atf animal task force
A European Public-Private Partnership

EAAP European Federation of Animal Science

2nd one-day symposium of the Animal Task Force & the EAAP Commission on Livestock Farming Systems

FAO report: Technical Advisory Group on Methane emissions:

Methane Emissions in Agriculture and Discussion of Metrics

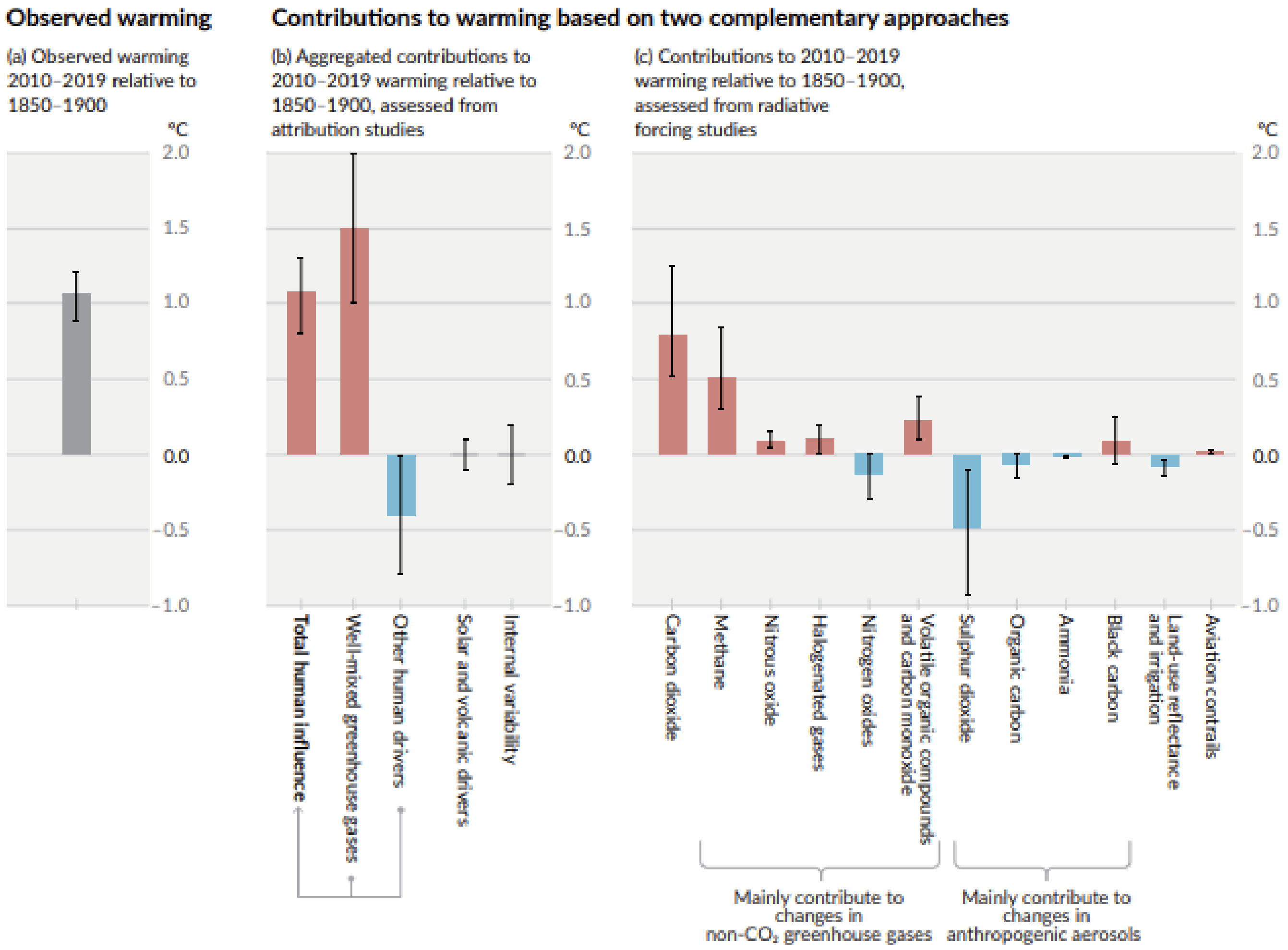
John Lynch
(University of Oxford)

Summary

- Context – why focus on methane?
- Overview of FAO report on *Methane Emissions in Agriculture*
  - Methane sources and sinks
  - Quantification of methane emissions
  - Mitigation of methane emissions
  - Metrics for quantifying impact of methane emissions

Methane

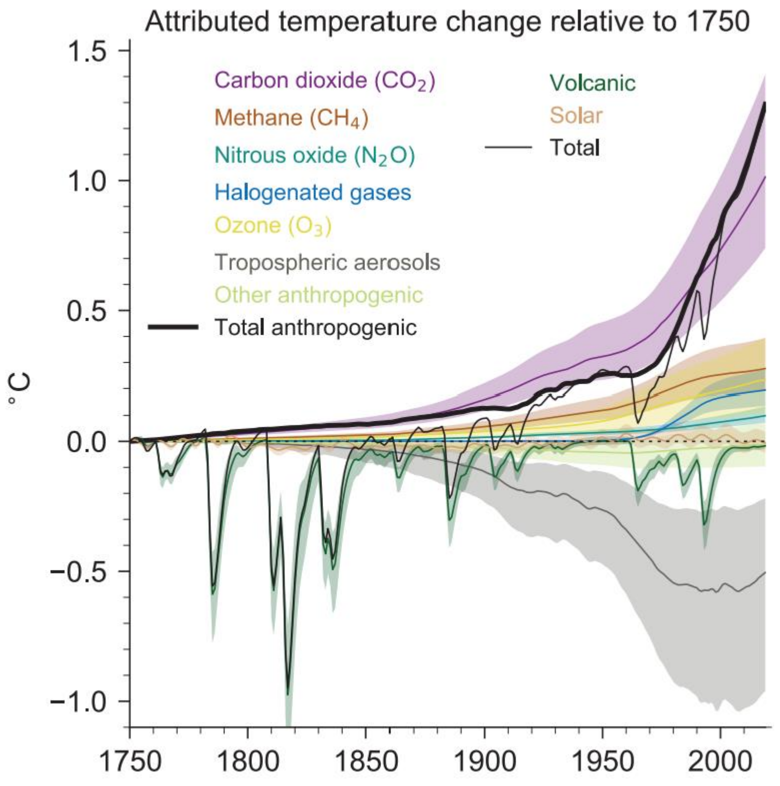
- 2nd largest contributor to global warming



