

Cloud-seeding ships could combat climate change

Sep 4, 2008 [19 comments](#)

It should be possible to counteract the global warming associated with a doubling of carbon dioxide levels by enhancing the reflectivity of low-lying clouds above the oceans, according to researchers in the US and UK. John Latham of the National Center for Atmospheric Research in Boulder, US, and colleagues say that this can be done using a worldwide fleet of autonomous ships spraying salt water into the air.

Clouds are a key component of the Earth's climate system. They can both heat the planet by trapping the longer-wavelength radiation given off from the Earth's surface and cool it by reflecting incoming shorter wavelength radiation back into space. The greater weight of the second mechanism means that, on balance, clouds have a cooling effect.

'Twomey effect' boosts reflectivity

Latham's proposal, previously put forward by himself and a number of other scientists, involves increasing the reflectivity, or "albedo", of clouds lying about 1 km above the ocean's surface. The idea relies on the "Twomey effect", which says that increasing the concentration of water droplets within a cloud raises the overall surface area of the droplets and thereby enhances the cloud's albedo. By spraying fine droplets of sea water into the air, the small particles of salt within each droplet act as new centres of condensation when they reach the clouds above, leading to a greater concentration of water droplets within each cloud.

Latham and co-workers, including wave-energy researcher Stephen Salter of Edinburgh University, claim that such spraying could increase the rate at which clouds reflect solar energy back into space by as much as 3.7 Wm^{-2} . This is the extra power per unit area that scientists say will arrive at the Earth's surface following a doubling of the concentration of atmospheric carbon dioxide compared to pre-industrial levels — 550 ppm vs 275 ppm ([Phil. Trans. R. Soc. A DOI:10.1098/rsta.2008.0137](#)).

New spin on sailing

The 300-tonne [unmanned ships](#) used to seed the clouds would be powered by the wind, but would not use conventional sails. Instead they would be fitted with a number of 20 m-high, 2.5 m-diameter cylinders known as "Flettner rotors" that would be made to spin continuously. This spinning would generate a force perpendicular to the wind direction, propelling the ship forward if it is oriented at right angles to the wind ([Phil. Trans. R. Soc. A DOI: 10.1098/rsta.2008.0136](#)).

These rotors would be easier to operate remotely than sails and would also serve as the conduits for the upward spray, with the spray consisting of droplets $0.8 \mu\text{m}$ in diameter generated by passing sea water through micro nozzles. The power for the spray and the cylinder rotation would be provided by oversized propellers operating as turbines.

The immediate effect of seeding clouds in this way would be a local cooling of the sea surface, and as such the technique could be targeted at coral reefs, diminishing polar ice sheets or other vulnerable regions. However, the great thermal heat capacity of the ocean and the currents within it mean that these initial effects would eventually spread across the globe.

Fleet of 1500

Latham and colleagues calculate that, depending on exactly what fraction of low-level maritime clouds are targeted (with some regions, notably the sea off the west coasts of Africa and North and South America, more susceptible to this technique than others), around 1500 ships would be needed altogether to counteract a carbon doubling, at a cost of some £1m to £2m each. This would involve an initial fleet expanding by some 50 ships a year if the

scheme is to keep in step with the current rate of increase in atmospheric carbon-dioxide levels.

This cloud-seeding proposal is one of a number of ideas put forward by scientists in recent years to “geoengineer” the Earth in response to climate change rather than, or as well as, deal with the causes of the change. A series of papers on several proposals, including Latham’s, have been published in a recent issue of the journal *Phil. Trans. R. Soc. A* entitled [Geoscale engineering to avert dangerous climate change](#).

Latham maintains that his group’s idea is not pie in the sky and that its feasibility is supported by two of the world’s leading computer climate models, as well as recently obtained experimental cloud data. He points out that, unlike rival techniques, the system could be used to vary the degree of cooling as required and could be switched off instantaneously if needed. However, he adds more research must be done to find out a number of unknowns — such as exactly what fraction of spray droplets will reach the clouds — and to establish that the technique would not create any harmful climatic side effects. More work must also be done on the spray technology, he says.

