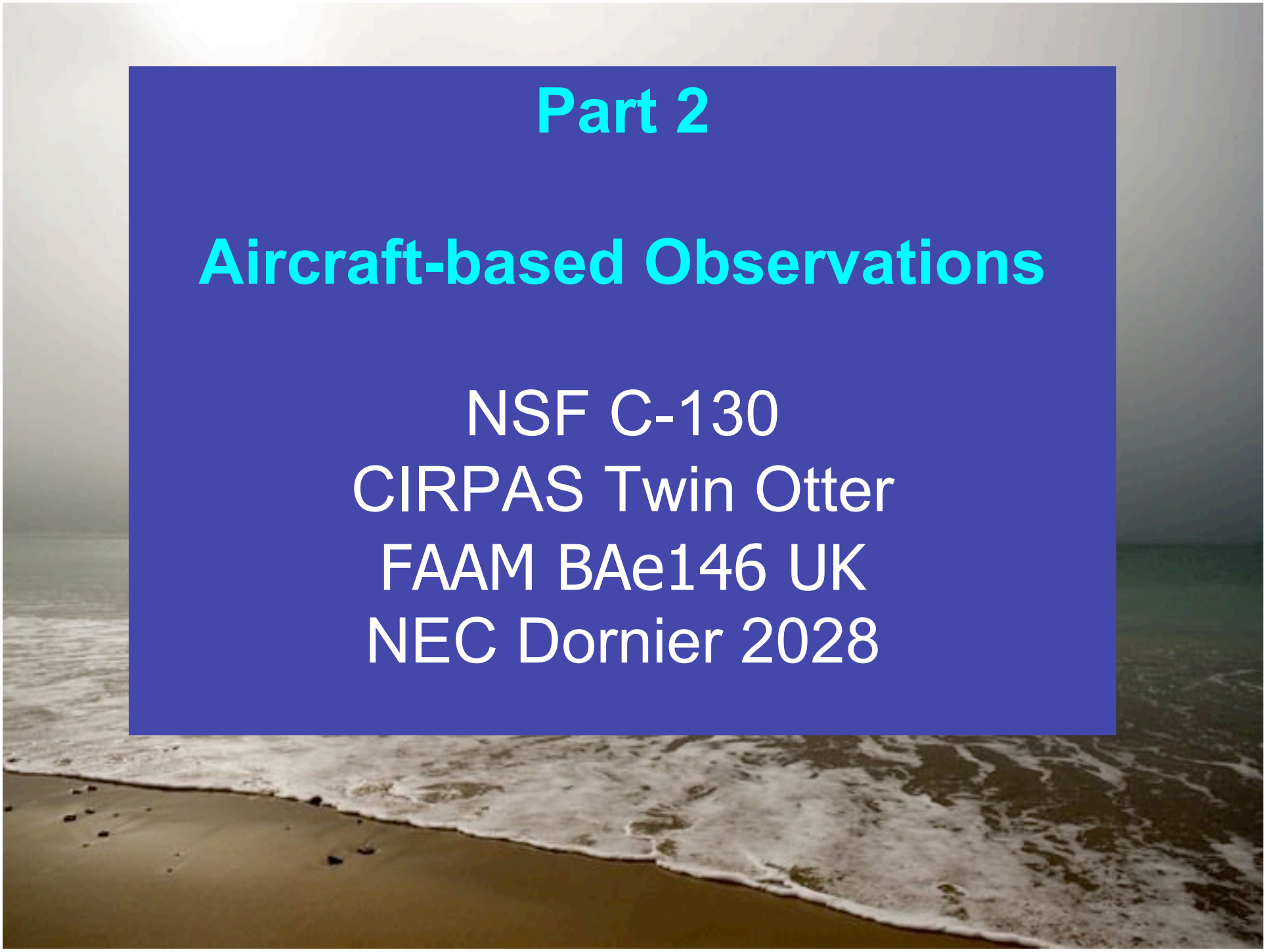


Part 2

Aircraft-based Observations

NSF C-130
CIRPAS Twin Otter
FAAM BAe146 UK
NEC Dornier 2028

NSF C-130 Platform Report

Robert Wood

MISSIONS

(a) 20°S Cross-Sections [4 full missions+5 partial missions]

- to characterize structure of MBL, aerosols, clouds along the 20°S parallel from 72-85°W
- collaborative (RHB, BAe-146, Do-228, G-1)

(b) POC Drift missions [5 missions including 1 POC Lagrangian with BAe-146]

- investigate structure of boundary between closed and open cellular stratocumulus

(c) Pollution Surveys [2 missions total]

- coast-parallel surveys to 30°S to study how pollutants are transported into the MBL

INSTRUMENTS

RAF instruments:

Microphysics, Turbulence, Thermodynamics suite, Radiation

Special Remote sensing:

Wyoming Cloud Radar (zenith+nadir+slant), Cloud Lidar (zenith), Microwave radiometer (GVR, 183 GHz, zenith)

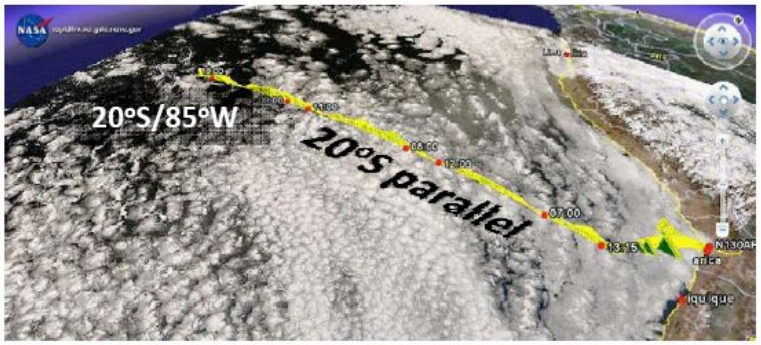
Special Chemistry/aerosols/clouds:

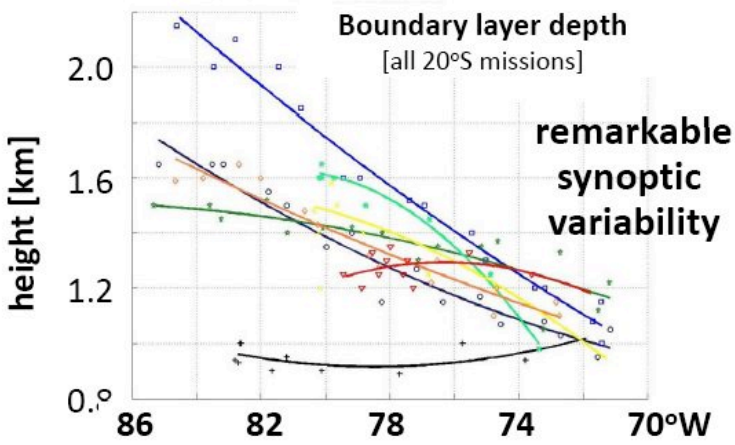
CCN, CVI, Streakers, Giant CCN, Special CN counters (+ultrafine), LDMA, RDMA, Aerosol Mass Spec, volatility, nephelometer, SP2/PSAP, DMS/SO_2,Cloud water collector, CO/O_3, fast FSSP