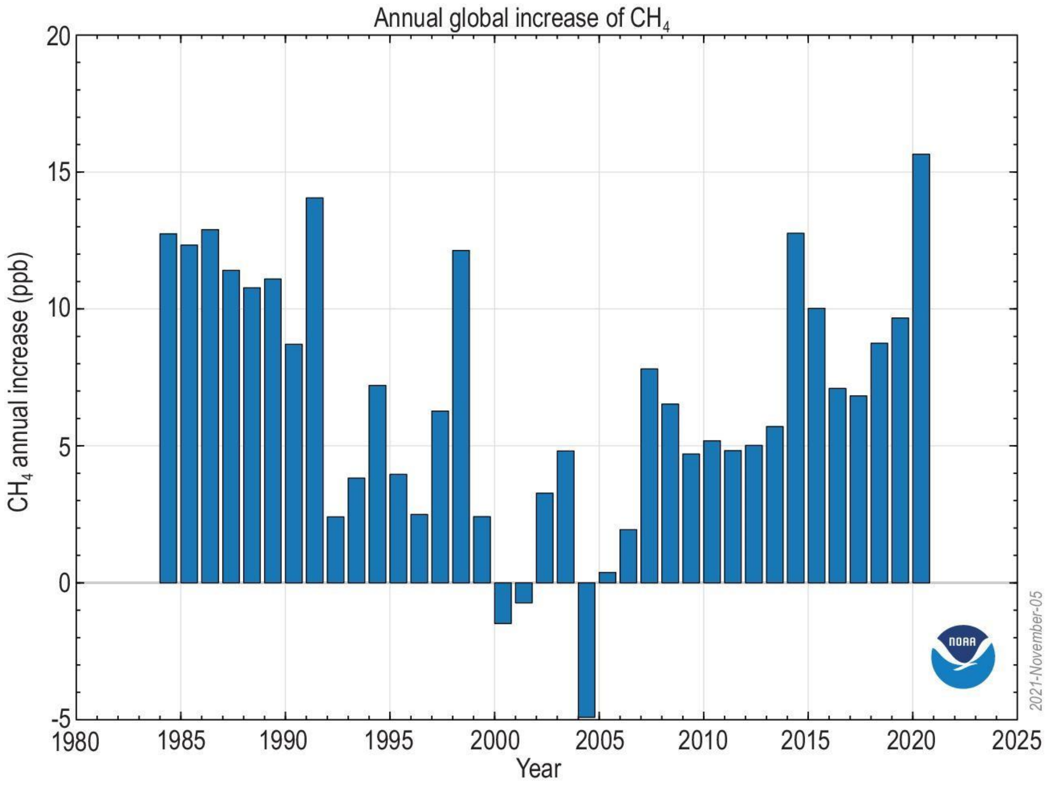
IPCC (2021) AR6 WG1 SPM

Methane

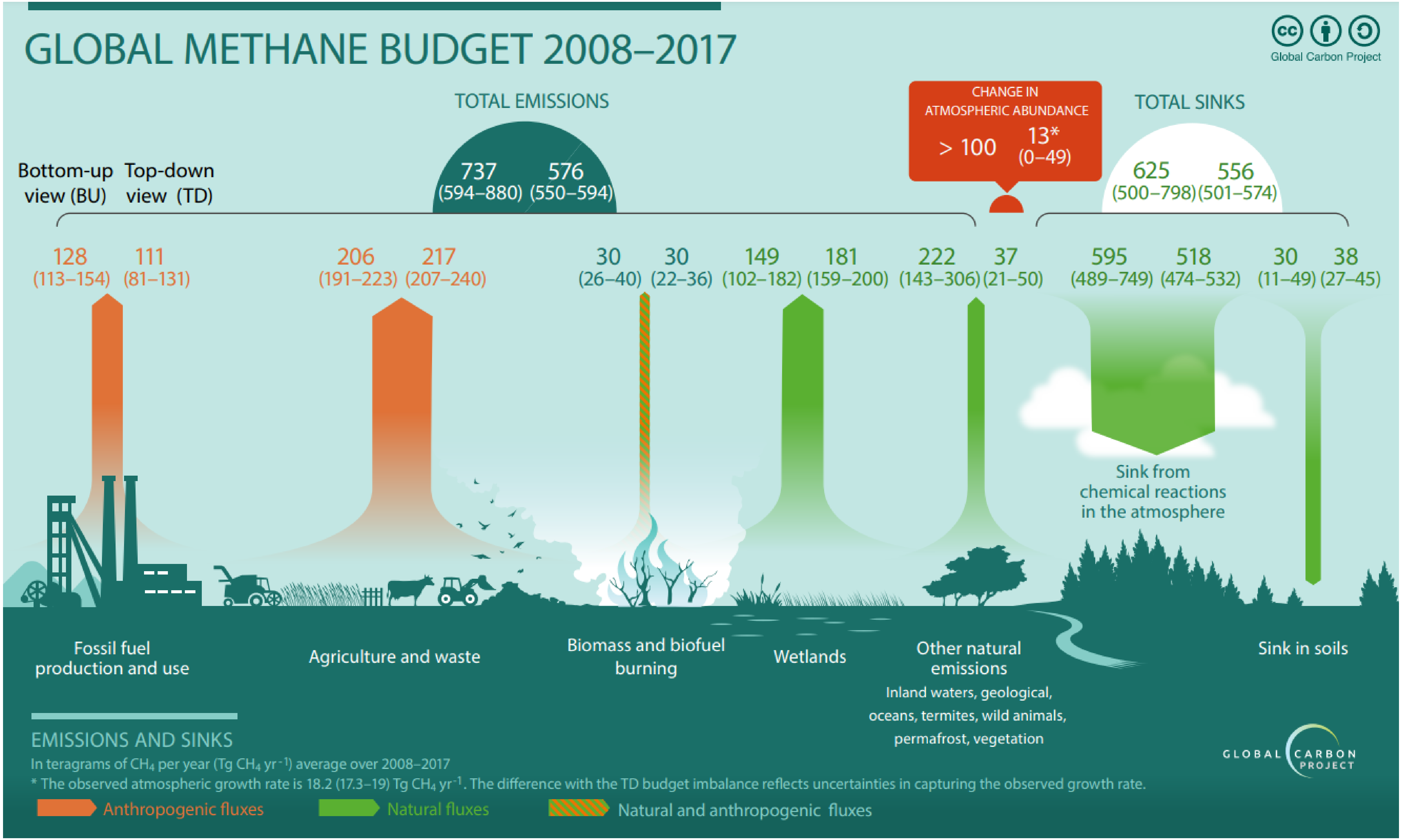
- 2^{nd} largest contributor to global warming
- Increasing atmospheric concentrations and warming contribution



