NSE
Nuclear Science and Engineering

science : systems : society

MIT

EAPS
Earth, Atmospheric and Planetary Sciences

The Climate Problem: Solutions and Opportunities

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Essential Points

Presentation starts by stating main points and policy implications

- Though there remain important uncertainties in detailed outcomes, there is ample evidence that climate change presents significant risks.
- Technological energy developments, largely based on U.S. science and innovation, provide the basis for large economic opportunities
- Roadblocks to innovation and development, mostly in the form of cumbersome and outdated regulations, are preventing the U.S. from reaping the economic benefits of its own innovations

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Important Points about Climate and Climate Science

- Current understanding of climate science built on much more than giant climate models

- Although many uncertainties remain in climate projections, current evidence points to serious climate risk to future generations

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Climate Science Has a Long History

Svante Arrhenius, 1859-1927

"Any doubling of the percentage of carbon dioxide in the air would raise the temperature of the earth's surface by 4°; and if the carbon dioxide were increased fourfold, the temperature would rise by 8°." – *Världarnas utveckling* (Worlds in the Making), 1906

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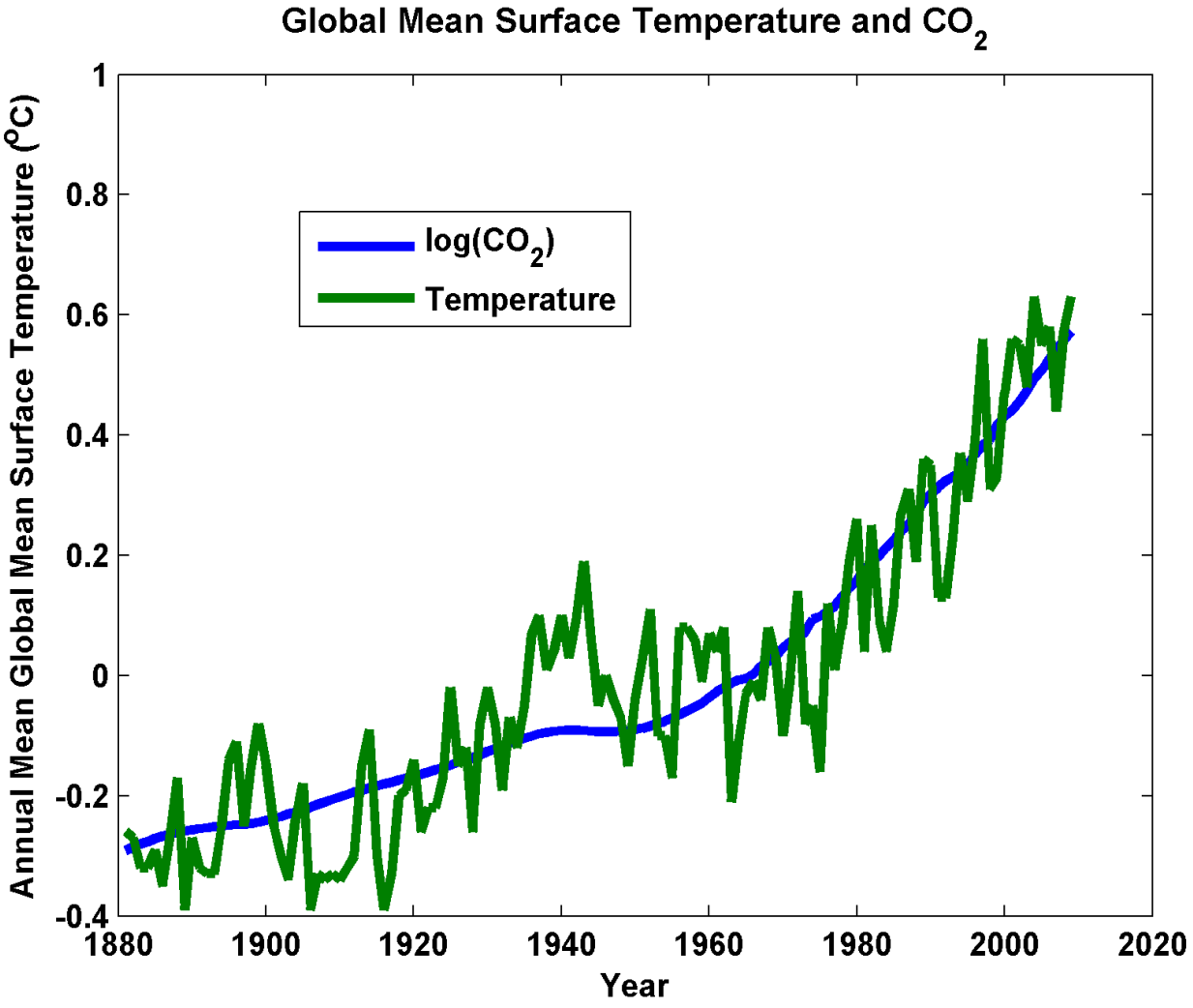
Scientific Predictions, Dating Back More than 100 Years, Are Well Verified by Observations