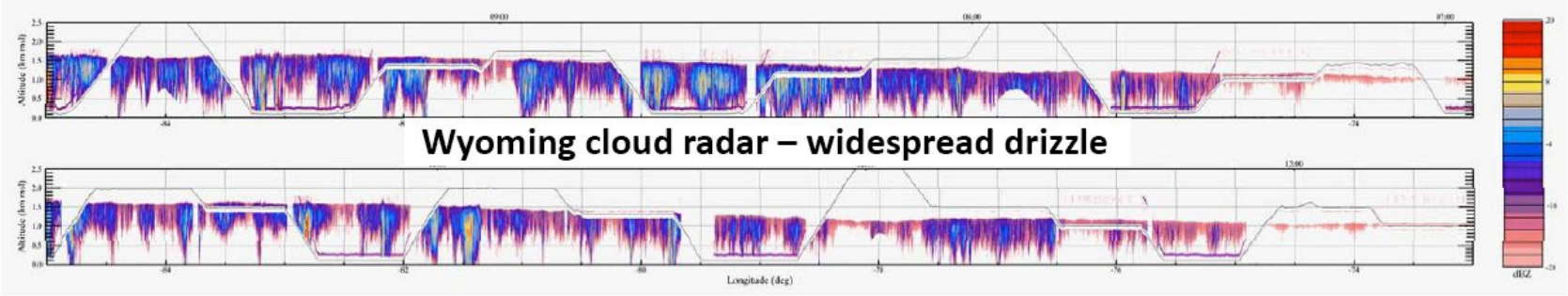
NSF C-130 Payload

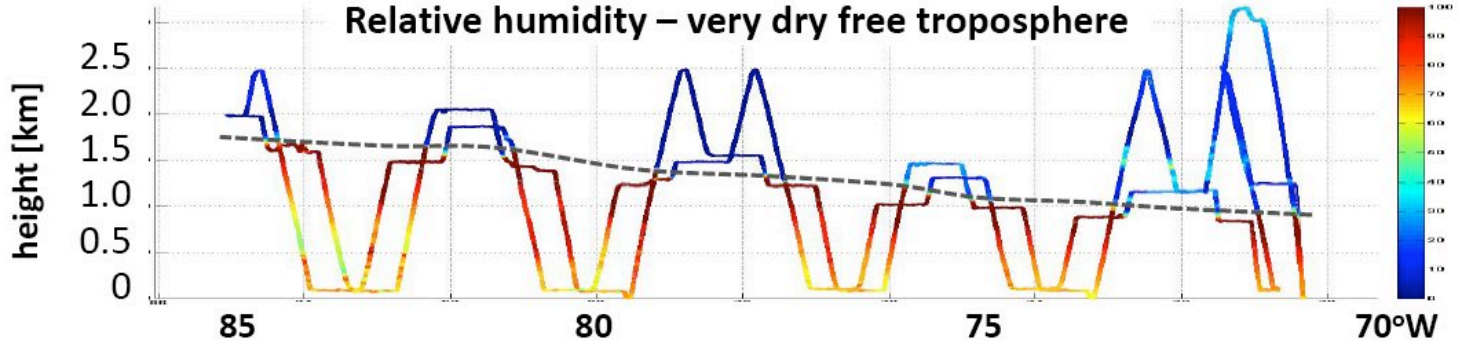
- **RAF instruments**: Microphysics, Turbulence, Thermodynamics suite, Radiation
- **Special Remote sensing**: Wyoming Cloud Radar (zenith+nadir+slant), Cloud Lidar (zenith), Microwave radiometer (GVR, 183 GHz, zenith)
- **Special Chemistry/aerosols/clouds**: CCN, CVI, Streakers, Giant CCN, Special CN counters (+ultrafine), LDMA, RDMA, Aerosol Mass Spec, volatility, nephelometer, SP2/PSAP, DMS/SO_2,Cloud water collector, CO/O_3, fast FSSP.

20°S Missions





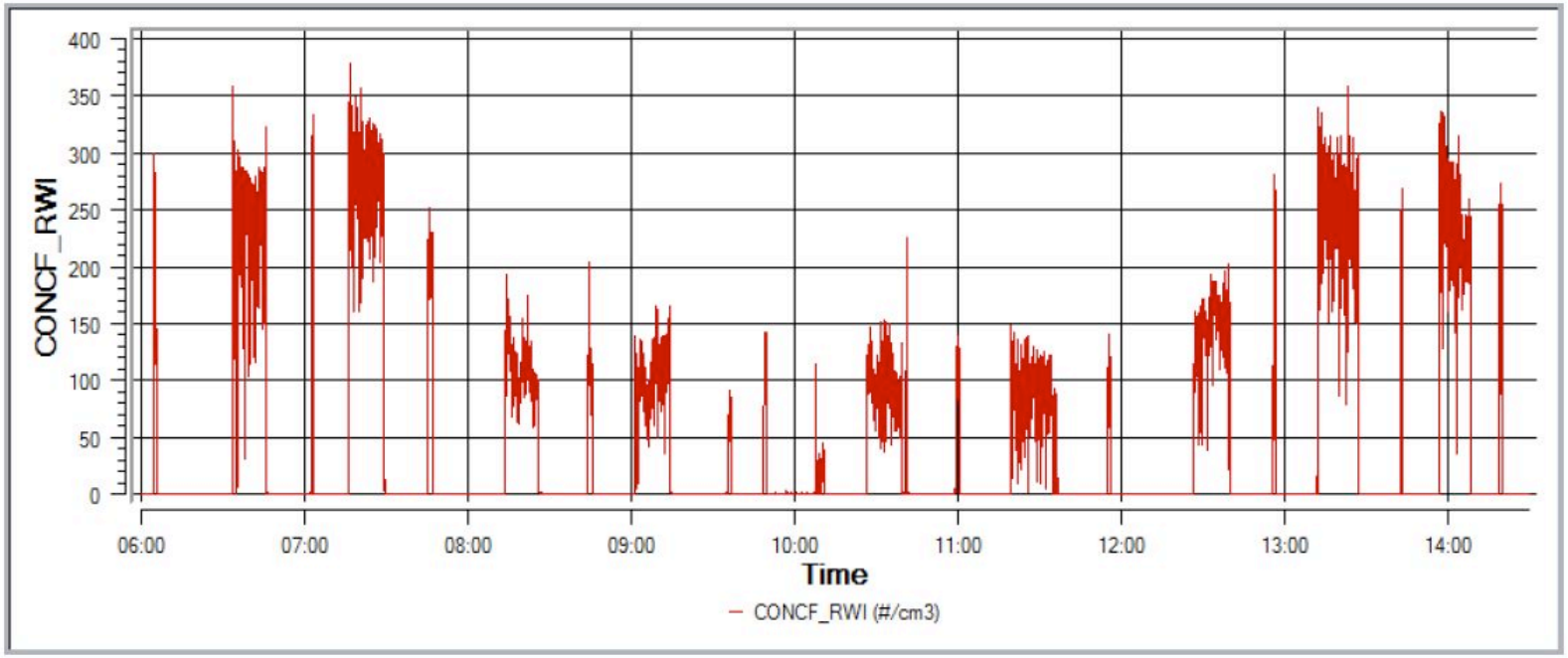


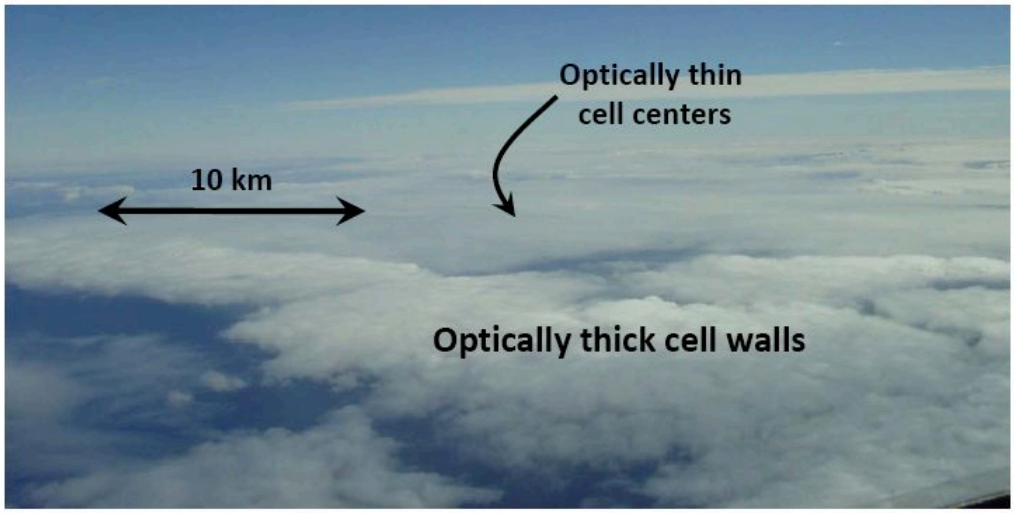


RF03 Cloud droplet number concentration

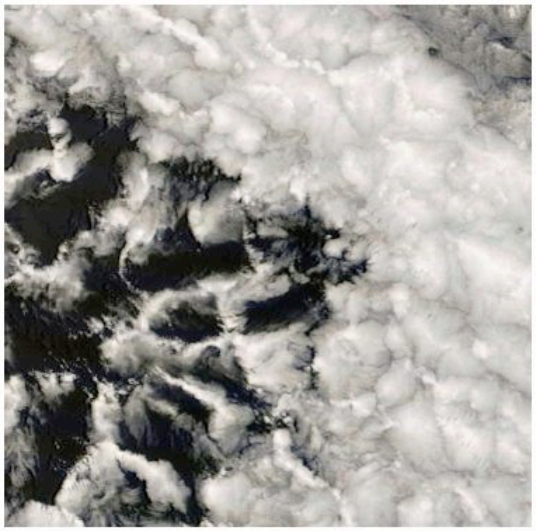
Transition from Polluted to Clean Clouds and Back

