CH_4 trends and interactions with O_3 at the European and global levels

TFIAM53 - Paris 15 -17 April 2024

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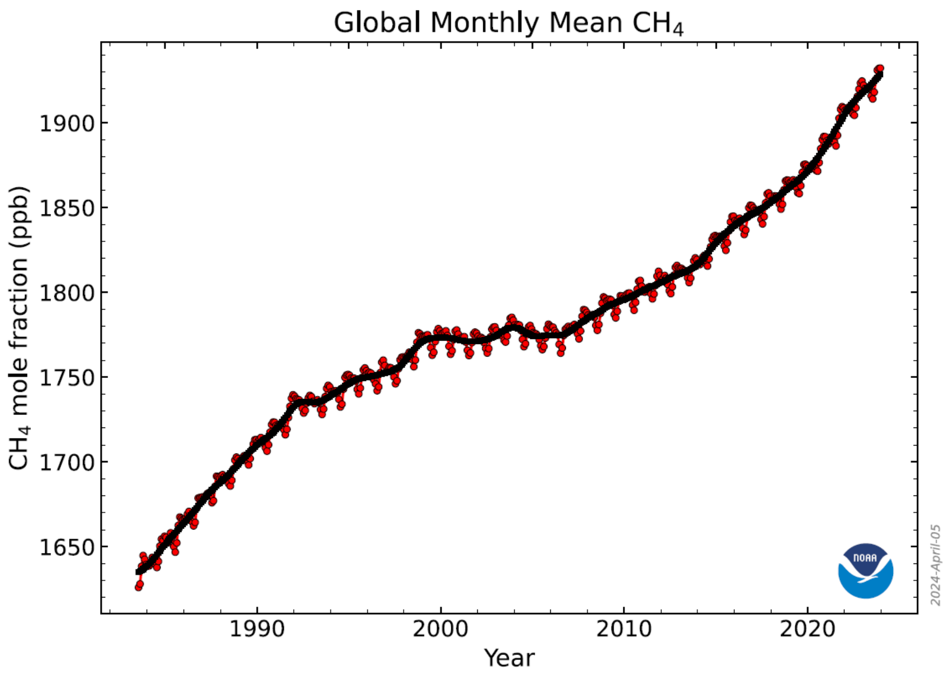
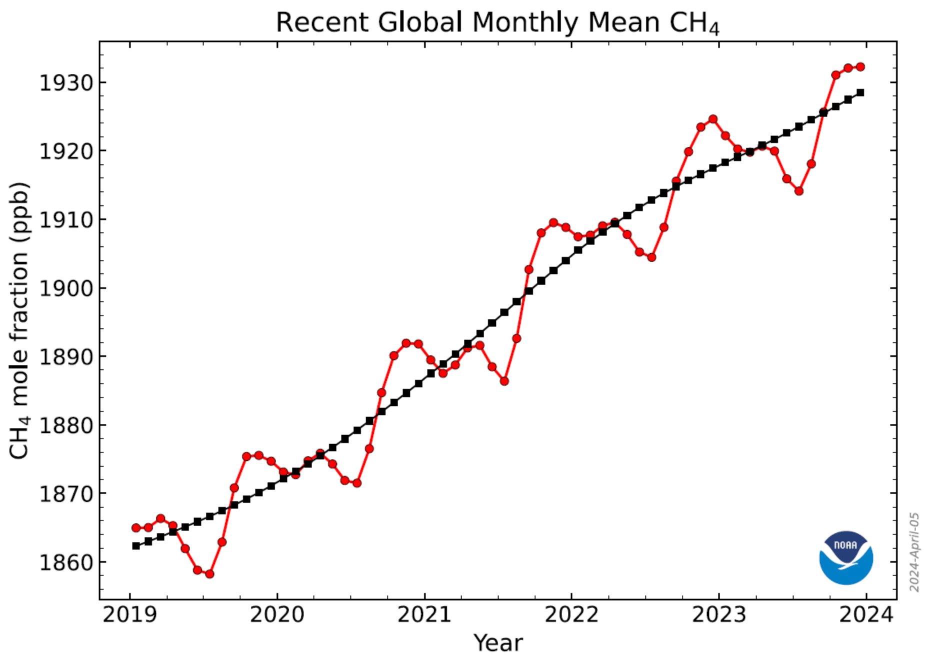
Outline of the presentation

- The global CH_4 trends
- Trends of anthropogenic CH_4 emissions
- Sectoral break-down of anthropogenic CH_4 emissions
- Future CH_4 emissions
- Ozone trends and links to CH_4
- Air quality impacts of CH_4 emissions
- Conclusions

