A NEW TECHNIQUE FOR STUDYING AEROSOL-CLOUD INTERACTIONS IN MARINE STRATOCUMULUS

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1. Introduction

A cloud seeding experiment conducted offshore of Monterey, California in June 2006 aimed to study aerosol interaction with marine stratocumulus clouds. Instrument loaded Center for Interdisciplinary and Remotely Piloted Aircraft Studies (CIRPAS)'s Twin Otter Research Aircraft was used for cloud observations, while Weather Modification Inc. (WMI)'s Cheyenne-II aircraft was used for seeding purposes.

Fig. 1: Ice Crystal Engineering (ICE) hygroscopic flares mounted underneath the wing of Cheyenne II aircraft.

2. Procedure & Observations

On 28 June 2006 visible satellite imagery was used to select a solid cloud location for the experiment. A sounding in the area made before the seeding provided definition of the cloud and the boundary layer structure. After the initial inspection, seeding was done by the Cheyenne II producing two aerosol plumes in the cloud layer. After the seeding, Cheyenne II exited the area and the Twin Otter sampled the seeded cloud areas, making a total of 16 transects across the two plumes. The Twin Otter flight path during the observation period is shown in Fig. 2. Plume crossings with the Twin Otter were easily identified by a pronounced double-peaked increase in the PCASP aerosol concentrations compared with the background cloud values as shown in Fig. 3.

Table 1: Summary of instruments onboard CIRPAS's Twin Otter research aircraft.

Instrument	Characteristics
Passive Cavity Aerosol Spectrometer Probe (PCASP)	0.1 µm to 3 µm, 20 channel
Forward Scattering Spectrometer Probe (FSSP)	2.25 µm to 40 µm, 20 channel
Cloud Imaging Probe (CIP)	25 µm to 1500 µm, 62 channel
Met. Suit	Temp., Press., Wind, Humidity sensors.

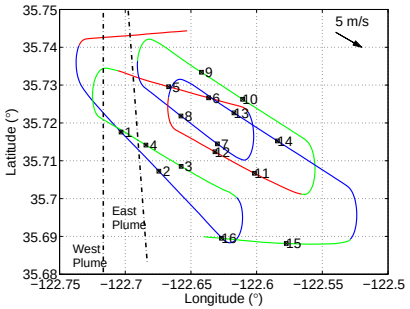

Fig. 2: Flight track of CIRPAS's Twin Otter during observation period. Numbers indicate plume crossings. Initial location of aerosol plumes is also shown. Colors are for clarity purpose only!

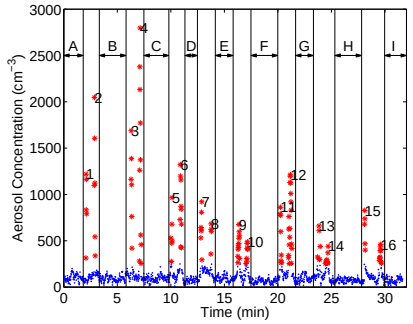

Fig. 3: Aerosol concentration during observation period. Numbers indicate plume transects while letters indicate background events.

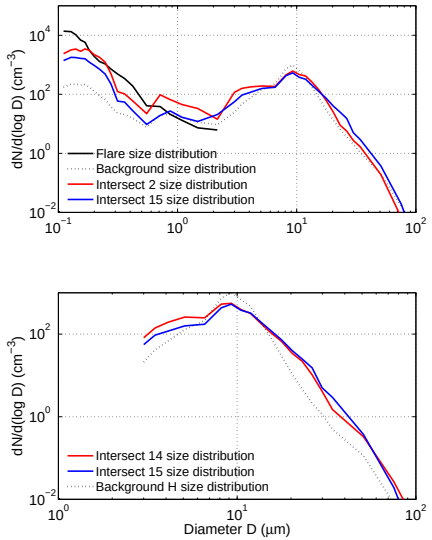

Fig. 4: Flare, transect 2, transect 15 & average background cloud size distribution (top) and transect 14, transect 15 & background H size distribution (bottom).

3. Results & Summary

Giant hygroscopic aerosols were introduced in a solid marine Stratocumulus cloud by burning hygroscopic flares creating two aerosol plumes within cloud layer. An increase in the cloud effective diameter (Fig. 5a) and DSD width (Fig. 5b) was observed in plumes compared to the background cloud. Also a 5-fold increase in the volume of large drops (20-40 µm) was observed 30 minutes later (Fig. 5d). The results point to the possibility of using controlled cloud seeding experiments at ARM observing facilities for studying aerosol-cloud interactions.

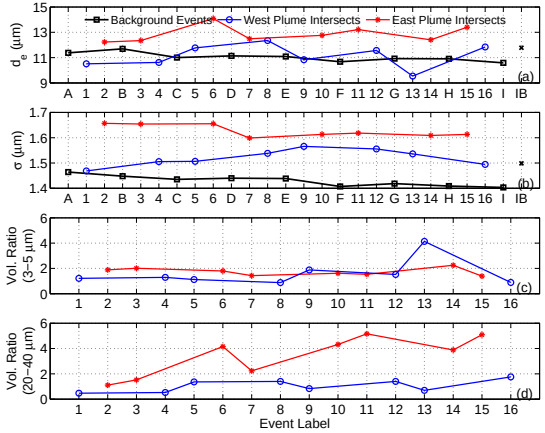

Fig. 5: (a) Cloud effective diameter (d_e); (b) Lognormal DSD width (σ) for all the events. (c) and (d) show the ratio of volume of drops in the plume to those in background for drops in the range (3 – 5 µm) and (20 – 40 µm) respectively. (x) in (a) & (b) show the average values for in-between (IB) plumes conditions.

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