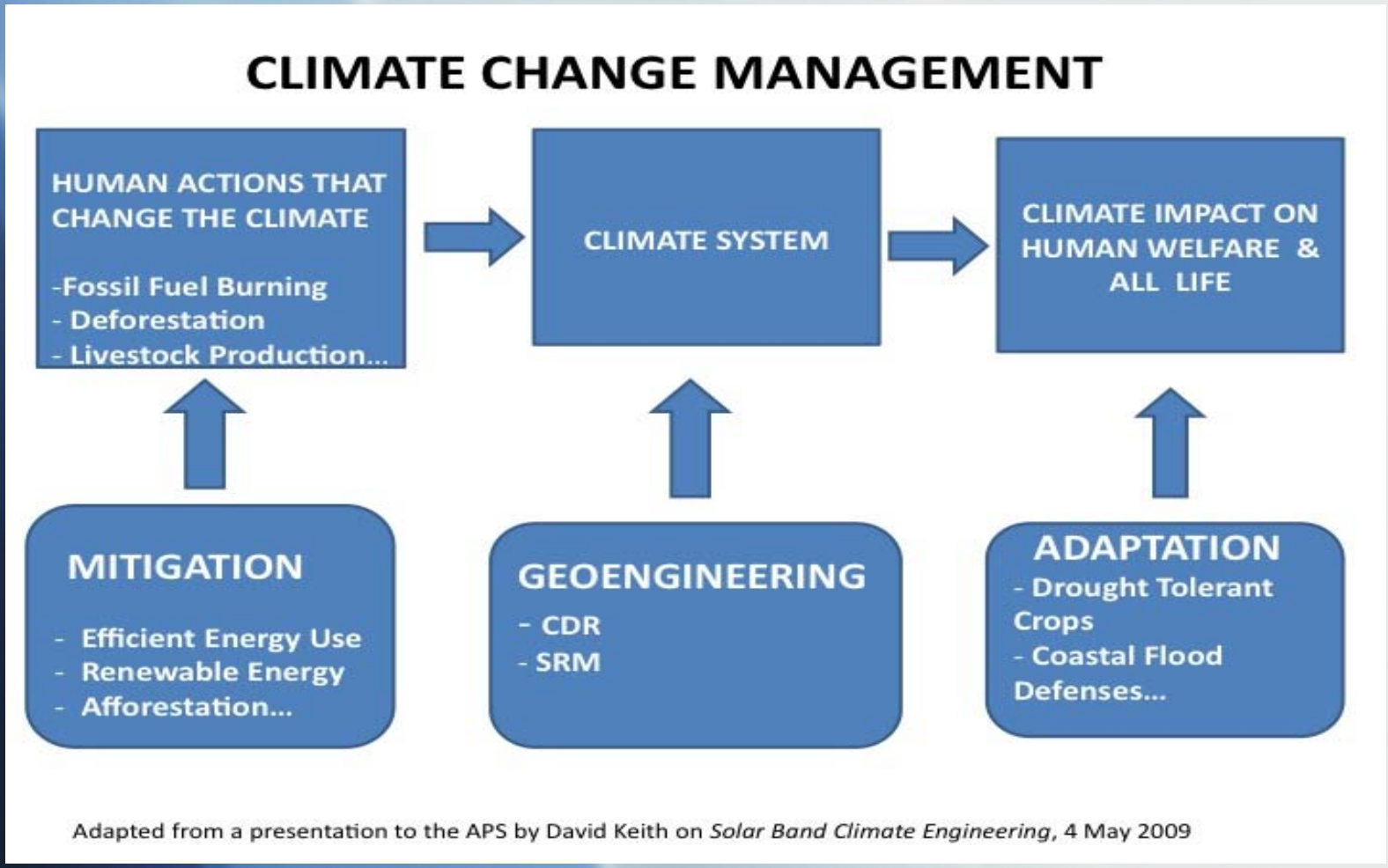
GEOENGINEERING
FOR
DECISION MAKERS

Bob Olson
Senior Fellow
Institute for Alternative Futures

A Framework
for Thinking About Geoengineering



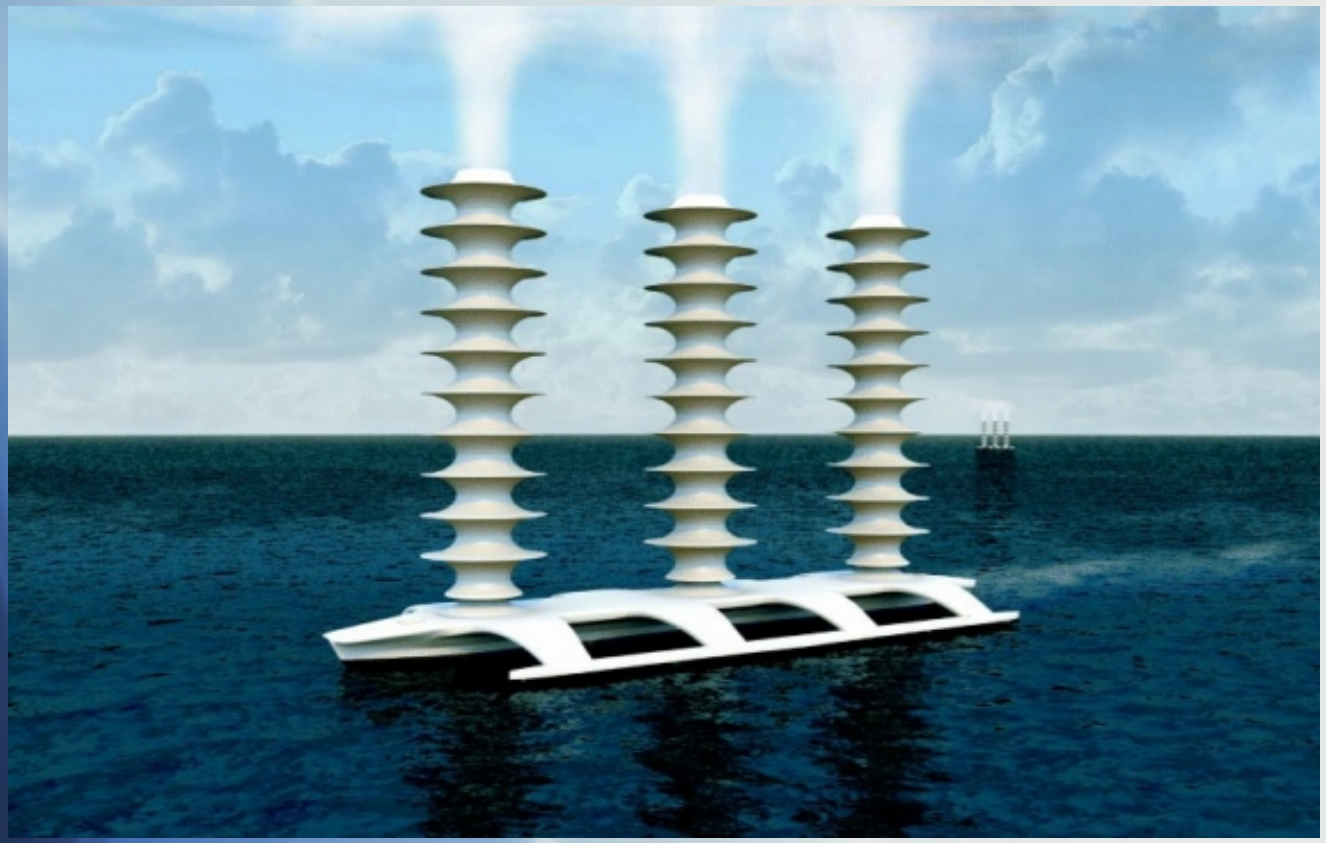
