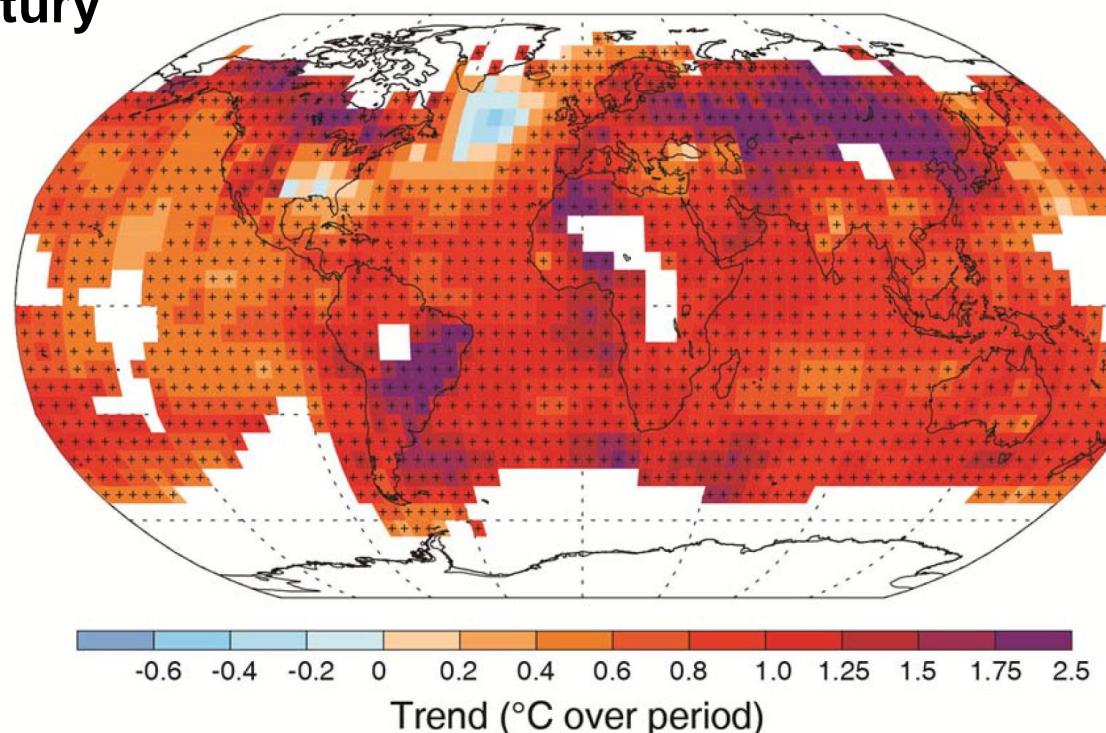


School of Geography and the Environment & Department of Physics
myles.allen@ouce.ox.ac.uk

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It is extremely likely that human influence has been the dominant cause of the observed warming since the mid-20th century

