

Global Warming Potentials

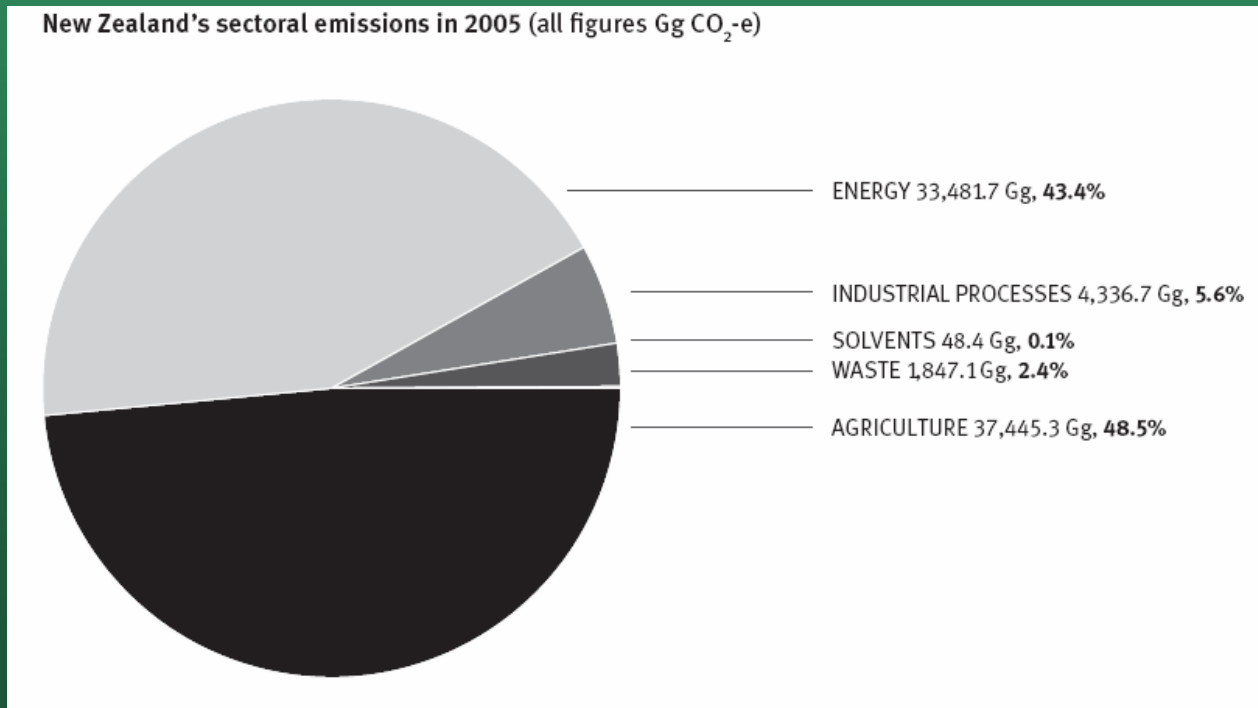
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Overview

- What is the purpose of GWPs?
- What are the alternatives?
- What are the caveats?
- What are the latest values?

Why GWPs

- To combine emissions of different GHGs on a common scale
- Implicit in the Kyoto protocol 'basket' of gases – but not in the UNFCCC



Why GWPs

- To combine emissions of different GHGs on a common scale
- Implicit in the Kyoto protocol 'basket' of gases – but not in the UNFCCC
- Fungibility (substitution) seen as enabling economic efficiency through least cost abatement options
- Decentralises the decision framework for mitigation options
- There is some use of substitution flexibility at project levels, but mainly occurs at the country level.

California Global Warming Solutions Act of 2006

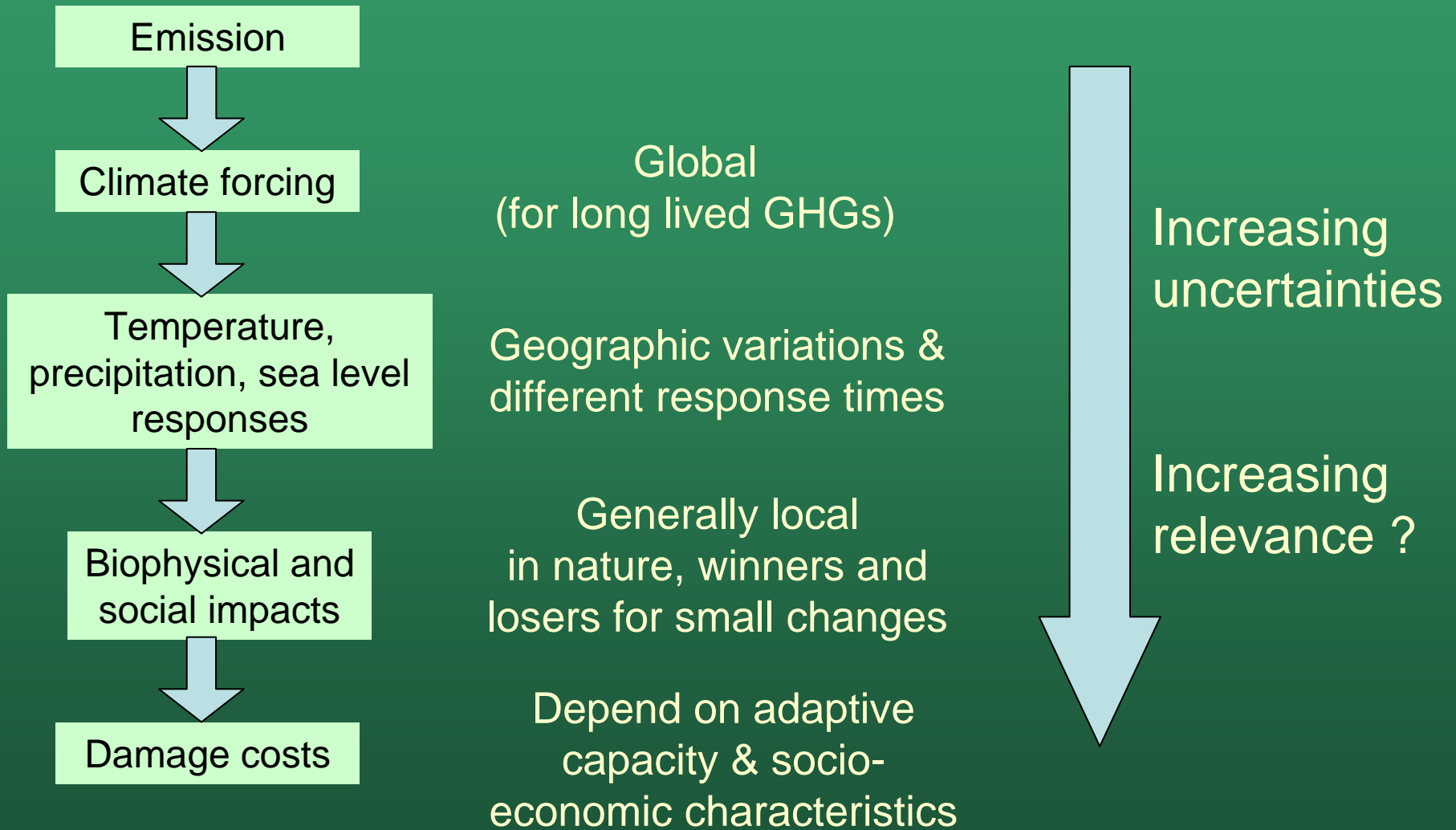
Definitions:

(c) “Carbon dioxide equivalent” means the amount of carbon dioxide by weight that would produce the same global warming impact as a given weight of another greenhouse gas, based on the best available science, including from the Intergovernmental Panel on Climate Change.

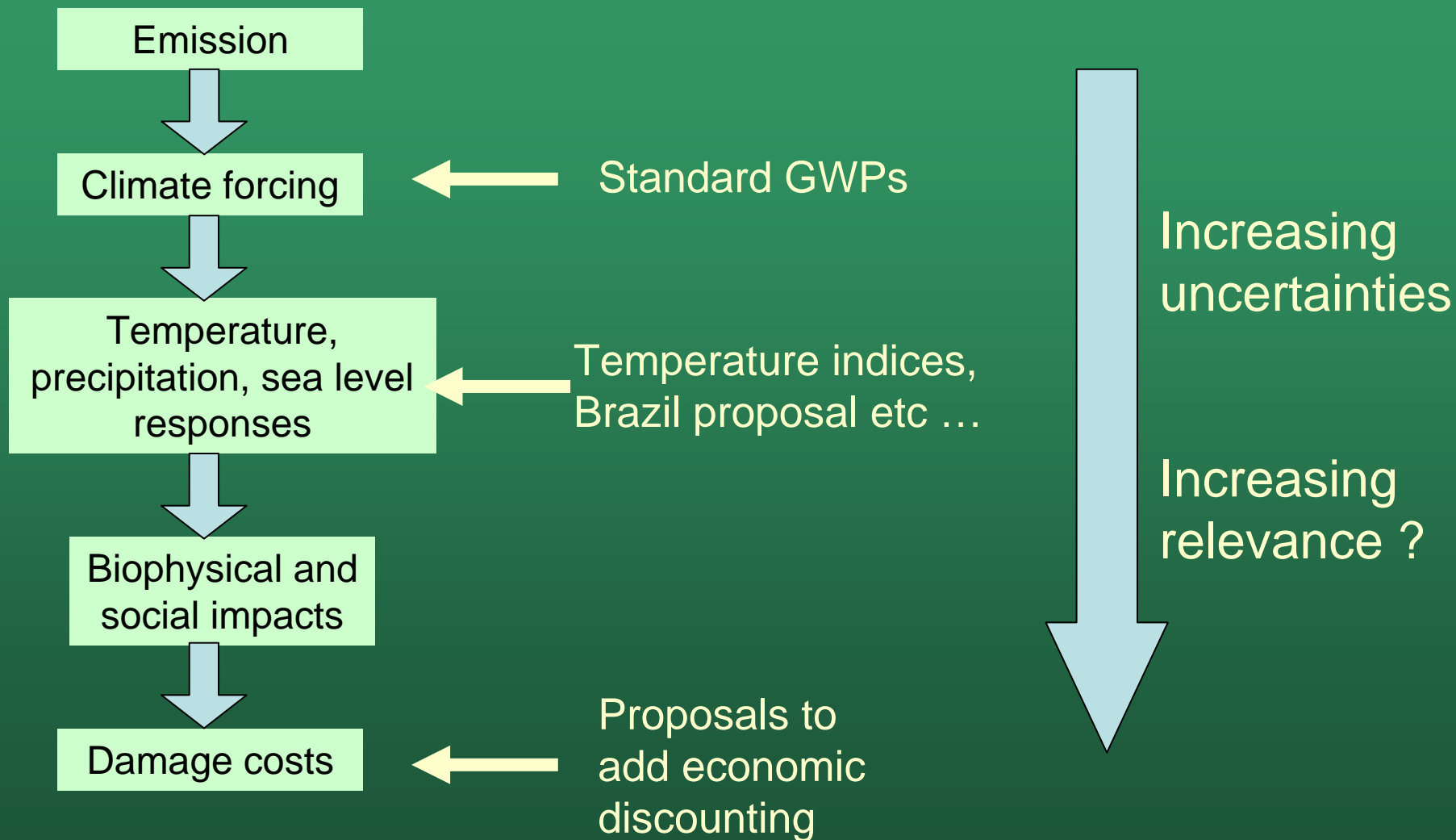
This is ambiguous and does not match IPCC definitions.

1. ‘Impact’ could be interpreted in many ways.
2. There are fundamental differences between CO₂-eq concentrations and CO₂-eq emissions. The former are straightforward, the latter depend on GWPs, requiring a choice of time horizon (not made by IPCC).