About the author

Edwin Cartledge is a science journalist based in Italy

19 comments

Comments on this article are now closed.

1 Liz Kalaugher

Sep 4, 2008 4:11 PM
Bristol, United Kingdom

This, and other geoengineering techniques, might help with cooling temperatures but won't have any effect on ocean acidification, which threatens coral reefs and shelled marine organisms - see [environmentalresearch...27405](#) and [environmentalresearch...35031](#) as well as [environmentalresearch...33881](#) for details of a debate on geoengineering at the European Geosciences Union assembly in May.

2 CDMGSDAD

Sep 4, 2008 5:24 PM
HUNTINGTON, United States

There are ALWAYS unforeseen consequences.

Haven't they done enough harm already?

3 CDMGSDAD

Sep 4, 2008 5:24 PM
HUNTINGTON, United States

There are ALWAYS unforeseen consequences.

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4 Zephir

Sep 4, 2008 6:09 PM
Prague, Czech Republic

Global climate engineering

I can agree with the above complains completely. The problem is, the salt particles cannot evaporate from water droplets, they will remain circulating in atmosphere like particles of hydroscopic smog. The content of halogens in such particles can accelerate the ozone hole spreading. The most probable local effect of these experiments can be promotion of spouts and cyclones formation.

BTW Isn't the formation of reflective clouds considered as one of factors of global climate change by some scientists?

[www.sciencedaily.com...070410131926.htm](#)

Edited by Zephir on Sep 4, 2008 6:12 PM.

5 erichj

Sep 5, 2008 6:33 AM
McGaheysville, United States

Carbon to the Soil

Biochar , The low cost way to Geo-Engineering;

Charles Mann ("1491")in the Sept. National Geographic has a wonderful soils article which places Terra Preta / Biochar soils center stage.

I think Biochar has climbed the pinnacle, the Combined English and other language circulation of NGM is nearly nine million monthly with more than fifty million readers monthly!

We need to encourage more coverage now, to ride Mann's coattails to public critical mass.

Please put this (soil) bug in your colleague's ears. These issues need to gain traction among all the various disciplines who have an iron in this fire.

[ngm.nationalgeograph...mann-text](#)

I like his characterization concerning the pot shards found in Terra Preta soils;

so filled with pottery - "It was as if the river's first inhabitants had thrown a huge, rowdy frat party, smashing every plate in sight, then buried the evidence."

Biochar groups for more info: data base;

[terrapreta.bioenergy...](#)

Discussions;

[tech.groups.yahoo.co...b...guid=122501696](#)

I also have been trying to convince Michael Pollan (NYT Food Columnist, Author) to do a follow up story, with pleading emails to him

Since the NGM cover reads "WHERE FOOD BEGINS" , I thought this would be right down his alley and focus more attention on Mann's work.

I've admired his ability since "Botany of Desire" to over come the "MEGO" factor (My Eyes Glaze Over) and make food & agriculture into page turners.

It's what Mann hasn't covered that I thought should interest any writer as a follow up article.

The Biochar provisions by Sen.Ken Salazar in the 07 farm bill,

Dr, James Hansen's Global warming solutions paper and letter to the G-8 conference last month, and coming article in Science,

[arxiv.org...0804.1126.pdf](#)

The new university programs & field studies, in temperate soils

Glomalin's role in soil tilth & Terra Preta,

The International Biochar Initiative Conference Sept 8 in New Castle;

[www.biochar-intemat...i2008conference.html](#)

Given the current "Crisis" atmosphere concerning energy, soil sustainability, food vs. Biofuels, and Climate Change what other subject addresses them all?

