

# New Developments in “Fingerprint” Studies with Atmospheric Temperature

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MIT Global Change Forum

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# Vertical fingerprinting: Origins

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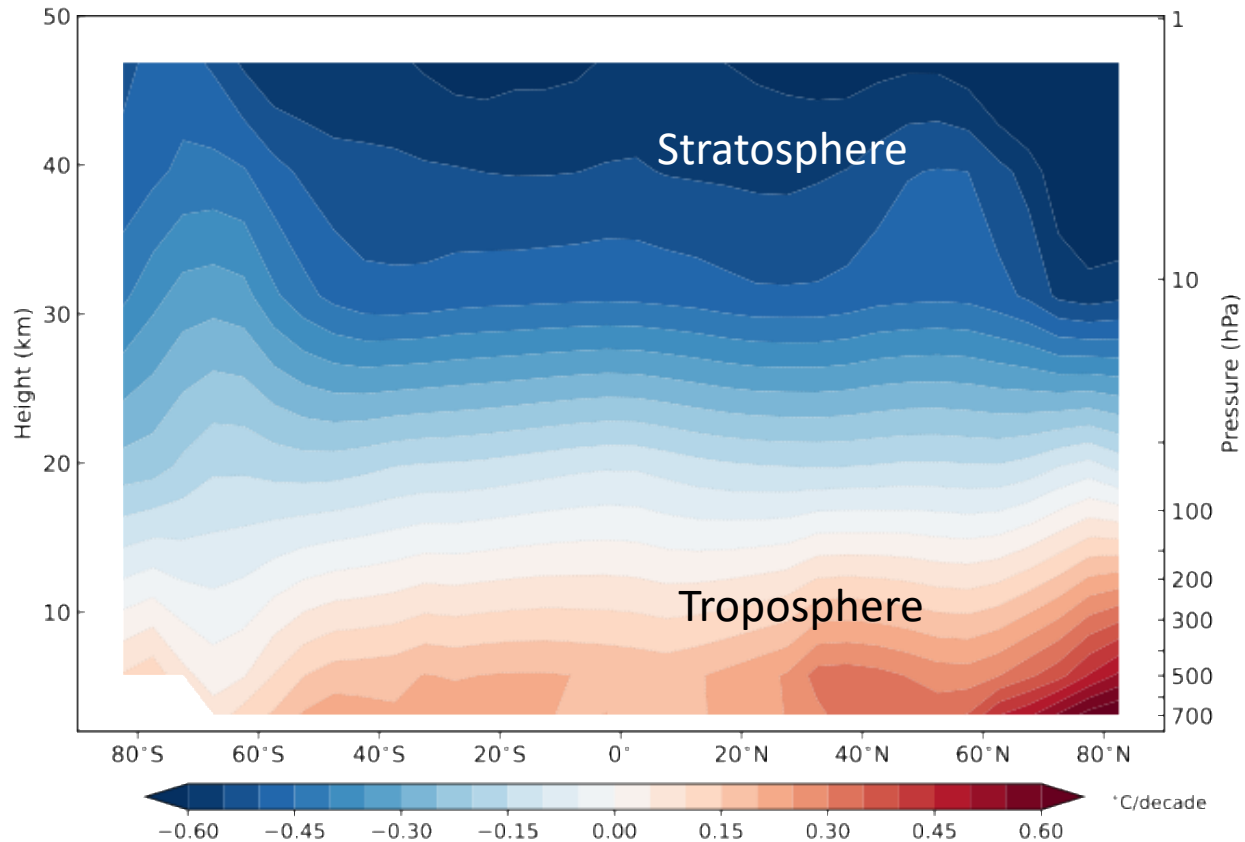
## Thermal Equilibrium of the Atmosphere with a Given Distribution of Relative Humidity

SYUKURO MANABE AND RICHARD T. WETHERLAND

*Geophysical Fluid Dynamics Laboratory, ESSA, Washington, D.C.*  
(Manuscript received 2 November 1966)