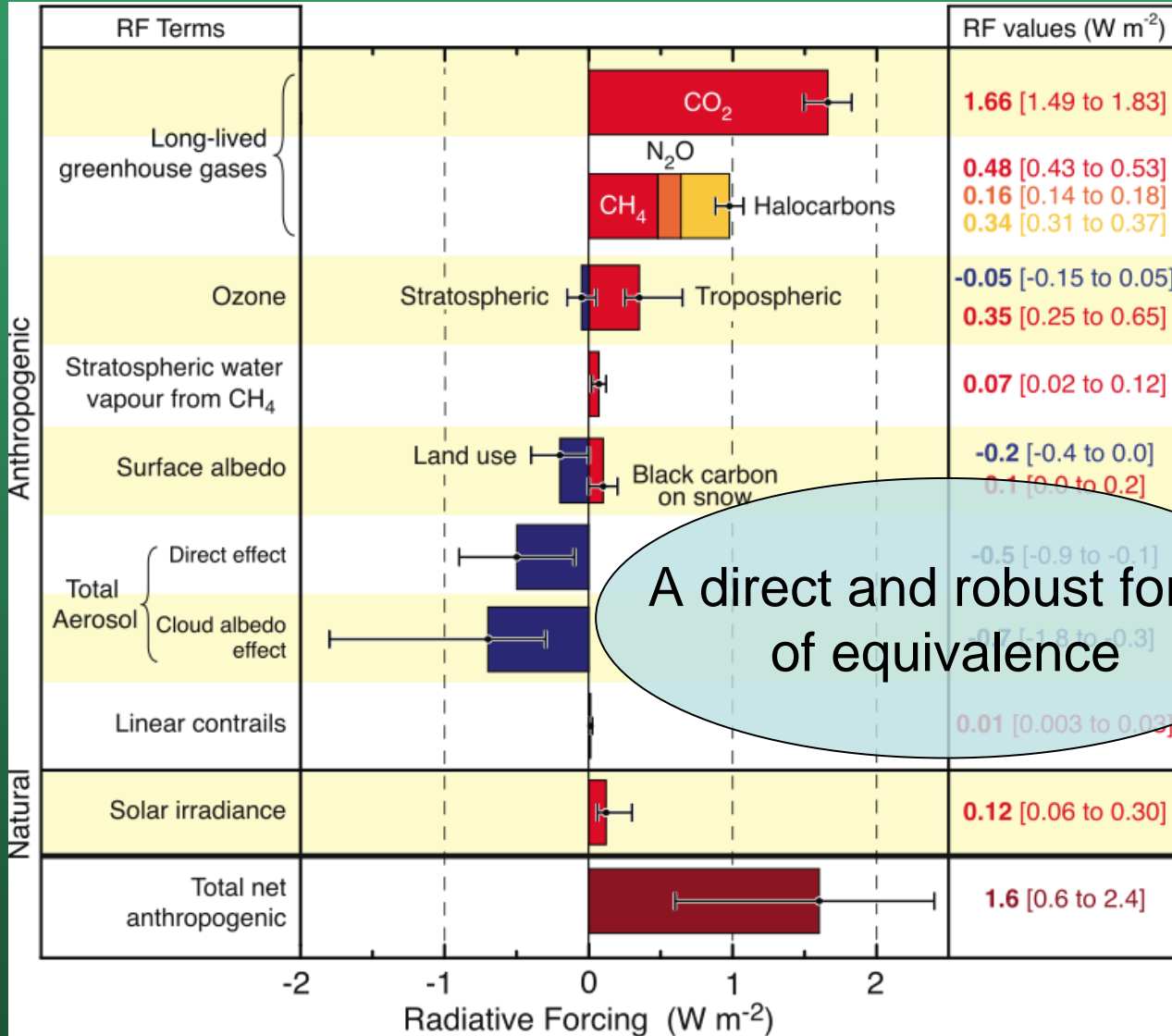
What are the alternatives



What are the alternatives



Radiative forcing



A direct and robust form of equivalence

Change in radiative energy balance at one point in time.

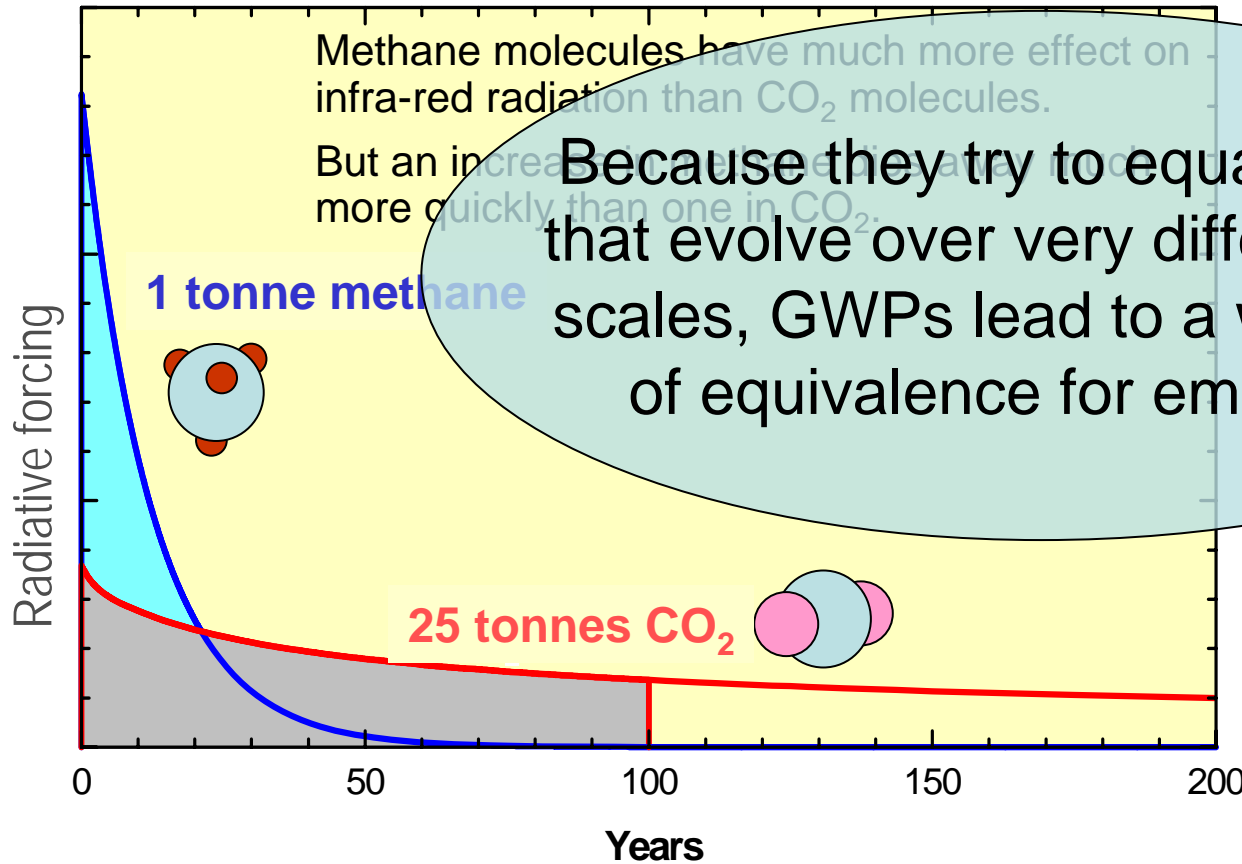
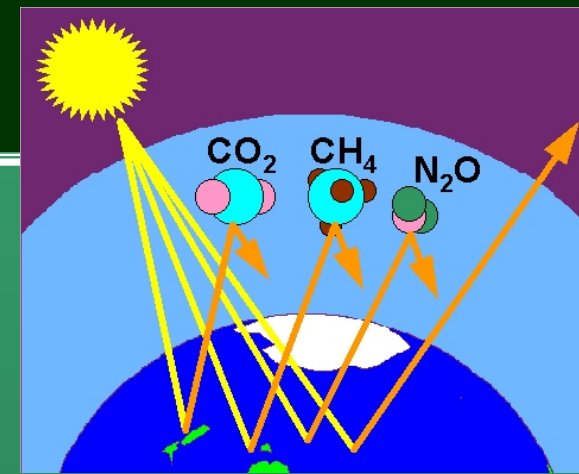
For well mixed GHGs is a simple function of gas concentration.

