A New Technique for Studying Aerosol-Cloud Interactions in Marine Stratocumulus

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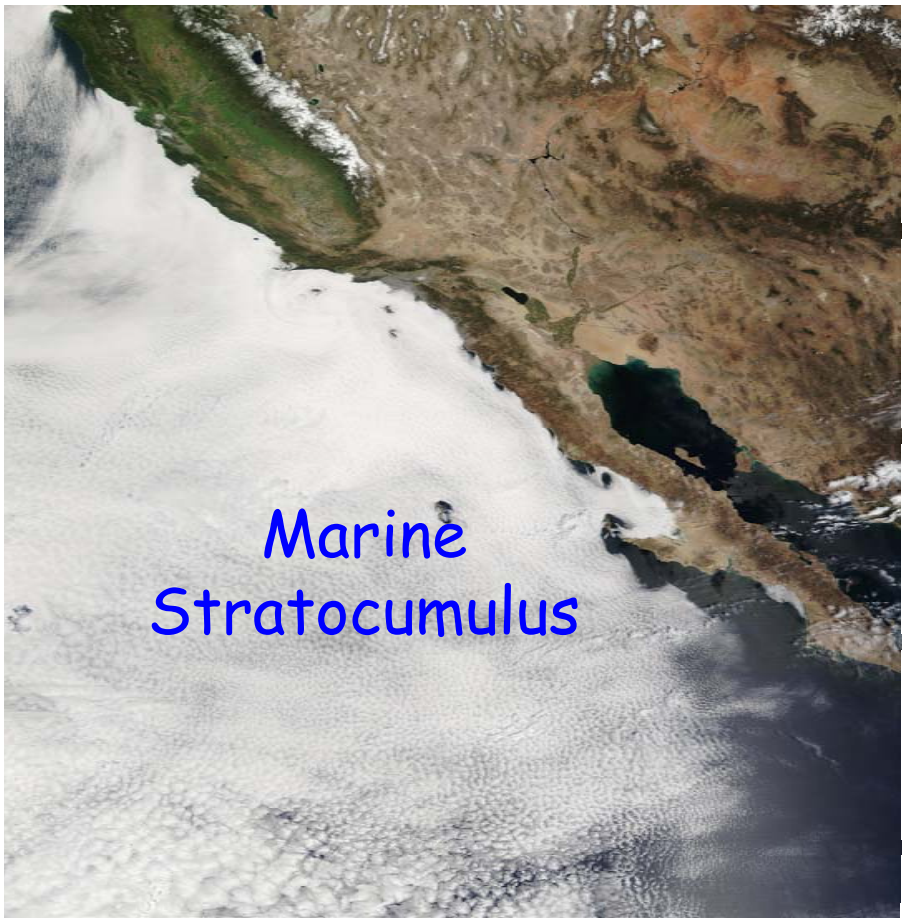
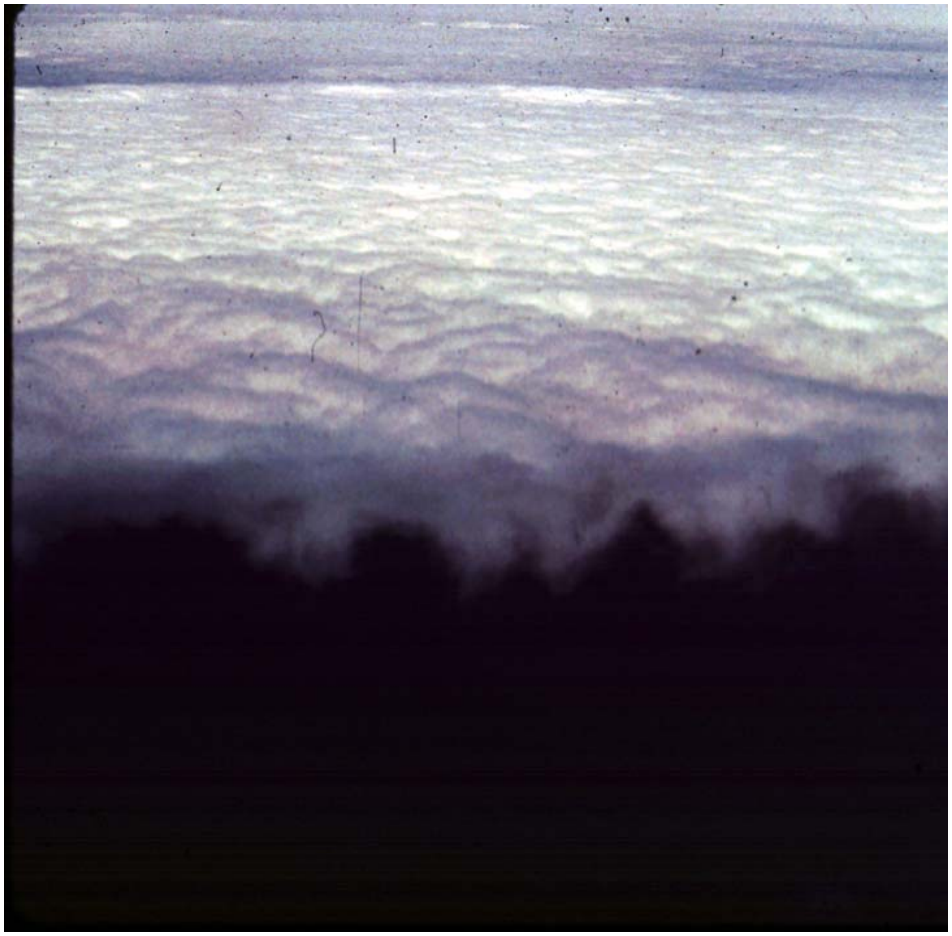
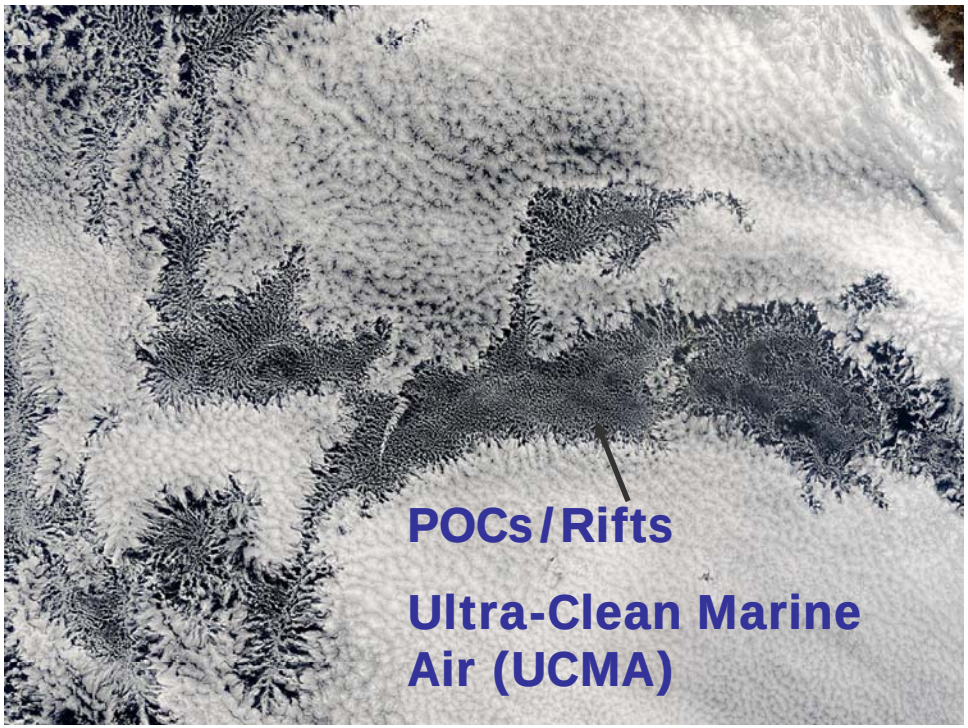
Marine Stratocumulus — Natural laboratory for cloud microphysical studies