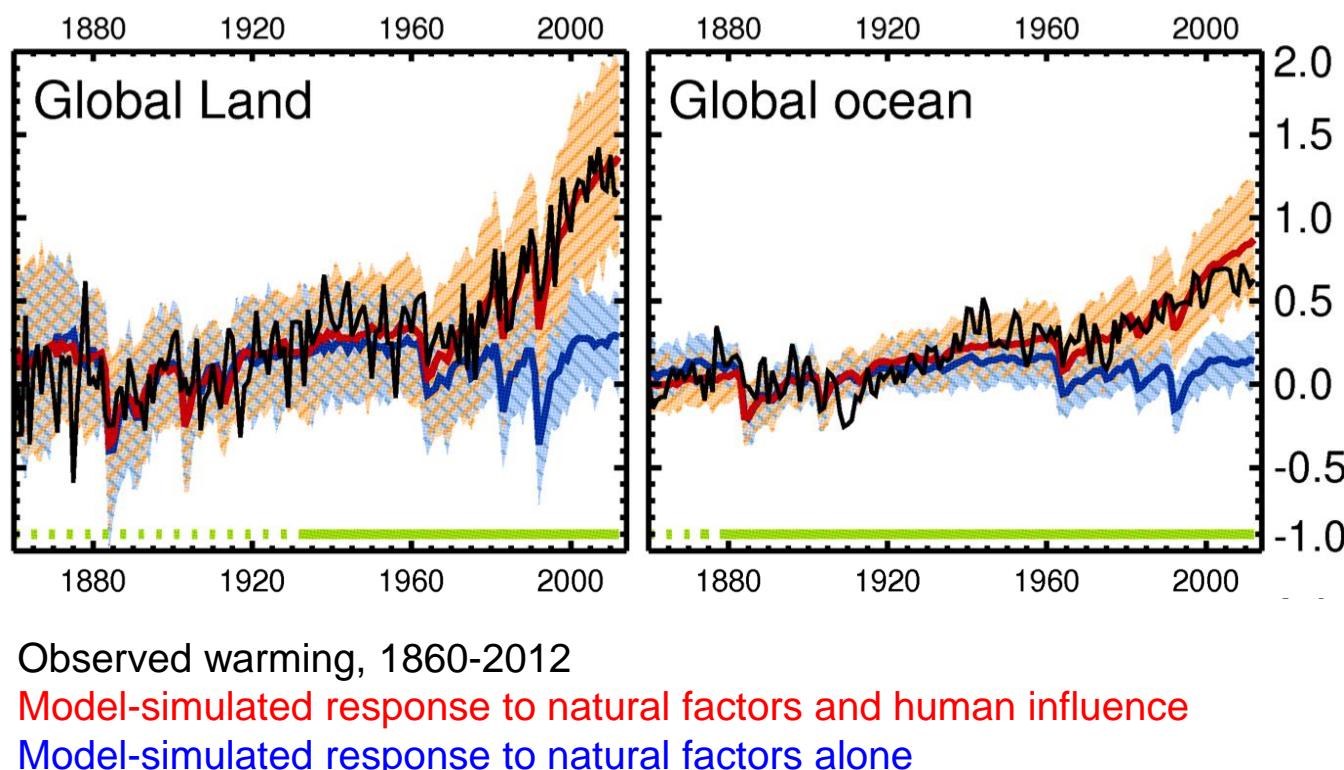


Observed warming, 1901-2012 (IPCC WGI, Fig. SPM.1b)

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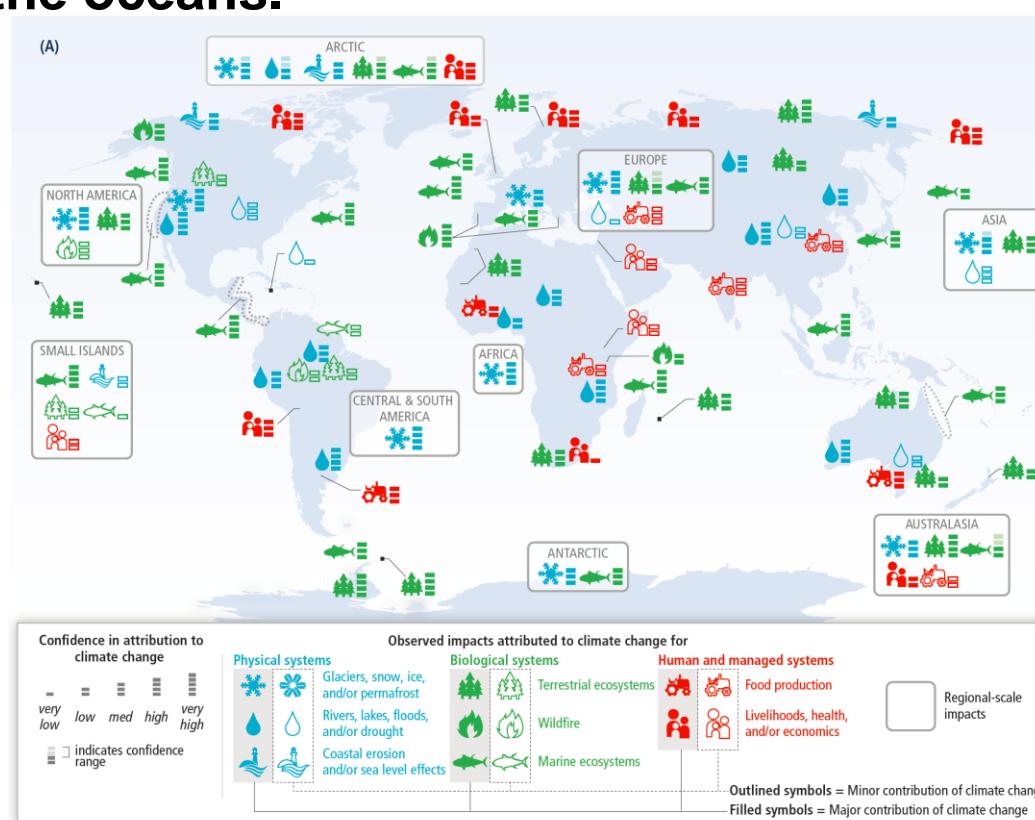
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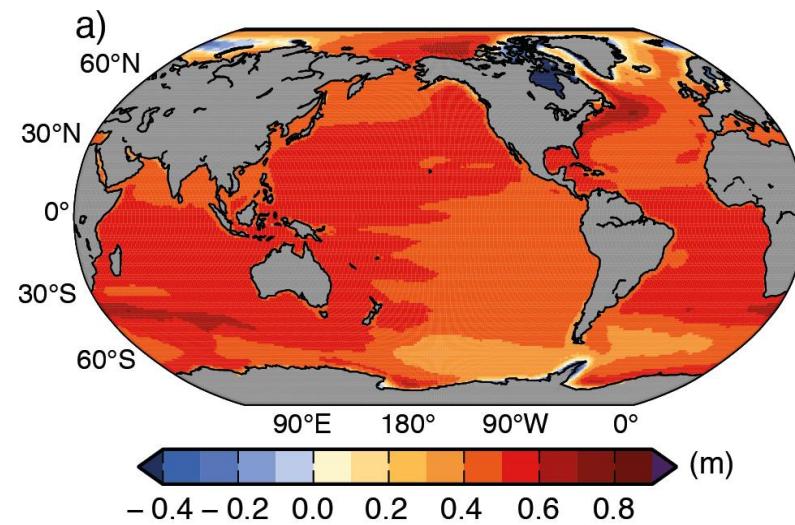
In recent decades, changes in climate have caused impacts on natural and human systems on all continents and across the oceans.



