Global trends of methane emissions and their impacts on ozone concentrations

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Policy-relevant questions:

- What is our current understanding of observed changes of CH_4 concentrations and background O_3, and modelling capacity to understand these changes?
- What is the current knowledge on the geographical distribution of CH_4 emissions and on the contributing sources?
- What are policy-relevant CH_4 emission scenarios until 2050 and how are they expected to contribute to O_3 concentrations in Europe and other parts of the world?
- What are benefits to human health, crops and vegetation of CH_4 emission reductions in the EU alone, and through collaboration with other parties?
- Which are the most promising economic sectors to effectively achieve CH_4 emission reductions?


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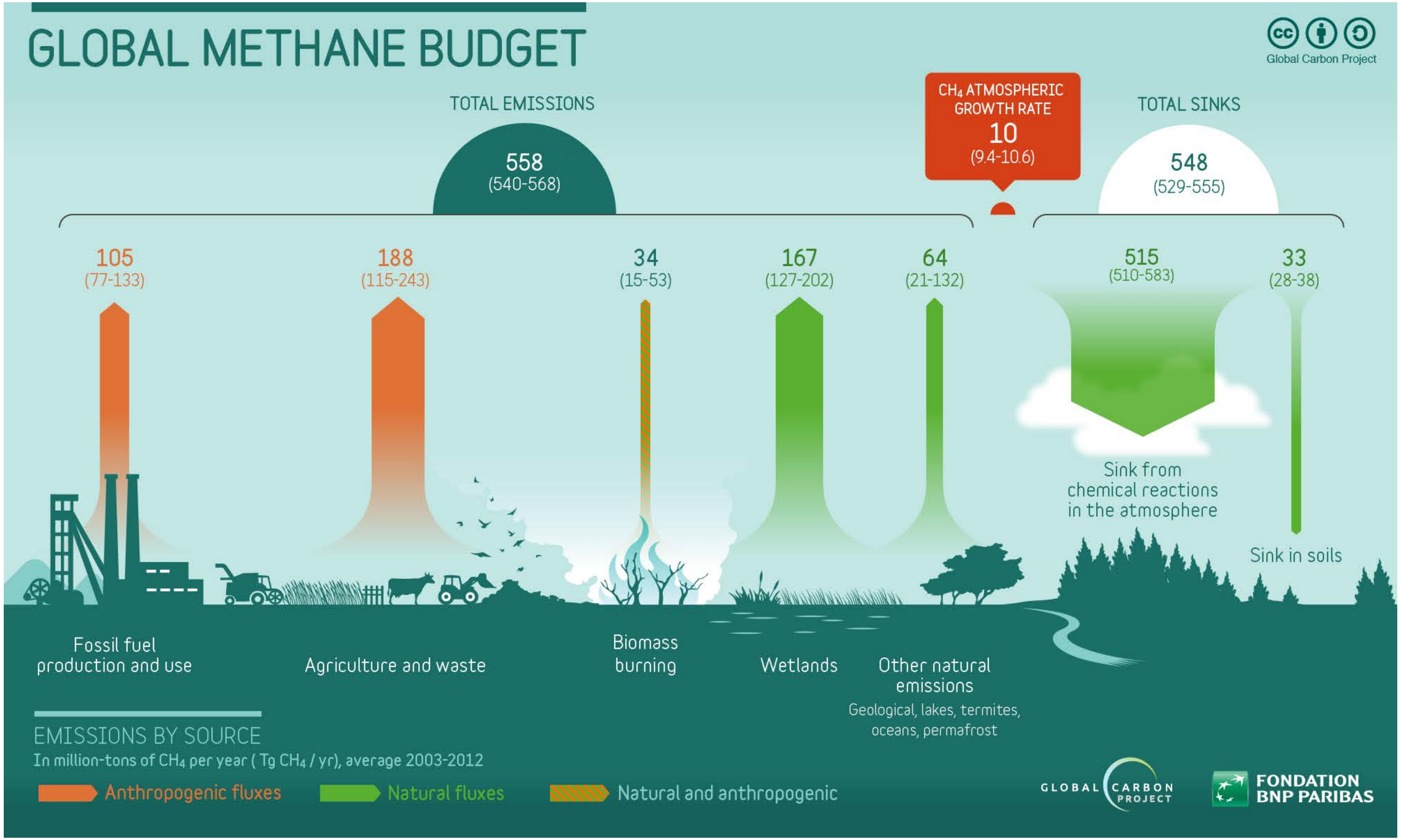
Global Methane Budget 2003 – 2012 (Tg/yr)



