Attributing harm to greenhouse gas emissions: principles and current status

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Attributing harm to greenhouse gas emissions

- How do we quantify the contribution of past emissions to large-scale warming?
- How do we quantify the impact of large-scale warming on extreme weather events?
  - The example of Typhoon Haiyan
- How do we quantify actual harm attributable to either large-scale warming or extreme weather?
  - Examples of impacts on health and economic growth
- How do we assess whether harm is avoidable?

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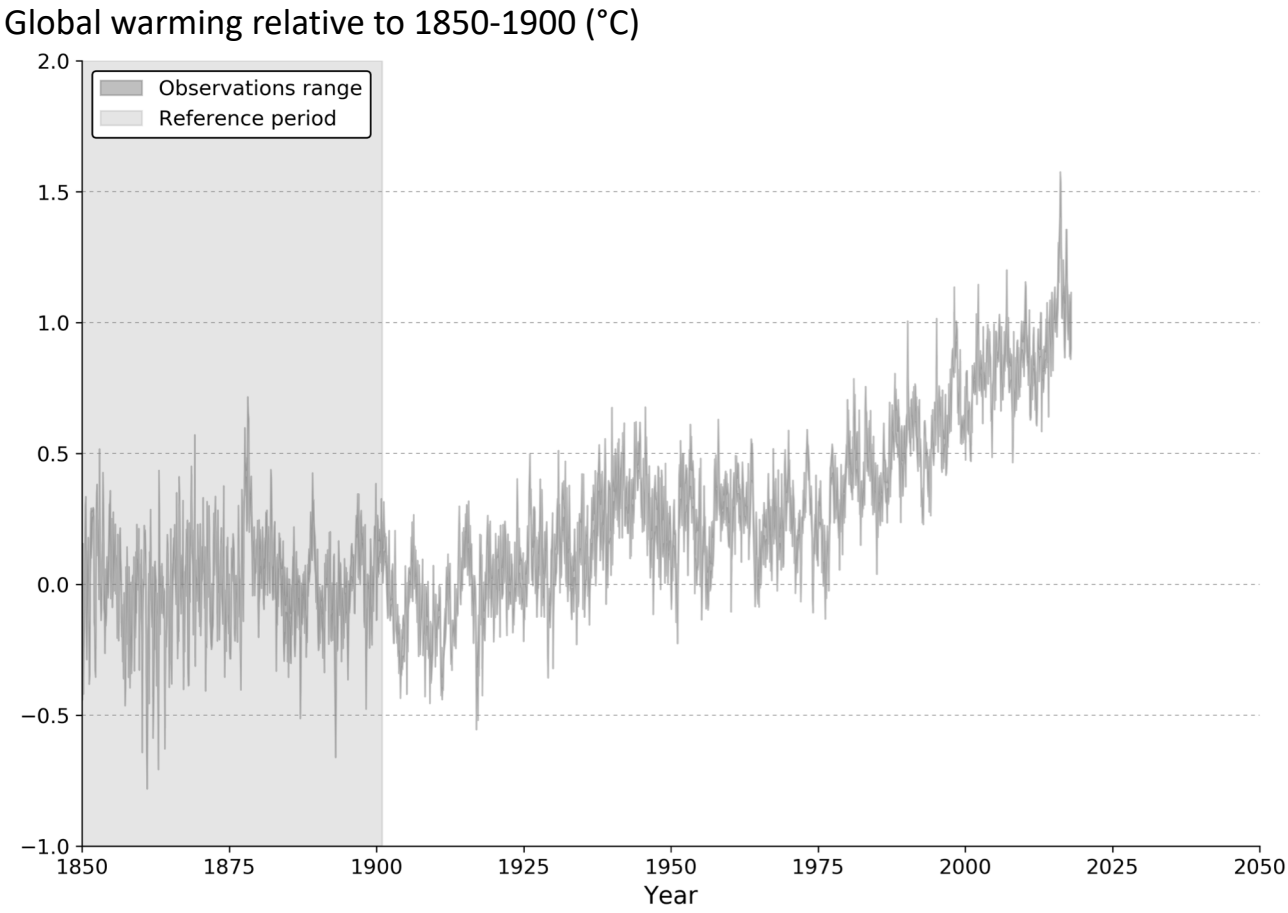
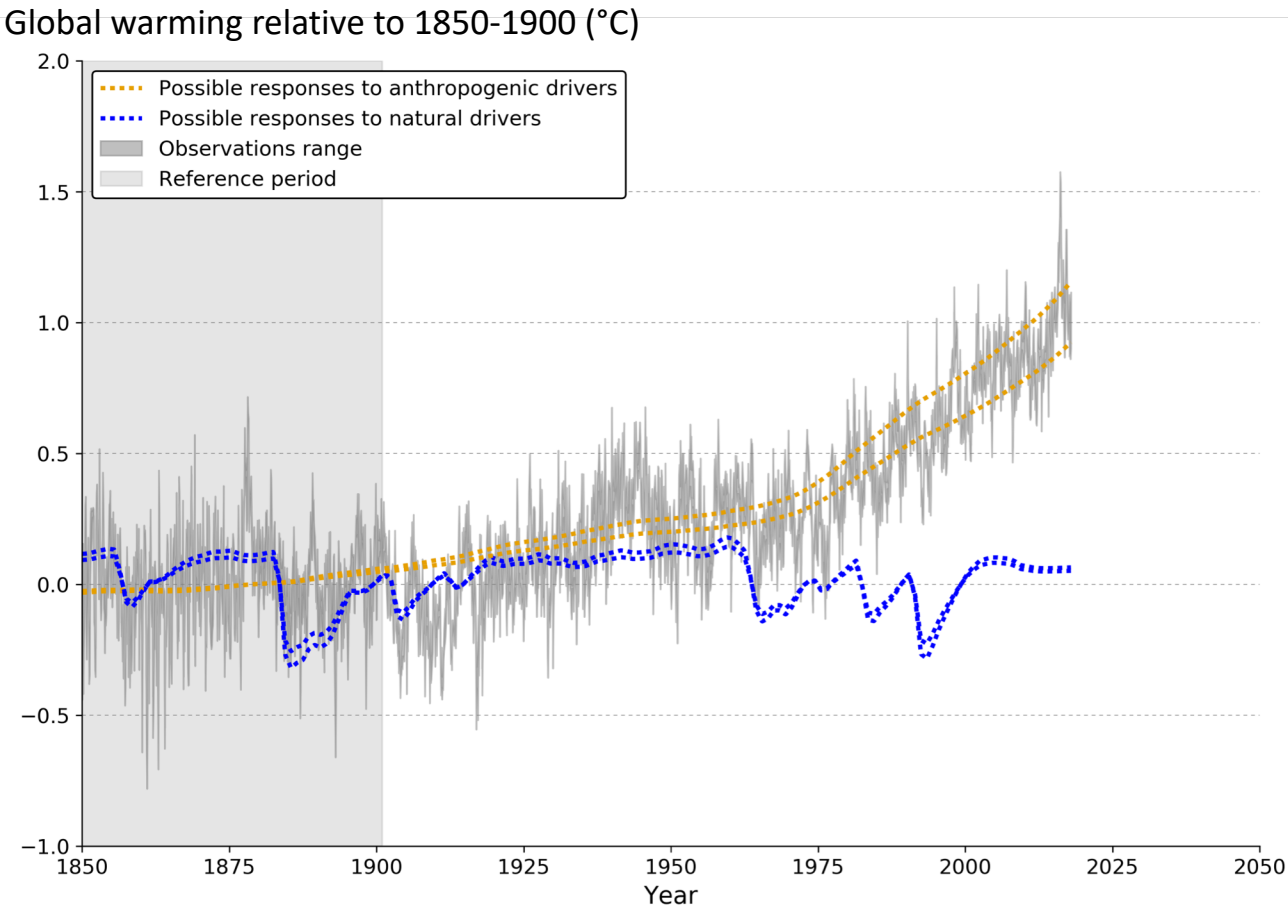
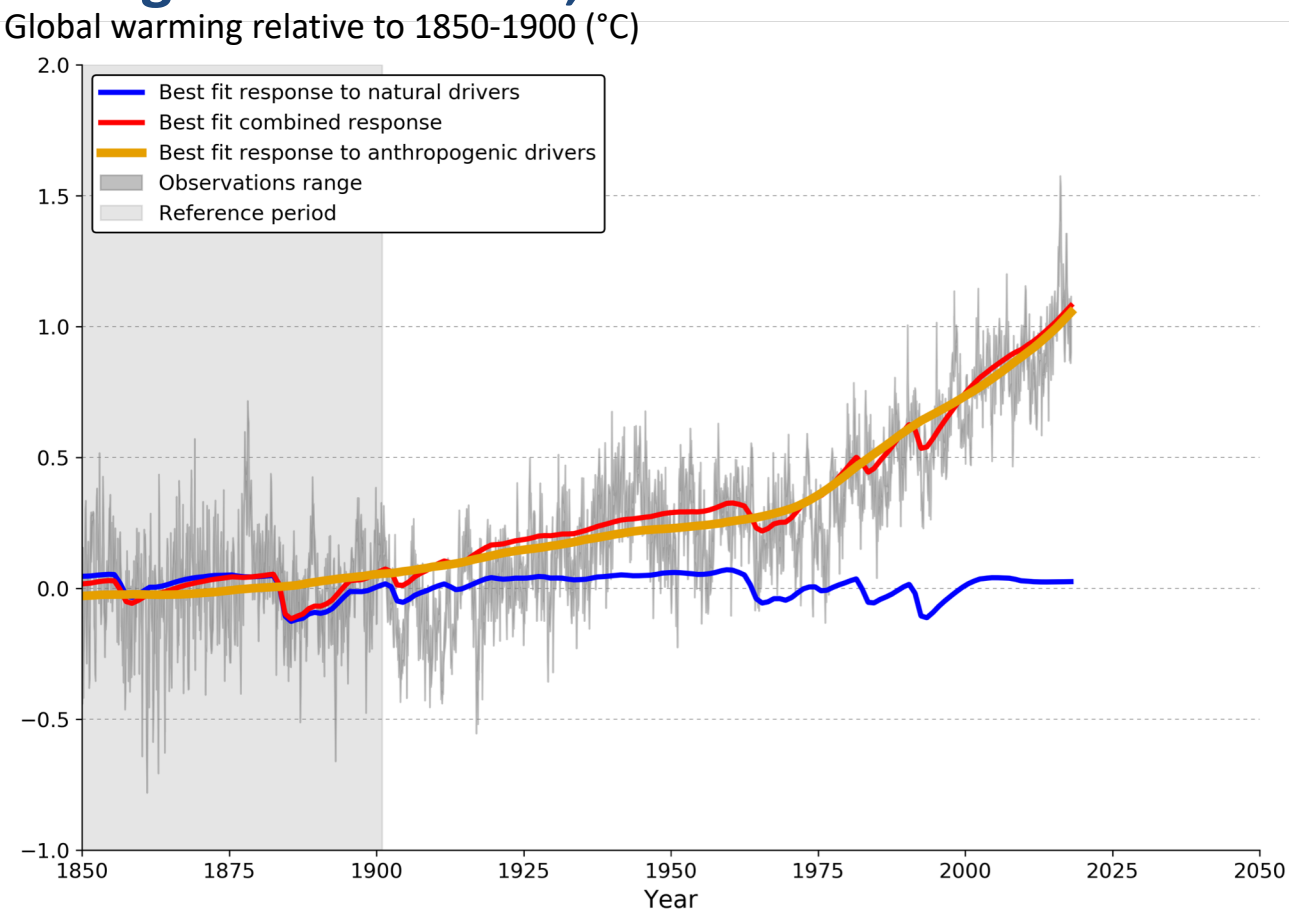
Observed global mean surface temperature



