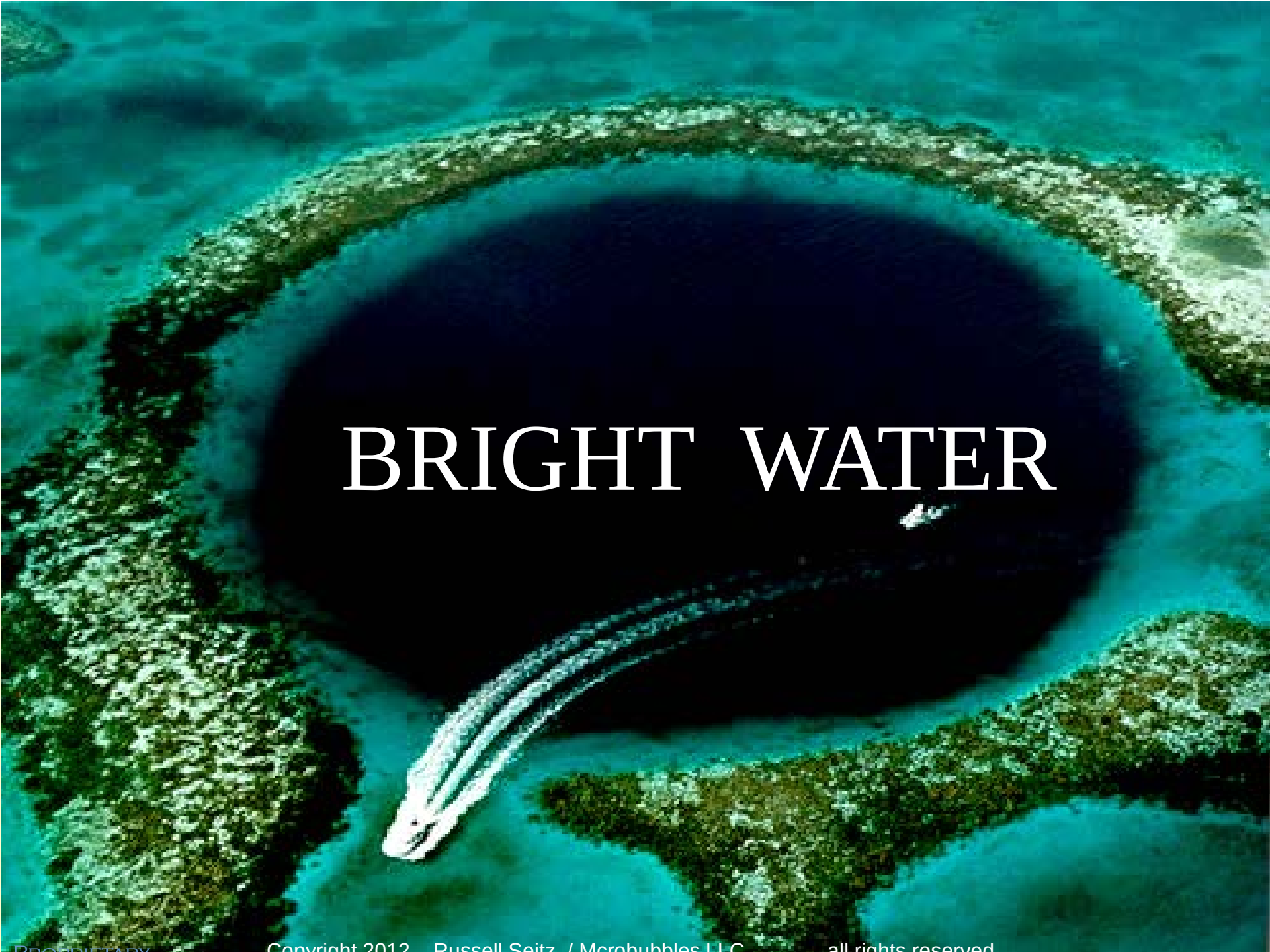


What color is your planet?

- Earth is not ‘pale blue dot’- it’s largely covered by a **deep blue ocean**
  dark as an asphalt parking lot
- Earth’s albedo is low because water soaks up 93% of the sunlight striking it.
  Besides warming water, solar heating drives evaporative water loss

A GLOBAL ECONOMIC PARADOX

The world loses a ton of water per capita a day to solar evaporation, but water conservation scarcely exists in practice because

Water is too cheap to conserve!

The world loses a ton per capita of stored water to evaporation every day

This costs farmers $10 Billion a month

- Global water reservoir area > 1 Million KM^2
- Annual evaporation loss: ~ 2 meters of depth
- Total stored water loss ***> 2 Trillion tonnes***

California loses >10% of irrigation supply

Australia	~ 40%
Middle East	> 50%

This is true of large reservoirs as well. From Arizona to the Indus , evaporation concentrates pollution and reduces hydropower production.