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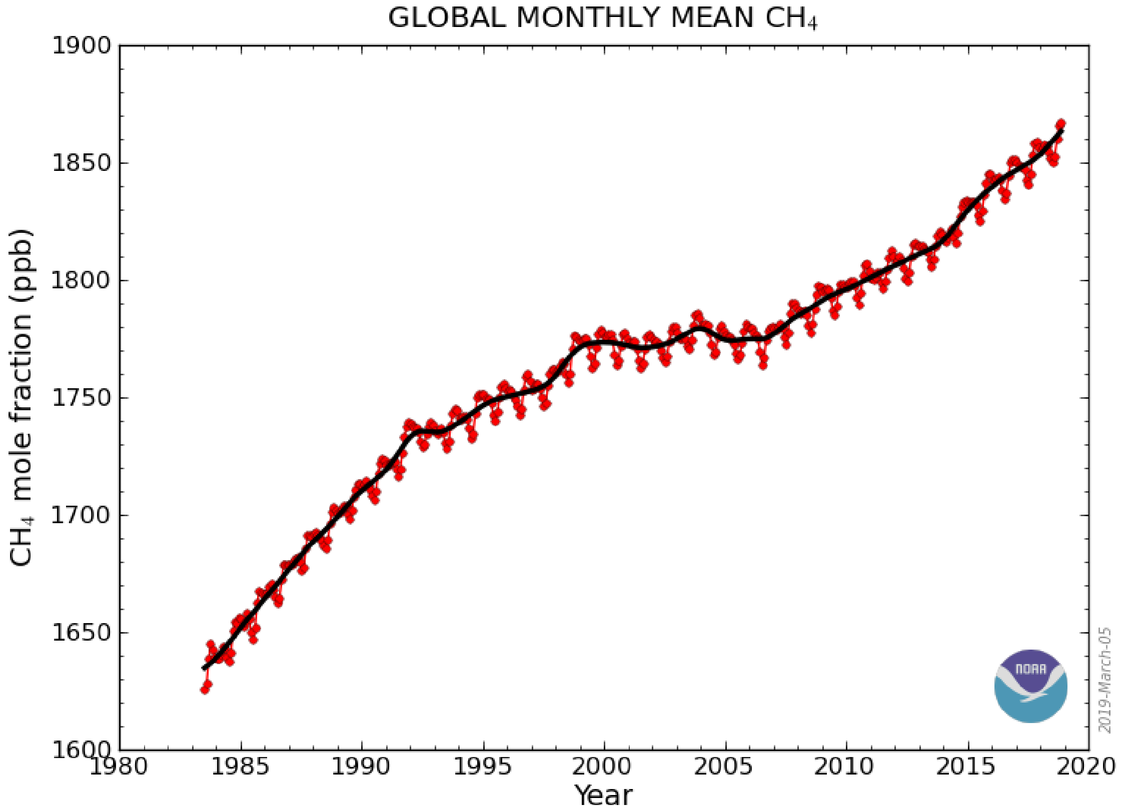
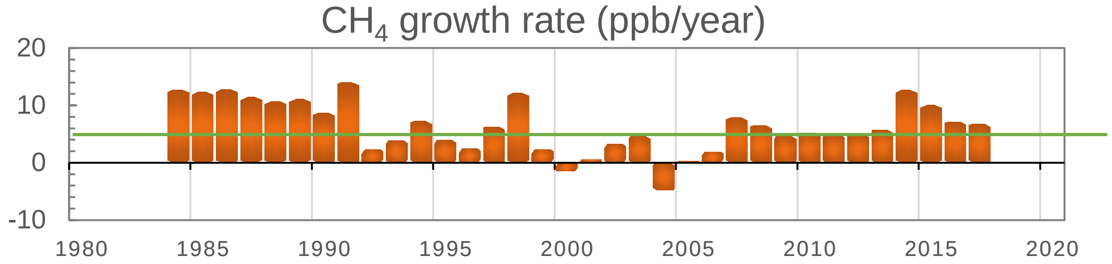
Methane: observed global concentration trend





Pre-industrial: 722 ppb

After plateau 1998 – 2007 methane concentration increasing again

Average growth rate since pre-industrial

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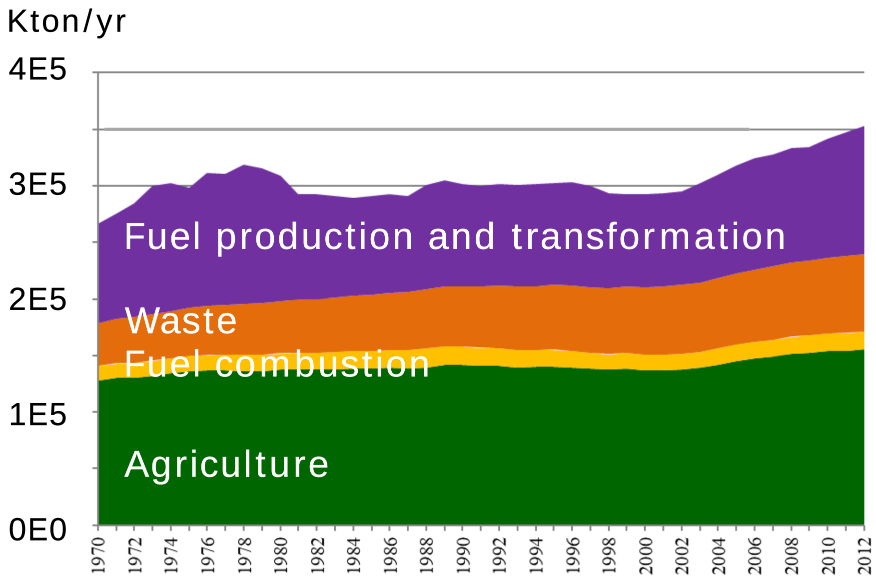
Anthropogenic methane emission trends by sector 1970 – 2012