70°W **85°W** **70°W**

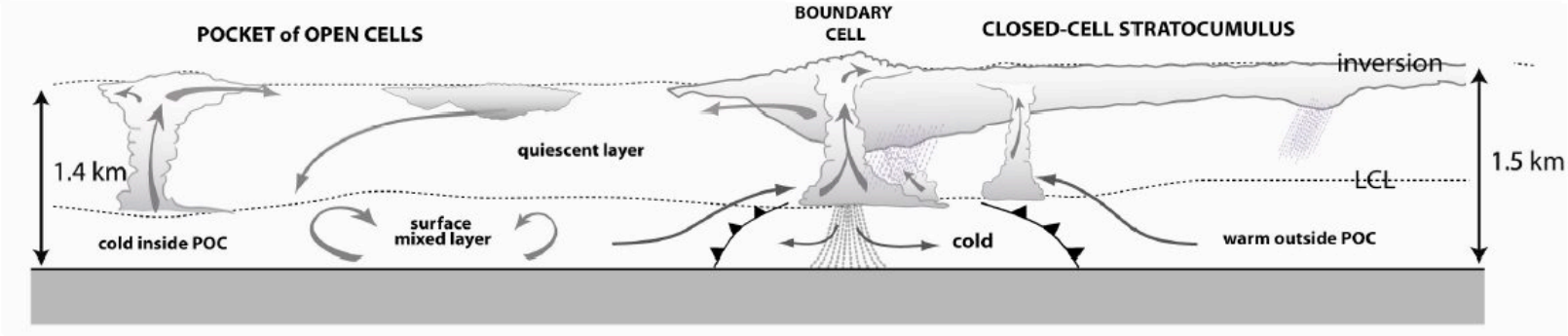




POC Missions

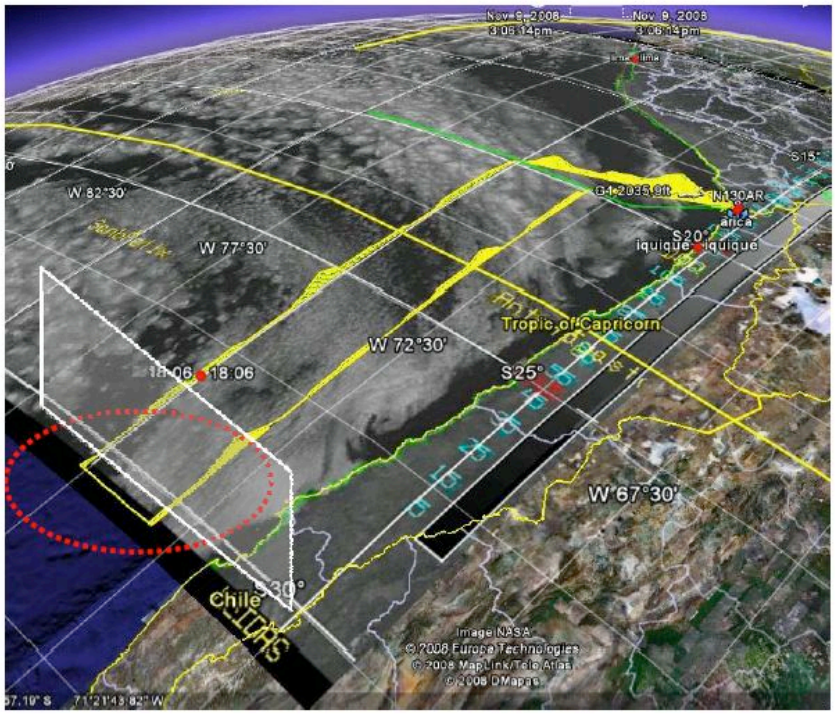


- Lowest CN concentration ever measured
- Remarkable contrasts in microphysics and cloud dynamics across POC boundary [aerosols, drizzle, cloud structure and morphology, CO and O_3]
- Ultraclean clouds in optically-thin cloud centers
- Quasi-linear boundary cells with copious drizzle scavenge aerosols