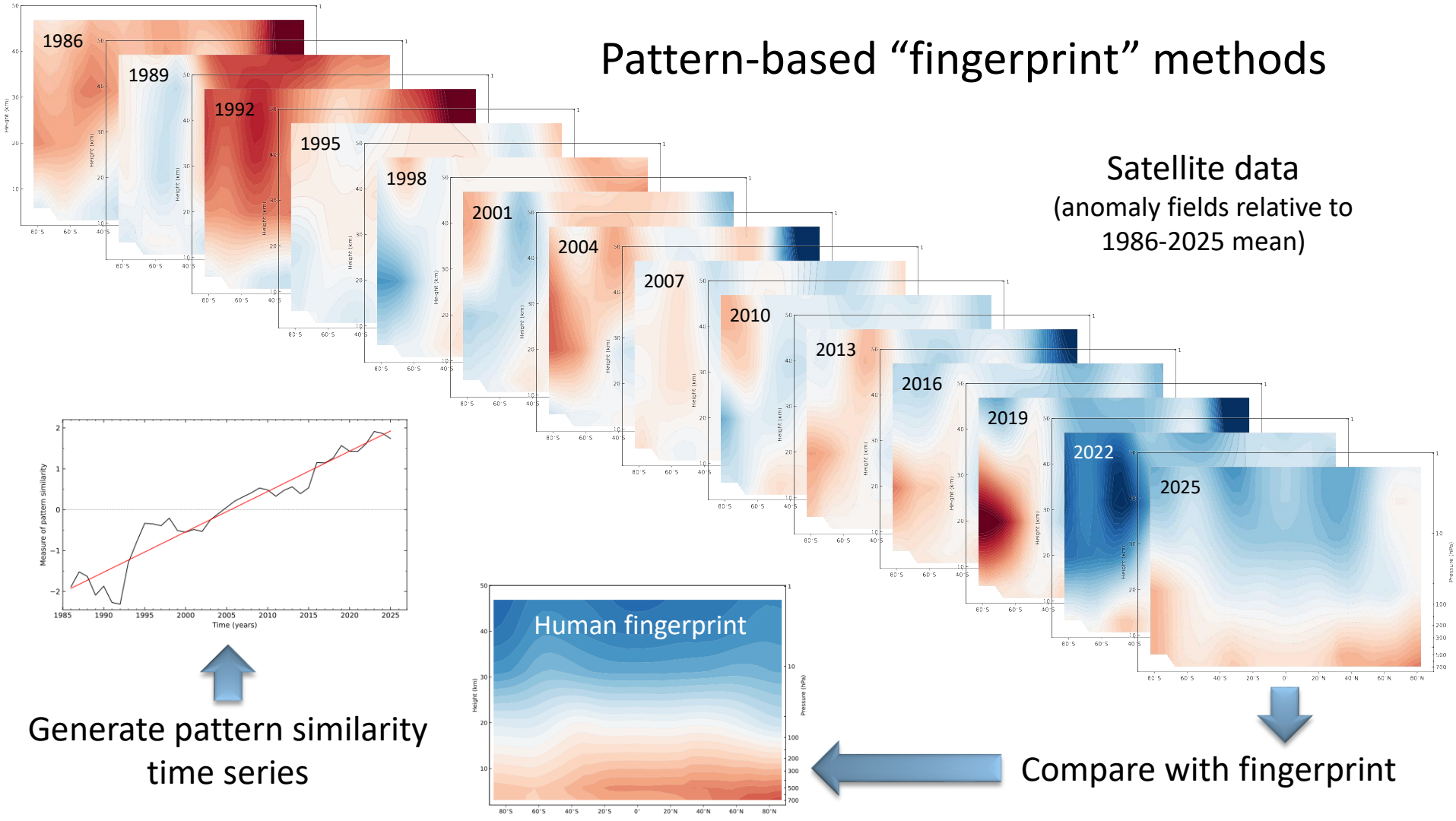
# Manabe's "vertical fingerprint" is in the satellite temperature data



