

# Remediation and Geoengineering

The Gods will not save you — Ervin Burrell.

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# Be Prepared

Be prepared

Be very prepared

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# 1. Get CO<sub>2</sub> Out Of The Air

- ▶ *Not* undoing combustion:  $\text{CO}_2 \rightarrow \text{C} + \text{O}_2$ .
- ▶ Instead:
  - ▶ Sequester CO<sub>2</sub> into underground reservoirs.
  - ▶ Speed up natural sequestration:
    - ▶ Rock weathering.
    - ▶ Ocean CO<sub>2</sub> absorption.

# Social Cost Of Carbon

- ▶ Logically, sequestration cost is the upper limit to IAMS' Social Cost of Carbon (SCC).
- ▶ Of course, there is no world government.
  - ▶ SCC and sequestration cost are both intellectually interesting,
  - ▶ but practically irrelevant for the real world.
- ▶ What would \$20/tCO<sub>2</sub> say about the world's free-rider problem?
  - ▶ When do you think it will change?

# Lumber

## Cheapest Sequestration Process:

- ▶ Foresting *with* lumber harvesting.
- ▶ Local benefits of trees on water, air, etc.
- ▶ As cheap as ***\$10/tCO<sub>2</sub>!***
  - ▶ on the margin, even cheaper, and
  - ▶ probably for the first 1 GtCO<sub>2</sub>/year.
- ▶ Nevertheless, not pursued at large scale.
  - ▶ Instead, poor farmers burn Brazilian forest.

*Environmentalists won't like tree-felling.*

# Lumber Farming

- ▶ Needs more research:
  - ▶ What trees where for most efficiency?
  - ▶ How much sequestration at what cost?
    - ▶ Is 20 GtCO<sub>2</sub> feasible at \$40/tCO<sub>2</sub>?
  - ▶ Local benefits can justify local subsidies.
- ▶ Easy US suggestion:
  - ▶ Grant free Federal shrub lands to purpose.
  - ▶ Tie Brazilian and Indonesian trade to satellite-measured forestation.

# Other Processes

- ▶ Algae are potentially even more efficient.
  - ▶ Yet perhaps not as economical.
  - ▶ Needs more research first.
- ▶ Ocean liming
  - ▶ Crush and shovel chalk into ocean.
  - ▶ Needs more research first.
- ▶ Sequester on top of coal smokestack?
  - ▶ Maybe yes. Maybe never. Cost?

# Crazy Ideas — Why?

- ▶ Industrial processes (e.g., Climeworks)
  - ▶ Wrestling towards \$200/tCO<sub>2</sub>.
  - ▶ Business Model: Sell carbon credits to environmentalists.
  - ▶ What?
- ▶ Enhanced rock weathering
  - ▶ Wrestling towards \$150/tCO<sub>2</sub>.
- ▶ Research *only if* cost can go to <\$50/tCO<sub>2</sub>.
  - ▶ (I don't mean alternative cement research.)

*Usually, I am for research, but this seems still-born.*



## 2. Change Solar Radiation

*(Reduces warming only, not ocean acidification.)*

### 1. Star Trek Space Shield?

- ▶ Nonsense, too expensive.

### 2. Sulfur particles into stratosphere.

- ▶ Feasible, cheap, think 1% of CO<sub>2</sub> removal;
- ▶ circulates for 2-5 years.

### 3. Cloud Seeding.

- ▶ Potentially cheaper yet, shorter-term,
- ▶ but not much known.

# Radiation Management Problems

- ▶ Dangerous unknown unknowns,
  - ▶ but modest interventions can and should be researched.
- ▶ We don't even know for sure if it works
  - ▶ though volcanoes have suggested it would.
- ▶ Many possible unintended consequences,
  - ▶ but so does the current alternative:  
*global warming.*

# Global Cooling

- ▶ We may also need solar radiation capture on demand:
  - ▶ i.e., heating up earth, e.g., reducing albedo.
  - ▶ Think Asteroid *Apophis* 99942.
- ▶ We don't know enough about this either!
- ▶ Much less urgent for now.

# Be Prepared

- ▶ Solar radiation management is dangerous!
  - ▶ It is also potentially the only way to stop a run-away loop (e.g., Permafrost Methane melting) in its tracks,
  - ▶ to buy humanity some time.
  
- ▶ Do not deploy!
  - ▶ But research and understand,
  - ▶ and think about acceptable use scenarios.

# Conclusion

- ▶ Subsidize lumber farming.
- ▶ Research intelligent sequestration.
- ▶ Research solar radiation management.