GLOBE



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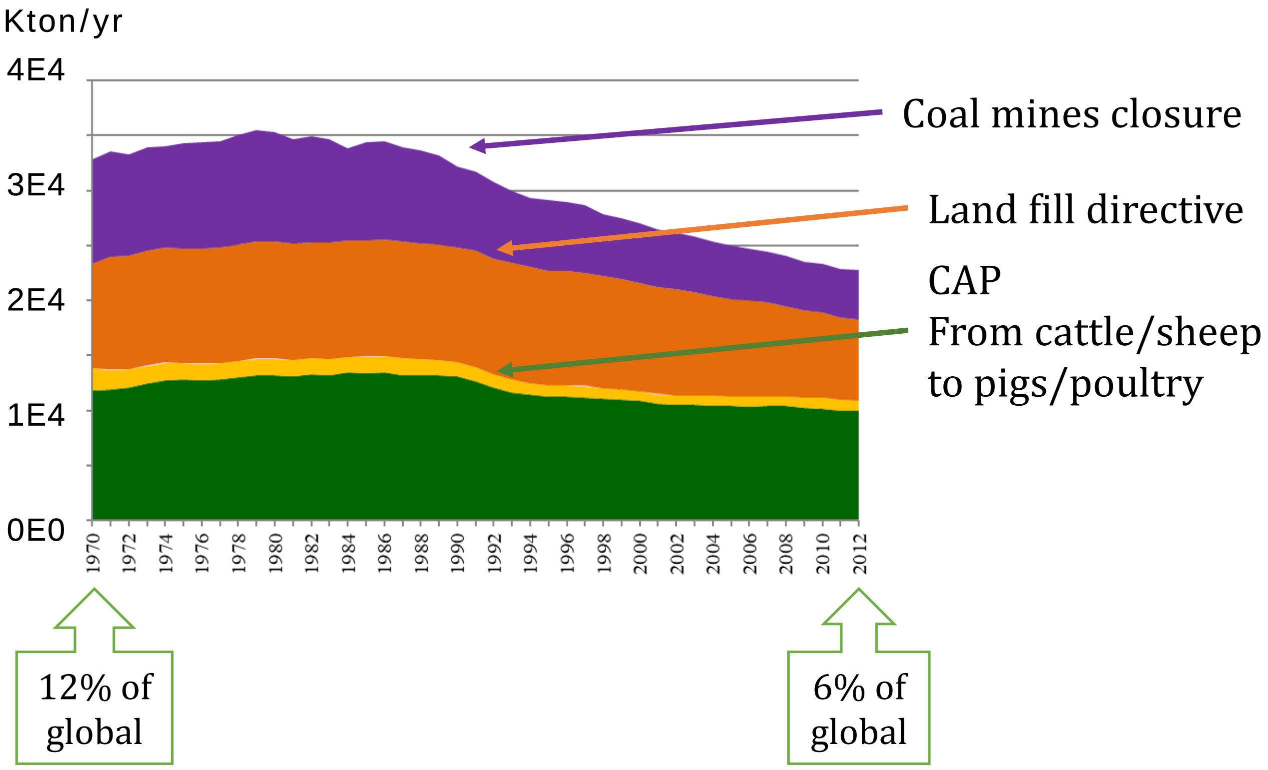
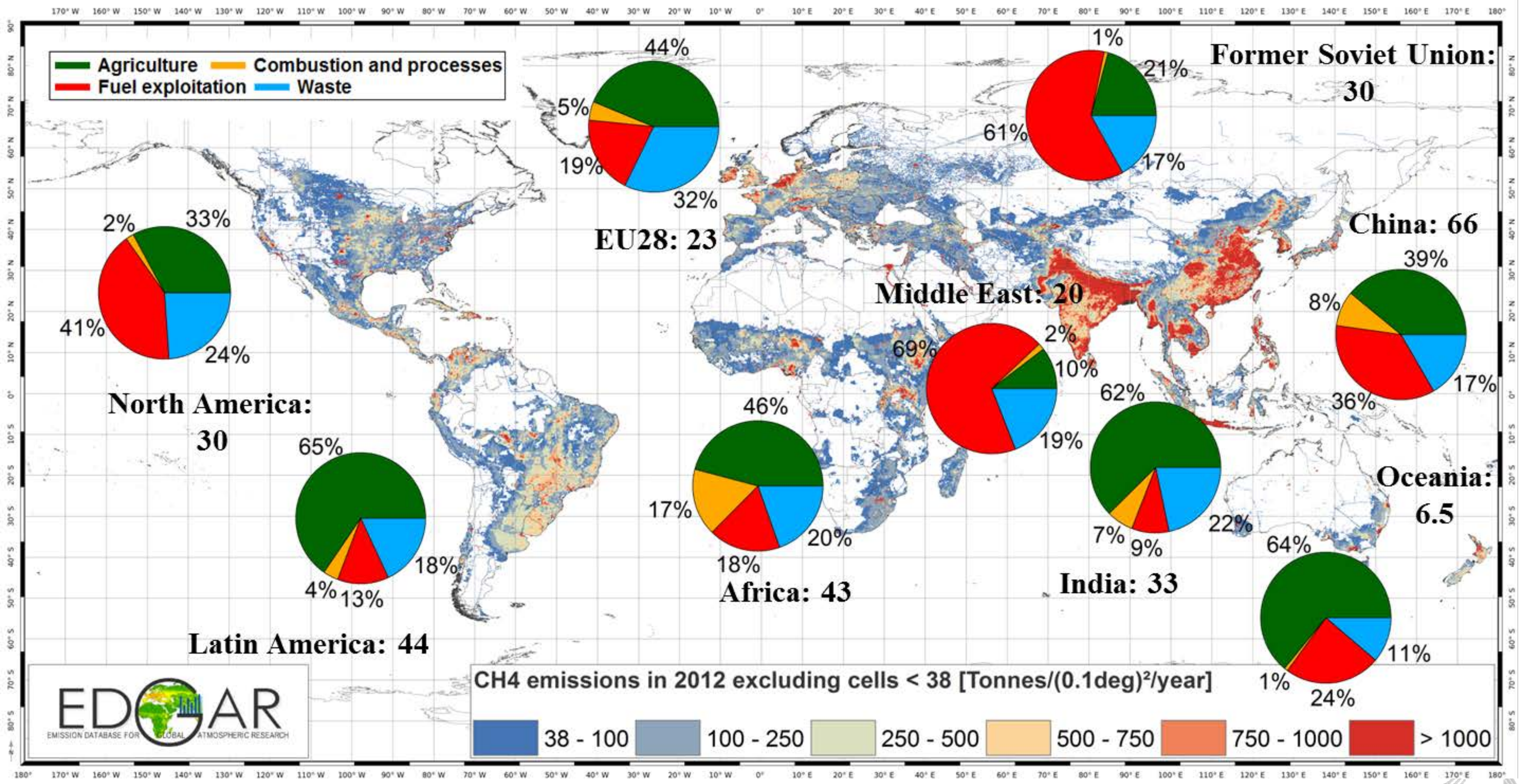


