Cool emissions from ships

Global warming is accelerating, and even if all greenhouse gas emissions ceased tomorrow, the climate would warm for decades, thanks to the previously emitted CO2 and a wide range of climate feedback mechanisms. To prevent complete loss of ice caps and thawing of the permafrost, it may be necessary to use a type of geo-engineering known as Solar Radiation Management (SRM). Some forms of SRM such as stratospheric sulfur injection have long-lasting global consequences, and hence carry enormous risk ("Snow Piercer" is fiction but gives you the idea). Marine cloud brightening (MCB) is another type of SRM; here tiny salt particles are released into the air in targeted areas of the remote oceans. The salt particles act as Cloud Condensation Nuclei (CCN), promoting the formation of clouds that reflect sunlight back to space. The impact of the CCN injection is very limited in time and space, which means that it is feasible to contain the risks. The atmospheric processes are complex, but scientists know a lot about it from the un-intentional MCB that resulted from sulfur in ship fuels. In the last few years, sulfur has been removed from the fuel, and "ship tracks" (figure below, an older NASA satellite photo) have been largely eliminated. Eliminating these CCN emissions has had a net climate warming effect, perhaps comparable to the ship's use of fossil fuels.

The sulfur was removed from marine fuels for good reasons: it was in a form that produced sulfuric acid in the atmosphere, bad for people when inhaled, and bad for rivers and lakes when it rains acid over the land. **What if we could modify the ship's exhaust emissions so that they contained CCN, but in an environmentally benign form, and only targeted where it would have a good chance of forming effective, reflective clouds?** This is theoretically possible and benchtop experiments indicate that this is in principle feasible.

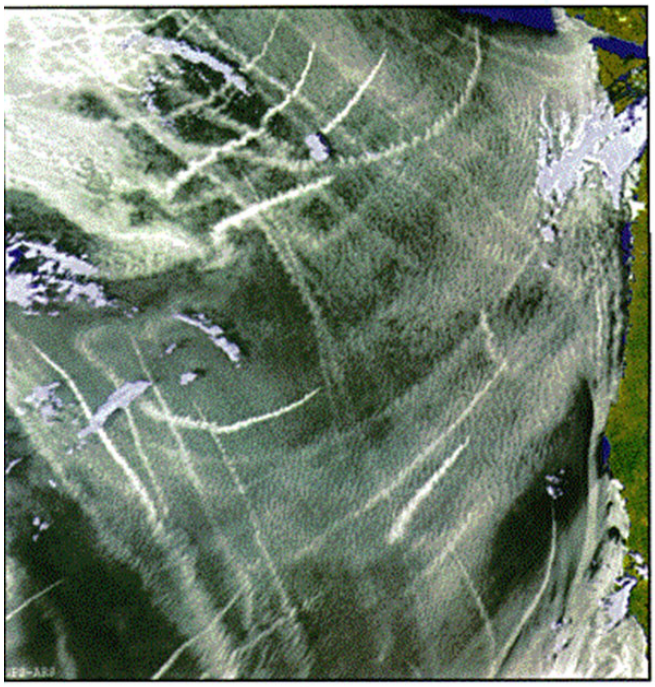

Figure 1: Ship tracks off the coast of Washington

We need to explore further the range of temperatures and salt concentrations to see if it can be matched to the practical ship engine exhaust conditions. What this means is running benchtop experiments with a burner (simulating engine exhaust), adding salt aerosols of different types and concentrations and temperatures, and measuring the resulting exhaust particle size distribution and composition to see if we are producing particles that would be effective as CCN. **That's your job.**