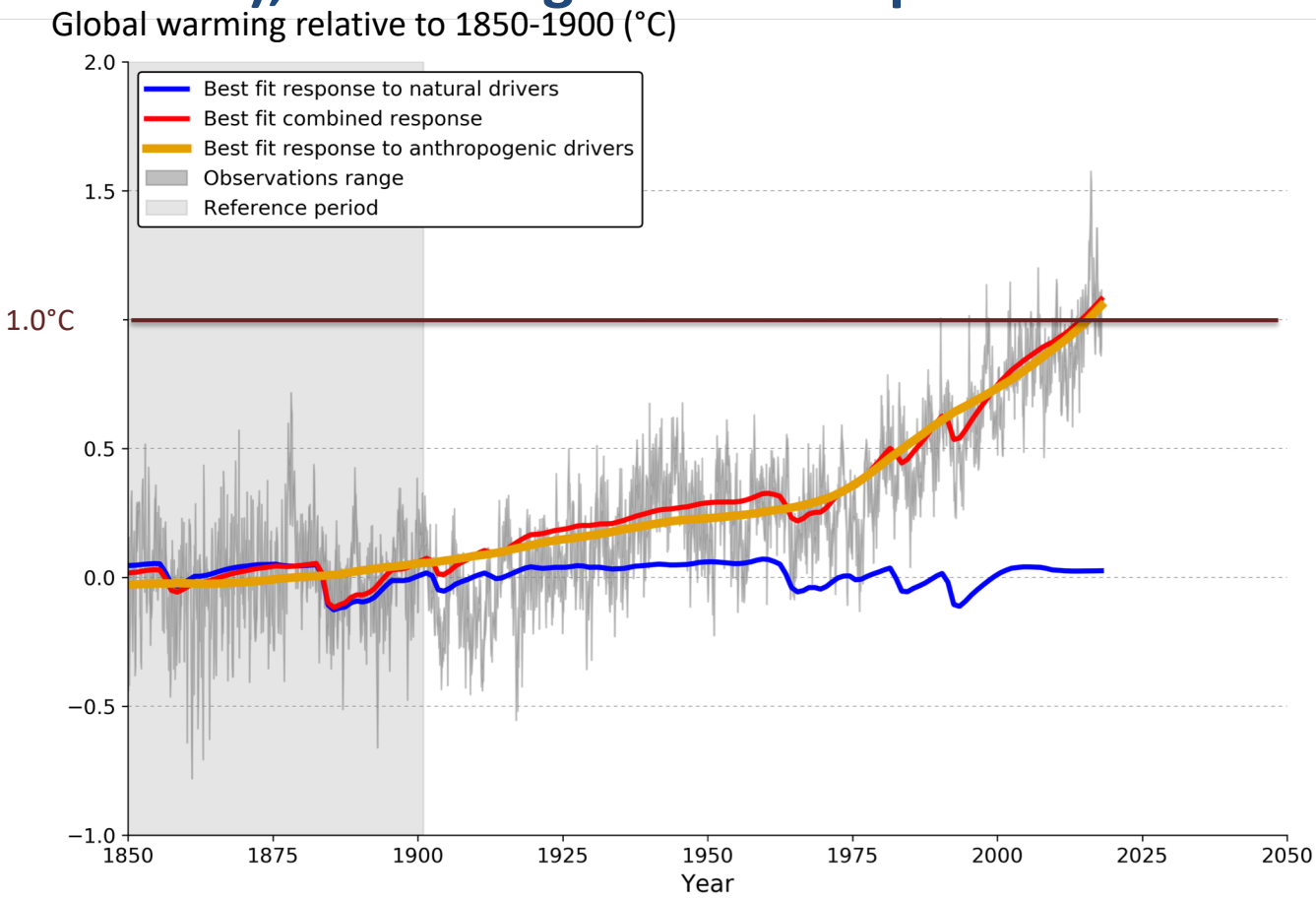
How much warming is due to human influence?