GEOENGINEERING IS AN INTEGRAL PART OF THE LANDSCAPE OF HISTORY

257 years ago an American scientist noted :

'We are, as I may call it, scouring our Planet,
by clearing America of Woods & so making
thif side of our Globe reflect a brighter Light'
B. Franklin 1751

But

To Tell The Truth,

Ben Didn't start it >>

12/20/08

When water is worth only $50 an acre-foot and cover materials costs thousands of dollars an acre, It's hard to imagine a solution

Hard, but not impossible –

Air is cheaper than water and can reduce solar heating & evaporation by brightening water from within.

While deep water is dark as asphalt, its reflectivity can be raised by exploiting the refractive index contrast of *very small bubbles*

A liter of water ordinarily dissolves ~20 cc of air, but at ~50 PSI that amount doubles. Releasing the pressure can create a HYDROSOL containing literally trillions of mirror-like microbubbles- just as refractive index contrast makes whitecaps white, tens of grams of air can cool hectares of water by reflecting megawatts of solar energy

Hydrosols are Clouds turned Inside Out

Clouds are aerosols of water drops too small to fall fast through the air

Hydrosols are clouds of air bubbles too small to rise fast through water

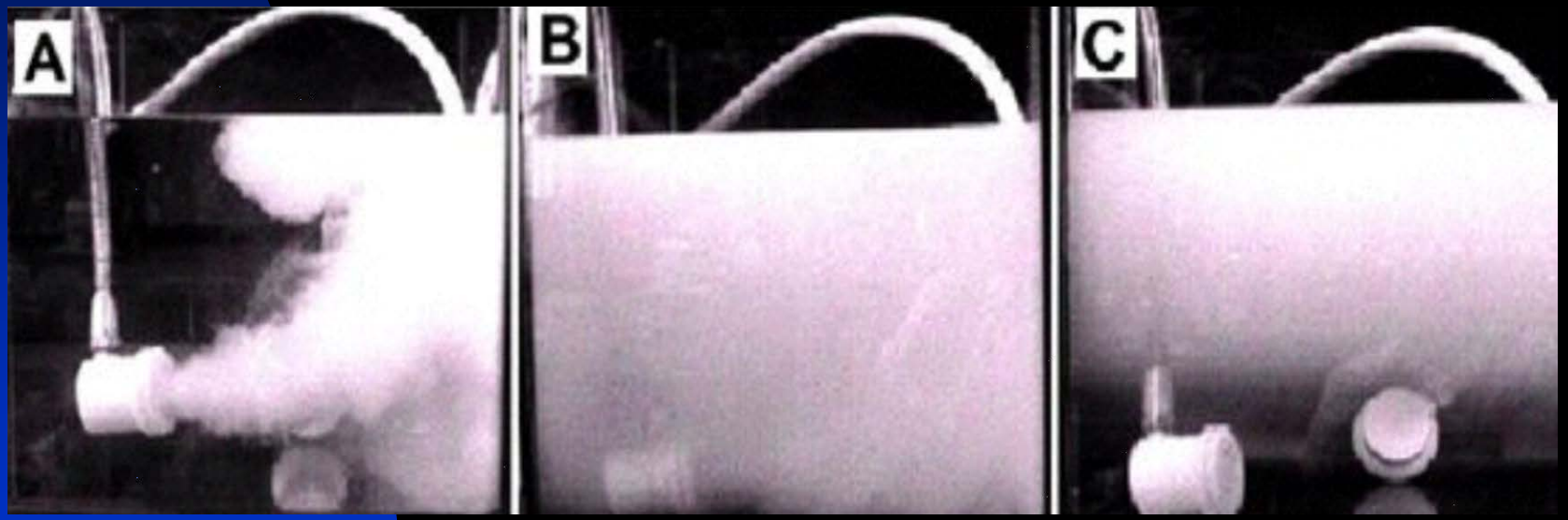
They are optically identical

Both reflect solar energy by light scattering,

But air weighs 1000 times less than water

Making clouds underwater

WATER SUPERSATURATED WITH COMRESSED AIR BEING RELEASED THROUGH A VORTEX NOZZLE



START STOP 2 MINUTES LATER

Bright Water works like White Roofs, but on a bigger scale

- The global roof supply is ~ 25 m^2 per capita
  Earth's hydrosphere is over 1,000 times larger!
- It's easier & cheaper to brighten one pond than 10,000 roofs

Geoengineering from the top down
versus
Albedo mitigation from the bottom up

Degree of Control	Latitude	Longitude	Time
Stratospheric Aerosols	Poor	None	Months
Marine Cloud Nucleation	Good	Fair	Days
Hydrosols	Excellent	Excellent	Hours

