VACATING THE ENDANGERMENT FINDING

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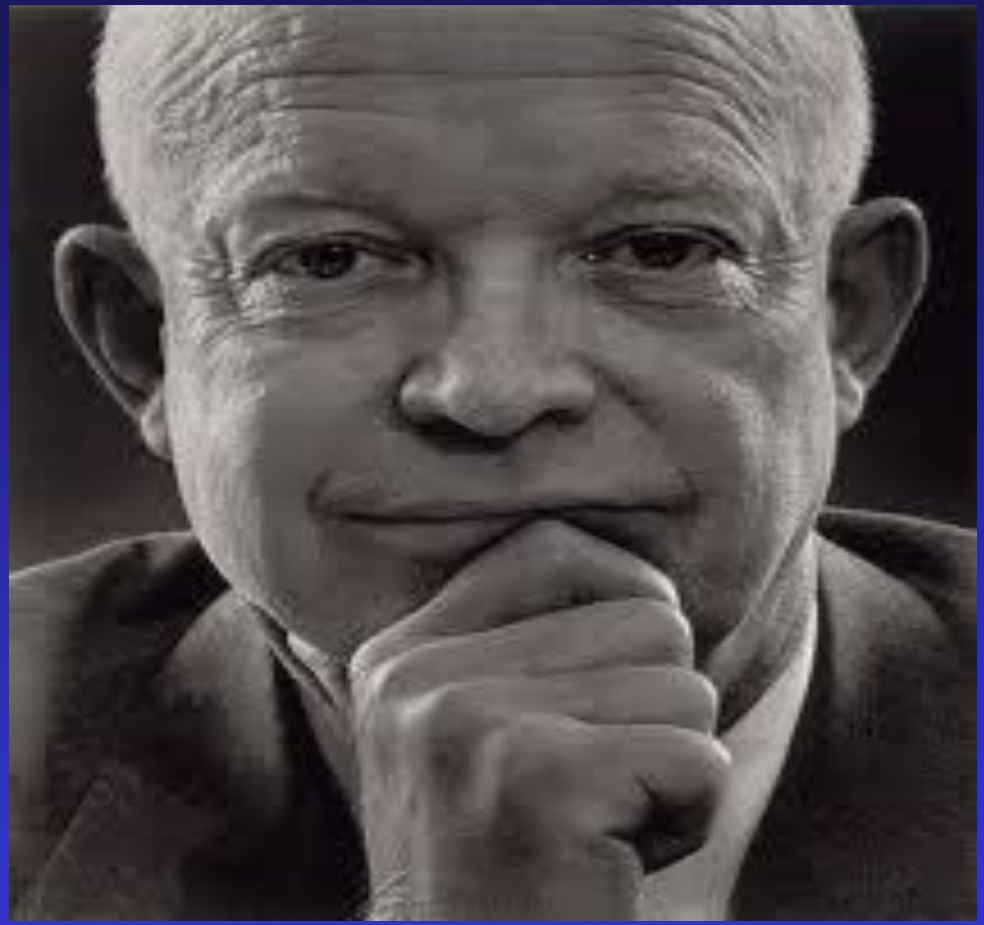


Eisenhower's Farewell Address, January 17, 1961

Famous statement on "Military-Industrial Complex"

In the councils of government, we must guard against the acquisition of unwarranted influence, whether sought or unsought, by the military-industrial complex. The potential for the disastrous rise of misplaced power exists and will persist.

Un-noticed next section:

The free university, historically the fountainhead of free ideas and scientific discovery, has experienced a revolution in the conduct of research. Partly because of the huge costs involved, a government contract becomes virtually a substitute for intellectual curiosity…

Yet, in holding scientific research and discovery in respect, as we should, we must also be alert to the equal and opposite danger that public policy could itself become the captive of a scientific-technological elite. The prospect of domination of the nation's scholars by Federal employment, project allocations, and the power of money is ever present – and is gravely to be regarded.

State Science Institute

MASS V. EPA, 2007

The court held that:

The 1992 Clean Air Act clearly states that if EPA finds that carbon dioxide is a pollutant (endangering human health and welfare), it must regulate it.