Marine Stratocumulus Features Show Clear Evidence for Aerosol-Cloud Interactions

Nature's Way

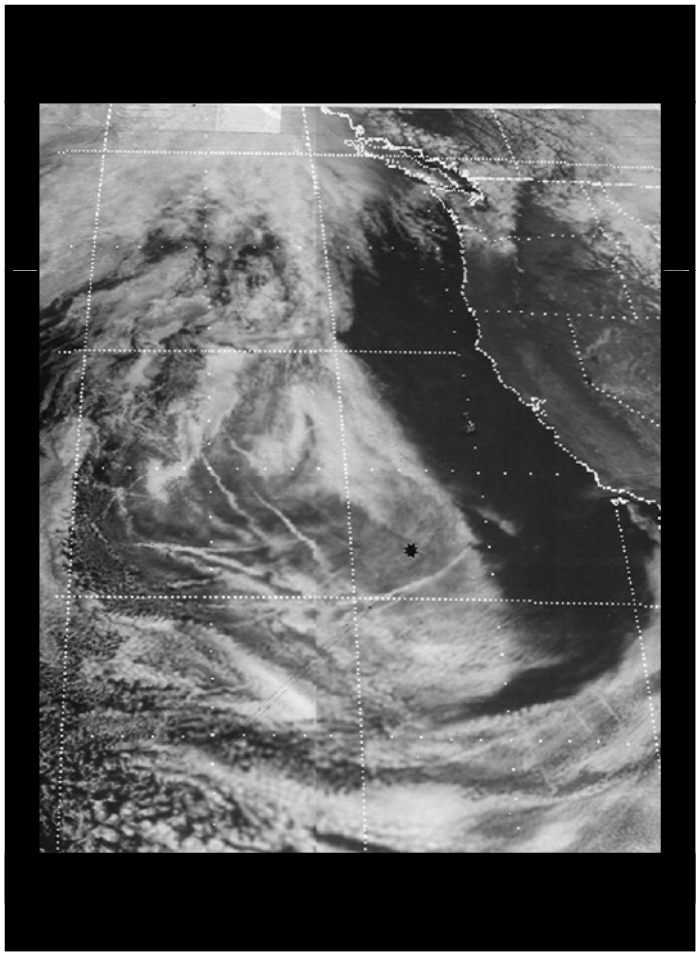


Stevens et al. (2005)
Sharon et al. (2006)

Man's Way

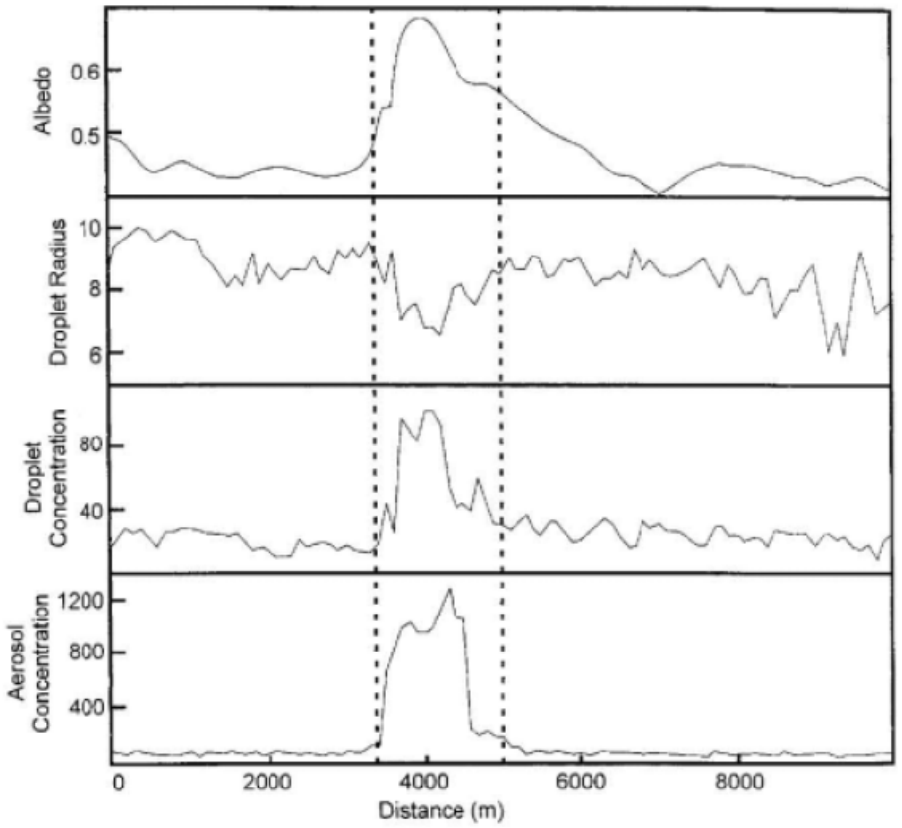
Durkee et al. (2000)

