

Geoengineering 1: Solar Radiation Management

EES 3310/5310

Global Climate Change

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Geoengineering

Scope of Problem

- After 10,000 years:
 - High-level nuclear waste: about 0.03% of excess radioactivity remains
 - CO₂: about 25% remains in atmosphere (for release of 4,000–5,000 GTC)
- Consequences uncertain
 - Possible catastrophic consequences lasting thousands of years
 - Experts think “business as usual” has high probability (>50%) of tipping point to disaster
- Eliminating fossil fuels quickly looks very challenging, expensive

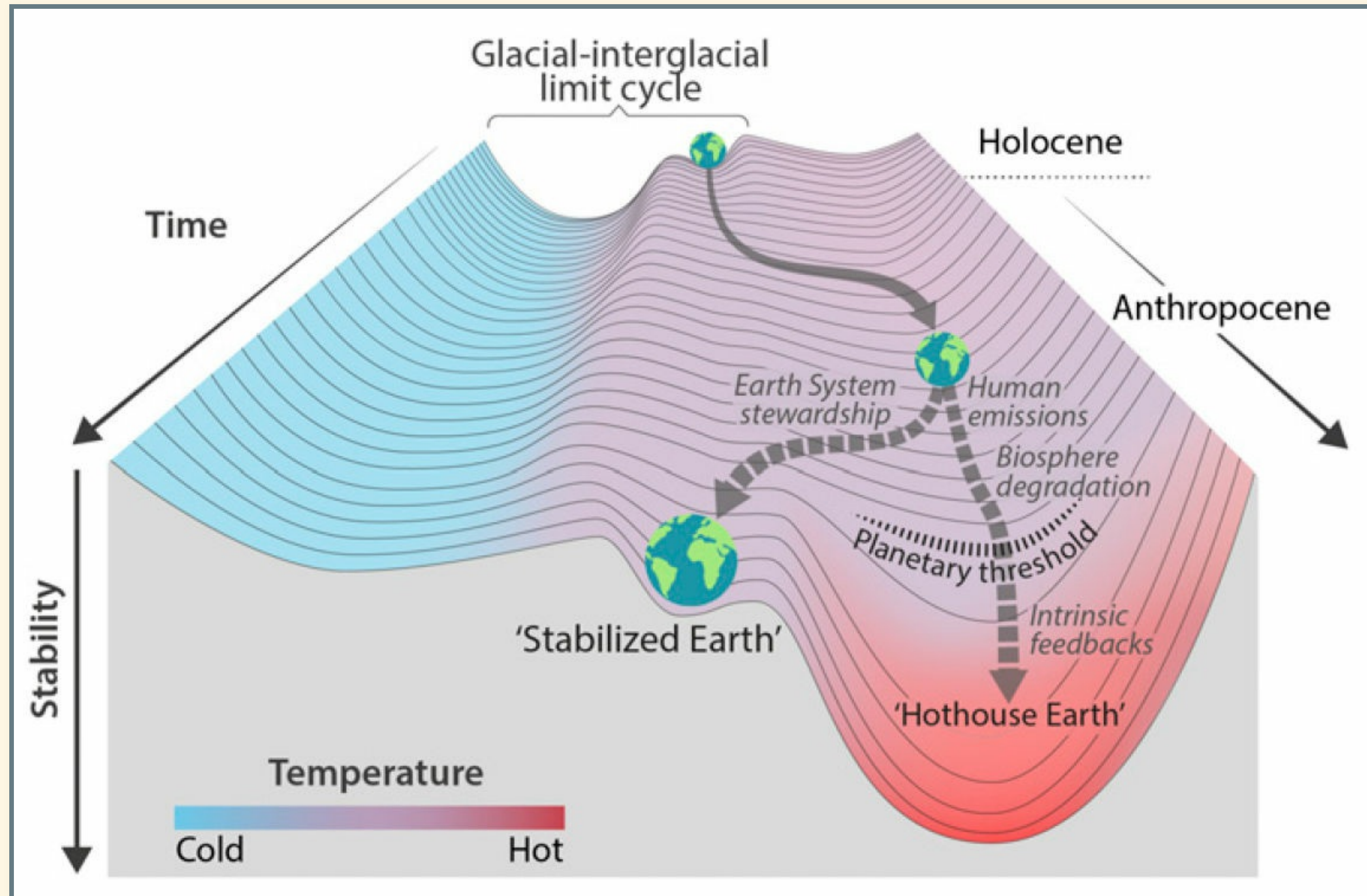
Comparing imperfect solutions

- Mitigation:
 - Cut emissions
 - Geoengineering
- Adaptation
 - Manageable, unmanageable, and unmanaged systems
- Do nothing

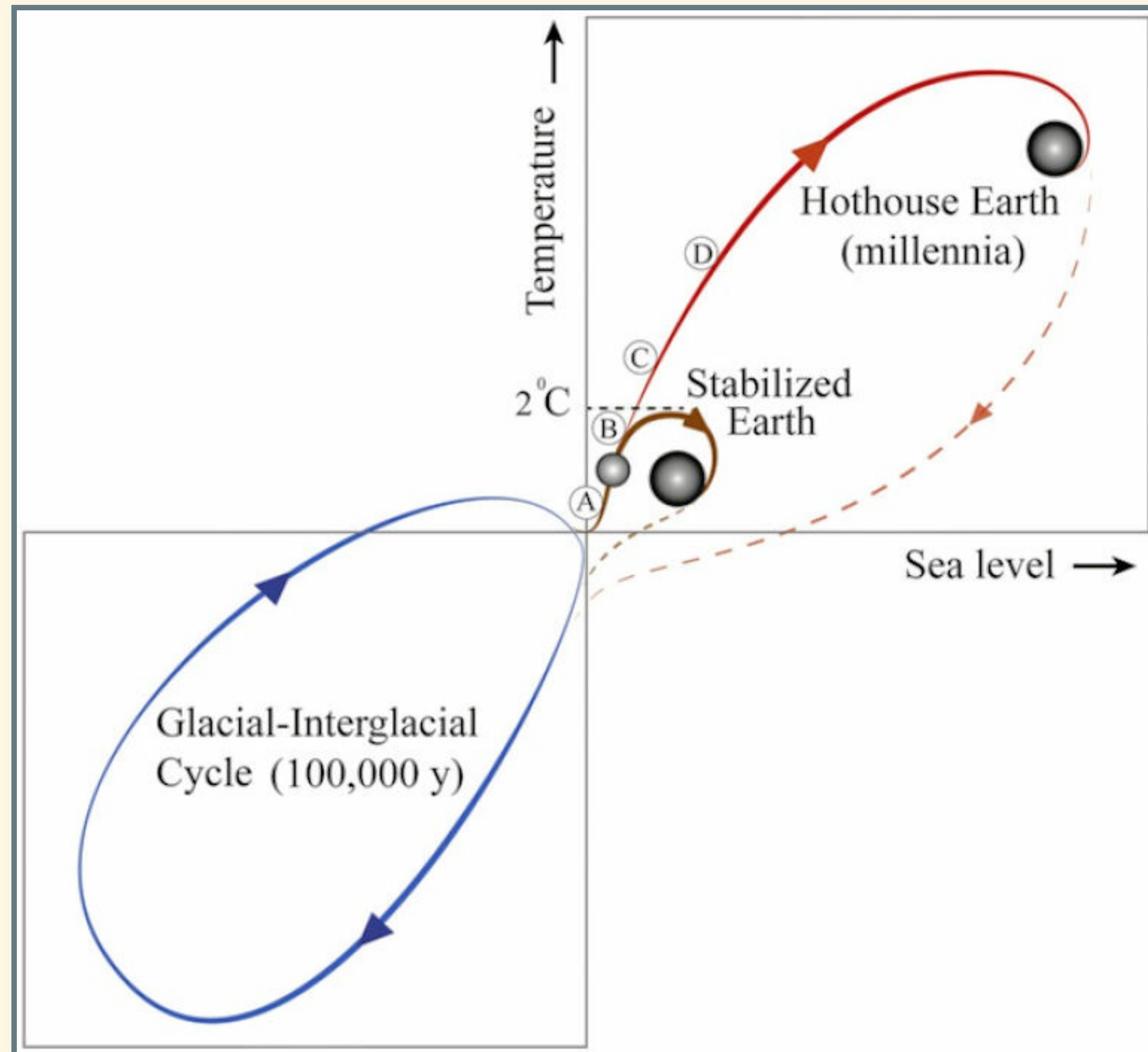
*“We have three options:
mitigation, adaptation, and suffering.”
— Prof. Lonnie Thompson*