Slide title is a complete sentence that states the main takeaway



Axes are labeled and legible

Data sources: Temperature: NASA GISS Global Land-Ocean; CO2: NASA GISS

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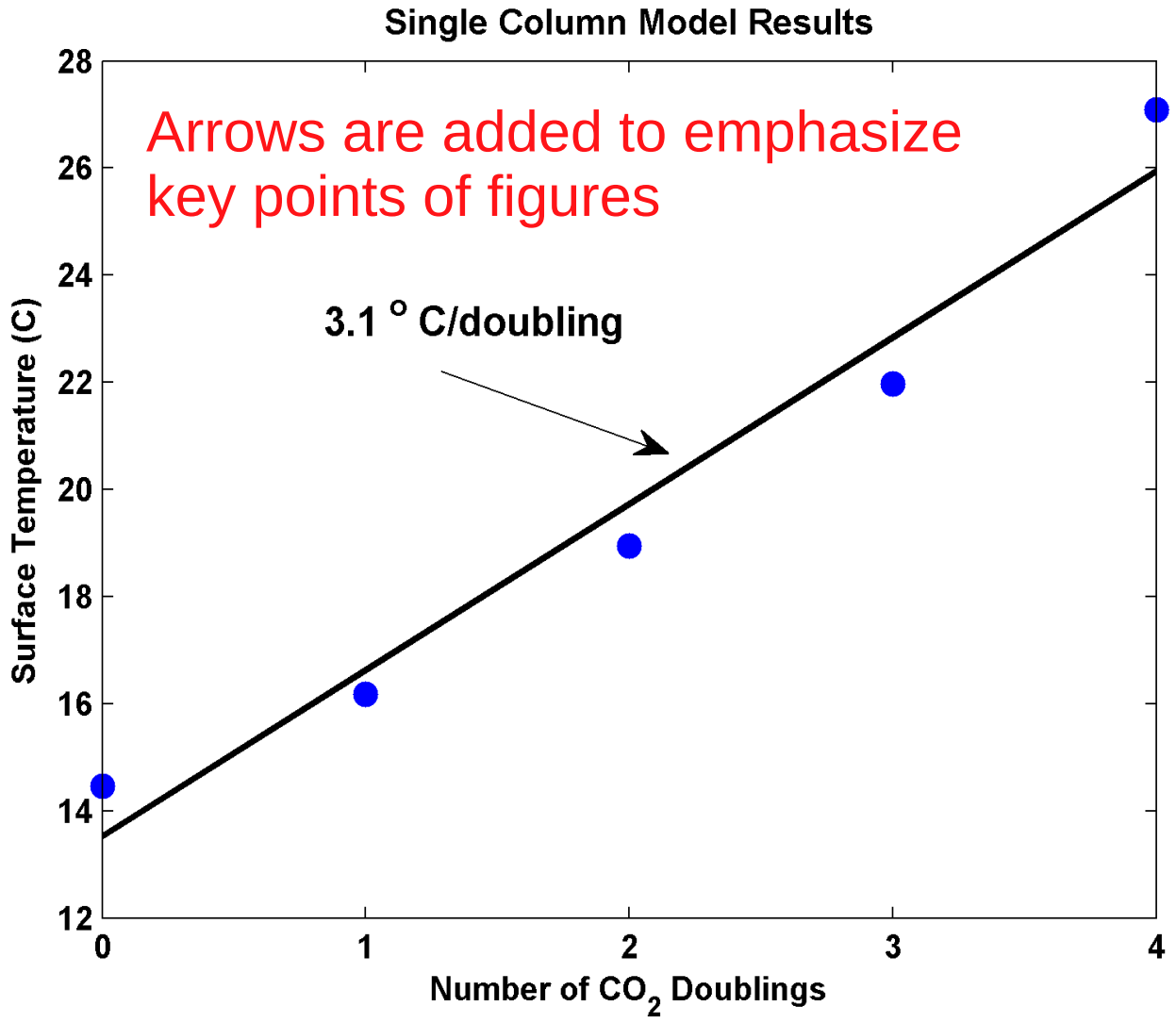
Earlier Predictions in Accord with Advanced Understanding of Climate Physics



