Options for Estimating the Global Economic Impacts of Climate Change and the Social Cost of Carbon Module-by-Module

A Public Educational Webcast Series Presented by Stanford University and EPRI

John Weyant (Stanford University) and Steven Rose (EPRI)

April 17, 2024 – Webcast #3

Series Focus on Global Economic Impacts Calculation Modules

January 11th

Future economies and emissions

TODAY'S TOPIC

Future climates and earth systems

February 26th

Future economic impacts ($/year)

NEXT

Discounting

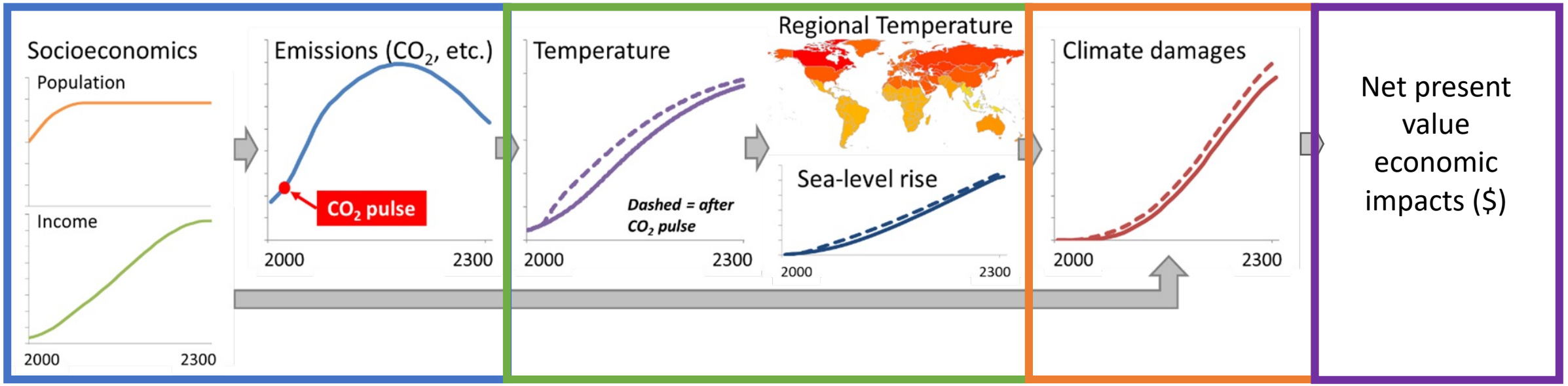


Figure: Rose et al (2017, 2014).
Used in NASEM (2017).
CO_2 pulse and dashed lines represent the secondary calculations required in social cost of carbon estimation.

The Series

Expert panels

- Convene panels of leading experts on the science related to each of the modules associated with estimating global economic impacts, and overall issues
- Each panel will share its thoughts on the available science, options, technical issues, and opportunities

Series' goals

- Improve the state of understanding regarding the available science related to each module
- Facilitate scientific and public dialogue on approaches, alternatives, and opportunities
- Inform the development of the scientifically reliable estimates needed for robust decisions and public confidence

Topics

January 11th
- Series introduction and projecting economies and emissions for estimating the global economic impacts of climate change (speakers: van der Mensbrugghe, van Vuuren, Delink, Rose)

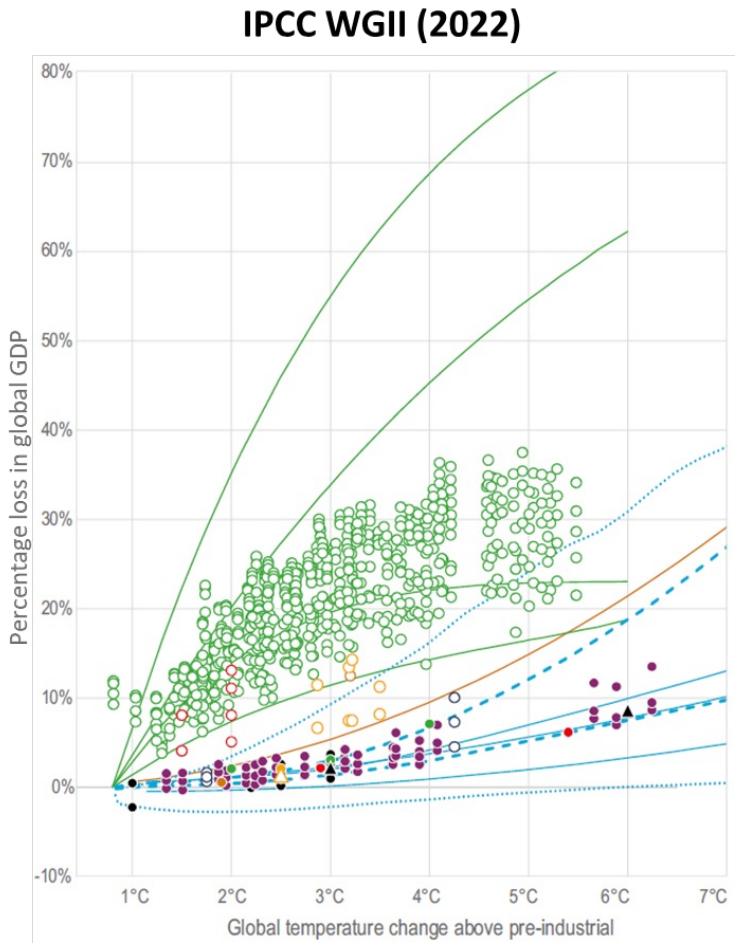
TODAY
- Modeling global climate change and earth system responses to greenhouse gas emissions

February 26th
- Estimating the global economic impacts response to a future climate (speakers: Ciscar, Rose, Auffhammer, Sue Wing)

NEXT
- Discounting future global economic impacts of climate change
- If not the social cost of carbon, what else or what in addition to it?
- Is module-by-module modeling of the global economic impacts of climate change credible?