Source: JRC EDGAR v4.3.2
http://edgar.jrc.ec.europa.eu

Methane yr 2012 emission by sector, by region



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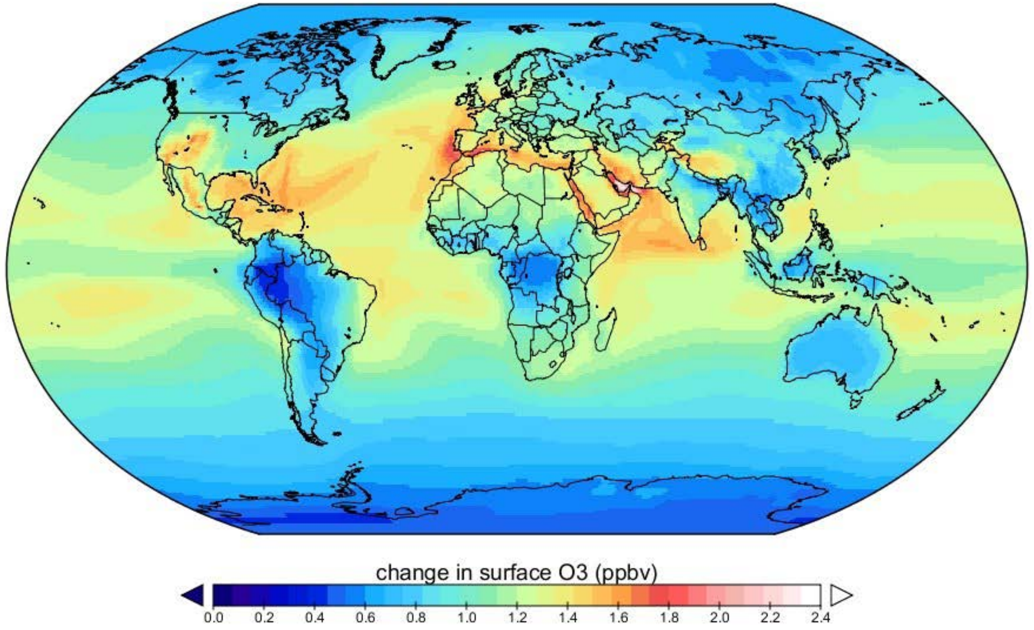
Ozone response to (globally uniform) CH_4 concentration reduction