The global CH_4 trends





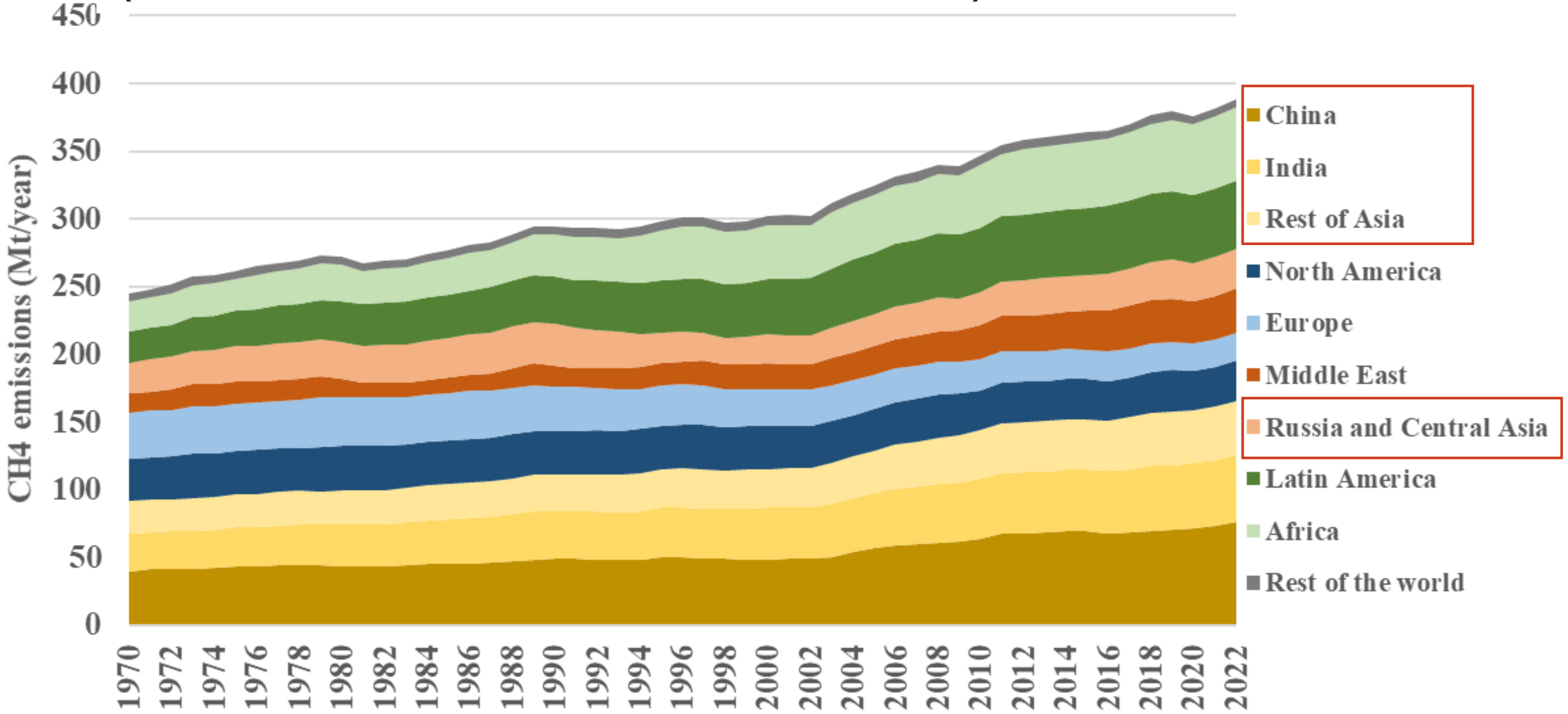
Methane is an important greenhouse gas (GHG) that has a 100-year warming potential about 29 times larger than carbon dioxide (CO_2; for fossil gas)

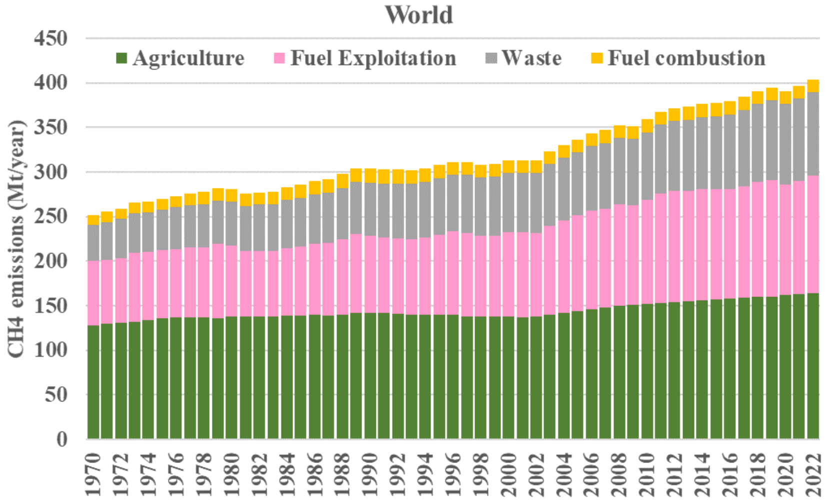
According to AR6 (IPCC, 2021) almost half of the total net global warming since pre-industrial levels is explained by increased levels of CH_4 . This means that, about 0.5°C of the observed increase of 1.1°C in global temperatures can be attributed to CH_4 emissions.

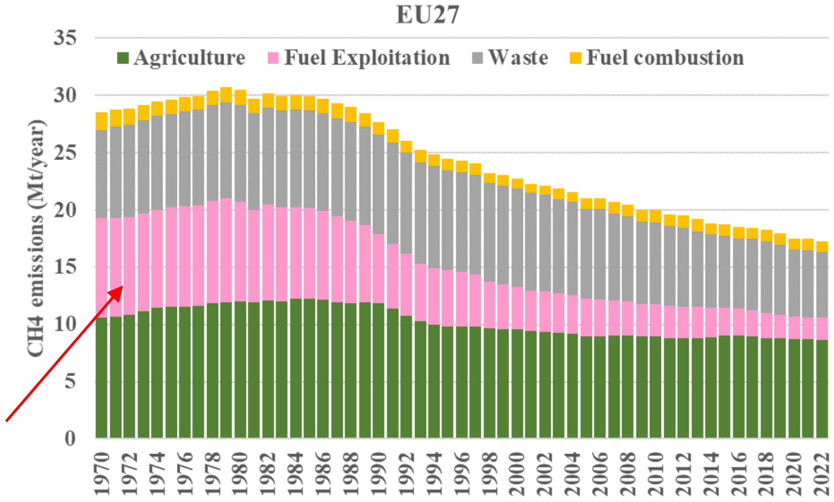
Note that this observed global increase in temperature is net and includes the cooling effect from aerosols. In comparison, natural (solar and volcanic) drivers change global surface temperatures by -0.1°C to +0.1°C.