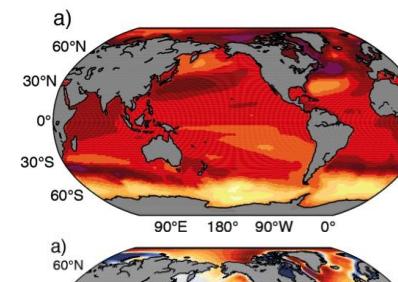
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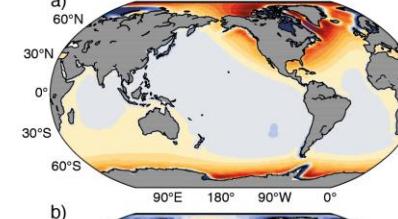
Coastal systems and low-lying areas will increasingly experience adverse impacts



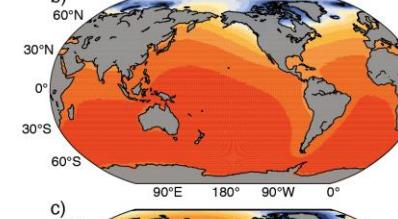
Ensemble mean sea level rise, 2081-2100 relative to 1986-2005, and contributions from different factors
(IPCC WGI, Figs. 13.16, 13.18, 13.19)



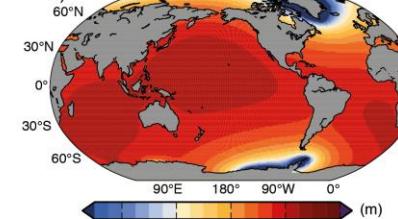
Thermal expansion



Rebound from Ice Age (natural)



Melting glaciers



Melting ice sheets

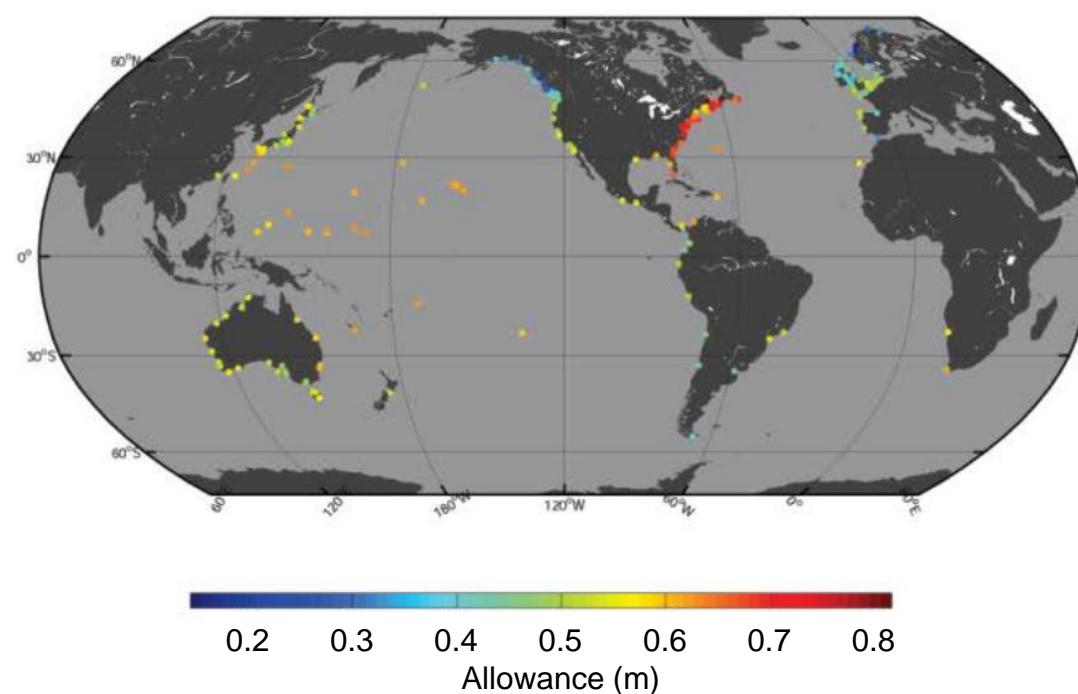
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Coastal systems and low-lying areas will increasingly experience adverse impacts