Control criteria:
Poor >30^{o} Fair >10^{o} Good <5^{o} Excellent <1^{o}

All climate is local-

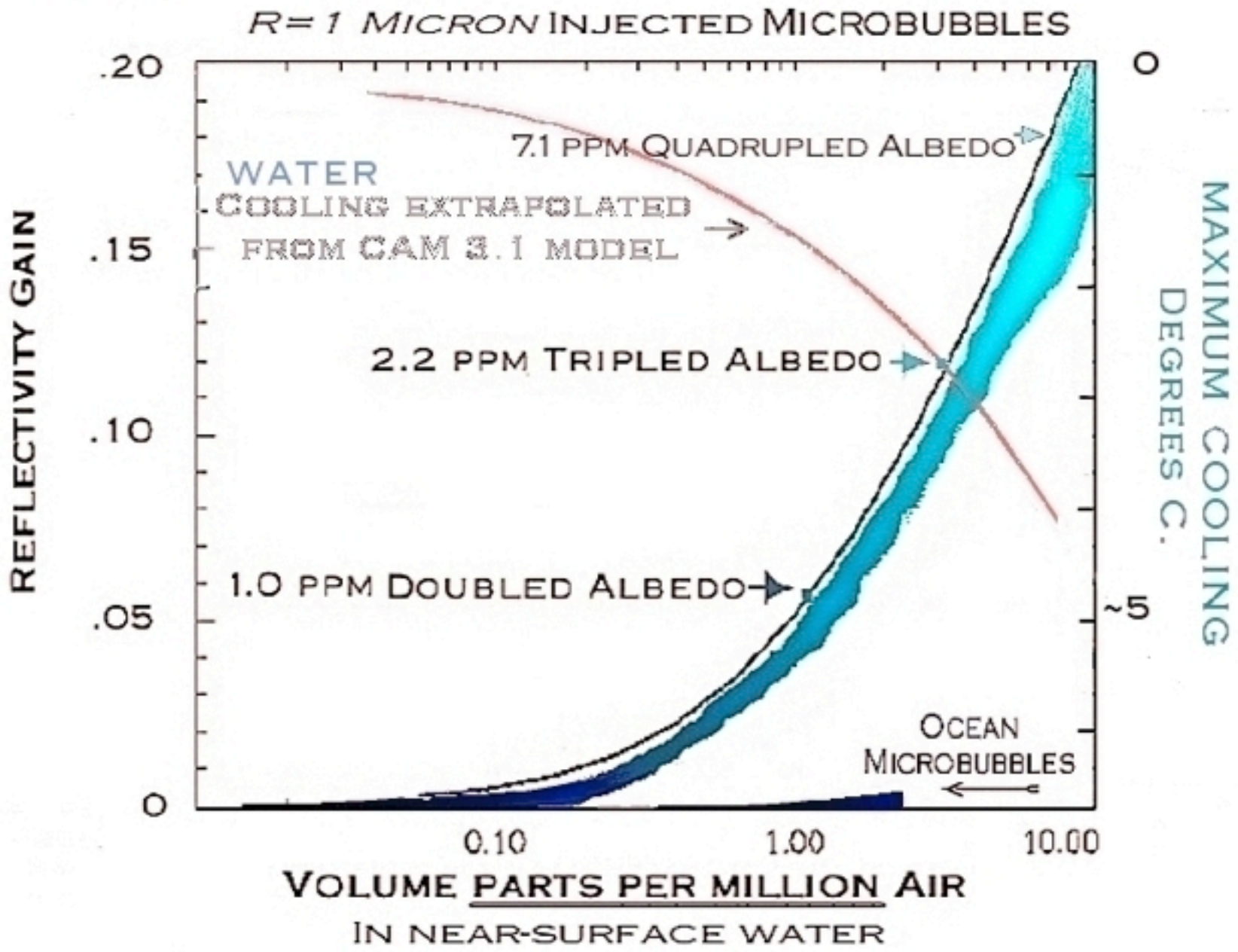
What if geoengineering were as well?

Rough water conservation cost per acre-foot

Roofs and sheds	$ 200,000 -1,000,000
Screen geodesics	~ 20,000- 50,000
Buoyant geotextiles	15,000-25,000
Snow making	1,750-3,500
Glass Microballoons (3M K-1)	900 – 1,800
TiO2 on plastic film	500 -1,500
Ice 911 mulch	??
Cenospheres	150 -350
Insulating Pumice	50 -150
Polymer latex sols	10 -100
Hydrosols	?? 5 - 50