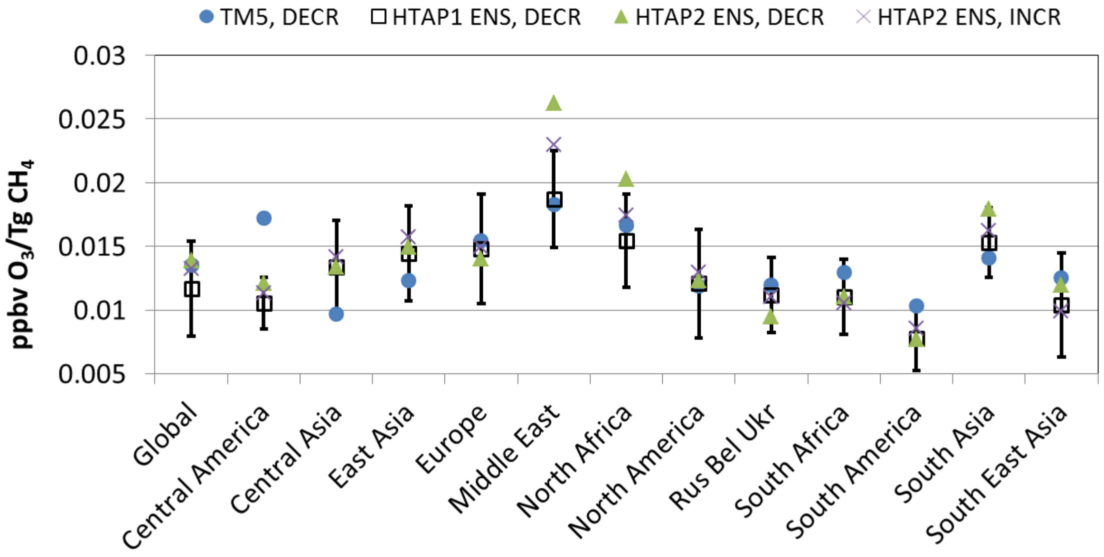
Local long-term CH_4 → O_3 response
- is largely **independent** of **location of CH_4 emission** change
- depends on **local NO_x and NMVOC** emissions

O_3 change upon 20% global uniform CH_4 concentration change



Source: JRC, TM5 model

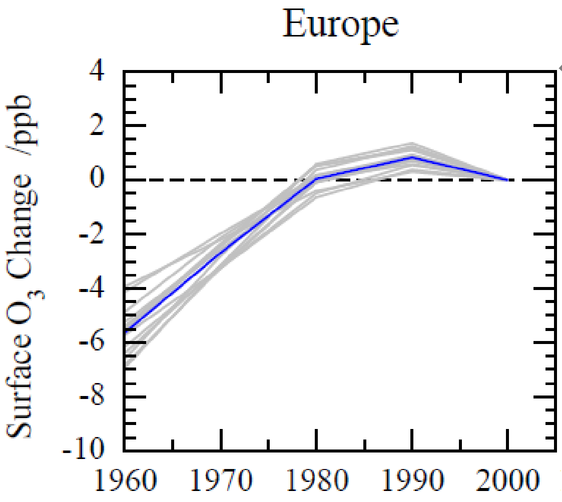
Surface O_3 response sensitivity to CH_4 emission change



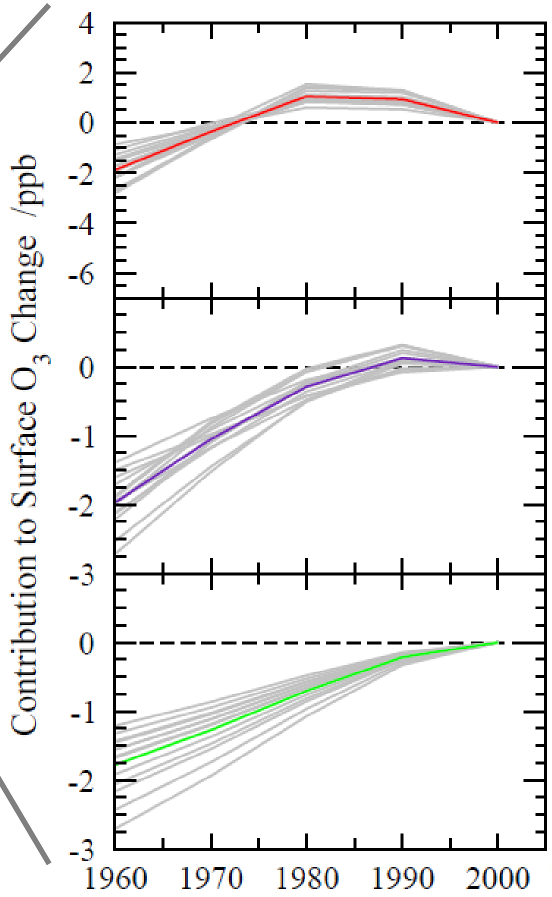
Source: JRC TM5 model, HTAP1 and HTAP2 models (Turnock et al., 2018)