Temperature trend over  
1986 to 2025

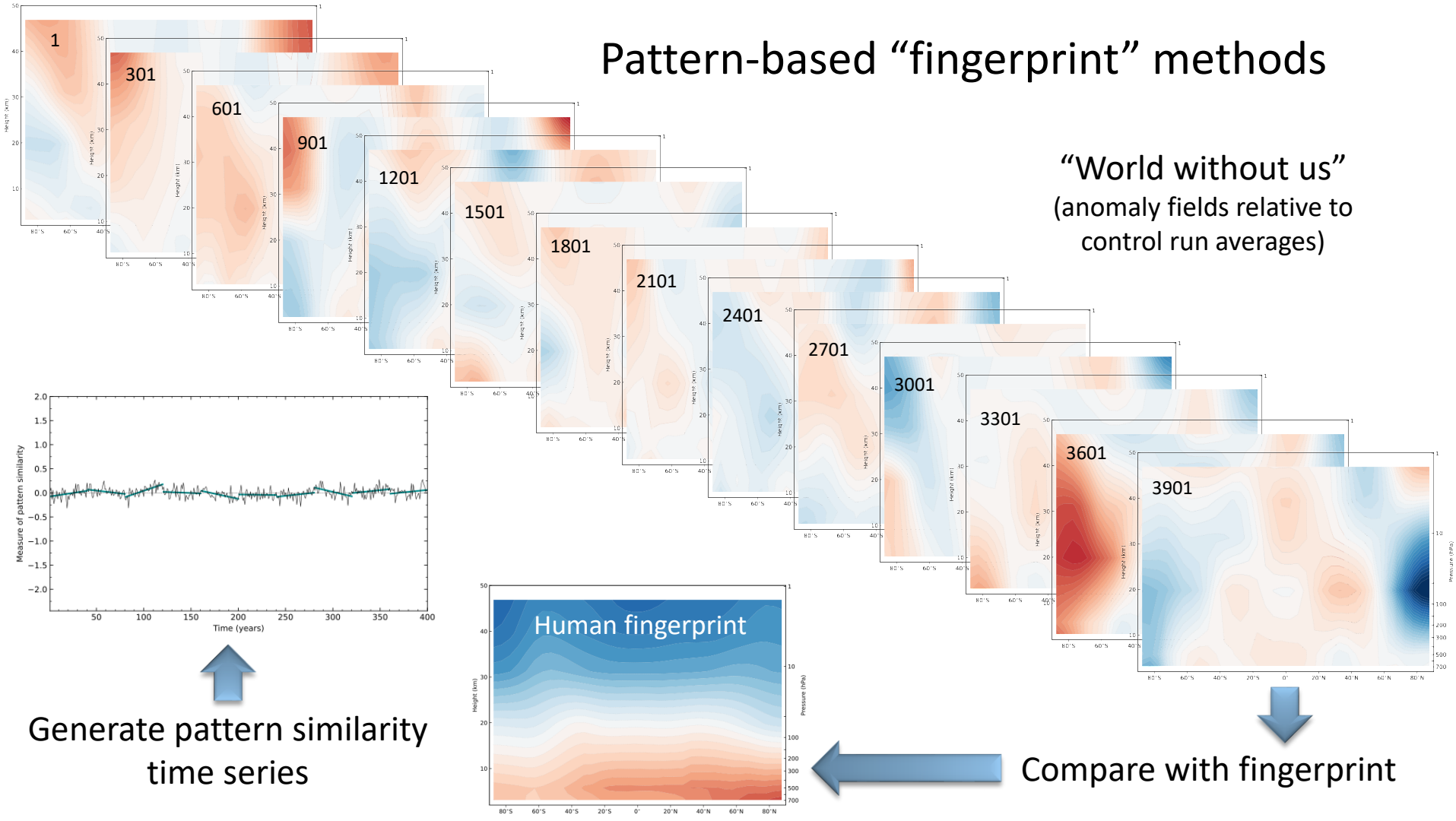
# Pattern-based “fingerprint” methods

Satellite data  
(anomaly fields relative to  
1986-2025 mean)