Determines global average warming at equilibrium.

Can be expressed as a CO₂-equivalent concentration.

Global Warming Potentials

GWPs compare the effect of emissions on radiative forcing accumulated over a chosen time horizon.

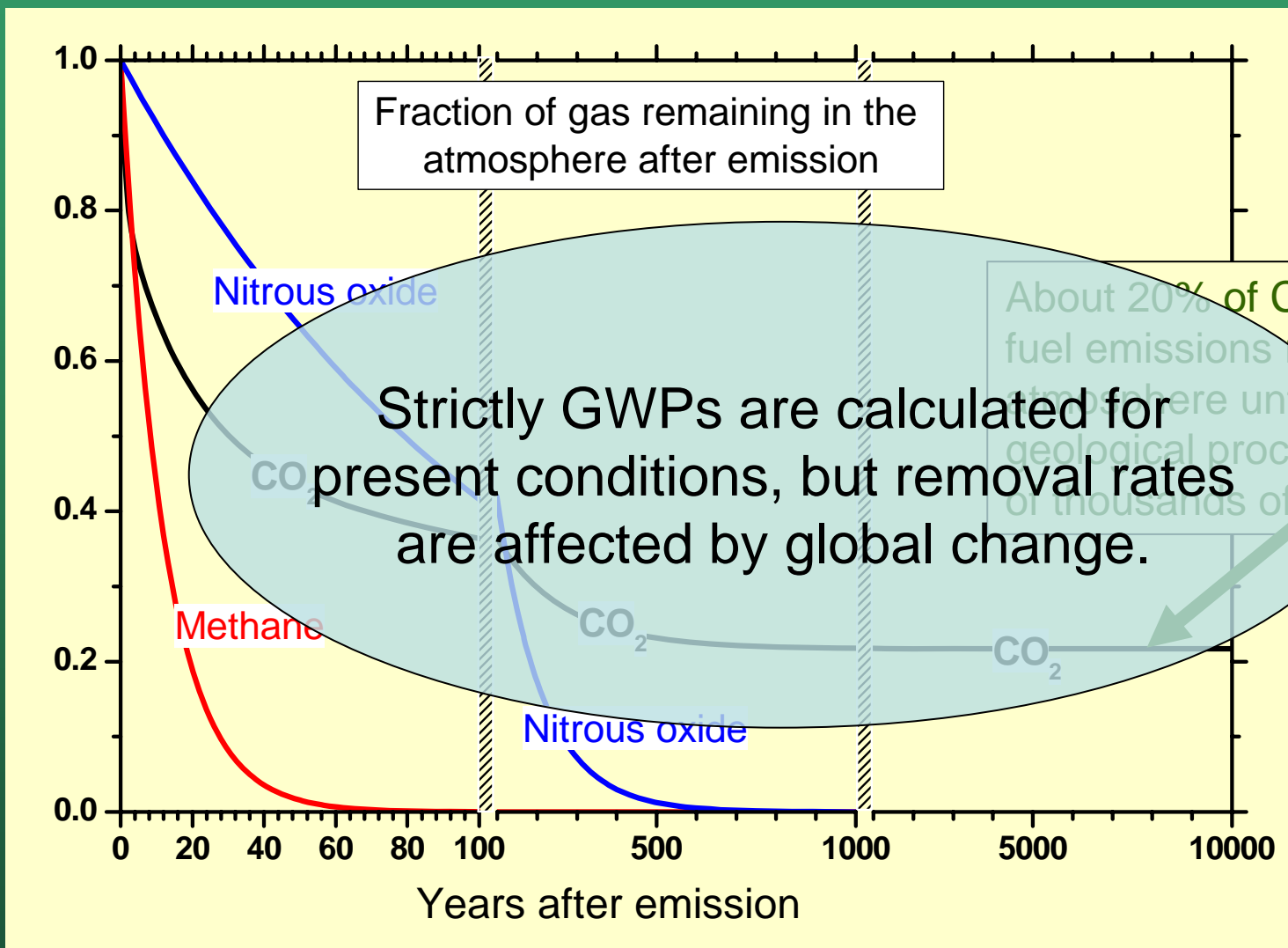


Over 100 years, 1 tonne of emitted methane causes as much accumulated RF as 25 tonnes of CO₂.

So the GWP for a 100 year time horizon is 25.

