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- Oliver Morton's bookblog for Eating the Sun
-
- **Free samples!**

  Eating the Sun|Excerpts, etc
- **What people say**

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  Amazon UK (hardback|paperback)

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  Waterstones

  Amazon US

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  Barnes&Noble

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- **Recent Posts**
  - Apologies
  - Earth monitoring: Damn it’s frustrating
  - Efficiency is not enough
  - Bruno Latour, the other world, and this world otherwise
  - Why people disagree about geoengineering
  - Superfreakonomics: what did Nathan Myhrvold say?
- **Top Posts**
  - Superfreakonomics: what did Nathan Myhrvold say?
  - Disagreeing with the Copenhagen geoengineering consensus
  - 10 best nature books
  - Copenhagen climate congress
  - Terraforming the Sahara
  - Review: Jeremy Cherfas in the Sunday Times
  - Perennial wheat progress
  - The Royal Society report: what the papers say
  - Why people disagree about geoengineering
  - Power-station-fed algae

- ## Categories
  - Artworks
  - Books
  - By, with or from EtS
  - Earth history
  - EtS Events
  - Farming
  - Geoengineering
  - Global change
  - Interventions in the carbon/climate crisis
  - Media
  - Nature writing
  - Plant physiology
  - Published stuff
  - Reviews received
  - Trees
  - Twitter
  - Uncategorized
  - Warning: contains molecules
- ## Archives

  Select Month
- ## Search:

  GO
- ## Blogroll
  - Agricultural Biodiversity Weblog
  - carbon Commentary
  - Climate Feedback
  - Dot Earth
  - Inventing Green
  - Muck and Mystery
  - R-squared
  - Without Hot Air
- ## Tweetstuff
  - Planetary Systems Now Forming in Orion http://bit.ly/8baq9N < swearing off astroporn, but this *is* pretty cool 5 hours ago
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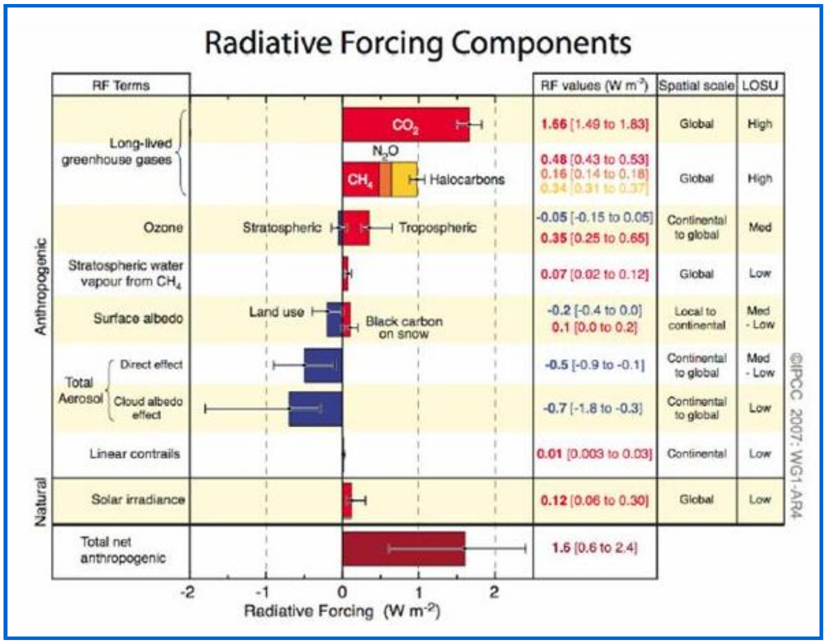
The International Maritime Organisation's plans to warm the world

August 20, 2009, 12:33 pm
Filed under: Geoengineering, Interventions in the carbon/climate crisis

Ship tracks in the Bay of Biscay

Yesterday Dan Lack of NOAA gave a talk to the NCAR media fellows about his work on pollution from shipping, and told us something I found pretty flabbergasting. Last year the International Maritime Organisation, as part of a number of measures aimed at air pollution, decided to do something about the sulphur emissions from shipping by reducing the amount of sulphur dioxide permissible from 4.5% today to 0.5% in 2020. This would have great benefits; sulphate pollution, and associated particulate matter, cause significant health problems. According to a new paper in *Environmental Science and Technology* by Winebrake et al, if in 2012 the world's shipping complied with this requirement, the associated sulphate pollution would cause 46,000 premature deaths; if that shipping used today's higher sulphur fuels the death toll would be 87,000.

However, sulphur emissions from shipping have another effect: the sulphate aerosols that form from the gas make the oceans cooler by increasing the cloud cover above them, as the image at the top of this post shows. The effect is large enough that shipping cools the planet through sulphate aerosols much more than it warms the planet through greenhouse gas emissions. In a companion paper in *Environmental Science and Technology*, this time with modeller Axel Lauer as first author, the same team looks at this effect. Using the same 2012 scenarios they used for the health figures the researchers find that the cooling effect using fuel like today's, expressed in terms of radiative forcing, is about 0.57 watts per square metre. The cooling effect if everyone uses the new low sulphur fuels is 0.27 W/m². That means a difference of 0.3 W/m² — which is to say that that's the amount of warming that switching to low-sulphur fuels would produce.



What does a radiative forcing of 0.3 W/m² mean? Here's a chart from the IPCC showing the radiative forcings associated with all human climate-changing activities as of today. The total (with biggish error bars) is 1.6 W/m², which shows straight off that 0.3 is quite a lot. It is, for example, twice the amount of forcing as is due to N2O, 60% of the forcing due to methane, and the same as the amount due to halocarbons (HFCs). A huge amount of money is currently being spent on the HFC problem.

Put another way (and I calculated these numbers myself, so please check and correct if you have the necessary skills) 0.3 W/m² is the radiative forcing you would expect if you dumped 47.5 billion tonnes of carbon (in the form of carbon dioxide) into the atmosphere, raising the concentration of CO2 from today's 387 parts per million to 409 parts per million. That's well over a decade's worth of carbon emissions and an enormous amount of warming for the IMO to have committed the world to with no-one, as far as I can see, paying very much attention. (The most obvious environmental response to the IMO changes, from the Clean Air Task Force, was to applaud the health effects of the cuts in sulphur while deploring the lack of action on greenhouse gases and not mentioning the cooling issues at all. If you accept Dan Lack's figure of just 0.06 W/m² for the total warming from shipping, that seems an odd omission.)