Trends of anthropogenic CH_4 emissions

60% of CH_4 global emissions are anthropogenic (increased 32% between 1990 and 2022)







CH_4 anth. emissions in 2022

Asia >50%

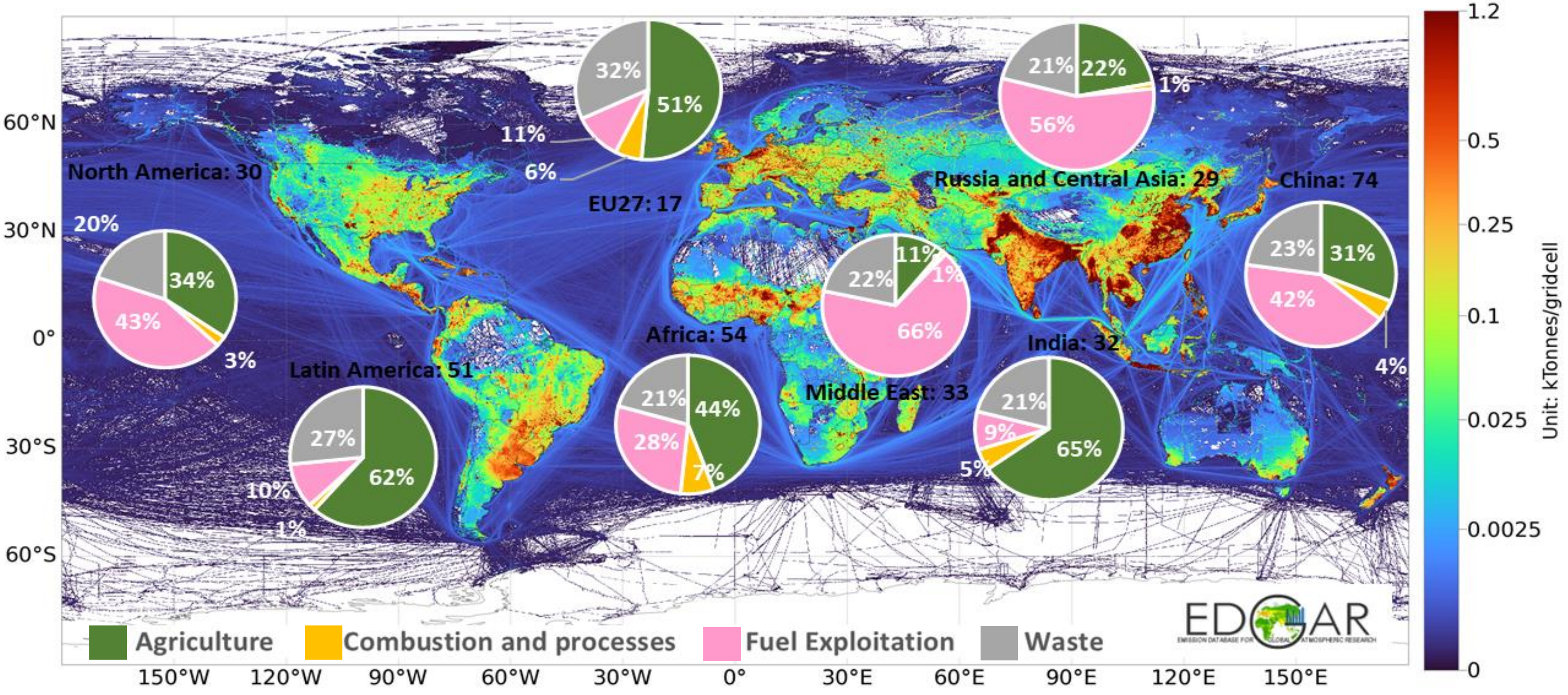
Europe ~ 5%

North America ~ 8%

EU new methane strategy for emission reduction in this sector

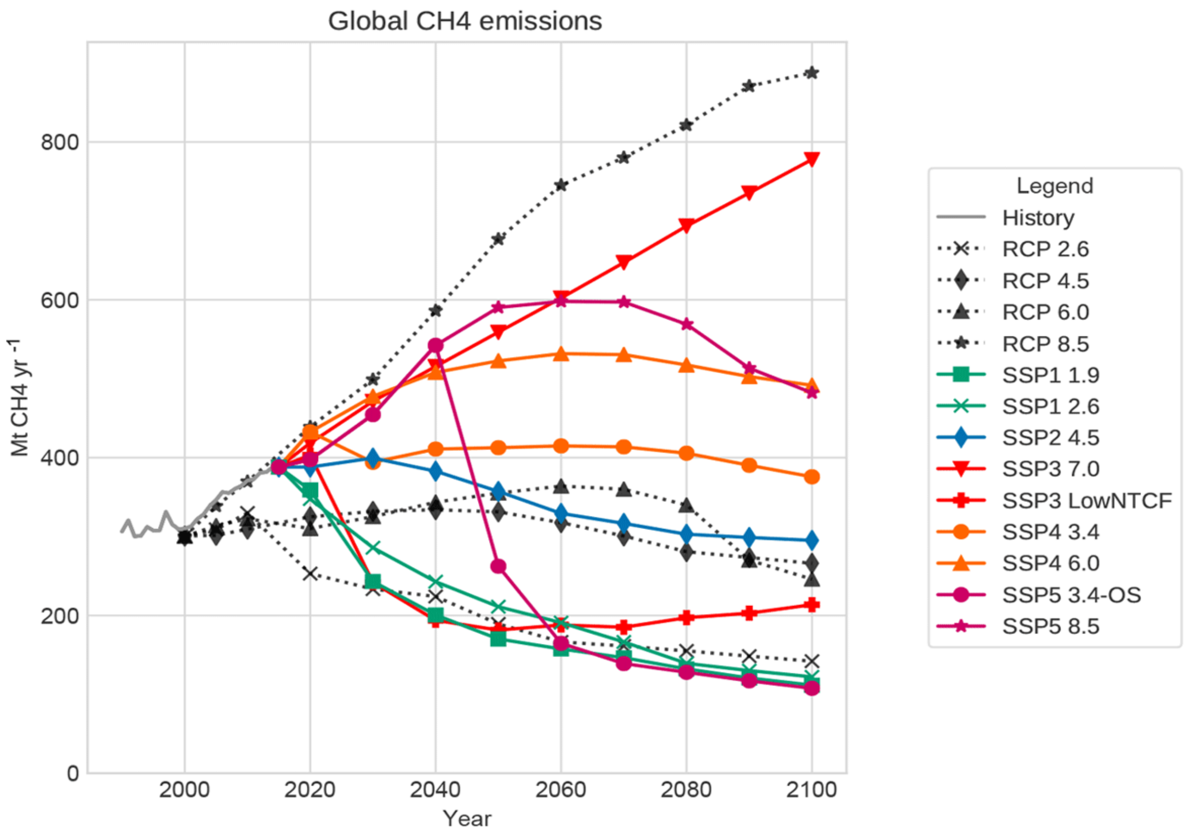
Methane emissions (Mt CH_4 yr-1): (a) global, (b) EU27, (c) by world region (Source EDGAR V8.0)

Sectoral break-down of anthropogenic CH_4 emissions



Global CH_4 emissions in 2022 with sector specific shares and regional total emissions (Mt=Tg) for major world regions (Source: EDGARv8.0).

