Cumulative carbon emissions and their implications

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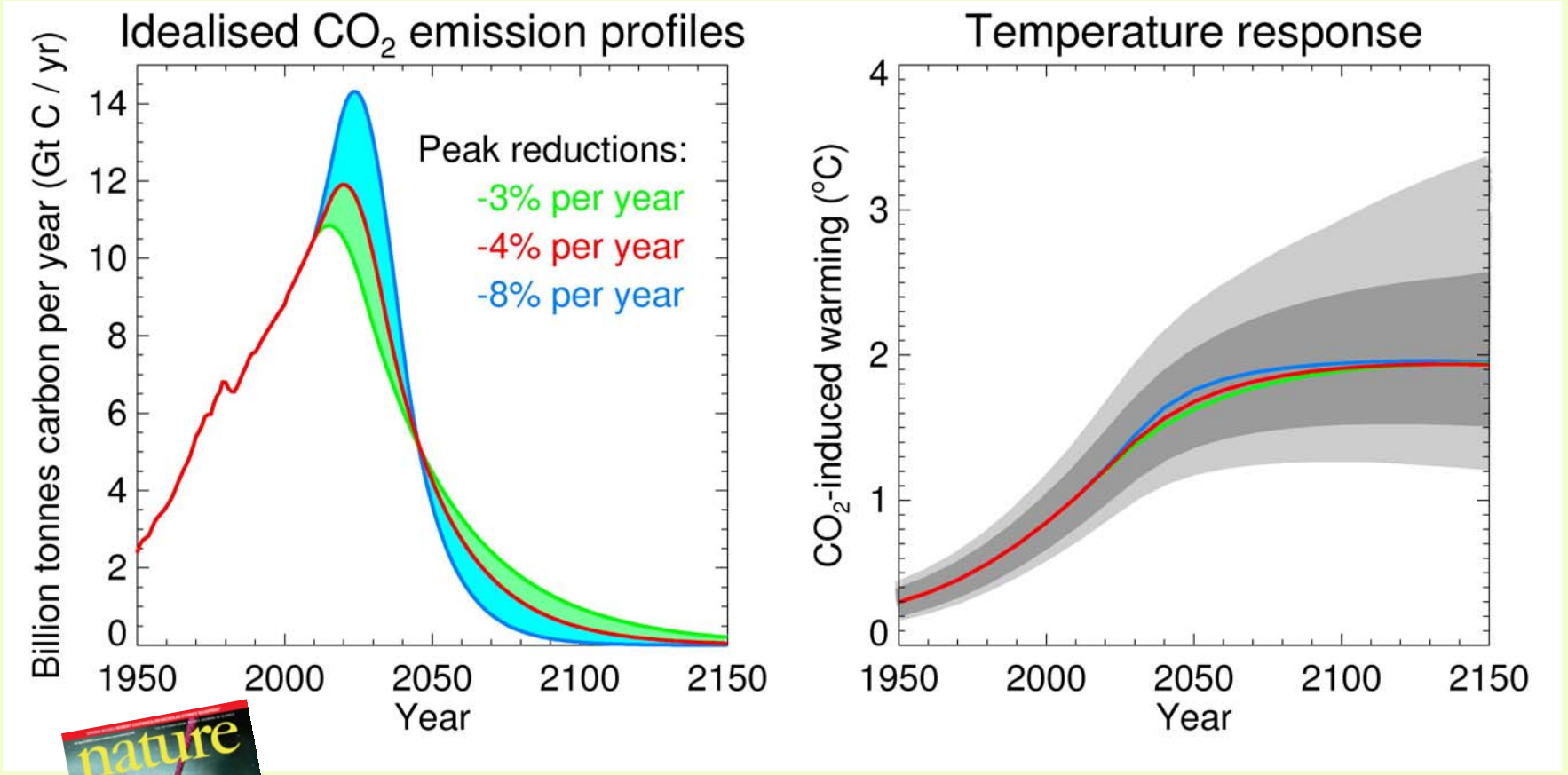
Key science message and policy implications