Estimating the size of human-induced and natural warming from the data, not from models



Anthropogenic warming has reached 1° C (±0.2° C), increasing at ~0.2° C per decade



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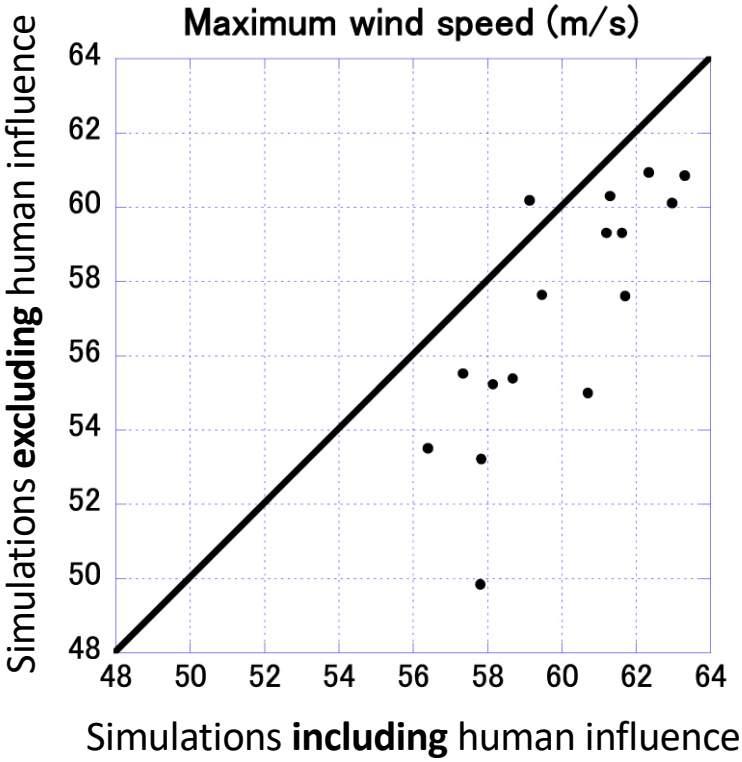
A specific event: the example of Typhoon Haiyan / Super Typhoon Yolanda

60 m/s = 216 km/hr



Takayabu et al 2015 Environ. Res. Lett. 10 064011

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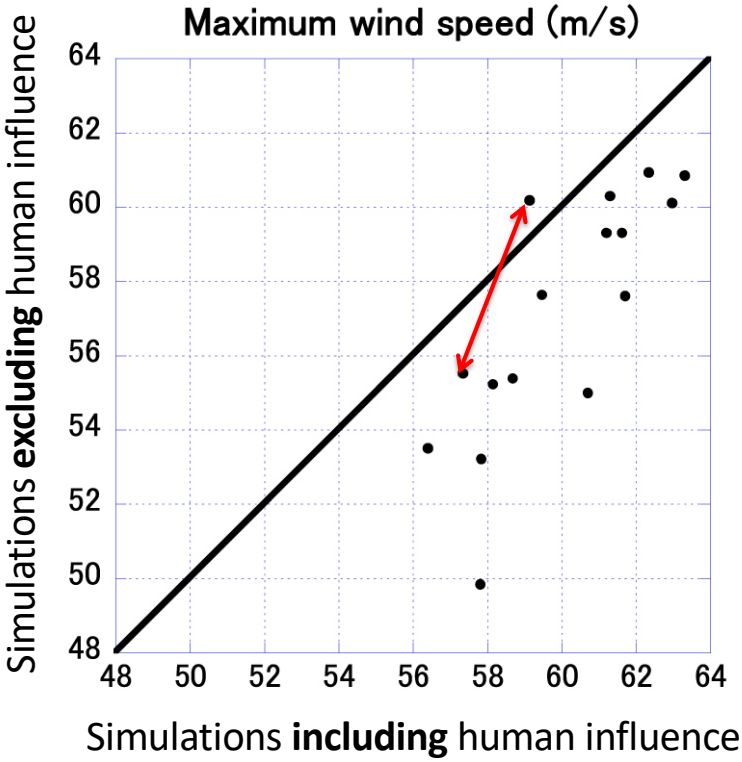