How much has CH_4 contributed to O_3 in Europe? (HTAP1 modeling results)

Change in annual mean surface O_3 concentration (ppb)



Contribution break-down:



Local precursors (NOx, VOC, CO)

Declining since 80ies

Contribution from long-range ozone transport

Declining since 90ies

Methane contribution

Not peaked yet

Source: Wild et al., Atm. Chem. Phys, 2012

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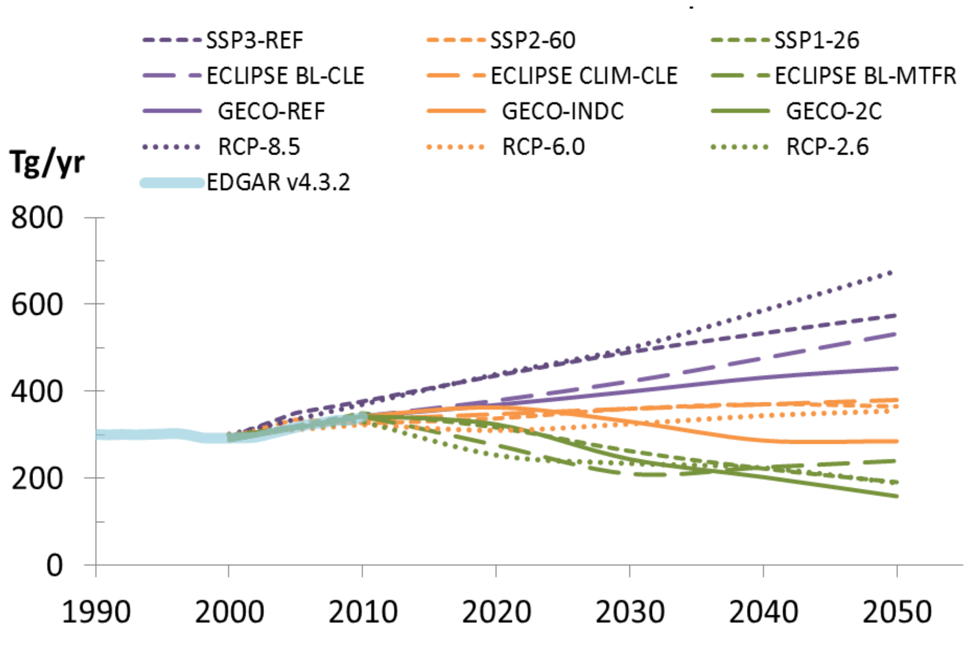
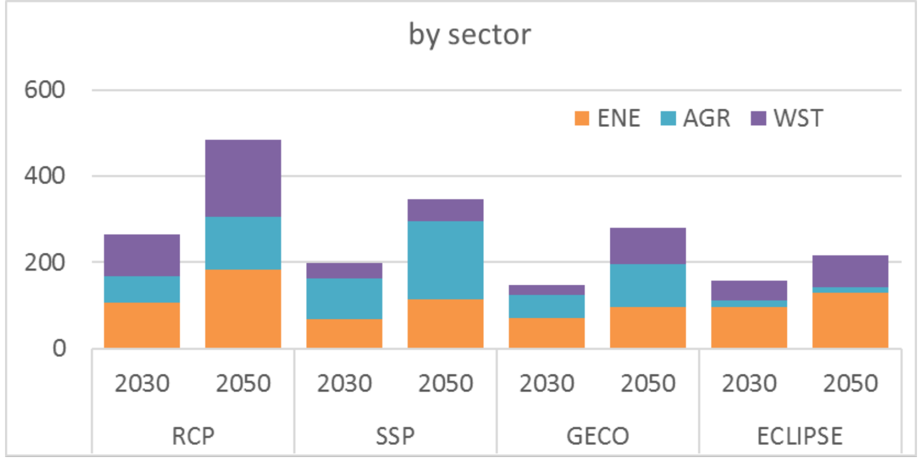
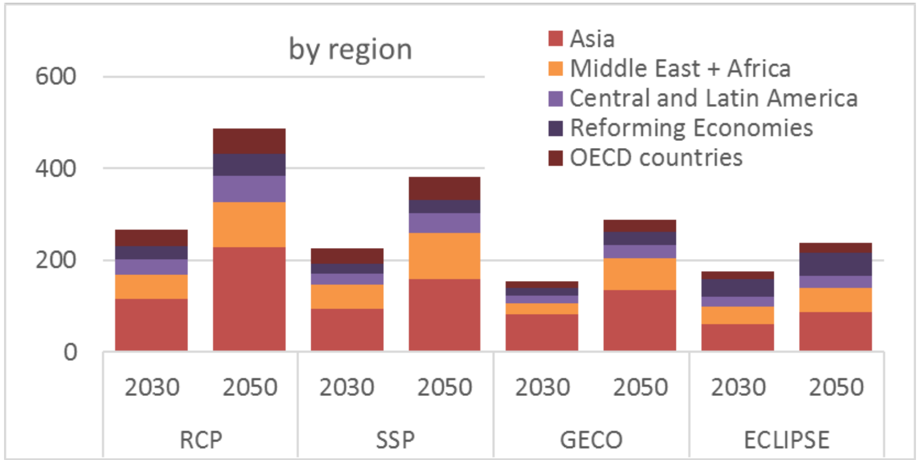
Future CH_4 emission scenarios