- **To avoid dangerous climate change, we need to limit the total amount of CO_2 released into the atmosphere: to a total that is substantially less than fossil carbon reserves.**
  - **Long-term vision must address the fate of fossil carbon that cannot be released into the atmosphere: measures to slow emission rate by 20% or 50% can buy time, but we also need a plan to reduce emissions to zero.**
  - **Emissions of short-lived agents only affect peak warming under conditions in which CO_2 emissions are already falling rapidly or close to zero.**

Cumulative emissions of carbon dioxide are the principal determinant of dangerous climate change



From Allen et al, *Nature*, 2009
& see also Meinshausen et al, *Nature*, 2009
& Solomon et al, *PNAS*, 2009

trillionthtonne.org

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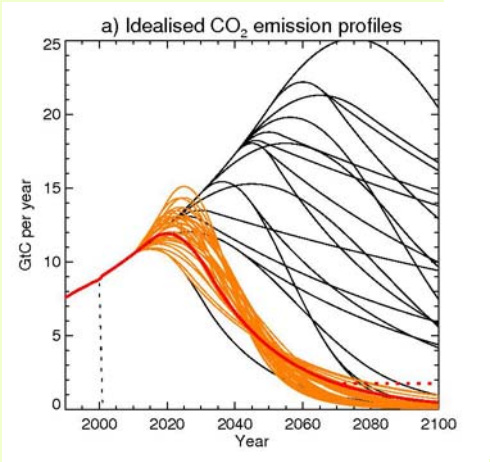
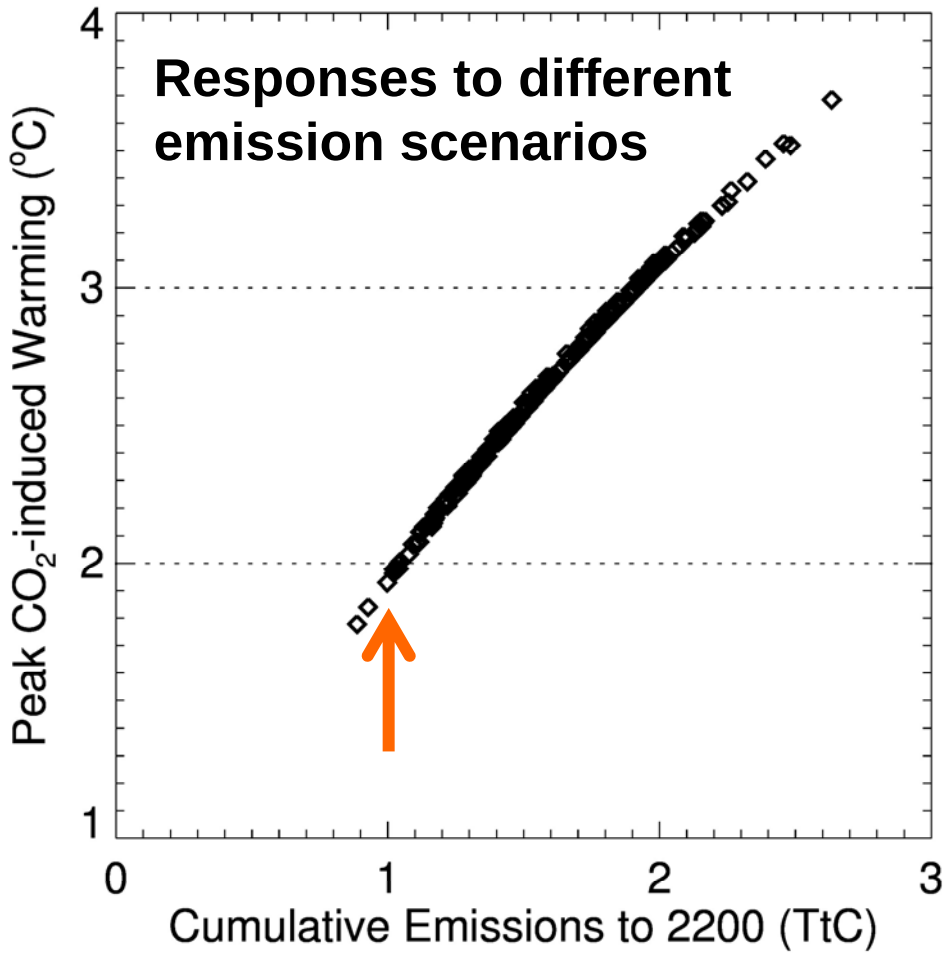
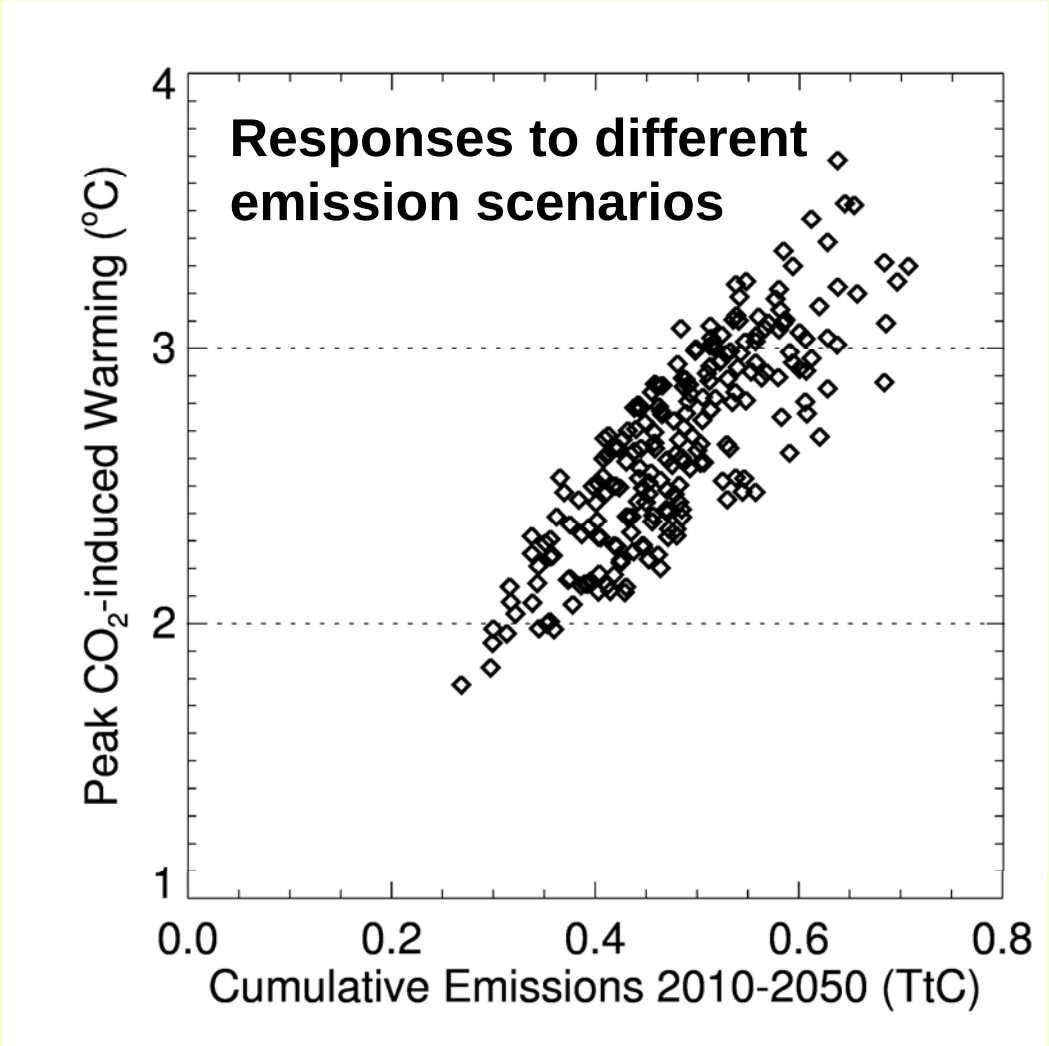
Most likely peak warming is strongly determined by cumulative CO_2 emissions to 2200