New Challenges

Stability of the Climate



Pathways for Climate System



Defining Geoengineering

- Scale and Intent
 - Intent without scale: *ornamental gardening*
 - Scale without intent: *pollution, global warming*
 - **Scale with intent: geoengineering**

Basic Concepts

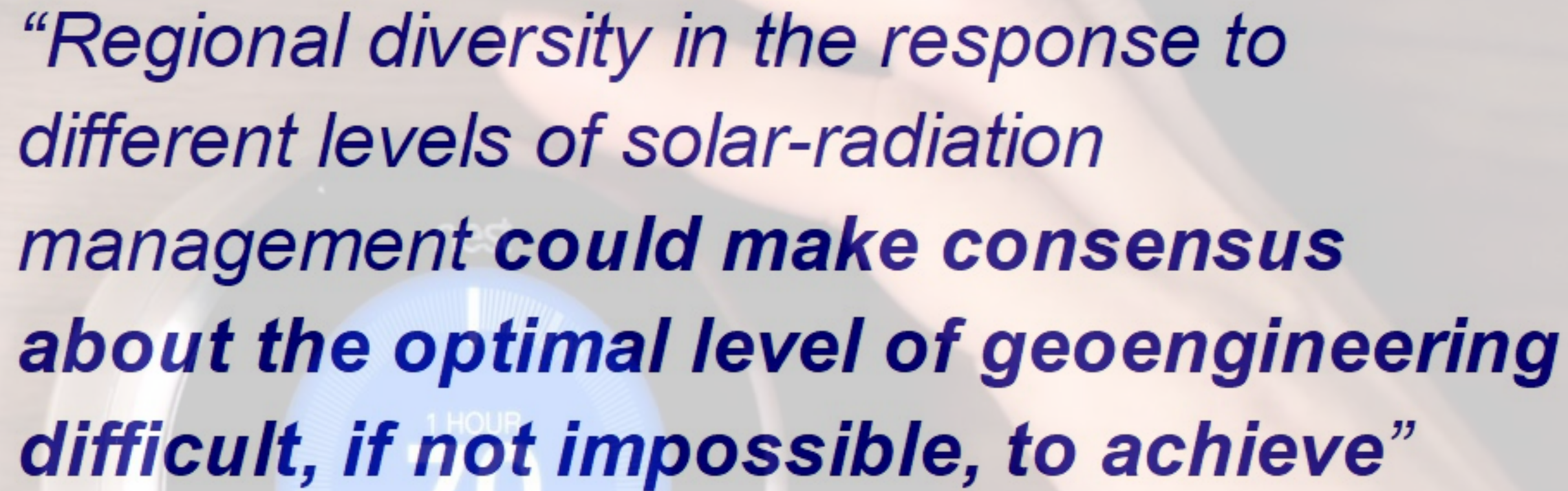
- Wicked problem
- Technological fix
- Geoengineering:
 - Albedo engineering
 - Pielke: Doesn't work as technological fix
 - Nordhaus:
 - Reflecting 2% of sunlight cancels doubling CO₂
 - Costs 1-10% as much as reducing emissions
 - "Fire truck" vs. "Fire insurance"
 - "Salvage therapy"
 - Air capture of CO₂
 - Pielke: Worth considering
 - Nordhaus:
 - All geoengineering poses a moral hazard problem