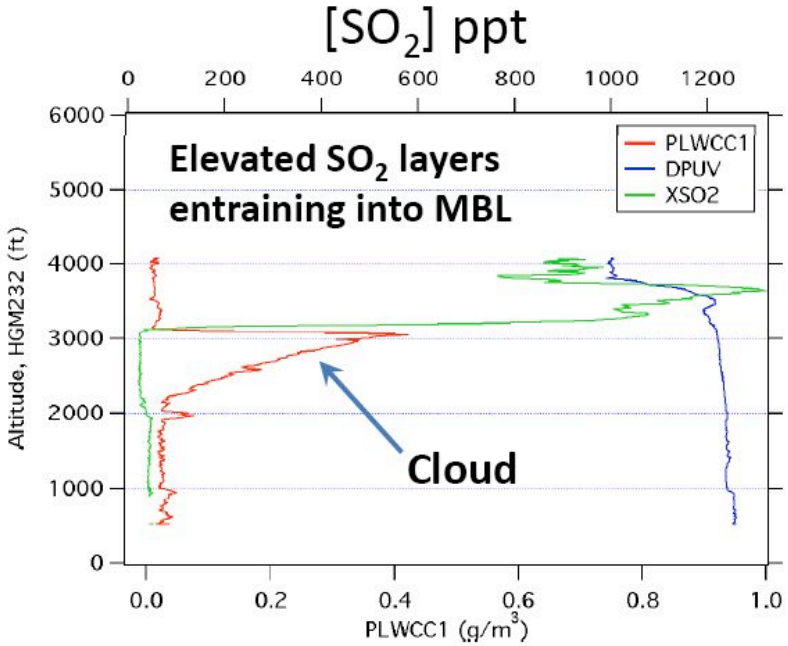


Pollution survey missions

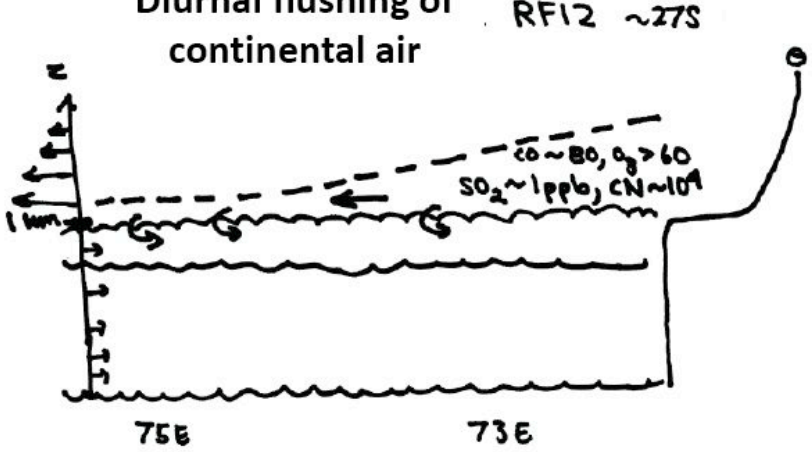
RF12, November 11th 2008



Santiago

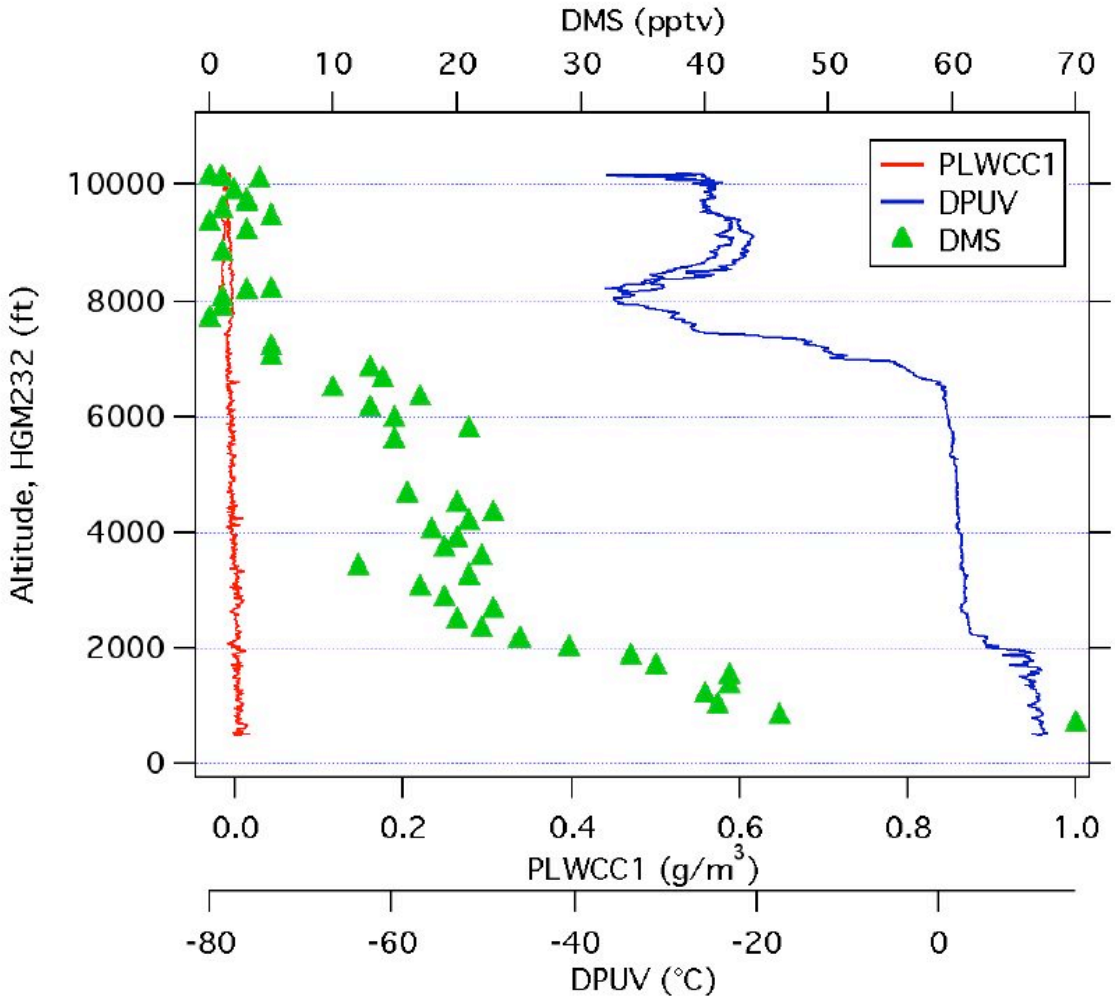


Diurnal flushing of continental air

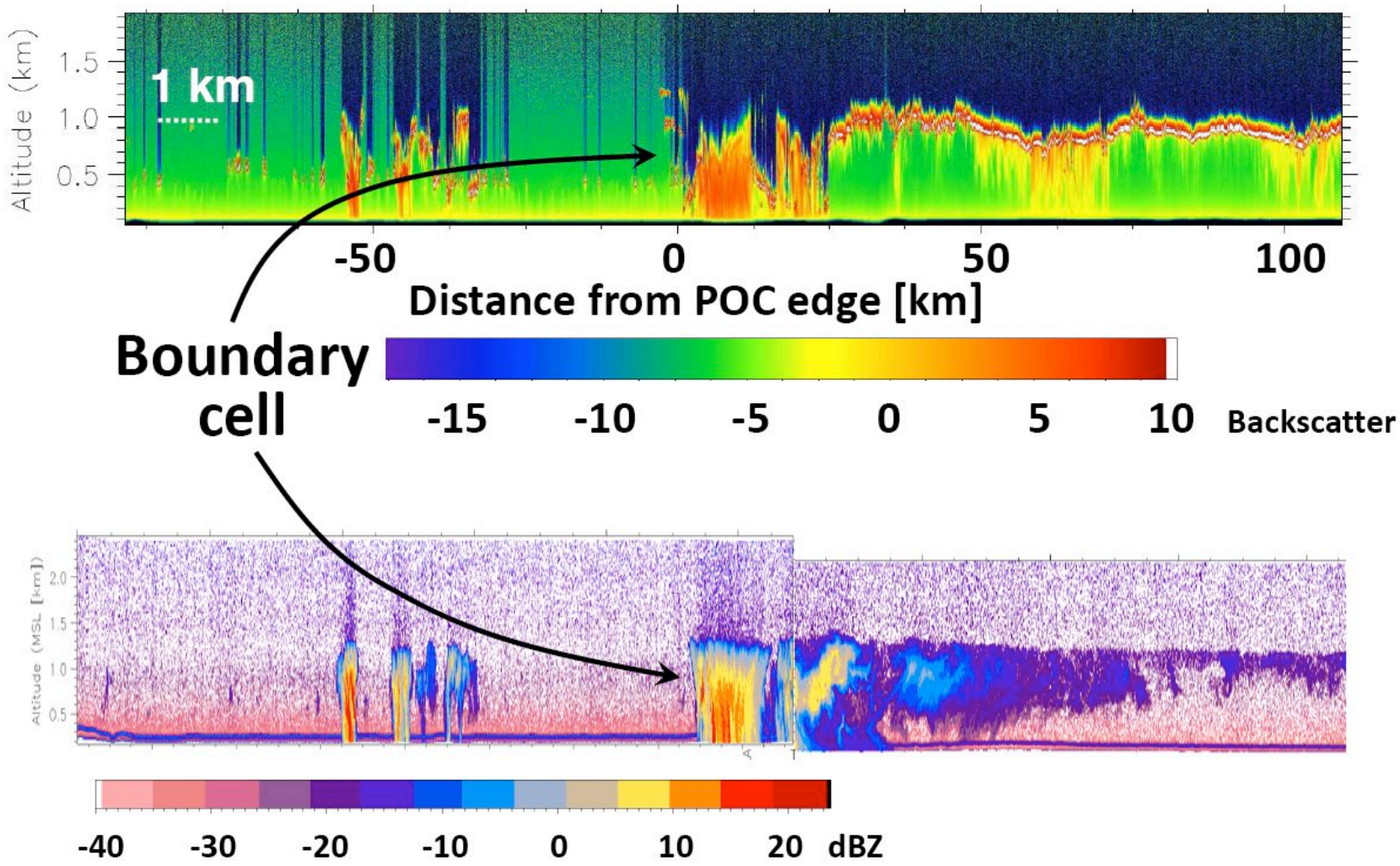


DMS Profiles

RF04

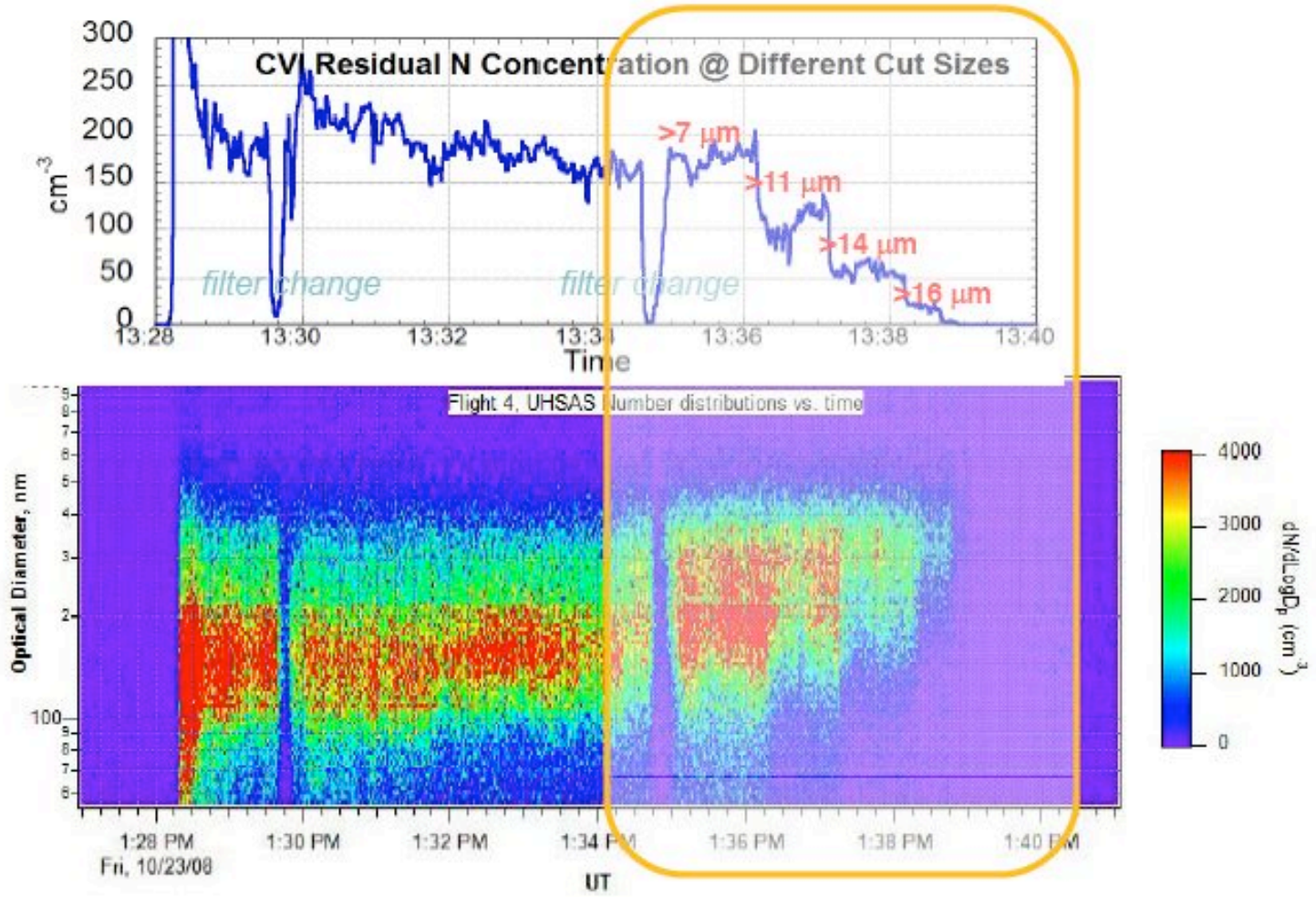


Wyoming cloud lidar (top) and radar (bottom)



Which Nuclei form Largest Drops?

Important for understanding droplet activation and drizzle formation



Measuring microphysical, chemical and optical properties of aerosols aboard the NCAR/NSF C-130 during VOCALS

Studying size-resolved aerosol cloud interactions and CCN physio-chemistry

University of Hawai`i, Hawai`i Group for Environments Aerosol Research
School of Ocean and Earth Science and Technology
A. Clarke, S. Howell, C. McNaughton, S. Freitag, L. Shank and V. Kapustin

HIGEAR
Hawaii Group for Environmental Aerosol Research

Drizzle in RF07 POC

Condensation Nuclei Counters (CNC's)