1 TtC total = 3.7 $TtCO_2$ gives about 2°C (1.6-2.6°C) of CO_2-induced warming.

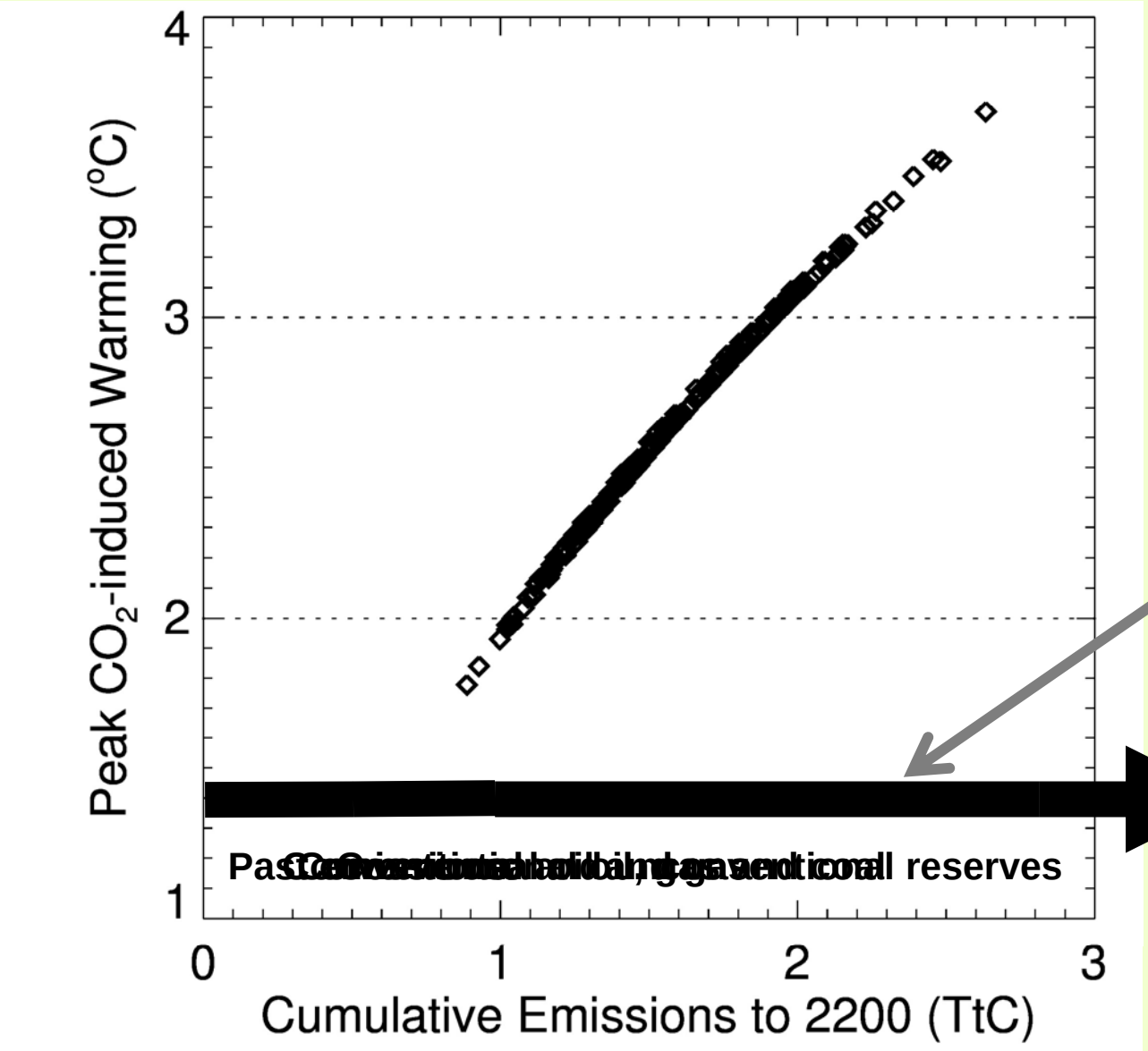
Most likely peak warming is only weakly determined by the CO_2 budget 2010-2050