Estimated increase in height of flood protection structures to preserve the same frequency of exceedences, 2081-2100 relative to 1986-2005
(IPCC WGII, Fig. 5.2)

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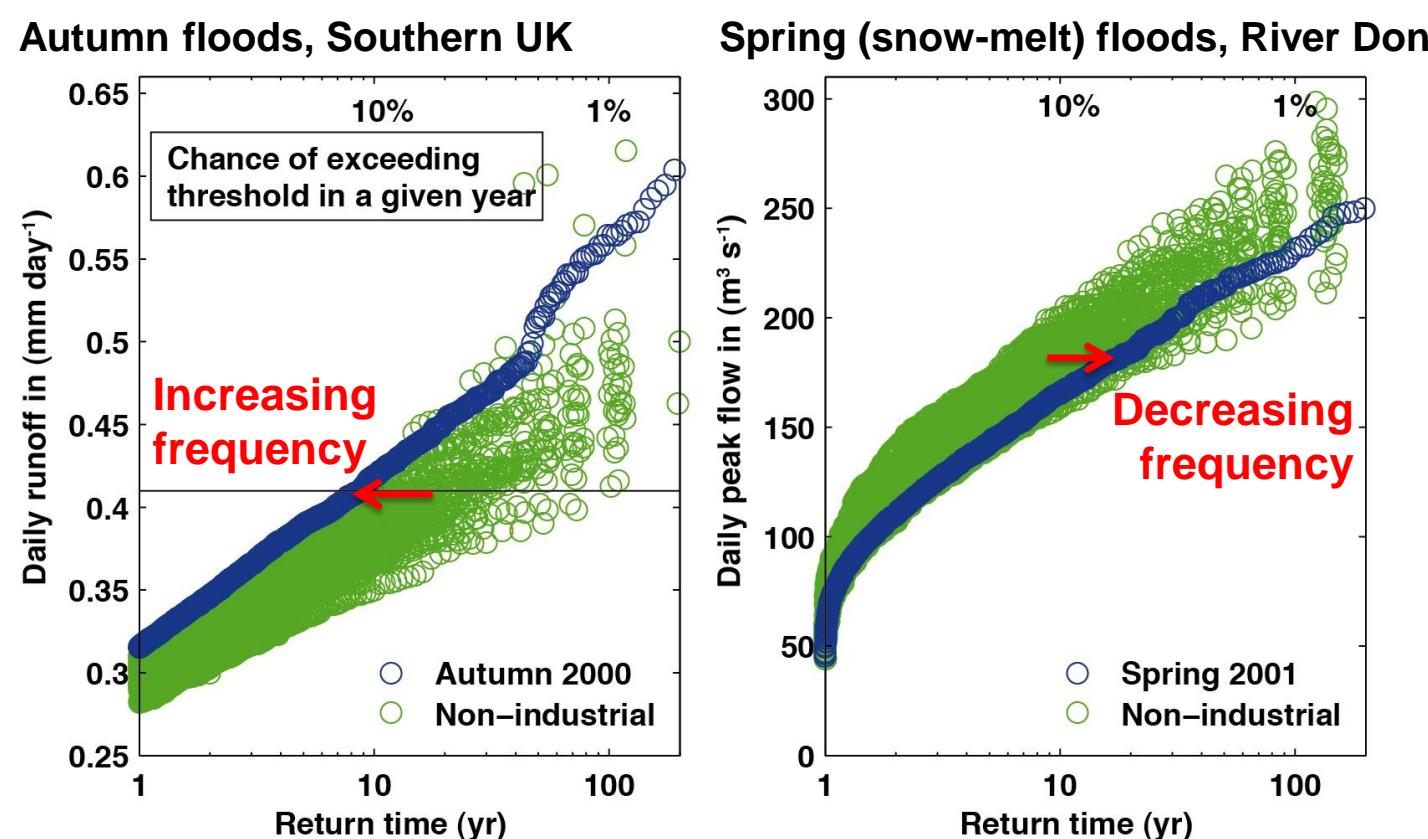
Climate change: loading the weather dice



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Some extreme weather events are becoming more frequent, some less frequent