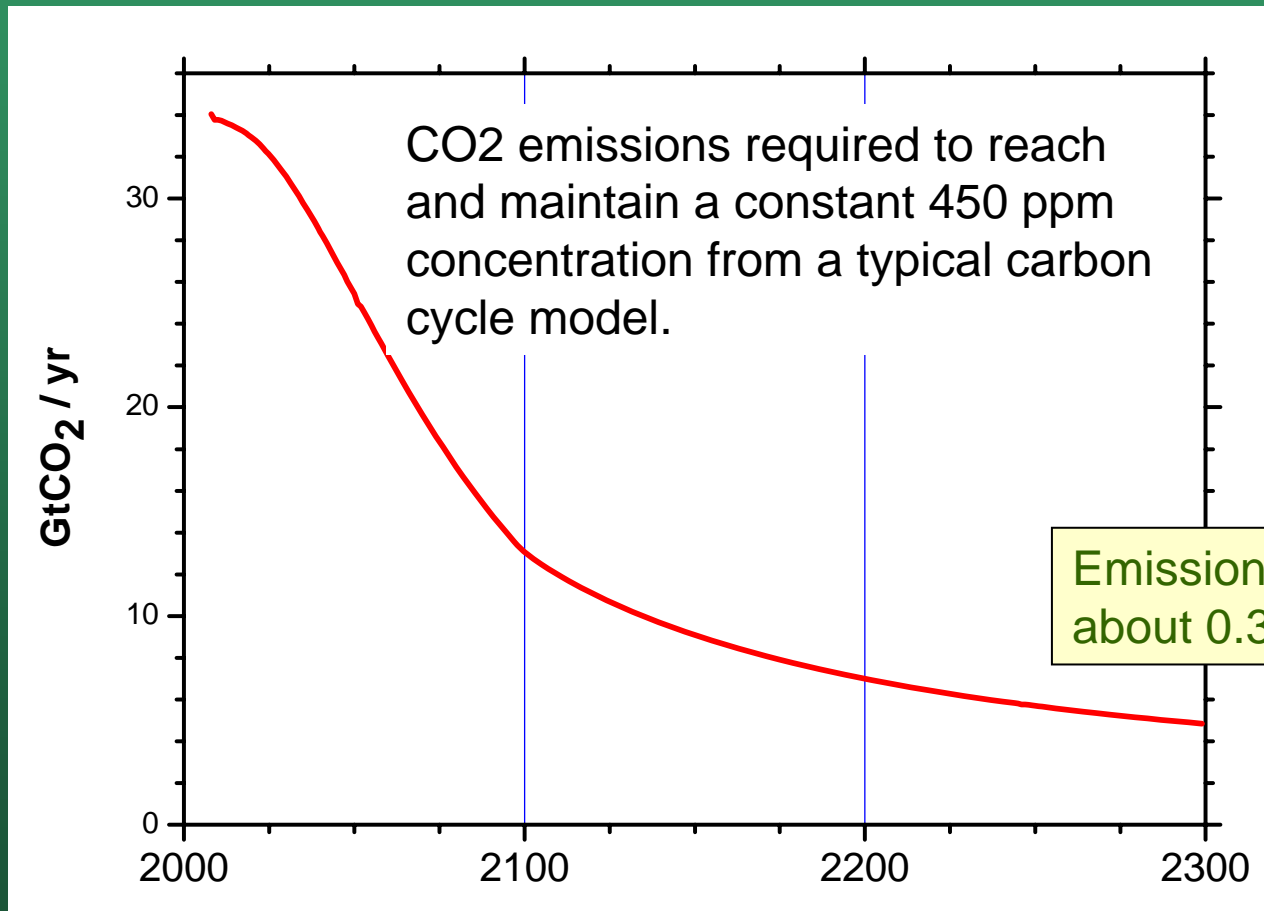
For shorter/ longer time horizons the methane GWP becomes larger/ smaller.

'Pulse Response Functions'



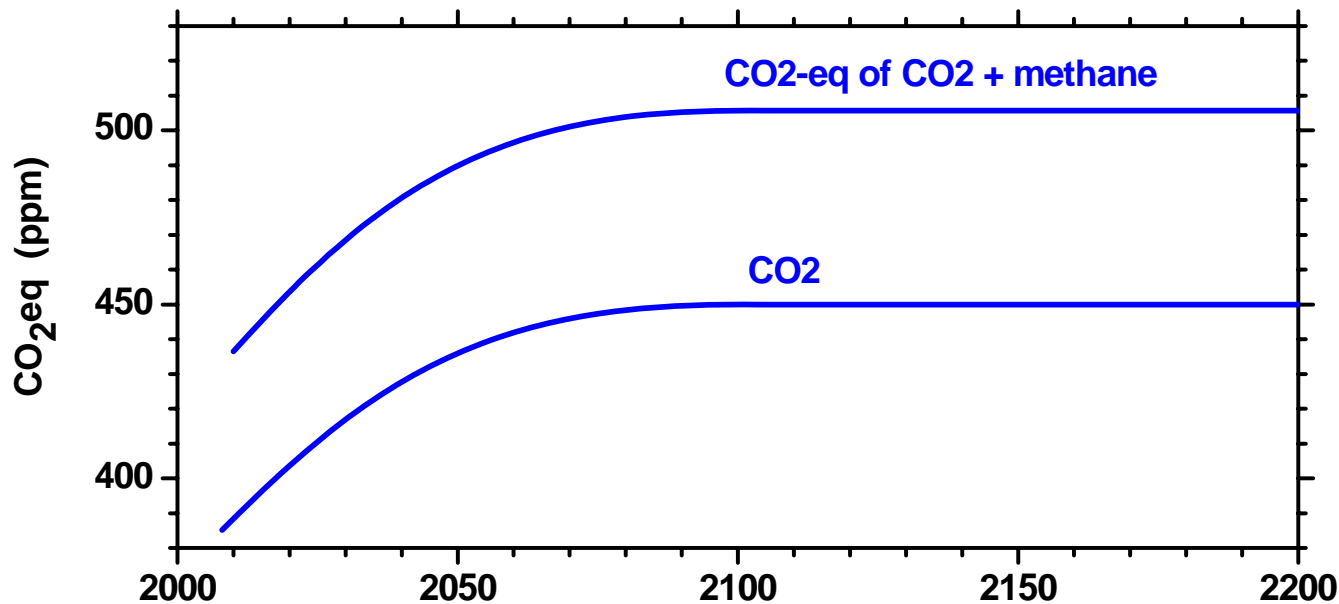
Implications for stabilisation

For other GHGs, stable concentrations (and radiative forcing) can be achieved with stable emissions, but for CO₂, a stable concentration requires emissions to decline steadily to zero over time.



Emissions eventually decline at about 0.3% per annum FOR EVER.

GWPs and the path to stabilisation?