-Total particle number > 0.010 μm
-Refractory particle number > 0.01 μm
-Total particle number > 0.003μm

Differential Mobility Analyzer (long-DMA & tandem-DMA)
-thermally resolved, Dp = 0.01 – 0.20 μm
-Dp = 0.01 – 0.50 μm

Optical Particle Counter (OPC)
-thermally resolved
-Dp = 0.1 – 10.0 μm

Aerodynamic Particle Sizer (APS)
-Dp = 0.7 – 20.0 μm

Aerodyne ToF-AMS – *S. Howell & L. Shank*
-Volatile aerosol chemistry
-SO4, NO3, NH4, Organics

Black Carbon Mass – *S. Freitag*
-DMT SP2
-Dp ~0.1 – 0.50 μm

Light Scattering & Absorption
-TSI Nephelometer – λ=450, 550, 700 nm
-2 RR PSAP's – λ=470, 530, 670 nm

F(RH) at 550 nm
-parallel 1-λ Radiance Research Nephelometers
-RH = 80% (+/-5%) and < 20%

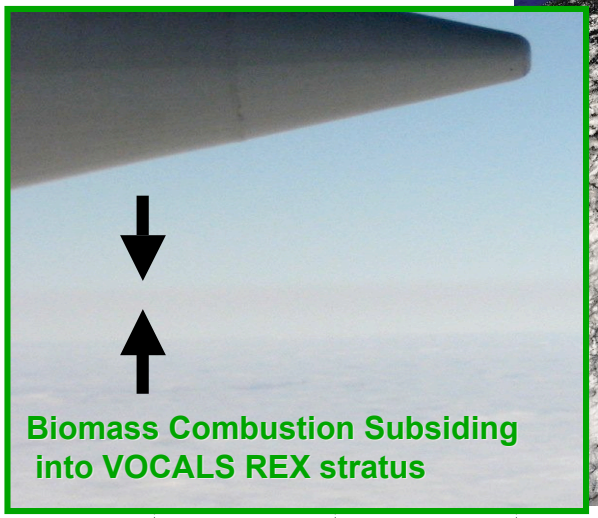
HIGEAR
Hawaii Group for Environmental Aerosol Research

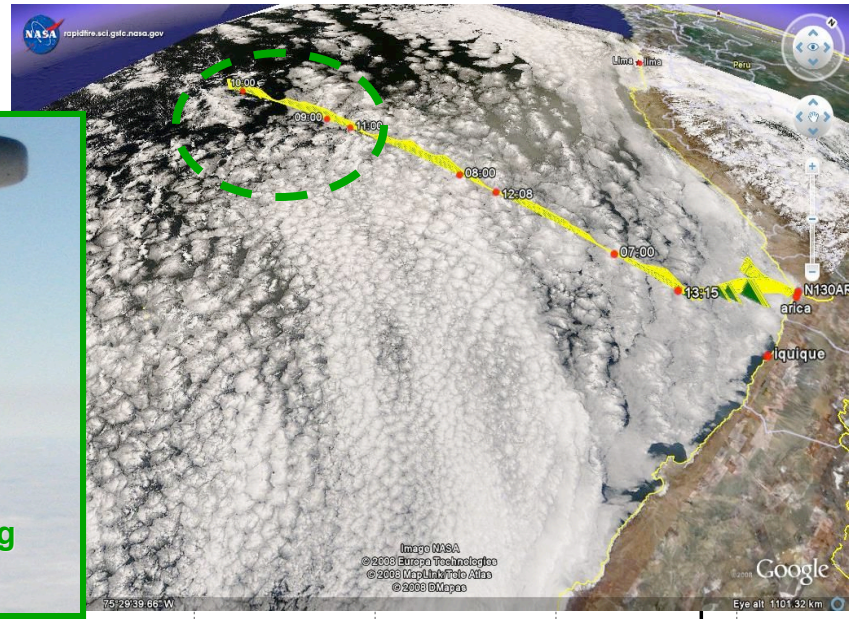
RF04 C-130 10/23/2000

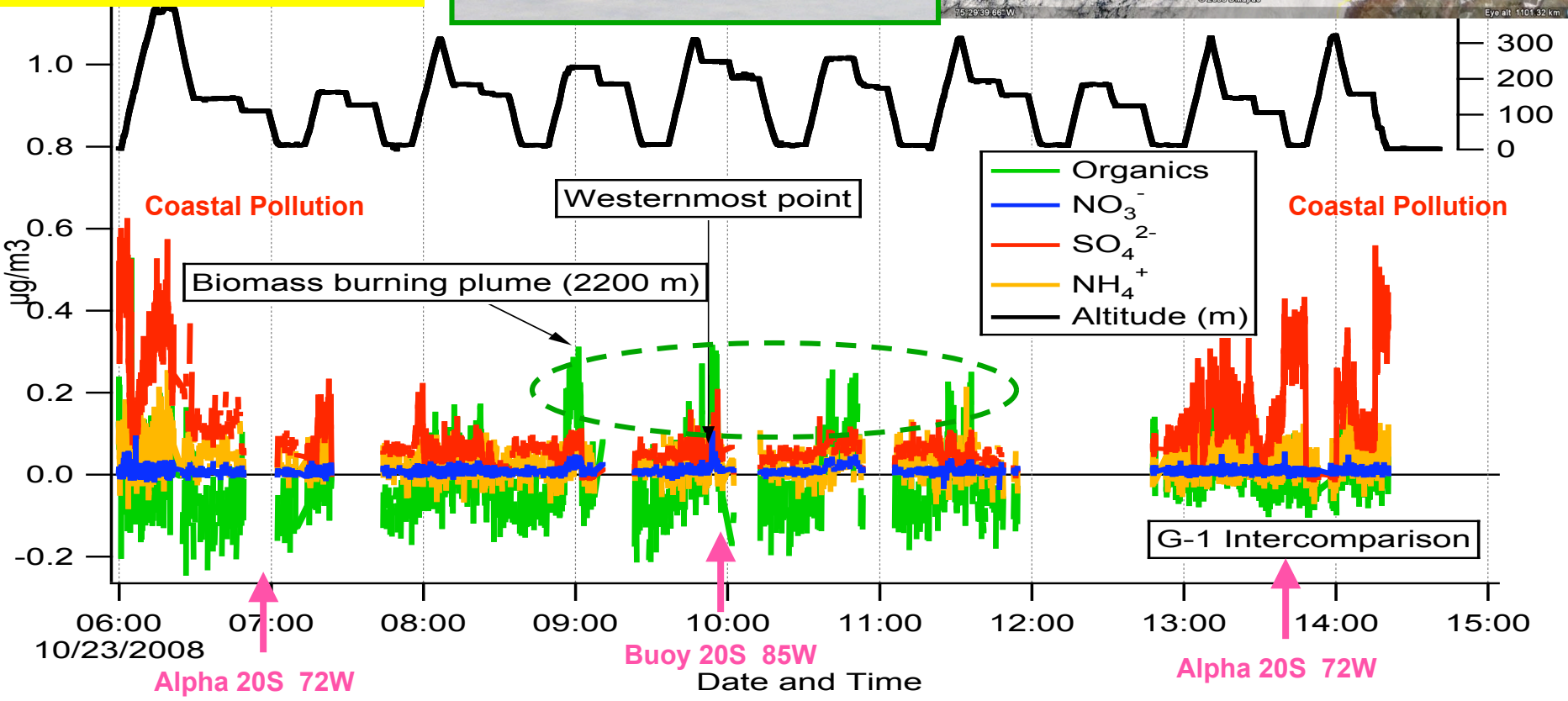
Aerosol Mass Spectrometry Preliminary Data