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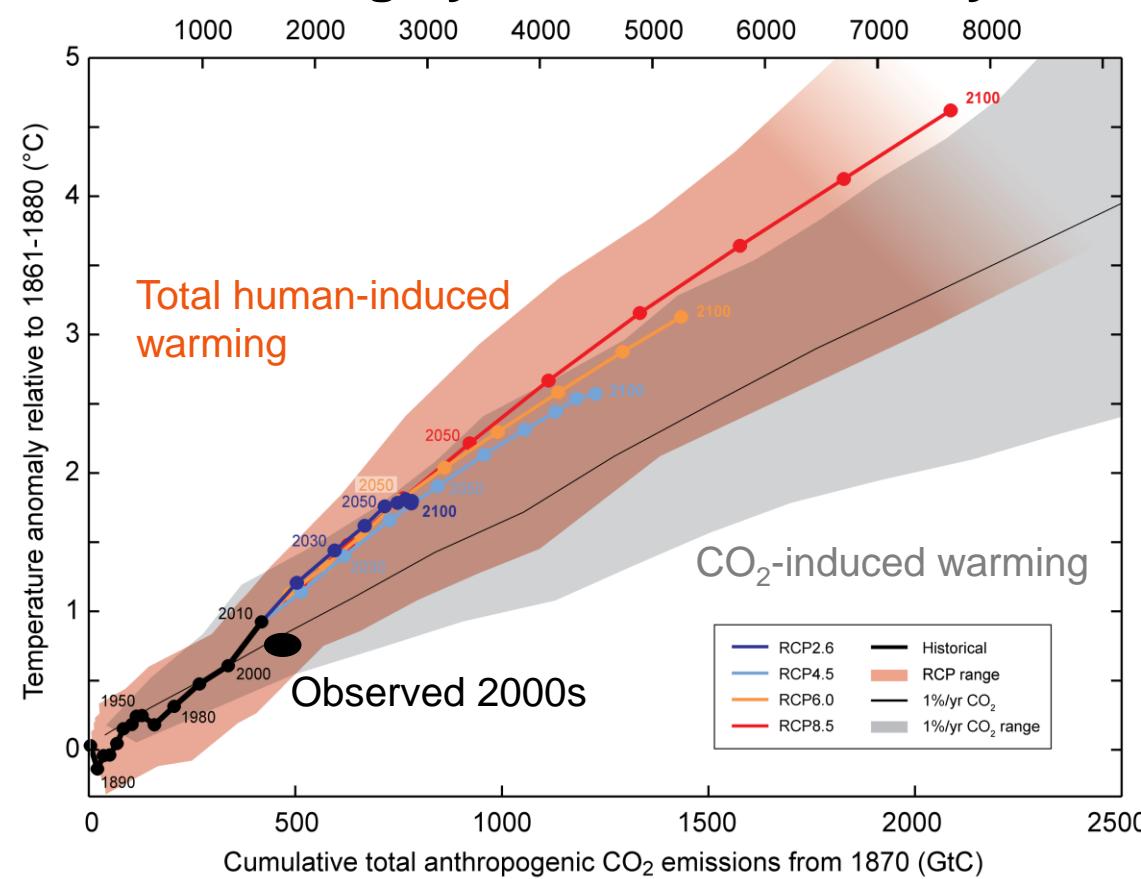
Key conclusions on observed and projected changes

- Human influence on climate is clear.
- Recent “pause” in ocean surface (not land) warming does not change the big picture.
- Evidence of impacts in all continents and many sectors.
- My personal view: the most important impacts over the coming decades will result from changing risks of extreme weather events that might have happened anyway, but have been made more or less frequent by climate change.
- Attributing changes in risk is still a new science: but at the global level, the overall trajectory is clear and the main drivers are also clear.