Adapted from a presentation to the APS by David Keith on *Solar Band Climate Engineering*, 4 May 2009

Geoengineering Technologies

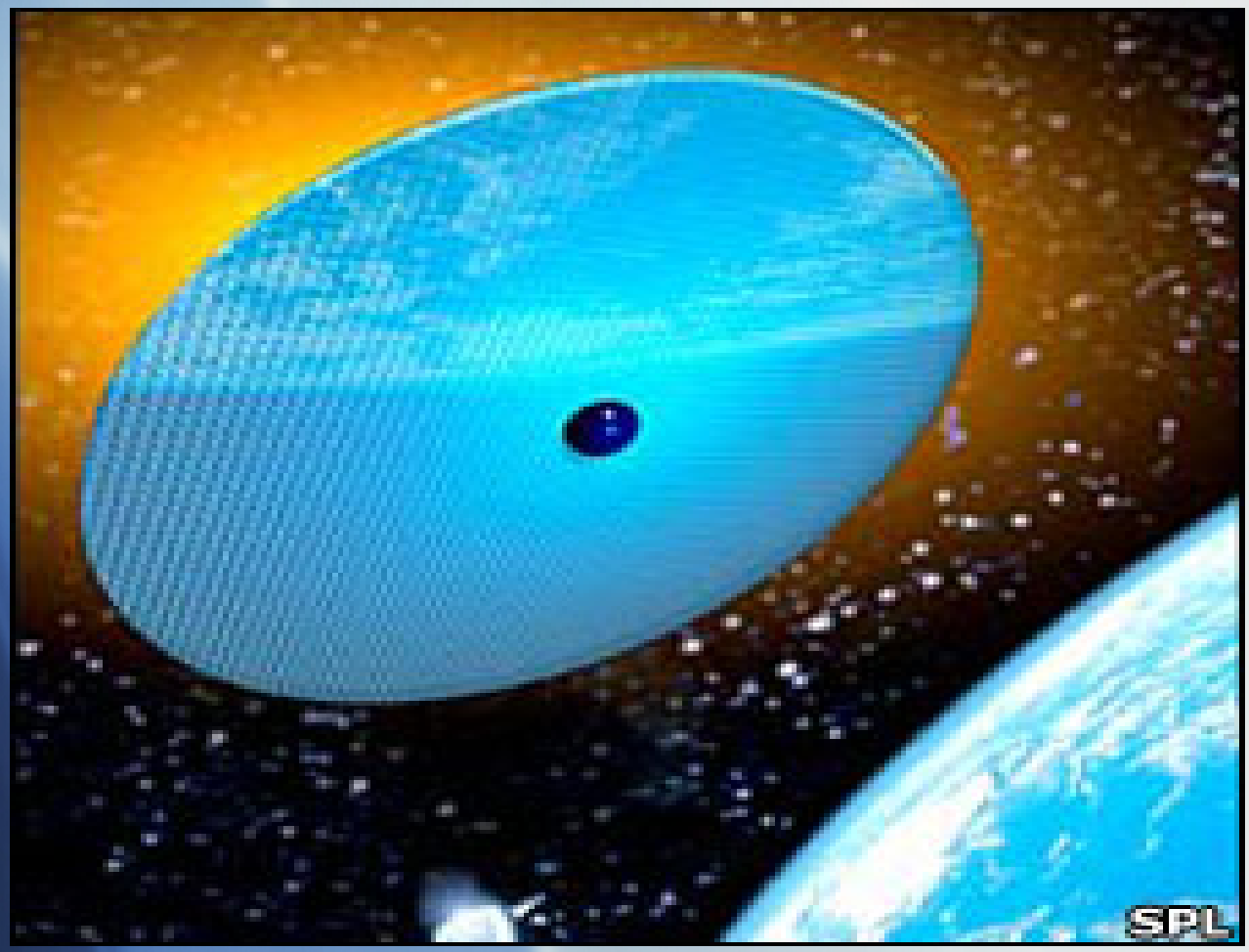
Solar Radiation Management (SRM)