ENDANGERMENT FINDING

- Global Warming second “action item” in Barack Obama’s first inaugural address
- Preliminary Finding of Endangerment issued in 90 days
- Final Finding issued on December 7, 2009

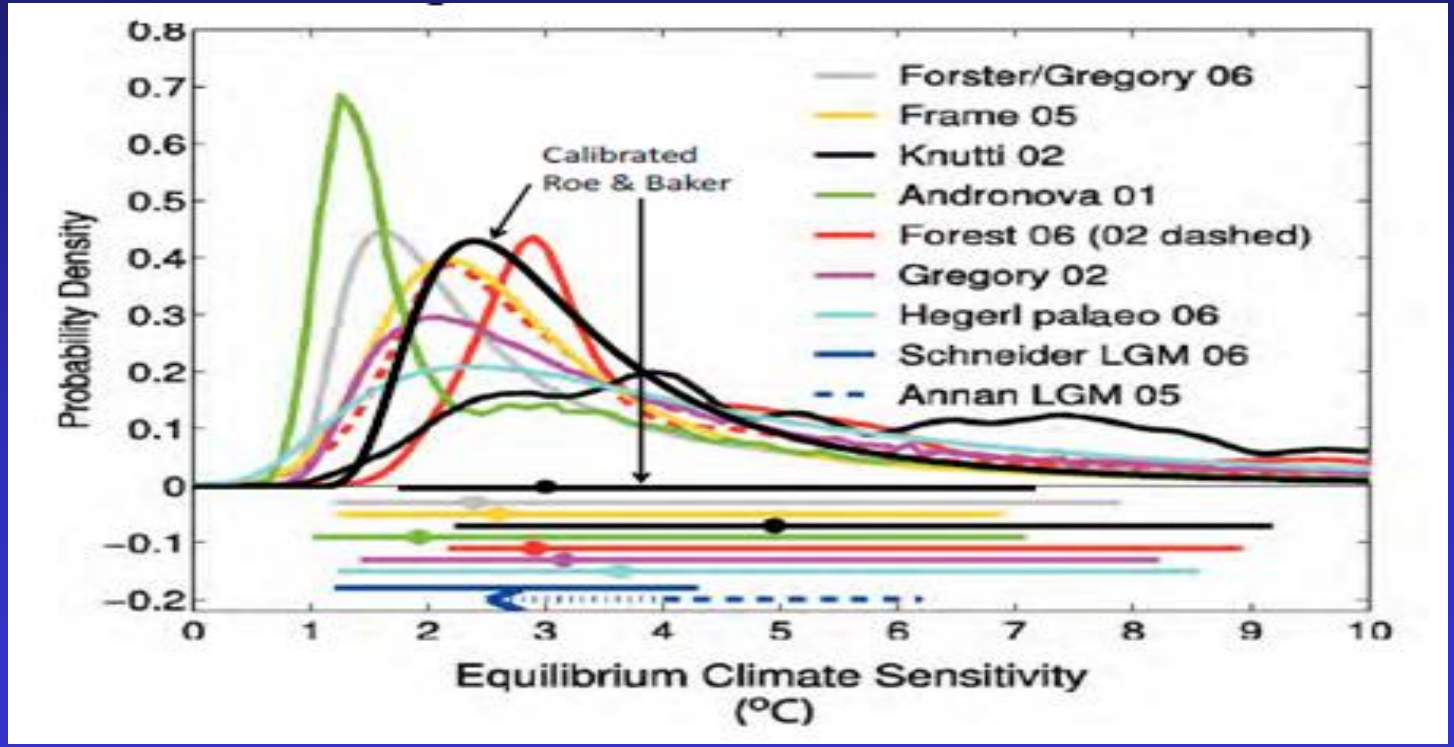
ENDANGERMENT FINDING

Based upon risk of high-end warming from models with “fat tails”