Sulfate mass gradient between coast and buoy consistent with gradient in accumulation mode number and associated cloud droplet concentrations.

Enhanced organics (green) suggest biomass burning aloft.

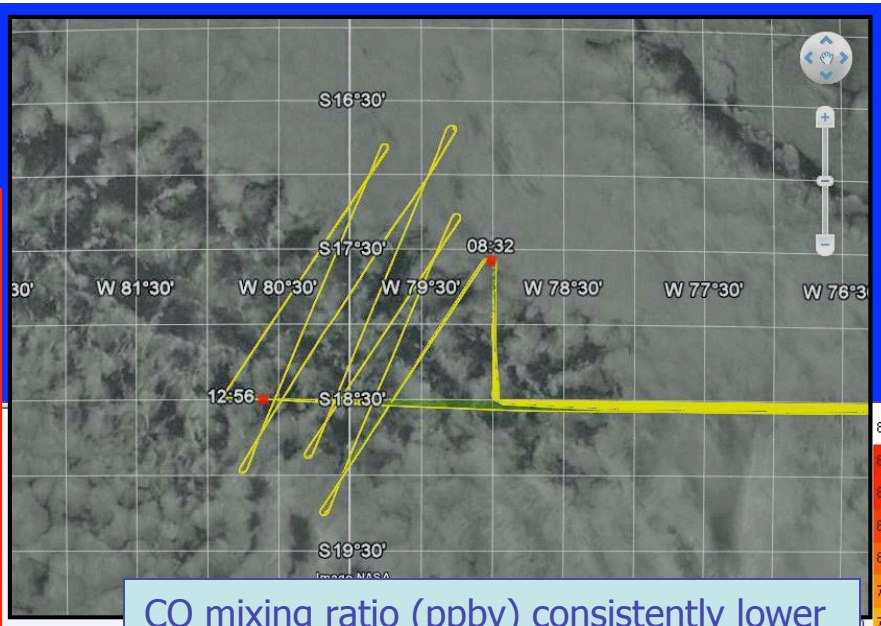




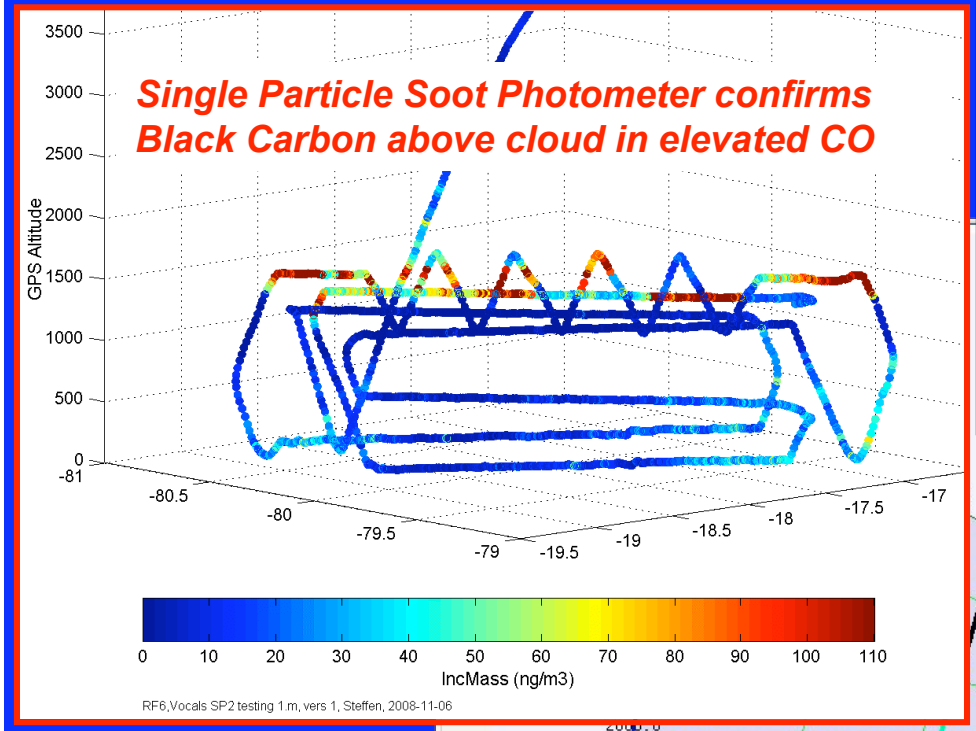


HIGEAR
Hawaii Group for Environmental Aerosol Research

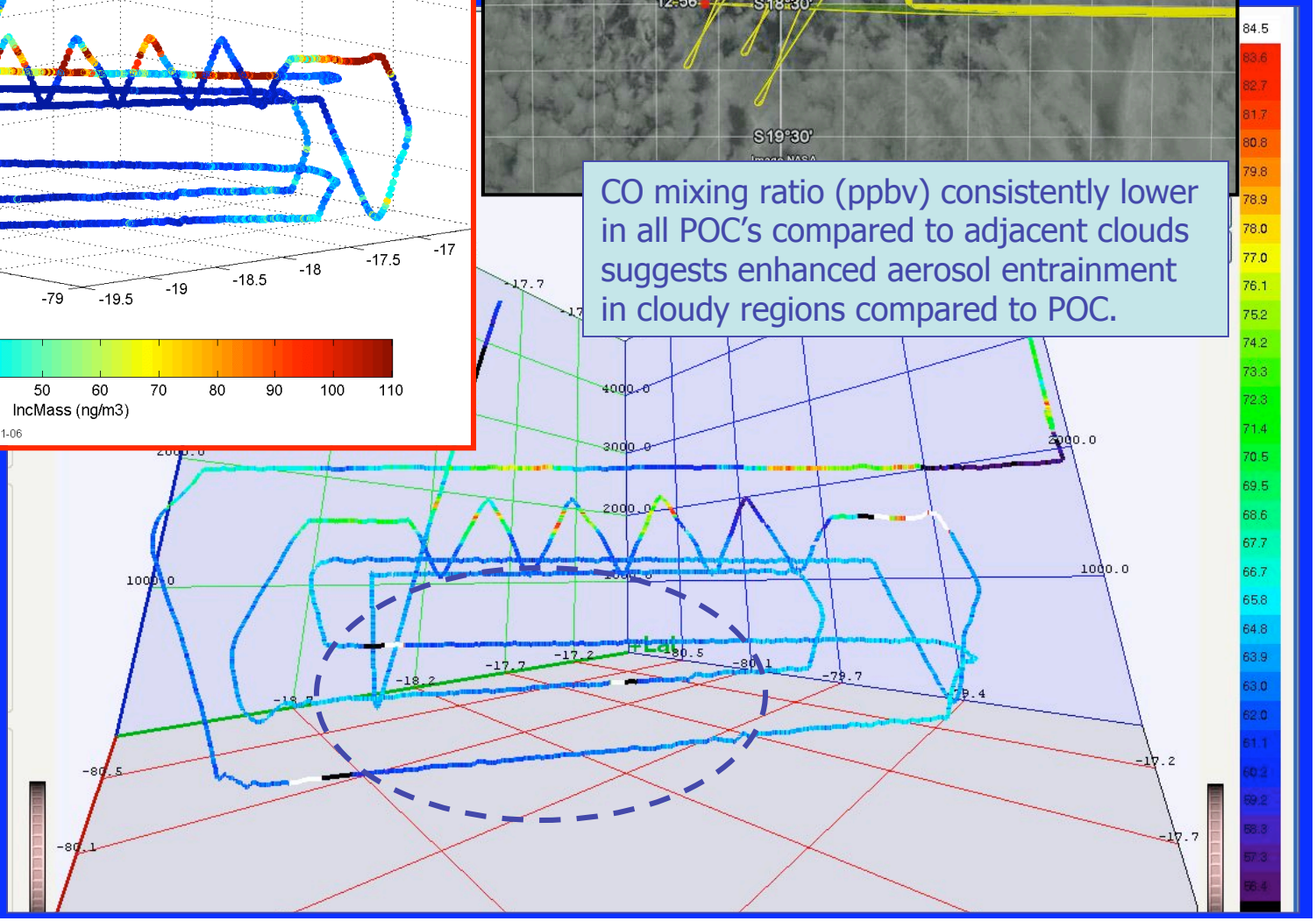