Some cases show higher max wind speed even without large-scale human-induced warming

Takayabu et al 2015 Environ. Res. Lett. 10 064011

A specific event: the example of Typhoon Haiyan / Super Typhoon Yolanda

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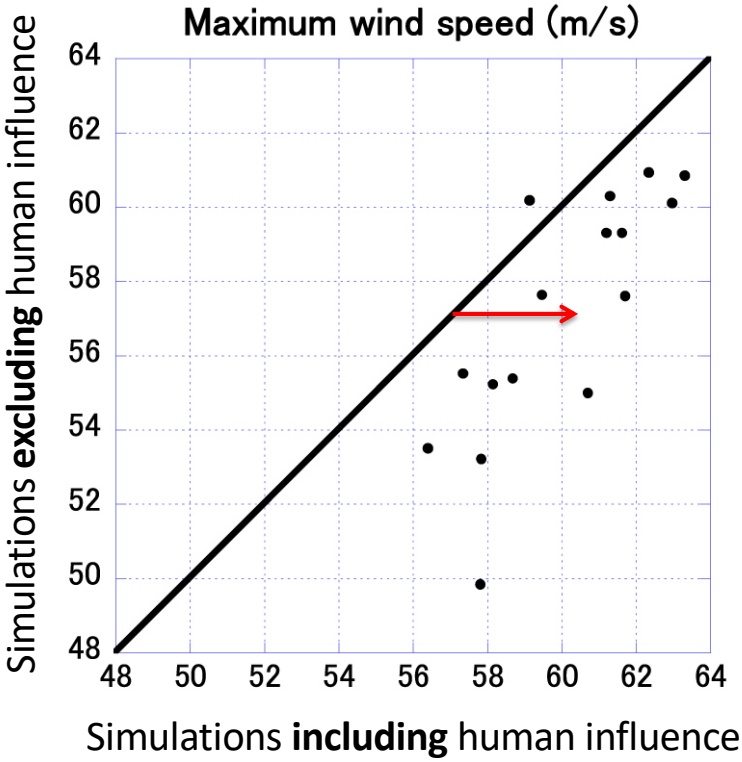
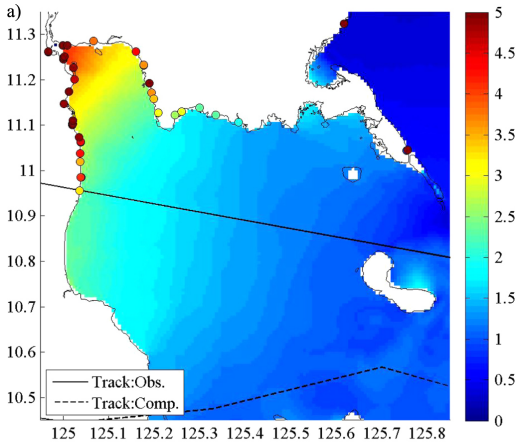


But on average, max wind speeds are increased if human influence is included, implying a higher probability of very high winds

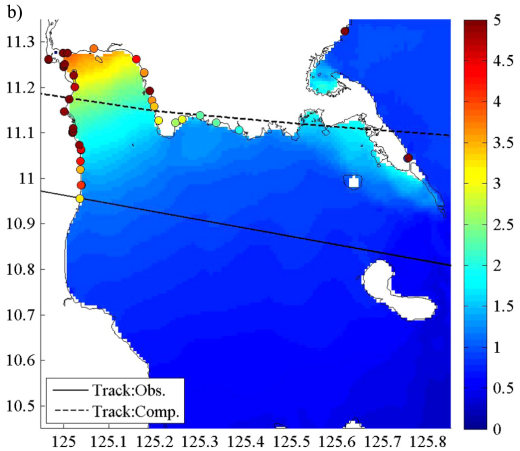
Takayabu et al 2015 Environ. Res. Lett. 10 064011

Implications for storm surge height in the Gulf of Leyte

Higher storm surges are primarily a consequence of higher wind speeds, not changes in cyclone track or global sea-level rise