Stratospheric Aerosols

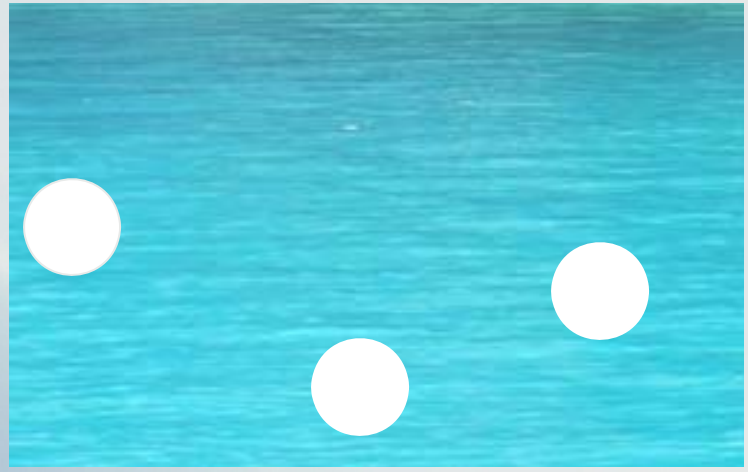
Cloud Brightening



Space Based Methods



Increased Surface Reflectivity



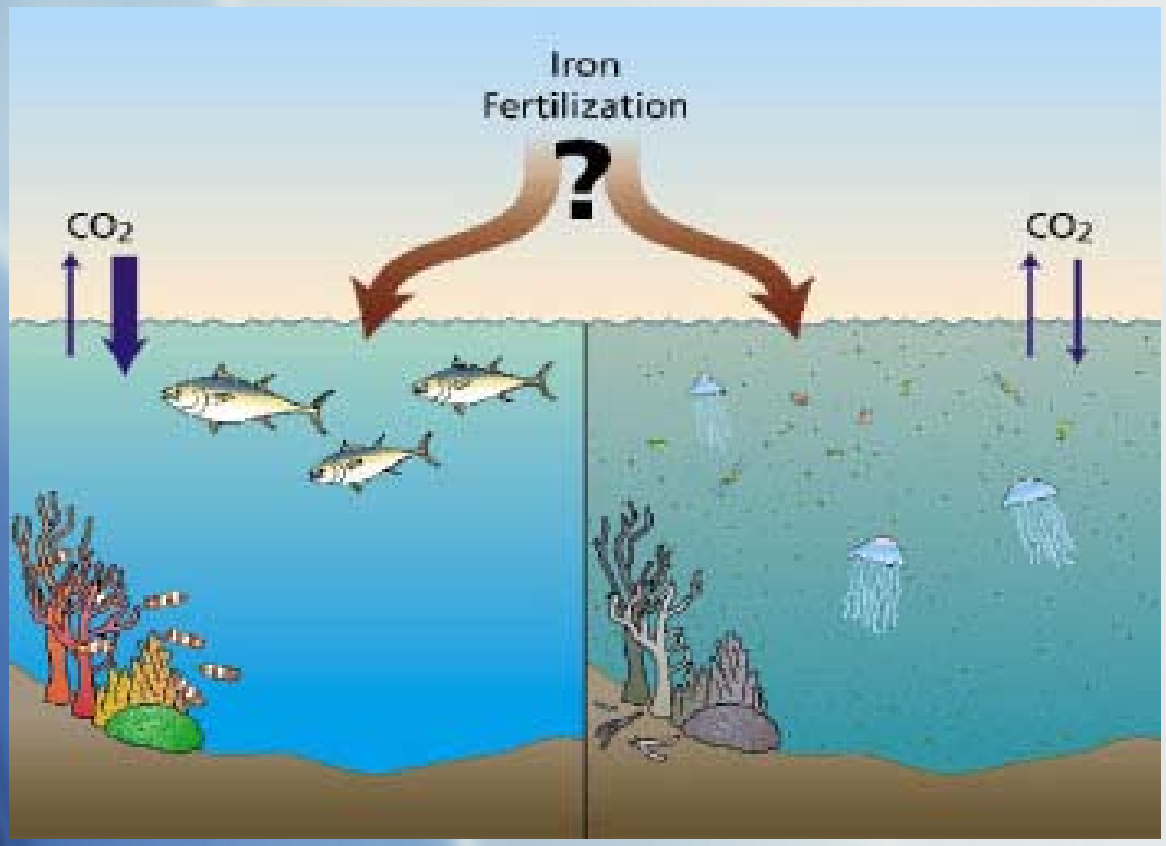
Geoengineering Technologies

Carbon Dioxide Removal (CDR)

Engineered CO_2 Capture From Air
"Artificial Trees"

David Keith and his team are working to efficiently capture the greenhouse gas carbon dioxide directly from the air. / Photo by Ken Bendiktsen