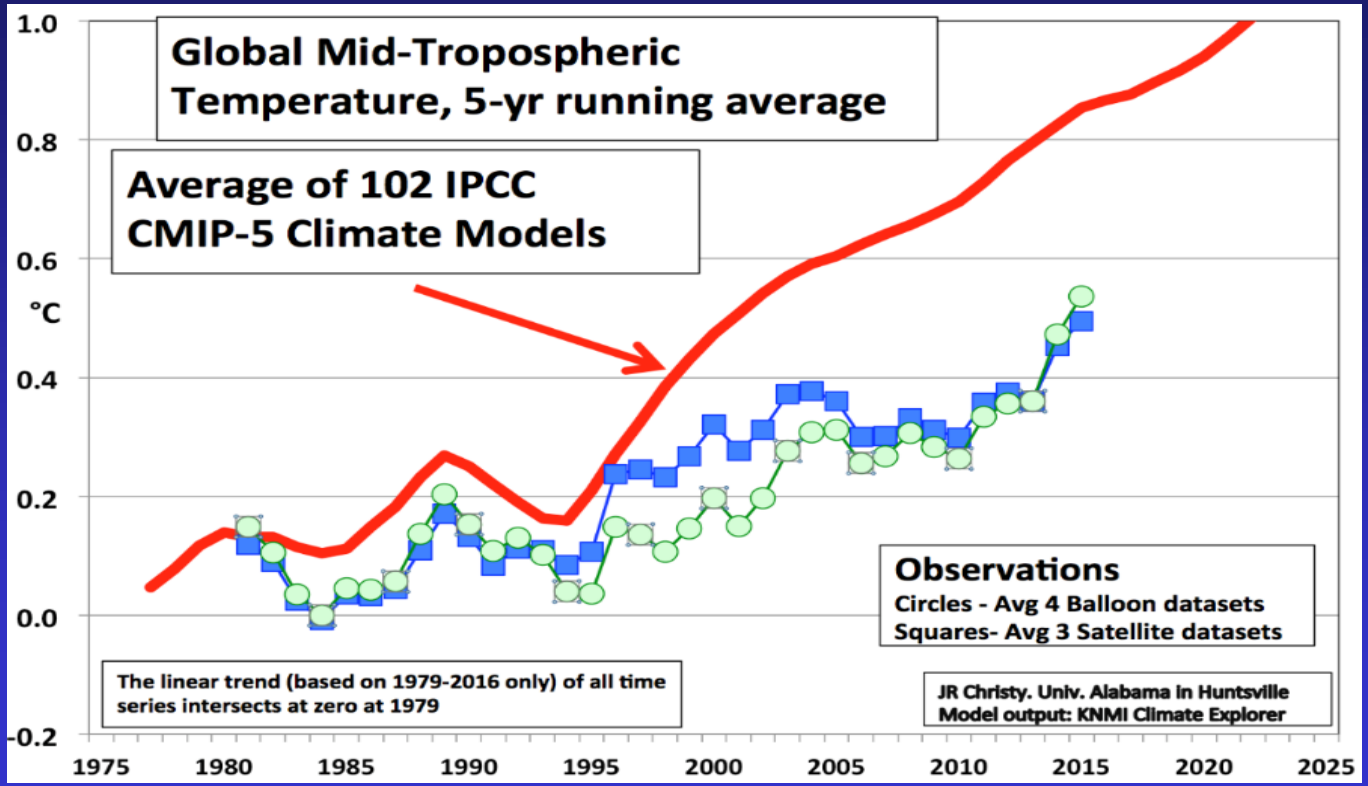
IT’S NOT THE HEAT…
…IT’S THE SENSITIVITY

Some Previous Estimates of the Probability Density Function for the Equilibrium Climate Sensitivity