Reactive/Inadvertent Probing --Ship Tracks



Aircraft Observations

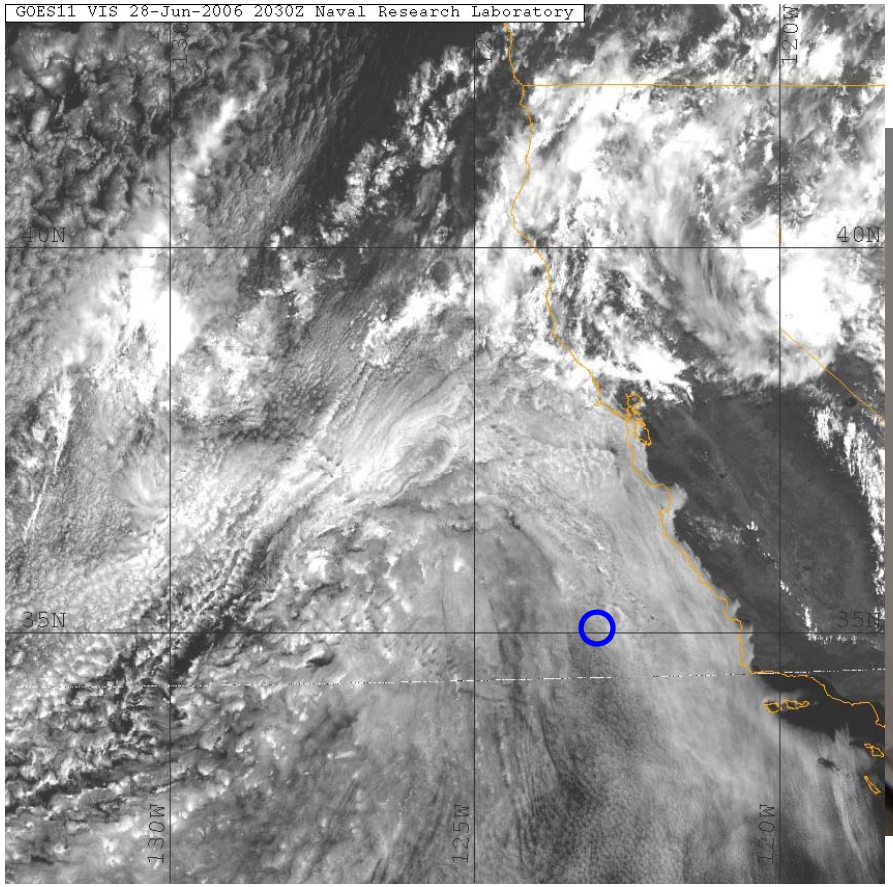
Ship Track



Durkee et al., 2000

Proactive Probing — Cloud Seeding

Purpose: Study response of cloud microphysics to artificial introduction of giant CCN

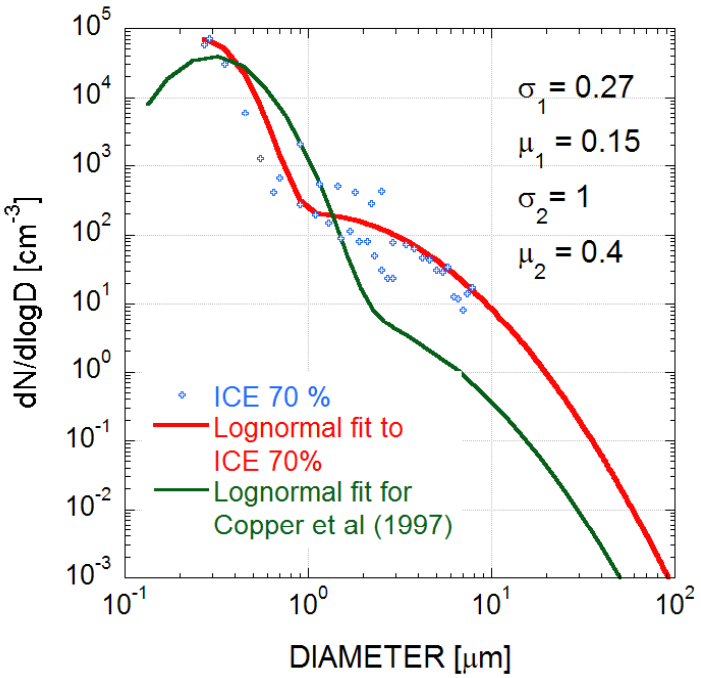


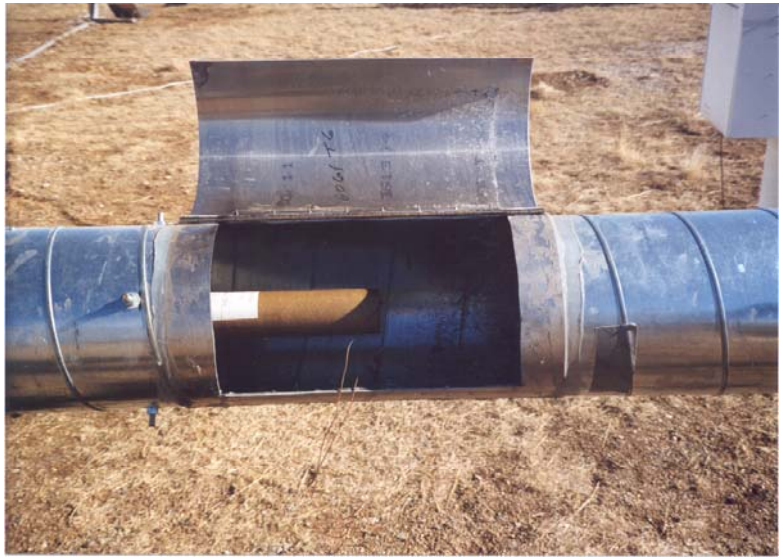
Hygroscopic Cloud Seeding Flares

Ice Crystal Engineering (ICE) 70%

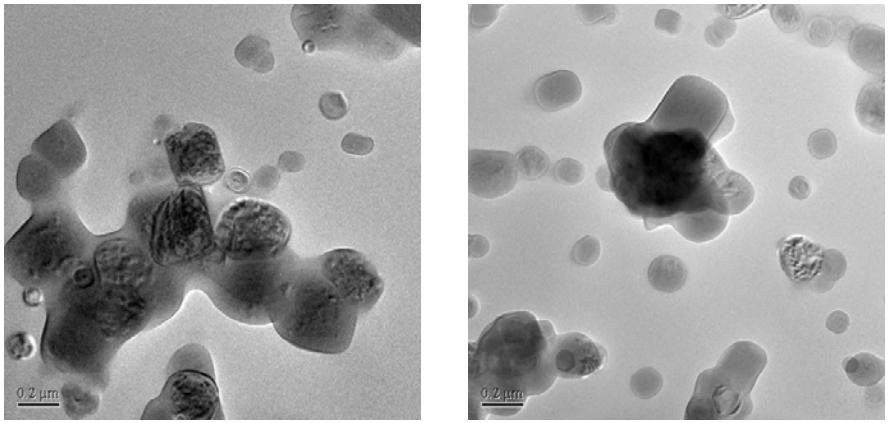
Magnesium/potassium perchlorate

(Bruintjes et al., 2006)