Series Motivation

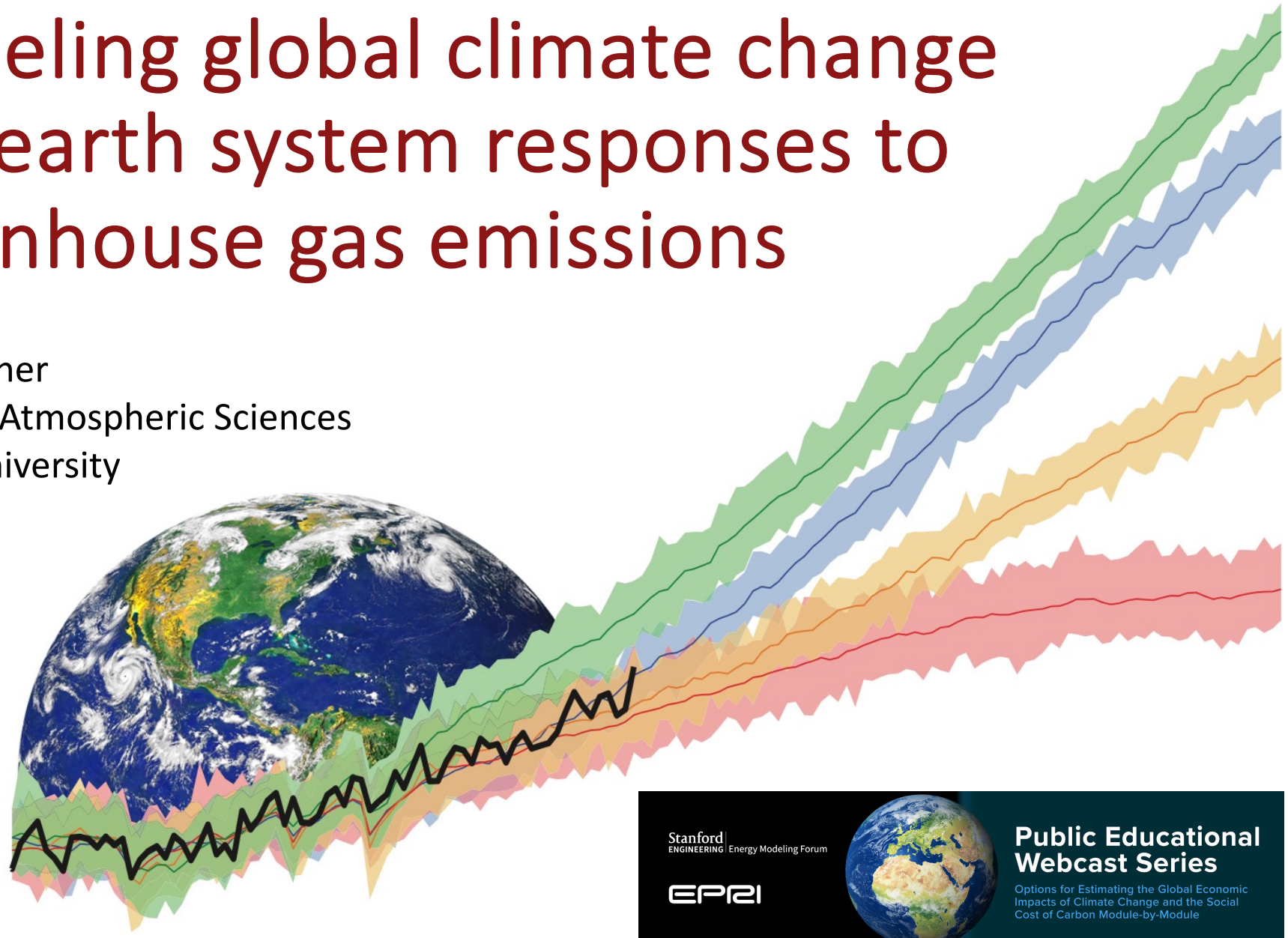
- Significant **policy & public interest** in understanding the global economic impacts of a changing climate
- This is **important information**:
  - For estimating the benefits of limiting warming to well below 2°C,
  - For evaluating macroeconomic climate risks to economies, and
  - For estimating the social costs of greenhouse gases (SC-GHGs) needed for evaluating the benefits and costs of policies
- However, these analyses are **technically and scientifically challenging**:
  - Requiring projecting global economic and physical systems for centuries
  - Dealing with significant uncertainty
- Recent IPCC reports and new SC-GHG methodology developments have created the **need for assessment of current underlying scientific knowledge** and translation of that information into global economic impacts of climate change modeling
- **Governments and stakeholders need scientifically reliable (grounded & robust) information to inform decisions with significant national and global ramifications**
- **Broad scientific and public engagement, understanding, assessment, and dialogue are essential**



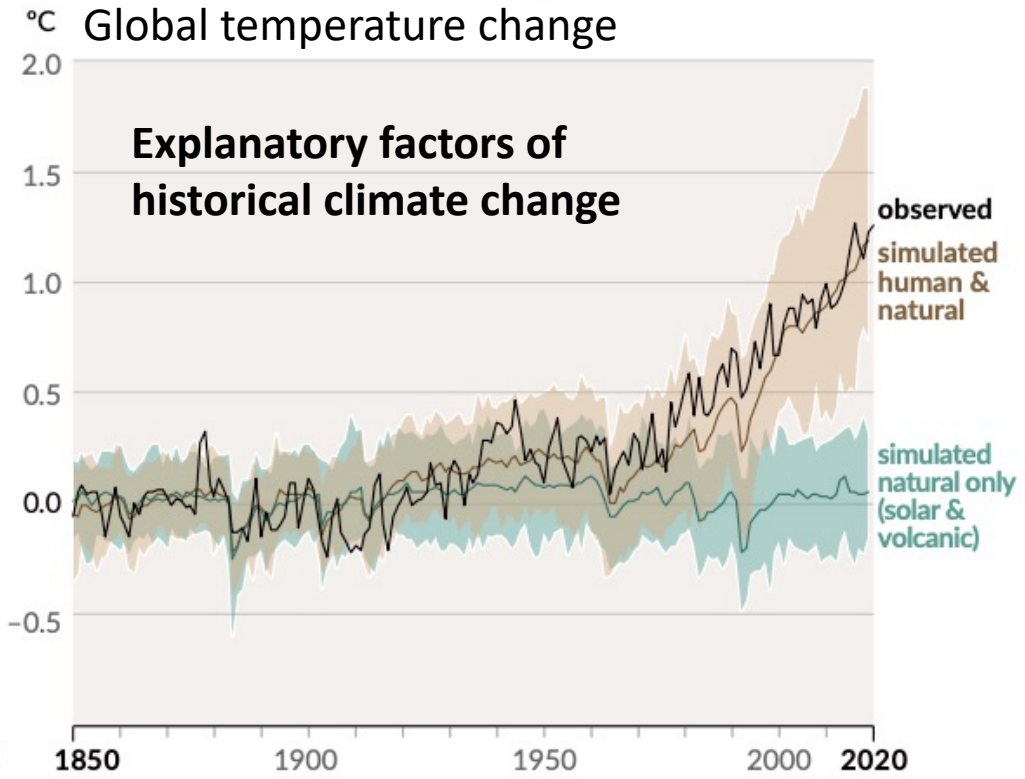
Source: Cross-Working Group Box | Estimating Global Economic Impacts from Climate Change. In IPCC WGII Chapter 16 (2022), https://www.ipcc.ch/report/ar6/wg2/.

Modeling global climate change and earth system responses to greenhouse gas emissions