Now there are obviously complexities and caveats. This is just one modelling study — but its figures for the amount of cooling due to sulphur fit with those quoted by of others, such as Dan Lack. Taken at face value it would imply both that the total cooling effect of sulphur on clouds was probably greater than the IPCC best guess, and that sulphate from shipping was responsible for a disproportionate amount of it. But the IPCC's guess has big error bars, and you would indeed expect sulphate from ships to be peculiarly effective — it gets sprayed into places where the clouds are very susceptible to such things. (This is the effect that John Latham's geoengineering scheme based on cloud brightening seeks to emulate). The papers compare effects for 2012 not 2020, which is when the regulations will call for al fuel to be low sulphur, but does anyone expect less shipping in 2020 than 2012?

So is this a matter of balancing 40,000 lives a year against a decade of global warming? Not necessarily. There is another sulphate reduction option: burn low-sulphur fuels when close to land, and ordinary fuels when far off. There are already some areas where ships have to use low sulphur fuels, and they could be extended to all the places where the sulphate is likely to do its greatest harm. In further scenarios the authors of the two papers looked at a world of 2012 in which ships' sulphur was reduced to 0.5% or even

0.1% when within 200 nautical miles of land, but left unchanged in mid voyage. In terms of fatalities the 0.1% in coastal waters is slightly better than 0.5% all over the place (44,000 deaths), 0.5% in coastal waters is slightly worse. In terms of cooling these two options are lower than business as usual but higher than a global reduction to 0.5% — their forcing is 0.45-0.48 W/m^2.

Low-sulphur fuels in coastal areas could lessen the warming associated with a global sulphur reduction and still save as many lives — or more. They would impose other costs, though. Getting sulphur out of fuel costs money, and this might make getting down from 0.5% to 0.1% an issue. Ships would have to carry two different types of fuel, which is also problematic, though not impossible. And going low-sulphur still deprives the world of a lot of cooling, even if the regulations only apply in coastal waters. That's largely because most shipping is coastal. (This suggests that forcing ships to take longer, less coastal routes — to put out straight to sea where possible, and spend more time further from land — might be an option. Again it has costs.)

Beyond preferring coastal controls to global controls I have no real policy case to make here. I'm aware that there is in general a trade off between air quality reasons for reducing sulphates and the possibility that their cooling effects can be climatically helpful. But the fact that this measure involves reducing sulphur emissions in places where they do no harm (the mid oceans) and where their cooling effects are greatly enhanced (by the presence of low clouds they can brighten) makes the question particularly pointed. I have no way to balance the advantages of reduced global warming against the advantages of decreased mortality. I don't know who has. But I do think that it's kind of extraordinary a regulatory change with this much effect on global warming could be made with so little apparent fuss.

And I also think this all makes the case for experiments with Latham-type techniques that brighten clouds to cool the seas even stronger than it already is. If, for good reason, we are actively reducing the amount of cooling provided by shipping, surely we should at least look at possible ways of putting it back?

Citations

"Mitigating the Health Impacts of Pollution from Oceangoing Shipping: An Assessment of Low-Sulfur Fuel Mandates", Winebrake, J. J. *et al, Environ. Sci. Technol.*, 2009, 43 (13), pp 4776–4782
DOI: 10.1021/es803224q

"Assessment of Near-Future Policy Instruments for Oceangoing Shipping: Impact on Atmospheric Aerosol Burdens and the Earth's Radiation Budget" Lauer, Axel *et al, Environ. Sci. Technol.*, 2009, 43 (13), pp 5592–5598
DOI: 10.1021/es900922h

Leave a Comment

More ocean mixing

August 3, 2009, 2:35 pm
Filed under: Earth history, Geoengineering

A sperm whale, off to stir up the depths

Following on from the post about artificial ocean mixing, last week's Nature has a new development in a story I've always thought rather fun: the role of animals in stirring up the ocean. The problem that this addresses is what can be called the "missing mixing". For the oceans to circulate from top to bottom, water has to sink — as it does in the North Atlantic and round Antarctica — but it also has to be lifted up; deeper, denser waters have to return to the surface. (If sinking was the whole story the ocean would simply remain stratified.) Considering how vast the ocean is, and what a huge and climate-crucial amount of heat it pumps around, the magnitude of the mixing required is remarkably small: two or three terawatts, or as William Dewar strikingly puts it in a News and Views piece accompanying the Nature article,

> Roughly speaking, all the energy needed to mix a cubic kilometre of subsurface ocean could be provided by a single hand-held kitchen mixer.

The problem is that, small as it is on a planetary scale, no one is sure how that couple of terawatts of mixing comes about. Astronomy offers a figure for the dissipation of energy by tides of almost 4TW, but a lot of the work done there is done in shallow seas not deep oceans. Carl Wunsch and others have estimated the amount of work attributable to wind at about 1TW. But there's no guarantee that all that work actually cashes out as mixing — you can do work on water that doesn't mix it up much. So winds and tides alone might be enough — but its quite possible that they are not.

Dewar has been arguing for a while that some of the missing mixing might be attributable to the movement of animals. In an endearing order of magnitude calculation a few years ago he suggested that the world's 360,000 sperm whales, which spend 80% of their time at depth expending about 5kW on their swimming, contribute more than a gigawatt of mixing. Dewar argues on various grounds that there could be a terawatt of biogenic mechanical energy in the oceans, about half of it due to the biosphere to fish and other swimmers and the other half to wigglers and splashers and squelchers of the prawny/jellyfishy/whatever persuasion.