Future CH_4 emissions



Trajectories of CH_4 emissions for various scenarios in the frame of the modelling exercise CMIP6 from (Gidden et al., 2019)

Evolution of CH_4 emissions from three main sectors in 2050 compared to 2010 according to 16 different scenarios

(SSP1-1.9, SSP1-2.6, SSP2-4.5, SSP3-7.0, RCP-2.6, RCP-4.5, RCP-6.0, RCP-8.5, GECO-1.5, GECO-NDC-LTS, GECO-REF, ECLIPSE-v6b-CLE, MFR, NFC)

Energy emissions may increase by 70% or decrease by 30-80%

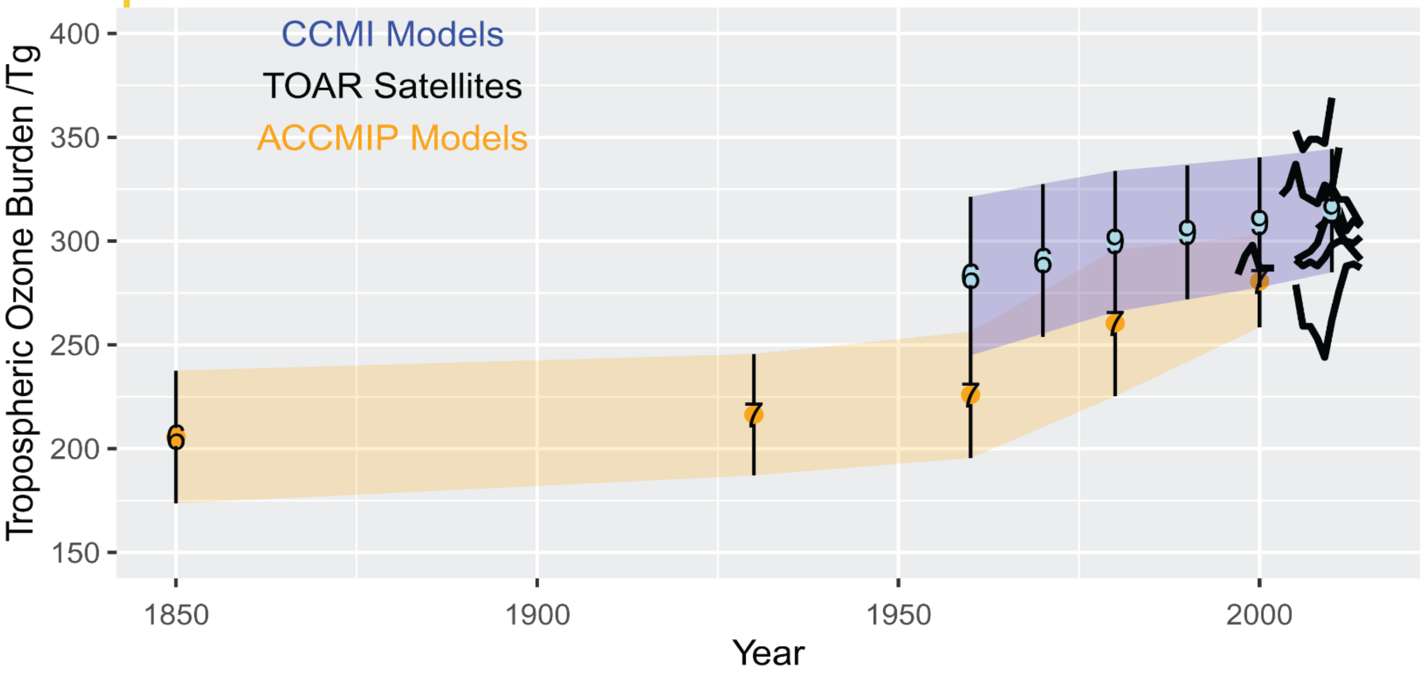
Agriculture emissions range from 80% increase to 40% decrease