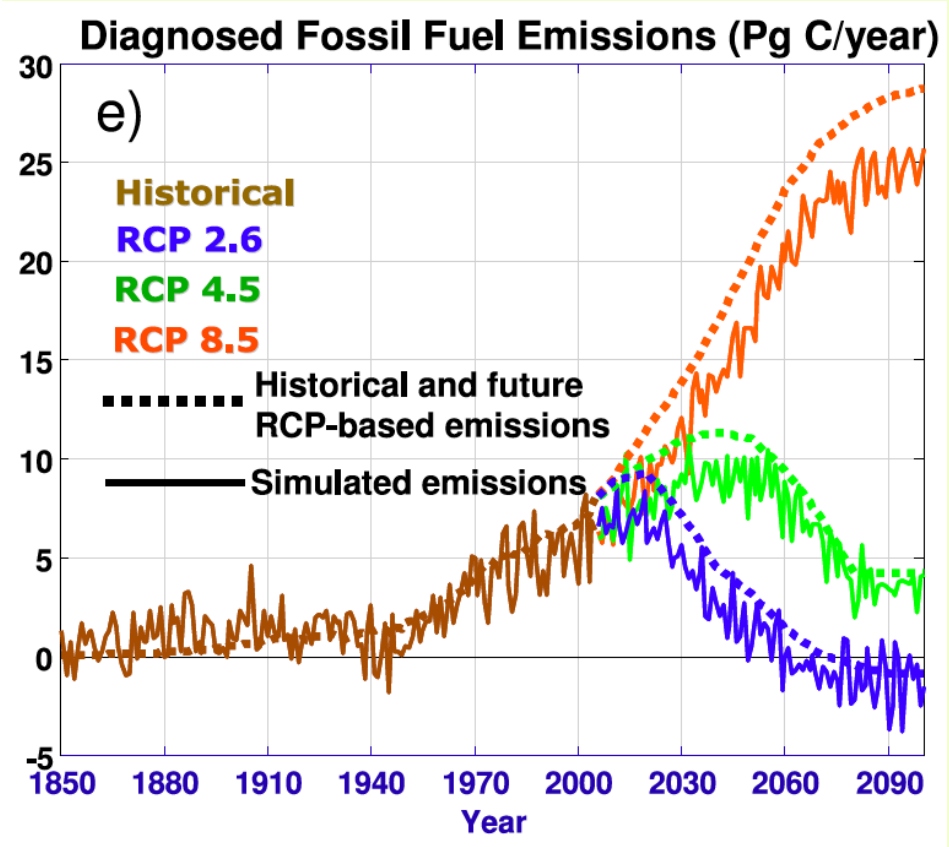
Does it matter? Who cares what happens after 2050?

- "If governments are serious … they will find ways to keep emissions within "safe" bounds. If they are not serious, it doesn't matter how you slice up the problem - it won't be solved." Richard Black, BBC
- Cumulative limits matter for:
  - How we cut carbon emissions: the technologies we need to cut by 20 or 50% may not help cut emissions to zero.
  - How we balance effort on CO_2 with effort on short-lived climate forcing agents.
- If we want to avoid dangerous climate change, we have only two options for the 2nd trillion tonnes:
  - Ban it: prevent that fossil carbon being used at all, ever.
  - Bury it: accept it will be used & sequester the resulting CO_2.