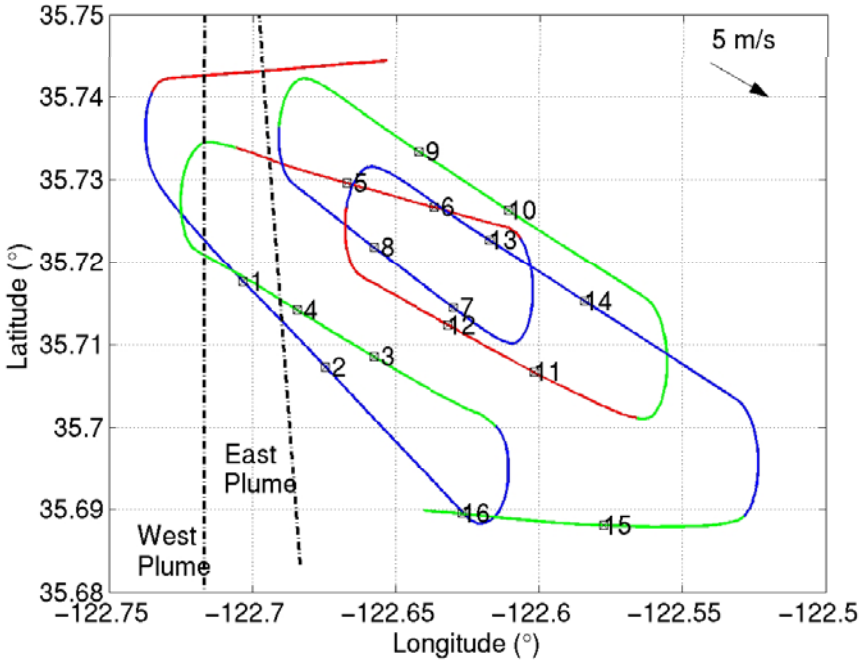


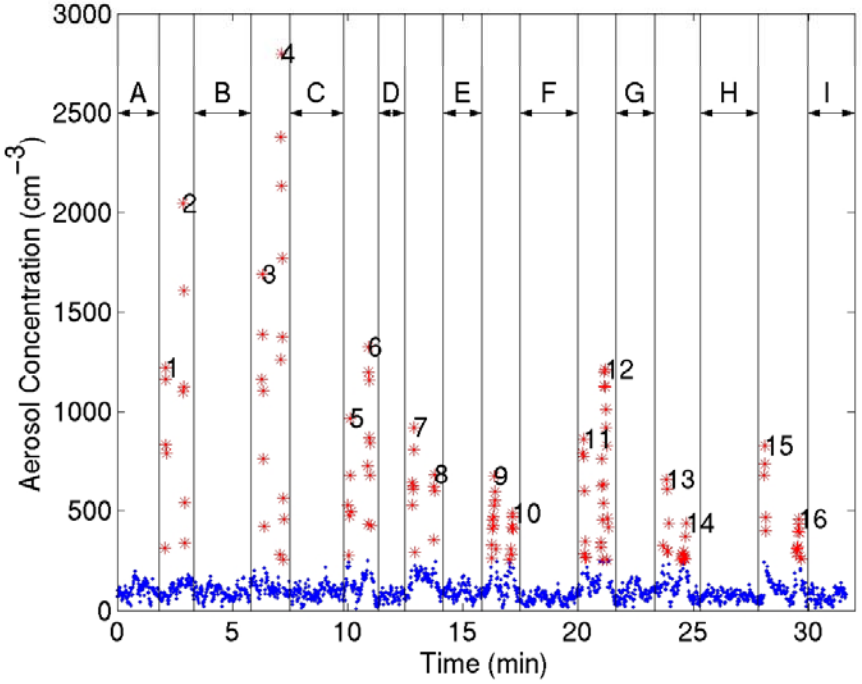
Flare Test Facility



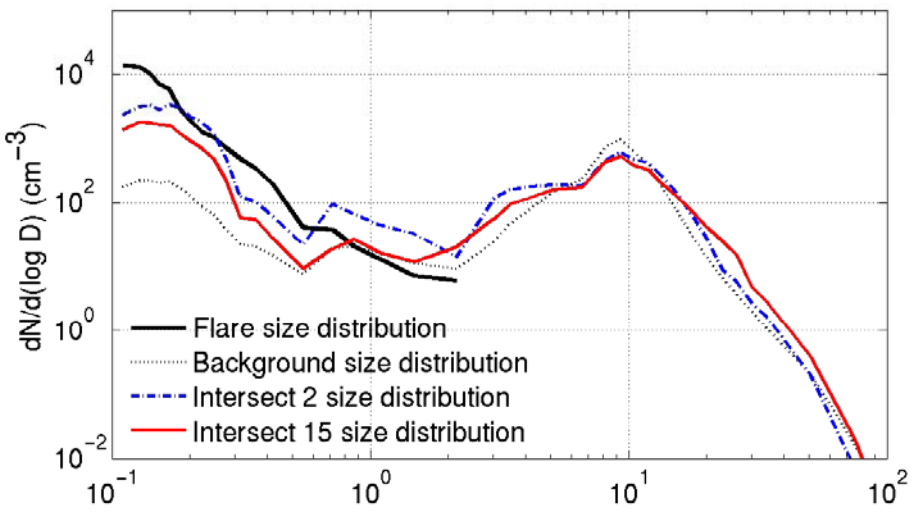
TEM images of salt aggregates

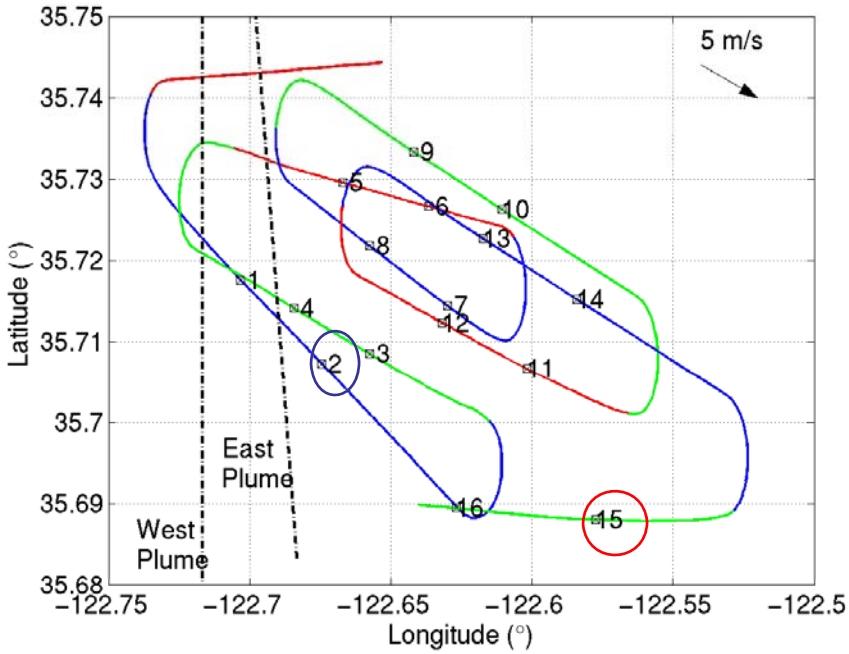
PCASP	0.1-3 µm
FSSP	2.25-40 µm
CIP	25-1500 µm
Met. Suit	T, RH, U etc.