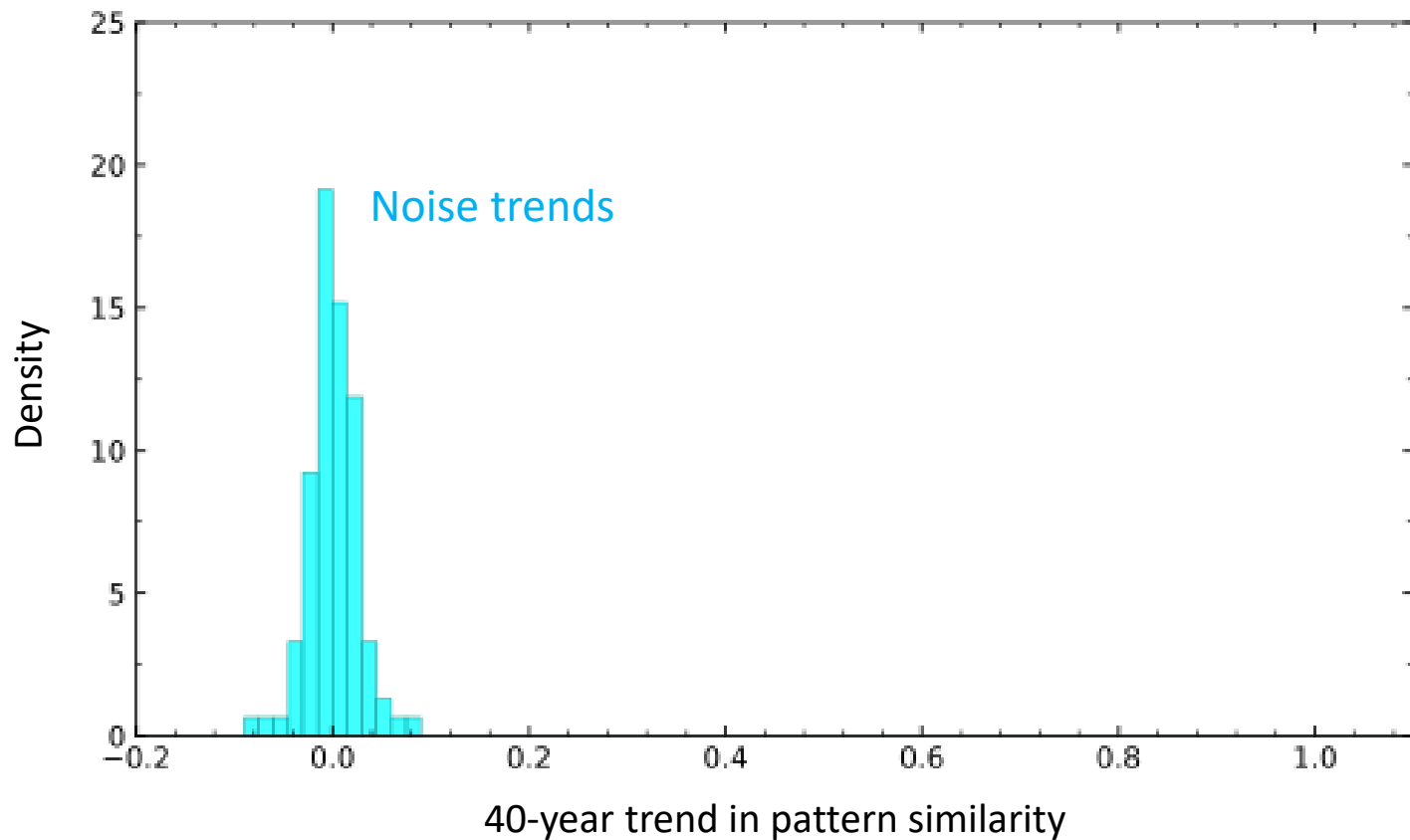


# Pattern-based “fingerprint” methods

