

Geoengineering 1: Solar Radiation Management

EES 2110

Introduction to 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

Defining Geoengineering

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

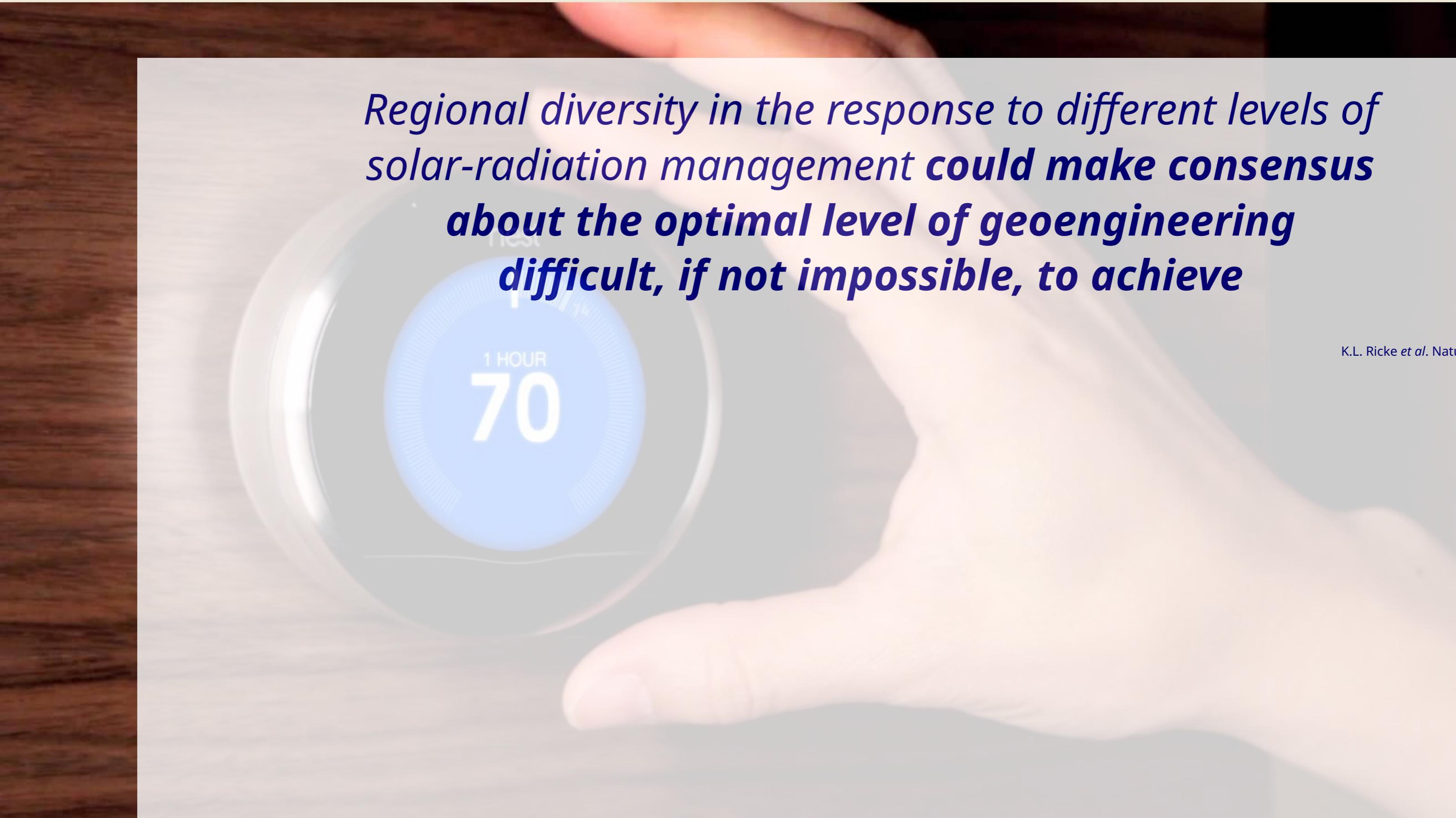
Criteria for Technological Fix

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



SPL

Who Controls the Thermostat?