From Climatic Change Paper , April 2011

BRIGHT WATER

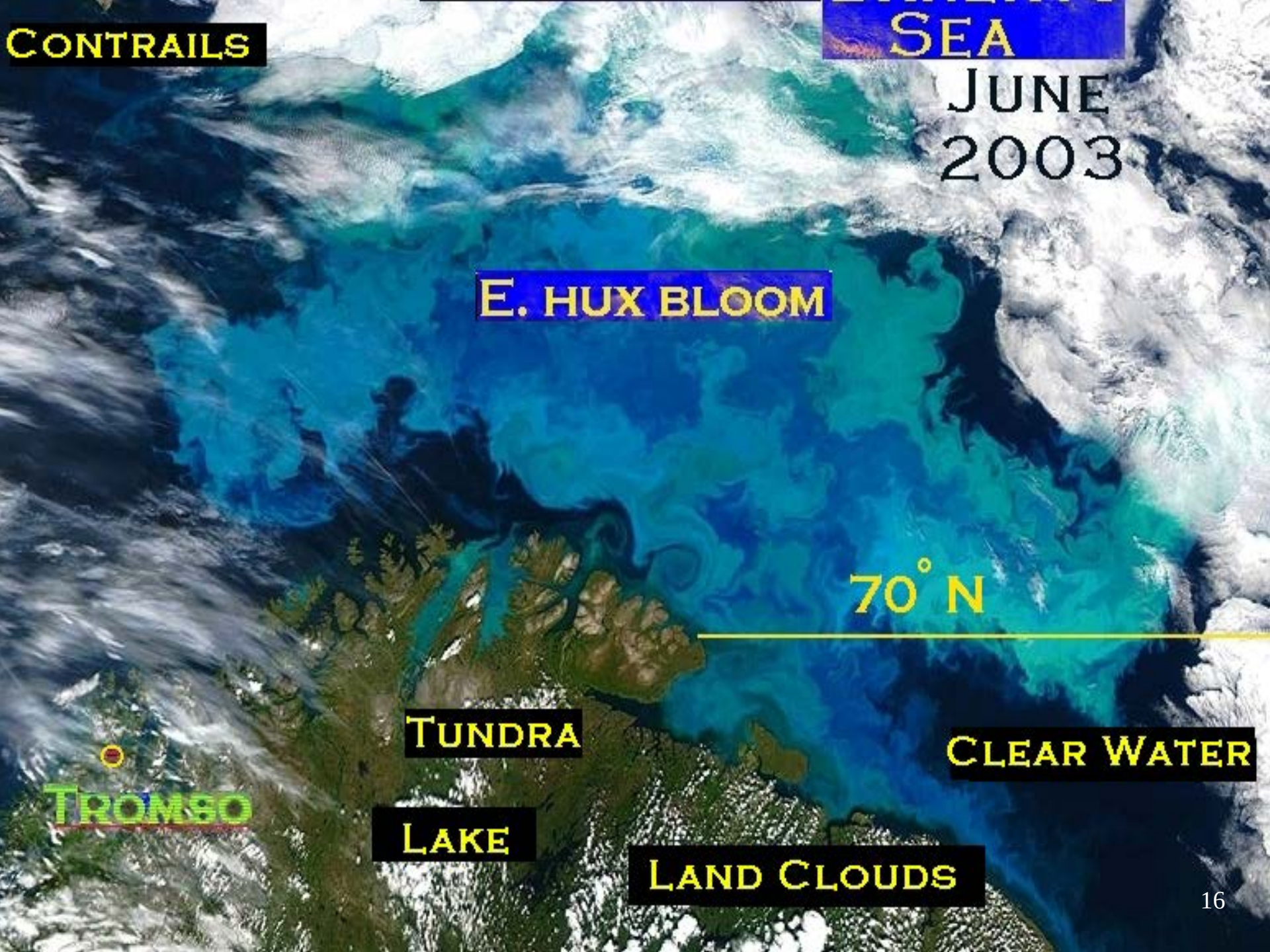


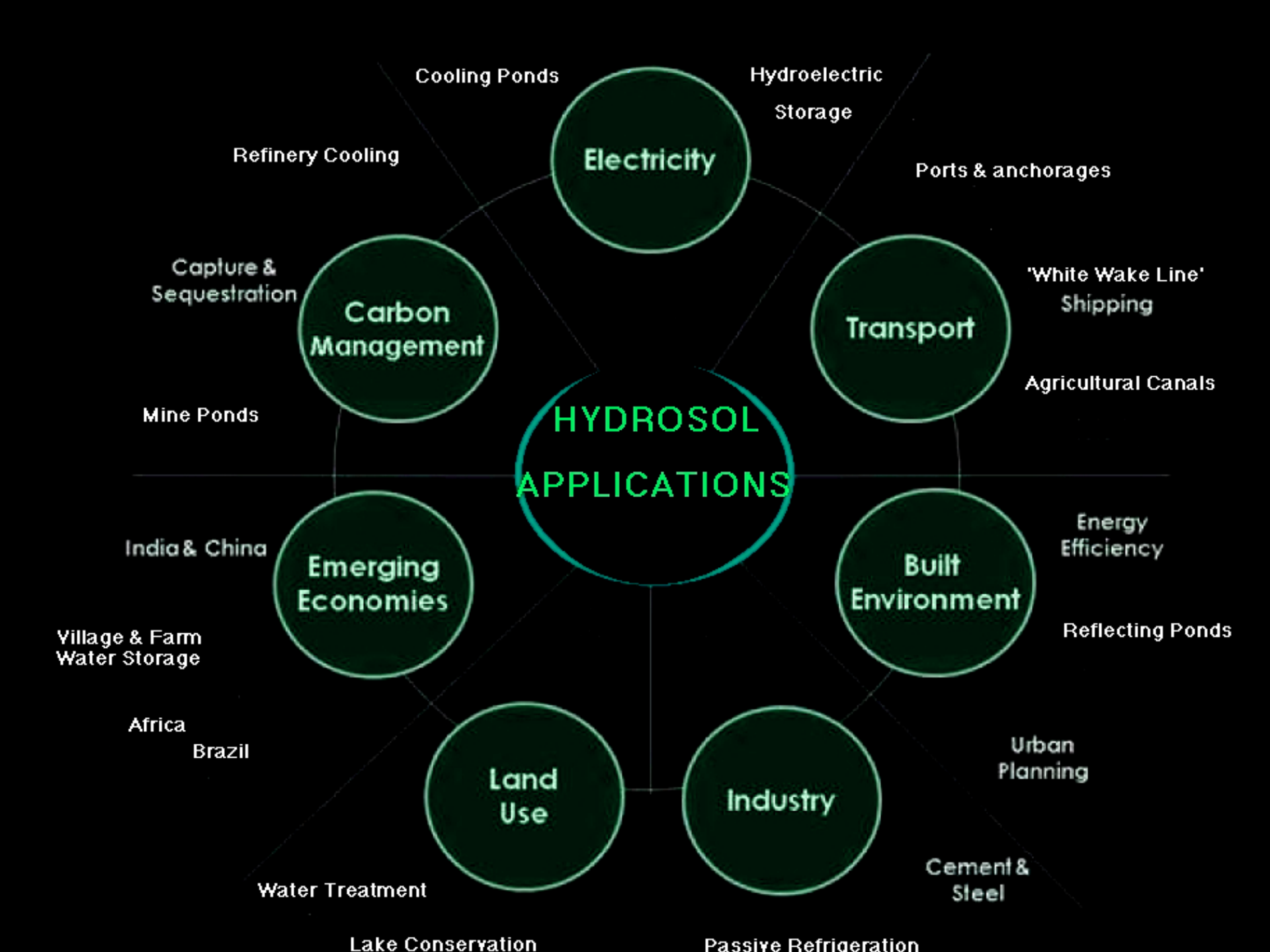
Research questions

- Can interdisciplinary expertise extend microbubble lifetimes in hydrosols as well as ice cream and paint?
- Where do natural surfactants come from and what can we do to promote the organisms that make them?
- What makes ocean microbubble lifetimes so variable?
- Some natural microbubbles last for days- can designed latex particles and surfactants yield persistent hydrosols?
- Can reducing water temperatures temper the impact of ocean acidification?

Can Sea Ice Be Saved ?

- Floating fabrics threaten marine life ; glass spheres and foam particles tend to rapidly raft up and blow ashore
- Hydrosols / latex present no windage and leave open seas
- The reality of Arctic shipping will bring the possibility of brightening water at the ice margins to slow summer albedo loss and mitigate climate feedback.
- Learning how to address fresh water thermal pollution may be a necessary prelude to dealing with Arctic ice.


CONTRAILS
SEA
JUNE
2003
E. HUX BLOOM
70° N
TUNDRA
CLEAR WATER
TROMSO
LAKE
LAND CLOUDS


HYDROSOL APPLICATIONS
Electricity
Cooling Ponds
Hydroelectric Storage
Refinery Cooling
Carbon Management