Biochar, the modern version of an ancient Amazonian agricultural practice called Terra Preta (black earth), is gaining widespread credibility as a way to address world hunger, climate change, rural poverty, deforestation, and energy shortages... SIMULTANEOUSLY!

This technology represents the most comprehensive, low cost, and productive approach to long term stewardship and sustainability.Terra Preta Soils a process for Carbon Negative Bio fuels, massive Carbon sequestration,10X Lower Methane & N2O soil emissions, and 3X Fertility Too. Every 1 ton of Biomass yields 1/3 ton Charcoal for soil Sequestration.

Carbon to the Soil, the only ubiquitous and economic place to put it,

Erich J. Knight

6 Pauline Rigby

Sep 5, 2008 10:07 AM

Bristol, United Kingdom

Paint cities white

I read somewhere recently - and I wish I could remember where - that we could counteract the effect of CO2 emissions simply by painting our cities white.

Apparently non-urban areas have an albedo of 0.29, and urban areas have an albedo of around 0.03. Painting roofs white would raise the albedo of the city to 0.3.

Sounds over simplistic, I know, but it makes sense because everyone knows how hot it can get in a built up area with acres of tarmac, and how relatively cool it is in a forest on the same day. In fact, in very hot countries they already paint their buildings white, or at least they used to... before skyscrapers took over.

Raising the albedo of clouds sounds like a formula for disaster to me. Less heat will reach the ground maybe, but then it will be more effectively trapped there. The clouds will prevent the heat from being radiated back out to space.

The cynic in me says big industry won't benefit from a simple solution like painting buildings white - they'll want to build expensive ships - releasing massive amounts of CO2 in the process.

Edited by Pauline Rigby on Sep 5, 2008 10:09 AM.

7 tpboden

Sep 5, 2008 2:57 PM
Denver, United States

Salt-water seeding

I do not claim to have any answers. I am not a scientist, nor do I often think like one, but I do think nonetheless. This idea of raising the albedo sounds good, but I really don't believe it's a good idea to tamper with that which we do not thoroughly understand. We are a very smart and clever species; so very smart and clever we have got ourselves into an unforeseen mess of extinction proportions. Really, this intelligence is also our downfall. We are trying to discover the Deus Ex Machina that will solve the issue of climate change, when in actuality there is no one single answer. Earth is an organism: a whole comprised of individual parts. We cannot attempt to fix one part of that whole without responding to the rest or researching the potential effects of the one-part fix to other one-part fixes. We would prove ourselves terribly naive and dense were we to do so. Ben Franklin is quoted as saying, "We must all hang together or, most assuredly we will all hang separately." This is very appropriate advice for our current struggle. Unfortunately for us, we are not quite smart and clever enough to holistically comprehend the totality of impact an individual solution would have in conjunction with many other individual solutions. We must act quickly, but aptly. And that Catch-22 of necessity to act comingled with lack of forethought of holistic reaction might propel us more rapidly into this decline.

I'm afraid duct tape and bailing wire isn't going to solve this one.

8 DennisA

Sep 5, 2008 4:09 PM
New Quay, United Kingdom

Geo-Engineering - Been there, done that...in 1971

Nothing new under the Sun....

"Since about 1840, a new warming trend has predominated and appears to have reached a climax in this century, followed by cooling since about 1940, irregularly at first but more sharply since about 1960. The periods of general warming were accompanied by increasing vigour of the westerly circulation in both hemispheres, bringing a more maritime climate to the continents, a northward displacement of cyclone paths, and a pronounced warming of the Arctic.

The recent cooling trend exhibits a reverse pattern: weakened westerly circulation, more variable and southerly cyclone paths, and a colder Arctic.

....suppose that the warming of the Arctic, which by 1940 had greatly reduced the thickness of the pack ice, had continued? As the ice receded farther in summer and the thinner ice become more fractured in winter, evaporation would have increased, thus increasing the density of the surface waters both by increasing the salt concentration and by cooling; this would tend to decrease the vertical stability of the upper layers of the ocean. (sound familiar?)