IPCC (2021) AR6 WG, Chapter 7

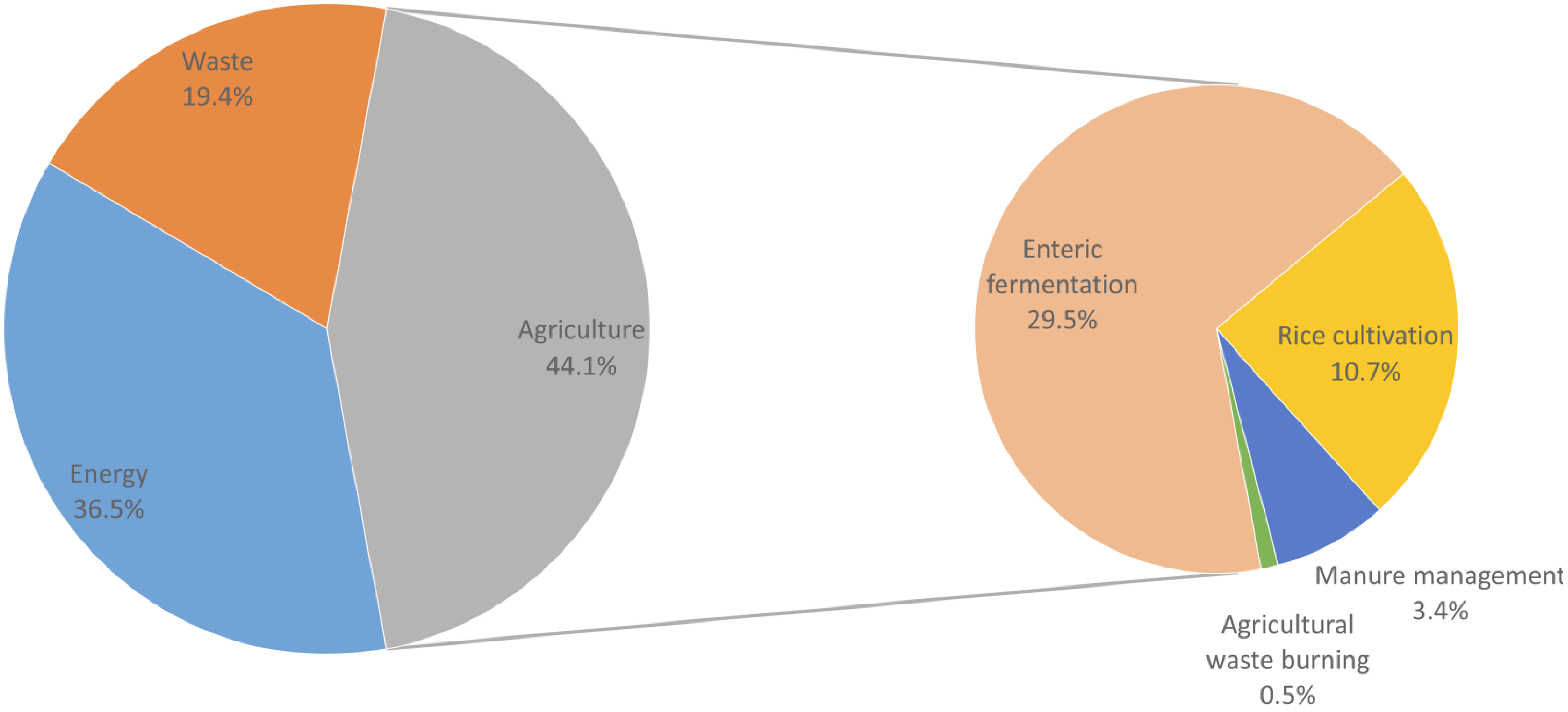


Nisbet (2022), NOAA data



GLOBAL METHANE BUDGET 2008–2017
Global Carbon Project
TOTAL EMISSIONS
737 (594–880)
576 (550–594)
CHANGE IN ATMOSPHERIC ABUNDANCE
> 100
13* (0–49)
TOTAL SINKS
625 (500–798)
556 (501–574)
Bottom-up view (BU)
Top-down view (TD)
128 (113–154)
111 (81–131)
206 (191–223)
217 (207–240)
30 (26–40)
30 (22–36)
149 (102–182)
181 (159–200)
222 (143–306)
37 (21–50)
595 (489–749)
518 (474–532)
30 (11–49)
38 (27–45)
Sink from chemical reactions in the atmosphere
Fossil fuel production and use
Agriculture and waste
Biomass and biofuel burning
Wetlands
Other natural emissions
Inland waters, geological, oceans, termites, wild animals, permafrost, vegetation
Sink in soils
EMISSIONS AND SINKS
In teragrams of CH_4 per year (Tg CH_4 yr^{-1}) average over 2008–2017
* The observed atmospheric growth rate is 18.2 (17.3–19) Tg CH_4 yr^{-1}. The difference with the TD budget imbalance reflects uncertainties in capturing the observed growth rate.
Anthropogenic fluxes
Natural fluxes
Natural and anthropogenic fluxes
GLOBAL CARBON PROJECT

Methane



Janssens-Maenhout et al. (2017)

Methane and global temperature targets

D. Limiting Future Climate Change

D.1 **From a physical science perspective, limiting human-induced global warming to a specific level requires limiting cumulative CO_2 emissions, reaching at least net zero CO_2 emissions, along with strong reductions in other greenhouse gas emissions. Strong, rapid and sustained reductions in CH_4 emissions would also limit the warming effect resulting from declining aerosol pollution and would improve air quality.**
{3.3, 4.6, 5.1, 5.2, 5.4, 5.5, 5.6, Box 5.2, Cross-Chapter Box 5.1, 6.7, 7.6, 9.6} (Figure SPM.10, Table SPM.2)

IPCC (2021) AR6 WG SPM

Methane and global temperature targets

D. Limiting Future Climate Change

D.1.8 Achieving global net zero CO_2 emissions, with anthropogenic CO_2 emissions balanced by anthropogenic removals of CO_2, is a requirement for stabilizing CO_2-induced global surface temperature increase. This is different from achieving net zero GHG emissions, where metric-weighted anthropogenic GHG emissions equal metric-weighted anthropogenic GHG removals. For a given GHG emissions pathway, the pathways of individual GHGs determine the resulting climate response,[46] whereas the choice of emissions metric[47] used to calculate aggregated emissions and removals of different GHGs affects what point in time the aggregated GHGs are calculated to be net zero. Emissions pathways that reach and sustain net zero GHG emissions defined by the 100-year global warming potential are projected to result in a decline in surface temperature after an earlier peak (*high confidence*).
{4.6, 7.6, Box 7.3, TS.3.3}

IPCC (2021) AR6 WG SPM

Methane and global climate policy

Paris Agreement (UNFCCC, 2015)

Article 2

1. This Agreement, in enhancing the implementation of the Convention, including its objective, aims to strengthen the global response to the threat of climate change, in the context of sustainable development and efforts to eradicate poverty, including by:

(a) Holding the increase in the global average temperature to well below 2°C above pre-industrial levels and pursuing efforts to limit the temperature increase to 1.5°C above pre-industrial levels, recognizing that this would significantly reduce the risks and impacts of climate change;

(b) Increasing the ability to adapt to the adverse impacts of climate change and foster climate resilience and low greenhouse gas emissions development, in a manner that does not threaten food production; and

(c) Making finance flows consistent with a pathway towards low greenhouse gas emissions and climate-resilient development.

2. This Agreement will be implemented to reflect equity and the principle of common but differentiated responsibilities and respective capabilities, in the light of different national circumstances.

Methane and global climate policy

Paris Agreement (UNFCCC, 2015)

Article 4

1. In order to achieve the long-term temperature goal set out in Article 2, Parties aim to reach global peaking of greenhouse gas emissions as soon as possible, recognizing that peaking will take longer for developing country Parties, and to undertake rapid reductions thereafter in accordance with best available science, so as to achieve a balance between anthropogenic emissions by sources and removals by sinks of greenhouse gases in the second half of this century, on the basis of equity, and in the context of sustainable development and efforts to eradicate poverty.