Flavio Lehner
Earth and Atmospheric Sciences
Cornell University



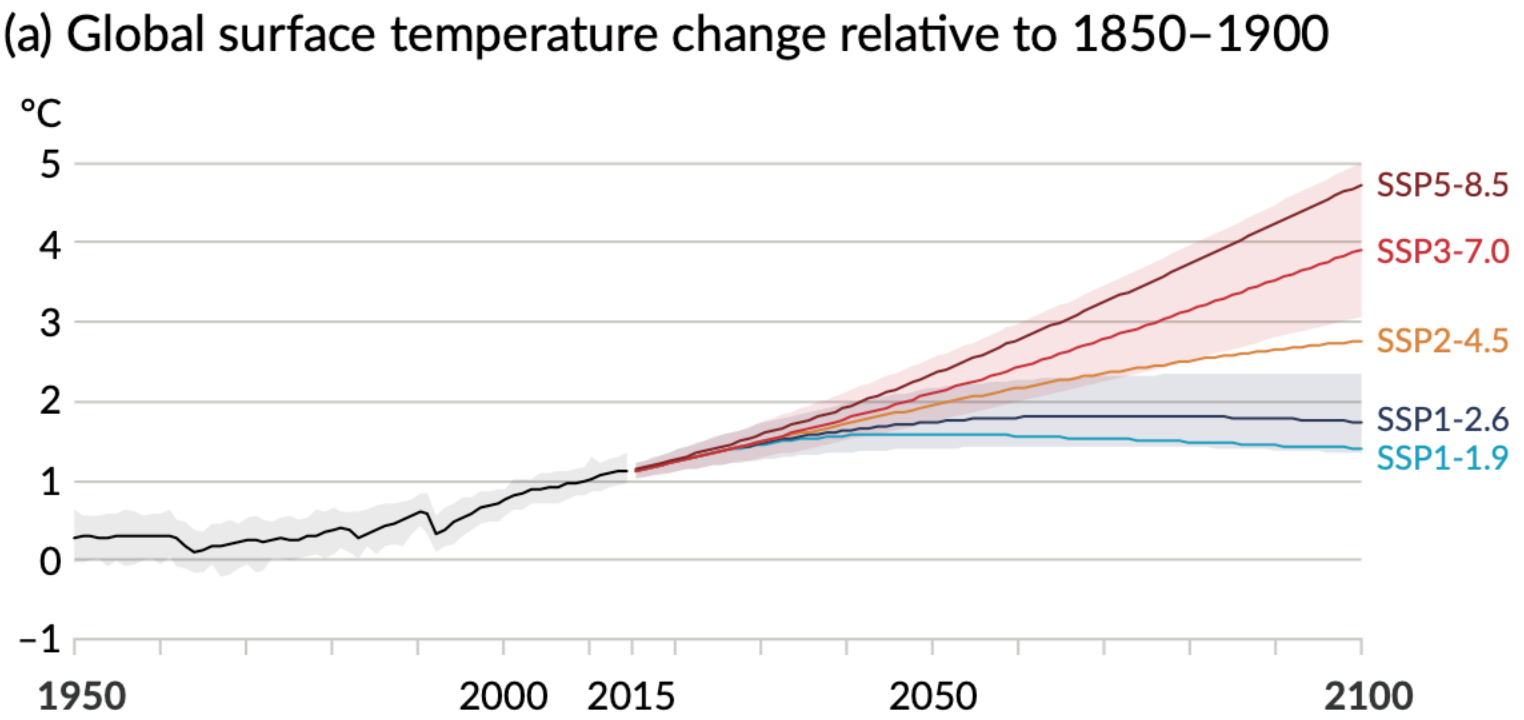
Climate models as a tool to understand the past and predict the future



IPCC AR6 WG1 SPM, 2021

Climate models can be used to **detect and attribute** historical climate change

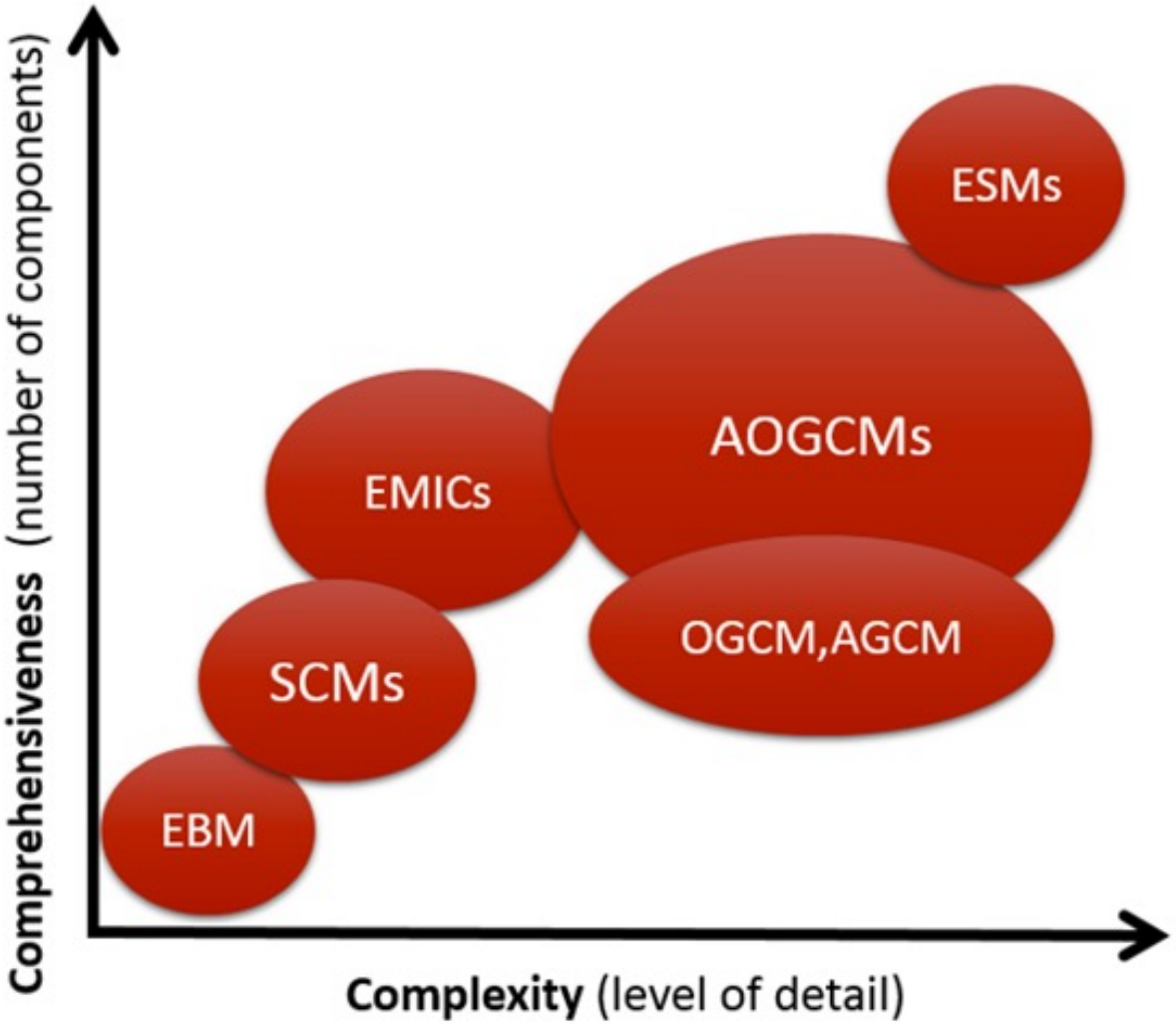
Climate models as a tool to understand the past and predict the future



