5.4 OBSERVATIONS OF GIANT NUCLEI WITHIN THE ITCZ

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1. INTRODUCTION

The effect of giant aerosol particles in the development of warm rain in cumulus convection has recently been given renewed attention. The observations by Woodcock near Hawaii (1953) indicated the presence of large and giant particles in the clear air aerosol spectrum. Recent numerical efforts (Yin et al, 2000) indicate that large nuclei do not have a large effect on warm rain development in maritime clouds.

In the present study we report observations obtained in the Eastern Pacific Ocean, within the ITCZ. The measurements were obtained during the field campaign of EPIC2001 (East Pacific Investigation of Climate).

2. MEASUREMENTS AND METHODOLOGY

Two aircraft (NCAR-C1310 and NOAA WP-3D) and two ships (NOAA R. Brown and NSF New Horizon) participated in the project, which lasted for 6 weeks from 1 September to 15 October 2001. In this study we concentrate on the measurements obtained by the C-130, which flew two main fight patterns. One pattern involved sampling developing convection in the region of the ITCZ determined by 8-12 ^{0}N and 93-97 ^{0}W. The other pattern was designed to determine the boundary layer structure along 95 ^{0}W from 12 ^{0}N to the Equator. Both patterns included low level flights at 30m above the surface, which have been analyzed for this study, a total of 13 research missions.

The C-130 carried 3 optical spectrometers to determine aerosol and droplet size distributions: a -PCASP (between 0.1 and 3.0 μm), an FSSP-300 (between 0.3 and 14 μm for index of refraction of water) and an FSSP-100 (between 2 and 50 μm), all manufactured by PMS. The spectra from these probes were obtained at 1Hz. A TSI 3010 CN counter (1 Hz) and a CCN counter (University of Wyoming) were also available. One CCN spectrum was obtained every 4-5 minutes, and were only determined during level portions of the flights. We have rejected in the analysis any 1 Hz sample that contained precipitation particles, as determined by the 260X, to concentrate on clear air aerosols at 30m above the surface.

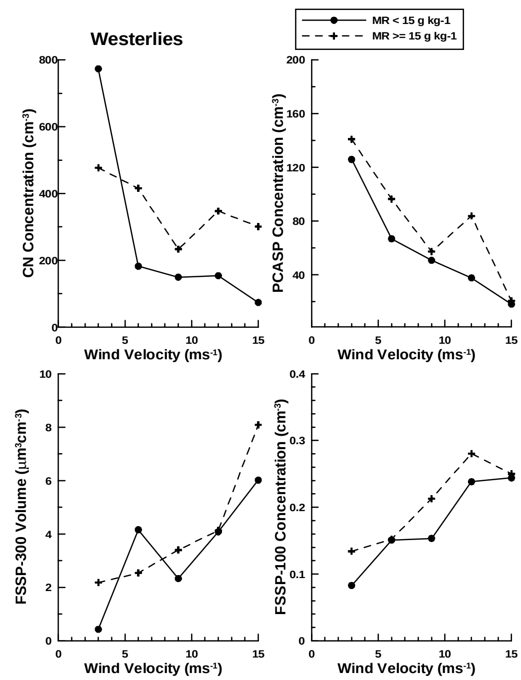

Figure 1. Average concentrations as a function of wind speed for the case of westerly winds. Top left panel: CN concentrations; top right panel: PCASP number conc.; lower left panel: FSSP-300 volume conc. and lower right panel: FSSP-100 number conc.

The data wasdivided as a function of the water vapor mixing ratio, which has a clear gradient from the ITCZ region (values of about 18-20 g/kg) to the Equator (about 10-11 g/kg). Values larger than 15 g/kg correspond generally to the ITCZ region, and we use that threshold to stratify the data. Furthermore, the data was separated into westerlies and easterlies. This was done to compare maritime aerosol spectra with those potentially influenced by continental or anthropogenic aerosol from Central America or Southern Mexico.