Capture & Sequestration
Mine Ponds
Transport
Ports & anchorages
'White Wake Line' Shipping
Agricultural Canals
Emerging Economies
India & China
Village & Farm Water Storage
Built Environment
Energy Efficiency
Reflecting Ponds
Land Use
Africa
Brazil
Water Treatment
Lake Conservation
Industry
Urban Planning
Cement & Steel
Passive Refrigeration

Some common misconceptions

It'll darken the depths and kill the plankton !

NO The effect on light of doubling water albedo resembles that of a cloudy day- bubbles scatter light down as well as up.

It will turn the ocean into a bubble bath!

WRONG Microbubbles don't rise in the first place.

They create underwater clouds , not suds on the surface.

You'll destroy the ozone layer and create a dead sea !

HUH? This is physics, not atmospheric chemistry.

Part-per-million hydrosols scarcely alter air-water equilibrium but surface cooling can **increase** available oxygen.

What about the RISKS ?

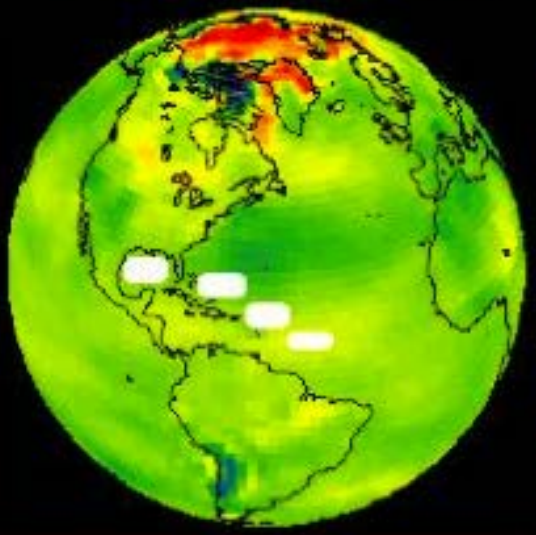
- Impact on phytoplankton of less light :
  Can be kept within cloud cover variation limits
- Altered photosynthetic compensation depth
  Plankton move up and down every day
- Surface temperature changes will alter local ecosystems
  Yes – But cooling could aid coral conservation