IPCC Estimate: 1.5-4.5 °C

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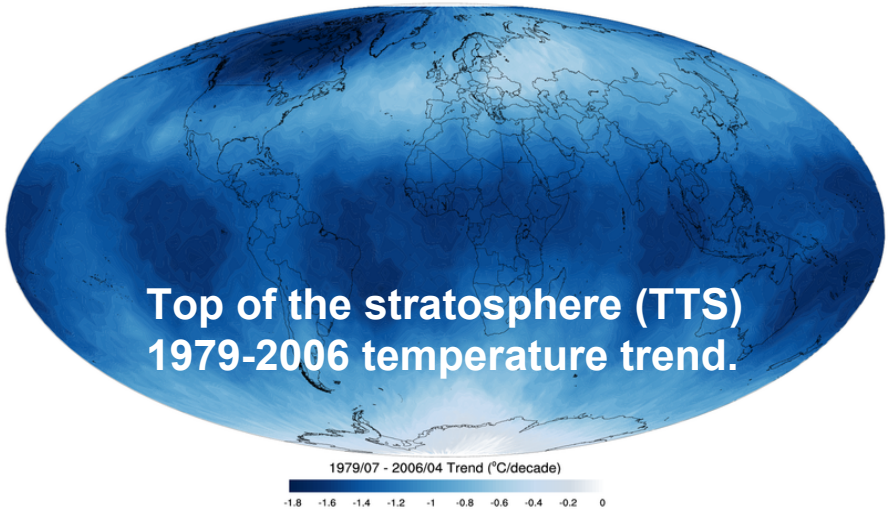
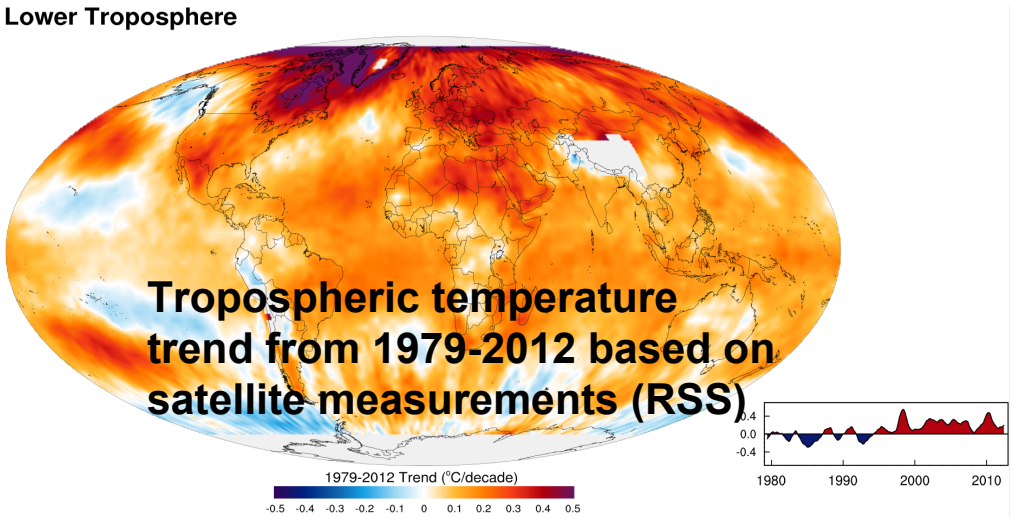
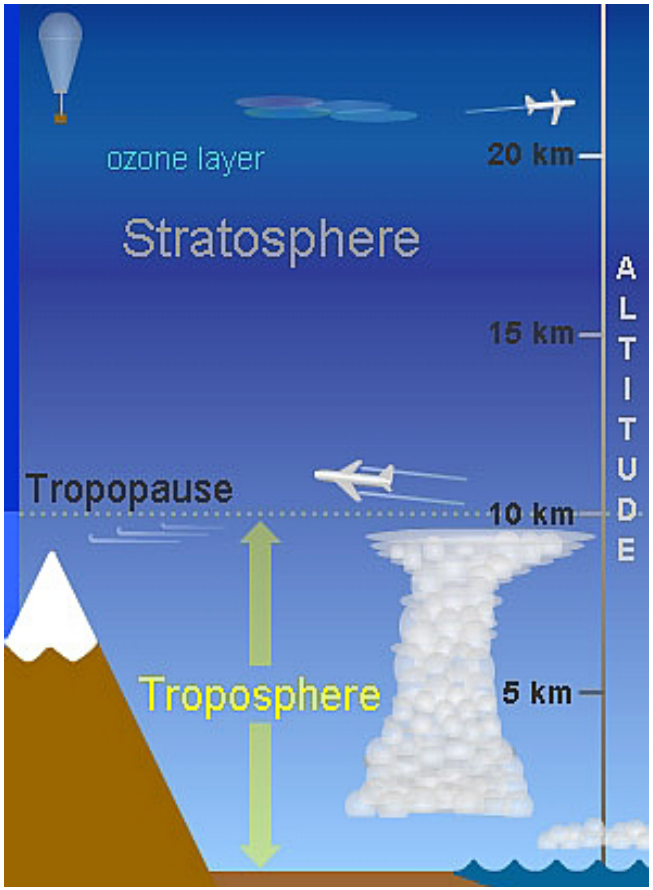
Increased CO_2 Fingerprint: Stratosphere Cools While Troposphere Warms







