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EPCAPE-Dalhousie Field Campaign Report

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Acronyms and Abbreviations

EPCAPE	Eastern Pacific Cloud Aerosol Precipitation Experiment
LWC	liquid water content

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1.0 Summary

This project supported the Eastern Pacific Cloud Aerosol Precipitation Experiment (EPCAPE), which aimed to characterize the extent, radiative properties, aerosol interactions, and precipitation of stratocumulus clouds in the Eastern Pacific coastal region of La Jolla, California. Given the frequent anthropogenic aerosols emitted into this region, characterization of this important coastal cloud region and the aerosol impact on the cloud characteristics will improve the understanding of aerosol indirect effects and its representation in global climate models.

This specific project deployed the fog droplet monitor (FM-120, Droplet Measurement Technologies) at the Scripps Institution of Oceanography's Mt. Soledad site from 16 February 2023 to 15 February 2024. This instrument measured droplet number size spectra between 2 and 50 microns, from which droplet number concentration, liquid water content, and effective diameter were calculated. These measurements will be used to characterize the seasonal variability of clouds at Mt. Soledad and investigate differences in cloud properties under regional polluted and clean marine conditions. The collected data will soon be posted as part of the digital collection for EPCAPE data hosted by the University of California, San Diego (Russell et al. 2023).

1.1 Results

Throughout EPCAPE, the fog droplet monitor collected continuous in situ measurements of droplet number size distribution from 2-50 microns at a time resolution of up to 1 Hz and subsequently averaged to 5 min. The instrument was situated on the roof of the Russell instrumentation van at Mt. Soledad, with an approximate elevation of 200 meters (above sea level), right next to the inlet of the ground-based counterflow virtual impactor deployed by Environment and Climate Change Canada (see Figure 1). Data were recorded on a laptop that was secured inside the instrumentation van. Over the 12 months of EPCAPE, the FM-120 operated for 86% of the study period and observed cloud conditions (droplet concentrations > 1 cm^{-3} and liquid water content > 0.05 g m^{-3}) approximately 4% of the time (a total of 306.9 hours over the entire study). Table 1 provides an overview of the monthly coverage and cloud occurrence.

Figure 1. Fog droplet monitor mounted behind the ground-based counterflow virtual impactor on the Mt. Soledad site during EPCAPE (photo credit John Liggio, Environment and Climate Change Canada).

Table 1. The hours of operation of the fog monitor and the hours of cloud observed throughout each month. Cloudy periods are defined to be when droplet concentrations > 1 cm^{-3} and liquid water content > 0.05 g m^{-3}.

Month	Hours of operation	Hours in cloud
February 2023	80.67	0.25
March 2023	665.8	35.8
April 2023	601.4	70.4
May 2023	591.8	15.9
June 2023	711.7	7.50
July 2023	735.6	77.3
August 2023	681.7	37.6
September 2023	705.3	7.50
October 2023	551.5	29.1
November 2023	711.6	9.92
December 2023	675.9	2.00
January 2024	438.6	9.58
February 2024	353.1	4.08

During fog/cloud events throughout the study, droplet concentrations peaked between 400-900 droplets/cm^3 and corresponding liquid water content peaked from 0.1- 1.76 g/m^3. The maximum effective diameter recorded during the study was 38 microns. As seen in Figure 2, seasonal shifts were observed in the number concentration, liquid water content, and effective diameter.

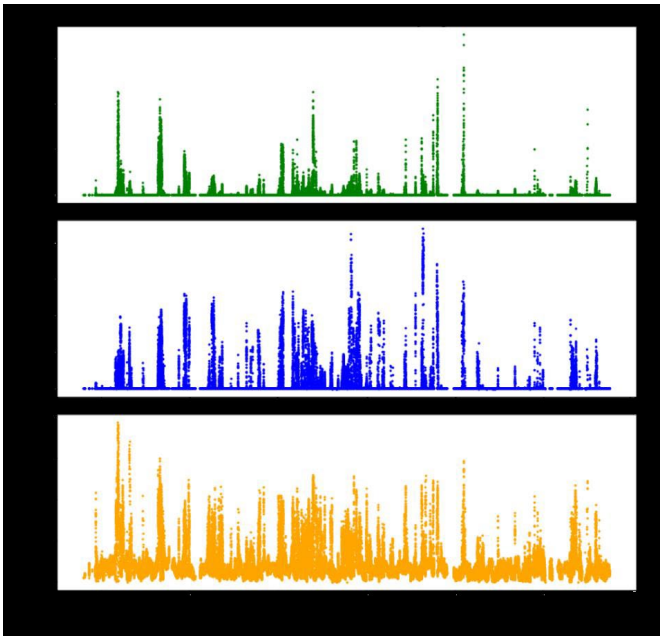

Figure 2. Liquid water content (LWC) (green), droplet number concentration (blue), and droplet effective diameter (orange) observed throughout the study.

The droplet size distribution observed at the Mt. Soledad site during EPCAPE were frequently bimodal, with peaks at approximately 5 and 22 microns. This bimodal droplet size distribution is frequently observed in surface fogs in the North Atlantic Ocean (Isaac et al. 2020, Fernando et al. 2021, Duplessis et al. 2021). It is expected that these observations will be linked to co-located aerosol measurements from the Mt. Soledad site to help constrain our understanding of aerosol-cloud interactions, specifically on how cloud properties vary with varying aerosol concentrations.

2.0 Publications and References

The fog droplet monitor data set will be added to the EPCAPE digital collection hosted at the University of California, San Diego.

2.1 Conference Presentations

Chang, R. 2024. "Understanding the role of aerosols in clouds and climate through in situ aerosol and droplet measurements." Presented at the Telluride Science and Research Conference Workshop Aerosols and Clouds: Connections from the Laboratory to the Field to the Globe, Telluride, Colorado, USA.

Robinson, L. 2024. "Cloud droplet microphysics observed in marine stratocumulus clouds in the San Diego region during spring and summer of 2023." Presented at the Atlantic Undergraduate Physics and Astronomy Conference, Sackville, New Brunswick, Canada.

2.2 References Cited

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Isaac, GA, T Bullock, J Beale, and S Beale. 2020. "Characterizing and Predicting Marine Fog Offshore Newfoundland and Labrador." *Weather and Forecasting* 35(2): 347–365, https://doi.org/10.1175/WAF-D-19-0085

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