Long-Term Climate Mitigation Perspectives and the 2°C Objective

based on Chapter 14 of *Climate Science Special Report* (CSSR)

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Presentation overview

Important concepts for any mitigation trajectory: long-term nature of CO_2 climate effect and short-term nature of some non-CO_2 species

Carbon budgets: how much can we still emit globally if the goal is to prevent X amount of warming?

2°C objective: some history and are we on a path to achieve this?

Geoengineering questions and concerns

Mitigation chapter: Key finding #1

Reducing net emissions of CO_2 is necessary to limit long-term warming. **Other greenhouse gases** (for example, methane) and **black carbon aerosols** exert stronger warming effects than CO_2 on a per ton basis, but they do not persist as long in the atmosphere; therefore, **mitigation of non-CO_2 species contributes substantially to near-term cooling** benefits but cannot be relied upon for ultimate stabilization goals. (*Very high confidence*)

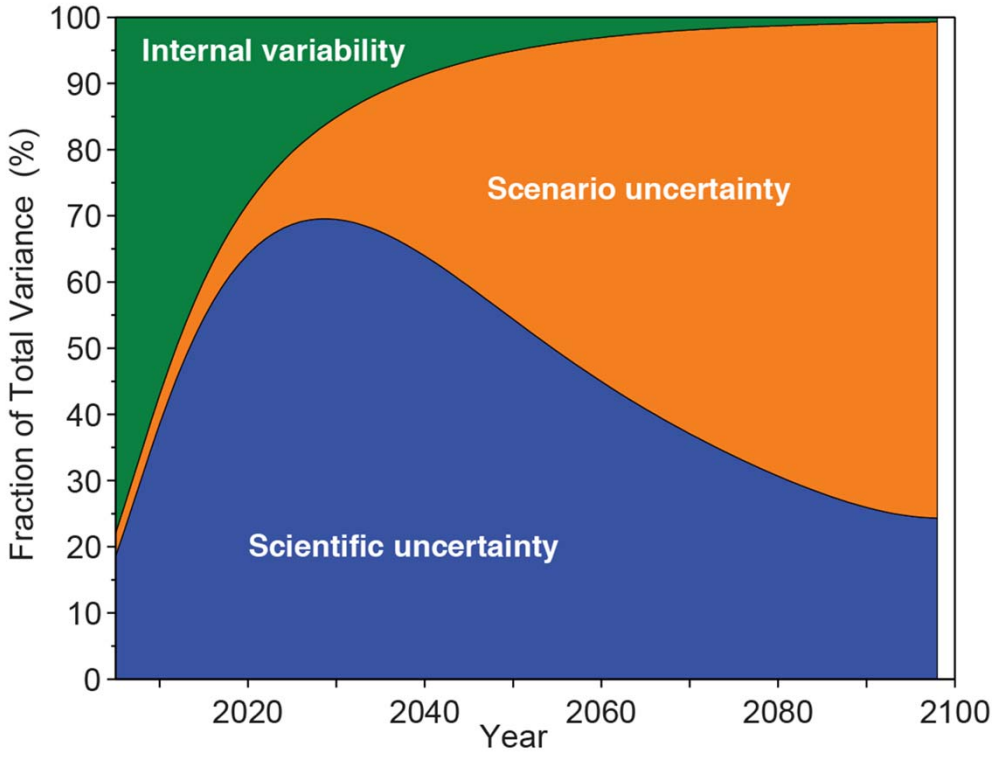
Long-term warming influence dominated by *cumulative* CO_2 emissions

IPCC estimated that 15% to 40% of CO_2 emitted until 2100 will remain in the atmosphere longer than 1,000 years