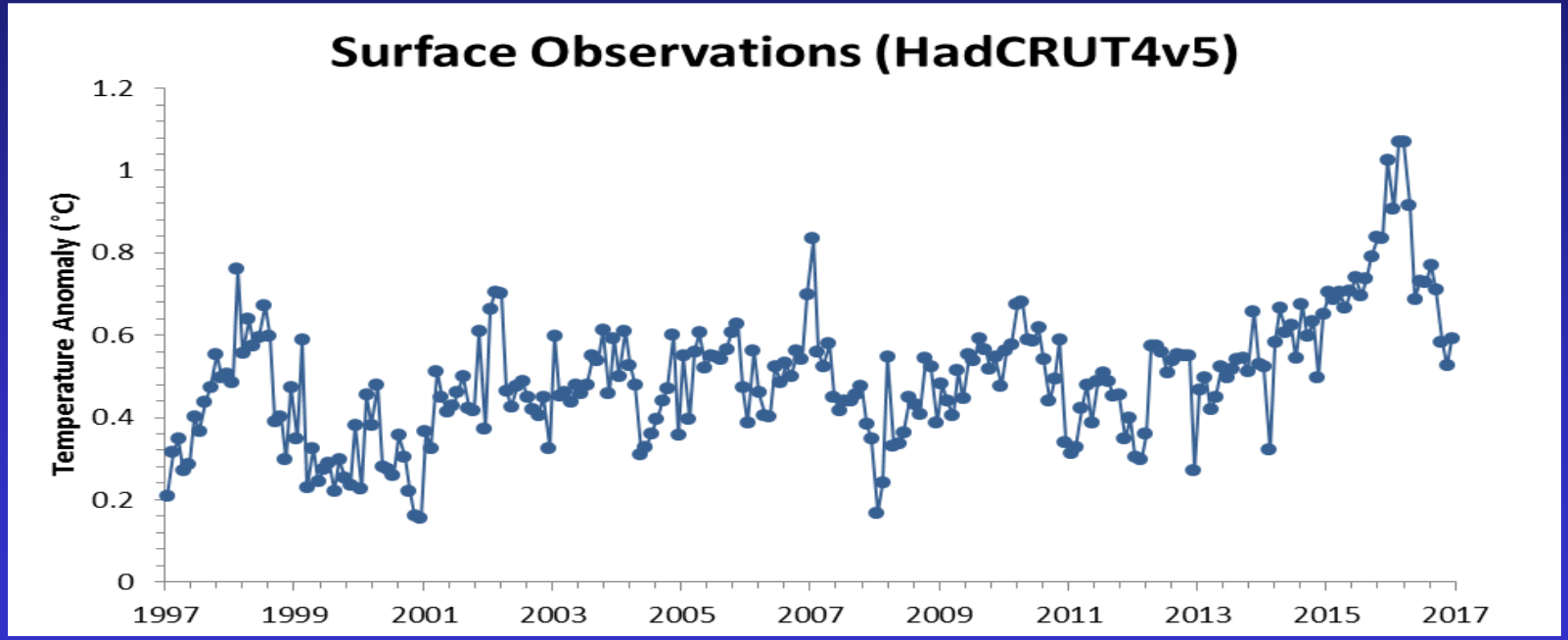
(including the calibrated Roe and Baker distribution)



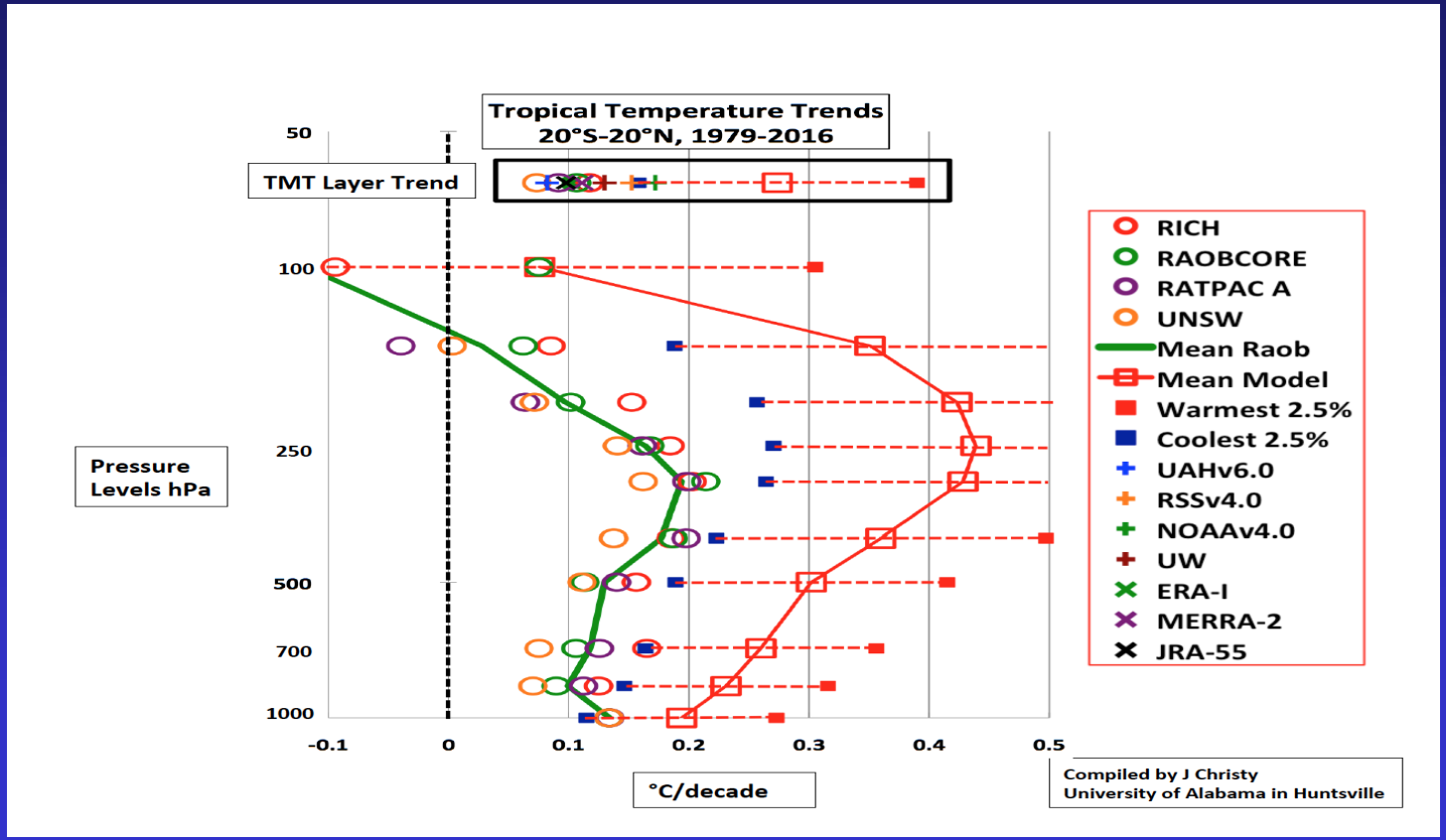
Comparison of Climate Model Projections and Observations of Temperature Changes in the Lower Atmosphere