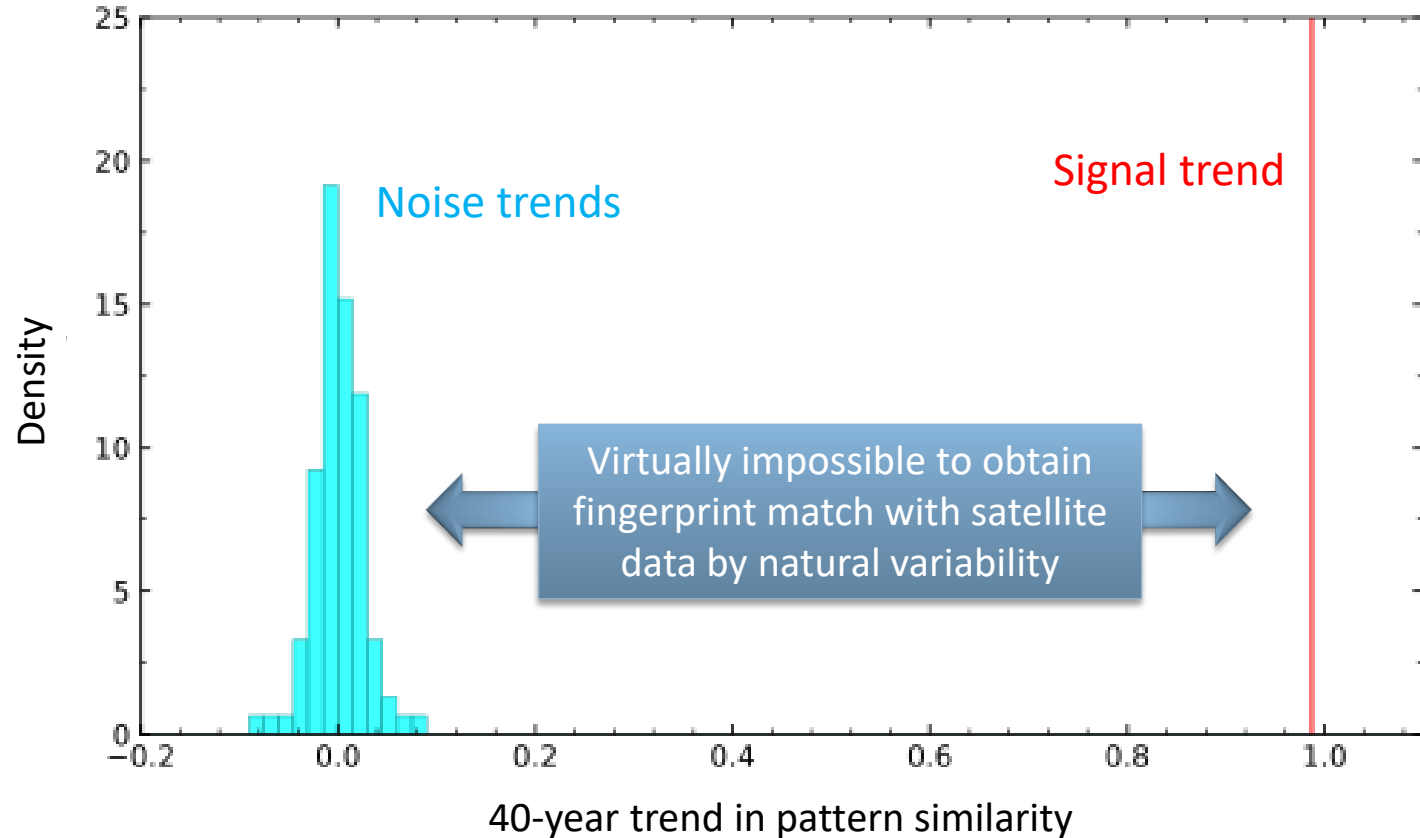
“World without us”  
(anomaly fields relative to  
control run averages)