How “atmospheric space” relates to fossil fuel reserves

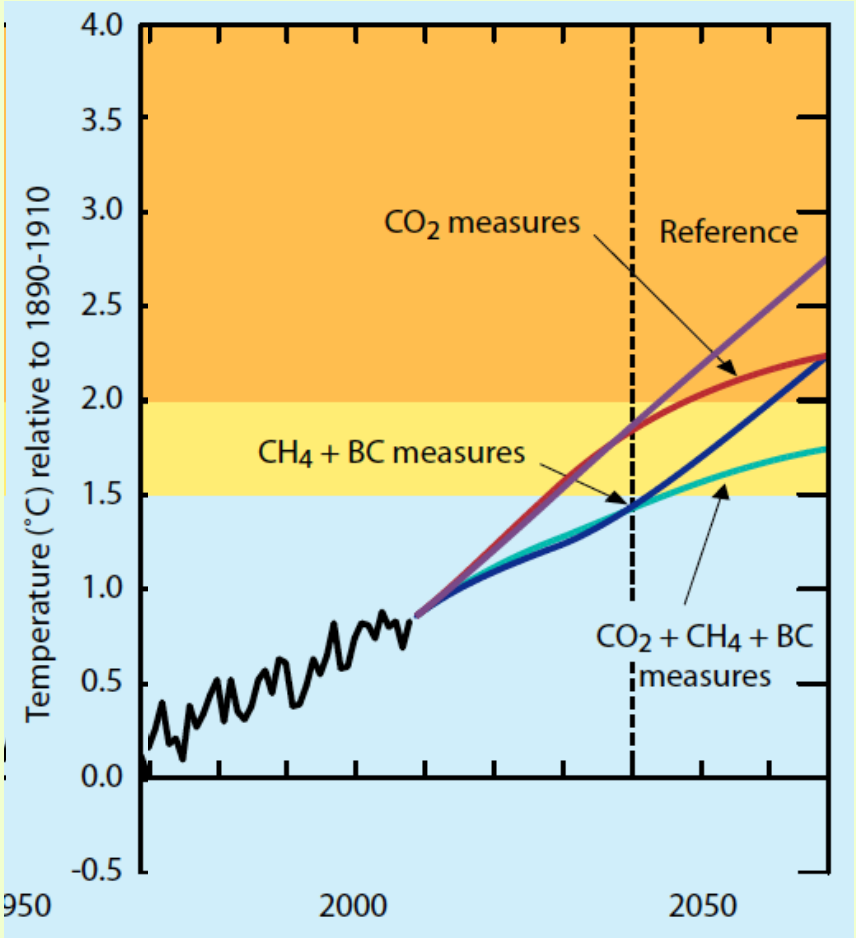


Complex ESMs including non-CO_2 forcing suggest an even smaller CO_2 budget



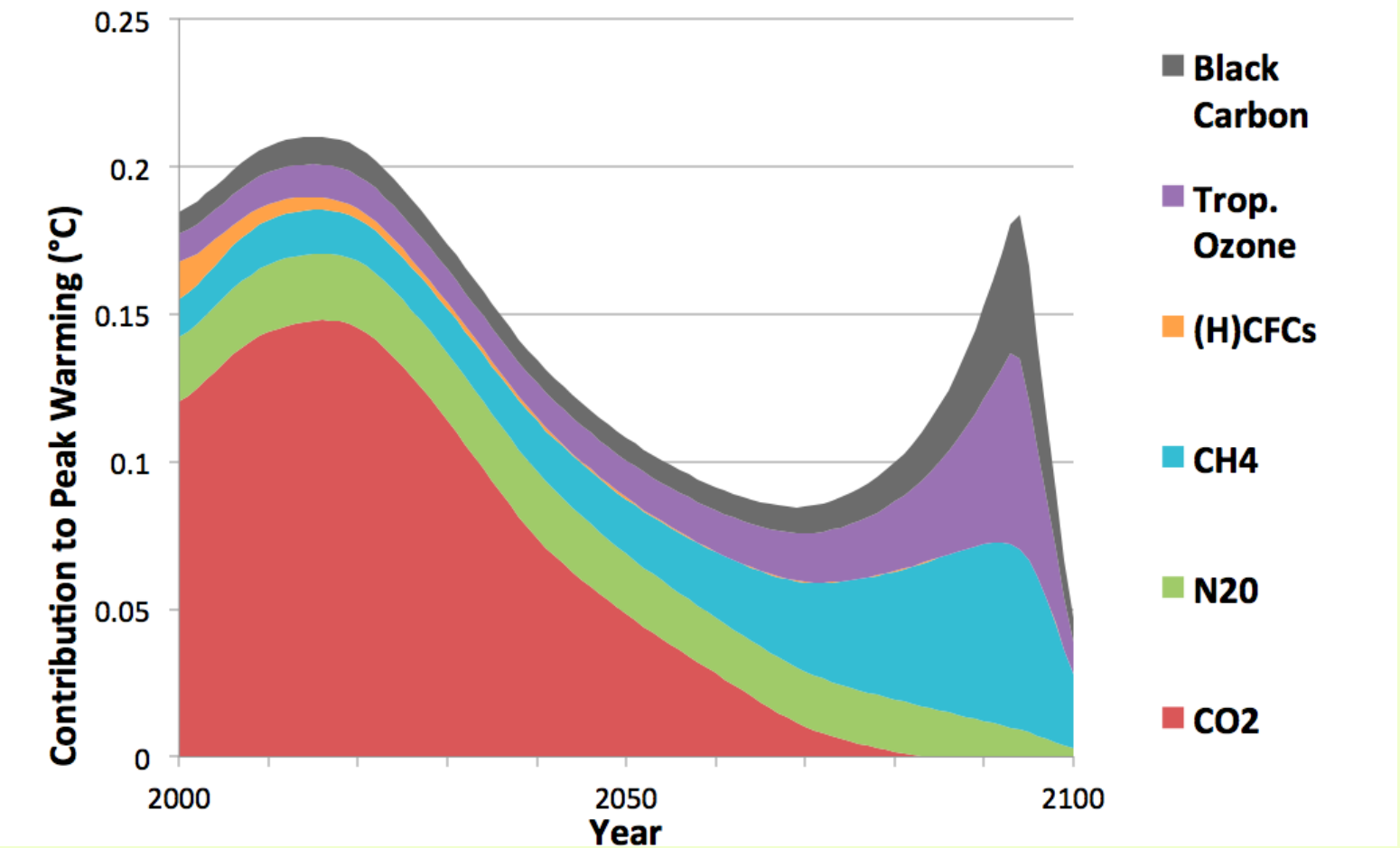
- Including non-CO_2 forcing suggests fossil carbon emissions have to fall immediately and become negative after 2060
  - Arora et al, 2011
- Preventing >2ºC warming cannot be achieved by cutting fossil carbon emissions alone.

But is action on short-lived climate forcing agents even a temporary alternative?