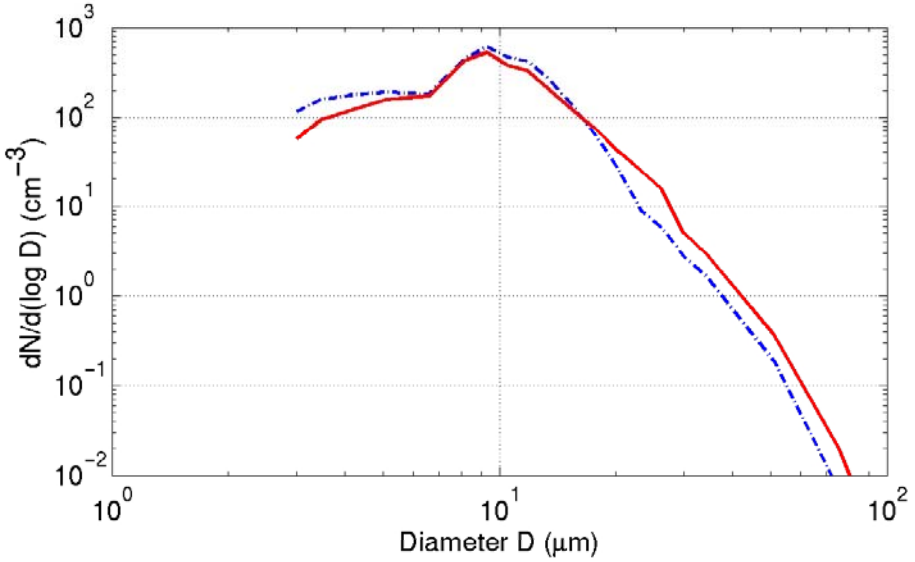


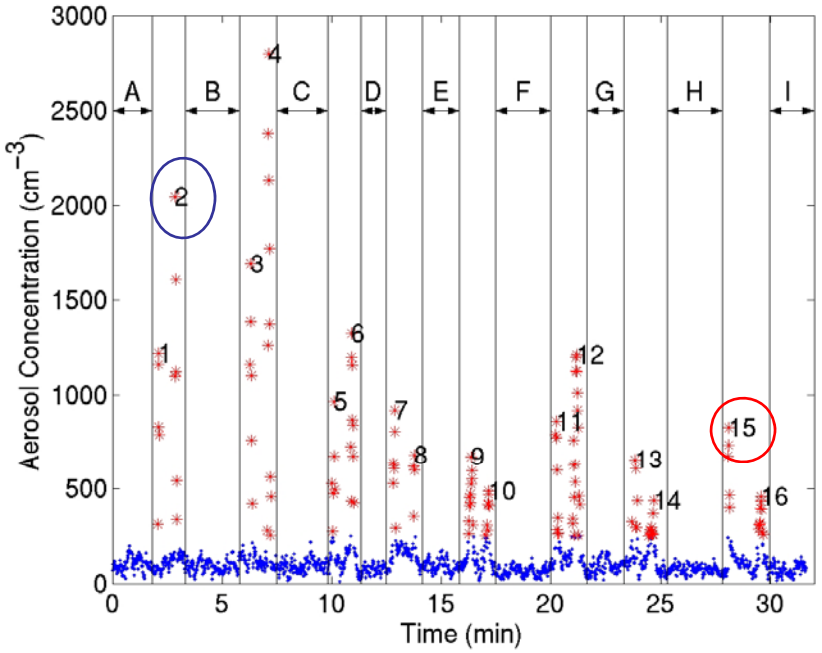


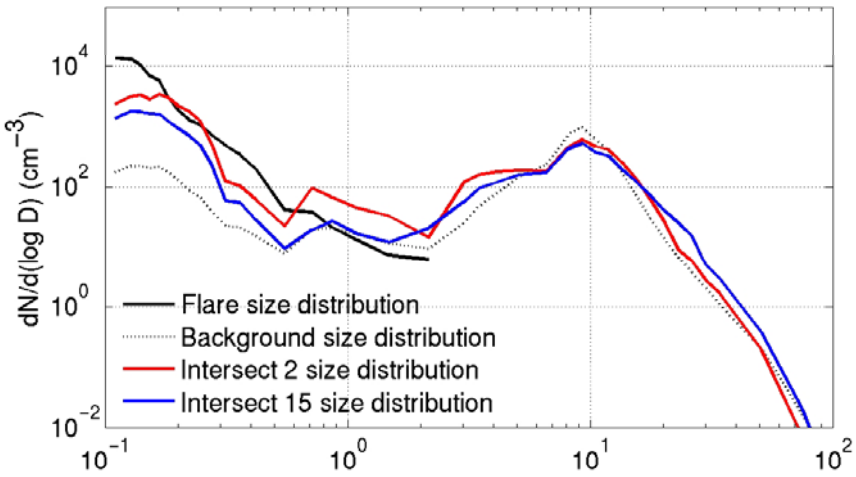
- 200 m thick cloud.
- In cloud flare burn in near North-South direction.
- Total of 16 transects across the two plumes.