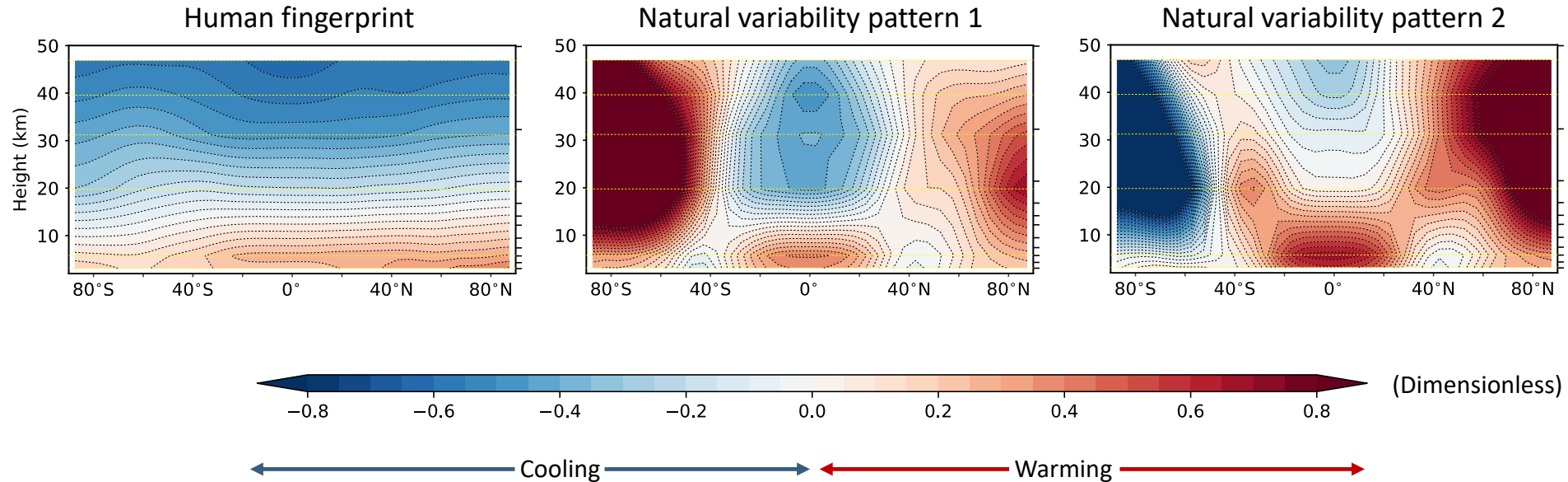
# “Vertical fingerprint” results



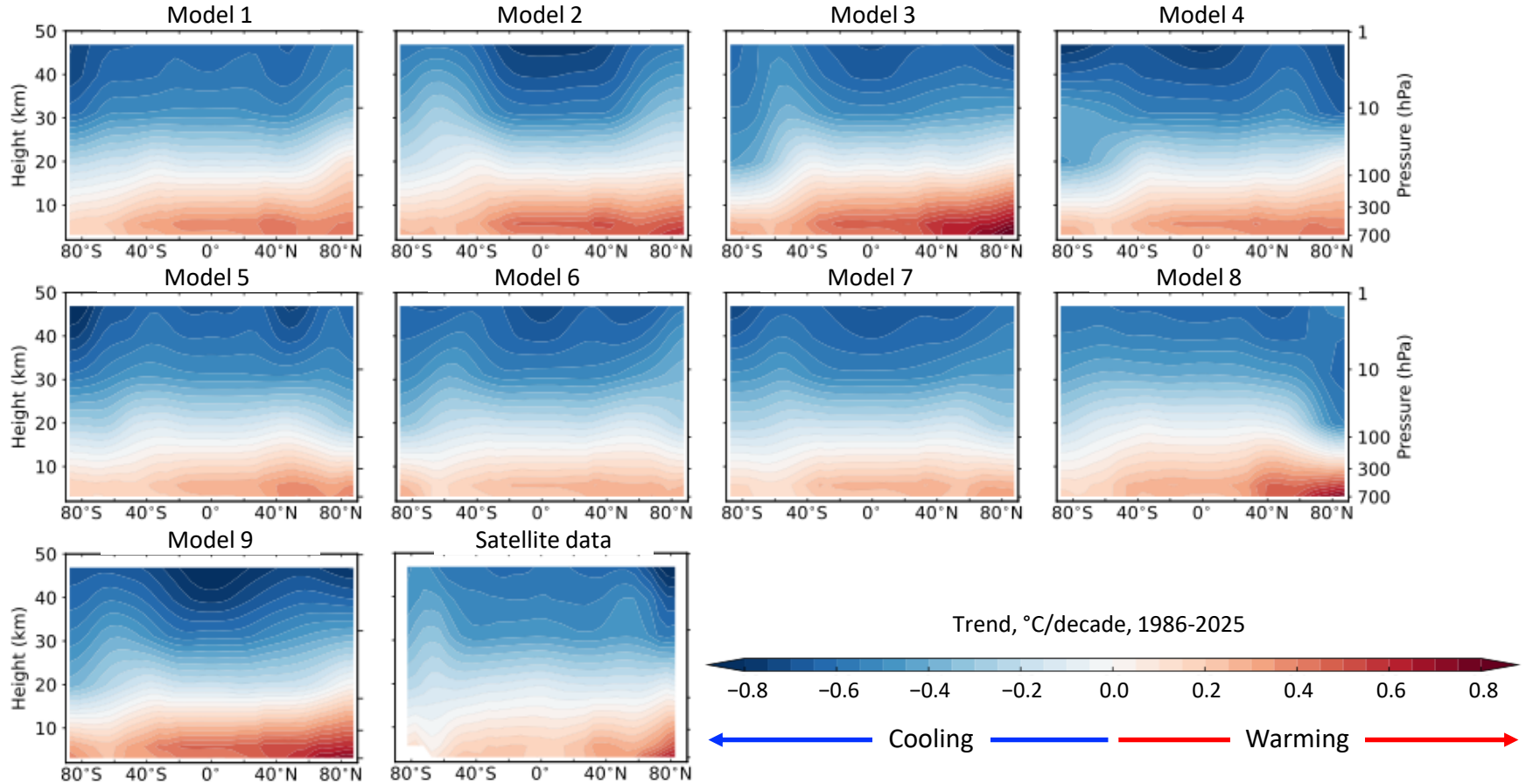
# “Vertical fingerprint” results



# Why is fingerprint detection so clear?



# The human-caused “vertical fingerprint” is robust across a range of climate models



# When could we have found this fingerprint in atmospheric temperature?

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## Scientists looked back in time to find the first signs of human-caused global warming. It's far earlier than previously thought