Ocean Fertilization

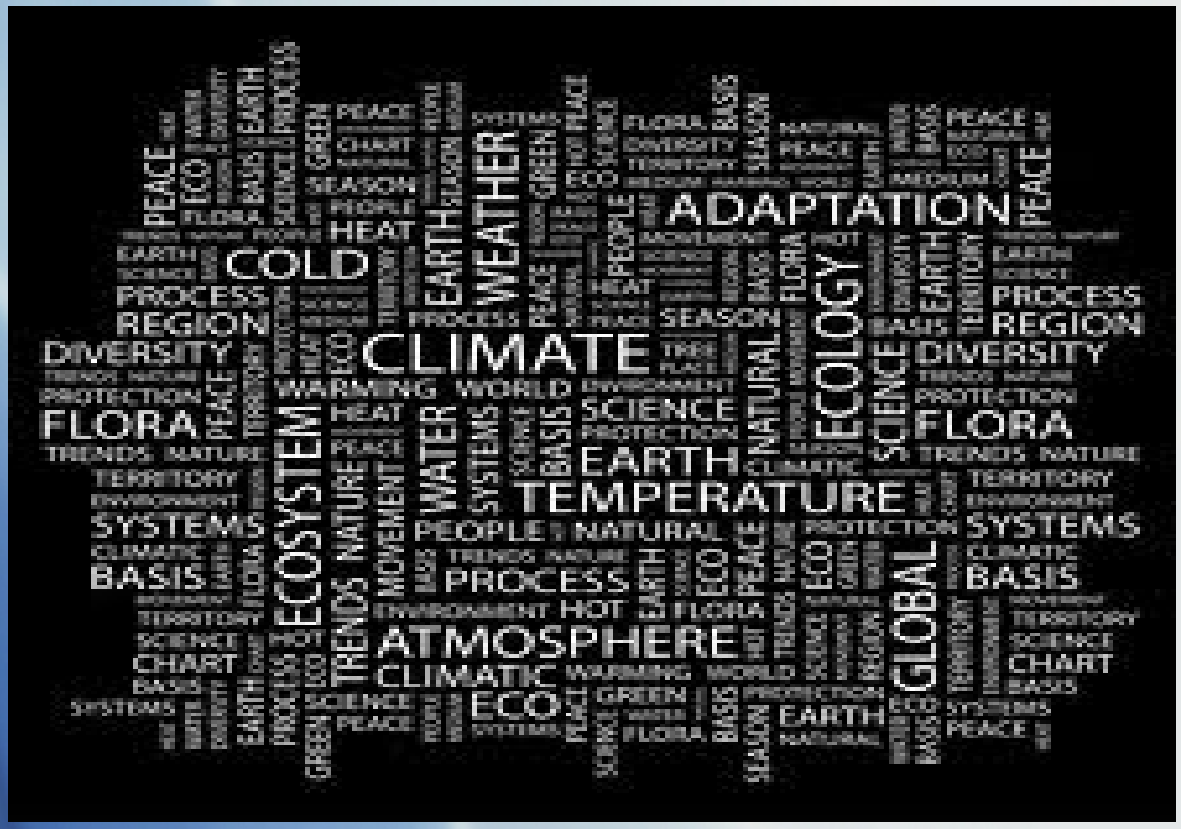


Bioenergy With CCS

+

Biochar

CONCERNS ABOUT GEOENGINEERING



Potential Negative Impacts

Example - Stratospheric Aerosols

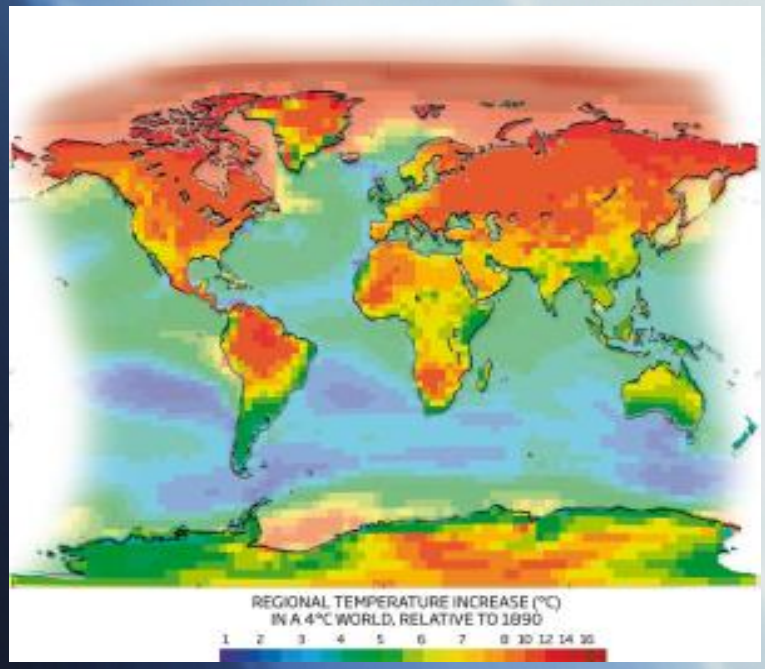
- Regional impacts on precipitation and river flows
- Impact on ozone layer
- Acid deposition
- Impact on crops & plants of reduced sunlight
- Reduced effectiveness of solar energy systems
- Psychological effects of loss of blue sky

Potential Ineffectiveness

MOST POWERFULL	LESS POWERFULL	WEAKER	VERY WEAK Some by an order of magnitude
▪Stratospheric Aerosols ▪ Cloud Whitening ▪ Space-based Methods	▪Air Capture ▪ Increasing the Reflectivity of Large Desert Areas	▪Biochar ▪ Afforestation & Reforestation ▪Increasing the Reflectivity of Vegetated Surfaces	▪ Ocean Fertilization ▪ Increasing the Reflectivity of the Built Environment ▪Ocean Upwelling, Downwelling

Danger of Undermining Emissions Mitigation

Risk of Sudden Catastrophic Warming



If the geoengineering effort should ever falter, the built up potential for climate change would hit us all at once.

Equity Issues

"Geoengineering changes in the environment could lead not only to "winners and losers" but even to conflicts over water resources and the potential for migration and instability…."