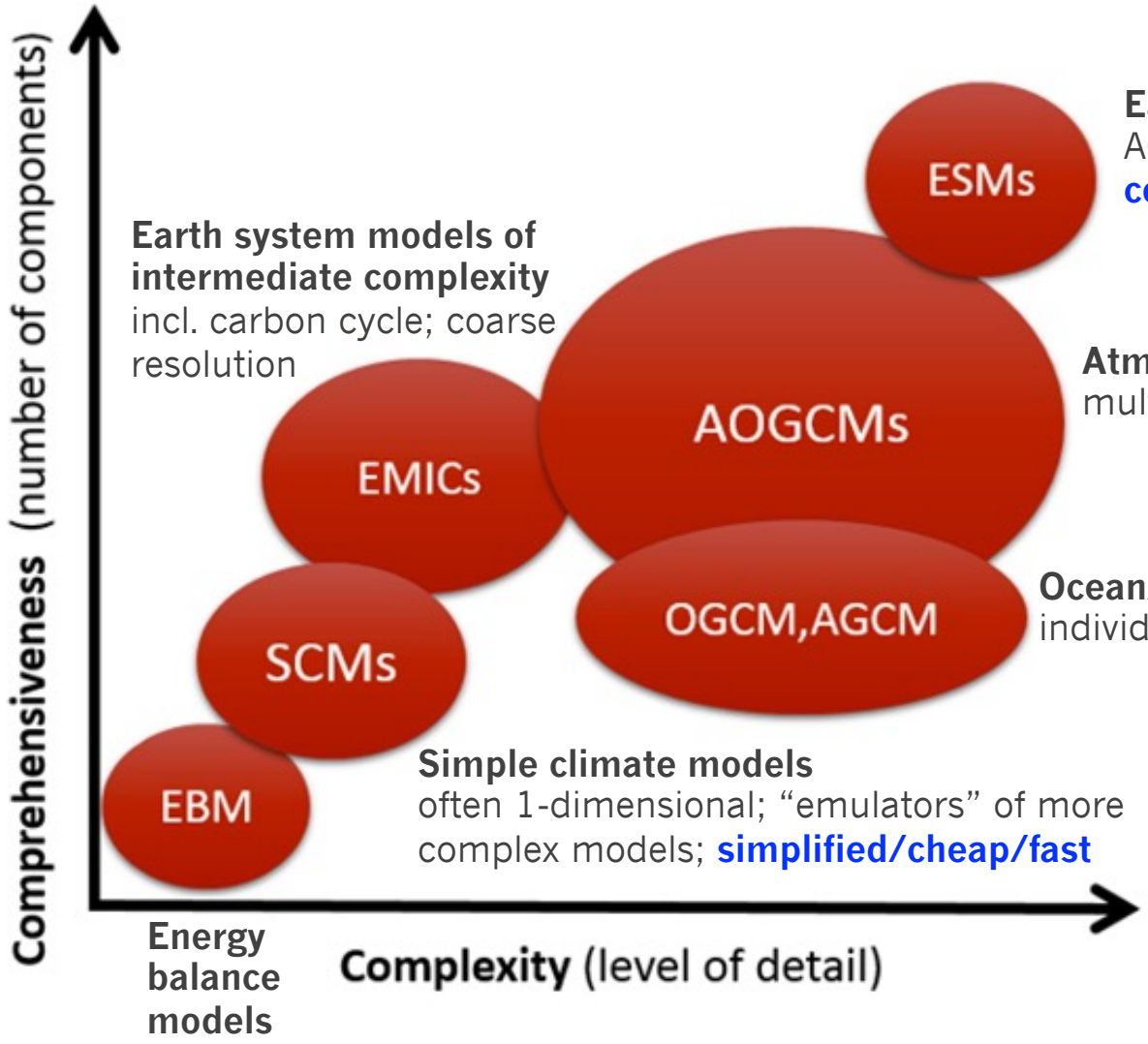
Climate models can be used to **predict/project** future climate change

IPCC AR6 WG1 SPM, 2021

Hierarchy of climate models



Hierarchy of climate models



Earth system models
AOGCMs incl. carbon cycle, chemistry
comprehensive/expensive/slow

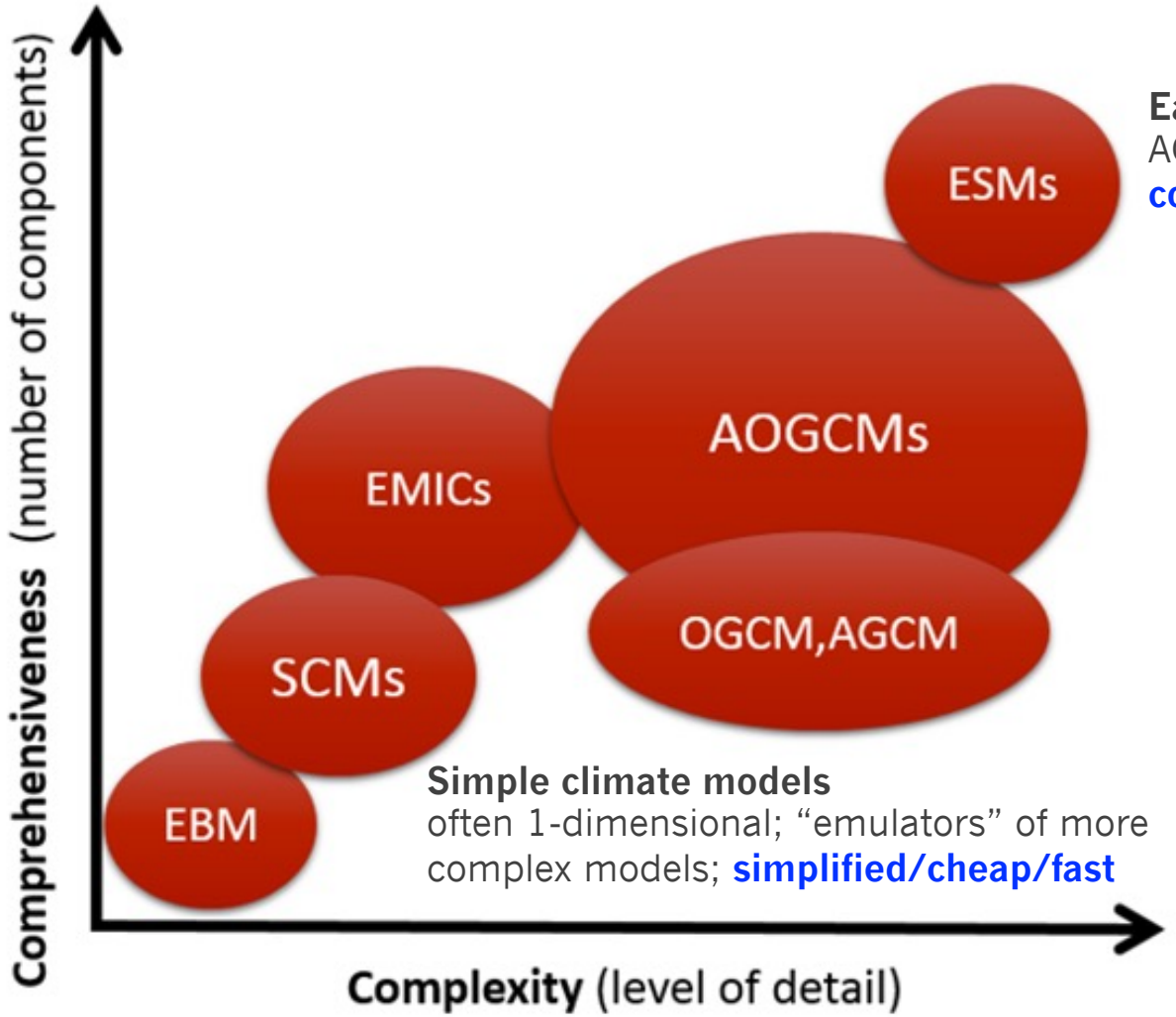
Earth system models of intermediate complexity
incl. carbon cycle; coarse resolution

Atmosphere-Ocean general circulation models
multiple components coupled; mostly just physics

Ocean/Atmosphere general circulation models
individual climate components; mostly just physics

Simple climate models
often 1-dimensional; "emulators" of more complex models; **simplified/cheap/fast**

Hierarchy of climate models



Earth system models
AOGCMs incl. carbon cycle, chemistry
comprehensive/expensive/slow

Simple climate models
often 1-dimensional; "emulators" of more complex models; **simplified/cheap/fast**

Hierarchy of climate models

Earth system models
AOGCMs incl. carbon cycle, chemistry
comprehensive/expensive/slow