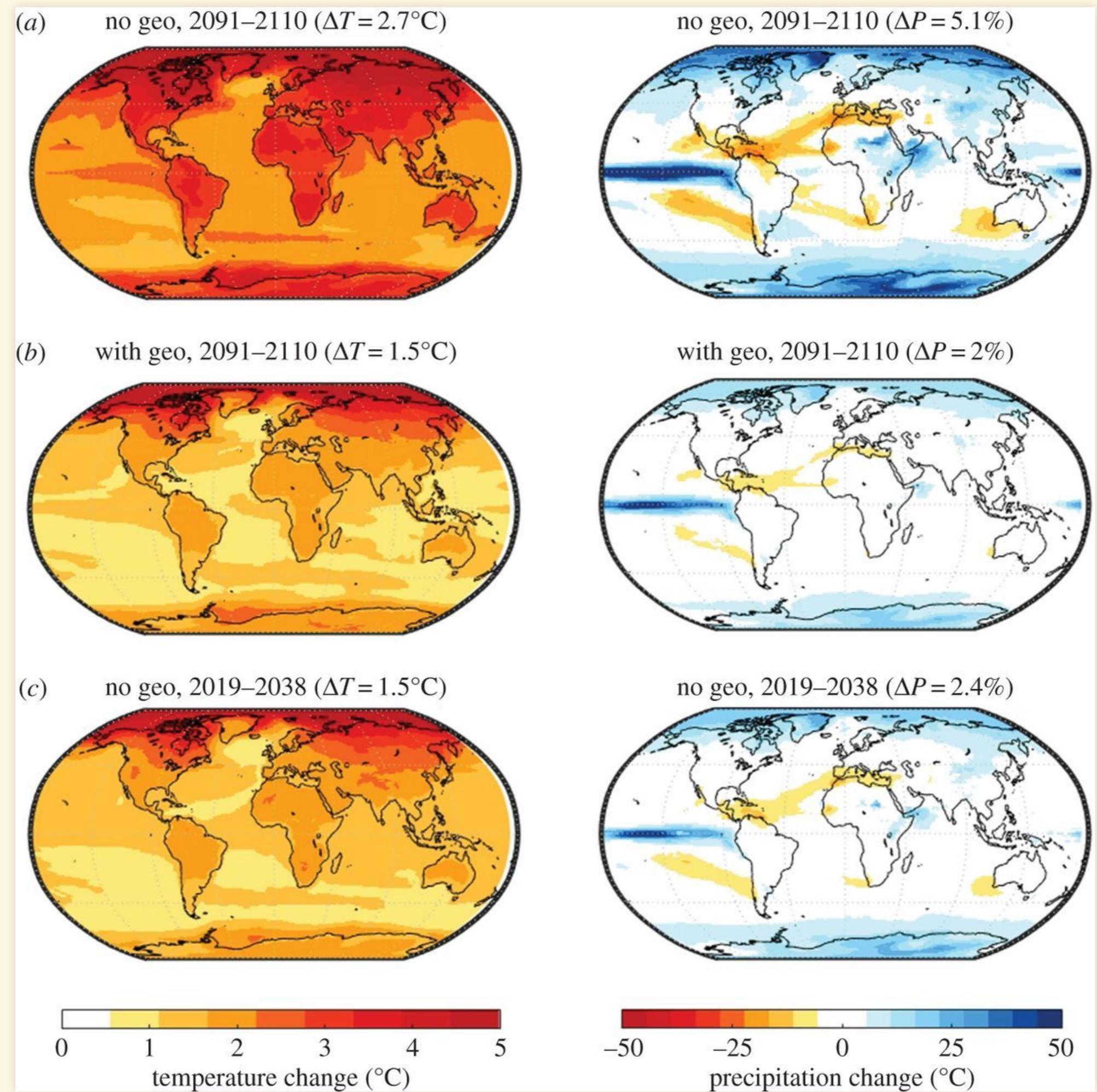
*Regional diversity in the response to different levels of solar-radiation management **could make consensus about the optimal level of geoengineering difficult, if not impossible, to achieve***

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

It's not just about
global average temperature

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?
- However...
 - It looks likely that it could reduce the harm from climate change.
 - Can't return planet to pre-industrial climate, but:
 - Can probably *reduce changes* in both temperature and precipitation
 - Can probably *reduce changes* across the whole planet
 - The same climate models we use to study climate change say SRM should work



Who's responsible for
unintended consequences?

Who's responsible for unintended consequences?



