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Superctical Saltwater Spray for Marine Cloud Brightening

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Interest in the Latham scheme (Latham 1990) for cloud albedo modification to reduce the thermal effects of global warming has steadily grown since its inception some 20 years ago, because of its benign and reversible aspects. It relies on the insertion of artificially created cloud condensation nuclei (CCN) into marine boundary layer clouds of low albedo. Carried by natural up-drafts, these CCN would increase the droplet density, thereby increasing the albedo of the cloud. Suitable CCN need to have a minimum mass estimated to be on the order of 7*1020 kg in order to be effective, and should be of a relatively narrow size distribution. However, the practical implementation of the CCN fabrication needed for this method still needs to be realized. The required droplet distribution is well beyond the reach of any conventional sprayer. A proposed implementation by Salter et al. (2008), suggests the production of 1017/sec salt CCN per vessel, obtained by the spraying of about 30 L/sec of filtered seawater in droplets approximately 0.8 Î¼m in diameter, formed using 0.5-Î¼m spray holes. These sprayers would be placed on wind-driven autonomous sail ships using advanced Flettner rotor technology.

Previously we reported (Latham 2010) on the production of suitable nuclei (75–85-nm salt crystals) using electro-hydrodynamic spraying of saltwater with Taylor cones. The CCNs formed readily converted at 0.5% supersaturation in the laboratory. Since each Taylor cone produces at best only 109 CCN/sec, scale-up would require the fabrication of 108 Taylor cones. This is estimated to require a 1-m2 sprayer of considerable complexity. We report here on the use of saltwater sprayed at or near its supercritical point (410 Ë[U+009A] C, 307 bar) through simple orifice nozzles. Initial results suggest that this method might be suitable both in terms of the average salt particle size generated, i.e. 60 nm, and the width of the particle size distribution (GSD=0.65). The total amount of fluid sprayed would be very low, i.e. on the order of 200 mL/sec, because of the extremely fine two-phase atomization that takes place. Nuclei formed this way rise and disperse rapidly in laboratory air as desired. Currently each nozzle generates on the order of 1014nuclei/sec, and therefore only a few thousand nozzles would be required. These crystals are so small that the aerosol is nearly invisible. This process is quite energy intensive, but conceptually very simple and inexpensive in terms of equipment cost. Therefore it is perhaps best suited to deployment on commercial ocean-going ships, where a lot of waste energy could be available. Such ships might then receive satellite signals to deploy their spray when sailing in areas suitable for cloud whitening.

Latham, J. 1990 Control of global warming? Nature 347, 339-340. (DOI:10.1038/347339b0)
Salter, S., Sortino, G. and Latham, J., 2008, Sea-going hardware for the cloud-albedo method of reversing global warming, Phil. Trans. Roy. Soc., 366, 3843-3862.
Latham, J. 2010, Cloud Brightening, Roy. Soc Geo-Engineering Meeting.

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