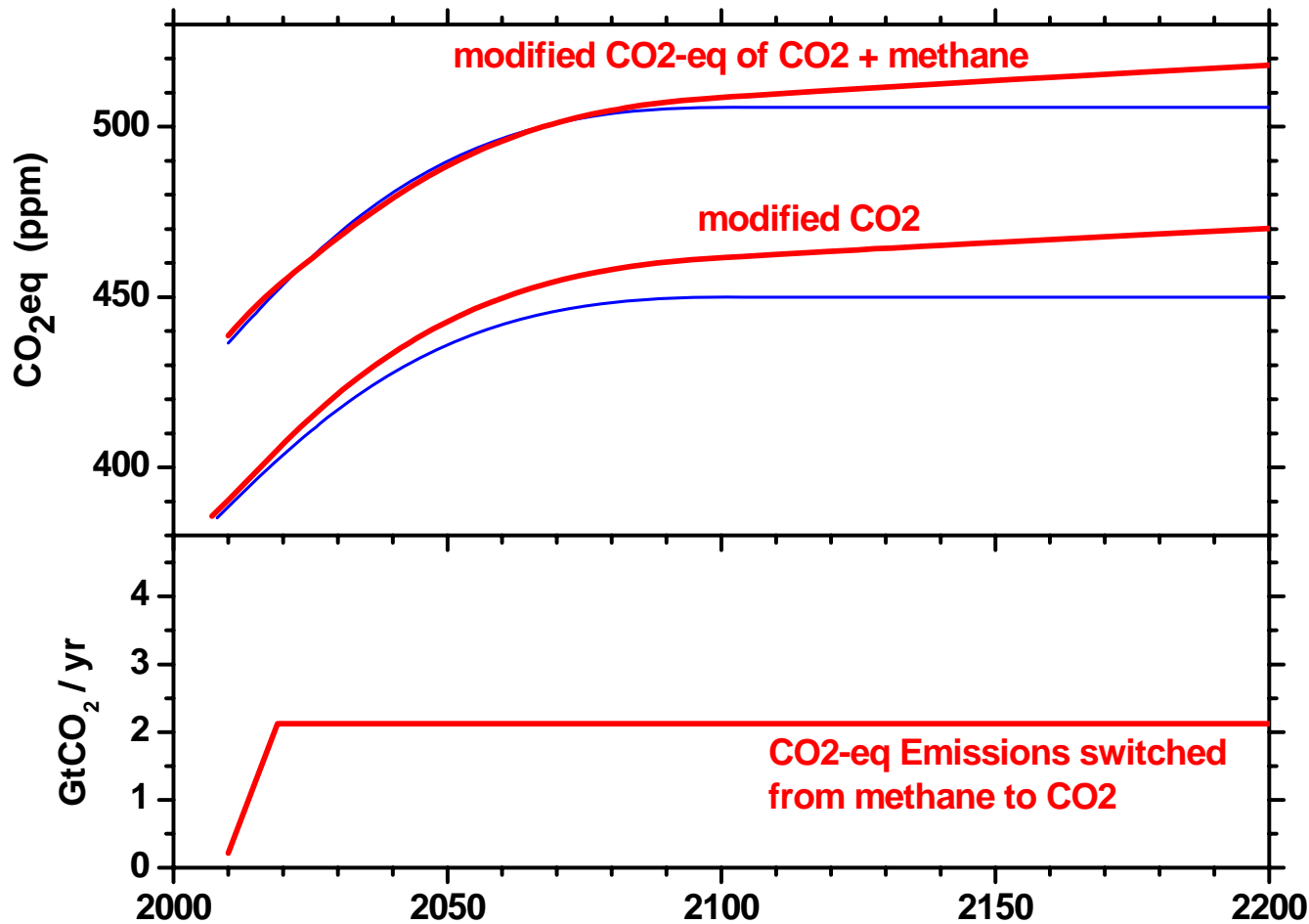


Case study:

Substitute 20% of anthropogenic methane with CO₂ over the period 2010 – 2020.

How does this affect a radiative forcing stabilisation pathway?

GWPs and the path to stabilisation?