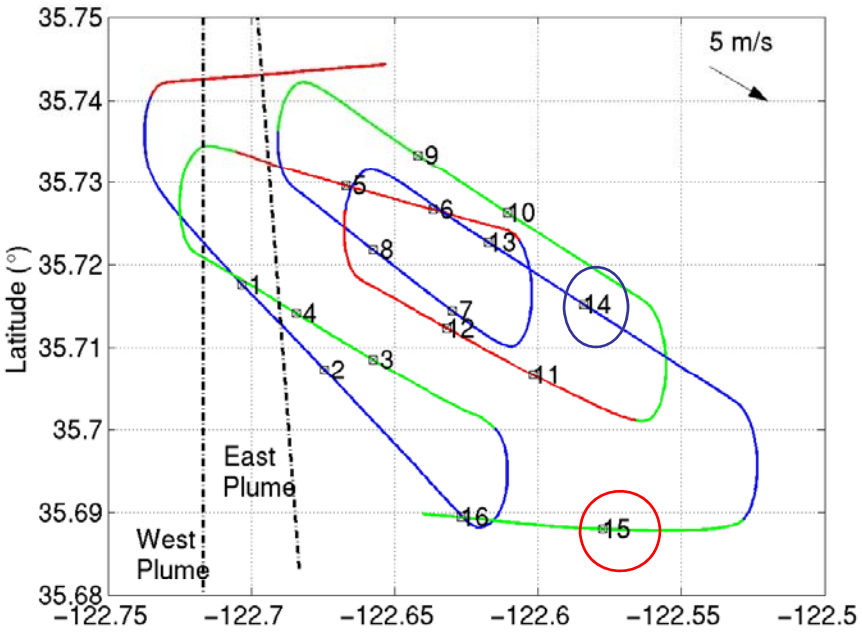

dN/d(log D) (cm^{-3})
Flare size distribution
Background size distribution
Intersect 2 size distribution
Intersect 15 size distribution

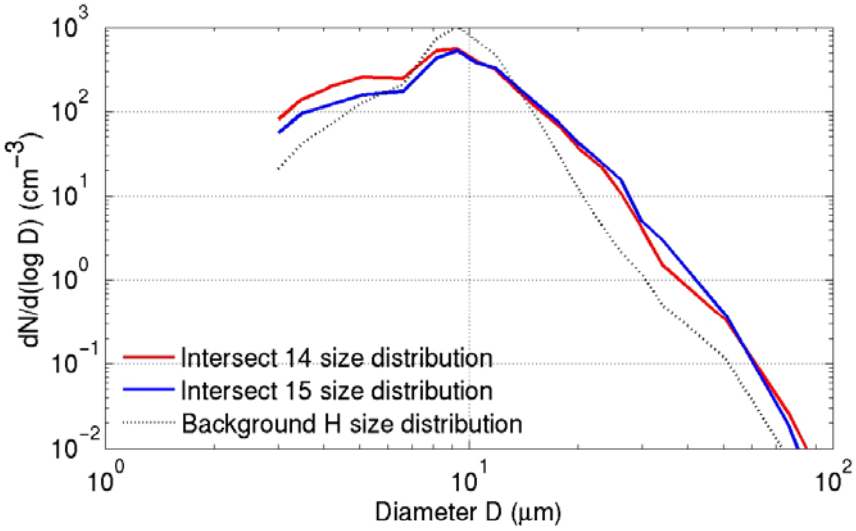

5 m/s
Latitude (°)
Longitude (°)
East Plume
West Plume

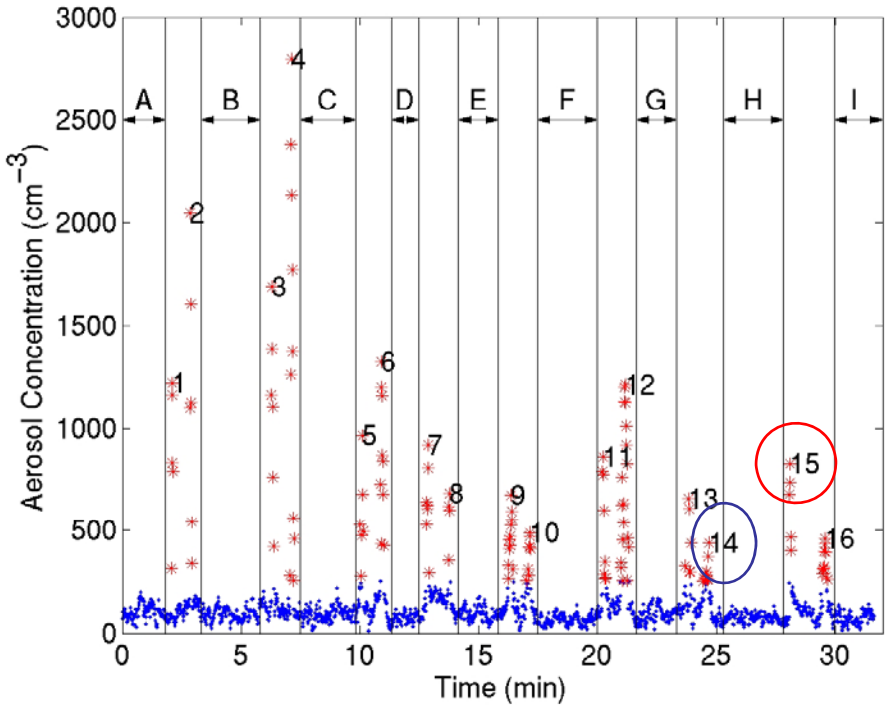

dN/d(log D) (cm^{-3})
Diameter D (μm)


A
B
C
D
E
F
G
H
I
Aerosol Concentration (cm^{-3})
Time (min)