Necessary to **develop confidence** in projected climate change

Feedbacks, physical hazards, regional details

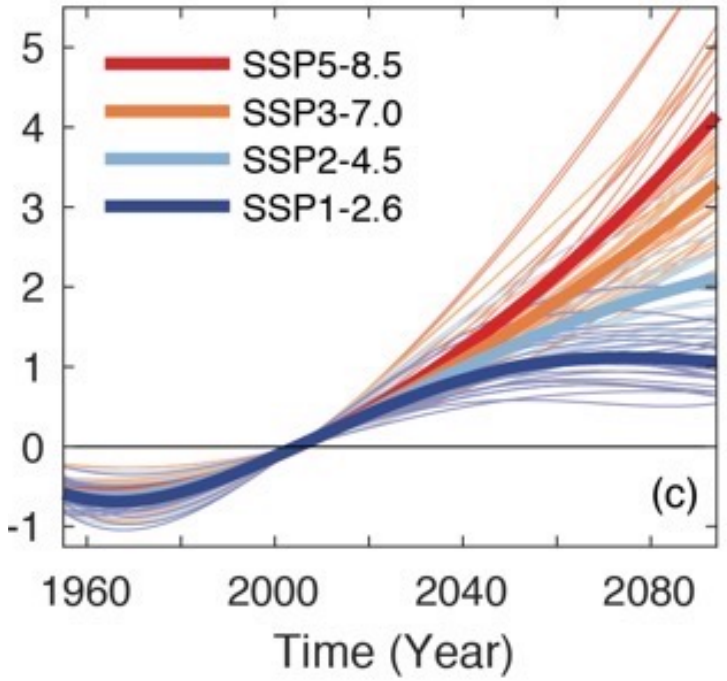
Simple climate models
often 1-dimensional; “emulators” of more complex models; **simplified/cheap/fast**

Necessary to **sample/create many possible futures**

Optimal pathways, economic impacts, social cost of carbon, benefits of mitigation

Uncertainty partitioning

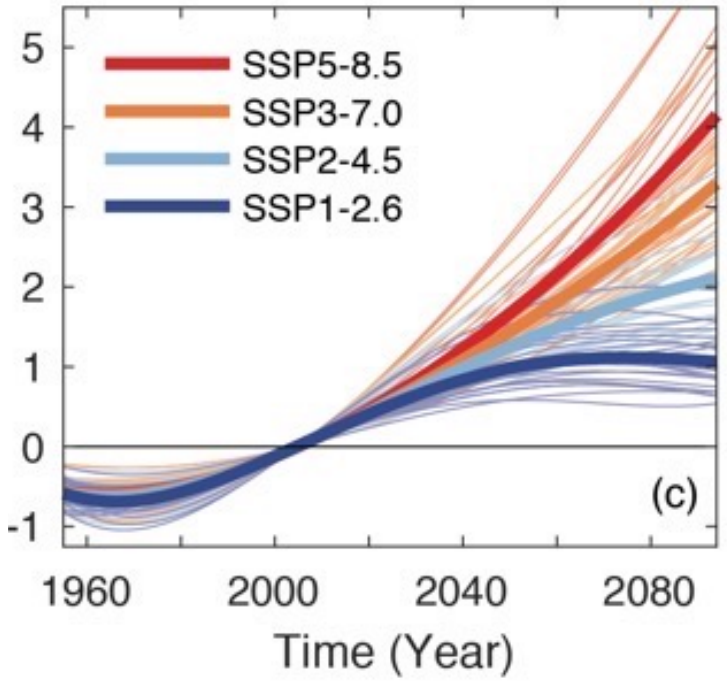
Global temperature change from CMIP6 (°C)



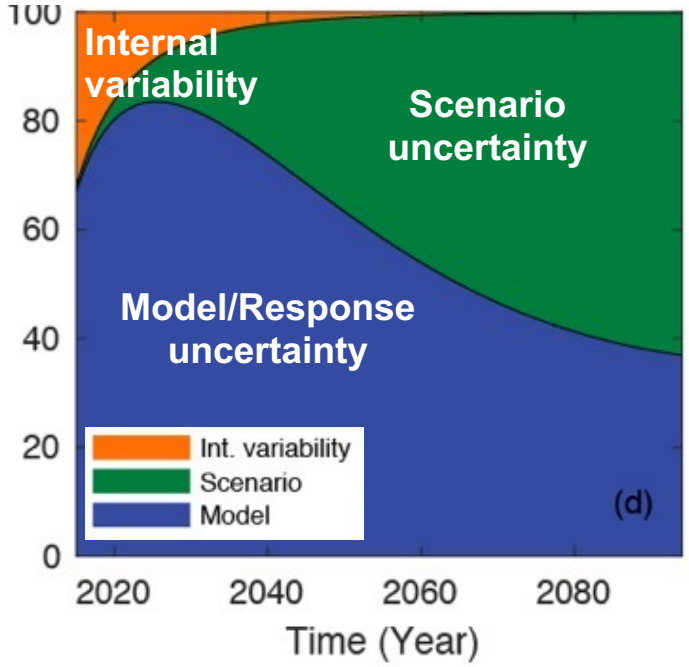
Lehner et al. (2020); see also Hawkins and Sutton (2009)

Uncertainty partitioning

Global temperature change from CMIP6 (°C)



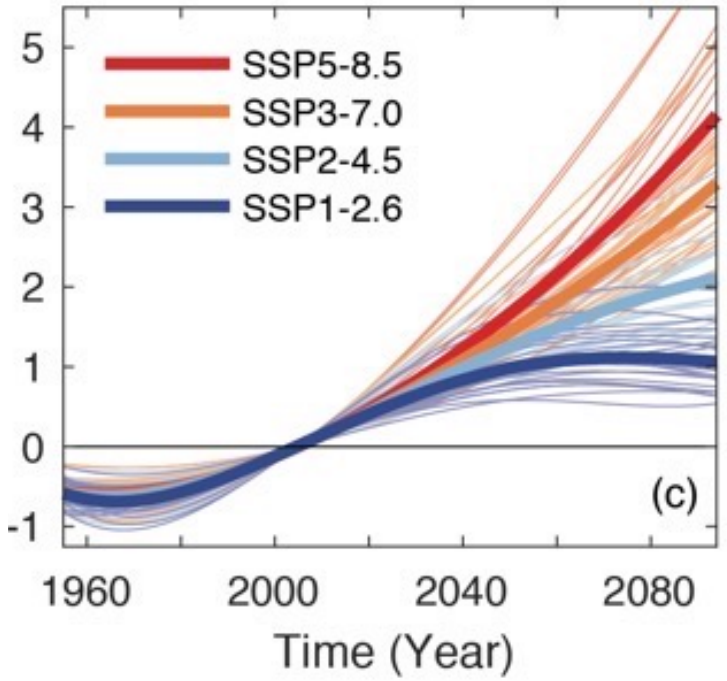
Fractional uncertainty contributions (%)



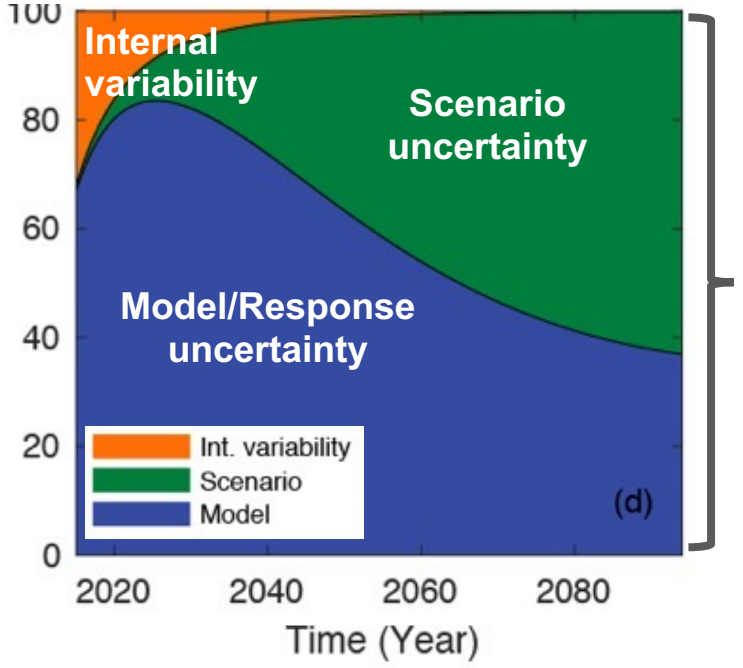
Lehner et al. (2020); see also Hawkins and Sutton (2009)