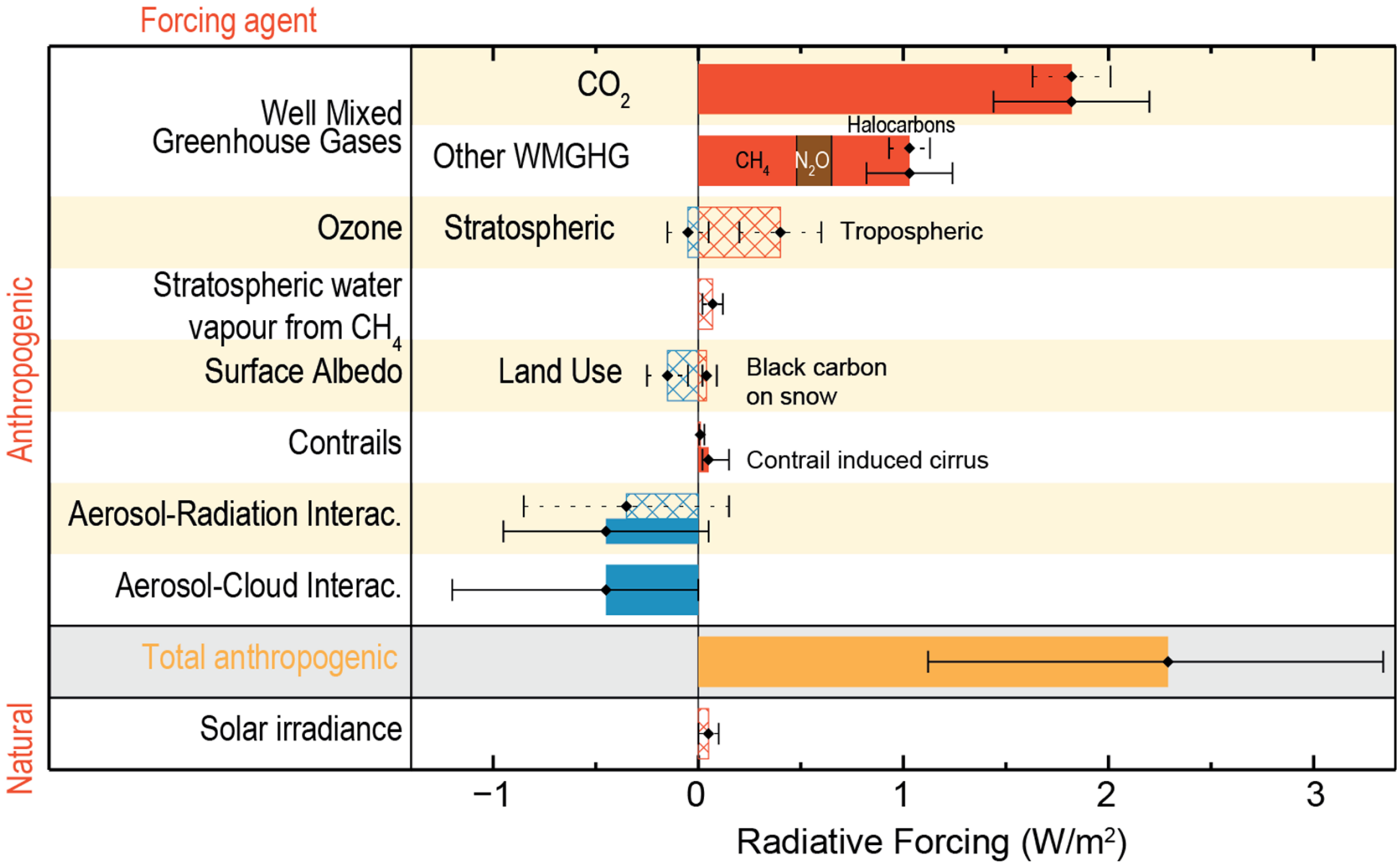
Persistence of warming is longer than the atmospheric lifetime of CO_2 (and other GHGs), owing in large part to the thermal inertia of the ocean

Large reductions in emissions of the long-lived GHGs are estimated to have modest temperature effects in the *near term* (e.g., over one to two decades)

Long-term projections of global surface temperature (after mid-century), on the other hand, show that the choice of global emissions pathway, and thus the long-term mitigation pathway the world chooses, is the dominant source of future uncertainty in climate outcomes