Changes in the previous two sectors are rather coherent across scenarios

Waste emissions may increase by 70% to 130% or decrease up to 80%

Trends are less coherent with ENE, AGR

Ozone trends and links to CH_4



O_3 precursors: NO_X-VOC and CH_4

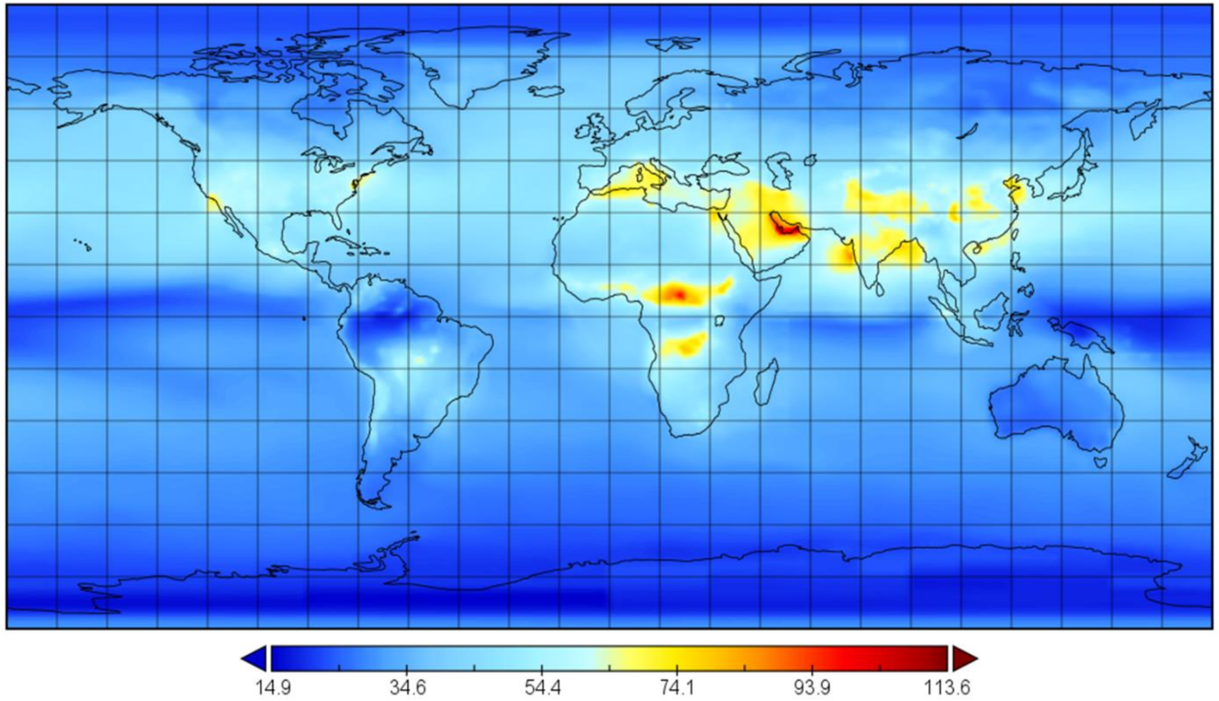
CH_4 and O_3 are connected through large-scale atmospheric chemistry and transport processes. Increasing CH_4 concentrations may partly contribute to these increasing trends or, in regions where O_3 declines due to local-to-regional air pollutant emission reductions, counteract these efforts.

Comparison of modelled (orange and blue envelopes) and satellite-observed (gray envelope) trends in the tropospheric ozone burden between 60°N and 60°S. Means of the model data are shown as circles with the vertical lines reflecting ±1 standard deviation of the mean. The number of models used in calculating the means are displayed in the circles (Archibald et al., 2020)

NOx emissions from international shipping over the high seas play a large role in the hemispheric-scale response of surface ozone to changes in methane (Butler et al., 2020).