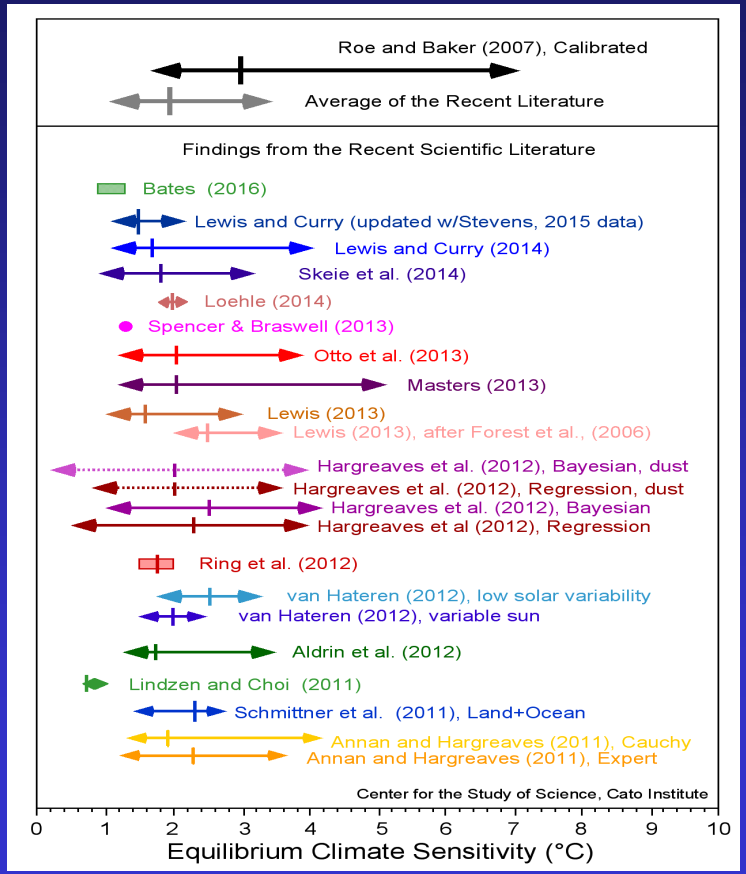
Recent Global Temperatures Changes Show the Effect of the Development and Subsequent Decay of the 2015-16 El Niño Event