But how much does that matter? Viscosity damps down turbulence, so the fact that something little is thrashing about doesn't necessarily mean it's contributing to large scale mixing. This is where the new paper from John Dabiri's lab at Caltech comes in. Dabiri and his student Kakani Katija have looked at a mechanism of mixing first discussed by Charles Galton Darwin (grandson of the more famous CD, head of Britain's National Physical Lab for a while, and a gloomy eugenicist with whom I believe Robert Heinlein was much taken) fifty years ago, which probably shouldn't be called entrainment, but sort of looks like it. This is the mixing due to water carried along with the mixer, and depends on the shape and volume of the creature involved. The paper concentrates on jellyfish, which seem to be a Dabiri specialty, and backs up its theoretical analysis with some nice videos demonstrating what goes on in practice ~~which I don't currently seem to be able to embed~~.

The paper shows that the Darwin entrainment effect is distinctly different from the wake turbulence previously considered; it also seems to operate at larger scales than the turbulence created by say the flapping legs of a shrip. Katija and Dabiri estimate that taking it into account could increase estimates of the animals' possible contribution from 1TW to at least 2TW, though as Dewar cautions "translation of Katija and Dabiri's results from anecdotes to assessments of possible global impacts remains to be carried out."

In an accompanying news piece, Roberta Kwok quotes Carl Wunsch on the "forbidding challenge" the work might pose to climate modellers, since it could require them to revisit estimates of the ocean's diffusivity, a key modelling parameter, and quite possibly vary it from place to place and time to time. An earlier bit of Nature journalism went into this, and the whole missing mixing story, in further detail (and both point out that some people, such as Andre Visser, aren't at all convinced there's anything of interest going on here, fish-stirring-wise).

The scientific debate looks set to run on for some time, and to be quite a lot of fun: if climate and people influence fish (jelly and otherwise) and fish influence mixing and mixing influences climate and people there could be all sorts of fun and important stuff to learn there. But it struck me that it was worth seeing whether there was an engineering issue, too. A couple of terawatts is, in geoengineering terms, pretty small potatoes (the effects of something like a stratospheric aerosol veil would be in the hundreds to thousands of terawatts) and if an intervention on such a small scale could have an effect on the rate at which the oceans transport heat, or replenish their nutrients, or transport cold carbon-dioxide-saturated waters into the deep, that could be interesting (I am *so* not advocating rearranging the ocean currents here: I'm just thinking about what sort of leverage there might be).

A rough estimate shows that this isn't an issue for the purportedly hurricane-thwarting pumps I wrote about last week. Though in terms of heat transfer such systems might clock in at 10GW or 20GW, that's because water has a large heat capacity. In terms of the mechanical work they would do my schoolboy physics suggests that it's on the order of a megawatt. But then those pumps aren't designed to do mechanical work: who knows what the inventive mind of Steve Salter would come up with if that was the primary objective. If we wanted to mix up the oceans as much as the fish or the winds do, it might not be all that hard.

[In an experiment with a new posting format, here are the main references to papers and aricles, corralled together]

The new paper: A viscosity-enhanced mechanism for biogenic ocean mixing, Katija, K and Dabiri, J, *Nature* **460**, 624-626 (30 July 2009) | doi:10.1038/nature08207

Dewar's News and Views article

Roberta Kwok's news story

Quirin Schiermeier's earlier News Feature on the missing mixing: Churn Churn Churn *Nature* **447**, 522-524 (31 May 2007) | doi:10.1038/447522a

Dewar et al's paper setting out the terms of the debate: *Does the Marine Biosphere Mix the Ocean?* Journal of Marine Research, **64**, 541-561 (July 2006)

Carl Wunsch's homepage: Munk W. and Wunsch, C., 1998, *Abyssal Recipes-II: Energetics of Tidal and Wind Mixing* (pdf) is of particular relevance

Sperm whale image from flickr user doublebug, under a creative commons licence: this version of the researchers' video is from Wired Science

1 Comment

Bill Gates, Geoengineer?

July 28, 2009, 6:01 pm
Filed under: Geoengineering, Interventions in the carbon/climate crisis

As various people have noticed, some interesting new patent filings from 2008 have just become public. They pretty clearly flow from brainstorming at a meeting of Intellectual Ventures, Nathan Myhrvold's innovation [cornucopia|extortion racket] and deal with cooling the surface layers of the ocean by pumping warm surface water below the thermocline. The interesting thing to note is that as well as Nathan and various people who, following Gladwell, I think of as his regular crew — patent lawyer Casey Tegreene, Rod Hyde and Lowell Wood and some other Livermore people — the names on the patent applications include Ken Caldeira, John Latham, Stephen Salter and William H. Gates III. Ken (with whom, I should say as disclosure, I am actually working on something at the moment) is, along with David Keith and possibly Alan Robock, the academic researcher currently most associated with geoengineering discussions. John Latham has championed the possibility of cooling the earth by increasing the reflectivity of marine clouds, and his collaborator Stephen Salter has designed hardware that might do the job (their approach was the focus of my article in Nature this May, as well as many many more by other hands). You probably don't need me to tell you who William H. Gates III is. He's half the couple whose Foundation may end up having saved more people than were killed by Stalin, Hitler and Mao.

The main patent application, filed through a company called Searete LLC, describes something a bit like a floating paddling pool with a long pipe dangling down from its centre. Because there will be waves outside the pool but not inside, water will splash in over its edge but not out, and so the water level inside the pool is higher than the level outside the pool. (It strikes me that the motive force here might be treatable as a macroscopic analogue of the Casimir force, but I will leave that for Phil Ball to puzzle over.) That difference in levels — the head — does not have to be very large in order to overcome the buoyancy of the warm surface water and drive it down through the pipe to the cooler depths. Thus heat is taken out of the surface layers. Since high surface temperatures are crucial to the formation of hurricanes, a flotilla of such systems acting to cool potentially-hurricane forming waters in the mid-Atlantic might stop the hurricanes actually getting going, or divert hurricanes moving in from elsewhere.