Simulations **including** human influence



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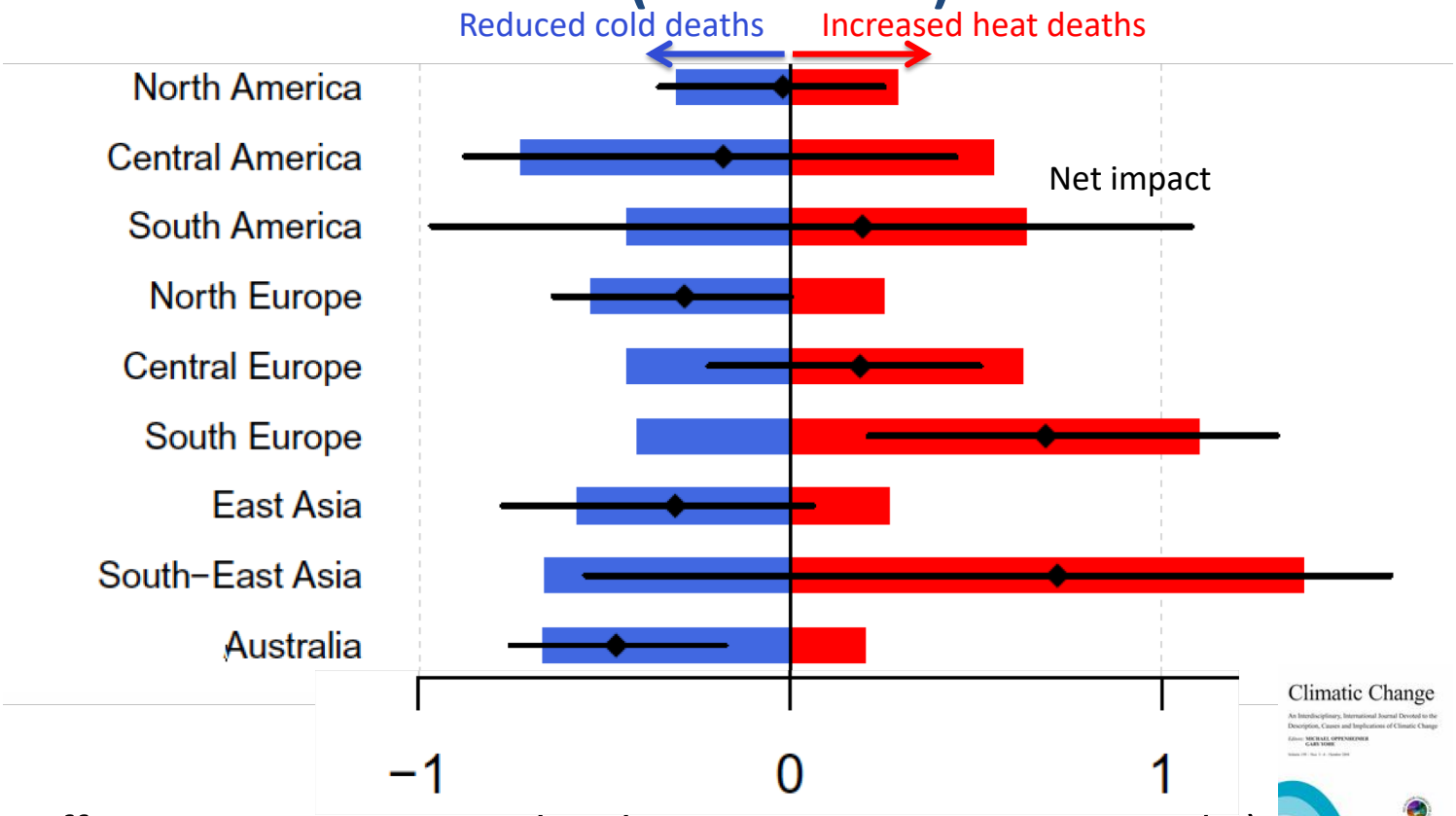
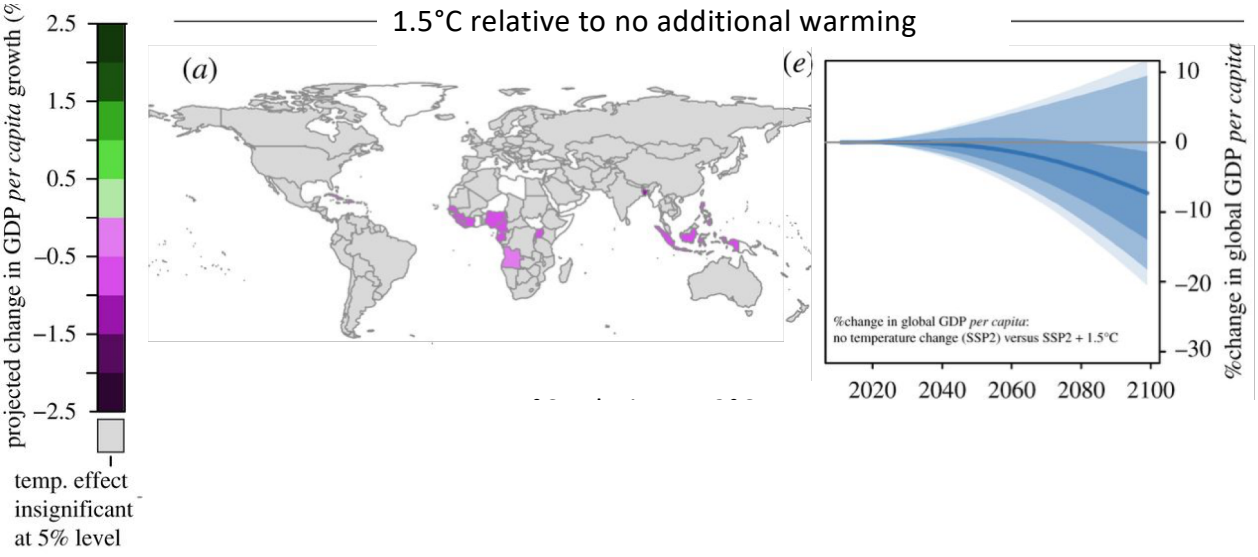
“Any increase in global warming is projected to affect human health” (IPCC SR1.5)



Difference in excess mortality due to extreme temperatures (%)
2°C versus 1.5°C - Vicedo-Cabrera et al (2018)

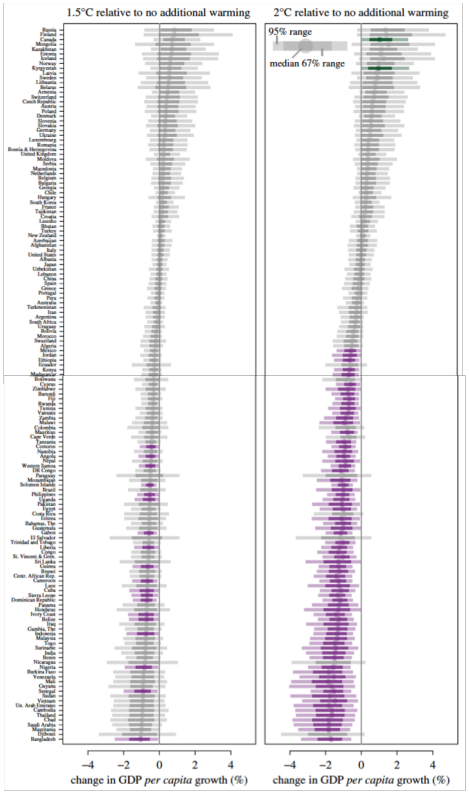
Impacts on economic growth



Felix Pretis et al. Phil. Trans. R. Soc. A 2018;376:20160460

PHILOSOPHICAL TRANSACTIONS OF THE ROYAL SOCIETY A

Many more countries experience significant reductions in GDP growth at 2° C vs. 1.5° C