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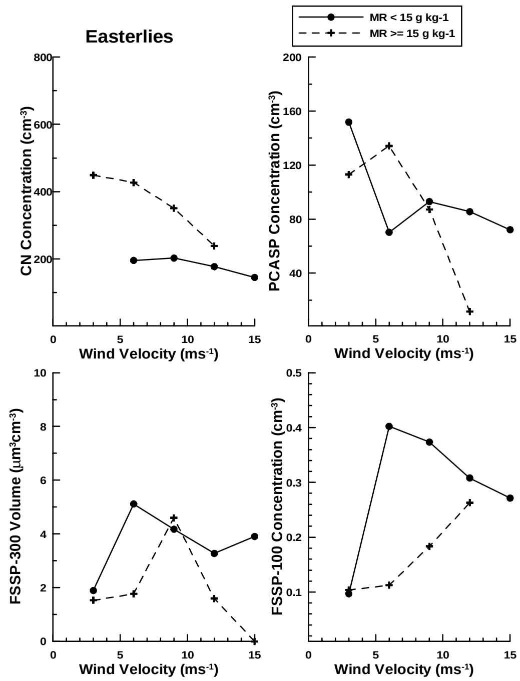

Figure 2. Same as Figure 1, but for easterly winds.

3. RESULTS AND DISCUSSION

Figures 1 and 2 present the results as a function of wind speeds for easterlies and westerlies, respectively. The panels correspond to a) CN conc., b) PCASP number conc., c) FSSP-300 volume conc.n and d) FSSP-100 number conc. The dashed curve corresponds roughly to the ITCZ region (where water vapor mixing ratio is larger than 15 g/kg), while the solid curve indicates the region with more stratiform convection over the cooler sea surface. The CN concentration shows a decrease with increasing wind speeds, for both regions and both wind sectors. The ITZC region has larger concentrations for both wind sectors, by up to a factor of 2-3. Average CN present the lowest concentrations for strong westerlies in the Southern (dryer) region. The patterns observed for the PCASP concentration are somewhat more complicated. In the case of westerlies, we also observe a decrease in concentration with increasing wind speed. Very low and quite similar concentrations are observed within and outside the ITCZ in the case of strong westerlies. For easterlies, while there is a general decrease in concentration with increasing wind speed outside the ITCZ, within it the maximum concentration is observed for 6 m/s, which corresponds to moderate wind conditions. In the case of westerly winds, the FSSP-300 volume concentration shows a clear increase with increasing wind speeds, as does the FSSP-100 concentration, both within and outside the ITCZ. This is the expected pattern, if the aerosol concentration were due primarily to mechanical processes, associated with wave breaking in strong wind conditions. Both CN and PCASP concentrations show opposing behavior to the FSSP conc.. This would seem to indicate that the concentration of smaller particles is the result of a balance between sources and sinks that differs from the one for larger particles.

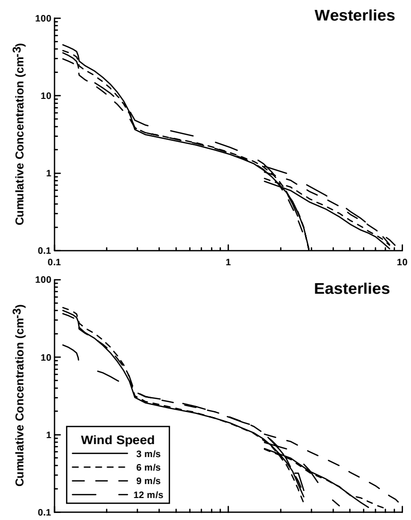

Figure 3. Cumulative size distributions combining PCASP and FSSP-300 data for westerlies (top panel) and easterlies (bottom panel), as functions of wind speed.

In Figure 3, while there are no significant differences between the spectra for low wind conditions, there is a systematic increase in the concentration of large particles with stronger winds. Note that the concentrations for moderate to strong winds are about 1 per cc, for 2 µm particles. This is roughly 2 orders of magnitude larger than the values used in the recent modeling efforts (Yin et al, 2000).

4. ACKNOWLEDGEMENTS
The authors acknowledge the efforts of the large number of people that made possible the project from NSF, NCAR and NOAA. Partial support for this study was provided by grant 33319 from Conacyt .

5. REFERENCES
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