Radiative Forcing of Climate Between 1750 and 2011

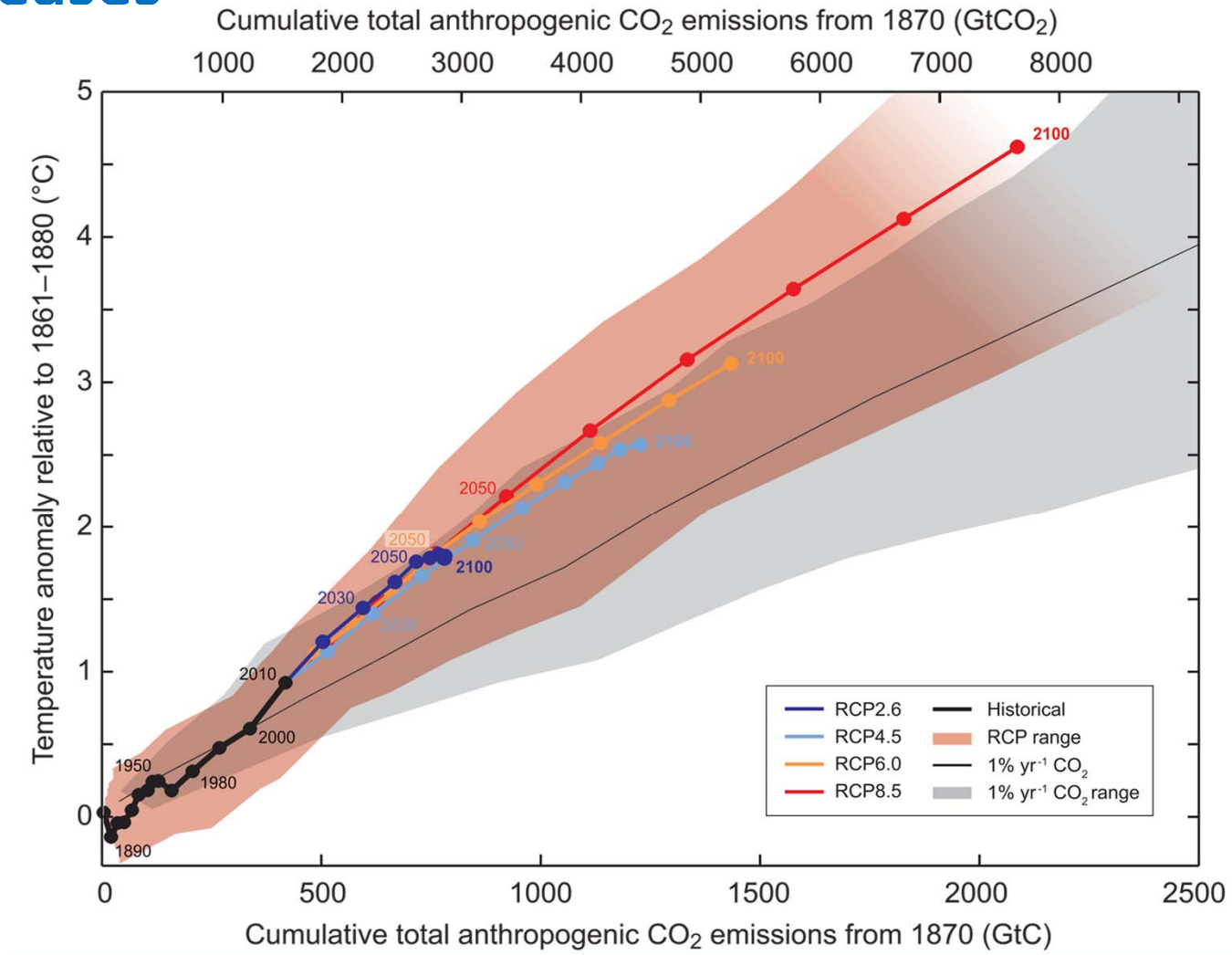


Mitigation chapter: Key finding #2

Stabilizing global mean temperature to less than **3.6°F (2°C)** requires **substantial reductions in net CO_2 emissions prior to 2040** and likely requires net emissions to become **zero or negative later in the century**.

Cumulative CO_2 emissions must stay below **about 800 GtC** in order to provide a two-thirds likelihood of preventing 3.6°F (2°C). Given estimated emissions since 1870, no more than approximately 230 GtC may be emitted in the future to remain under this. Assuming emissions equal to or greater than RCP4.5, **this cumulative carbon threshold would be exceeded in approximately two decades**. (*High confidence*)

Nearly linear relationship between cumulative CO_2 emissions and global mean temperature increases

