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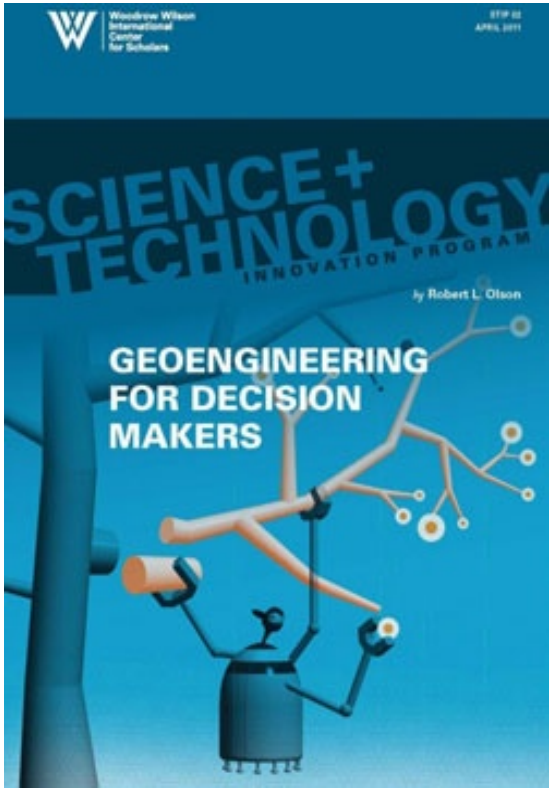
# What is Climate Geoengineering?

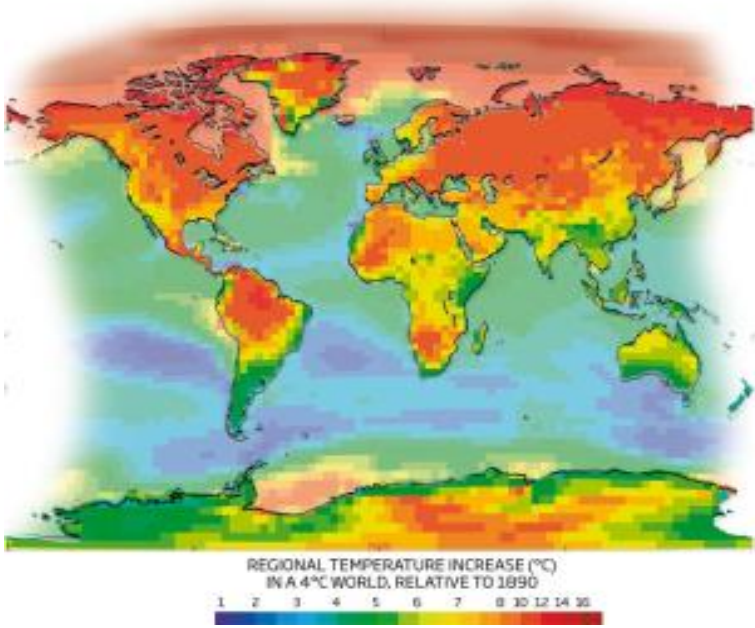
"… intentional interventions in the atmosphere, oceans, soils or living systems to cool the Earth."

***Geoengineering for Decision Makers***



# Why Geoengineering Is Important

- ✓ Speed of climate change
- ✓Failure □□to stop it (so far)
- ✓Danger of irreversible tipping points
- ✓ Scientists urging research
- ✓ Possible serious negative impacts



# Criteria for “Soft Geoengineering”

1. Can be applied locally
2. Scalable to larger areas
3. Low anticipated negative impacts on ecosystems or society
4. Rapid reversibility if problems do arise
5. Has multiple benefits, beyond impacts on climate
6. Analogous to natural processes
7. Effects are large enough soon enough to be worthwhile
8. Cost-effective with mature technologies deployed at moderate scale

# **Ice 911** (Leslie Field)

✓Loss of ice is largest climate threat

✓Goal: protect ice & possibly nucleate new ice by deploying high albedo covering material

✓Engineer to be easy to deploy, floatable, wind resistant, easily removable or biodegradable