Methane and global climate policy

Global methane pledge

CLIMATE & CLEAN AIR COALITION
TO REDUCE SHORT-LIVED CLIMATE POLLUTANTS

Briefing on the Global Methane Pledge
16 September 2021

2021 is the moment for methane. The CCAC-UNEP *Global Methane Assessment* set out an opportunity to change the climate trajectory within the next 20 years—a critical timeframe for slowing warming and self-reinforcing feedbacks enough to avoid passing dangerous tipping points. The 6th Assessment Report of the IPCC concluded that methane mitigation is a standout option for achieving near- and long-climate and air quality benefits.

- To capture this moment, U.S. and EU are leading a global effort for countries to commit to a Global Methane Pledge. The Pledge commits countries to collectively reduce emissions of methane from all sectors by at least 30% below 2020 levels by 2030 and to take comprehensive domestic action to achieve this target.

- Currently 121 participants countries
- Support from range of government, NGO and industry bodies

Methane and global climate policy

Global methane pledge

- If all countries commit to and take the necessary actions to achieve this goal:
    - **0.22°C** warming would be avoided by 2050;
    - **205,000 premature deaths** would be **avoided** annually due to respiratory and cardiovascular illnesses by 2030;
    - **624,000 asthma-related emergency room visits** and respiratory-related hospital admissions per year **would be avoided by 2030**;
    - **Crop yields would increase annually by 8,000,000** tonne in global wheat; **4,500,000** tonne in global soy; **6,000,000** tonne in global maize; and, **2,500,000** tonne in global rice by 2030;
    - **60 billion work hours lost** would be **avoided annually** due to heat exposure beginning in the 2040s;

Methane and global climate policy

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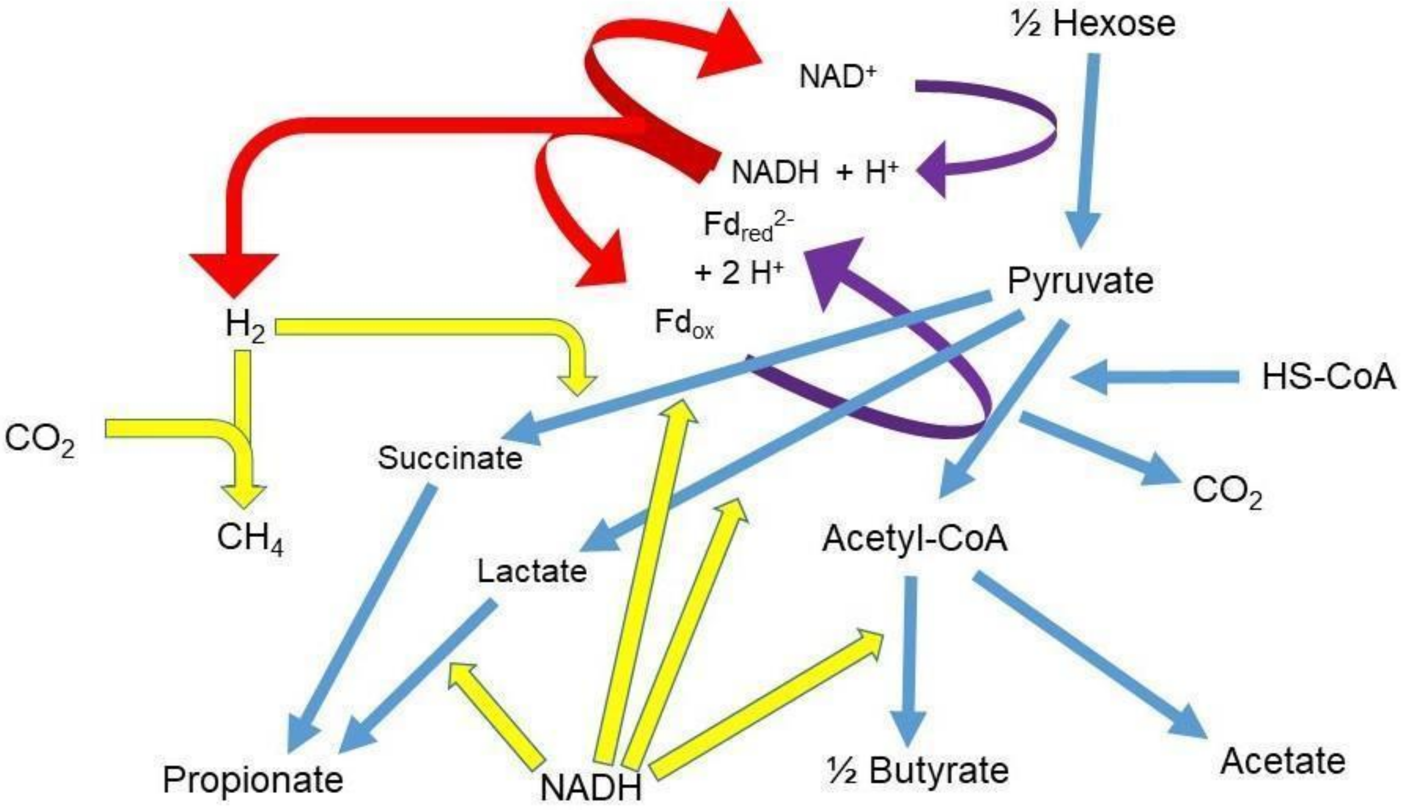
FAO report on *Methane Emissions in Agriculture*

- Comprehensive report on agricultural methane
  - Emissions
  - Mitigation
  - Metrics
- Technical Advisory Group of 50+ authors
- Began Summer 2021
- Draft being revised in response to public review, currently 292 pages