Past and projected global CH_4 emissions



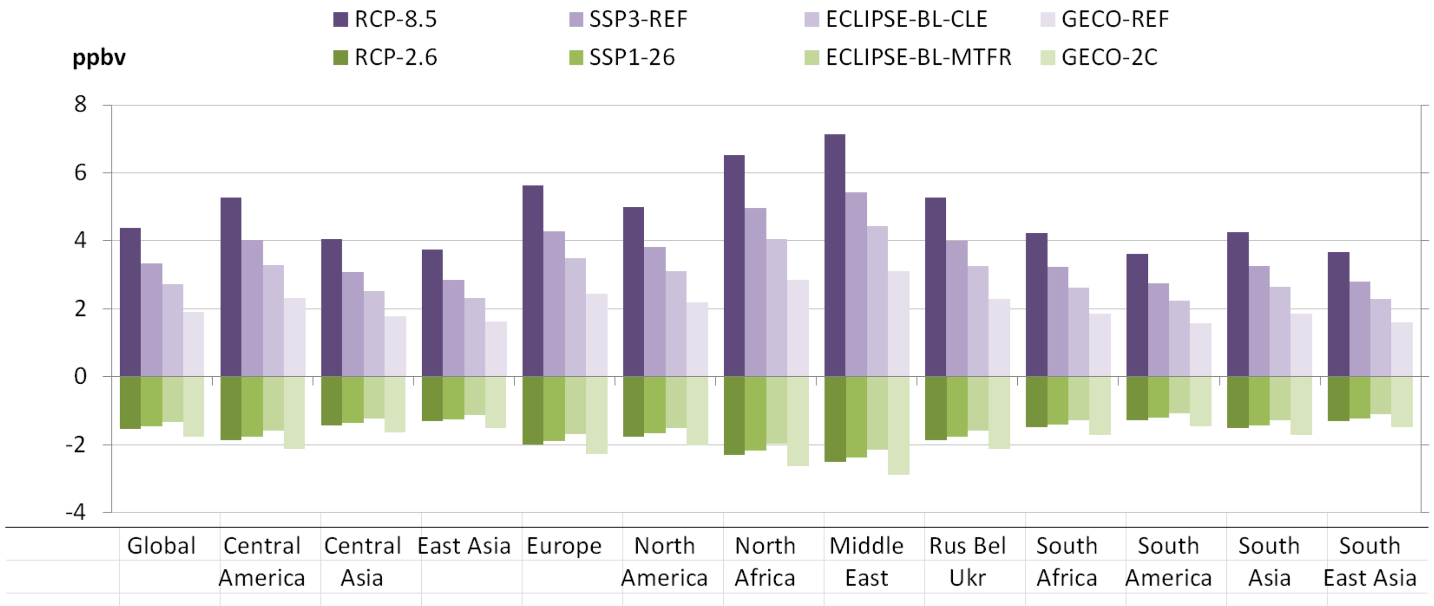
Delta between (H) and (L) scenarios (mitigation potential)