Comparison of Climate Model Projections and Observations of Temperature Trends in the Vertical Atmosphere

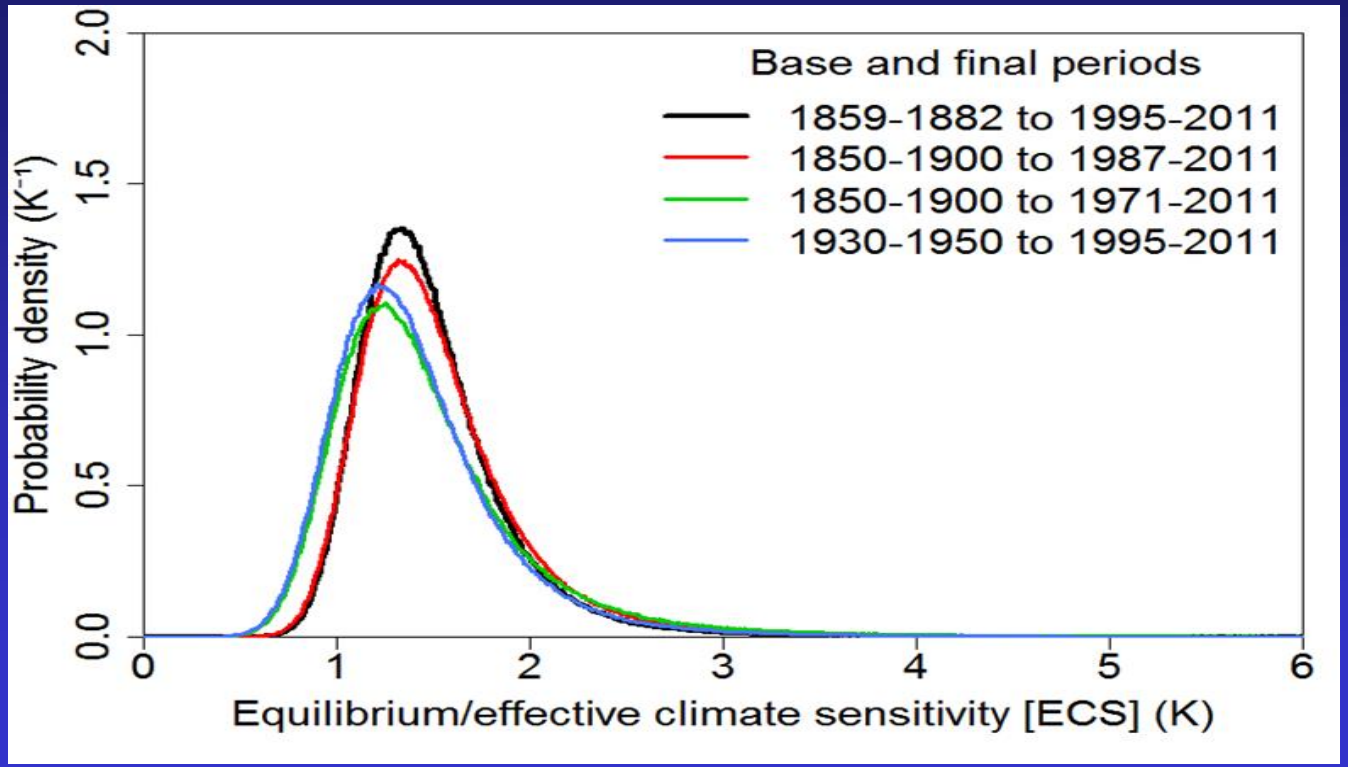


Some Estimates of the Equilibrium Climate Sensitivity from the Recent Scientific Literature



Equilibrium Climate Sensitivity

(Lewis and Curry, 2014 modified to reflect Stevens, 2015)



SENSITIVITY DETERMINATION

Objective, Right?

HISTORY OF THE GREAT REVEAL

- 1987 Wigley: Models too warm without adding a cooling parameter ("sulfate aerosol")

- 1995 IPCC: CO2-only models too warm. Either something interfering with warming or sensitivity is too high

- 1995-Present: Which road must the community take?

Voosen, Science, 2016

Storm clouds are too small for climate models to render directly, and so modelers must tune for them.