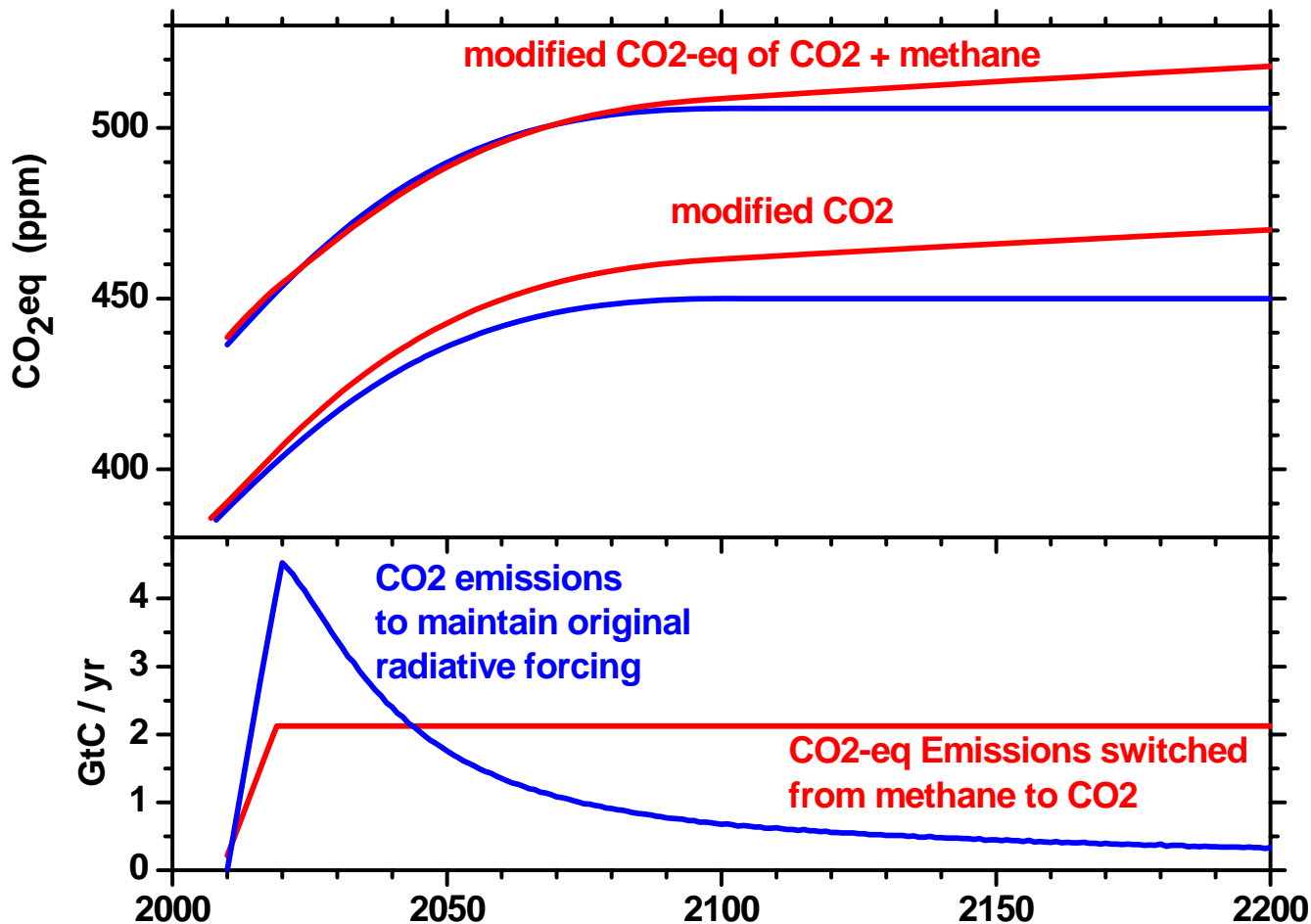


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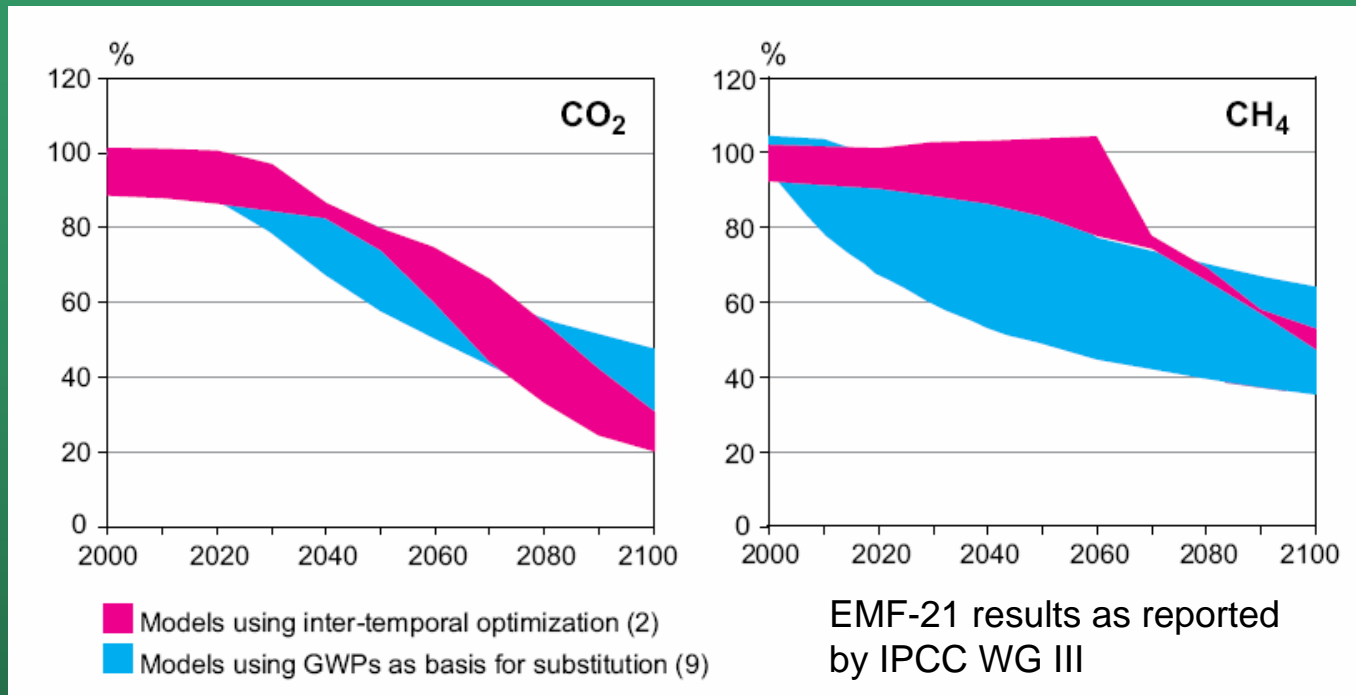


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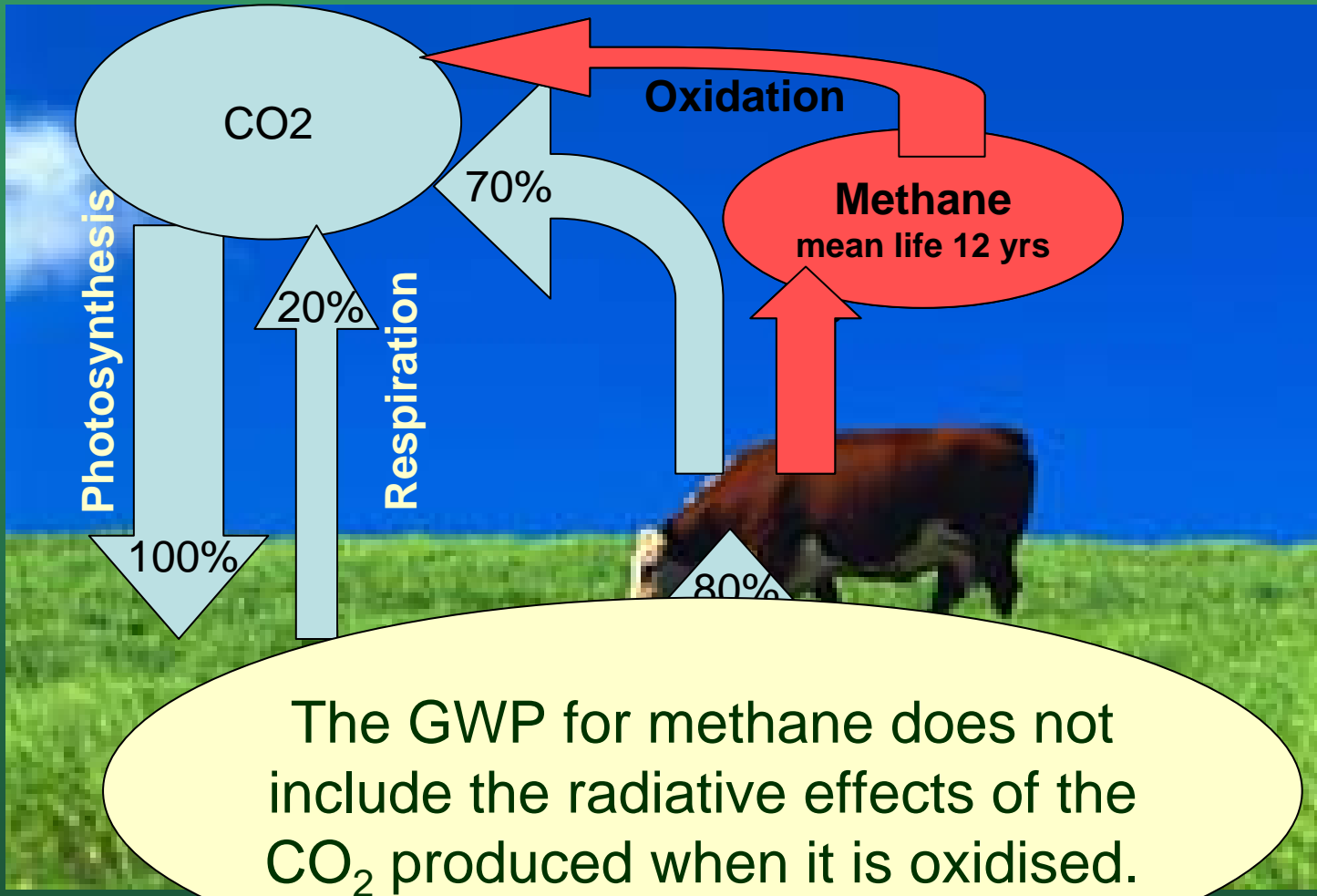
Integrated modelling



GWPs do not necessarily lead to the most cost-effective ways of reaching long term climate targets.

