# A Last Resort Attack on Global Warming

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The earth may be in an unprecedented runaway warming regime. “Runaway warming” here means that, barring significant intervention, not just reduction of human greenhouse gas emission, the temperature will rise to a regime where no liquid surface water can exist, similar to that of Venus. Such a regime may occur due to elimination of reflective ice and snow cover, emission of methane from sequestered clatherates, and thus the formation of dense high altitude water vapor, which greatly increases the greenhouse effect and thus increases extreme storms and surface water evaporation rates.

The Venus runaway greenhouse effect was not initially caused by CO2, but rather high altitude water vapor, which has a very powerful greenhouse effect. There is an area over the Pacific already in a *measurable* runaway regime, with the definition of “measurable” being limited. [1]. [2], [3] Melting of the polar ice caps and vast methane releases already underway may be enough to tip the balance to a clearly measurable global runaway regime. That may mean we that we are currently in a runaway regime, in the sense of a regime in which global warming will runaway unless drastic action is taken. This is not the definition of "runaway greenhouse effect" used in the ref. [2] above, but it is a definition that makes more sense. If the progression will not stop without drastic intervention, then that should be defined as "runaway". Any other definition only clouds the issue.

Given that all else fails to stop global warming, and action is taken soon enough that a 10 percent reduction in the solar insolation factor over the EM band around 10^-6 m, from latitudes 50 to -50, can stop or reverse the warming, then the following is suggested as a rough first estimate of how this might be done.

The objective might be met by dispersing orbiting aluminum nanopowder from latitudes 50 to -50, at, say, an altitude of about 800 km. This might be accomplished by deploying a ring of satellites that orbit between those latitudes, and then firing rockets in a direction normal to the direction of travel and a radial line through the earths center and such a satellite. The rocket firing would thus not change the orbit altitude, only the poles of the orbit. In this manner the nanopowder would be deployed at a constant altitude. During the firing the nanopowder would be deployed, possibly into the exhaust. It might be possible to design an electric rocket that uses the nanopowder as a reaction mass, and which runs on solar power.

It is presently possible to obtain metal nanopowders of dimension 8 nm. These then have volume of (8x10^9 m)^3 = 5.12x10^-22 m^3/particle, or 1.95x10^21 particles/m^3 of, say, aluminum. Aluminum weighs 2.70 g/cm^2 = 2700 kg/m^3. There is thus (1.95x10^21 particles/m^3)/(2700 kg/m^3) = 7.22x10^17 particles/kg.

If we assume that one such particle can reflect incoming photons of about 10^-6 m wavelength about 10 percent of the time within a radius of 10^-6 m, then each nanoparticle has the required coverage of Pi*(10^-6 m)^2 = 3.14x10^-12 m^2. This gives a coverage of (7.22x10^17 particle/kg)(3.14x10^-12 m^2/particle) = 2.98x10^6 m^2/kg.

The radius of the earth is 6.38x10^6 m, and if we deploy at 800 km then the effective radius of our deployment sphere is 7.18x10^6 m. Given that the area of the zone of a sphere is 2 Pi R h, the total deployment area is 2*Pi*(7.18x10^6 m)*((7.18x10^6 m)*sin(50 deg.)) = 2*Pi*(7.18x10^6 m)^2*(.766) = 4.96x10^14 m^2.

The total deployed mass is thus (4.96x10^14 m^2)/(2.98 m^2/kg) = 1.66x10^8 kg, or 166,000 metric tons.

Assuming the deployment of this amount of payload can get the price down to $10,000/kg, the cost of deployment is (1.66x10^8 kg)($10,000/kg) = $1.66x10^12. The price of, for a limited time, saving the earth when it is at the defined point of stress is about 1.7 trillion dollars.

The worst assumption in this rough first estimate is probably the assumption that an 8 nanometer particle can provide 10 percent reflection back into space of low infrared to visible radiation, radiation averaging about 10^-6 m wavelength, over an area about (10^-6 m)^2.

Ultimately the nanopowder will reenter the earth's atmosphere, but before doing so, might tend to form an equatorial ring, which will continue to give partial shelter from solar heating during both winter and summer, but not during the solstices. Hopefully such a dispersal will be planned to occur at sufficient altitude that it will last long enough for us, or subsequent generations, to solve the global warming problem.

A good means of dispersal might be the use of a laser or plasma torch to disperse in atomic form. This atomic form might achieve a much better initial coverage than nanoparticles, but would probably eventually aggregate into nanoparticles in space. This would also have the advantage that the payload could be carried in the more dense solid form.

Though feasible, nano-aluminum is maybe not such a great idea. It all comes back down to earth sooner or later, and aluminum has been linked to dementia. Aluminum or aluminum oxide in the lungs is not good either. Something the body can use and absorb might be better, like iron or calcium. It would take some research to create a benign but effective nanopowder for photon absorption in space. Still, dumping kilotons of aluminum into space is a lot better than stewing every living thing.

A good light and clean dispersant might be CaO. However, there is a fairly handy source of dispersant mass right in our sky ... the moon. We know that pieces of the moon and similar bodies enter our atmosphere continuously in the form of meteors, so lunar soil should not be too bad a dispersant.

One idea that might be developed is the use of a nuclear power plant that can use lunar soil as an inertial reaction mass. If it is feasible for such a rocket to escape from the moon carrying a decent payload, then single ships could make numerous journeys without refueling. The best scheme might involve low payload ferries that move mass from the moon to lunar orbit, and a second class of ship that brings the mass to earth orbit.

Rail guns are useful for getting things to a high altitude, but not for getting to orbital speed, to a high tangential velocity, which requires a rocket to go along with the payload. Might be worked out, and a lot of work has been done on this concept, especially for Mars to orbit lifting. Rail guns might be an ideal way to get payloads off the moon because they can be fired at a nearly tangential angle and the projectile has no air resistance. The projectile would still have to have some thrust capability in order to adjust to an orbit that would not impact the moon on the orbit return, but it would be nominal.

The use of a black particle, as opposed to a highly reflective particle is also feasible. It then merely heats up until the infrared Plank radiation comes to equilibrium with the rate of energy absorption. A black particle thus acts to downshift the radiation. Further, the radiation direction for a black particle would be at least 50 percent back to space. The original problem was that of obtaining a high absorption cross section. This problem is greatly diminished by the approach of using lunar soil. There is no practical limit to the amount of such material that could be brought to earth orbit in a multi-trillion dollar project, so the limitations and principle unknowns of the original concept of using aluminum nanopowder are completely circumvented. This is now a concept that can obviously actually be made to work ... *as a last resort.*

References:

[1] <http:www.sciencedaily.com/releases/2002/05/020516080752.htm>

[2] <http://www.astronomynotes.com/solarsys/s9.htm>

[3] Google: venus greenhouse water vapor

UPDATE 1/17/2006

See articles about James Lovelock, Gaia, and the point of no return for climate change:

http://news.independent.co.uk/environment/article338878.ece

http://comment.independent.co.uk/commentators/article338830.ece

http://news.independent.co.uk/environment/article338879.ece

UPDATE 4/18/2006

See new references on global dimming in:

http://www.mtaonline.net/~hheffner/MJonesSPF.pdf