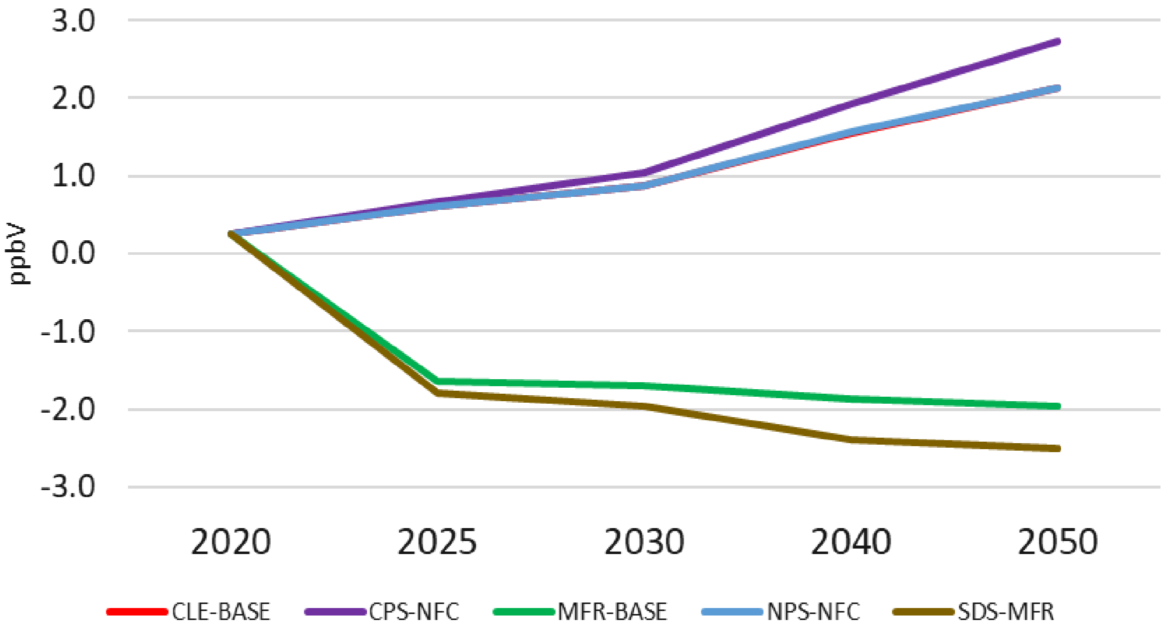
Air quality impacts of CH_4 emissions (1)

Exposure to ozone



Year 2015 Ozone exposure metric SDMA8h

Exposure to ozone attributable to CH_4 emissions



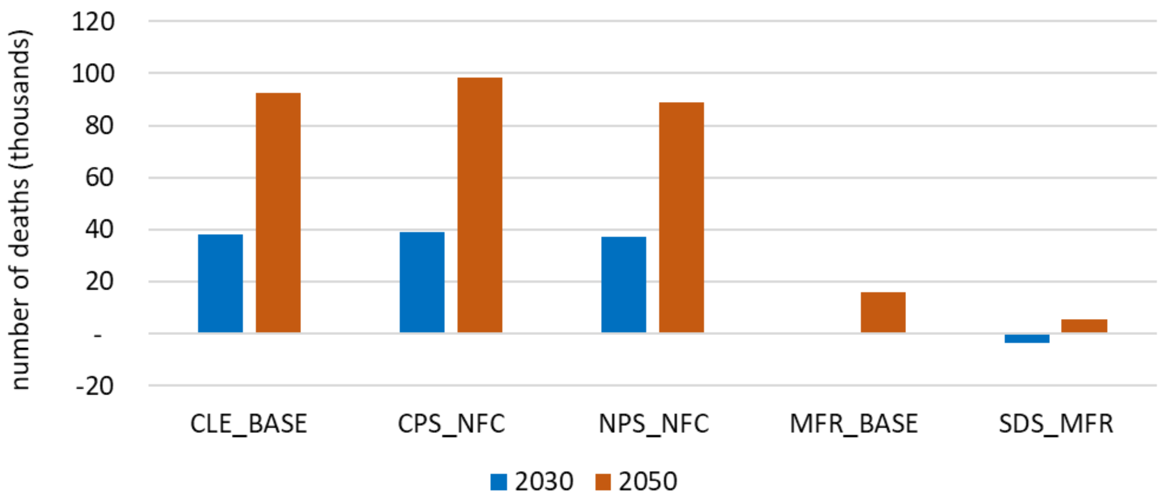
Projected change in ozone exposure metric SDMA8h over Europe, relative to year 2015, as a consequence of the global CH_4 emission trends

Source: JRC TM5-FASST, with ECLIPSE V6b scenarios (IIASA, 2019)

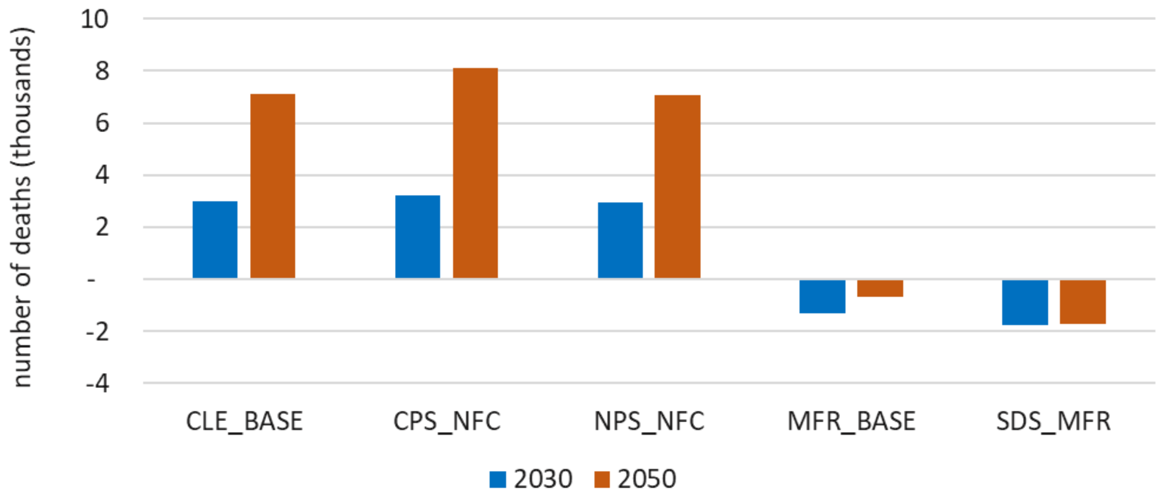
Air quality impacts of CH_4 emissions (2)