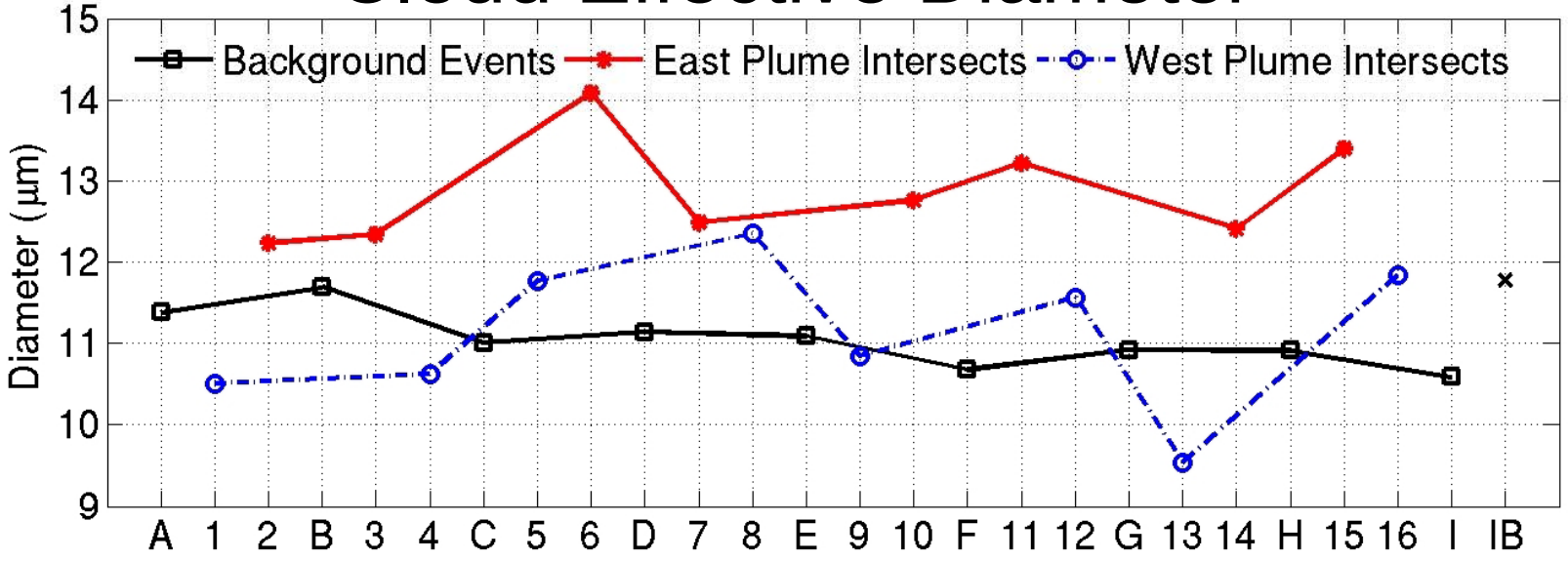

dN/d(log D) (cm^{-3})
Flare size distribution
Background size distribution
Intersect 2 size distribution
Intersect 15 size distribution


5 m/s
Latitude (°)
East Plume
West Plume

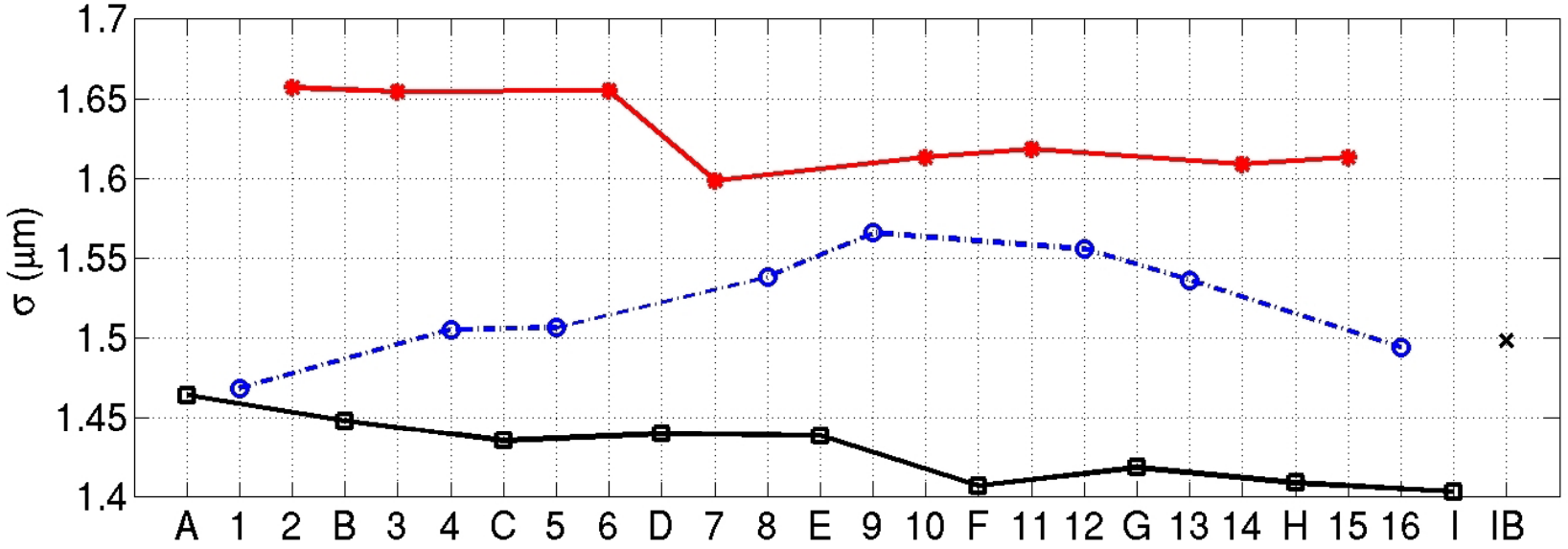

dN/d(log D) (cm^{-3})
Intersect 14 size distribution
Intersect 15 size distribution
Background H size distribution
Diameter D (µm)


Aerosol Concentration (cm^{-3})
A
B
C
D
E
F
G
H
I
Time (min)