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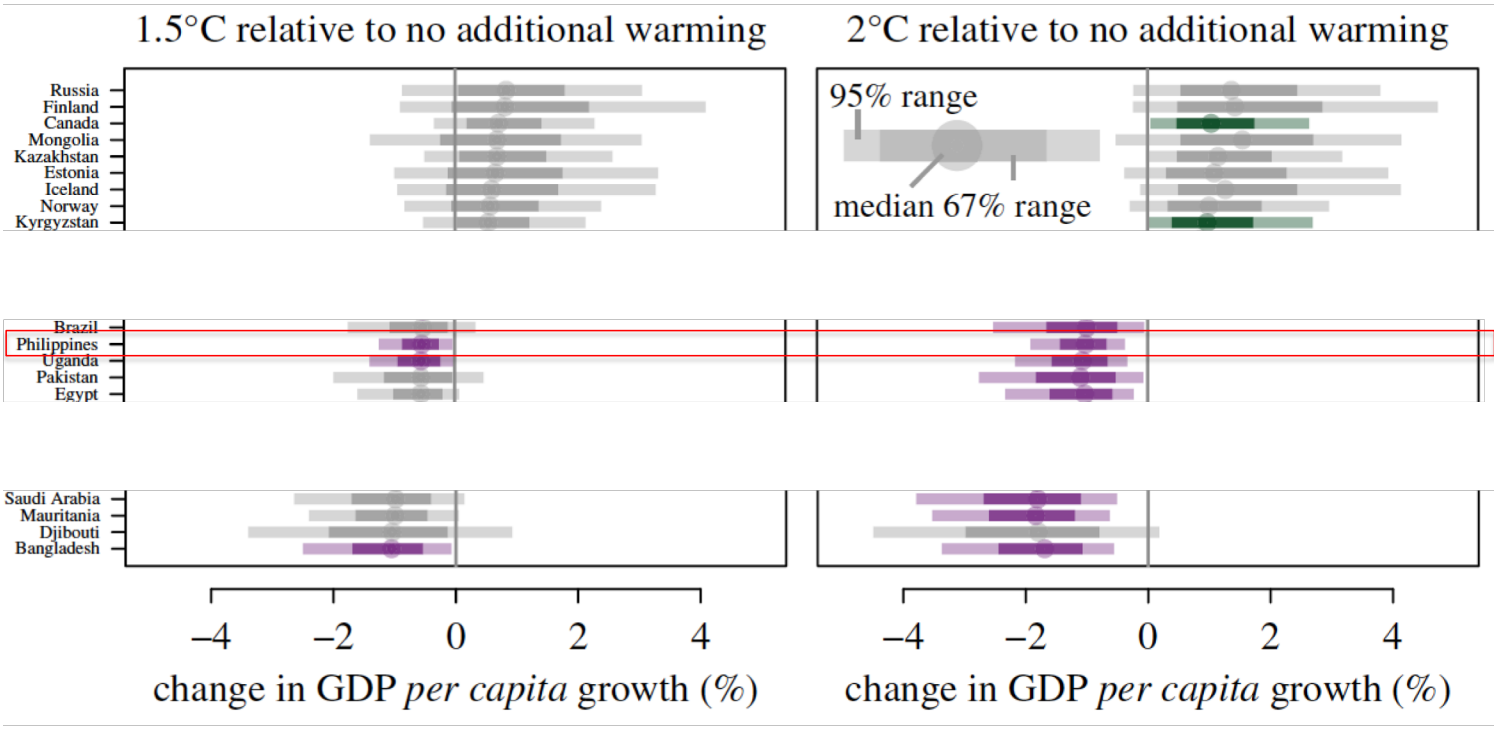
GDP growth in the Philippines is significantly reduced at both 1.5° C and 2° C of warming



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Was warming foreseeable?