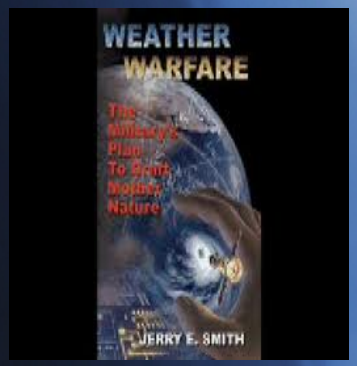
Difficulty of Reaching Agreement

- The science on potential impacts is not well established
- Negative impacts of some technologies may be large
- Strong opposition
- Distrust of government, low public awareness
- Liability could be a legal nightmare
- Religious/ philosophical opposition to “engineering the Earth”

Other Concerns

Could the drive for shareholder profits lead to inappropriate deployments?

Could the community of researchers become an interest group promoting the use of geoengineering?

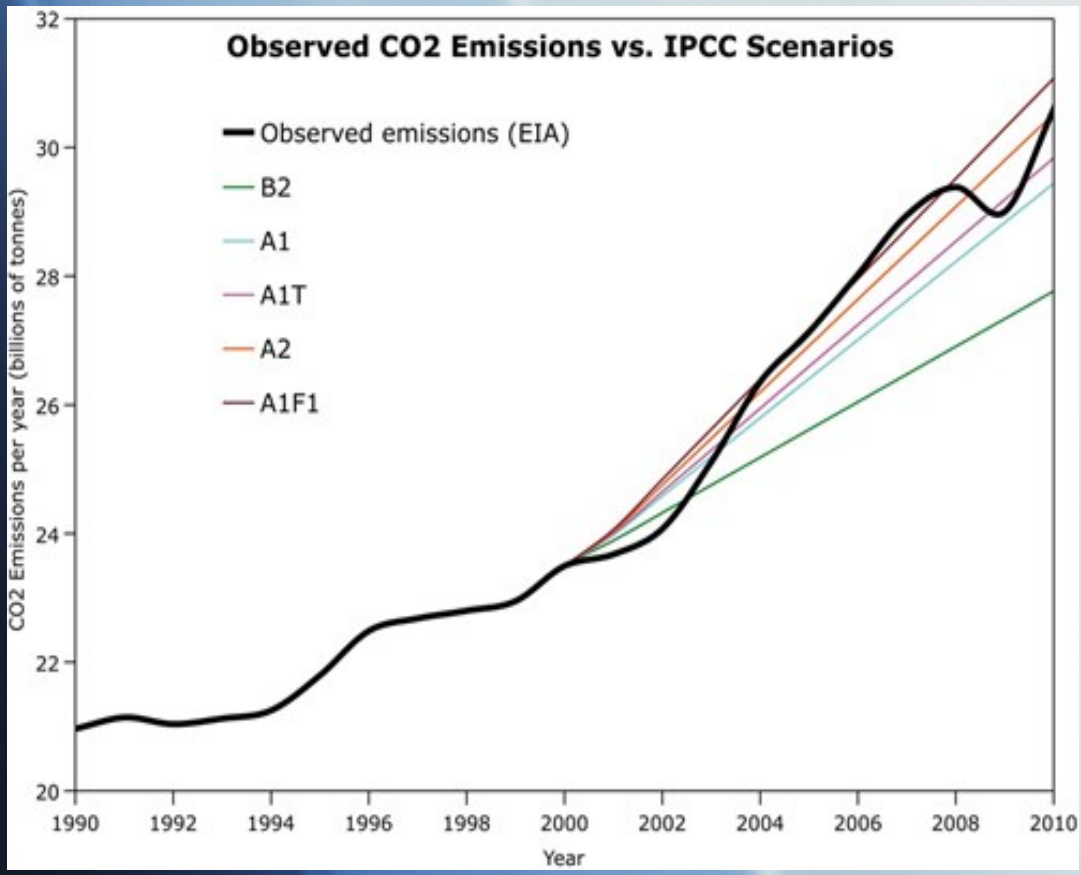


Could work on geoengineering lead to major advances in “weather control” for military use?

CAN WE REDUCE GHG EMISSIONS FAST ENOUGH?

The Key Question in Formulating Policy Toward Geoengineering

Emissions Are Near the IPCC "Worst Case" Scenario



Growth Rate:

1990s: 1%/year

2000-2008: 3.4%/year

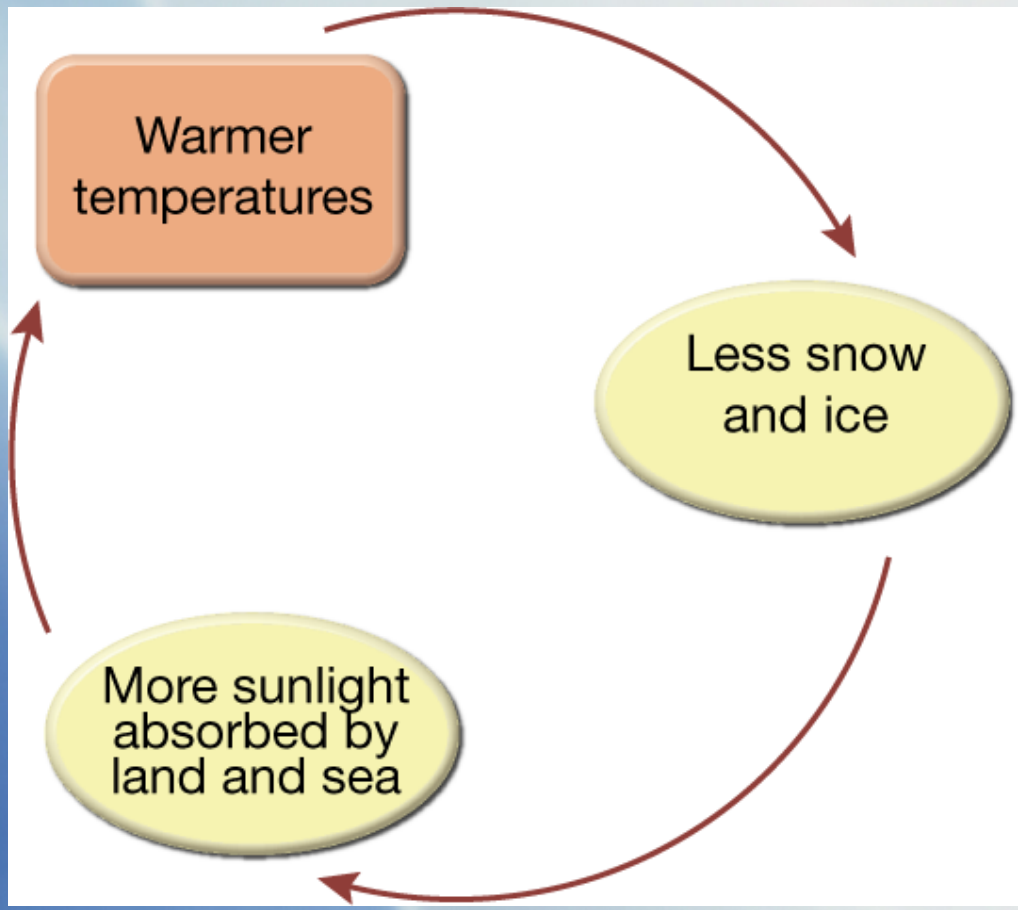
What Most Climate Scientists Expect

- Continued warming
- More & more extreme weather events
- Ice-free Arctic summers, possibly as soon as 2030
- Sea level rise up to 6.5 feet by 2100
- Serious disruption of ocean ecosystems by acidification, warming
- Worsening water scarcity in some areas
- Impacts on agriculture - winners and losers
- Sharp decline in biodiversity
- Serious health impacts from heat waves, malnutrition, tropical diseases moving into temperate zones
- Migration & refugees

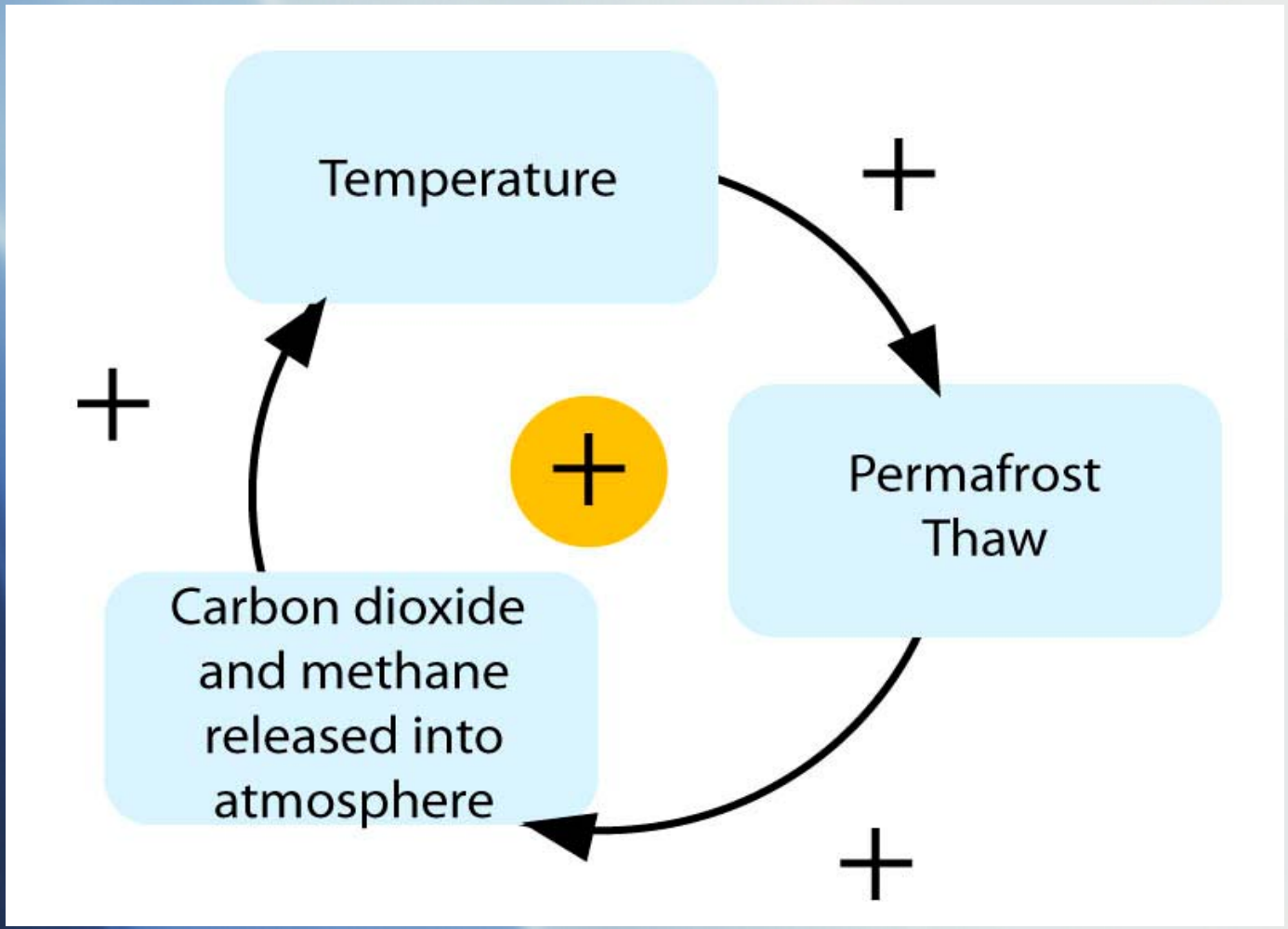
What Scientists Fear Most

Tipping Points of Irreversible Change

Arctic Melting



Permafrost Thawing



Abrupt Climate Change

- Roughly half of the north Atlantic warming since the last ice age was achieved in only a decade
- Many similar rapid changes are now known
- A “Hot House Earth” - the Paleocene-Eocene Thermal Maximum - occurred 55 million years ago, with a massive release of marine methane hydrates
- Abrupt climate changes usually occur when something is forcing the climate system to change rapidly
- This new understanding “is little known and scarcely appreciated in the wider community of…policy-makers”