Cooling surface waters to this end has been suggested before: a company called Atmocean has in fact built prototype systems which aim to do it in almost exactly the opposite way to the Searete patents, by using wave power to pump cool water up instead of sending warm water down. And as Atmocean and others have pointed out, if you can make such a system work there could be more global applications than stopping hurricanes. If you pump warm water down, you will be encouraging cold water to come up, and that cold water will contain nutrients. Lifting nutrients up from the dark depths to the lighter shallows is a way to encourage more photosynthetic growth. More photosynthetic growth might mean more net productivity — and thus more carbon dioxide turned into organic carbon and sequestered. In a 2007 correspondence in *Nature*, Jim Lovelock and Chris Rapley suggested that pumping up nutrients from the depths this way might be investigated as a geoengineering tool (here's my blog entry on it from the time). And the Searete patent specifically covers just such geoengineering applications:

> A system for altering an aqueous environment, comprising: an application of at least one vessel capable of moving water to lower depths in the water via wave induced downwelling; a system for determining the placement of the at least one vessel based on the application; and a system for placing the at least one vessel in the determined placement … wherein the application includes atmospheric modification … [and] climate modification.

For a fuller description not couched in the barbarous language of patent applications, have a look at Stephen Salter's submission (pdf) to the recent National Academies panel on geoengineering. This work, which describes itself as funded by Intellectual Ventures, discusses a system 100m wide which has an array of one-way valves that let wave water in but not out, a more efficient and subtler way of doing things than just having some of the water slop over the top (though also one which carries the risks of having many moving parts). A typically neat Salter touch is to have it largely made out of used tyres and concrete. According to his calculations, one such piece of kit could transfer heat out of the surface ocean at a rate of 20GW, which is very impressive (though not in itself much of a match for hurricanes, which dissipate heat at a rate of tens or even hundreds of terawatts, I believe). He also discusses various ways that the hurricane-defusing pumps might encourage carbon-dioxide uptake. I was struck by a neat idea of Ken Caldeira's: the system might be fine tuned to inject nutrients not into surface waters but into the bottom of the photic zone — the lowest waters at which photosynthesis is possible. It might be the case that increasing photosynthesis at deep levels like this, rather than at the surface as iron-fertilization experiments do, could have advantages in terms of the amount of biomass that ends up sequestered in the deeps.

None of this, I have to say, looks particularly practical or convincing. Jeff Masters at Wunderblog points to some generic problems with hurricane elimination/diversion/modification schemes — a raft of which, he points out, are under examination as part of a Department of Homeland Security project called HURRMIT, which grew out of this meeting in Colorado last year and in which Danny Rosenfeld, who also has an interest in geoengineering, seems to be playing a role. (Here are some associated subsequent presentations from a meeting of the American Meteorological Society). As Masters says, a major issue is that once you try and do something about a hurricane you may well end up getting sued for any damage that hurricane ends up doing, on the basis that if you hadn't meddled the hurricane might have played out differently. And I suspect it would be very hard to show that such a system worked without trying it out at full scale, which is to say spending billions.

As for the geoengineering application, various people had cogent criticisms of the Lovelock and Rapley idea, including Peter Williams of Bangor and John Shepherd of Southampton, who chaired the Royal Society report on geoengineering heading off to the printers this week and being released in September. But this application does at least have the advantage of being testable on small scales in a way that hurricane diversion simply isn't. David Karl and colleagues have already tried testing the Atmocean pumps to see if they can produce a double bloom of the sort that Karl's theories about nitrogen availability would predict. The preliminary results were not very helpful, though: there wasn't enough shiptime and the pump they deployed broke down:

> The "keel" designed by Atmocean was structurally insufficient, and welds of reinforcing material around connection points were also insufficient…The single pump that was recovered showed multiple signs of failure, most notably the tarp tube system that was used…The couplers designed by Atmocean also proved to be insufficient in terms of strength and weld integrity.

In this respect I imagine the no-moving-parts approach described in the Myhrvold et al would be a significant improvement.

The most significant thing about the patent, though, at least for the moment, is not necessarily how good the system is at achieving various goals. It's the appearance of Gates's name, which may be his first public demonstration of an interest in geoengineering technologies. Such an interest is hardly a surprise: if you were spectacularly wealthy, concerned for human well being, technologically minded and had a track record of intervention on a world-historic scale, wouldn't you be interested in at least looking at such technologies? For my part I don't find that interest unwelcome, either. But I can see it is the sort of interest one could imagine wanting to keep quiet. Some of the many anxieties about geoengineering, after all, focus on what David Victor has called the "Greenfinger" scenario of the billionaire geoengineer going it alone, and this is the sort of thing that could stoke such fears. One to watch.

3 Comments

Eating up the carbon

June 24, 2009, 9:47 pm
Filed under: Geoengineering, Global change, Interventions in the carbon/climate crisis, Published stuff

The last of my filling-in-for-Olivia columns at the NYT is now up, a quick run through some points from the later parts of Eating the Sun and subsequent stuff. It's a carbon-climate crisis, energy is about flows not stocks, many wedges needed, yadda yadda yadda:

> Given that humans are changing the atmosphere at an unprecedented rate, what responses should we expect from the biosphere? And is there anything that we can do to make those responses work to human benefit? For those in a hurry, the answers in brief: a) complicated ones; b) yes, at least a bit.

More…

1 Comment

A talk with Jim Lovelock

April 23, 2009, 10:27 am
Filed under: Earth history, Geoengineering, Global change, Interventions in the carbon/climate crisis, Plant physiology

Here's the video of a conversation I had with Jim at the *Nature* offices a few weeks ago. Also available in its full glory at the *Nature* site. And indeed apparently at The Guardian too. I'd post excerpts from a transcript if I had the time, or a transcript…

Leave a Comment

The biochar backlash

March 30, 2009, 11:07 am
Filed under: Farming, Geoengineering, Interventions in the carbon/climate crisis

Interest in biochar has been building up in the UK recently. There was a cover story by Fiona Harvey in the FT a month ago with a familiar headline, Jim Lovelock and James Hansen have been extolling its virtues, it's been on the Today Programme (text here on BBC News), there are new technologies being talked up and there's an interesting looking workshop at the newly established UK Biochar Research Centre in Edinburgh on April 1st. And so of course there is also a backlash: last Monday George Monbiot, whose written on such subjects before, delivered a stirring oppositional salvo in the Guardian (and here's the link to the version on his own site, same text but with references — a good habit more newspaper columnists should take up):