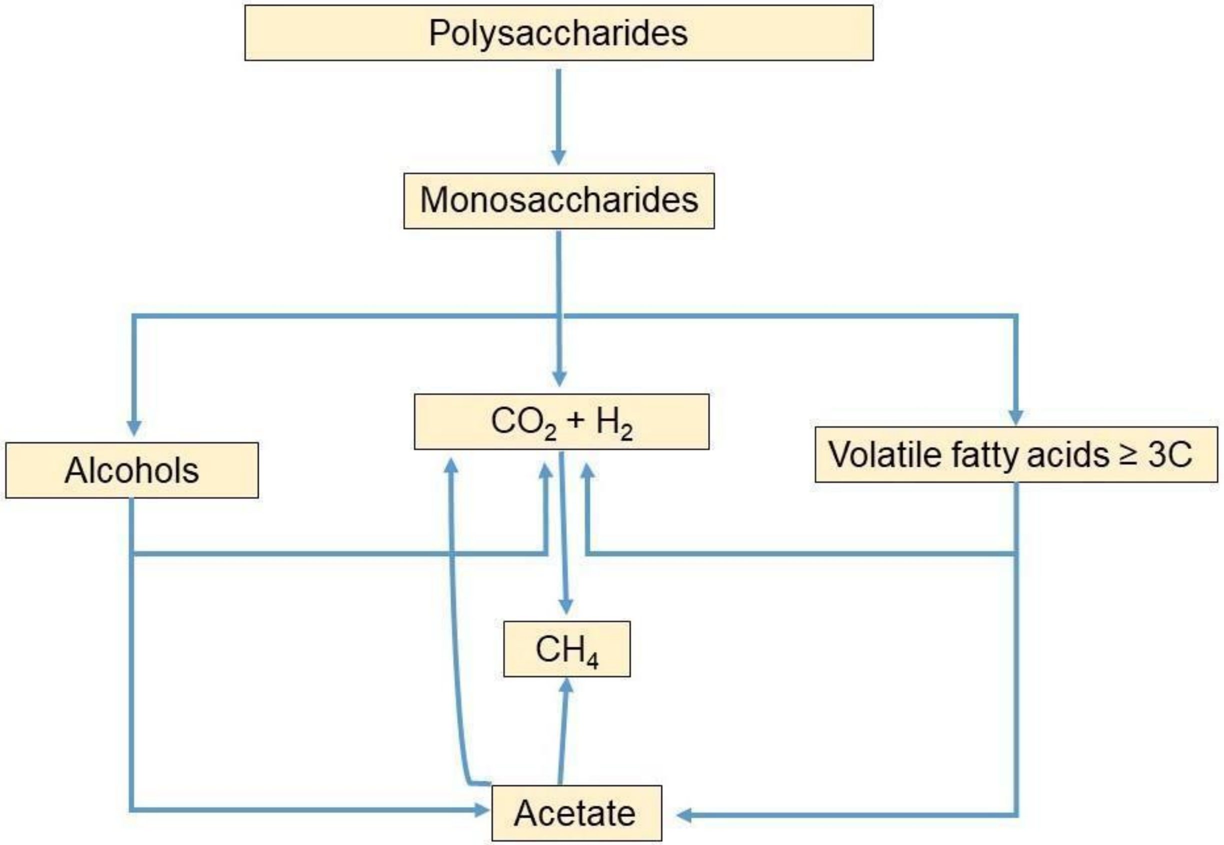
1: Sources and sinks of methane emissions in agriculture

- Sources
  - Rumen methanogenesis
  - Manure
  - Soil
  - Waste
  - Anaerobic digestion
- Sinks
  - Soil

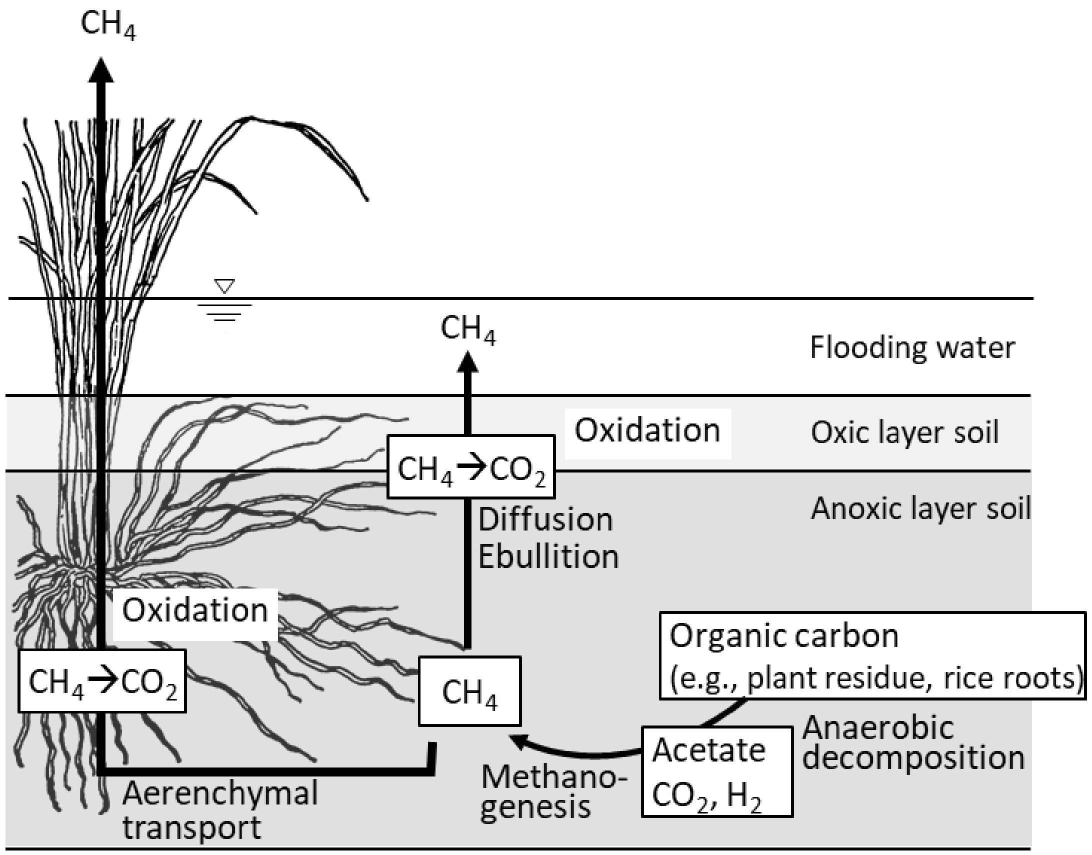
Rumen methanogenesis



Manure anaerobic digestion



Flooded rice soil emissions



Methane sinks

- Atmospheric sink (90-96% of annual removals)
  - Hydroxyl (OH) radicals
  - Chlorine (Cl) radicals
- Soil methane sink
  - Eubacterial methanotrophy
  - Influenced my management:
  - Decreases with nitrogen application and high stocking density
  - Soil under trees typically associated with greater CH_4 uptake

2: Quantification of methane emissions

- Measurement
  - Animal-based
  - Facility-based
  - Soil
  - Large-scale measurement and monitoring
- Estimation
  - Bottom-up modelling
  - Top-down approaches

Summary of methane measurement techniques

- List of techniques with comments on cost, applications, pros and cons. E.g:
  - Respiration chambers
  - Hood and/or headbox systems
  - Tracers
  - Gas sensor capsules
  - In vitro techniques
  - Open-path laser
  - Unmanned aerial/ground vehicles
  - Satellites
  - Computer modelling

Estimation of methane emissions

- ‘Bottom-up’
  - Identify sources within a given region / boundary and scale up
  - Models may be empirical or mechanistic; stochastic or deterministic; static or dynamic
  - Common use of empirical models: activity data x emission factors
  - Different tiers incorporating more or less animal, dietary, and management data
- ‘Top-down’
  - Observations of atmospheric methane and atmos. transport models
  - Can be challenging/uncertain to assign to individual sources
- Complementary use of bottom-up and top-down methods can improve assessments

3: Mitigation of methane emissions

- Mitigation of enteric fermentation methane
- Mitigation of animal manure-related methane emissions
- Mitigation of methane emissions from rice paddies
- Cross-cutting considerations

Mitigation of enteric fermentation methane

- Animal breeding and management:
  - Increased production
  - Lower methane generation
  - Improved feed efficiency
  - Improved animal health and reproduction
- Feed management: concentrate vs forage, digestibility, feed processing
- Dietary supplements
  - lipids, ionophores, methane inhibitors, 3-Nitrooxypropanol (3-NOP), essential oils, seaweeds, tannins, saponins, biochar, microbials
- Immunisation against methanogens
- Protozoa defaunation
- Alternative electron acceptors
- Early-life interventions