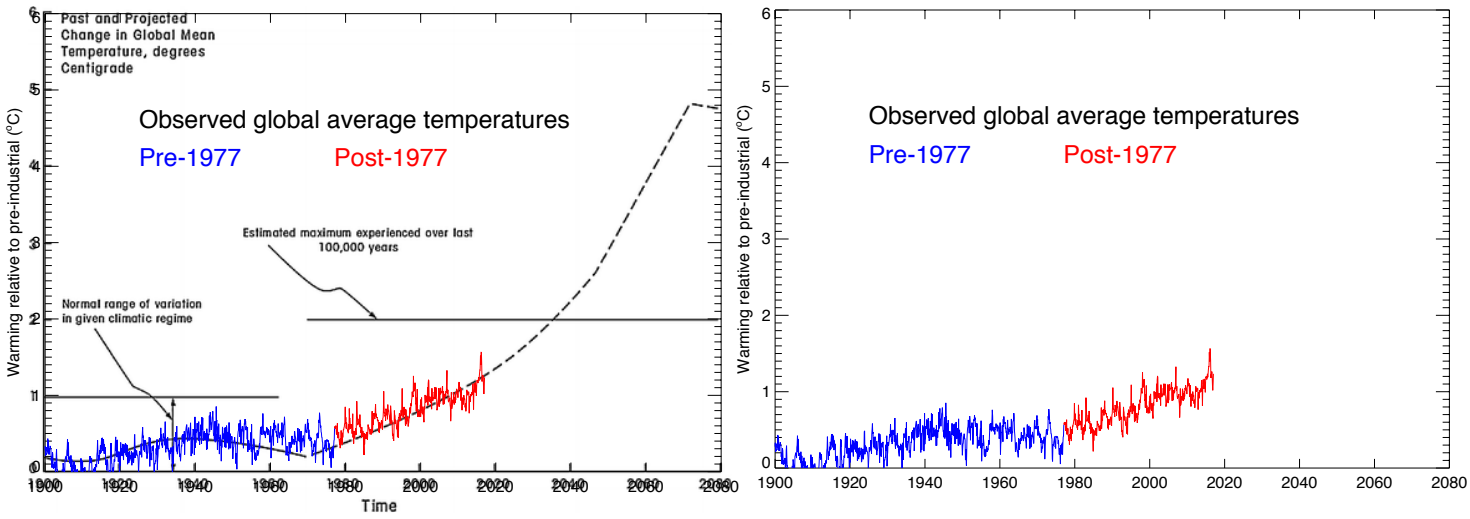
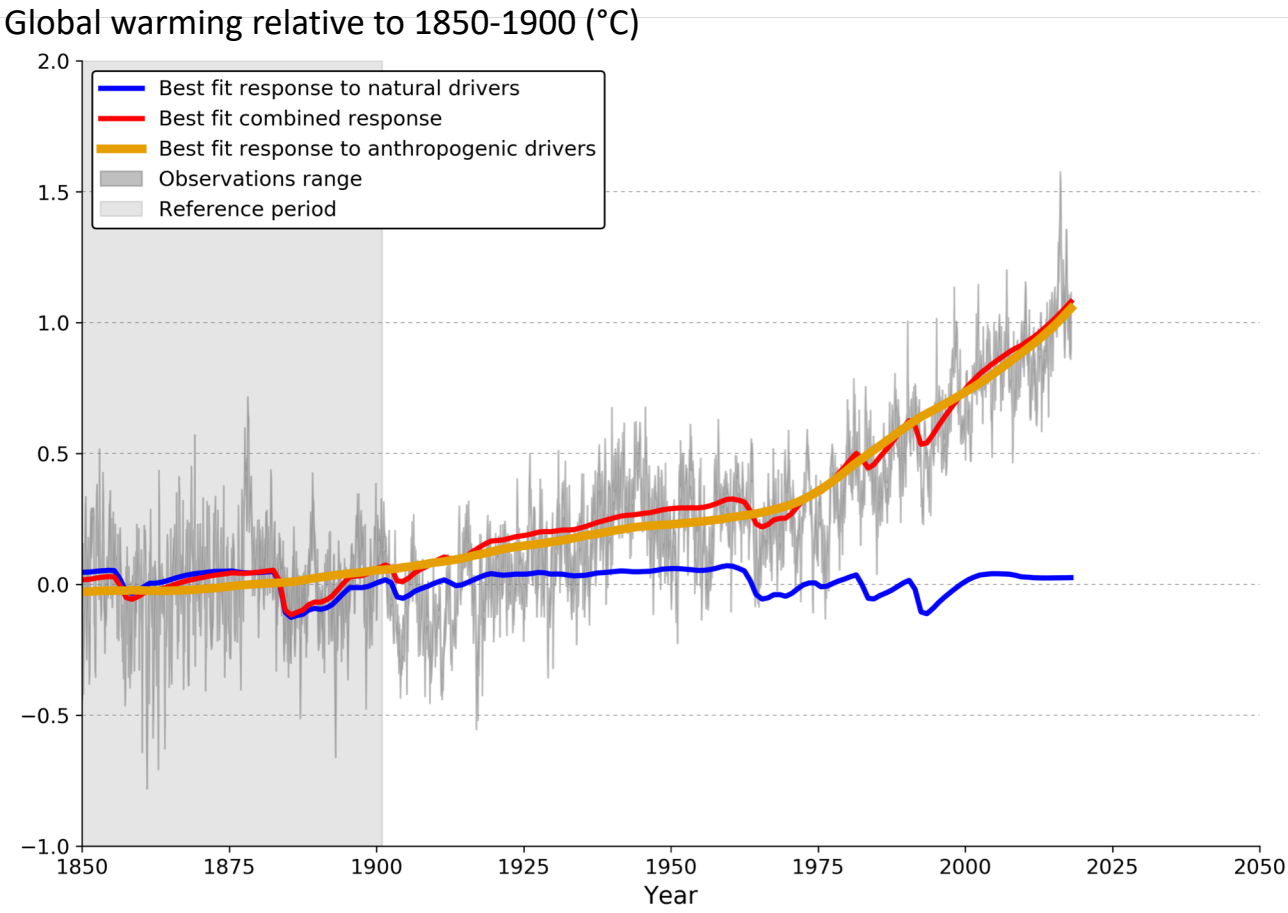


Figure 1 from William D. Nordhaus, “Strategies for Control of Carbon Dioxide”, Cowles Discussion Paper 477, January 6, 1977

Warming is predominantly due to ongoing emissions of carbon dioxide



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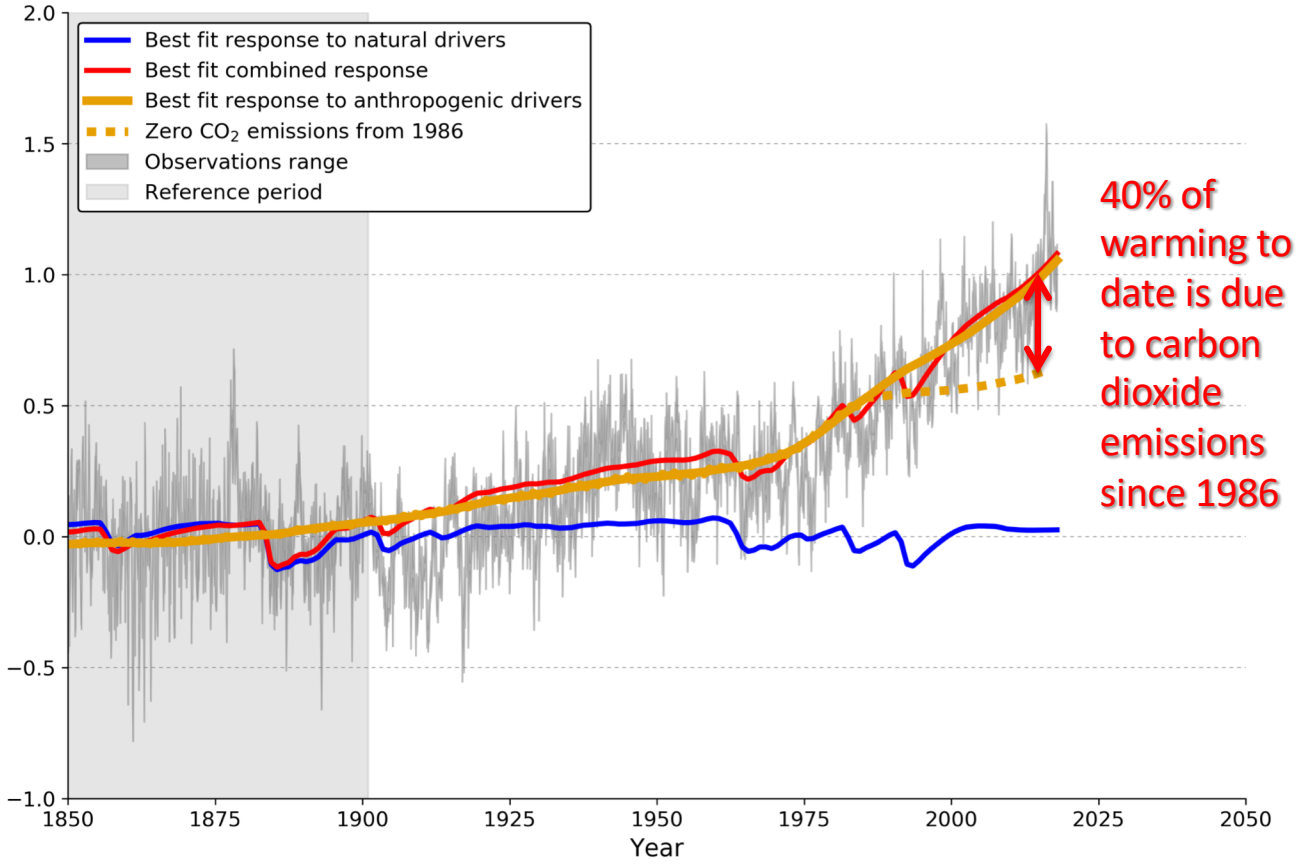
Global warming relative to 1850-1900 (°C)