Uncertainty partitioning

Global temperature change from CMIP6 (°C)



Fractional uncertainty contributions (%)

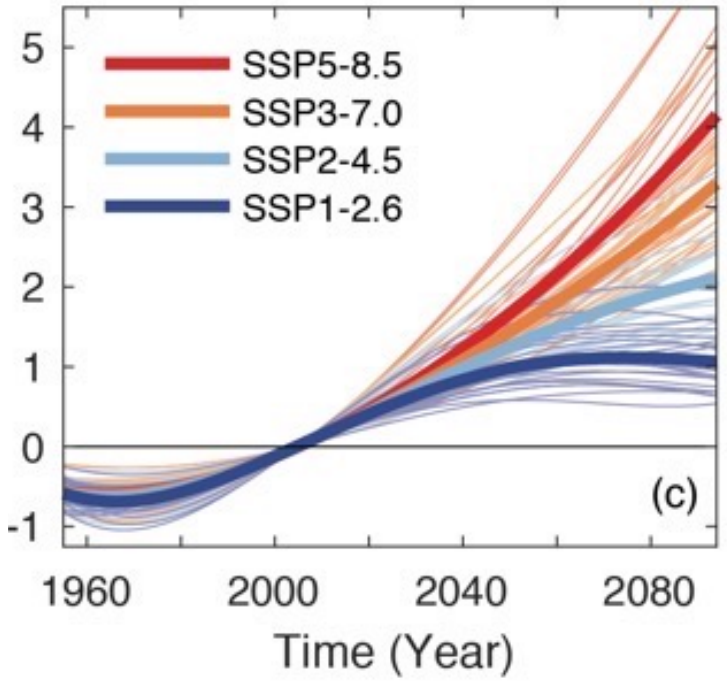


Many climate **impacts/costs** scale with global warming level (GWL) → acute need to understand, plan for, and ideally **reduce projection uncertainties**

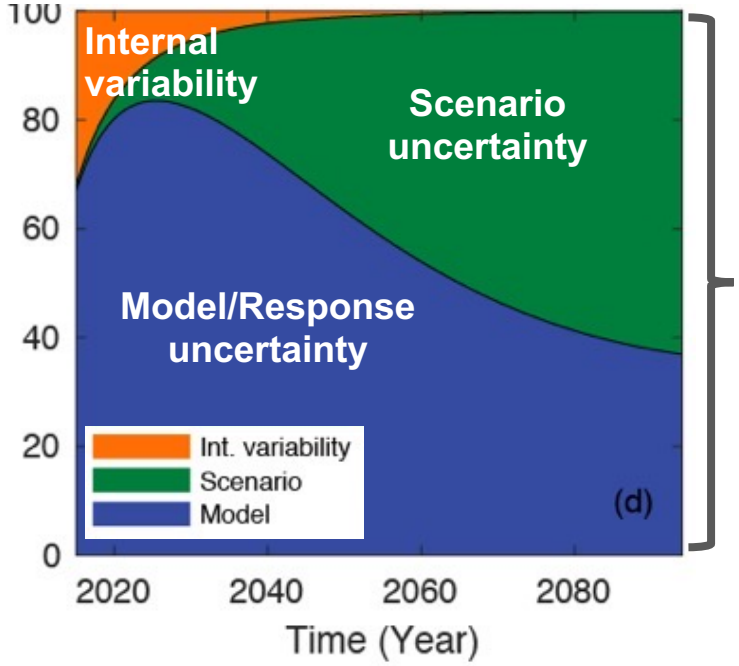
Lehner et al. (2020); see also Hawkins and Sutton (2009)

Uncertainty reduction?

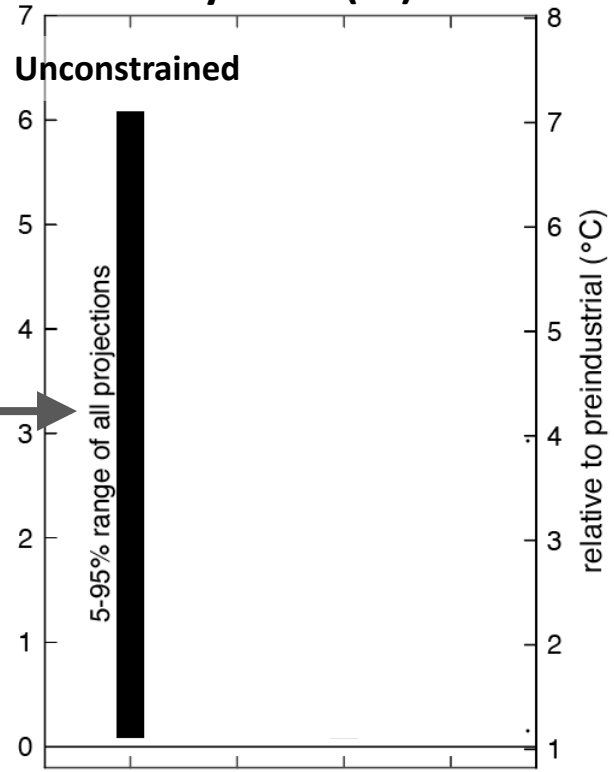
Global temperature change from CMIP6 (°C)



Fractional uncertainty contributions (%)



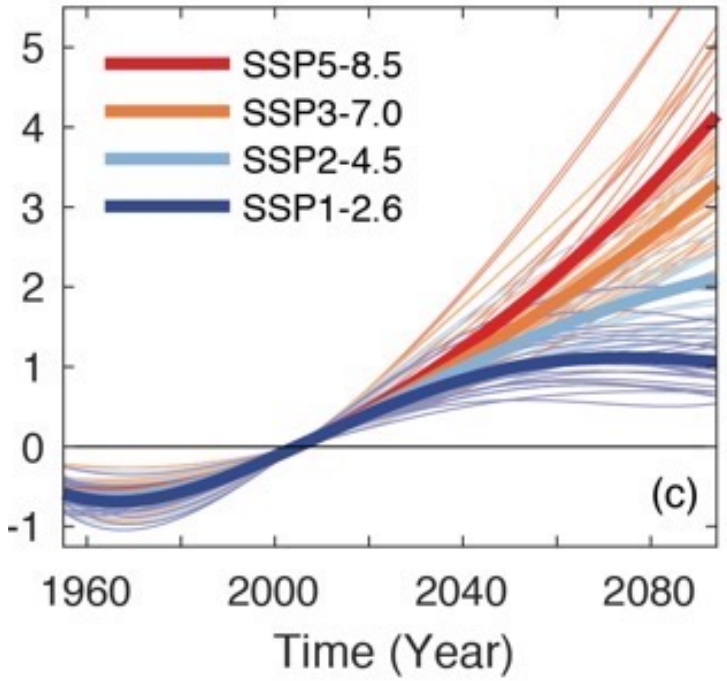
Global temperature change by 2100 (°C)