> This miracle solution has suckered people who ought to know better, including the earth systems scientist James Lovelock(3), the eminent climate scientist Jim Hansen(4), the author Chris Goodall and the climate campaigner Tim Flannery(5). At the UN climate negotiations beginning in Bonn on Sunday, several national governments will demand that biochar is eligible for carbon credits, providing the financial stimulus required to turn this into a global industry(6). Their proposal boils down to this: we must destroy the biosphere in order to save it.
>
> In his otherwise excellent book, *Ten Technologies to Save the Planet*, Chris Goodall abandons his usual scepticism and proposes that we turn 200 million hectares of "forests, savannah and croplands" into biochar plantations. Thus we would increase carbon uptake, by grubbing up "wooded areas containing slow-growing trees" (that is, natural forest) and planting "faster-growing species"(7). This is environmentalism?
>
> But that's just the start of it. Carbonscape, a company which hopes to be among the first to commercialise the technique, talks of planting 930 million hectares(8). The energy lecturer Peter Read proposes new biomass plantations of trees and sugar covering 1.4 billion ha(9).
>
> …
>
> In their book Pulping the South, Ricardo Carrere and Larry Lohmann show what has happened in the 100m ha of industrial plantations planted around the world so far(16). Aside from trashing biodiversity, tree plantations have dried up river catchments, caused soil erosion when the land is ploughed for planting (which means the loss of soil carbon), exhausted nutrients and required so many pesticides that in some places the run-off has poisoned marine fisheries.

> In Brazil and South Africa, tens of thousands of people have been thrown off their lands, often by violent means, to create plantations. In Thailand the military government that came to power in 1991 sought to expel five million people. Forty thousand families were dispossessed before the junta was overthrown. In many cases plantations cause a net loss of employment. Working conditions are brutal, often involving debt peonage and repeated exposure to pesticides.
>
> As Almuth Ernsting and Rachel Smolker of Biofuelwatch point out, many of the claims made for biochar don't stand up(17). In some cases charcoal in the soil improves plant growth; in others it suppresses it. Just burying carbon bears little relationship to the complex farming techniques of the Amazon Indians who created terras pretas. Nor is there any guarantee that most of the buried carbon will stay in the soil. In some cases charcoal stimulates bacterial growth, causing carbon emissions from soils to rise. As for reducing deforestation, a stove that burns only part of the fuel is likely to increase, not decrease, demand for wood. There are plenty of other ways of eliminating household smoke which don't involve turning the world's forests to cinders.

This kicked off a whole week of biochar stuff in the Guardian. Various people criticised came back to say that they were really talking only about making biochar from crop waste: here's Jim Lovelock's benevolent response and here's a slightly pricklier one from Hansen and Kharecha. Chris Goodall also came back in a let's find common ground sort of way, and there were letters pro and con. Peter Read's right-to-reply piece, by way of contrast, comes out fighting.

> This degraded land [a large amount of land discussed in Read's biofuel plans] is former forest that has been logged over and abandoned – not, as Monbiot says, "land occupied by subsistence farmers, pastoralists, hunters and gatherers". Given the chance, impoverished people often opt for a waged income. Does Monbiot wish to keep them impoverished for ever?
>
> In reality there is not the shortage of land Monbiot implies but a desperate shortage of investment in the land. His "global total" of 1.36bn hectares of arable land does not include 2.38bn of unused potential arable land reported by the UN's Food and Agriculture Organisation, into which such investment, eg irrigation, might go. Moreover, the productivity of the 1.36bn could be raised with biochar pyrolysed from currently wasted agricultural residues, thus linking carbon removal with increased food supply and incomes.
>
> Monbiot misses the point that the need for land-use improvements comes from the threat of climatic catastrophe. With too much carbon in the atmosphere and oceans, some of it has to be removed and put somewhere safer. Using the gift of nature – photosynthesis which enables green plants to use the sun's energy to absorb atmospheric carbon – is the only economic way.
>
> …
>
> The remedy is not "an easy way out" but needs hard work and good policy resulting in, to quote last year's Sustainable Biofuels Consensus, "a landscape that provides food, fodder, fibre, and energy; that offers opportunities for rural development; that diversifies energy supply, restores ecosystems, protects biodiversity, and sequesters carbon."

George comes back in kind:

> I wasn't harsh enough about Peter Read. In his response column today he uses the kind of development rhetoric that I thought had died out with the Indonesian transmigration programme.
>
> To him, people and land appear to be as fungible as counters in a board game. He makes the extraordinary assertion that "degraded land" – which he wants to cover with plantations – is uninhabited by subsistence farmers, pastoralists or hunters and gatherers. That must be news to all the subsistence farmers, pastoralists and hunters and gatherers I've met in such places. Then he repeats the ancient canard that, by denying such people the opportunity to have their land turned into a eucalyptus plantation/hydroelectric dam/opencast mine/nuclear test site/re-education camp or whatever project the latest swivel-eyed ideologue is trying to promote, we are keeping them in poverty.
>
> Has he learnt nothing from the past 40 years of development studies? Does he not understand that development is something that people must choose, not something that can be imposed on them from on high by megalomaniacs?

It should be fairly obvious to everyone who's not just in this for the aggro that there will be good biochar interventions and bad ones. Forcing biochar on people or soils that don't want it or can't prosper with it will not help; helping people to find systems that are biochar friendly could quite possibly provide the win-win prospects everyone wants to see. As usual, Gary has sensible things to say about this, with helpful comparisons to the use of manure and lime as soil additives — as might be expected from someone whose ideas are rooted in practice and who has been blogging on this topic a lot while remaining impressively self-critical.

My biggest worry about the technology is that its strengths could have within them a fatal flaw. The soil is an easily reached reservoir, and provides a multiplier effect that's crucial to the efficacy of biochar: the carbon stored in biochar schemes is not just the carbon in the charcoal, it's the increased organic carbon in the rest of the soil. But easily reached is also easily breached, and multipliers can work two ways. If people use biochar to store a lot of carbon in soil, but not enough to forestall significant warming (which is a not unlikely scenario in the world biochar enthusiasts imagine) then they'll have provided an extra bolus of soil carbon to be respired back into the atmosphere by the warmer, and thus harder working, soil bacteria; they will have effectively traded emissions now for emissions later. So the carbon could quickly come right back out. If the microbial priming effect kicks in in this scenario — with the easily mobilised carbon providing enough energy for the bacteria to tackle more refractory carbon they would normally ignore – you might end up with not just with the carbon you stored away leaking out, but also some of the carbon that was already there. This is a subject on which I'd like to see more research before squirelling away the odd gigatonne of carbon.

