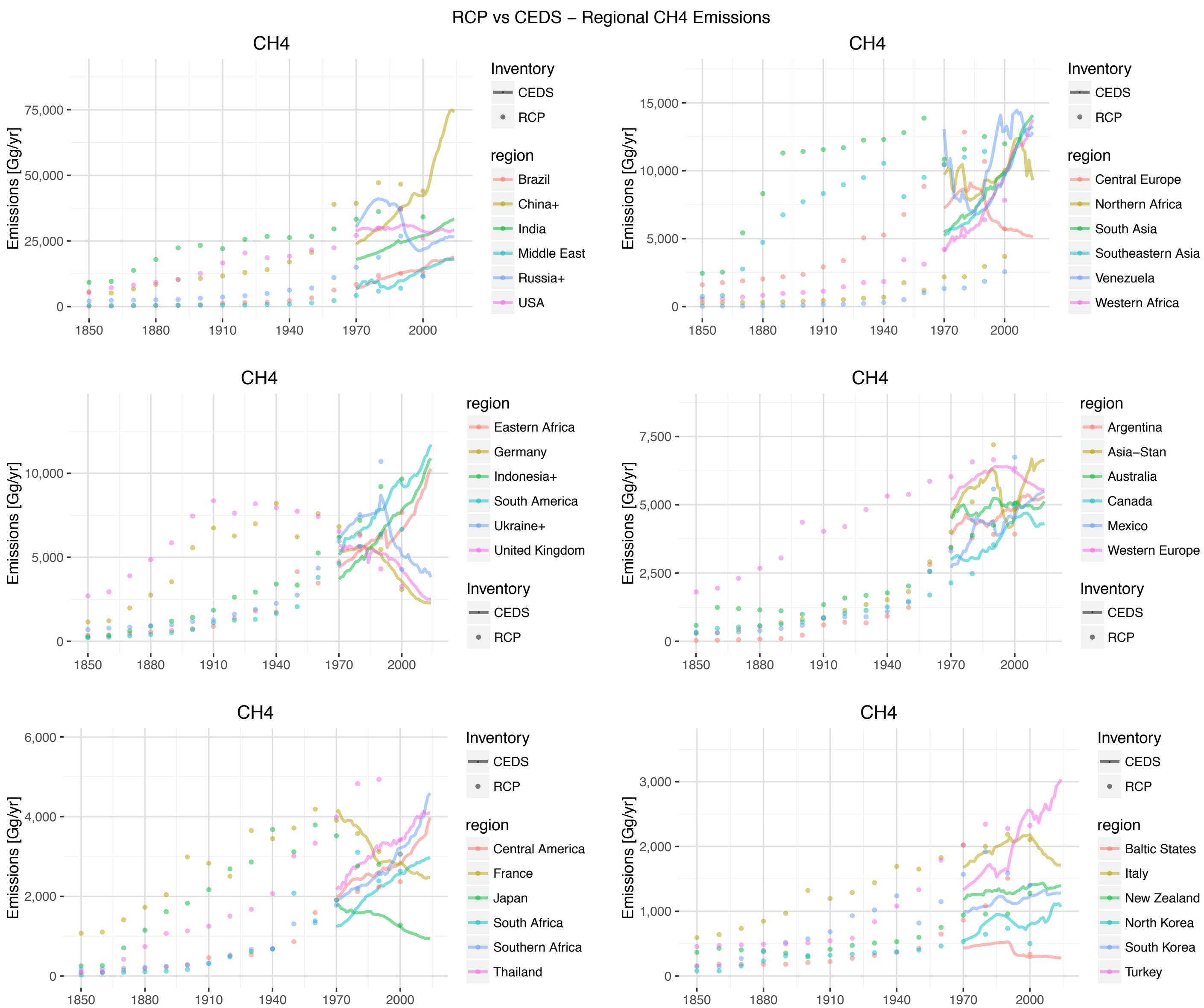

Figure 5 Methane Comparison of CEDS versus RCP by Region

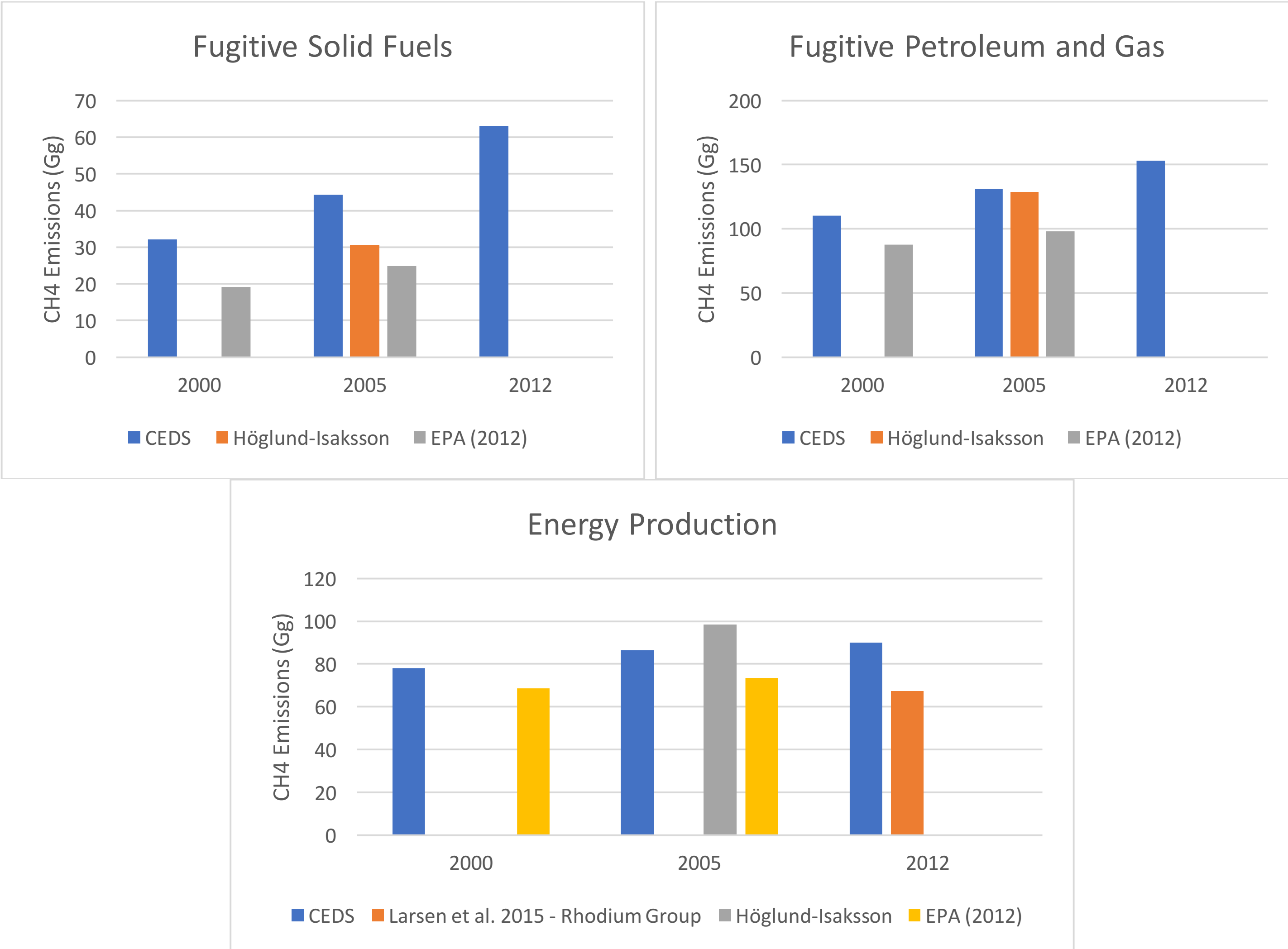

Figure 6 Comparison of global Methane from Energy Production Sectors compared to other additional inventories

Citations

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