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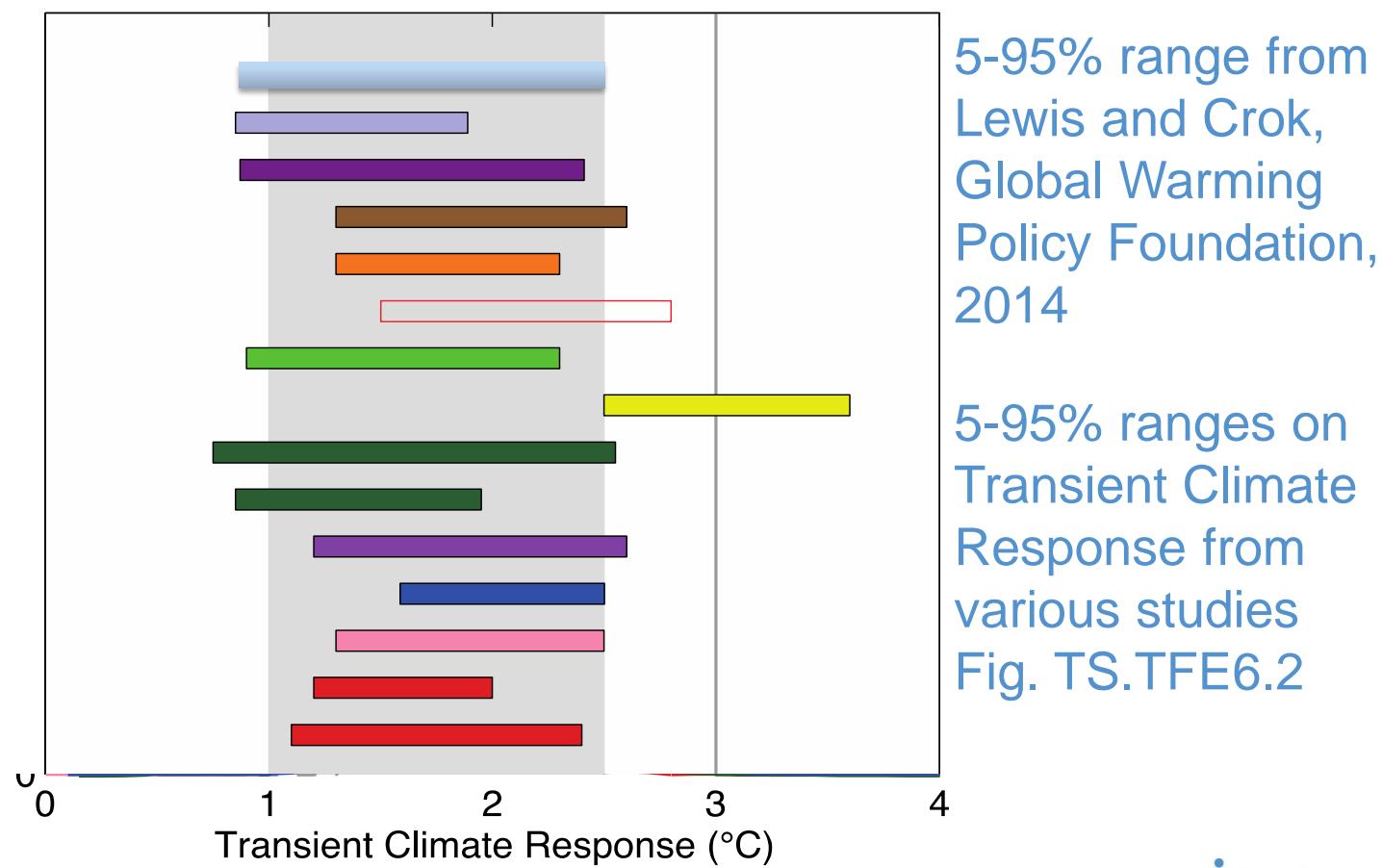
Cumulative emissions of CO₂ largely determine global mean surface warming by the late 21st century and beyond



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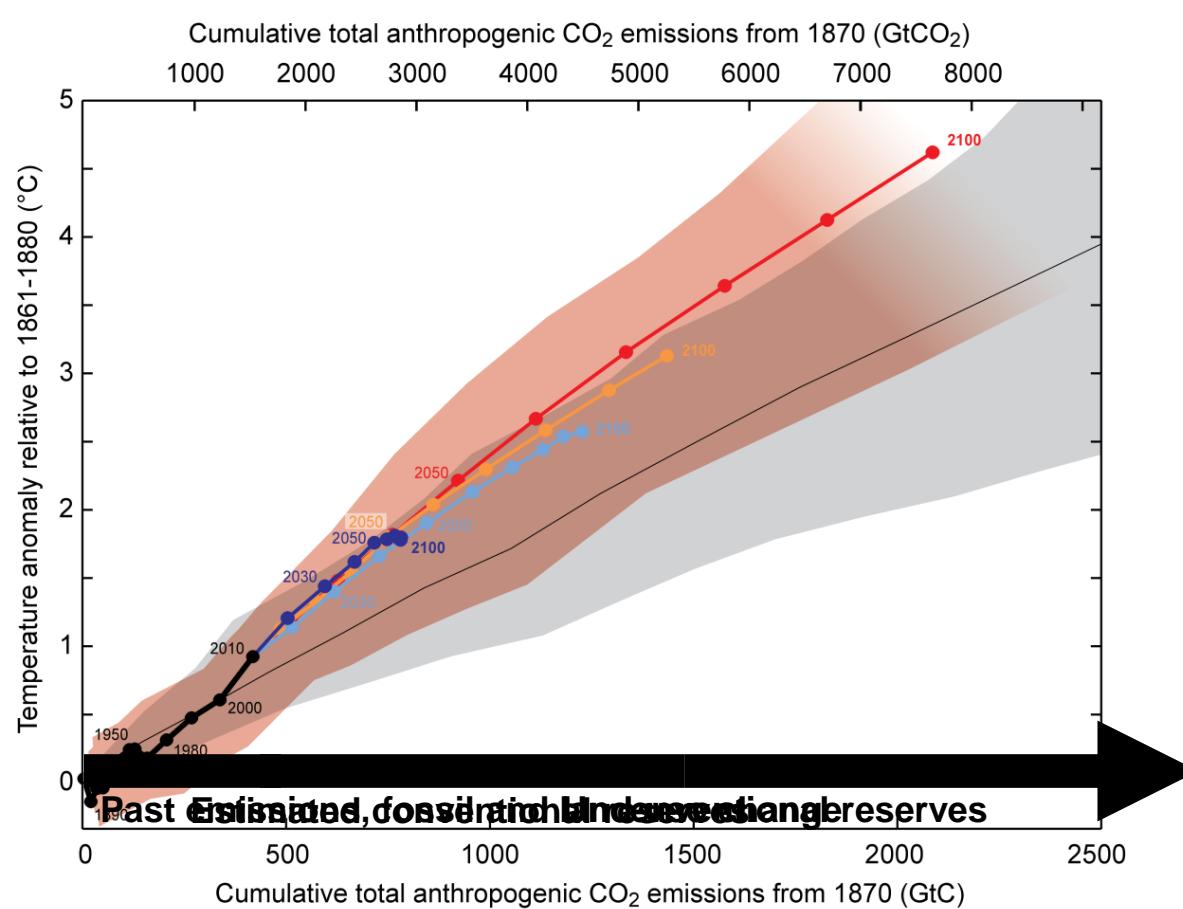
High level of agreement on the global-scale warming response to rising greenhouse gas levels