Change in mortality associated with ozone attributable to CH_4 emissions

Global mortality



Mortality in HTAP2 Europe region



Change in global mortalities from exposure to O_3 from global CH_4 emissions in 2030 (blue bars) and 2050 (orange bars), relative to exposure of year 2015 O_3 levels

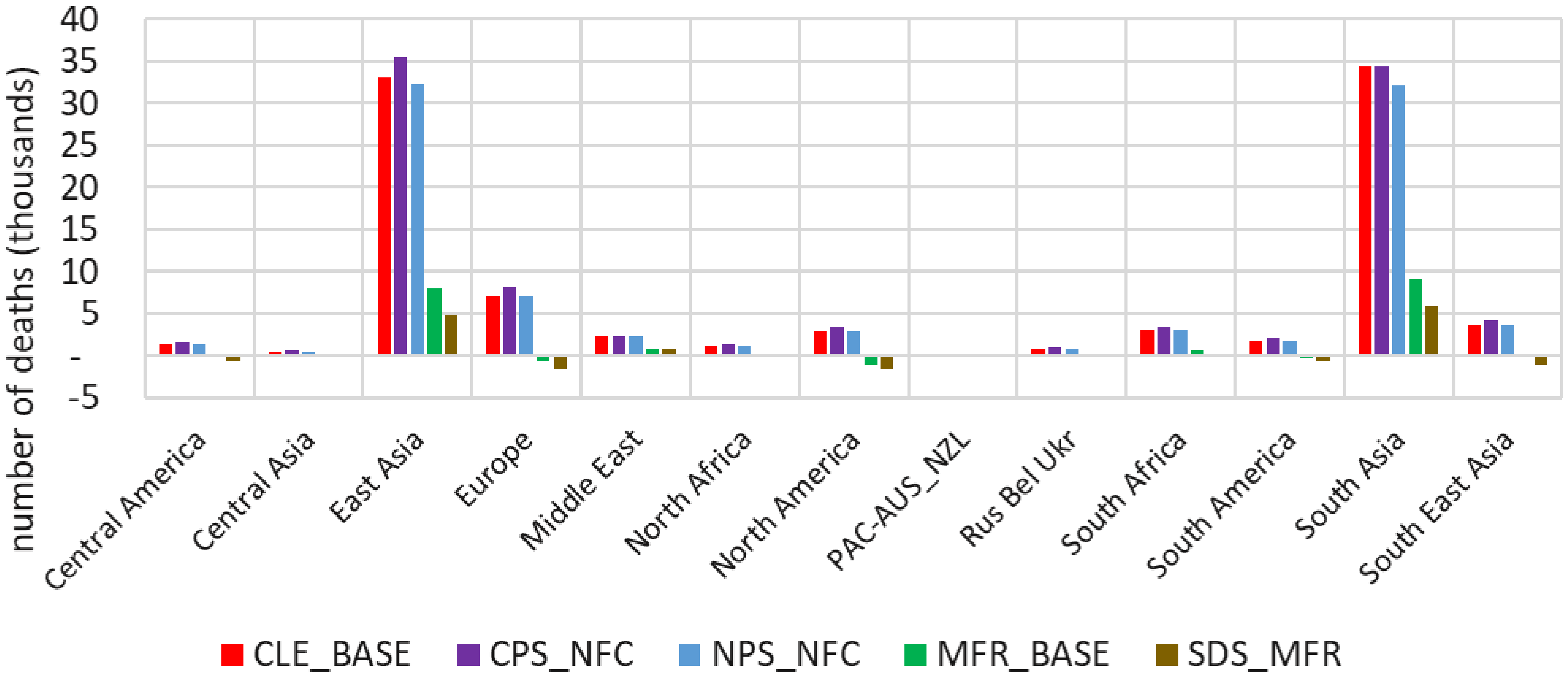
Change in mortalities in HTAP2 Europe region from exposure to O_3 from global CH_4 emissions in 2030 (blue bars) and 2050 (orange bar), relative to exposure of year 2015 O_3 levels

Source: JRC TM5-FASST, with ECLIPSE V6b scenarios (IIASA, 2019)

European Commission

Air quality impacts of CH_4 emissions (3)