SPECIFIC SCHEMES FOR CLIMATE MODIFICATION

All of these schemes share the common defect that their influence on the global system cannot yet be reliably judged.

ICE-FREE ARCTIC OCEAN

The largest scale enterprise that has been discussed is that of transforming the Arctic into an ice-free ocean.

Three basic approaches have been proposed:

- (a) influencing the surface reflectivity of the ice to cause more absorption of solar heat;
- (b) large-scale modification of Arctic cloud conditions by seeding;
- (c) increasing the inflow of warm Atlantic water into the Arctic Ocean.

BERING STRAIT DAM

The Soviet engineer, Borisov, has been the most active proponent of the much-publicized Bering Strait dam. The basic idea is to increase the inflow of warm Atlantic water by stopping or even reversing the present northward flow of colder Pacific water through the Bering Strait. The proposed dam would be 50 miles long and 150 feet

high.

DEFLECTING THE GULF STREAM

Two kinds of proposals have been discussed, a dam between Florida and Cuba, and weirs extending out from Newfoundland across the Grand Banks to deflect the Labrador current as well as the Gulf Stream.

DEFLECTING THE KUROSHIO CURRENT

The Pacific Ocean counterpart of the Gulf Stream is the warm Kuroshio Current, a small branch of which enters the Sea of Japan and exits to the Pacific between the Japanese islands. It has been proposed that the narrow mouth of Tatarsk Strait, where a flood tide alternates with an ebb tide, be regulated by a giant one-way 'water valve' to increase the inflow of the warm Kuroshio Current to the Sea of Okhotsk and reduce the winter ice there.

CREATION OF A SIBERIAN SEA

Dams on the Ob, Yenisei and Angara rivers could create a lake east of the Urals that would be almost as large as the Caspian Sea. This lake could be drained southward to the Aral and Caspian Seas, irrigating a region about twice the area of the Caspian Sea. In terms of climatic effects, the presence of a large lake transforms the heat exchange between the surface and atmosphere.

CREATION OF AFRICAN SEAS

This is the largest known proposal for creating man-made lakes. If the Congo, which carries some 1,200 cubic kilometres of water per year, were dammed at Stanley Canyon (about 1 mile wide), it would impound an enormous lake (the Congo Sea). The Ubangi, a tributary of the Congo, could then flow to the north-west, joining the Chari and flowing into Lake Chad, which would grow to enormous size (over 1 million square kilometres). This large lake (the Chad Sea) would approximately equal the combined areas of the Baltic Sea, White Sea, Black Sea, and Caspian Sea.

All these ideas were to WARM the Planet because of global COOLING and are from the book "Omega – Murder of the Eco-system and the Suicide of Man", Paul K Anderson, 1971

Chapt. Controlling the Planet's Climate, J. O. Fletcher (Rand corporation)

9 Trevor B.

Sep 6, 2008 6:47 PM
Springfield, United States

Extra Information

A few days before this article I was watching the Discovery Channel and there was a good hour long show on Latham and the development of this idea. It is one in a series of shows about different projects to battle global warming through geoengineering; including a giant sun reflector launched into space and seeding cut down forests by planes. These shows also appear on the Science Channel and information can be found at:

dsc.discovery.com...project-earth.html

One of the biggest arguments against geoengineering is the unseen consequences that may result in messing with our environment. Science has only just begun to understand our climate, so we could inadvertently causes many deaths if we accidentally increase the frequency of hurricanes. One of the reasons this idea is so good is because if something goes wrong we could easily shut down all the ships by remote. Things would then be back to the way they were before in a couple of days.

Edited by Trevor B. on Sep 6, 2008 6:47 PM.

10 allan minns

Sep 7, 2008 4:47 AM
Troy, United States

Quote:

Originally posted by Zephyr
BTW Isn't the formation of reflective clouds considered as one of factors of global climate change by some scientists?