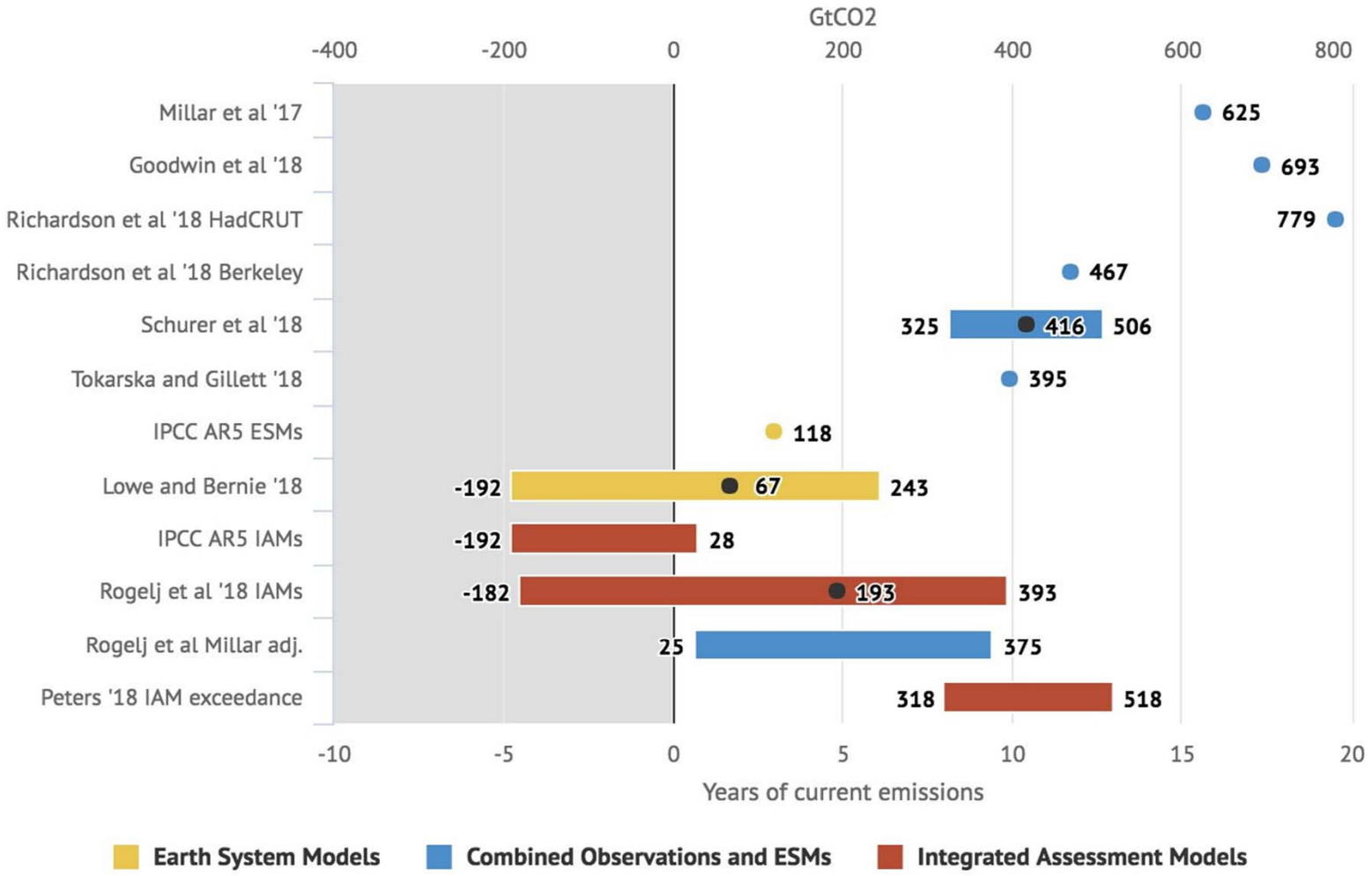


Source:
IPCC 2013

Dates by when cumulative carbon emissions (GtC) since 1870 reach amount commensurate with 3.6°F (2°C), when accounting for non-CO_2 forcings:			
	66% = 790 GtC	**50% = 820 GtC**	**33% = 900 GtC**
RCP4.5	2037	2040	2047
RCP8.5	2033	2035	2040

Dates by when cumulative carbon emissions (GtC) since 1870 reach amount commensurate with 2.7°F (1.5°C), when accounting for non-CO_2 forcings:			
	66% = 593 GtC	**50% = 615 GtC**	**33% = 675 GtC**
RCP4.5	2019	2021	2027
RCP8.5	2019	2021	2025

Remaining carbon budget for a 66% chance of less than 1.5C warming



Source: Carbon Brief, https://www.carbonbrief.org/analysis-how-much-carbon-budget-is-left-to-limit-global-warming-to-1-5c

Some history and background on 2°C (3.6°F)

The idea of a 3.6°F (2°C) goal can be found in the scientific literature as early as 1975.