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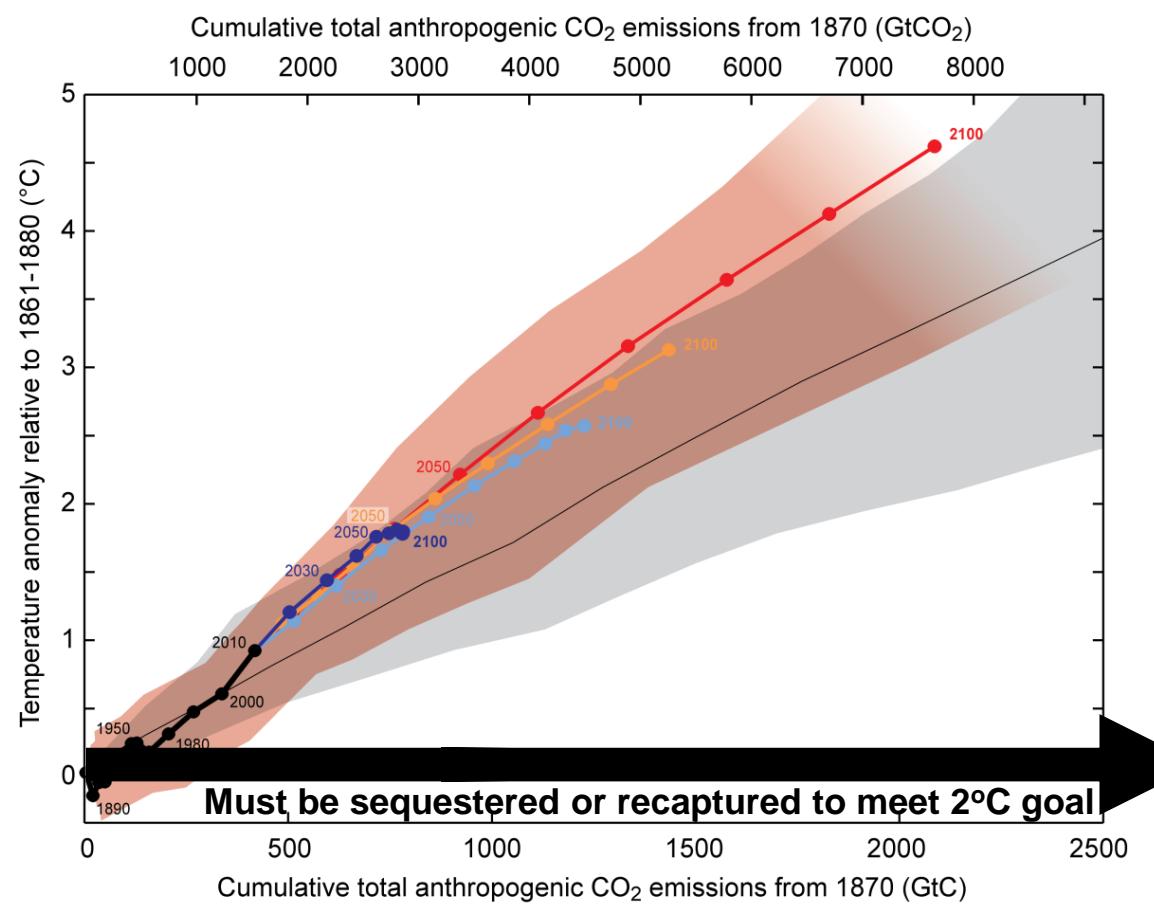
Cumulative emissions and fossil carbon reserves