UPDATED JUN 16, 2025

By Andrew Freedman

PNAS

RESEARCH ARTICLE

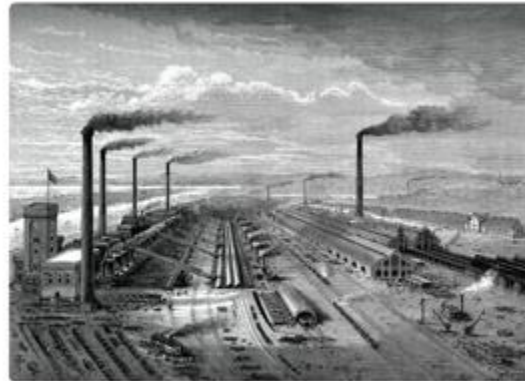
EARTH, ATMOSPHERIC, AND PLANETARY SCIENCES

### Human influence on climate detectable in the late 19th century

Benjamin D. Santer<sup>1</sup>, Susan Solomon<sup>2</sup>, David W. J. Thompson<sup>3</sup>, Qiang Fu<sup>4</sup> and Yaowei Li<sup>5</sup>

Affiliations are included on p. 11.

Edited by Ralph F. Keeling, Scripps Institution of Oceanography, La Jolla, CA; received January 13, 2025; accepted April 22, 2025, by Editorial Board Member Mark H. Thieme

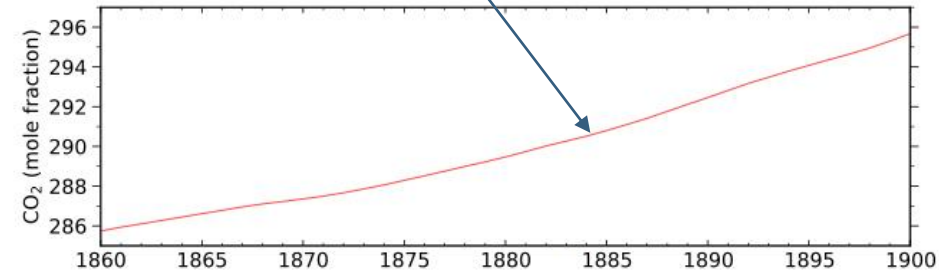


An iron and steel works factory in England in 1880. (Prior Collection/Fullan Archive/Getty Images)

# When could we have known?

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Carbon dioxide



## Bottom line finding of the thought experiment

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“ A human-caused stratospheric cooling signal would have been identifiable by approximately 1885, before the advent of gas-powered cars. Our results suggest that a discernible human influence on atmospheric temperature has likely existed for over 130 years. ”

# Vertical fingerprinting in the DOE report

- Release of the U.S. Dept. of Energy Climate Working Group Report
- July 29, 2025

I've reviewed the report carefully, and I believe it faithfully represents the state of climate science today. Still, many readers may be surprised by its conclusions—which differ in important ways from the mainstream narrative. That's a sign of how far the public conversation has drifted from the science itself.