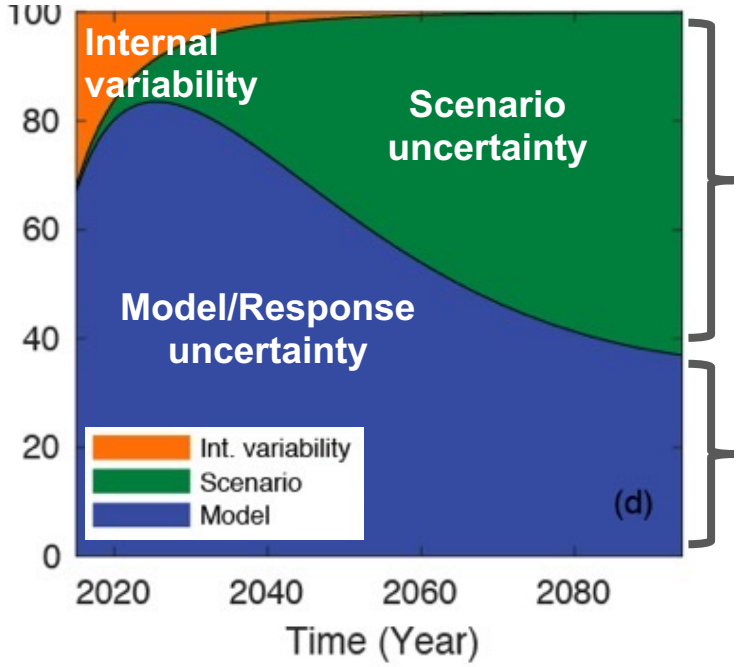
Lehner et al. (2023)
Moore et al. (2022)
Qasmi & Ribes (2022)
Hausfather & Peters (2020)

Uncertainty reduction?

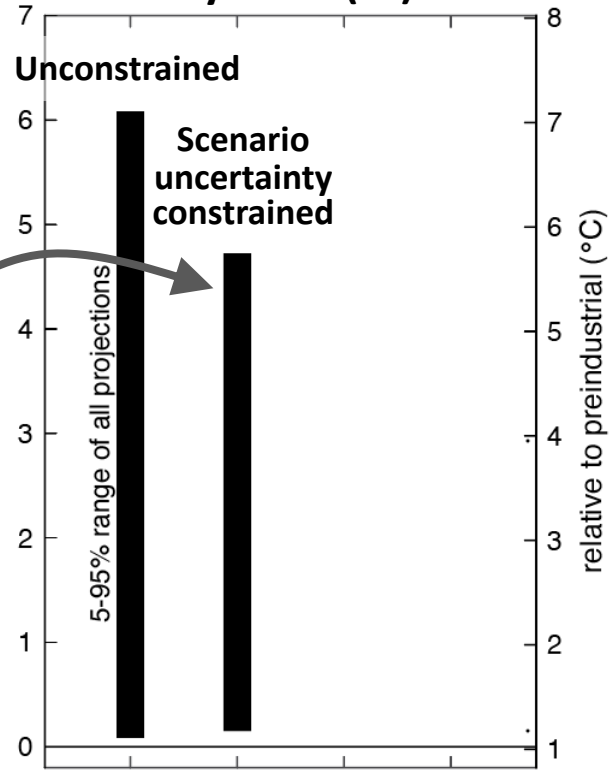
Global temperature change from CMIP6 (°C)



Fractional uncertainty contributions (%)



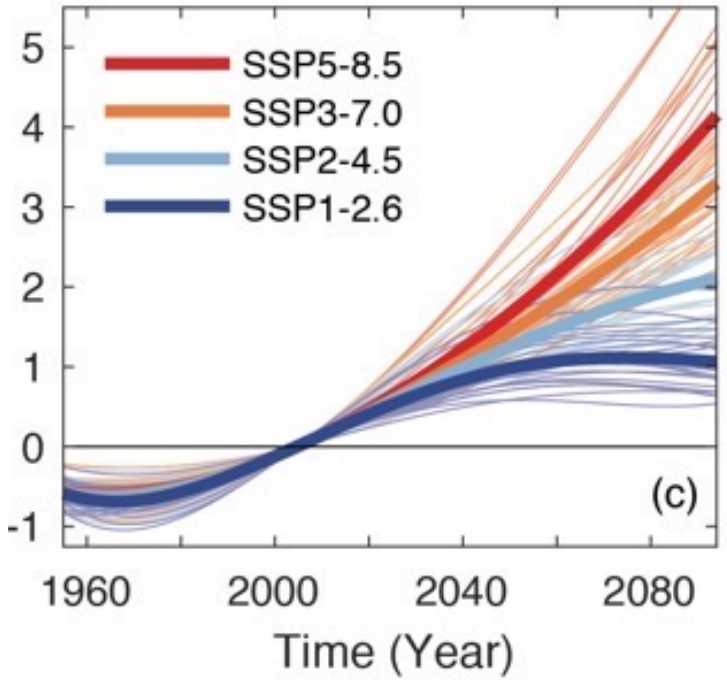
Global temperature change by 2100 (°C)



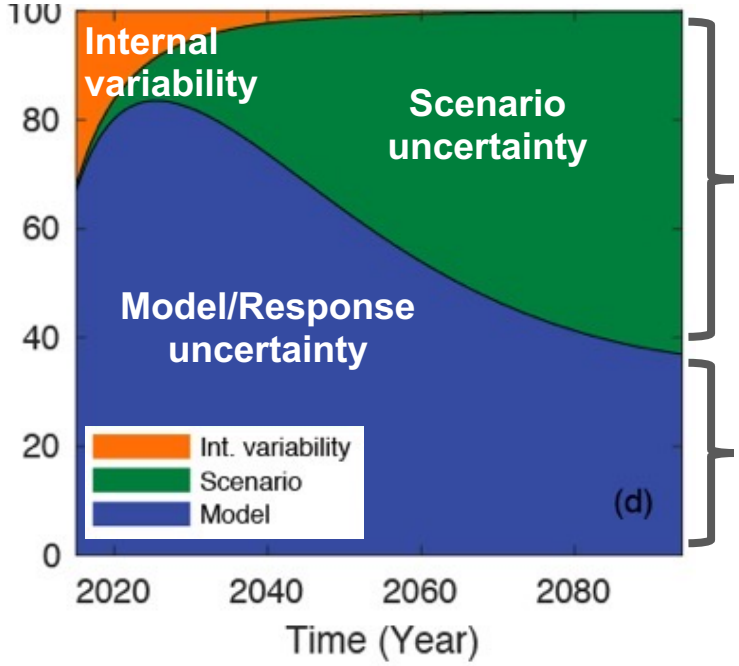
Lehner et al. (2023)
Moore et al. (2022)
Qasmi & Ribes (2022)
Hausfather & Peters (2020)

Uncertainty reduction?