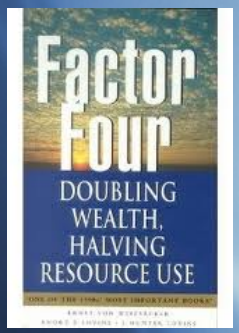
- NAS report on *Abrupt Climate Change*

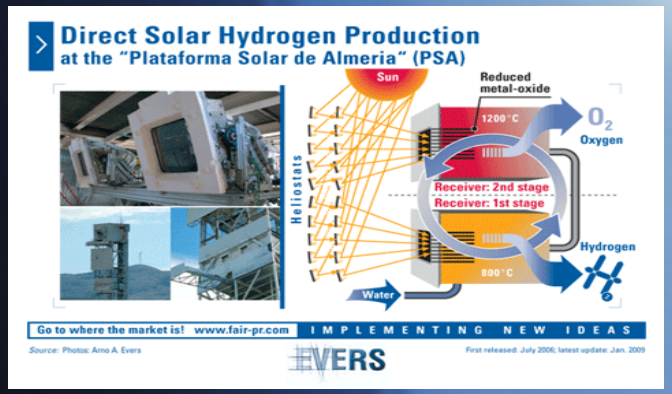
What It Will Take

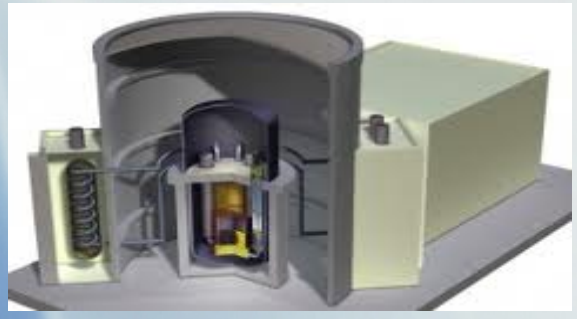
Stabilization at 2 degrees C requires annual global CO_2 emissions to fall to an average of two tons per capita by mid-century and one ton by 2100. The world average emission level is 5 tons per capita and the U.S. level is 20 tons per capita.

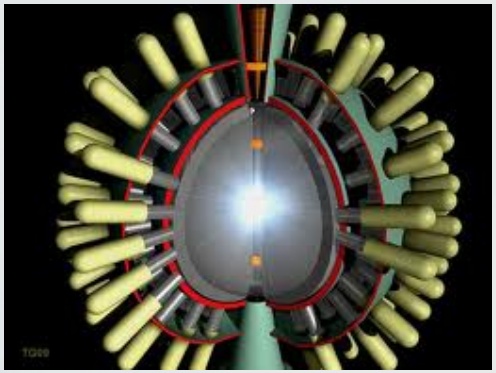
- Robert Socolow, Princeton University

The Needed Technological Revolution







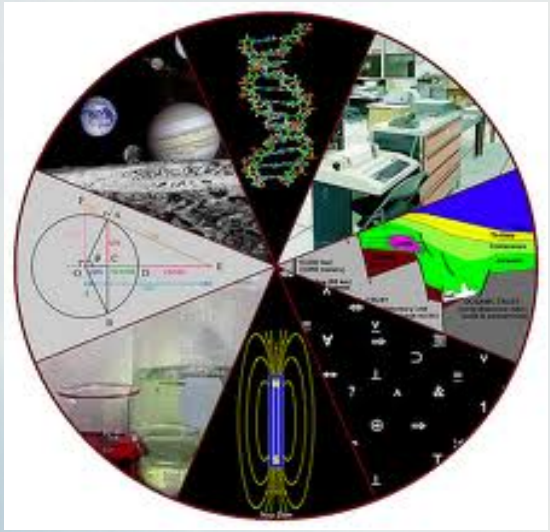


"Atmospheric stabilization of carbon dioxide and other greenhouse gases below the level that risks dangerous climate change will require a societal mobilization and technological transformation at a speed and scale that has few if any peacetime precedents."