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Risks

- Increasing sea level
- Increasing hydrological events… droughts and floods
- Increasing incidence of high category hurricanes and associated storm surges and freshwater flooding
- More heat stress and other health risks
- Armed conflict

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Benefits

- Some increase in plant productivity
- Reduction in health problems related to cold weather

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Sources of Uncertainty

- Cloud Feedback
- Water Vapor Feedback
- Ocean Response
- Aerosols

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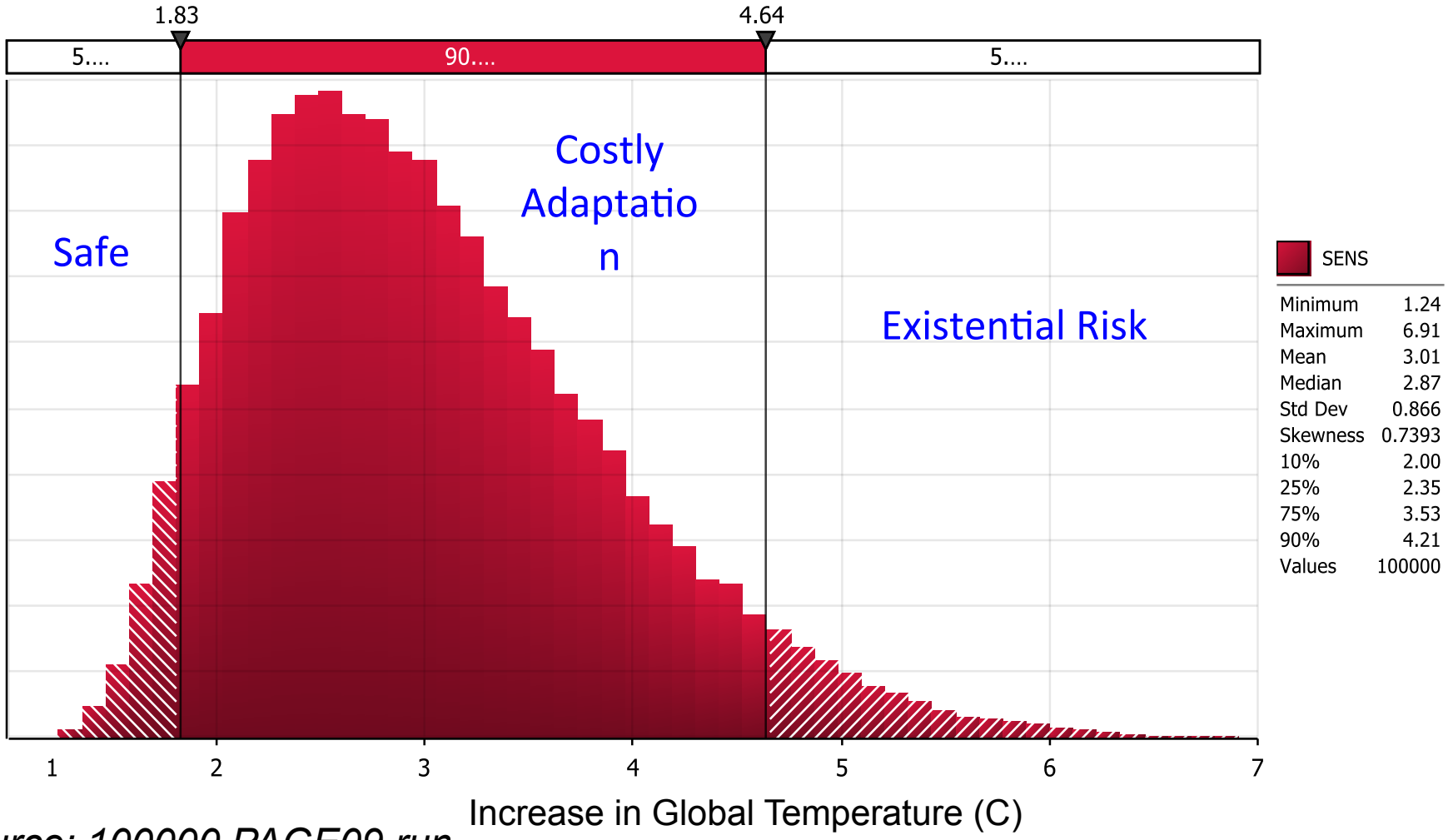
A Probabilistic Estimate of Global Mean Temperature Increase