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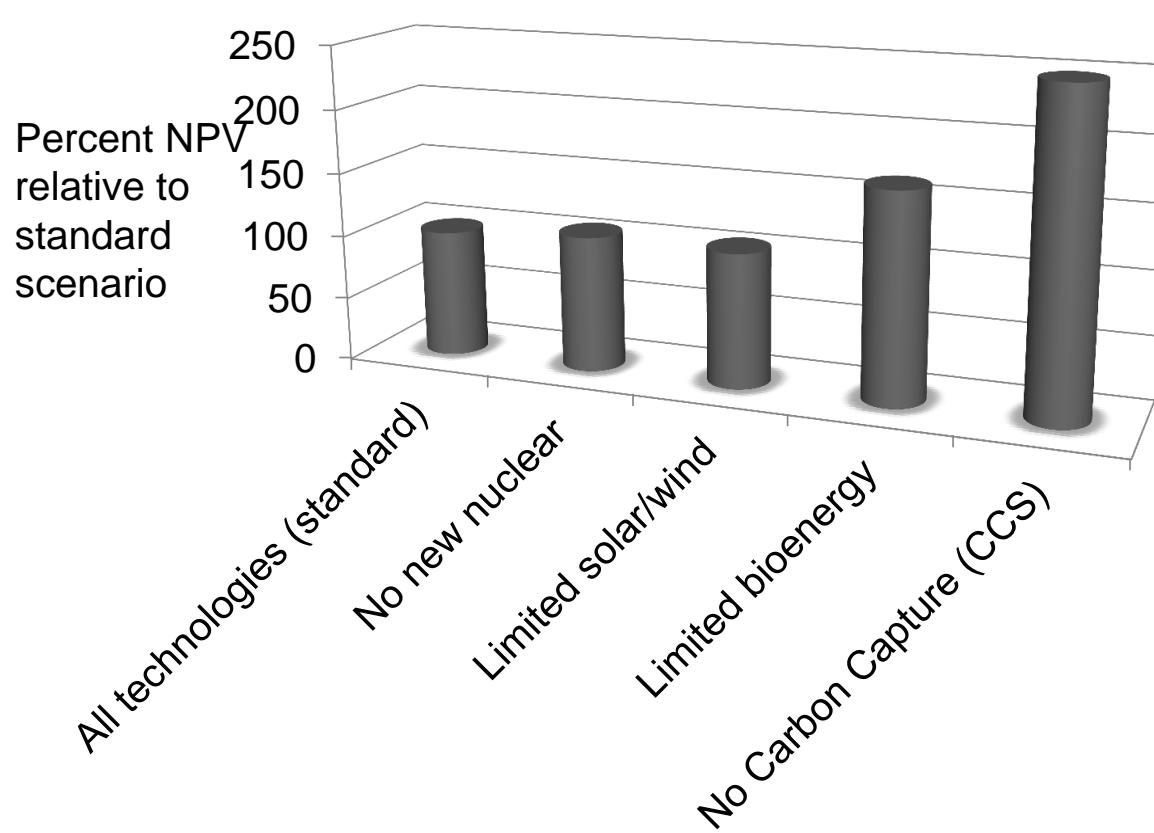
Cumulative emissions and fossil carbon reserves



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Cost of mitigation scenarios likely to meet the 2°C goal



Adapted from IPCC WGIII Fig. 6.24

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Some personal observations

- Cumulative CO₂ emissions determine long-term warming, and carbon budget for 2°C is much less than fossil carbon reserves.
- Meeting the 2°C goal means either:
 - Forbidding the citizens of India of the 2080s from using their coal (ethically questionable and politically impossible).
 - Providing the citizens of India of the 2080s with technologies to use their coal without causing dangerous climate change.
- Carbon capture and storage will take decades to develop, test, deploy and reassure the public.
- This should be the priority now, while fossil fuels are still relatively cheap and climate impacts are only beginning.

trilliontonne.org
Explaining the need to limit cumulative emissions of carbon dioxide.

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Where is the real climate front line?

New York climate march



Gorgon gas project, Western Australia



UNFCCC climate talks

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See also: Allen, Frame and Mason, *Nature Geoscience*, 2:183-814, 2009

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