Criteria for Technological Fix

1. Cause-effect relationship
 - Can it work in theory?
2. Assessable effects
 - Can we tell whether it's working?
3. Established technological base
 - Research and development needs somewhere to start
 - Beginning from scratch takes too long to be useful.
 - Focus on incremental improvements
 - Don't bet on big breakthroughs



Who Controls the Thermostat?

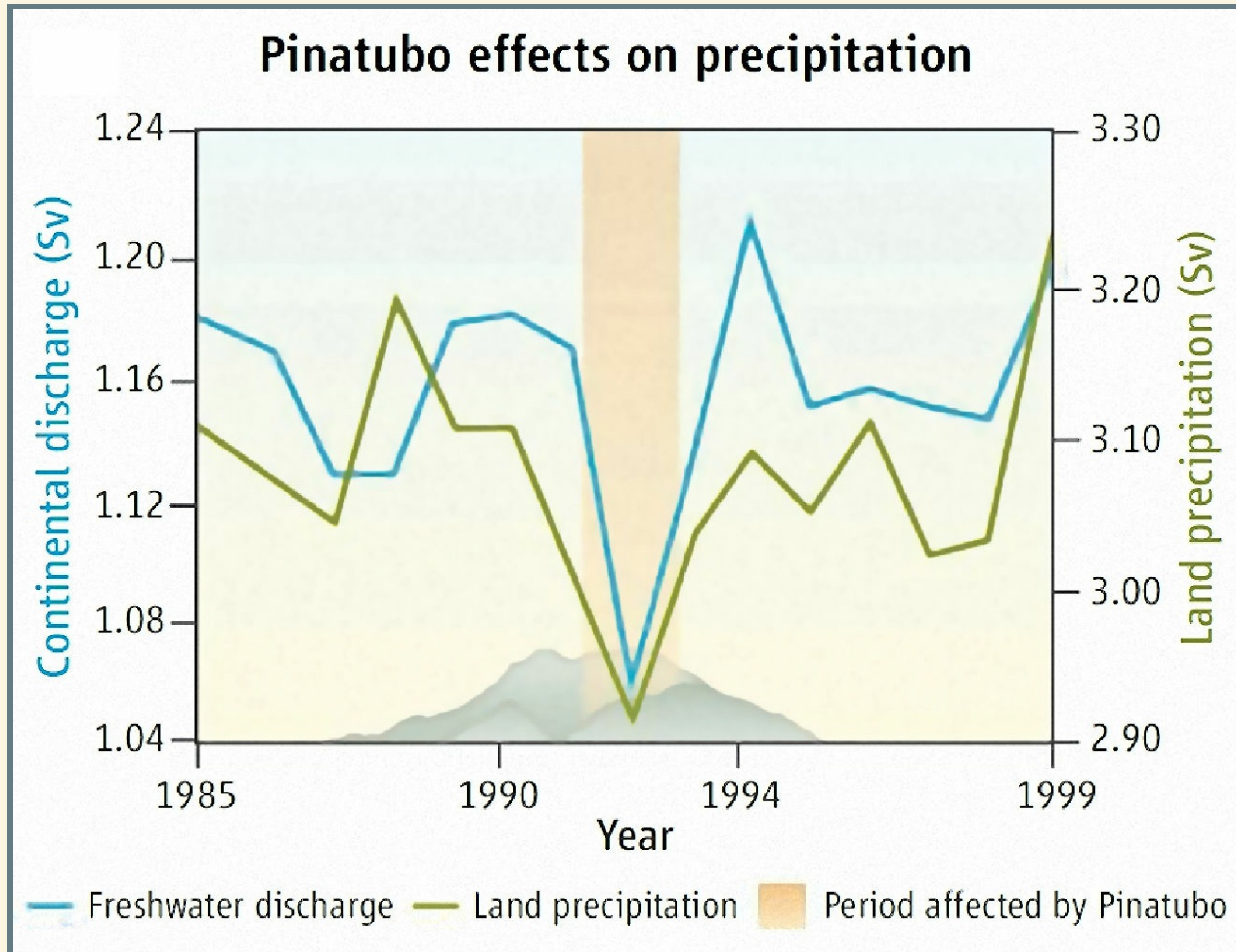
A close-up photograph of a hand turning a circular thermostat dial. The dial is white with a blue face and a black needle. The hand is positioned on the right side of the dial, with the thumb and index finger visible. The background is a blurred indoor setting.