✓Field tests over four seasons with different materials and configurations

# **Bright Water** (Russell Seitz)

✓Water is dark, but microbubbles of air make it highly reflective and are slow to rise

✓Brightening a large pond can have same effect as 10,000 white roofs

✓Use on “edges” to retard ice loss

✓Eventually, perhaps thousands of ships laying hydrosol wakes

✓Important for water conservation

✓Potential for “outdoor air conditioning,” hurricane suppression

# Environmental Benefits

Extended dry season water supply

Increased river flow

Conserving wetland habitats

Reduced methane release

Reduced coral stress

Increasing lake area reduces sea level rise

No ozone layer risk

No change in solar spectrum - Sky stays blue

Net reduction of atmospheric $CO_2$

# **Cool Cities** (Hashem Akbari)

✓White roofs and pavements could increase urban albedo by ~ 10%

✓Only small global cooling impact - not worth the cost

✓But would allow ~20% reduction in A/C cost and make outdoor environments more comfortable

✓Small climate cooling as a bonus to major energy cost saving

# Air Capture & Use of $CO_2$ (David Keith)

✓Too expensive? New startups are betting it's feasible

✓At $200/ton, could sell $CO_2$ to oil companies for use in EOR, later to companies producing algae-based biofuels

✓Makes a carbon-neutral fuel system possible

# **Soil Building** (Freeman Dyson)

✓Stop carbon in atmosphere from increasing by storing carbon in soil

✓~ 1/100 inch per year increase in soil biomass averaged over 1/2 of Earth's land area that has soil would stop global warming

✓Can be done by shifting to no-till farming, breeding plants to have larger root systems, using cover crops

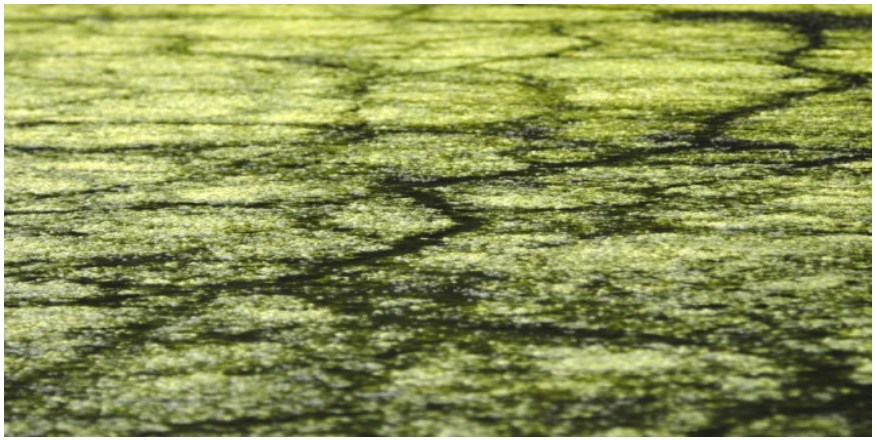
✓Another approach: use of biochar as a soil amendment

# Rough Rating of Technologies

| | Ice 911 | Bright Water | Cool Cities | Air Cap. | Build Soil |
|---|---|---|---|---|---|
| Can be applied locally | Yes | Yes | Yes | Yes | Yes |
| Scalable | Yes | Yes | Yes | Yes | Yes |
| Low negative impacts | Yes* | Yes* | Yes | Yes | Yes* |
| Rapid Reversibility | ? | Yes | No | Yes | No |
| Multiple Benefits | Yes | Yes+ | Yes | Yes | Yes |
| Analogous to natural | Yes | Yes | Yes | Yes | Yes |
| Worthwhile time/effect | Yes | Yes | No | Yes | Yes |
| Cost-effective | ? | ? | Yes | ? | Yes |

* Low negative impacts when used at local or modest scale; careful assessment needed for larger-scale use

# Geoengineering Governance



✓Danger of Rogue geoengineering, other unsafe use

✓Need for legitimate processes to manage research risks

✓Critics and regulations focused on global-impacts geoengineering could also block use of less problematic soft geoengineering technologies