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SEI

ClimateCost

Chris Hope, U. Cambridge
courtesy Tim Palmer

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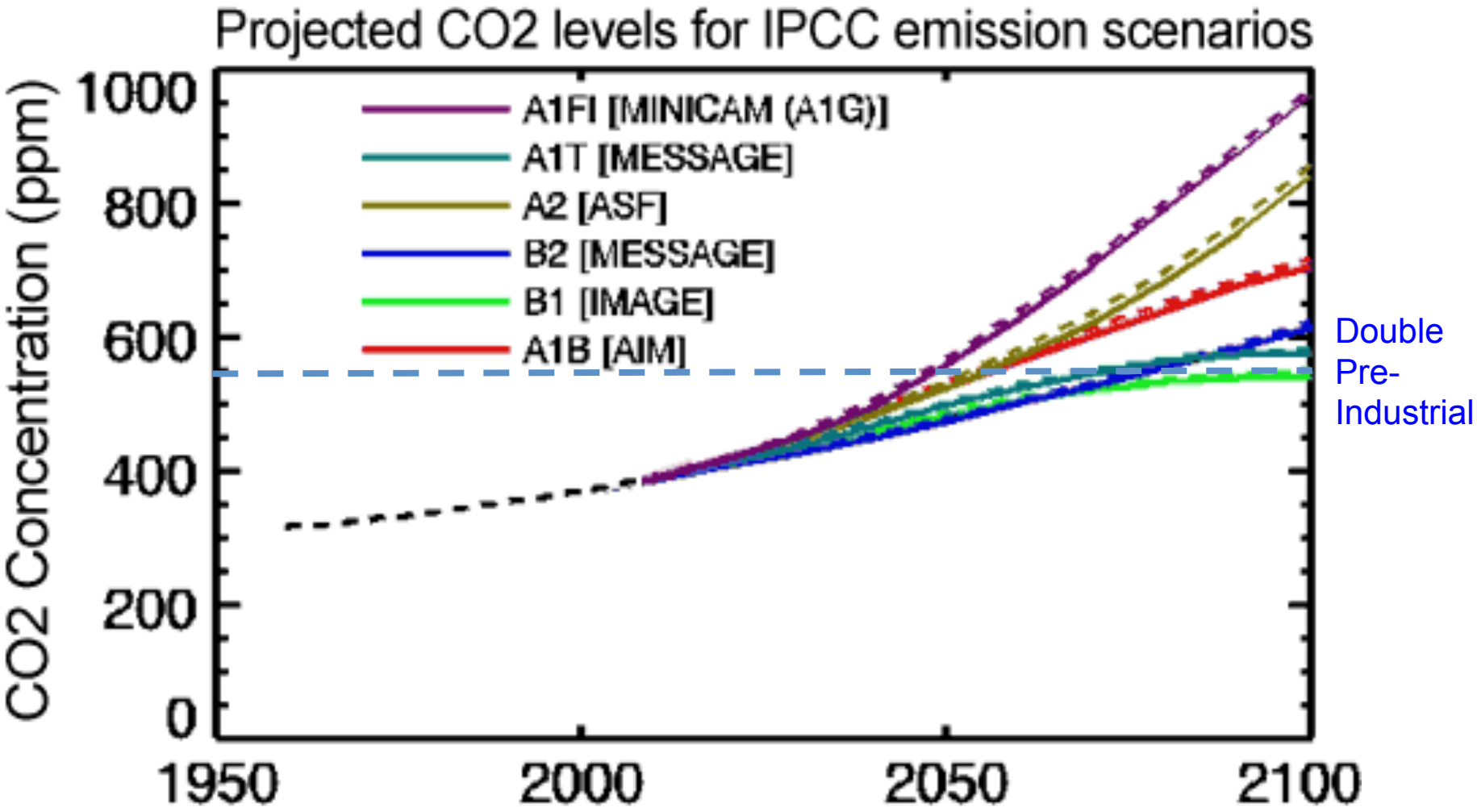
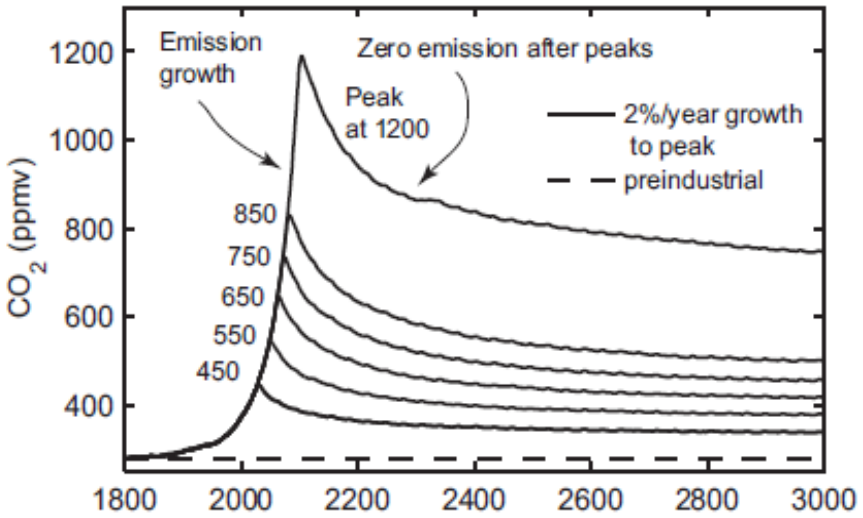
CO_2 Will Go Well Beyond Doubling