*“Regional diversity in the response to different levels of solar-radiation management **could make consensus about the optimal level of geoengineering difficult, if not impossible, to achieve**”*

K.L. Ricke *et al.* Nature Geosci. 3, 537 (2010).

It's not just about global average temperature

- Can geoengineering manage all parts of the planet at once?
- Can we manage both temperature and precipitation?
- What about other effects of CO₂?
 - Ocean acidification?



G.C. Hegerl & S. Solomon, Science **325**, 955 (2009).

Who's responsible for unintended consequences?



Geoengineering Litigation

HARVARD LAW REVIEW

Property— Property Rights Incident to Ownership of Land—Cloud Seeding Infringes Property Rights of Subadjacent Landowners — *Southwest Weather Research, Inc., v. Rounsville* (Tex. Civ. Appl. 1958)

73 Harvard L. R. 790 (1958).

THE LEGAL ASPECTS OF RAINMAKING

Since the first successful experiments in the laboratories of the General Electric Company in 1946, the artificial precipitation of rain and snow has become a reality. The method developed by such experiments involves the use of dry ice and similar cooling materials.

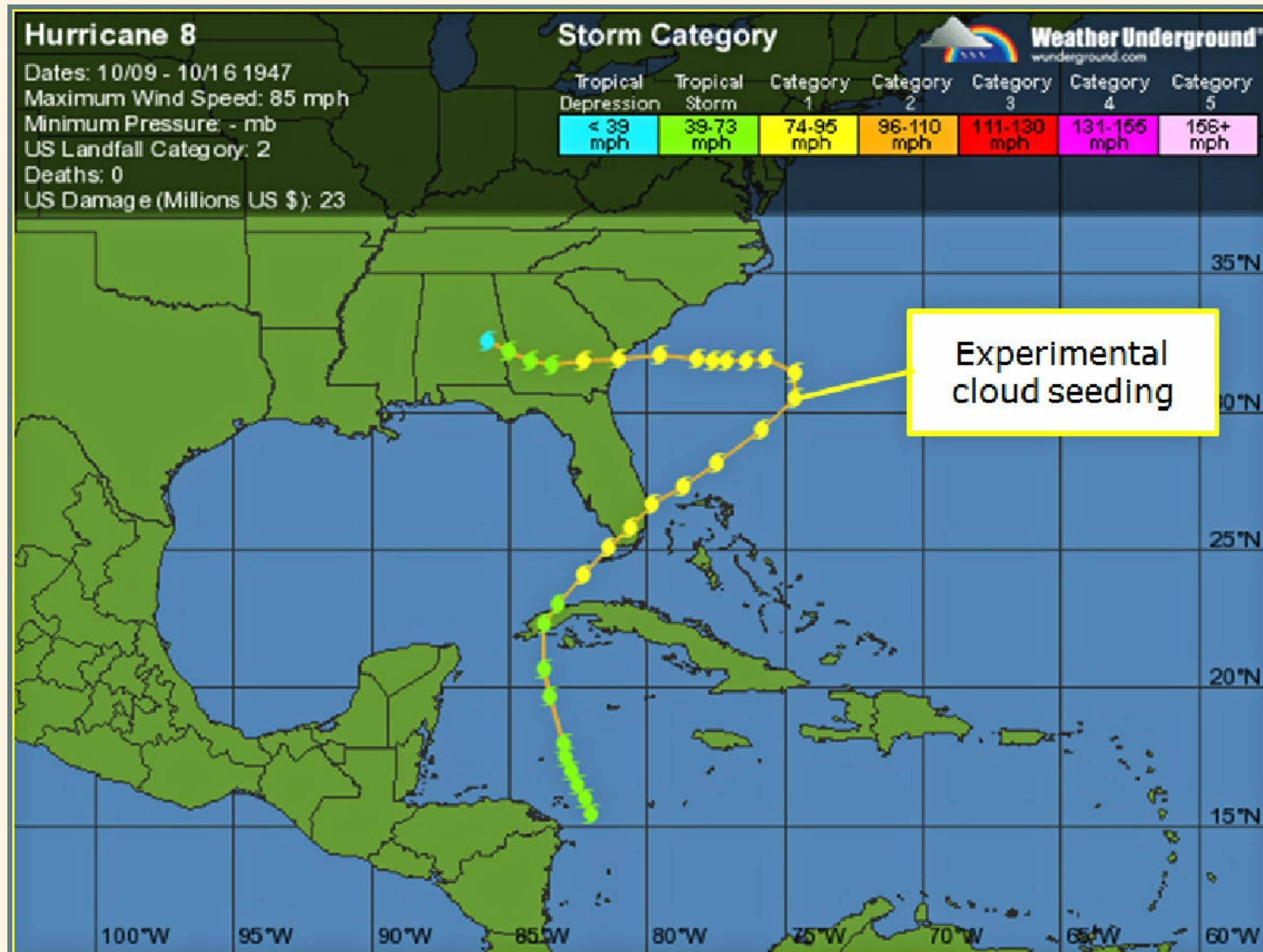
37 Calif. L. R. 114 (1949).

LEGAL REMEDIES FOR “CLOUD-SEEDING ACTIVITIES”

The important question of liability for “cloud seeding” has been decided at the appellate-court level for the first time. The decision, *Southwest Weather Research, Inc. v. Duncan*, attains added significance in that it delineates the landowner’s rights in the rain clouds above his land and circumscribes the applicable remedy.