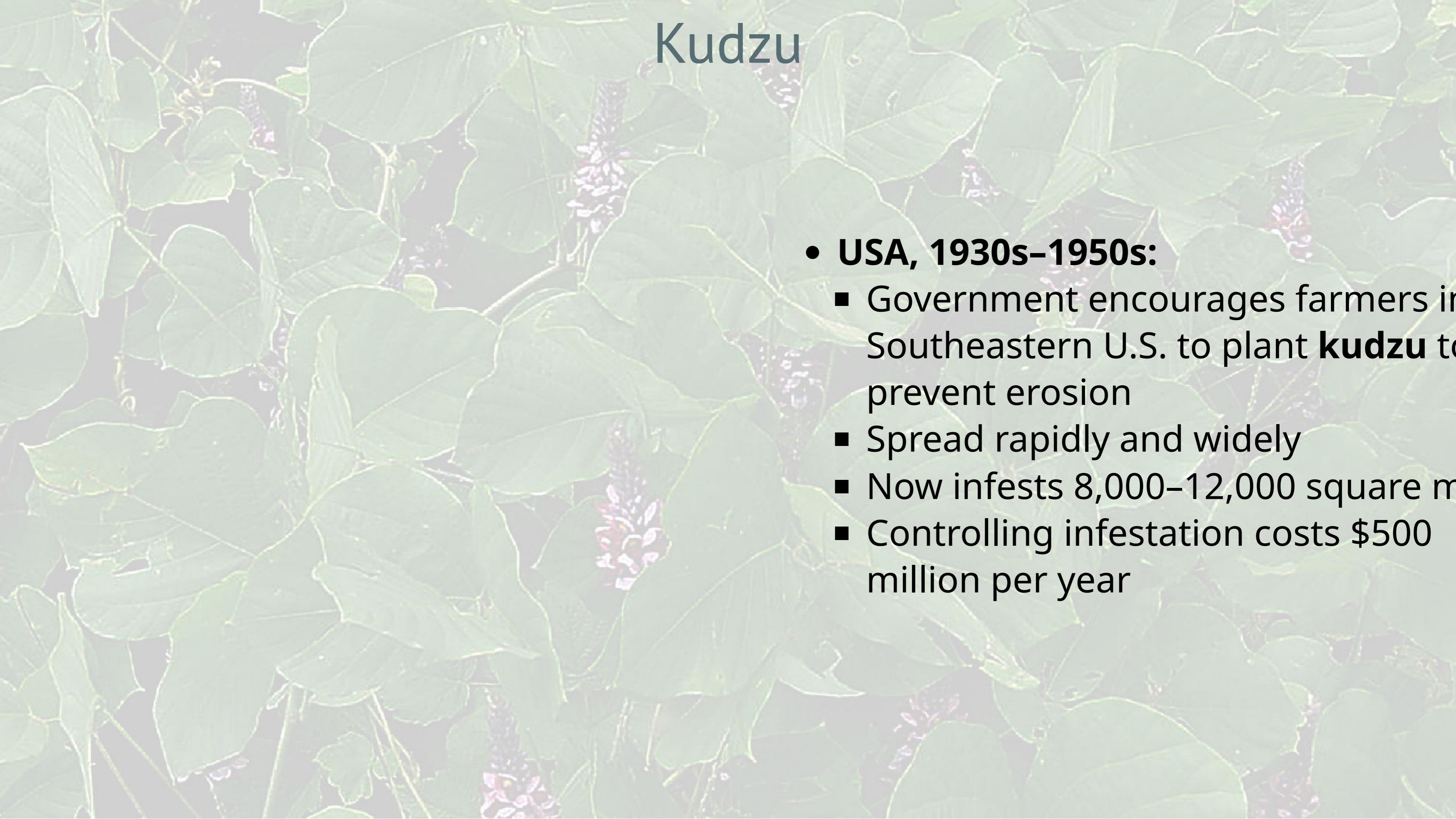
Cane Toad

- Australia, 1933:
 - Beetles infesting sugarcane
 - 102 toads imported from Hawaii to eat beetles
 - Toads eat other bugs, leave beetles alone
 - No predators: toad population out of control

Mongoose



- Hawaii, 1883:
 - Mongoose introduced to control rats
 - Predates on lizards, insects
 - Spreads disease leptospirosis

A close-up photograph of a kudzu plant, showing its large, heart-shaped leaves with prominent veins and clusters of small, purple, pea-like flowers hanging from the leaf axils.