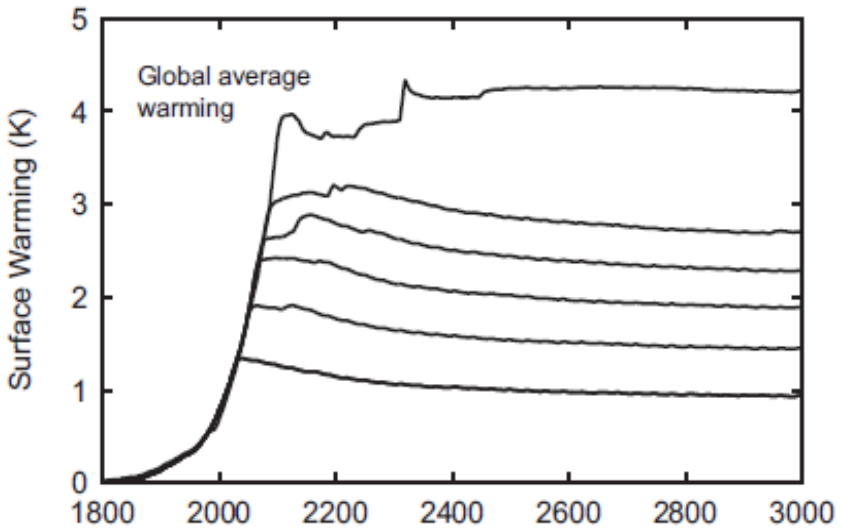
Slide title is a complete sentence that states the main takeaway

Long Lifetime of CO2 in Atmosphere Locks in Change for Millennia

Atmospheric CO_2 assuming that emissions stop altogether after peak concentrations



Global mean surface temperature corresponding to atmospheric CO_2 above



Source: Solomon et al., *PNAS*, 2009

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Presentation ends with reiteration of key messages and takeaways

Summary of Main Points

- Several aspects of climate science are well established
- Projections remain uncertain; this uncertainty is not likely to diminish in the near future
- Outcome probability distributions are broad and contain dangerous tail risks that become central risks late in the century
- Lifetime of CO_2 in atmosphere measured in millennia; cannot afford to wait for more certainty

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