The greatest moral risk may lie in ignoring our own albedo footprint

End of Presentation

- SOME Q& A SLIDES FOLLOW

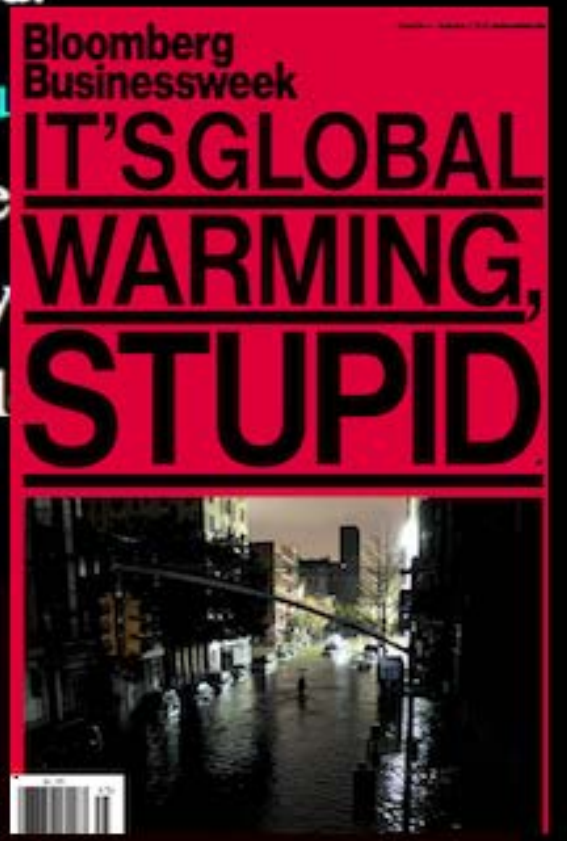
GeoE 2.0 : Shredding The Envelope



12/20/08

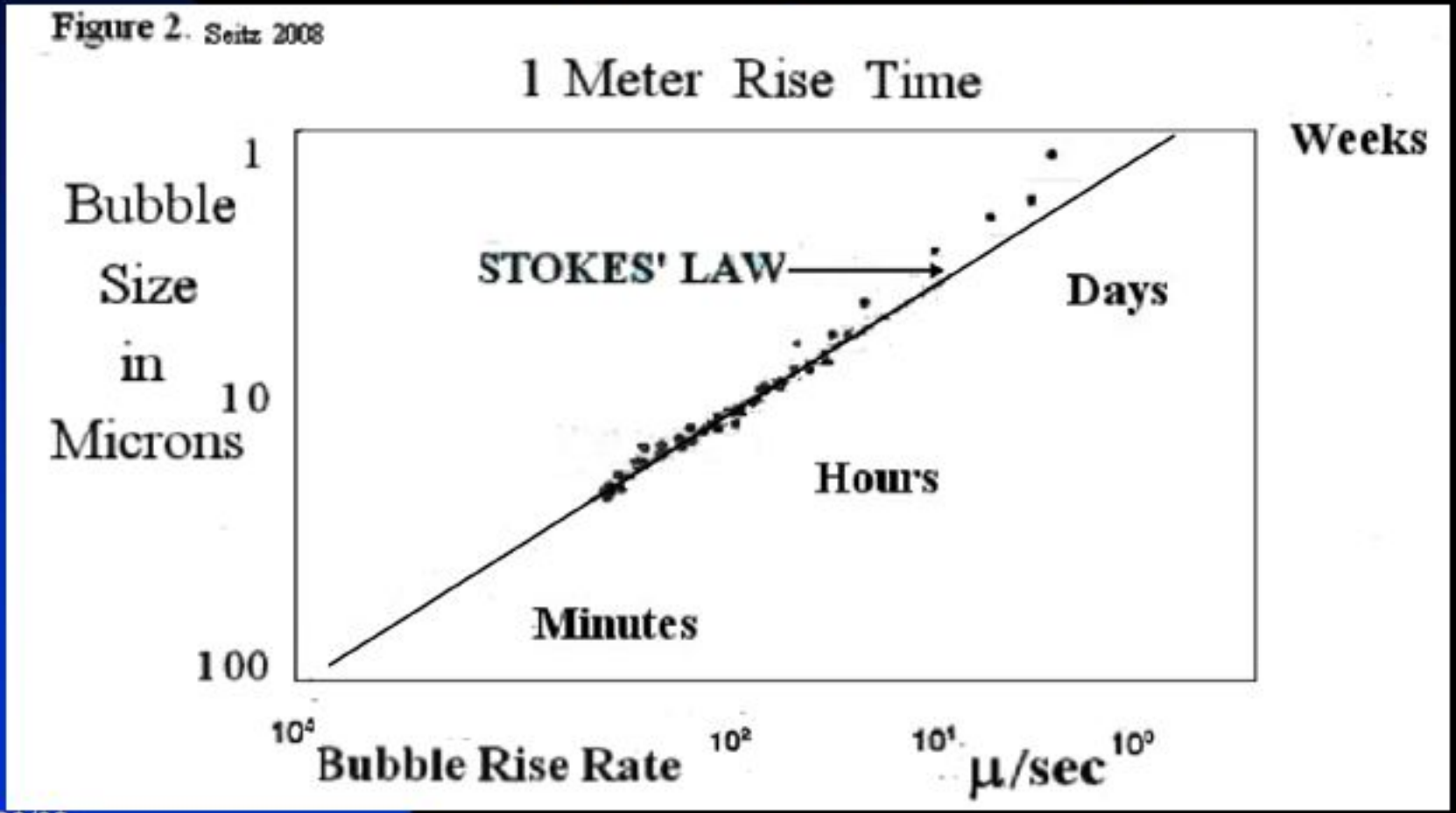
Hurricane suppression- using hydrosols to cool the sea in advance of tropical storm tracks could keep some from intensifying into Class 5's, and steer others away from land.