Further resources: International Biochar Initiative, CSIRO biochar report (pdf), Biofuelwatch

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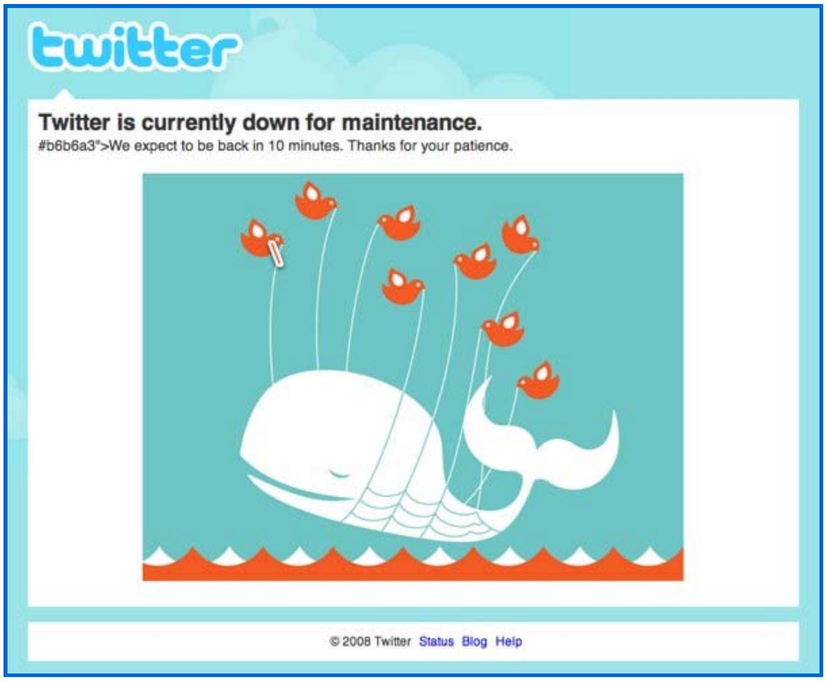
3 Comments

Twitter lessons

March 11, 2009, 10:15 pm
Filed under: Geoengineering, Published stuff



An avian emplacement approach to cetacean albedo ehancement

As mentioned, I twittered the geoengineering session I just posted on: http://preview.tinyurl.com/CopehagenGeoengTweets. I am sure there would have been better ways to do so — I am an egg in these matters. Glad to hear feedback and advice, but in the meantime here's my self-assessment, FWIW.

a) some of the tweets are, to be kind to myself, hard to parse:

> Battisti: if field testing need to look at monitoring capacity in order to differentiate results from background

b) as a form of note taking, not too bad; looking back on them, the tweets cover a lot of the key points I would have wanted people to take away. And a few dashes of levity too.

c) They were helpful to me as a focusing mechanism. Often I will drift off in some talks, or even leave a session. The self imposed twitter discipline meant that i had to be on top of each presentation enough to get 140 characters out of it.

d) also time efficient: there's an (admittedly perhaps challenging) 800 words of reasonably useful commentary there. If it had been done afterwards, would have taken time away from caffeination and schmoozing. And wouldn't have mentioned as many aspects of what was said.

e) that said, if done afterwards, would have been shaped, balanced and more clearly analytic. Looking at this stream, you might think Zeng's presentation on burying trees marked an exciting new idea. Don't think it did; but tweeting its main points I forgot to tweet scepticism.

f) and if done afterwards — as a post here, say – the set would have had its own URL, findable by google, and been categorised for users of the blog. By using the advanced search function it's possible to get them all on a page that stands some chance of staying stable, but whether that really lasts, who knows? And they will not show up in searches for geoengineering because I didn't have the characters to spare for such a long word.

g) Even if people could find them, not sure they would gain much thereby. People who have a real interest in geoengineering might find them of some interest or use: probably not terribly helpful, if at all, for a broader audience.

h) it would have had more value, perhaps, if other people had also been tweeting. But that seems more likely to happen at the sort of meetings where @doctorow and @timoreilly are to be found than around here.

Some questions: Too many tweets, or too few? Would TinyUrls for the abstracts of each talk have helped enough to make up for the loss of characters entailed? Was value added?

Will I do this again? Dunno.

3 Comments

The truth is not yet out there…

March 11, 2009, 10:13 pm
Filed under: Geoengineering

For those not eager to trawl through the aforementioned geoengineering tweetstream here's the most interesting thing I took from the geoengineering session — a point on which, interestingly, David Keith and Ken Caldeira, who are keen to see and do more research on the topic, are close to agreeing with David Santillo of Greenpeace, who isn't.

The problem is in some ways pretty obvious: No one knows whether geoengineering can really be made to work. As Keith pointed out, even for the best characterised putative intervention — a stratospheric aerosol like those produced by volcanoes — the comparatively cursory research to date has turned up a wealth of complexities that have not yet been addressed by proponents, and more research will turn up even more of them. To Keith and Caldeira, this raises a nightmare scenario: that the world will have in the back of its mind that geoengineering is there as a fallback, will find that it needs a fallback, and will then find out that the fallback is not there in any practical sense. On this basis the sooner it is clear that there is no way out the better: time to do some serious research.

That is similar to Santillo's position, except he doesn't want to do the research needed to find out for sure. I took it from his talk that he wants instead to create a climate of opinion where the nagging hope that geoengineering might save us was firmly shut down more or less a priori, with commitment to emission cuts the sole and reaffirmed goal of all.