Change in mortality associated with ozone attributable to CH_4 emissions

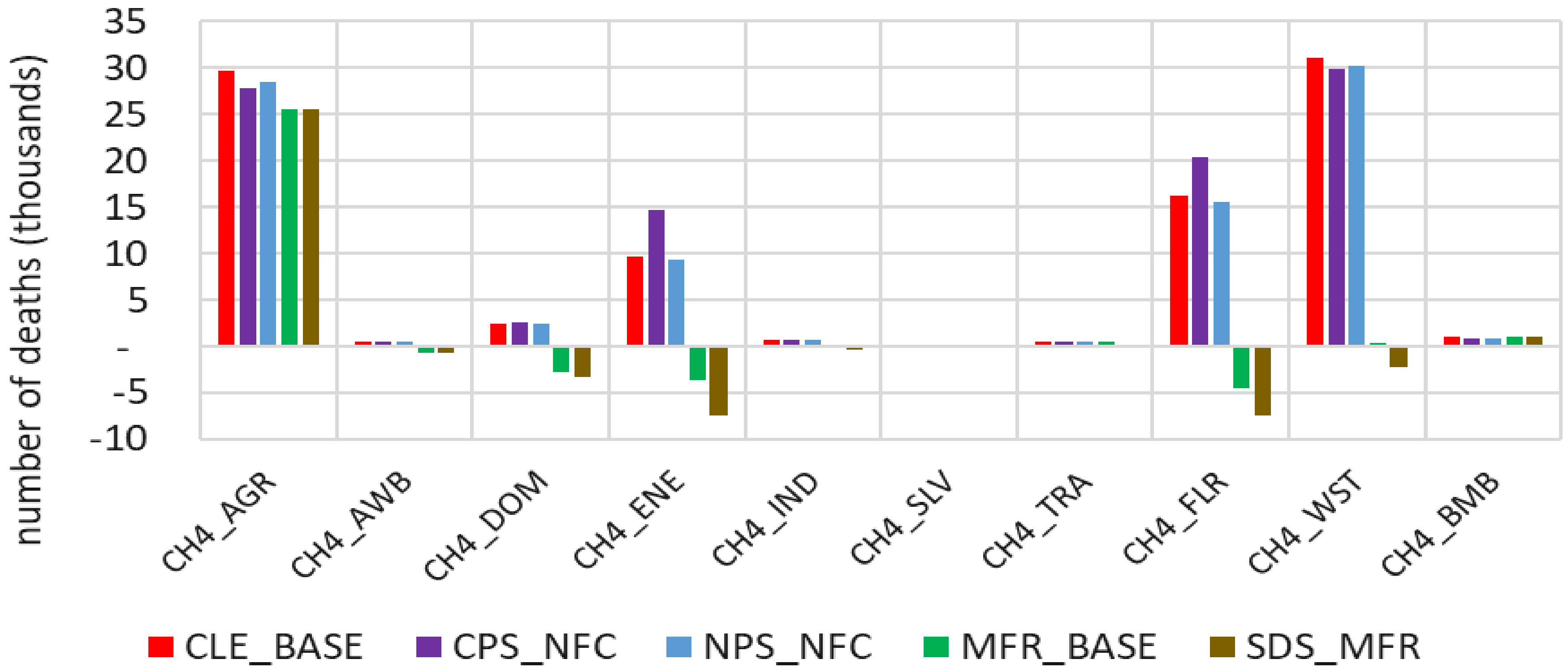


Year 2050 O_3 differences in global mortality attributable to CH_4 relative to year 2015 split by anthropogenic sources

Source: JRC TM5-FASST, with ECLIPSE V6b scenarios (IIASA, 2019)

Air quality impacts of CH_4 emissions (4)

Change in mortality associated with ozone attributable to CH_4 emissions



- AGR, agriculture
- AWB, open burning of agricultural waste
- DOM, residential combustion
- ENE, energy production
- IND, industrial combustion and processes
- SLV, solvent production and use
-TRA, transport
- FLR, gas venting and flaring
- WST, waste
- BMB, biomass burning

Year 2050 O_3 differences in global mortality attributable to CH_4 relative to year 2015 split by anthropogenic sources

Source: JRC TM5-FASST, with ECLIPSE V6b scenarios (IIASA, 2019)

Summary of relative impacts due to CH_4 induced O_3

Percentage change in CH_4-related O_3 mortalities relative to 2015 exposure levels				
	High emission scenarios		Low emission scenarios	
	Global	Europe	Global	Europe
2030	46% to 49%	28% to 31%	-4% to 1%	-13% to -17%
2050	112% to 123%	68% to 78%	7% to 20%	-7% to -16%
Percentage change in crop yield loss (RYL) relative to 2015 (4 crops)				
	Global	Europe	Global	Europe
2030	13% to 16%	17% to 20%	-32% to -37%	-27% to -32%
2050	35% to 47%	43% to 55%	-36% to -45%	-32% to -41%
Change in crop economic loss relative to 2015 (million USD)				
	Global	Europe	Global	Europe
2030	142 to 184	17 to 20	-442 to -497	-34 to -39
2050	404 to 566	43 to 57	-497 to -590	-39 to -48

Source: JRC TM5-FASST, with ECLIPSE V6b scenarios (IIASA, 2019)

Conclusions

- About 60% of the current global anthropogenic methane is emitted by sources like **agriculture**, **landfills and wastewater**, and the **production and pipeline transport of fossil fuels**, while ca. 40% is from natural sources.
- Asia represents more than 50% of world methane emissions in 2022.
- While ozone peaks have shaved off mainly due to the reduction of NOx-VOC emissions, baseline ozone levels are increasing caused by the increasing role of CH_4.
- Considerable impacts of CH_4 induced O_3 concentrations on health and crop production in low ambition scenarios
- Global Methane Pledge and the EU methane Strategy are key initiatives to abate CH4 emissions.
- HTAP modelling exercise important to constrain uncertainties and move forward in understanding the impacts of CH_4 emissions.

Thank you
and keep in touch

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