Multi-gas models with stabilisation at ~650 ppm CO₂-eq, show that substitution based on GWPs and marginal abatement cost lead to earlier reductions in methane than strictly necessary to hit a long term climate target. This increases the accumulated costs.

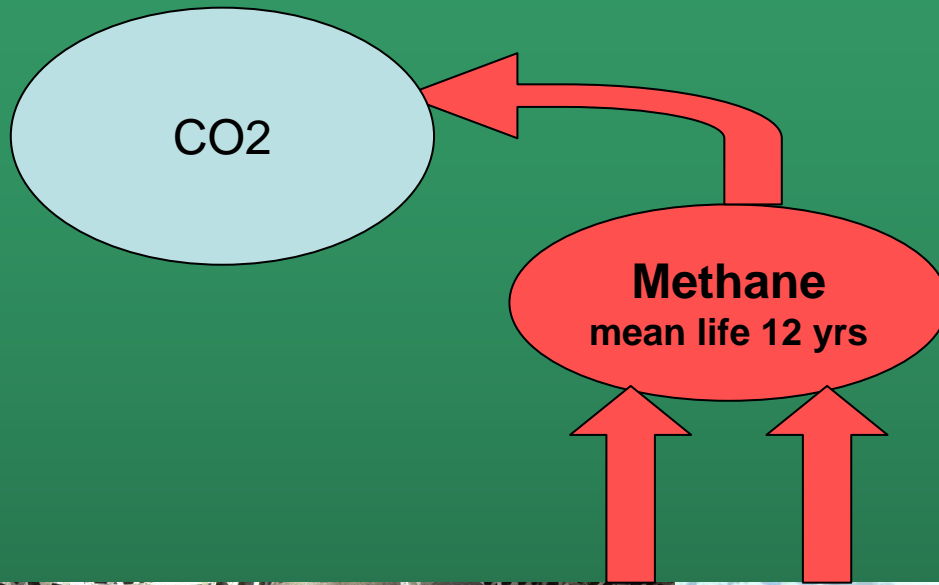
Biogenic vs Fossil methane?



Biogenic methane comes from carbon that was recently atmospheric CO₂

It modifies the cycling of carbon but does not lead to a net increase in CO₂

Biogenic vs Fossil methane?

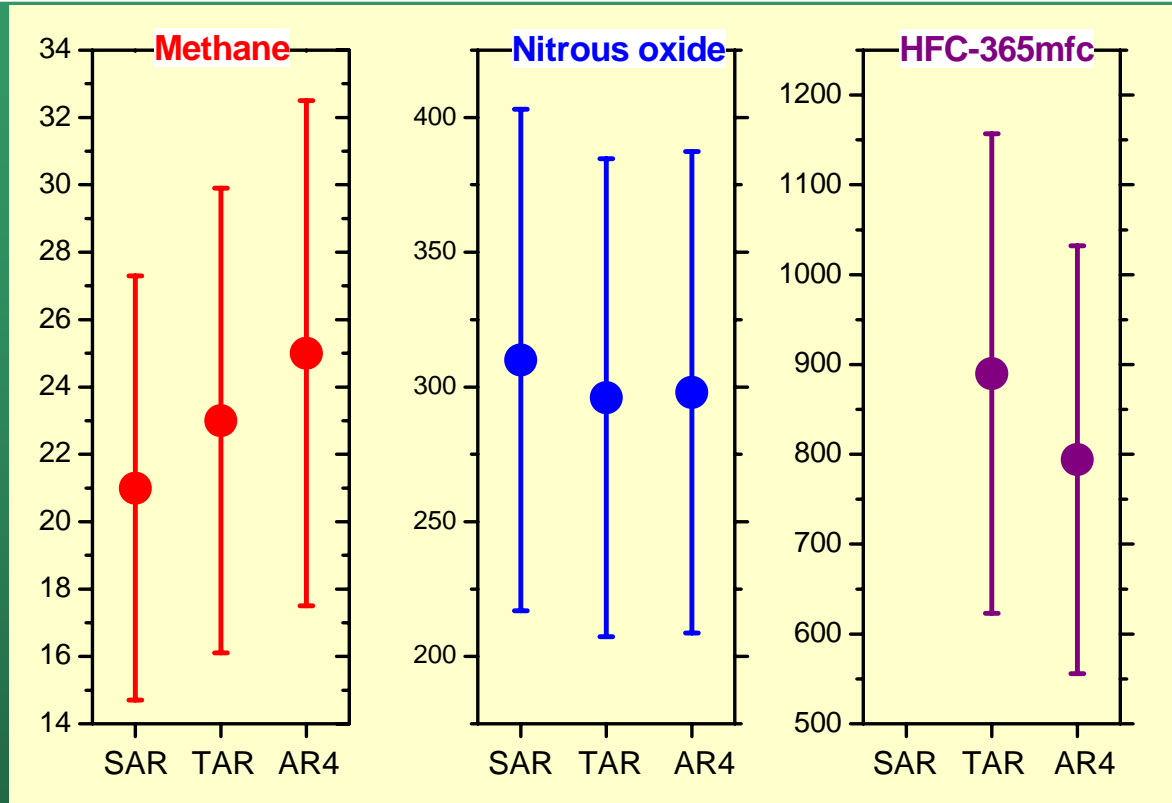


Fossil fuel derived methane does lead to a net increase in CO₂.

15 – 20% of anthropogenic methane comes from fossil carbon.

The GWP for methane does not include the radiative effects of the CO₂ produced when it is oxidised.

Revisions to GWPs



From Second to Third Assessment: Main revisions due to new estimates of CO₂ removal.

From Third to Fourth Assessment: Main revisions due to indirect effect of methane on stratospheric water vapor, and new information on radiative properties of more exotic gases.

Summary

- Climate scientists and economists continue to have concerns about the GWP concept – but as yet have no alternative
- The GWP time horizon is a critical policy choice – but masks inherent differences in the timing of future effects
- Expect further science revisions to GWPs
- Normalising to CO₂ transfers carbon cycle uncertainties to the non-CO₂ GHGs
- Use of 100-yr GWPs to plan pathways to stabilisation this century seems reasonably reliable
- Don't use GWPs to establish long-term commitments that extend beyond their time horizon.