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Stabilization of Global Temperature and Polar Sea-ice cover via seeding of Maritime Clouds

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The marine cloud albedo enhancement (cloud whitening) geoengineering technique (Latham1990, 2002, Bower et al. 2006, Latham et al. 2008, Salter et al. 2008, Rasch et al. 2009) involves seeding maritime stratocumulus clouds with seawater droplets of size (at creation) around 1 micrometer, causing the droplet number concentration to increase within the clouds, thereby enhancing their albedo and possibly longevity. GCM modeling indicates that (subject to satisfactory resolution of specified scientific and technological problems) the technique could produce a globally averaged negative forcing of up to about -4W/m2, adequate to hold the Earth's average temperature constant as the atmospheric carbon dioxide concentration increases to twice the current value. This idea is being examined using GCM modeling, LES cloud modeling, technological development (practical and theoretical), and analysis of data from the recent, extensive VOCALS field study of marine stratocumulus clouds. We are also formulating plans for a possible limited-area field test of the technique.
Recent general circulation model computations using a fully coupled ocean–atmosphere model indicate that increasing cloud reflectivity by seeding maritime boundary layer clouds may compensate for some effects on climate of increasing greenhouse gas concentrations. The chosen seeding strategy (one of many possible scenarios), when employed in an atmosphere where the CO2 concentration is doubled, can restore global averages of temperature, precipitation and polar sea-ice to present day values, but not simultaneously. The response varies nonlinearly with the extent of seeding, and geoengineering generates local changes to important climatic features. Our computations suggest that for the specimen cases examined there is no appreciable reduction of rainfall over land, as a consequence of seeding. This result is in agreement with one separate study but not another. Much further work is required to explain these discrepancies and to address the crucially important issue of adverse ramifications associated with the possible deployment of this geoengineering technique.
We envisage, should deployment occur, that wind-driven, unmanned Flettner spray vessels will sail back and forth perpendicular to the local prevailing wind, releasing seawater droplets into the boundary layer beneath marine stratocumulus clouds. In an effort to optimize vessel performance, computations of flow around a Flettner rotor with Thom fences are being conducted. An early result is that that the lift coefficient on the rotating cylinder undergoes very large, slow variations in time, with a frequency an order of magnitude below that of the rotation frequency of the cylinder. The vessels will drag turbines resembling oversized propellers through the water to provide the means for generating electrical energy. Some will be used for rotor spin, but most for the creation of spray droplets. One promising spray production technique involves pumping carefully filtered water through banks of filters and then micro-nozzles with piezoelectric excitation to vary drop diameter. Another involves electro-spraying from Taylor cone-jets. The rotors offer convenient housing for spray nozzles, with fan assistance to help initial dispersion of the droplets.
This global cooling technique has the advantages that: (1) the only raw materials required are wind and seawater; (2) the amount of global cooling could be adjusted by switching on or off, by remote control, sea-water droplet generators mounted on the vessels; (3) if necessary, the entire system could be immediately switched off, with conditions returning to normal within a few days; (4) since not all suitable clouds need to be seeded, there exists, in principle, flexibility to choose seeding locations so as to optimise beneficial effects and subdue or eliminate adverse ones.

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