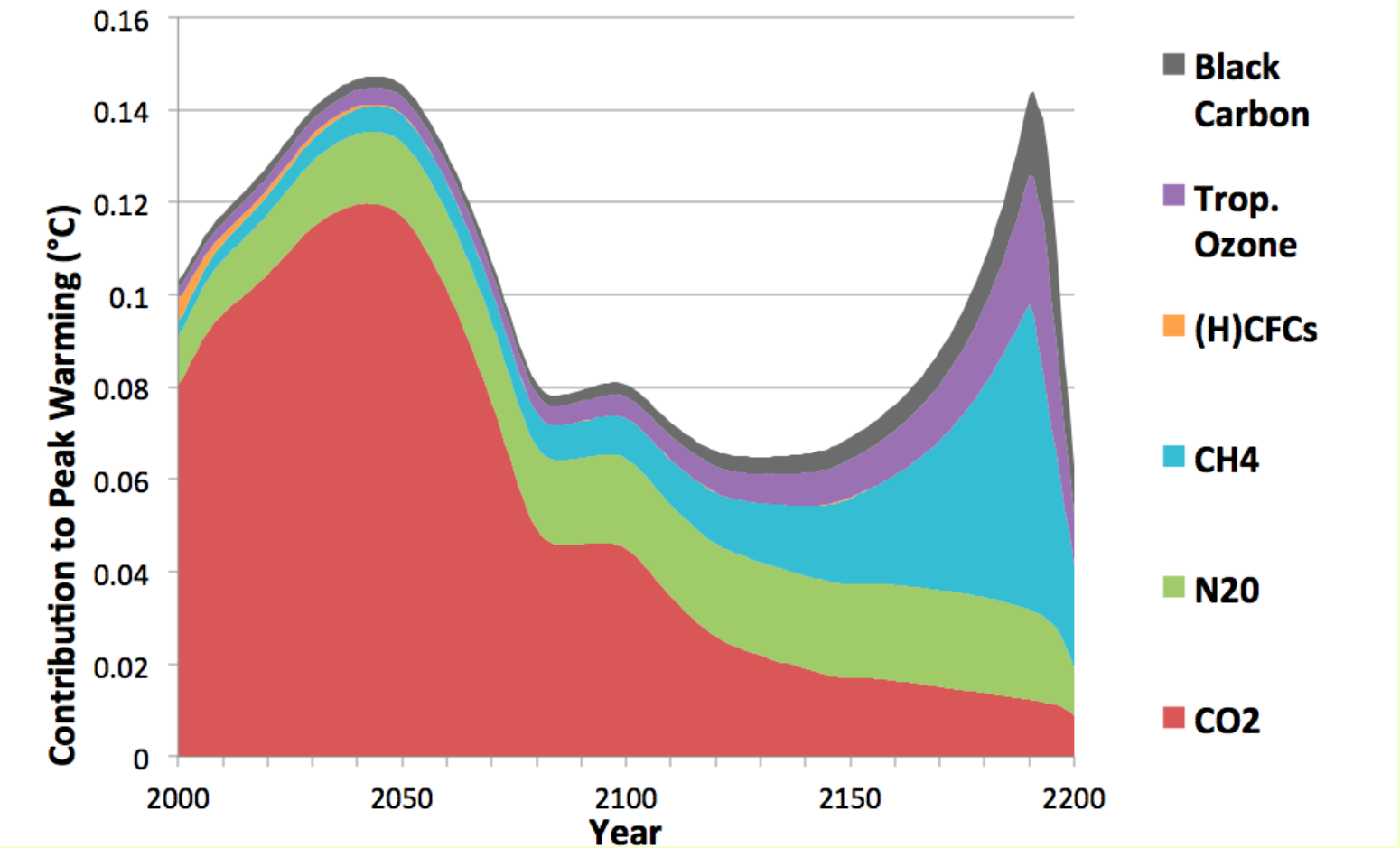
- **"near-term emission control measures (on CH4 and BC), together with measures to reduce CO2 emissions, would greatly improve the chances of keeping Earth's temperature increase to less than 2°C."**
- **But emissions of short-lived agents over the coming decades have relatively little impact on peak warming around or after 2100.**

Contributions of emissions in individual decades to peak warming: “Two-degrees scenario”



Most likely response: RCP3PD scenario

Contributions of emissions in individual decades to peak warming: “Three-degrees scenario”



Most likely response: RCP4.5 scenario

Key science message and policy implications

- **"We urge the participants … to acknowledge the need to limit cumulative CO_2 emissions as one element of their vision for long-term cooperative action to avoid dangerous climate change."**
  - **Allen, Archer, Frame, Matthews, Meinshausen, Schneider, Weaver, Zickfeld, Open Letter to SBSTA participants, 2009**
- **It's not just about reducing emission rates:**
  - **Burning carbon slower does not solve the problem.**
  - **Exclusive focus on short-term targets may lead to underinvestment in technologies, like CCS, that will be needed to get emissions to zero.**
- **Emissions of short-lived agents only affect peak warming under conditions in which CO_2 emissions are already falling rapidly or close to zero.**