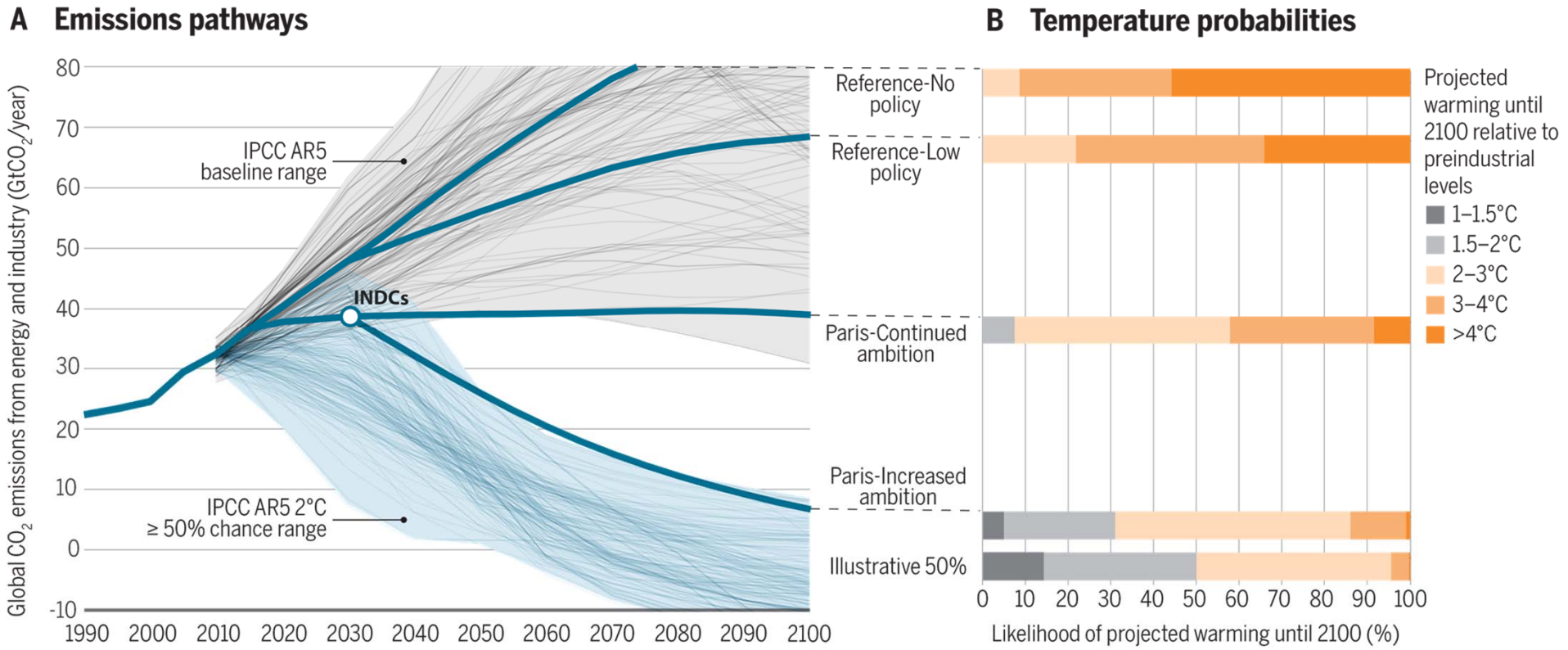
> **Nordhaus justified it by simply stating, "If there were global temperatures more than 2 or 3°C above the current average temperature, this would take the climate outside of the range of observations which have been made over the last several hundred thousand years."**

The Stockholm Environment Institute published a report in 1990 stating that 3.6°F (2°C) "can be viewed as an upper limit beyond which the risks of grave damage to ecosystems, and of non-linear responses, are expected to increase rapidly."

In 2007, the IPCC Fourth Assessment Report stated, among other things: "Confidence has increased that a 1 to 2°C increase in global mean temperature above 1990 levels (about 1.5 to 2.5°C above pre-industrial) poses significant risks to many unique and threatened systems including many biodiversity hotspots."

Mitigation chapter: Key finding #3

Achieving reductions before 2030 consistent with actions announced by governments in the lead up to **Paris** would **hold open the possibility of meeting the long-term temperature goal** of limiting warming to 3.6°F (2°C) above preindustrial levels, whereas there **would be virtually no chance if net emissions followed a pathway well above those** implied by country announcements. Actions in the announcements are, by themselves, insufficient to meet a 3.6°F (2°C) goal; the **likelihood of achieving that goal depends strongly on reductions after 2030**. (*High confidence*)



Source: Fawcett et al. 2015

Mitigation chapter: Key finding #4

Further assessments of the technical feasibilities, costs, risks, co-benefits, and governance challenges of **climate intervention or geoengineering** strategies, which are as yet unproven at scale, are a **necessary** step **before judgments about the benefits and risks** of these approaches can be made with high confidence. (*High confidence*)

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