Mitigation of manure methane

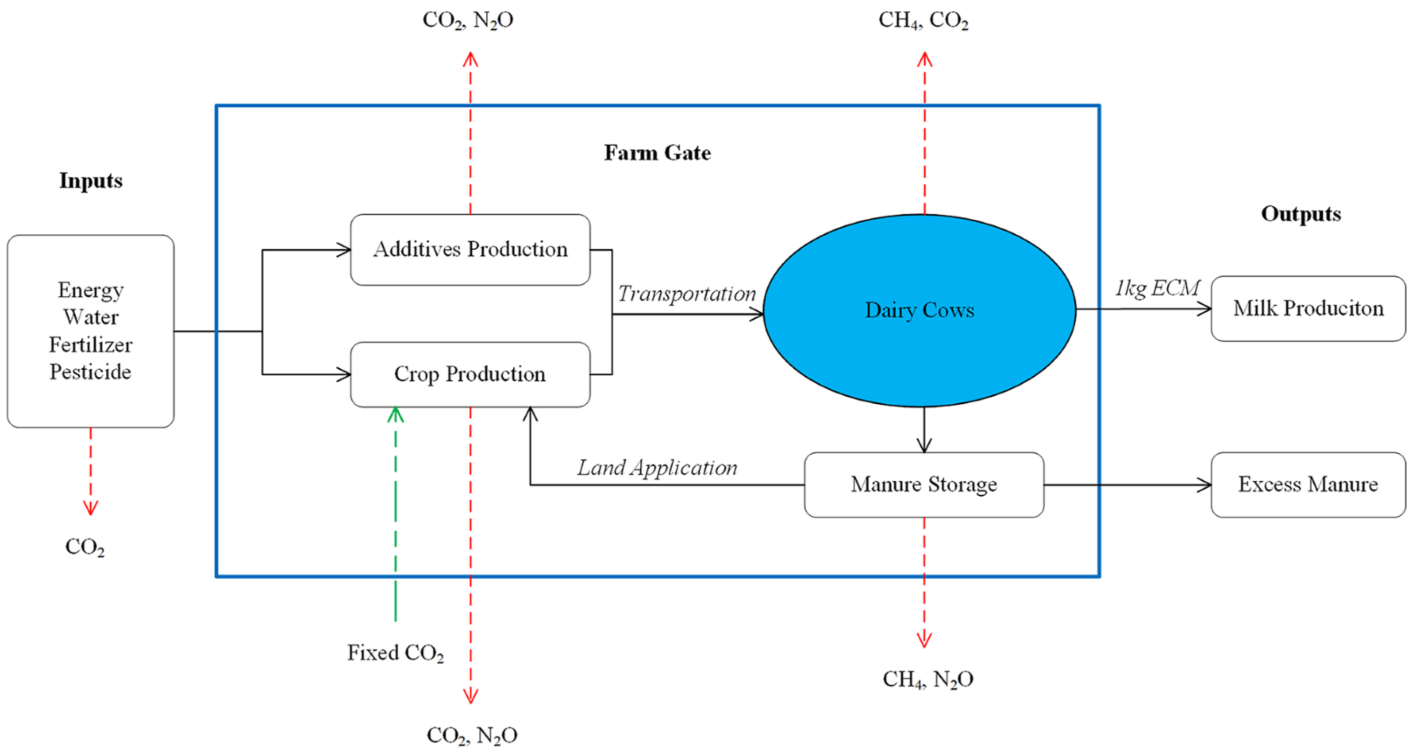
- Biogas collection and utilisation
- Manure management:
  - Cooler storage, acidification, methane inhibitors, decreased storage time, solid separation, composting and aeration, biofilters and scrubbers
- Manure incorporation and injection
- Manure application timing
- Animal nutrition strategies

Mitigation of rice methane

- Water management
- Organic amendments
- Fertiliser and other amendments
- Planting methods and crop management
- Rice breeding
- Reduced combustion of rice straw

Cross-cutting issues for methane consideration

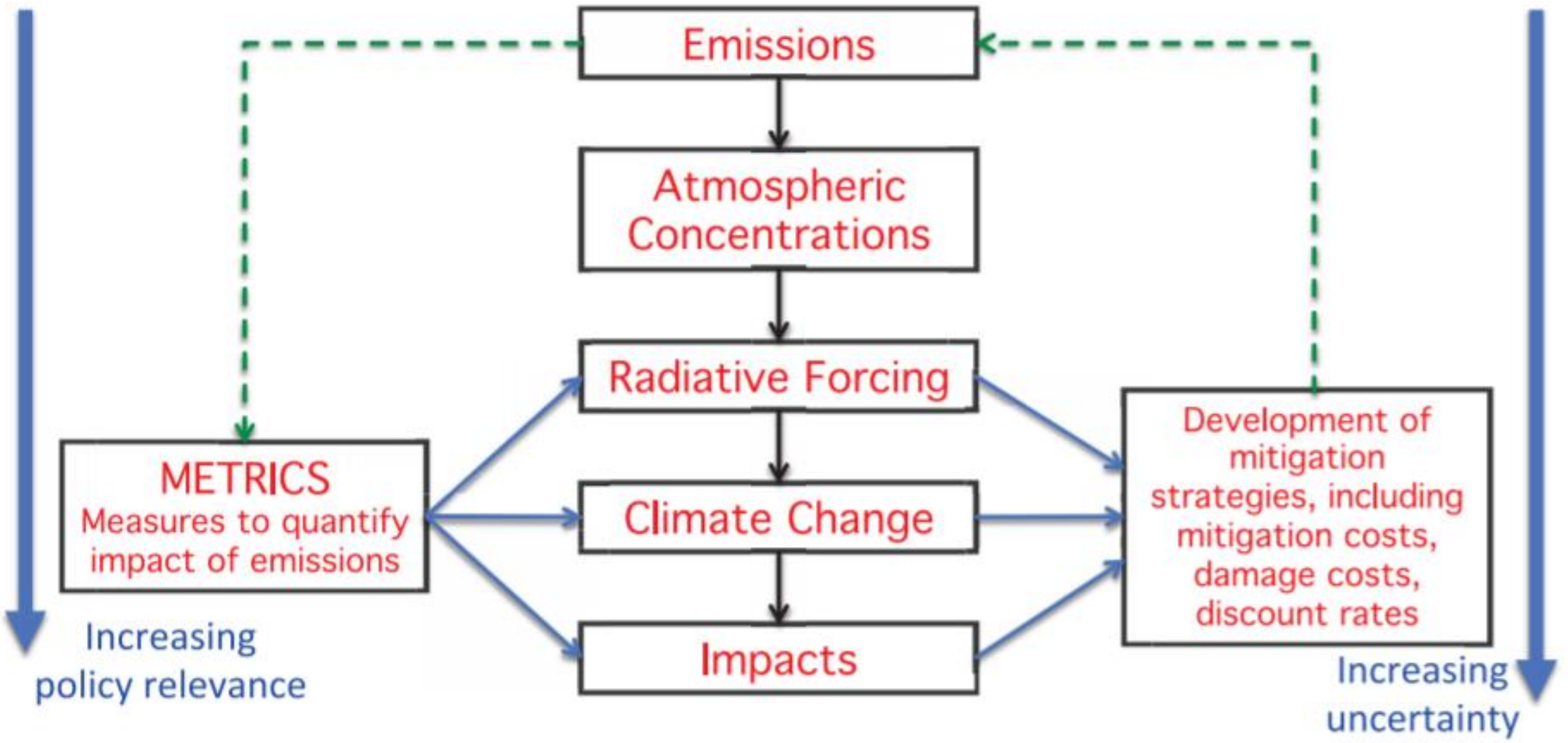
- Trade-offs (wider GHGs and other): need LCA