Offshore microbubble infrastru air to the water : a 1 meter pipe could deliver 1Tg of air a day lines emulating submarine cabl offshore dispersion arrays.

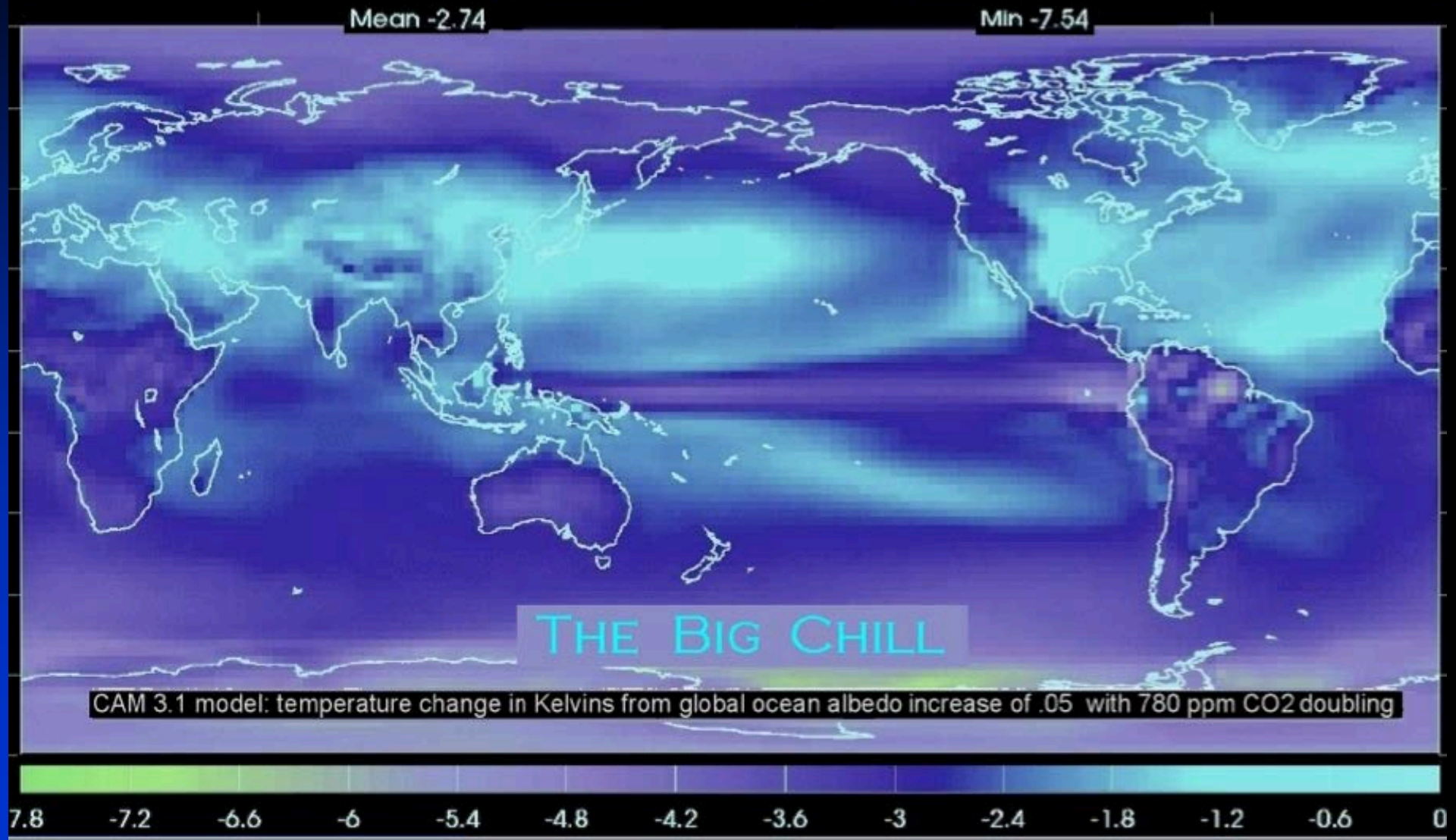


Outdoor air conditioning :What would happen to power demand in Houston or Baltimore if water in Galveston or Chesapeake Bay got brighter at noon and stayed 5 K. cooler ? Ditto Singapore.

