Methane impacts in global warming

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Understanding the role of methane in climate change policy

- Methane is a major contributor to the current global energy imbalance (1/3-1/2 the impact of CO$_2$).
- Immediate cuts in methane emissions could have as great an impact on temperatures over the next few decades as similar (more expensive) cuts in CO$_2$.
- But, immediate cuts in methane emissions have little impact on peak warming unless CO$_2$ emissions are cut at the same time.
- So priorities depend on policy goals:
  - To limit warming over next 20-40 years, prioritize methane.
  - To limit peak warming, prioritize CO$_2$. 
“Cumulative emissions of carbon dioxide largely determine global mean surface warming by the late 21st century…"
“All current greenhouse gas emissions [...] affect the rate and magnitude of climate change over the next few decades”

Impact of 2011 emissions on future temperatures:

Current emissions of short-lived climate pollutants (methane and soot) mostly affect climate to mid-century
Why this matters for mitigation priorities

**CO₂ emission scenarios**

- **High emissions**
- **Ambitious mitigation**
- **Delayed mitigation**

- **Year**
  - 2020
  - 2040
  - 2060
  - 2080
  - 2100

- **Billion tonnes per year (GtCO₂/yr)**
  - 0
  - 20
  - 40
  - 60
  - 80
Impact of immediate SLCP (methane and soot) mitigation

Impact of CO\textsubscript{2} and SLCP cuts

- No emission cuts
- SLCP only
- CO\textsubscript{2} only
- CO\textsubscript{2} & SLCP cuts

Period of SLCP cuts

Year

2020 2040 2060 2080 2100

Warming (°C)

1.0 1.5 2.0 2.5
Impact of delayed SLCP mitigation

Impact of delayed emission cuts

Both delayed

Delayed CO₂

Delayed SLCP

Both early

Delayed cuts

Early cuts

Year

Warming (°C)

2020 2040 2060 2080 2100
So what is the right “metric” to use to relate methane emissions to CO$_2$?
The metric problem: relative importance depends on what you look at and the choice of time horizon.
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Impact of a one-billion-tonne injection

Global energy imbalance (W/m²)

Years after time of emission

Carbon dioxide
Methane
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![Graph showing methane metric value over time horizon]
The metric problem: relative importance depends on what you look at and the choice of time horizon

Impact of “equivalent” emissions (in terms of GWP$_{100}$):

- a) 38GtCO$_2$-e pulse emissions

![Graph showing global temperature change (°C) over years after time of emission for different greenhouse gases, including Black Carbon, Methane, HFC-152a, HFC-134a, Nitrous Oxide, and CO$_2$. The graph illustrates the differing contributions and impacts of these emissions over time.]
So what can we say about what methane emissions are worth?
Comparing the impacts of one-off CO\textsubscript{2} emissions and *permanent* changes in methane emission rates

Comparing the impacts of a pulse emission of CO\textsubscript{2} with equivalent (GWP\textsubscript{100}) SLCP emissions spread out over 100-year time horizon.
How to compare methane and CO$_2$ emissions

"Equivalent" mitigation options

- a) Carbon dioxide ✓
- b) Carbon dioxide ✓
- c) Methane ✓
- d) Methane ✗
Implications

- $\text{GWP}_{100}$ measures relative impact on temperatures 20-40 years after emission.
- Comparing one-off methane and $\text{CO}_2$ emissions using $\text{GWP}_{100}$ overstates the importance of methane for peak warming unless temperatures are expected to stabilize by mid-century – for which net $\text{CO}_2$ emissions need to be approaching zero.
- Options:
  - Don’t worry about methane emissions until $\text{CO}_2$ emissions are falling fast enough to predict the time to peak warming.
  - Only attempt to equate a temporary delay in $\text{CO}_2$ reductions with a permanent, sustained methane reduction.
Beware the Faustian bargain

24 years of low-cost climate mitigation...

So I can stop worrying about my carbon footprint?