VOCALS RF06 – 10/28/08 POC Mission

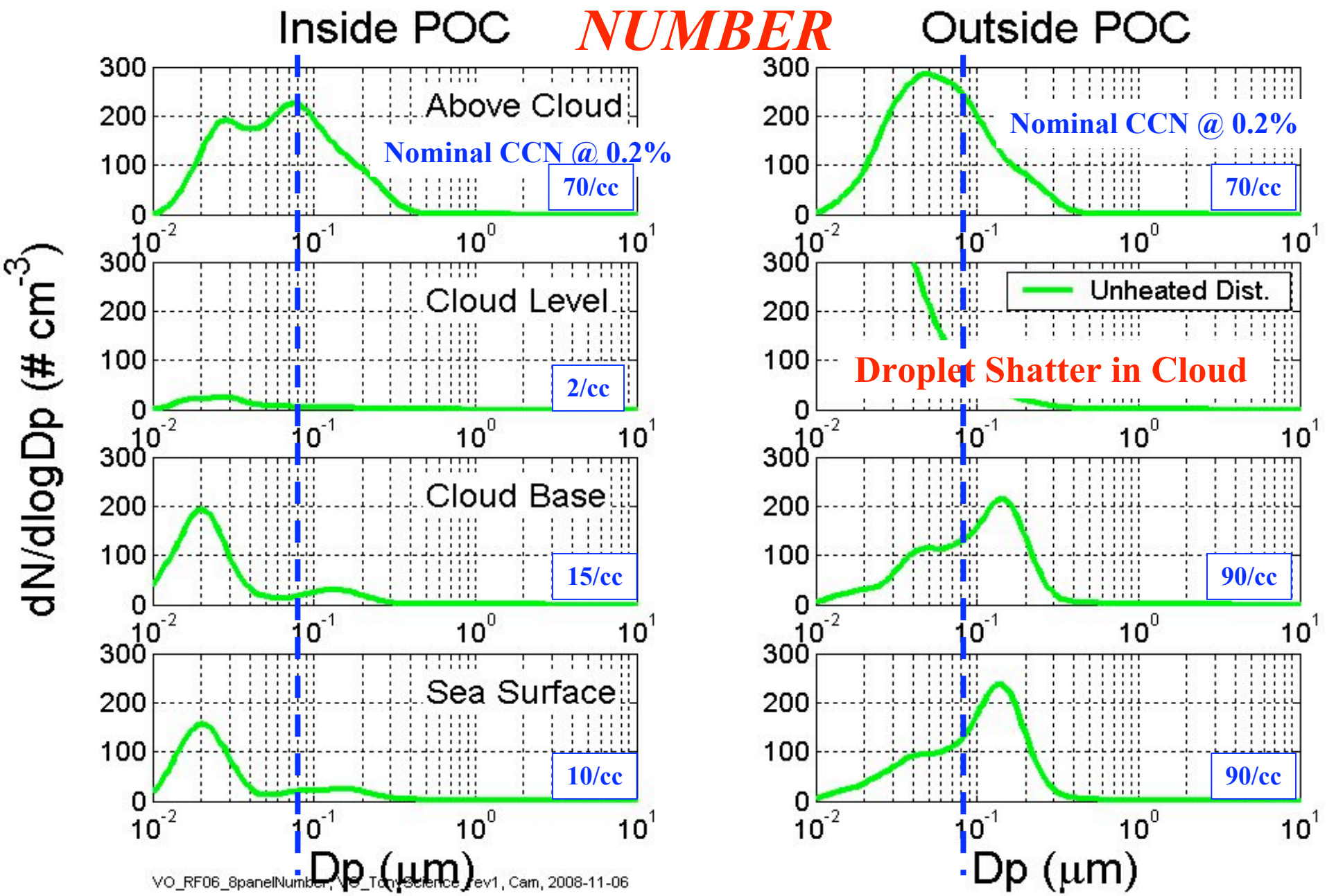


Single Particle Soot Photometer confirms Black Carbon above cloud in elevated CO

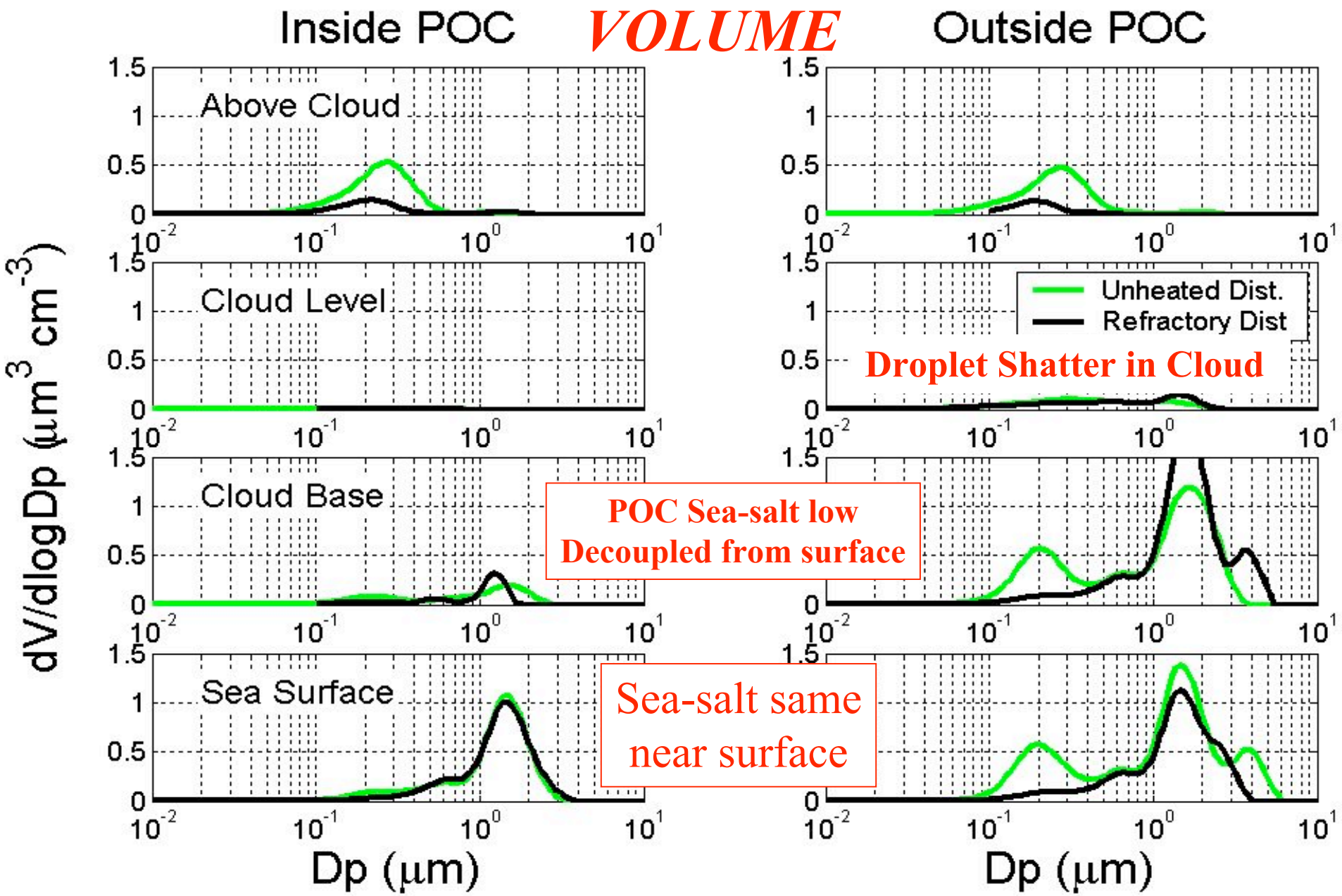


CO mixing ratio (ppbv) consistently lower in all POC's compared to adjacent clouds suggests enhanced aerosol entrainment in cloudy regions compared to POC.