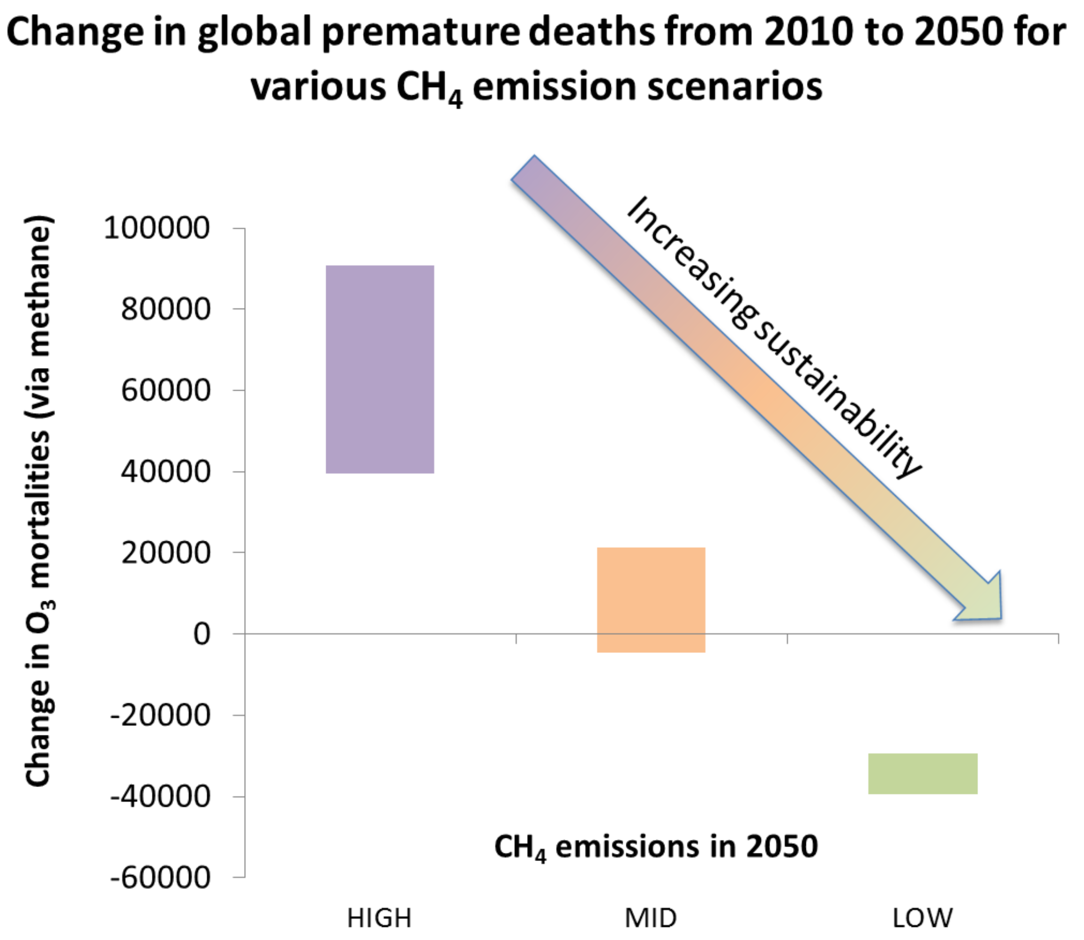
Future CH_4 emission scenarios and their impacts on O_3 and health

Projected change in regional mean ozone exposure metric 6mDMA1 in 2050, relative to year 2010, for the highest and lowest global CH_4 emission scenarios in each family.



Source: JRC TM5-FASST

O_3 health benefit from CH_4 mitigation



CH_4 mitigation potential

Sector	Control measure
Livestock	Enteric fermentation: diet changes, vaccination
	Improving animal health and productivity: genetic improvement, diet changes
	Manure management: anaerobic digestion, direct injection in soils of liquid manure.
Rice cultivation	Mixed: interrupted flooding and alternate wetting and drying, alternative hybrids, sulfate amendments
Agricultural waste burning	Ban on burning.
Solid waste	Maximum separation and treatment, no landfill of biodegradable waste
Wastewater	Extended treatment with gas recovery and utilization
Coal mining	Pre-mining degasification
	Ventilation air oxidizer with improved ventilation systems
Conventional natural gas production	Recovery and utilization of vented associated gas
	Good practice: reduced unintended leakage
Unconventional natural gas production	Good practice: reduced unintended leakage
Long-distance gas transmission in pipelines	Leakage control, especially at the pumping units
Gas distribution networks	Leakage control and replacement of grey cast iron networks
Oil production and refinery	Recovery and utilization of vented associated gas
	Good practice: reduced unintended leakage

Technically feasible control measures for CH_4 emissions in a number of key-sectors.
Source: Höglund-Isaksson et al. (2012; 2015)

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Key messages:

- Unabated, global anthropogenic CH_4 emissions could increase by 35 to 100% by 2050 for a range of pessimistic scenarios, causing 40,000 (+12%) to 90,000 (+26%) more O_3 premature deaths compared to present-day O_3 levels.

- By contrast, optimistic sustainability scenarios project CH_4 emission reductions of up to 50% by 2050 saving worldwide 30,000 (-9%) to 40,000 (-12%) lives.

- Except for most stringent mitigation scenarios, the relative contribution of CH_4 to surface O_3 (and its environmental impacts) will increase in the next decades

- Sustainable scenarios assume structural changes in the energy, waste and agricultural sectors, together with the implementation of all currently available emission abatement technologies.
  A number of the methane emission reduction technologies may have negative, zero or small positive costs, making them attractive targets for policies.

- The benefits of CH_4 of emission reductions are globally distributed, therefore global mitigation strategies are most effective in reaching substantial health benefits within and outside individual world regions

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Thank you!

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