1960 Duke L. J. 305 (1960).

Hurricane #8, Oct. 1947



In North Carolina, hurricanes did what scientists could not: Convince Republicans that climate change is real

“I always thought climate change was a bunch of nonsense, but now I really do think it is happening,” said [Margie] White, a 65-year-old Trump supporter.

Washington Post, Oct. 18, 2018

Yes, Climate Change Made Harvey and Irma Worse

... the consensus among scientists is that the effects of climate change ... made these storms far more destructive.

CNN, Sept. 19, 2017

Are Tornadoes More Powerful Due to Climate Change?

AccuWeather, June 15, 2012

Links between More Extreme Weather and Climate Change

... the key thing, then is that all of the weather that is occurring, all of the storms are occurring in an environment that is simply different than it used to be.

NPR Science Friday, Apr. 5, 2012

Colorado Flooding: Did Climate Change Play A Role in Recent Disaster?

Huffington Post, Sept. 14, 2013

- **Most scientific reviews on link between climate change and extreme weather are inconclusive**
- **But public, media jump to conclusions**
- **Will they also blame geoengineering?**







GISS Global Average Temperature Anomaly

+ Anthro Forcing, 3 Mt/a Arctic,
5 Mt/a Tropical, 10 Mt/a Tropical

Geoengineering
ends

Temp Anomaly (°C) from 1951-1980 mean