The increase in Noctilucent clouds and overall global warming are symptoms of the same thing. Read the article that you linked.

Edited by allan minns on Sep 7, 2008 5:04 AM. Reason: made it shorter

11 caelum

Sep 7, 2008 10:22 PM
Austin, United States

nobody mentioned...

this deliberately accelerates global dimming.

[en.wikipedia.org...Global dimming](http://en.wikipedia.org...Global_dimming)

12 kfung.rivas

Sep 8, 2008 1:13 AM

Santa Cruz, United States

Carbon Capture

There's a ton of great and original inventions that effectively capture and store carbon dioxide. TREES and indeed PLANTS. AND they are aesthetically pleasing no?

13 backvan

Sep 8, 2008 3:55 AM
China Lake, United States

Effects on Hurricane

Would the potential sea surface temperature drop enough from salt water spraying to lessen the intensity of hurricanes? Especially in the Gulf of Mexico.

14 knutten

Sep 8, 2008 11:13 AM
Varberg, Sweden

What global warming?

This is bs.

Why is it saying "...the global warming" into beginning - when we all know that the opposites are at hand. The last decade has not had any global temperature rising, but a cooling. Before that the warming was just caused by natural causes - there is no such thing as "man made global warming".

It has been warming in the whole solar system.

Wake up and stop lying!

15 Zephir

Sep 8, 2008 5:22 PM
Prague, Czech Republic

Climate myths

Quote:

Originally posted by **knutten**
..there is no such thing as "man made global warming"...

This is just a blind belief of yours. The people can influence the global whether even on a week period basis, therefore I can feel a quite improbable, their activity couldn't affect the climate from a long term perspective.

[planetsave.com...](#)

Quote:

Originally posted by **knutten**
..last decade has not had any global temperature rising, but a cooling...

Not at all: the ocean water has a ten thousand times larger capacity and the global warming still continues here. By the same way, like the CO2 and methane concentrations. You simply don't know all facts and their consequences.

[www.noaanews.noaa.gov...0080423_methane.html](#)
[environment.newscien...stopped-in-1998.html](#)

Edited by Zephir on Sep 8, 2008 5:27 PM.

16 allan minns

Sep 8, 2008 5:30 PM
Troy, United States

It's true

Ever hear of terraforming?

17 vbarashkov

Sep 9, 2008 12:46 AM
Hartsville, United States

dumb

This would certainly be the dumbest way to combat global warming, assuming that it even works and doesn't make the situation worse down the road if it does work. They would have to make so many ships and use so much fuel it would simply be disastrous. Like the previous commenter above stated why not paint the buildings white,

that to me sounds like a much much better idea. Of course scientists would not like it because it is too simple, and has almost no risk.

18 s501100kross

Sep 9, 2008 5:20 AM

santa barbara, United States

Just another silly attempt to fix something [perfectly natural climate variability] that isn't broken!

Latham et al should seek real employment instead of producing Walter Mitty dreams.

19 jje Herrera

Sep 9, 2008 6:11 PM

Ciudad Universitaria, Mexico

Not THAT dumb

Quote:

Originally posted by vbarashkov

This would certainly be the dumbest way to combat global warming, assuming that it even works and doesn't make situation worse down the road if it does work. They would have to make so many ships and use so much fuel it would simply be disastrous.

They actually thought about that problem:

Quote:

The 300-tonne unmanned ships used to seed the clouds would be powered by the wind, but would not use conventional sails. Instead they would be fitted with a number of 20 m-high, 2.5 m-diameter cylinders known as "Flettner rotors" that would be made to spin continuously. This spinning would generate a force perpendicular to the wind direction, propelling the ship forward if it is oriented at right angles to the wind (Phil. Trans. R. Soc. A DOI: 10.1098/rsta.2008.0136).

That's an old technology which was abandoned with the advent of fueled ships, but might be useful for certain purposes.