In making this argument, he came up with a nice pithy account of what he sees as the 5 drivers for geoengineering research: desperation, aspiration, fascination, delegation, remuneration. The first two he sees as essentially reasonable, the third — "it is just such fun to play with these ideas!" — troubling, the fourth — "O good, someone else can solve the climate I don't have to" — dangerous and morally defective (my term not his), and the fifth beyond the pale. (Actually in the presentation he didn't call the fifth driver "remuneration" he just called it "money" — but he told me later he'd thought about listing it as remuneration, and I think it's slicker that way…)

What all these people agree on is that the lopsided way in which geoengineering is discussed, with a level of prominence in the media (and the unpublished musings of researchers, in my experience) and the imagination disproportionate to the actual level of knowledge among experts, needs to be seen as a real problem. Geoengineering is widely enough discussed that the thought it might be there as a last resort is widespread and quite possibly spreading wider, even though it still may be an illusion. Keith laid out the argument for reducing this disproportionality in a more formal way, looking at scenarios comparing the value of "Early Learning" v. late learning. I didn't note down all the details, but Early Learning seemed, by the economic metric he was using, to be a big, big winner.

Cross-posted at Climate Feedback

3 Comments

Geoengineering by the numbers

January 28, 2009, 12:34 am
Filed under: Geoengineering, Global change, Interventions in the carbon/climate crisis

A very useful paper (abstract|pdf|discussion space) comes out today in *Atmospheric Chemistry and Physics* by Tim Lenton and his student Naomi Vaughan. Tim told me when I was reporting the Andy Ridgwell paper on leaf albedo (*Nature* story|blog entry) that he'd become pretty interested in evaluating geoengineering schemes, and was setting up a group at the University of East Anglia to assess them. This paper presumably represents the first fruits of that interest, providing a ranking of most of the geoengineering schemes proposed in the literature in terms of the amount of radiative forcing they can provide.

Radiative forcing is, more or less, the difference in terms of energy per square metre that's associated with any given action that changes the climate; it's a pretty routine way of expressing things in IPCC-land. The IPCC puts the radiative forcing associated with the greenhouse gas industrial and industrialising societies pumped into the atmosphere from 1800 to 2005 at about 1.6W/m², and the forcing for a doubling of CO_2 at about 3.7W/m².

Lenton and Vaughan first divide geoengineering proposals into two sorts: shortwave and longwave. Shortwave schemes seek to reduce the amount of energy that gets into the earth system by reflecting away incoming sunlight. Longwave schemes seek to increase the amount of energy leaving the earth system by making the atmosphere more transparent to outgoing infrared radiation — that is, by reducing the greenhouse effect. Then they assess the two with some very simple modelling (well, for the longwave there are some wrinkles, but it's all in principle pretty simple). They don't claim that the figures they come up with are the best available in any particular case, just that they are all derived the same way, and so allow fairly straightforward comparisons. By standardising the techniques they also show up a few errors in previous analyses: for example, if you increase the total amount of light reflected back into space by clouds, you reduce the amount reflected by the surface, simply because less light gets there in the first place.

The first and most striking conclusion is that if you want to have a big effect, go shortwave. Sulphate aerosols in the stratosphere (which were the main topic of this piece and these Climate Feedback posts) and mirrors/refractors in space (also in that piece, and in this paper by Roger Angel) both have the potential to provide as much by way of negative forcing as a doubling of CO_2 provides by way of positive forcing. Not surprising; if you're not constrained by money or by concerns about environmental side effects, you can put mirrors in the sky and particles in the stratosphere until it's darkness at noon.

When you leave these global technologies behind, the other shortwave interventions rank, unsurprisingly, more or less according to the area they affect. Increasing the brightness of marine stratocumulus clouds, as proposed by John Latham, would affect about 17% of the earth's surface, and the Lenton-Vaughan analysis suggests that the whitening effect would have to be considerably more marked than previous work has assumed; but if that brightening could be achieved then a negative forcing that averages more than $3W/m^2$ should be possible. Covering non-sandy deserts with aluminium and polyethylene (not an idea I had come across before, and a pretty silly one as far as I can see: more here if you want it) makes 2% of the surface a lot brighter, and gets you an average $1.7W/m^2$ of negative forcing, obviously very unevenly spread. Increasing the brightness of the planet's grassland as Robert Hamwey has discussed (pdf) gets you $0.64W/m^2$, and the Ridgwell et al idea of planting brighter crops gets you $0.44W/m^2$ at best, croplands being smaller than grasslands. Lightening everywhere that people actually live (another idea from the Hamwey paper) gets you $0.19W/m^2$; increasing the area of plankton blooms that seed the creation of clouds in parts of the southern ocean gives you just $0.016W/m^2$ (and that may be an overestimate) and restricting yourself to just creating shinier cities gives you no more than $0.01W/m^2$.

What of the longwave? In principle, capturing carbon dioxide from the air (pdf of the Keith et al paper) and burying it in the ground could give you whatever radiative forcing you wanted; the limits to such a scheme are entirely economic, rather than being imposed on the earth system. All the other schemes, though, which involve making changes in the natural carbon cycle, are quite constrained, with none able to counter a doubling of carbon dioxide, even given the most extreme assumptions.

The biggest effect comes from really aggressive planting of forests, as described in an essay (pdf) by Peter Read on his global gardening plans. This involves growing enough plant material in the next 50 years to more than completely make up for all the arbon dioxide lost through deforestation and land use change over the past few centuries, which is really remarkably ambitious, especially if people are still going to have some space to grow food. By 2050 this strategy gets you an effective $0.49W/m^2$ of negative forcing thanks to 88 gigatonnes of carbon dioxide being stored away. A variant of the idea in which you grow the biomass and burn it in power stations fitted out for carbon capture and storage does even better: $0.69W/m^2$ by 2050 and almost $2W/m^2$ by 2100 (For the longwave calculations, the radiative forcing depends on how long the programme has been going on. It also depends on what assumptions you make about how effective carbon-emissions control is; Lenton and Vaughan calculate all the forcings in terms of what extra relief the carbon-dioxide drawdown provides in a world that is already making serious cuts in emissions).

A lower tech idea that Read is fond of, as for that matter am I, is turning biomass into biochar and ploughing it into the ground. Jim Lovelock, Lenton's mentor and friend, was extolling this as a possible way of making things better in New Scientist last week, speaking to the in-this-case-aptly-named Gaia Vince. This may make sense for all sorts of reasons, and the fact that making the charcoal also provides you with fuel (see Johannes Lehmann's commentary in *Nature* a few years ago) is obviously a plus, but even a really aggressive campaign along these lines gives ou a negative forcing of only 0.40W/m² by 2100.

