**Polar Ice Preservation by Winter Cloud Clearance.**

S.H.Salter, Institute for Energy Systems, School of Engineering, University of Edinburgh, Mayfield Road, Edinburgh EH9 3DW Scotland. S.Salter@ed.ac.uk. +44 131 650 5704

There is increasing concern about the rate of loss of polar ice 1,2.3 and the results elsewhere. The recent estimate from PIOMAS 4 is about 10,000 cubic metres a second for the Arctic. The latent heat of ice fusion is 334 Joules per gram implying a melting power of 3 x1012 watts. The area of Arctic ice ranges from 9 to 12 x 106 km2 so the power density of the ice loss is 0.25 to 0.35 watt/m2. This note suggests one possible intervention based on increased aerosol concentration of the right size.

Both snow and ice have a high emissivity at long wavelengths. The Stefan Boltzmann equation predicts that an ideal black body at – 40 ˚ C would radiate 233 watts/m2. Curry5 suggests that the winter down-welling of long-wave radiation at 80 ˚ N is about 200 watts/m2 . A very small reduction in the energy reflected back by clouds would reduce the rate of ice loss.

Alterskjær and Kristjanssen6 used the Norwegian Earth System Model (NorESM) to study John Latham’s proposal7,8 to increase the concentration of cloud condensation nuclei over the sea by spraying micron and submicron sized drops of sea water into the marine boundary layer. This would increase cloud reflectivity because of the Twomey effect9 and so reduce global warming The statistical distribution of atmospheric aerosol sizes is split into three separate modes called Aitken, accumulation and coarse with effective diameters of 0.08, 0.44 and 4.92 microns . The Norwegian team modelled the thermal effects of all three modes if salt masses of a range of amounts were released between 30˚ N and 30˚ S. The central accumulation mode produced a cooling of 3.3 watts per square metre as expected by Latham. This would be enough to offset the thermal effect of double preindustrial concentrations of CO2. But the other two modes worked in the *wrong* direction. The Aitken mode produced a warming 2.5 times larger than the cooling of the accumulation mode because the smaller particles were taking water vapour without achieving nucleation. This would result in a lower cloud fraction and more solar energy reaching the sea surface.

The winter cloud fraction in the Arctic is high. If we can inject Aitken mode aerosol into air parcels which will later be blown over polar ice we may be able to reduce the Arctic cloud fraction and so increase radiation out to deep space. Thus smaller spray size in the Arctic winter can produce a cooling effect like larger spray at lower latitudes all the year round. If some difficult plankton filtration problems can be solved, the aerosol could be produced by wind-driven spray vessels10 operating safely outside the ice when the wind is in a favourable direction.

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