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# An Experimental Study of the Role of Surfactant Materials on Warm Cloud Formation in Laboratory

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## Introduction

Atmospheric aerosols are very important in the Earth climate system due to their role in climate of the Earth, scatter sunlight and serve as cloud condensation nuclei (CCN). However, there are still many unanswered questions about how the composition of the aerosol varies and how this composition affects the climate system. While aerosols contain a mix of organic and inorganic material, a sub-fraction of the organic material in atmospheric aerosols is surface active agent (surfactant).

Aerosol particles that act as cloud condensation nuclei cause changes in droplet number affecting the albedo and persistence of clouds (Lohmann and Feichter, 2005). Reduced surface tension, compared to that of pure water, has been demonstrated in bulk samples of atmospheric cloud and fog water (Facchini et al., 2000). The importance of surfactants in aerosol and cloud water has been recognized for many years (Gill et al., 1983).

## Materials and Methods

In this study, two different surfactants (Acetaldehyde, Stearic acid) solute in water were used to produce cloud condensation nuclei in a chamber (with the volume of 20 liters) to create warm cloud by an adiabatic expansion of nearly saturated moist air. The cloud concentration was also measured by the attenuation of a laser beam going through the cloud chamber. During cloud formation, the opacity of the chamber was changed, so that with the increase of cloud concentration less light reached the detector due to the scattering of laser light by cloud droplets. Temperature and humidity sensors are digitized using a computer with an Analogue to Digital convertor, with typical sampling time of 0.5 of second. Cloud concentration is determined by fluctuations in the laser signal. Experiments were performed for these two materials with five different concentrations (2.5, 5, 7.5, 10, 12.5 ppm) and the base state (with distilled water only) with 4 repetitions.

## Conclusion

The results showed that with increasing Stearic acid and Acetaldehyde concentration in water, the rate of droplets formation augments and the maximum cloud opacity was acquired in 7.5 ppm. Acetaldehyde had stronger effect than the Stearic acid on droplet formation. Lifetime for Stearic acid in all concentration was lower than the base state while for Acetaldehyde the minimum lifetime occurred for the first concentration and after that it trend to increase until the fifth concentration (12.5 ppm). Precipitation number was more than the base state for these two materials. Maximum precipitation number occurred for the third and first concentration for Stearic acid and Acetaldehyde.

**Keywords:** Cloud lifetime, Cloud opacity, Laboratory, Surfactant, Warm cloud.

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