But are carbon dioxide emissions an inevitable consequence of provision of affordable energy?

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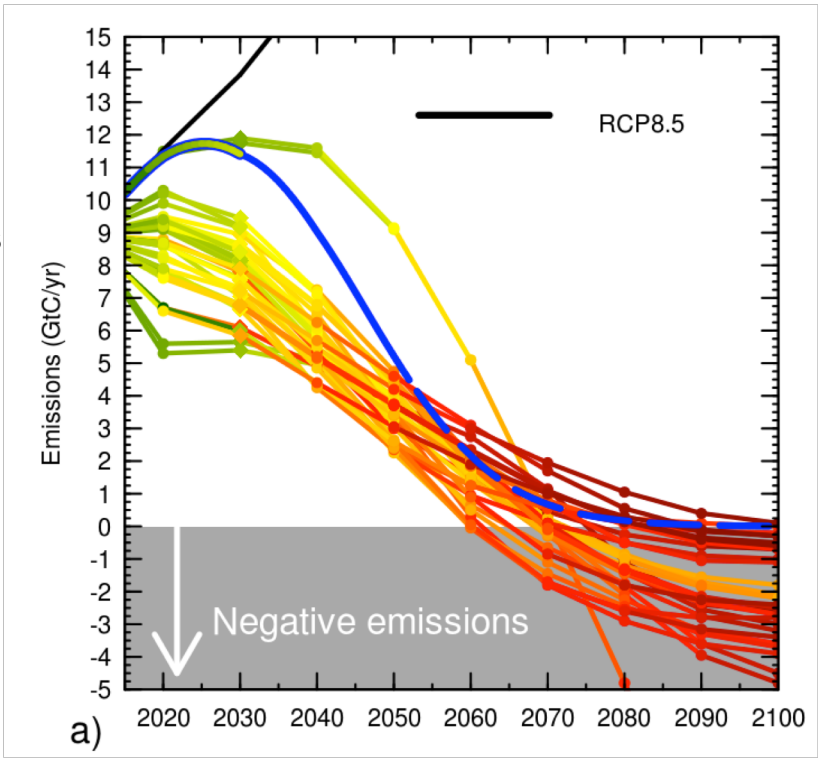
Characteristics of “cost-effective” well-below-2° C scenarios

Total emissions in scenarios in IPCC WGIII “430-480ppm” (lowest) scenario category

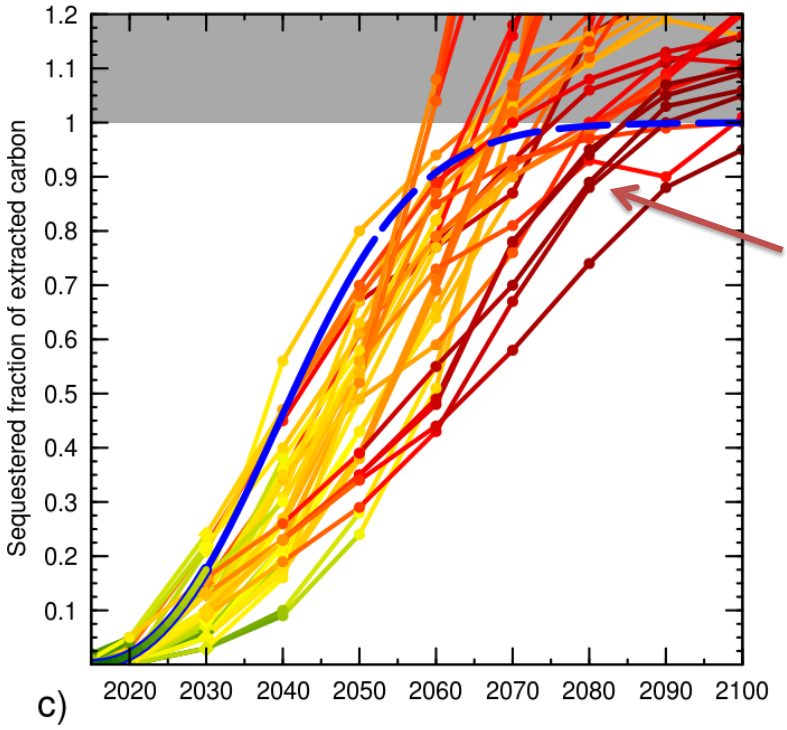


Colours show total policy cost in US$$_{2005}$$

Figures courtesy of Richard Millar based on IIASA database

Characteristics of "cost-effective" well-below-2° C scenarios

Net fraction of extracted carbon that is disposed of through capture at source (CCS) or recapture from the atmosphere



Delayed deployment of CO_2 disposal is associated with high future mitigation costs

Figures courtesy of Richard Millar based on IIASA database

Harm could have been avoided at an affordable cost

- Current models indicate that within 30 years of initiating a cost-effective policy to limit future warming to less than 1° C, about 25% of the fossil carbon still being used is no longer being dumped into the atmosphere.
- So if fossil fuel companies had started such a carbon dioxide disposal program in 1986, we now be on a path to limit warming to 1.5° C.
- This would add less than $10 to the cost of a barrel of oil.
- Costs increase as the carbon disposal fraction rises, encouraging an orderly transition away from fossil fuels.

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