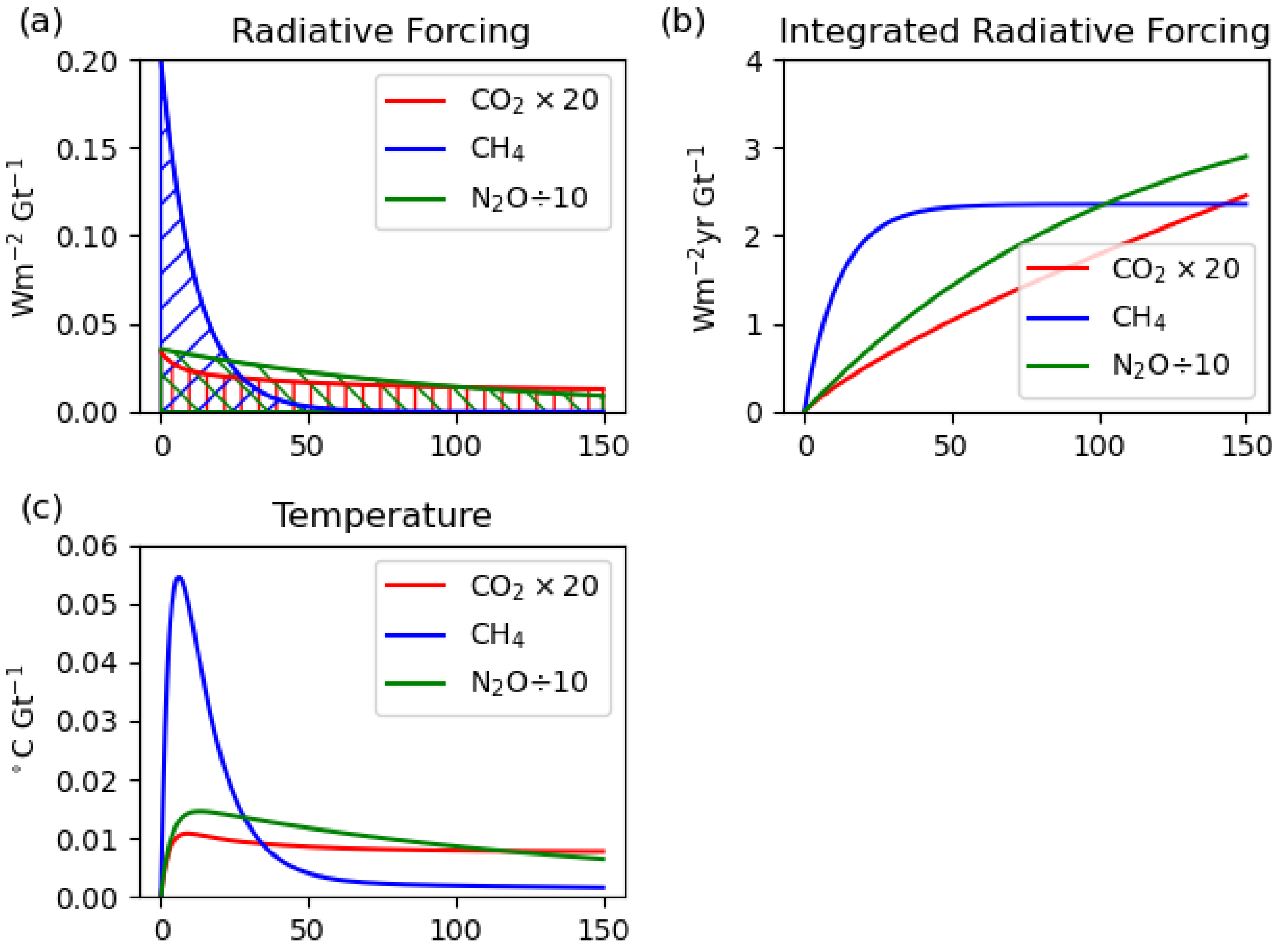
4: Metrics for quantifying the impact of methane

- Definitions and common metrics
  - GWP
  - GTP
  - GWP*
- The use of emission metrics in impact and mitigation assessments
- Climate targets and related issues

GHG emission metrics



IPCC (2013) AR5, WG1 Chapter 8


(a)
Radiative Forcing
Wm^{-2} Gt^{-1}
0.20
0.15
0.10
0.05
0.00
0
50
100
150
CO_2 × 20
CH_4
N_2O÷10
(b)
Integrated Radiative Forcing
Wm^{-2}yr Gt^{-1}
4
3
2
1
0
0
50
100
150
CO_2 × 20
CH_4
N_2O÷10
(c)
Temperature
°C Gt^{-1}
0.06
0.05
0.04
0.03
0.02
0.01
0.00
0
50
100
150
CO_2 × 20
CH_4
N_2O÷10

GHG emission metrics

- Latest IPCC metric values (6th Assessment Report, 2021)

	GWP_{20}	GWP_{100}	GTP_{20}	GTP_{100}
Fossil CH_4	82.5	29.8	54	7.5
Non-fossil CH_4	79.7	27.0	52	4.7
N_2O	273	273	297	233

New metric concepts: ‘step-pulse’

- E.g. GWP*
  - $CO_2\text{-we}(t) = GWP_{100} \times (4.53 \times CH_4(t) - 4.25 \times CH_4(t-20))$
- Also
- Combined Global Warming Potential (CGWP)
- Combined Global Temperature change Potential (CGTP)
- (Both Collins et al, 2020)