COMPUTER MODELING

Climate scientists open up their black boxes to scrutiny

Modelers becoming less hush-hush about tuning, the "secret sauce" that controls fine-scale processes

By **Paul Voosen**

It began with an unplanned leave of absence. But it has blossomed into a full-fledged transparency movement for climate science.

In 2010, Erich Roeckner, a longtime guru behind the global climate model at the Max Planck Institute for Meteorology (MPIM) in Hamburg, Germany, was unable to work. The timing was inopportune: Deadlines loomed for an international project that would compare the major climate models with one another, and MPIM's had a bug.

Roeckner's skill was handling details like the effects of rough terrain or the formation of clouds—processes too fine-grained for models to render within the imaginary boxes, tens of kilometers on a side, into which they divide the atmosphere and ocean. Instead, modelers "parameterize" such details, coming up with equations meant to approximate their effects. When the equations miss the mark and the model strays from the known climate, scientists like Roeckner bring it back into harmony by adjusting them. Other disciplines might call this calibration. In climate science, it's called tuning.

With Roeckner out of commission, a team of six people spent several months tuning the MPIM model to match the climate and eliminate the glitch. Their work, though laborious, was fairly routine. What was unusual was their decision, in 2012, to publish a detailed accounting of it. Roeckner's absence was random. But in hindsight, it was the butterfly flapping that has now led climate modelers to openly discuss and document tuning in ways that they had long avoided, fearing criticism by climate skeptics.

Next week, many of the world's 30 major modeling groups will convene for their main annual workshop at Princeton University; by early next year, these teams plan to freeze their code for a sixth round of the Coupled Model Intercomparison Project (CMIP), in which these models are run through a variety of scenarios. The output will ultimately help the next United Nations climate change panel make its predictions. By writing up their tuning strategies and making them publicly available for the first time, groups hope to learn how to make their predictions more reliable, says Bjorn Stevens, an MPIM director who has pushed for more transparency. And in a study that will be submitted by year's end, six U.S. modeling centers will disclose their tuning strategies—showing that many are quite different. "Most groups take pride in calibrating their models in different ways," says Gavin Schmidt, who's coordinating the study and directs NASA's Goddard Institute for Space Studies in New York City, another prominent modeling center.

At their core, climate models are about energy balance. They divide Earth up into boxes, and then, applying fundamental laws of physics, follow the sun's energy as it drives phenomena like winds and ocean currents. Their resolution has grown over the years, allowing current models to render Earth in boxes down to 25 kilometers aside. They take weeks of supercomputer time for a full run, simulating how the climate evolves over centuries.

When the models can't physically resolve certain processes, the parameters take over—though they are still informed by observations. For example, modelers tune for cloud formation based on temperature, atmospheric stability, humidity, and the presence of mountains. Parameters are also used to describe the spread of heat into the deep ocean, the reflectivity of Arctic sea ice, and the way that aerosols, small particles in the atmosphere, reflect or trap sunlight.

It's impossible to get parameters right on the first try. And so scientists adjust these equations to make sure certain constraints are met, like the total energy entering and leaving the planet, the path of the jet stream, or the formation of low marine clouds off the California coast. Modelers try to restrict their tuning to as few knobs as possible, but it's never as few as they'd like. It's an art and a science. "It's like reshaping an instrument to compensate for bad sound," Stevens says.

Indeed, whether climate scientists like to admit it or not, nearly every model has been calibrated precisely to the 20th century climate records—otherwise it would have ended up in the trash. "It's fair to say all models have tuned it," says Isaac Held, a scientist at the Geophysical Fluid Dynamics Laboratory, another prominent modeling center, in Princeton, New Jersey.

