Climate Restoration using Natural Earth Systems: Iron Salt Aerosol

It looks very much as though Mother Nature may have provided an affordable scalable tool that in combination with other mitigation efforts would deplete most greenhouse gases, reducing warming. That tool also provides powerful, rapid cooling mechanisms. Until recently the only information on Iron Salt Aerosol was essentially invisible to all but the most determined academic researchers. Now an Australian website ironsaltaerosol.com provides a description of twelve natural cooling processes. Accessible technical material is also appearing on the ClimateGameChangers.org website. A growing international team of volunteers are promoting Iron Salt Aerosol as an immediate initiative for addressing climate change.

Iron Salt Aerosol (ISA) is $FeCl_3$ (ferric chloride) nebulized into the troposphere. It could be produced *in-situ* from chemical precursors combusted in hot flues designed to lift a plume 1km above sea level. Adding a total of 150,000 tons of iron annually to the polar regions could remove 12 billion tons of carbon dioxide and equivalents per year (doubling the abatement of the whole Paris Accord over the next decade). Iron Salt Aerosol could be implemented safely, quickly and at low cost. A first order estimate based on materials cost is 45 US cents per tonne of carbon-dioxide equivalent removed. Our official estimate is currently $1 per tonne of carbon-dioxide equivalent, which incorporates a 120% uncertainty.

The strongest Iron Salt Aerosol climate restoration mechanisms are:

- Oxidation of powerful warming agents: methane and tropospheric ozone. A sunshine-induced photo-catalytic reaction produces chlorine radicals – a powerful oxidising agent that is estimated to deplete methane at four times the natural rate, possibly much faster.
- A reaction that renders black/brown particulates more readily washable out by rain;
- Carbon-dioxide drawdown, from very low concentration but widely dispersed ocean fertilisation. In the Southern Ocean this amounts to adding 10 grams of iron per square kilometre per day;
- Rapid cooling from marine cloud brightening, by Iron Salt Aerosol itself and the airborne excreta of the ISA-activated phytoplankton;
- Ocean brightening, as growth of phytoplankton turns it from black-blue to turquoise.

The ocean bottom has been a natural carbon sink for millions of years. We argue it is capable of safely and permanently sequestering around 10 billion tons of carbon that needs to be removed yearly from the atmosphere from anthropogenic sources.

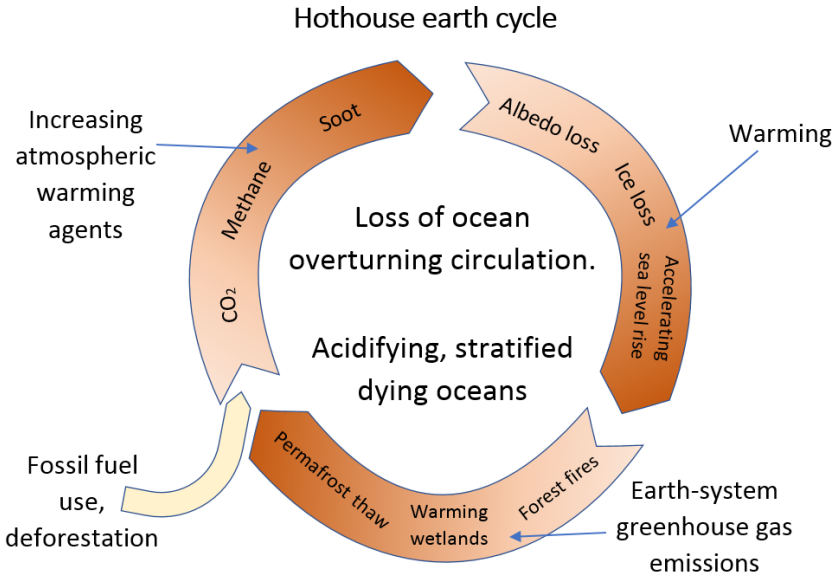
Iron Salt Aerosol already exists in the troposphere from steel manufacturing, coal fired power stations (along with the undesirable mercury compounds and particulates etc) and numerous other sources, including windblown dust.

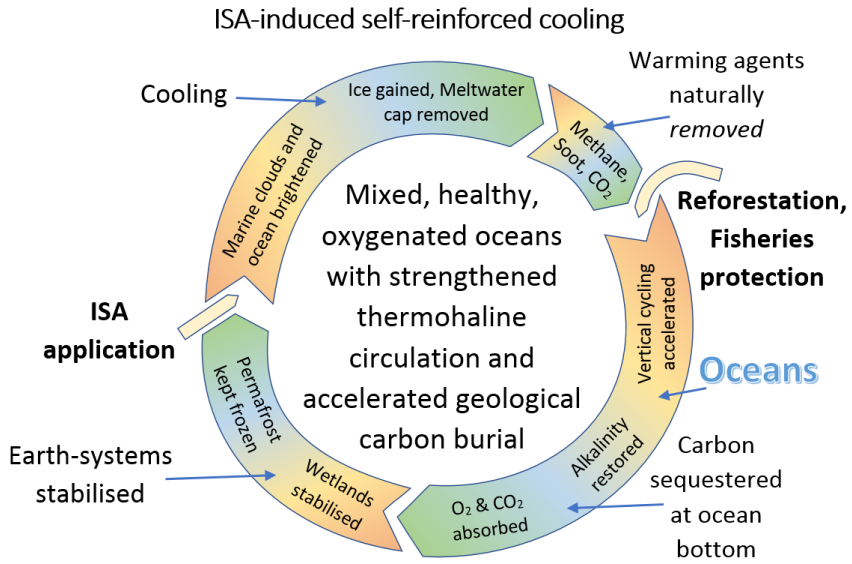
An incremental scaling approach with testing at each stage is required to measure efficacy and safety. The initial proposal is to double the existing level of tropospheric Iron Salt Aerosol, by adding 75,000 tons of iron annually to each polar region. Arctic regions have high concentrations of methane, and the Southern Ocean is ‘High Nutrient, Low Chlorophyll’, making it an ideal candidate for iron fertilisation. The resulting cloud brightening would also have a cooling effect on those regions.

There is much more to it than that. Focused largely on chemistry, the ISA team have researched the way Iron Salt Aerosol encompasses both the global water cycle including ocean circulation, and large parts of the long-term geological carbon cycle, including sequestration into the ocean crust and sediments. We do not accept the claim that the oceans can absorb only 1 billion tons of carbon each

year owing to hypothetically large carbon-dioxide outgassing from plankton litter oxidation. Most of the organic material produced by phytoplankton growth and its downstream food-web is stable and can remain in the ocean for centuries. In addition, contrary to claims that Iron Salt Aerosol damages the stratospheric ozone layer we argue that ISA depletion of halo-methanes is much more likely to strengthen it.

The two diagrams below contrast the current warming cycle towards a Hothouse Earth with the beneficial effects of an ISA program.





The lead authors of the Iron Salt Aerosol paper (https://www.earth-syst-dynam.net/8/1/2017/) are chemical engineers Franz Oeste, and Renaud de Richter. Their proposal is being promoted in Australia by Robert Tulip and John Macdonald, and in the UK by Clive Elsworth. The Australians are in early discussions with Australian local government to plan an initial trial off the Bass Strait.

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