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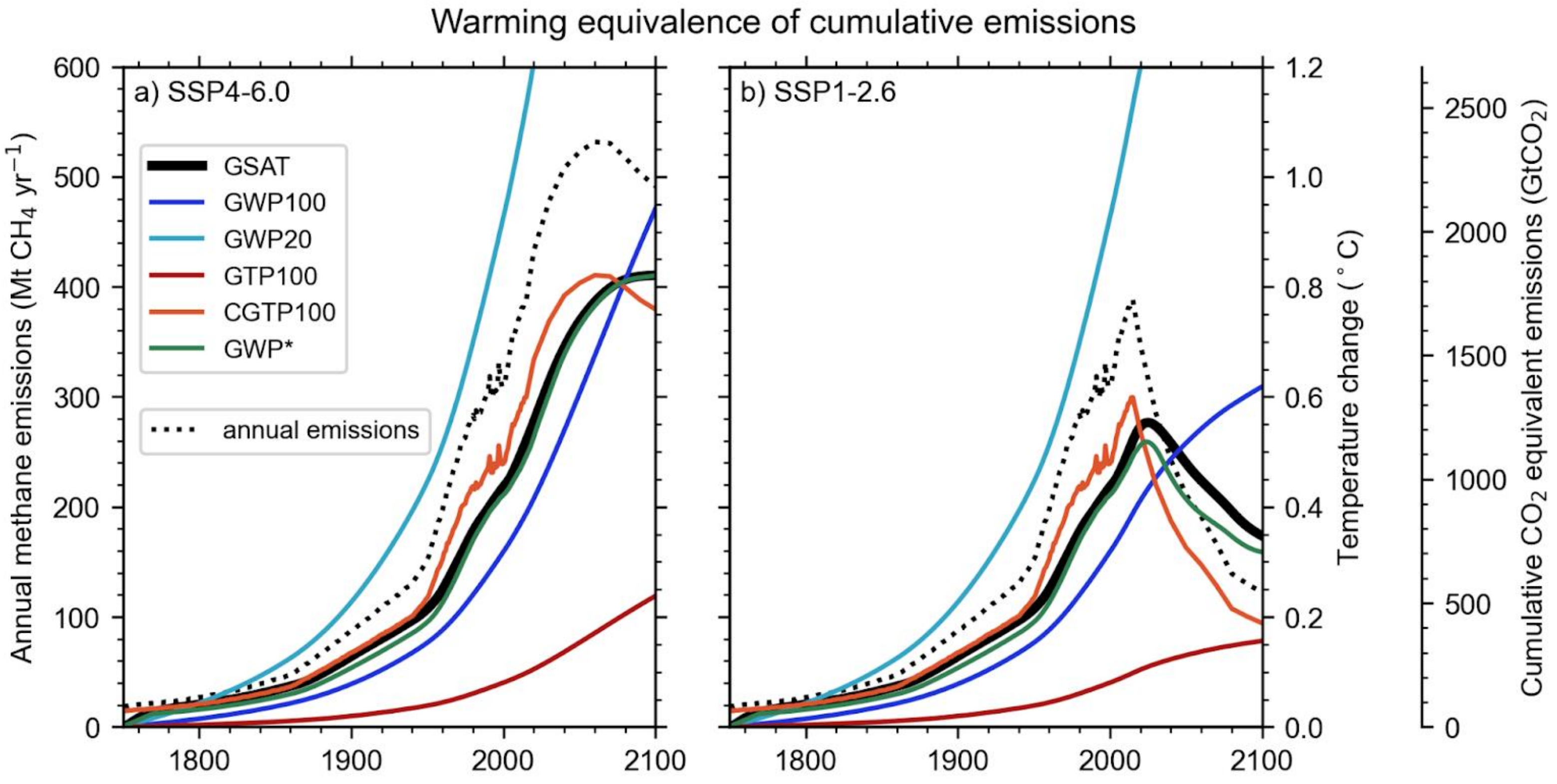
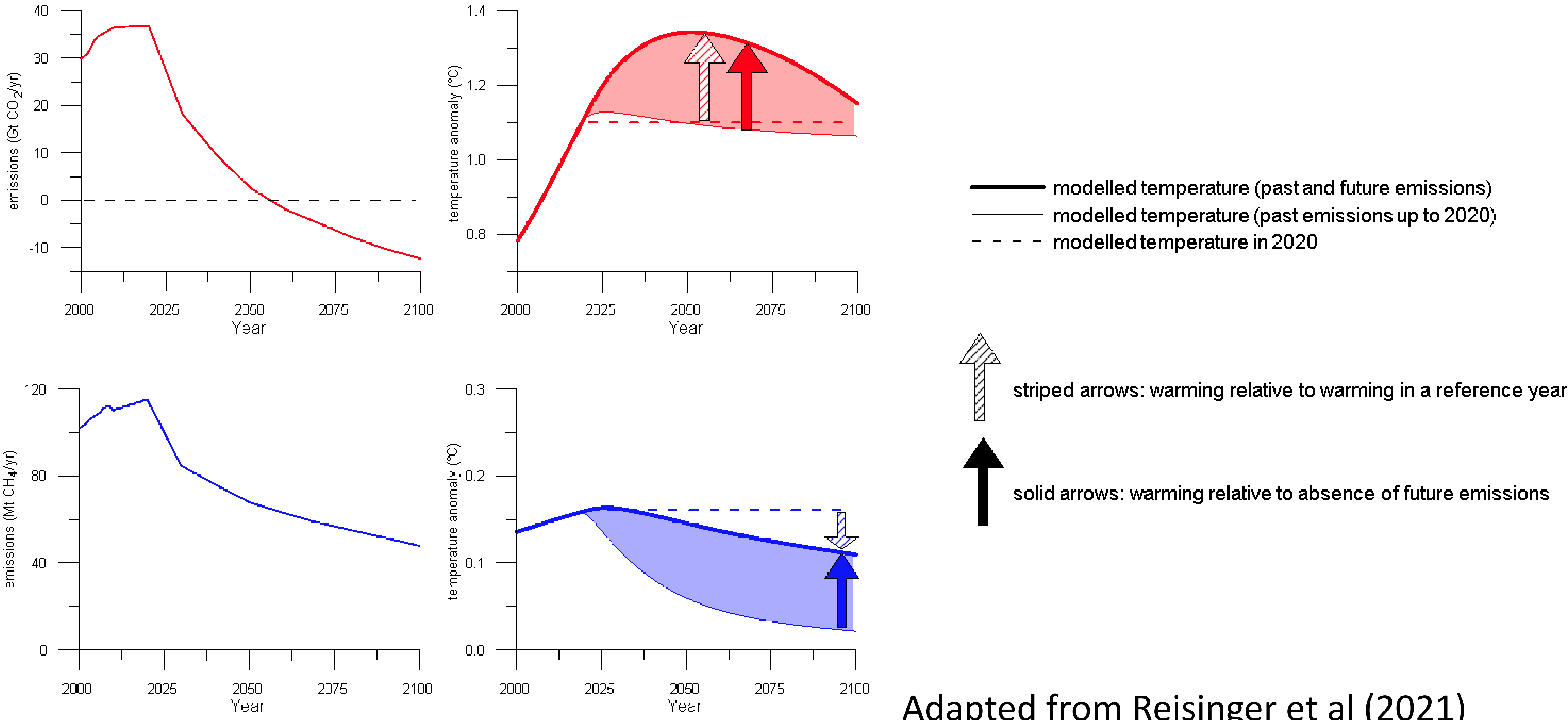
Why ‘step-pulse’ emission metrics?



IPCC (2021) AR6, WG1 Chapter 7

Different framings of emission metrics



Adapted from Reisinger et al (2021)

GHG emission metrics: challenges

- What do you want to know?
- Relative difference in emitting vs not emitting
- Relative temperature change vs a baseline
  - Present day
  - Pre-industrial
- Purpose of metrics
  - Cost-effective emission reduction
  - Social cost of present-day emissions
  - Overall temperature change contributions
  - Physical requirements to meet a global temperature target

Thank you!

Anything controversial was my own opinion..!