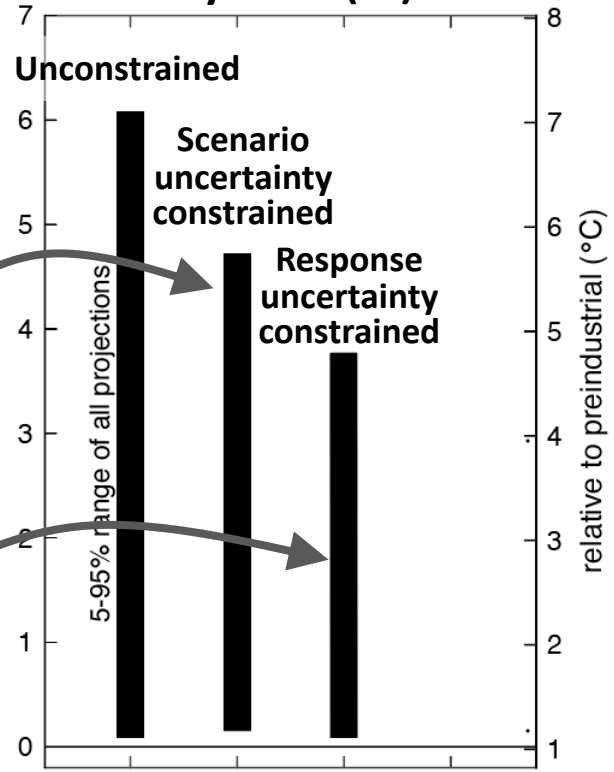
Global temperature change from CMIP6 (°C)



Fractional uncertainty contributions (%)



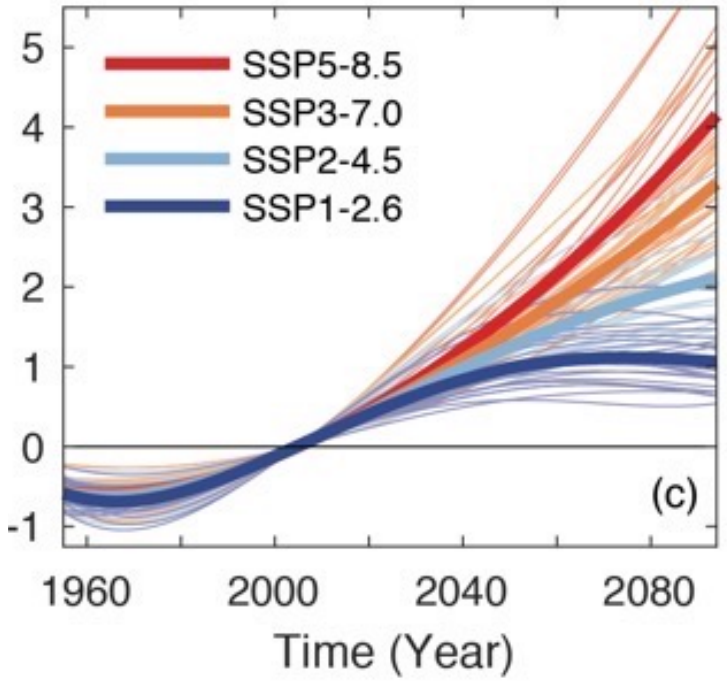
Global temperature change by 2100 (°C)



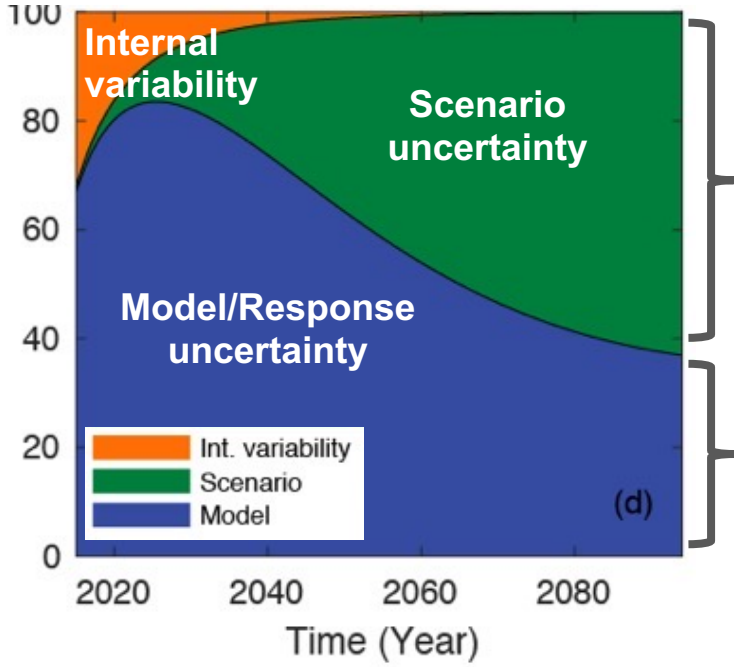
Lehner et al. (2023)
Moore et al. (2022)
Qasmi & Ribes (2022)
Hausfather & Peters (2020)

Uncertainty reduction?

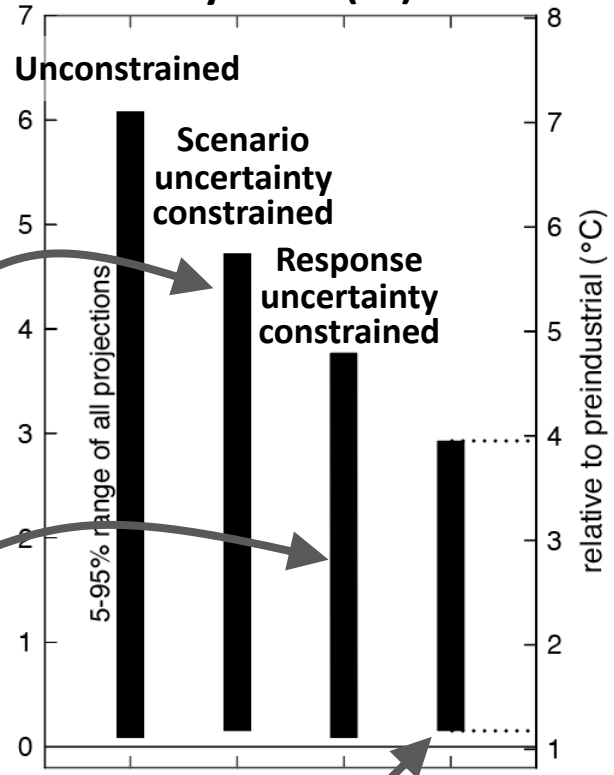
Global temperature change from CMIP6 (°C)



Fractional uncertainty contributions (%)



Global temperature change by 2100 (°C)



Combination of published constraints **narrows likely warming range**

Lehner et al. (2023)
Moore et al. (2022)
Qasmi & Ribes (2022)
Hausfather & Peters (2020)

Conclusions and current issues

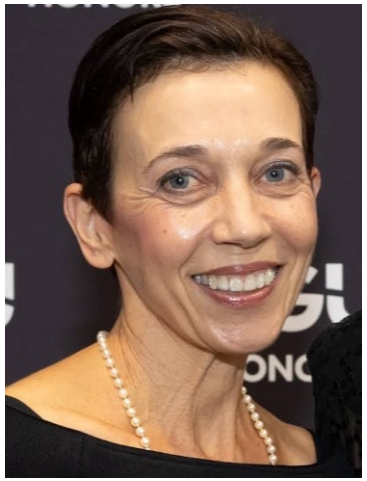
- A plethora of tools and data exists; deciding how to make best use requires **expert knowledge**
- Climate change uncertainties at the global scale are *slowly* being constrained – planning within an **uncertain future**
- Climate modeling is a resource-limited endeavor with many **competing interests**
- What do we need to know to make **better/more useful projections**?

Today's panelists

- Erwan Monier (University of California, Davis)
- Corinne Hartin (U.S. Environmental Protection Agency)
- Claudia Tebaldi (Pacific Northwest National Laboratory)

Dr. Monier

Dr. Hartin



Dr. Tebaldi

If you have questions?

- Questions will be taken during the discussion
- Please submit your questions via the Zoom Q&A feature (bottom of screen)
- We will be monitoring the Q&A and sequence and group questions
- We may not get to all the questions. We will do the best we can.

Panelist remarks

Thank you for participating today!

Next webcast in the series

Discounting future global economic impacts of climate change

Date TBD

Series information, including slides, bios, recordings:

https://emf.stanford.edu/stanford-epri-public-educational-webcast-series

Comments and questions: weyant@stanford.edu, srose@epri.edu