For years, climate scientists had been mum in public about their "secret sauce": What happened in the models stayed in the models. The taboo reflected fears that climate contrarians would use the practice of tuning to seed doubt about models—and, by extension, the reality of human-driven warming. "The community became defensive," Stevens says. "It was afraid of talking about things that they thought

PHOTO: ZOONAR GMBH/ALAMY STOCK PHOTO

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Hourdin et al, 2016

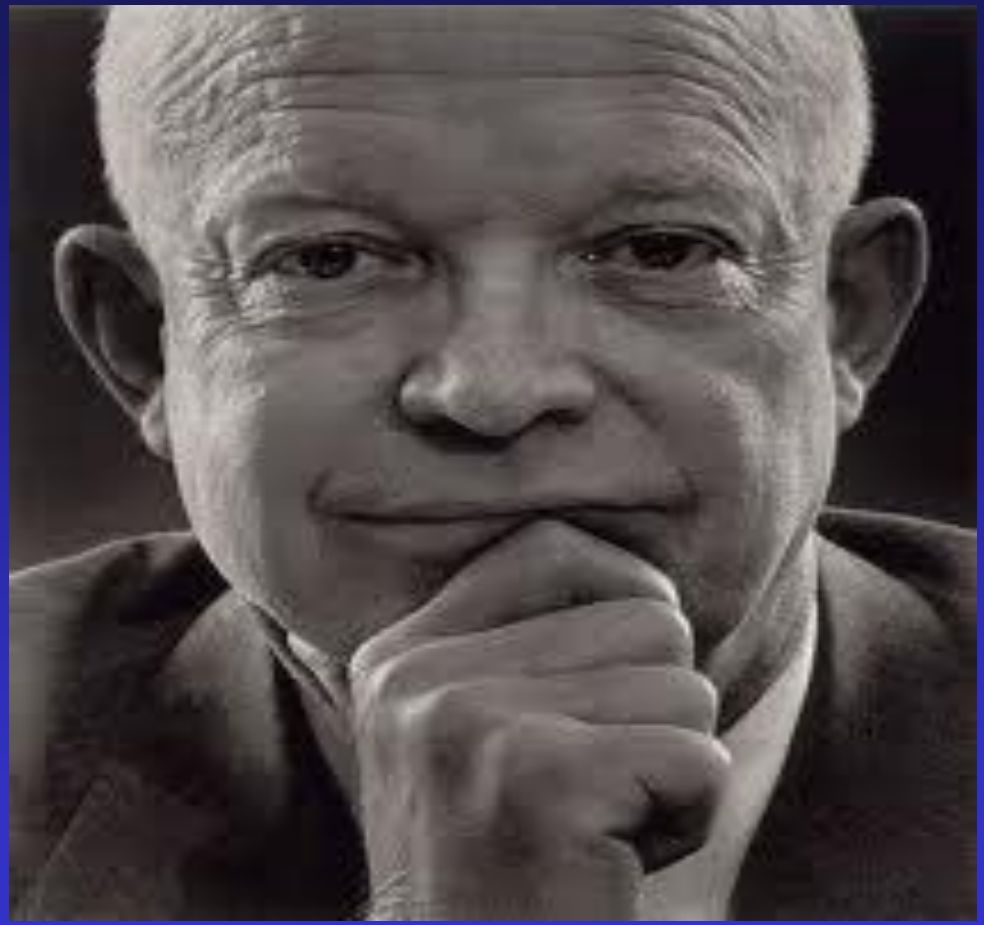
“The Art and Science of Climate Model Tuning”

“With the increasing diversity in the applications of climate models, the number of potential targets for tuning increases. There are a variety of goals for specific problems, and different models may be optimized to perform better on a particular metric, related to specific goals, expertise or cultural identity of a given modeling center.”

“One can imagine changing a parameter which is known to affect the sensitivity, *keeping both this parameter and the ECS in the anticipated acceptable range,* and retuning the model otherwise with the same strategy toward the same targets.

Either reducing the number of models or over-tuning, especially if an explicit or implicit consensus emerges in the community on a particular combination of metrics, would artificially reduce the dispersion of climate simulations. It would not reduce the uncertainty, but only hide it.

We end by expressing the hope that this article will encourage both a systematic effort by the community to document this arcane aspect of model construction, and for more people to join a vigorous debate on model tuning and evaluation.



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CONCLUSION

- All models are tuned to the 20th century climate.

- They fail systematically compared to satellite and radiosonde data—the best we have.

- It is the modeler, not the model, that decides what the "anticipated acceptable range" is for the sensitivity.

IMPLICATIONS

- **Failure to correctly simulate observed climate would cause a modification of hypothesis *if this were science*.**

- **The model, and not the modeler, would determine the sensitivity *if this were science.***

THEREFORE,

The Endangerment Finding is not based upon anything close to normative science and* MUST *be vacated.