- Geoengineering for Decision Makers

GEOENGINEERING GOVERNANCE

NGO
NETWORK



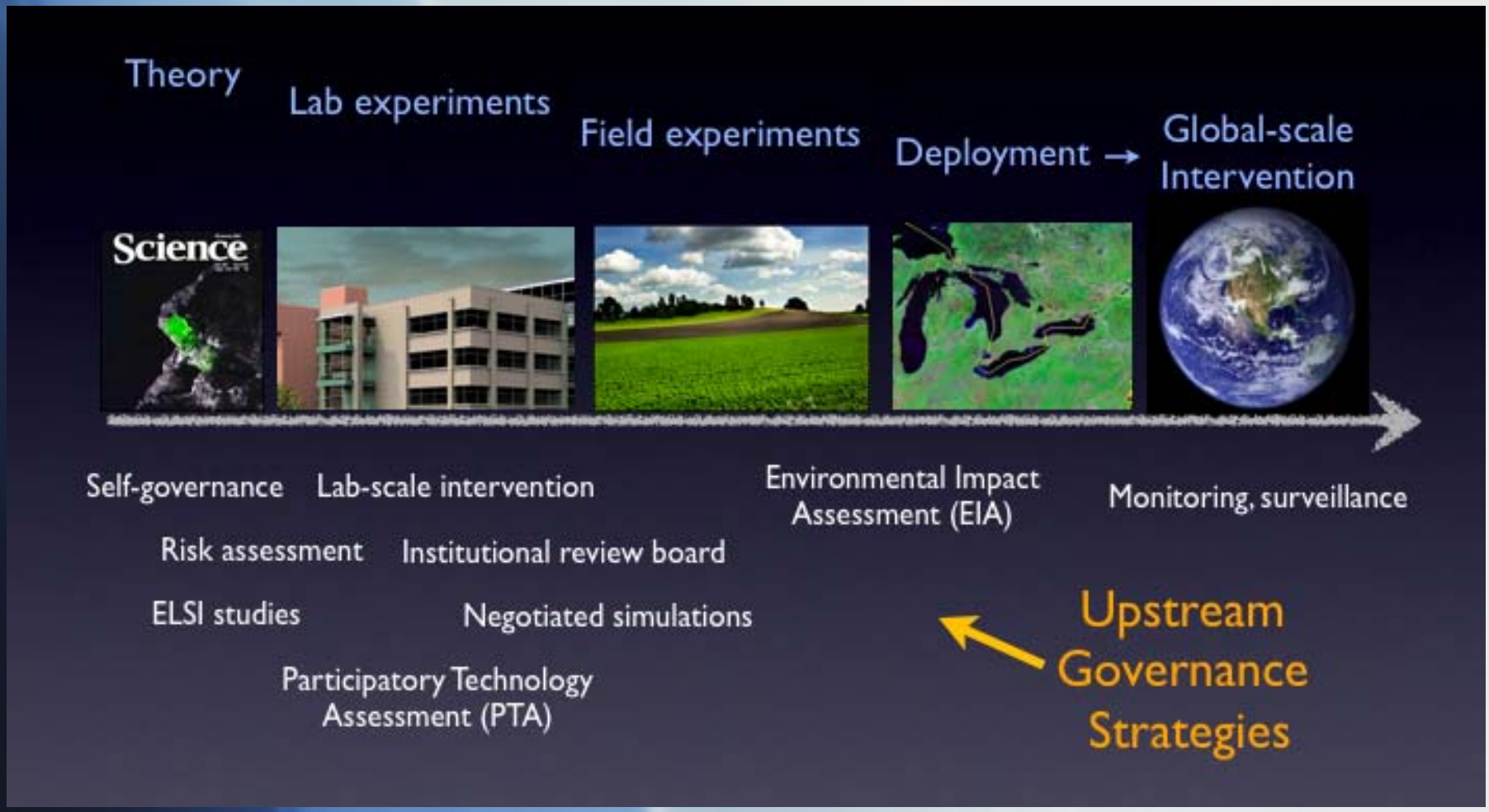
The Moral Argument for Doing R&D

"If there is even a modest chance we will fail to prevent dangerous climate change through emission reductions, then a resilient, far-sighted approach must include preparing to deal with that failure before it occurs.

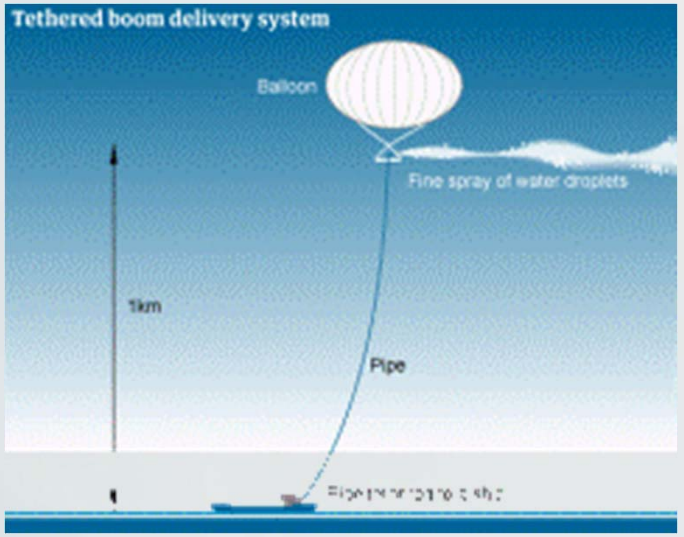
"If it comes to a situation where geoengineering is the only recourse to a global climate catastrophe, decision makers will almost certainly choose to do geoengineering. They should not be put in the position of either letting dangerous climate change occur or deploying untested technologies at full scale."

- Geoengineering for Decision Makers

The Importance of Upstream Governance



Small-Scale Field Experiments



Large-Scale (Climate Impacts) Testing

- Global impacts monitoring needs to be in place
- Need for a legitimate international process for approval and oversight
- A moratorium on large-scale testing until these needs are met

Key Recommendations

- Approach geoengineering in the broader context of *climate change management*
- Look for systemic approaches that provide simultaneous solutions to multiple problems
- Commit to creating an energy system based on high efficiency & carbon-free energy sources
- Fund basic science & R&D on high-risk, high-reward supply options

Key Recommendations

- Treat geoengineering as a legitimate option, but…
- Distinguish clearly between CDR and SRM
- Never treat SRM methods as a substitute for emissions mitigation
- Do not consider near-term deployment of powerful SRM methods
- Make extensive use of *upstream governance*

Key Recommendations

- Insist that all SRM research be in the public domain
- Place a moratorium on large-scale testing until a legitimate international process for approval & oversight is agreed upon
- Organize informal but focused international dialogues about needed “downstream” governance arrangements

Key Commonalities Across All Three Reports

- Geoengineering technologies pose serious risks & are not now ready for use or large-scale testing
- Mitigation and adaptation are the first priority & geoengineering should never substitute for them
- Climate change also poses extremely serious risks
- Research on geoengineering is justified as an "insurance policy," should focus on evaluating risks & be informed by public engagement
- Importance of "upstream governance" & transparency
- Value of international cooperation