Kudzu

- **USA, 1930s–1950s:**
 - Government encourages farmers in Southeastern U.S. to plant **kudzu** to prevent erosion
 - Spread rapidly and widely
 - Now infests 8,000–12,000 square miles
 - Controlling infestation costs \$500 million per year



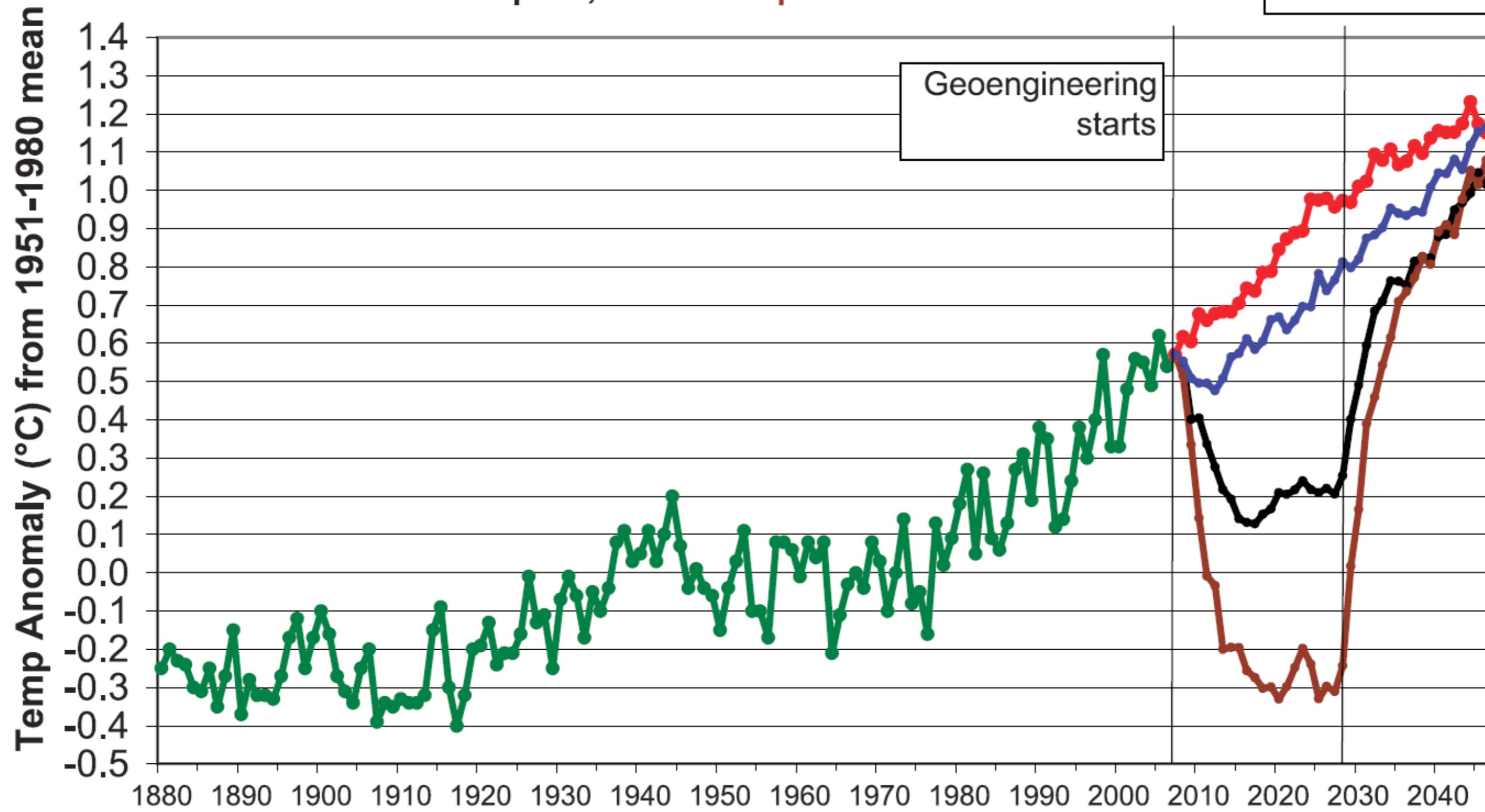


Maintenance



GISS Global Average Temperature Anomaly
+ Anthro Forcing, 3 Mt/a Arctic,
5 Mt/a Tropical, 10 Mt/a Tropical

Geoengineering
ends



Summary

Summary

- Is Solar-Radiation Management a Feasible Technological Fix?
 - Pielke says no
 - Relation between cause and effect is complex and uncertain
 - Can't assess the effects without a full-scale global experiment
 - Doesn't build off existing technology
 - Others say maybe
 - It can't cancel out global warming, but it could make it much less bad.
 - It's quickly reversible so we could adjust as we learn more
 - It doesn't need fancy technology.
 - Many problems are more political than scientific:
 - How should decisions about geoengineering be made?
 - Who should participate in decision-making?