Unlike surface whitecaps, microbubble clouds in the sea can last a long time: *Stokes Law* $V_{ST} = 2gr^2/9\nu$ predicts



Local can add up to global: GCM runs based on hydrosol physics show a 5% ocean albedo rise *more than offsets warming from doubled CO2*



ENVIRONMENTAL BENEFITS

Increased river flow

COLORADO, SHAT AL ARAB

Extended dry season water supply

INDIA, ISRAEL, AUSTRALIA

Cooler water increases available oxygen

Reduced methane release & coral stress

LAKE NASSER, GREAT BARRIER REEF

Conserving wetland habitats

Increasing lake area reduces sea level rise

LAKE CHAD, US GREAT BASIN, TARIM DEPRESSION, ARAL SEA

Net reduction of atmospheric CO_2

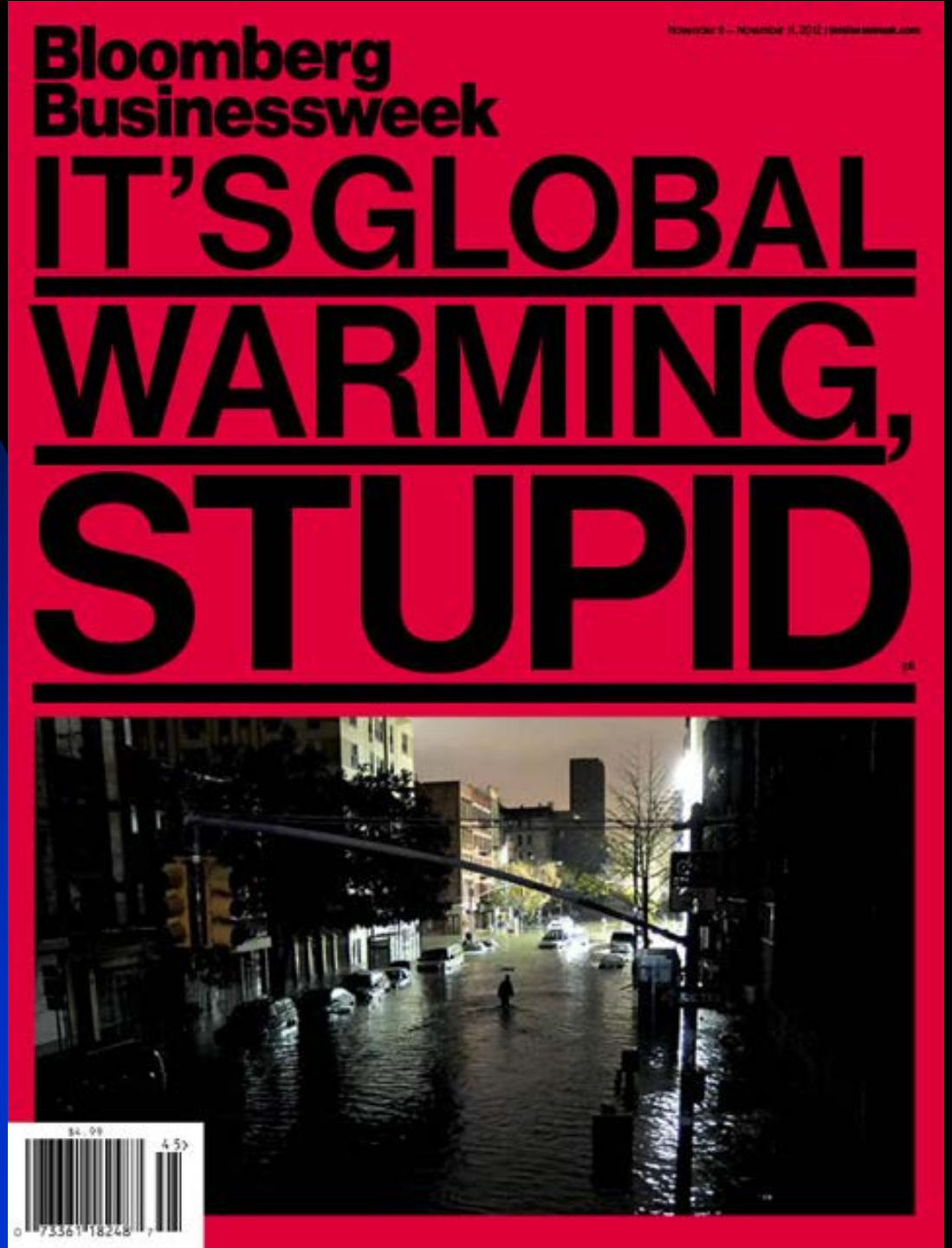
No intrinsic ozone layer risk

No change in solar spectrum-Sky stays blue

The Inevitable
Executive Summary:

Crutzen Somewhat Simplified

Seitz Somewhat Simplified


Bloomberg
Businessweek
IT'S GLOBAL
WARMING,
STUPID