After that come a bunch of ocean fertilization schemes, using phosphorous, nitrogen and iron, all of which offer something in the region of 0.1-0.2W/m². A system of pumping nutrient-rich water up to the ocean surface sketched out by Lovelock and Chris Rapley (earlier blog entry) delivers a truly meagre 0.003W/m² by 2100.

None of this, as Lenton and Vaughan are at pains to make clear, counts as an endorsement; all the schemes have side effects and risks, as well as in some cases (ahoy there, vast fleet of space parasols) quite remarkable costs. But looking at the options this way does allow a sense of what might be possible, and a way of seeing what might be done in a mix and match sort of way. And the fact that the paper is published in the discussion section of ACPD means that the various researchers whose work is discussed will have a chance to answer back, correct any poor assumptions, and carry the debate forward.

Cross-posted to Climate Feedback

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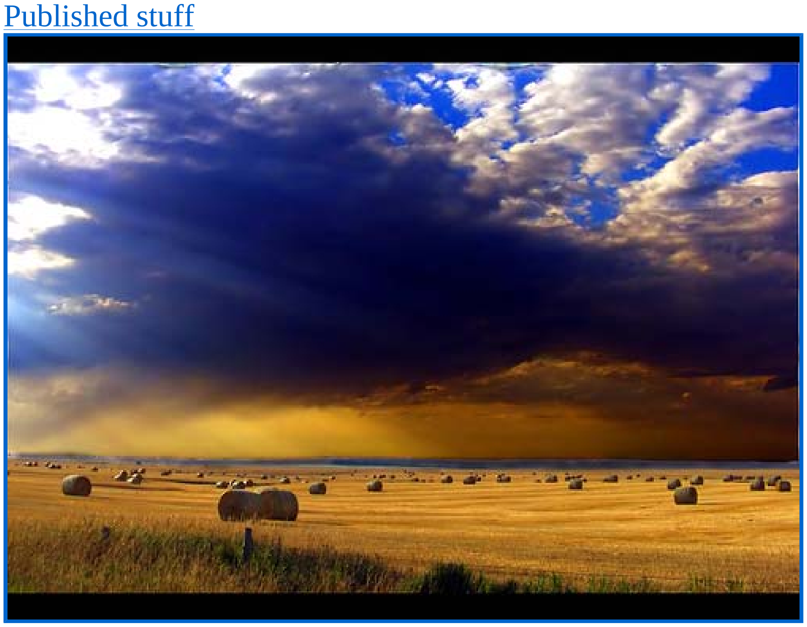
2 Comments

Leaf albedo engineering

January 15, 2009, 11:03 pm
Filed under: Farming, Geoengineering, Interventions in the carbon/climate crisis, Plant physiology, Published stuff



Let's brighten this up...

I wrote a little piece for Nature today today about a paper by Andy Ridgwell at Bristol and some of his colleagues on changing the albedo of crops. The gist as published:

> Manipulating the waxiness of crops through traditional breeding techniques or genetic modification should raise their albedo by about 20%, from 0.2 to 0.24. On the basis of climate modelling they calculate that the planet would cool by a modest 0.11 ºC. "It's very small on the global average," says Ridgwell. But "what is more important is the summertime effect in specific regions". The mid-latitudes of North America and Eurasia could cool by as much as 1 °C in June, July and August, according to the models. Ridgwell and his colleagues report their results in *Current Biology*.
>
> The models also show pronounced cooling in the North Atlantic Ocean and the Barents Sea in the wintertime — which might have a positive effect on sea ice — but a drying out of the soil in some parts of the subtropics. Ridgwell points out that climate models do not predict future precipitation well on a regional basis and treats the latter results more as evidence that there might be effects far from the fields being changed than as a clear indication that there would be damaging consequences.

There are some interesting details and implications to this "bio-geoengineering" scheme. Though you might think that reflecting more light off the surfaces of leaves means less photosynthesis, according to the paper the evidence in the literature suggests not. This may be because more reflective leaves stay cooler and more efficient; another possibility is that the light is reflected mostly from leaves in direct sunlight (which are not constrained by a lack of light) and some of what is reflected ends up with leaves that are in shadow (which are constrained by lack of light). More detailed studies, of course, may show that in fact photosynthesis does go down.

Making the plants more reflective, if it proved a good idea at all, might well necessitate genetic engineering, which in some places is distrusted. That engineering might be more acceptable in energy crops than it is in food crops. It might make sense, if people are going to engineer energy crops for other purposes, to make them a little lighter too, all other things being equal.

Another point is that this is very small beer as geoengineering goes. A similar but more dramatic proposal along similar lines by Robert Hamwey (pdf) has a radiative forcing of about 0.6 Wm-2, which is smallish by the standards of the CO_2 forcing; I would guess if they expressed it in the same way the forcing in the Ridgwell et al scheme would be a good bit less than that. But it might still have some marginal utility. This is a trend I suspect we will be seeing more and more of in geoengineering studies over the next few years, a shift away from totalising projects such as sunshades for the whole earth and layers of aersosol all through the stratosphere towards smaller regional and semi regional ideas.

Talking about this trend Tim Lenton has suggested that we may be moving towards a discussion of geoengineering that has some similarities to Socolow's "wedge" approach to decarbonization: breaking the big problem down into smaller lumps that feasible technologies could bite off and chew; as I report in the Nature piece, Tim and some colleagues are looking at setting up a unit to compare geoengineering schemes and their potential payoffs on this basis. I'm not sure this is necessarily a good development. Every geoengineering scheme has strange knock-ons and side effects around the edges, and it seems reasonable to suspect that the more such schemes you have, the more chance there is for one of the side effects to be unexpectedly serious — or for two of them to interact with each other catastrophically. But that said, the fact that it is probably a lot easier to find little forcings than big ones suggests that the portfolio approach may be in the ascendant for a while.

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2 Comments

« Previous Page — previous »
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