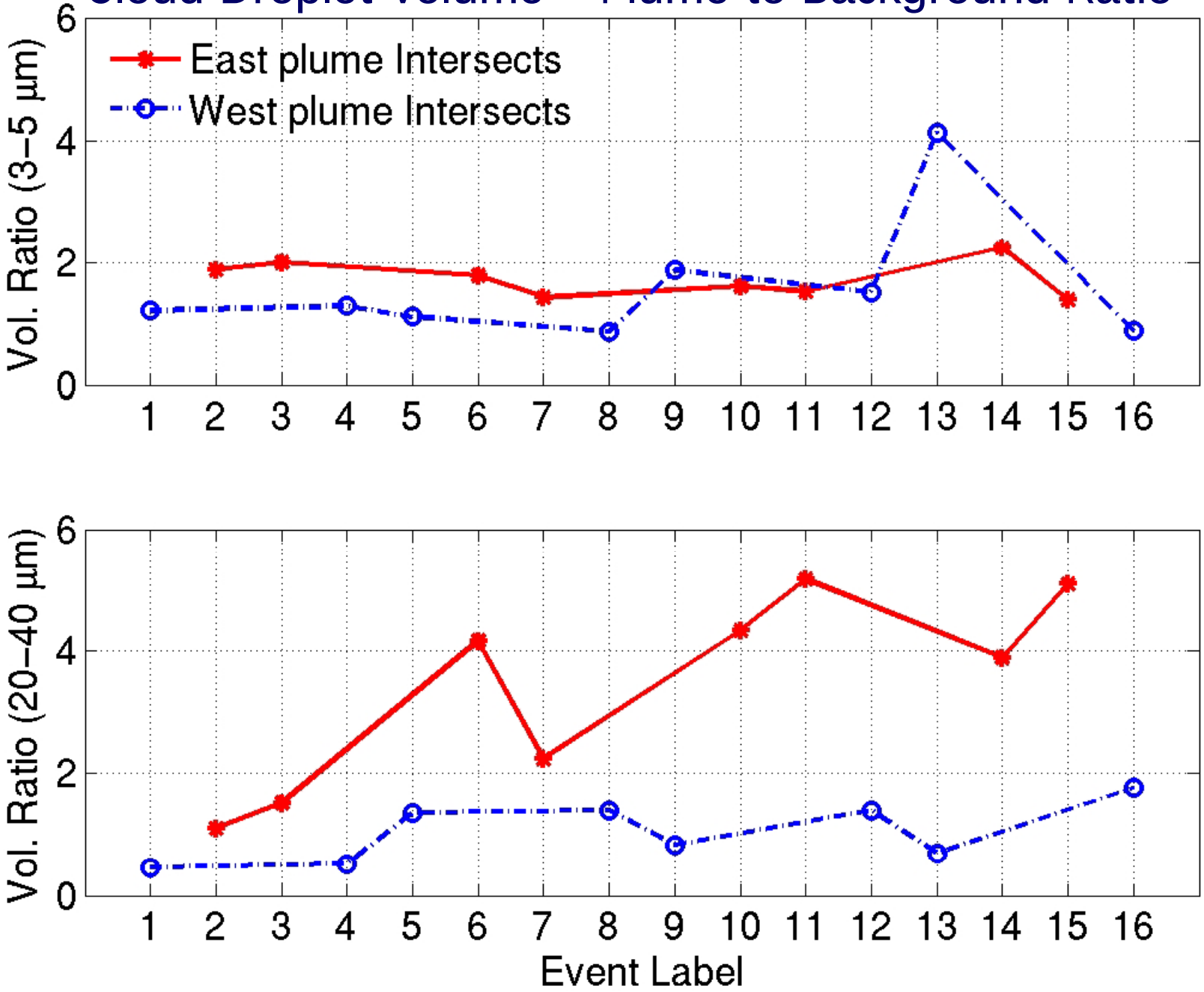
Cloud Effective Diameter



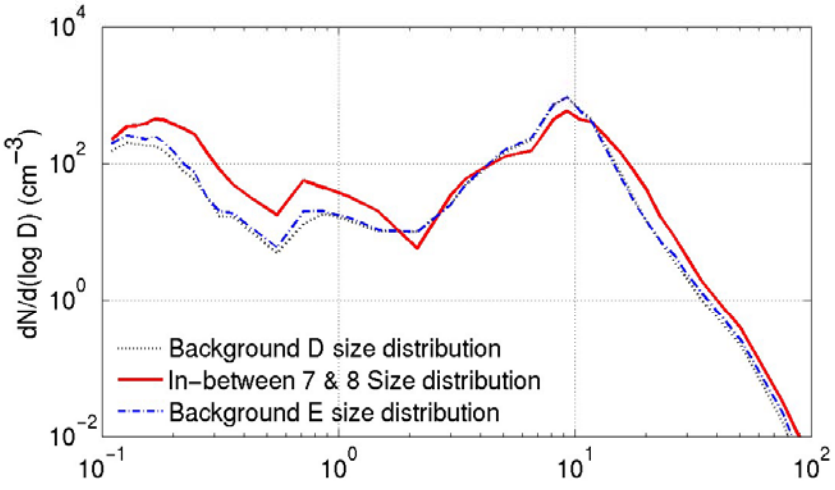
Lognormal DSD width

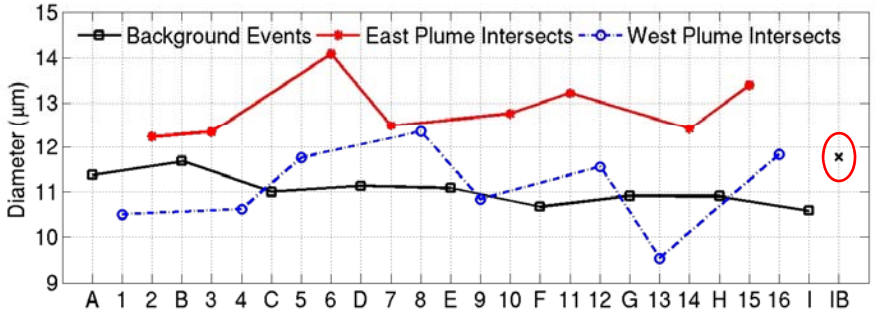


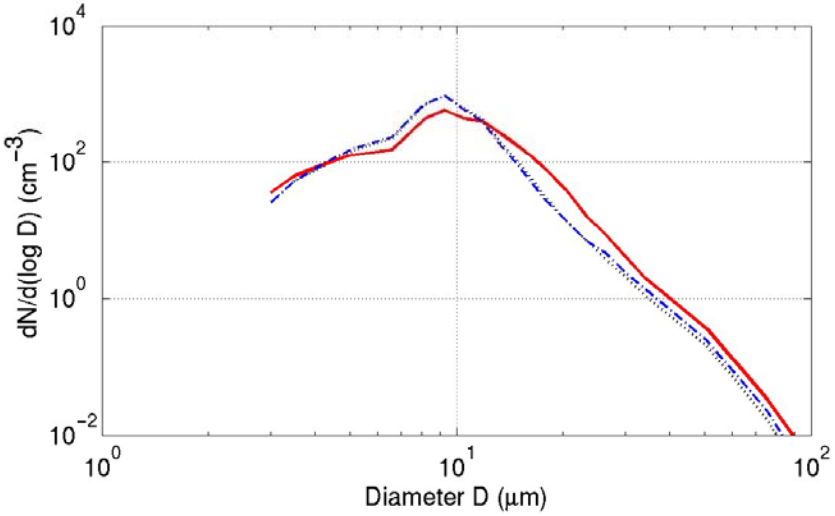
Cloud Droplet Volume – Plume to Background Ratio

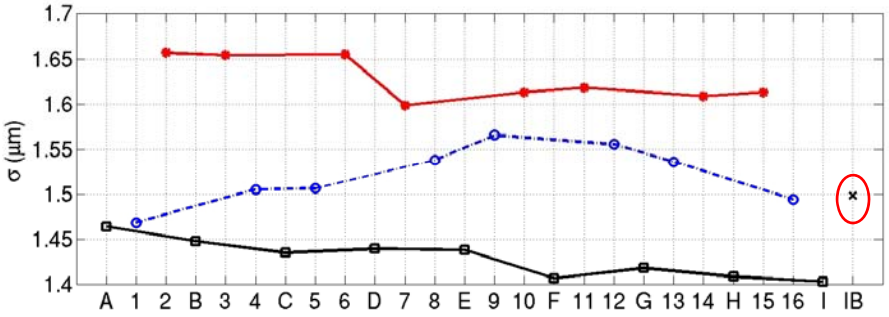


Between plume cloud response









Summary and Conclusions

- Feasibility demonstrated
  - Marine stratocumulus provide stable background
  - Small (cloud-inactive) aerosols produced by flares make useful tracers
  - Clear evidence of broadening of the cloud droplet distribution by condensational growth and collision and coalescence processes
- Potential for future studies
  - Model evaluations of microphysical responses to aerosol forcing
  - Controlled cloud seeding experiments at ARM observing facilities.