Foreword from Secretary of the U.S.  
Dept. of Energy, Chris Wright



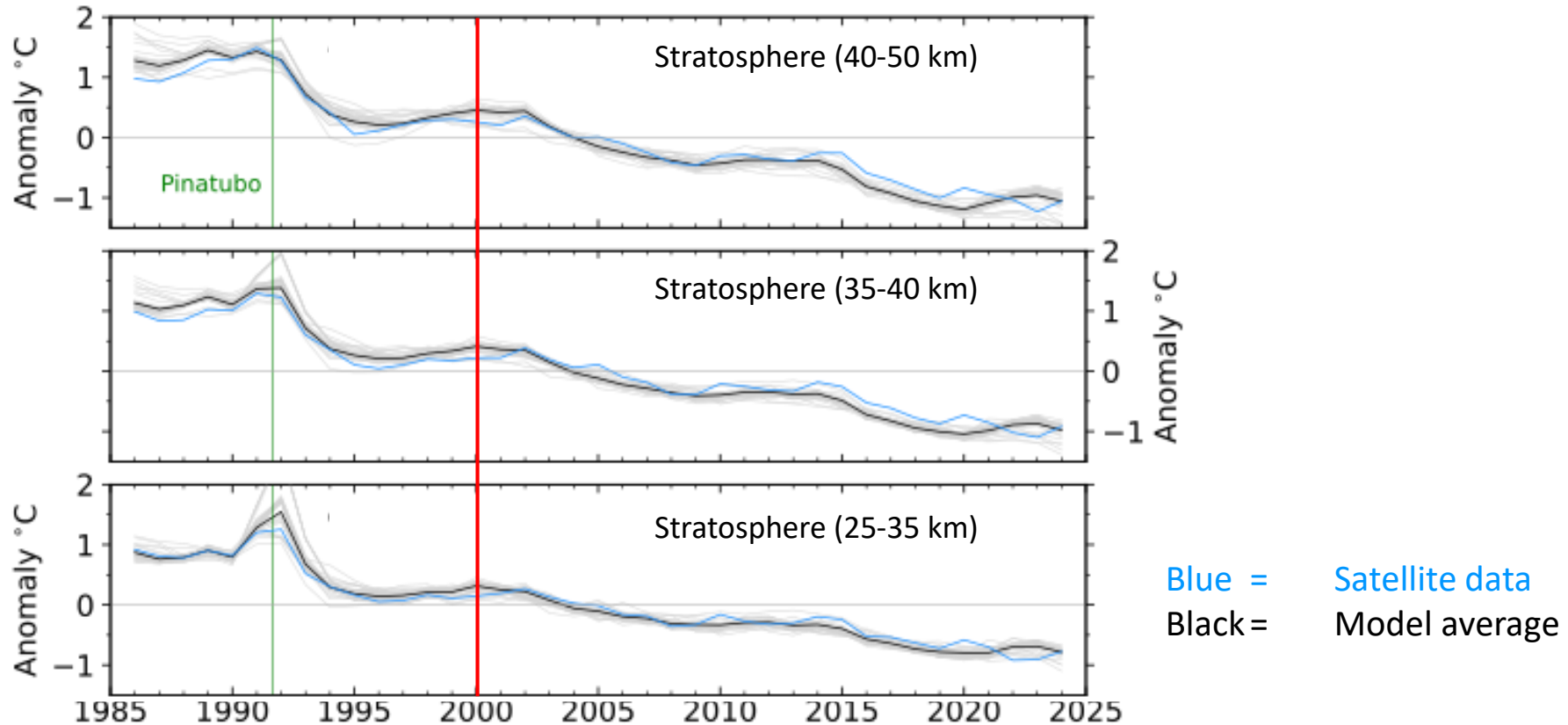
A Critical Review of Impacts of Greenhouse  
Gas Emissions on the U.S. Climate

# What does the July 2025 DOE report say about “vertical fingerprint”?

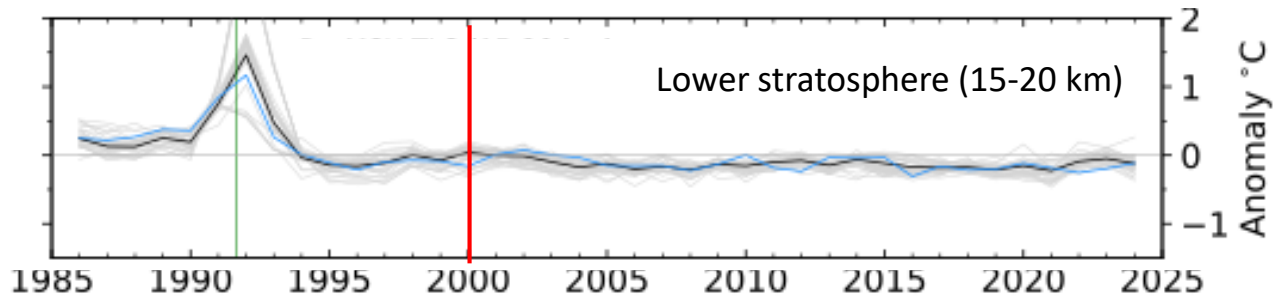
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- “A combination of tropospheric warming and stratospheric cooling is a commonly cited “fingerprint” of anthropogenic climate change. Stratospheric warming since 2000 coincides with continued surface and tropospheric warming, a pattern that is not found in climate model simulations and is not apparently consistent with the anthropogenic fingerprint” (Section 5.5 of DOE report)

# There isn't "stratospheric warming since 2000" in the middle to upper stratosphere!



# The DOE report claim that the stratosphere has been warming since 2000 relates to the **lower stratosphere**



Blue = Satellite data  
Black = Model average

The DOE report's claim that **stratospheric warming since 2000** invalidates all “vertical fingerprint” studies is verifiably false!

# Summary

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- Changes in the vertical structure of atmospheric temperature are a key piece of evidence for human effects on global climate
- This “fingerprint” was predicted nearly 60 years ago
- It has been identified with high confidence in weather balloon and satellite temperature data
- A recent U.S. Dept. of Energy report claims that this human influence fingerprint is inconsistent with data
- The DOE claims are verifiably false