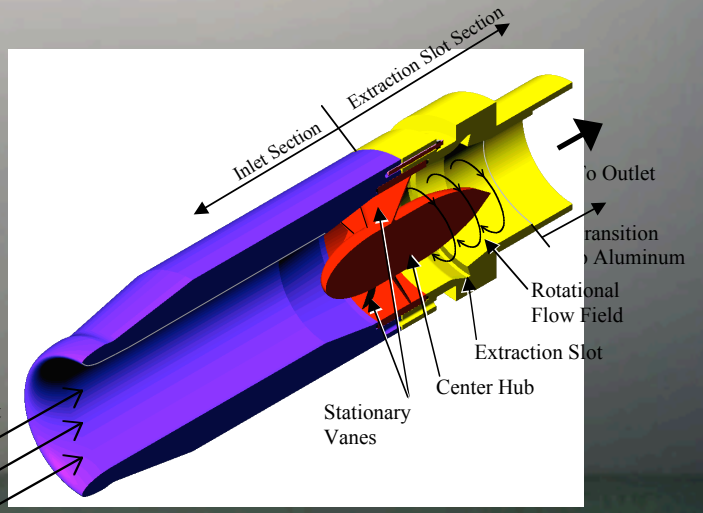
Comparisons of aerosol NUMBER distributions and estimated CN inside POC (left) and outside of POC under cloud (right) for four indicated altitudes.



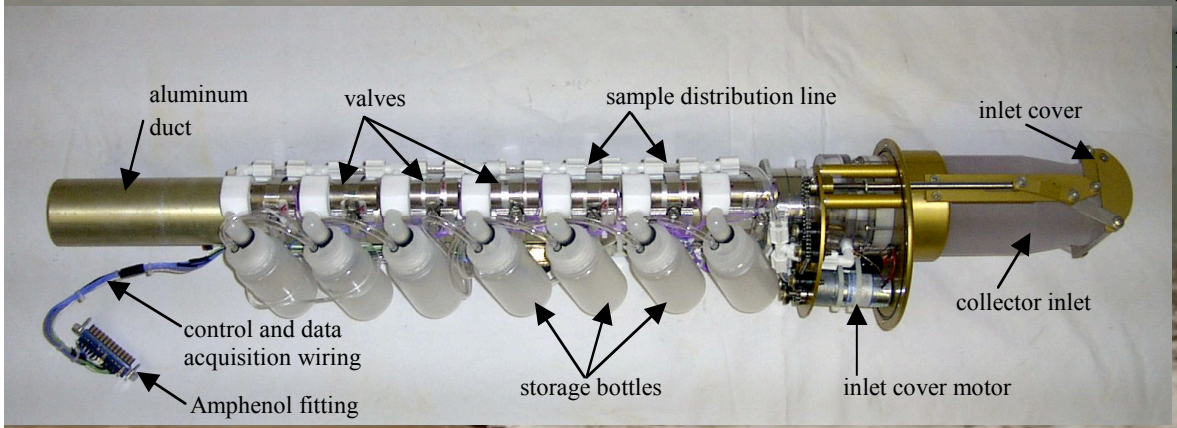
Comparisons of aerosol VOLUME distributions (Heated and unheated) inside POC (left) and outside of POC under cloud (right) for four indicated altitudes.

VOCALS-Rex cloud chemistry measurements

Taehyoung Lee, Katherine Beem, and Jeffrey Collett
Atmospheric Science Department
Colorado State University



NCAR/CSU Airborne cloudwater collector



30 m/s inlet flow (based on 115 m/s aircraft speed)

Summary of CSU cloudwater samples

Cloudwater sample by species aliquot

Aliquot	pH	Ions	H2O2	S(IV)	Metal	Organic acid	HCHO	TOC
Sample #	63	72	58	54	48	41	31	20
Duplicate sample#		6	3	3	3	3	3	

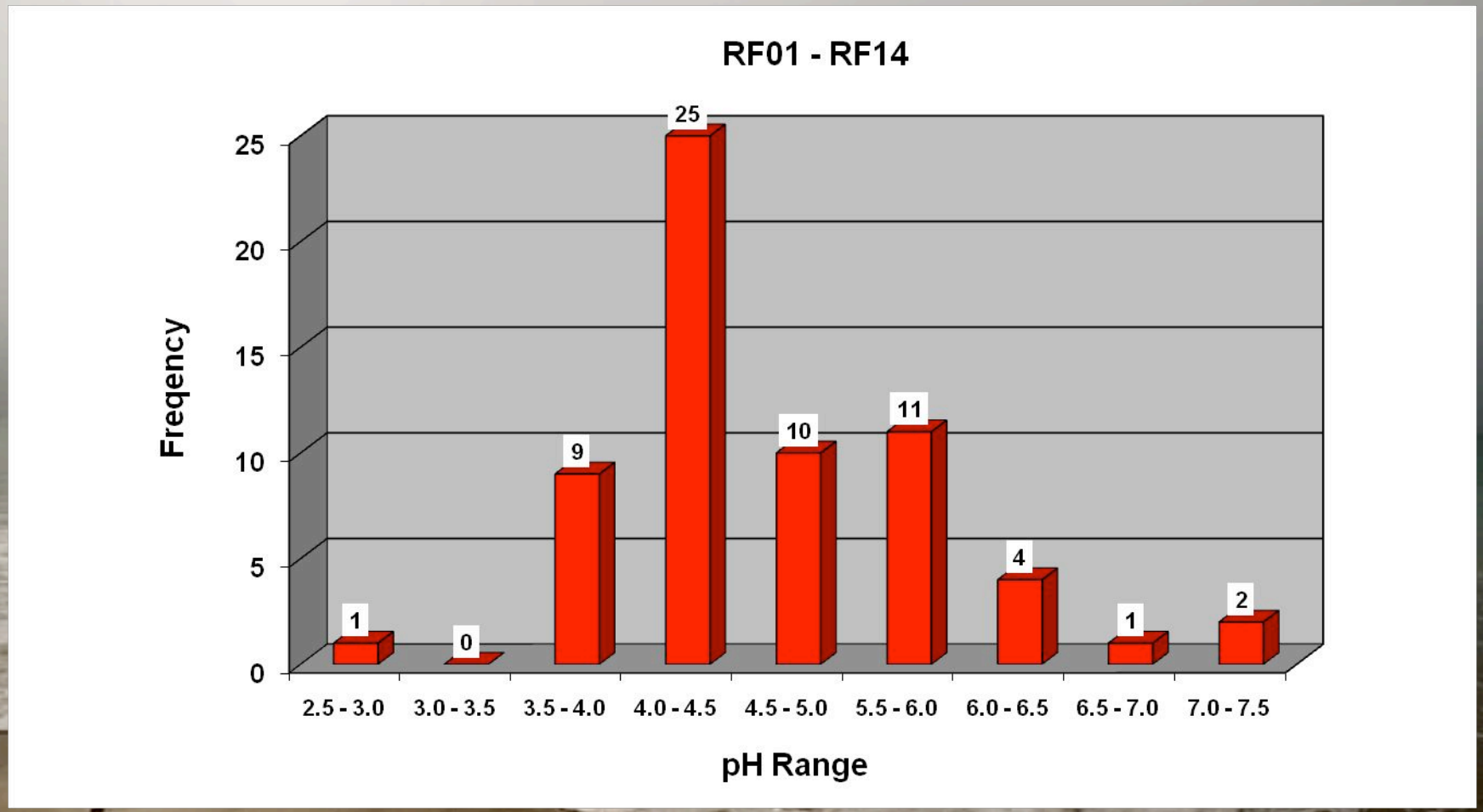
Note : The collected cloud water samples are immediately analyzed for pH on-site and derivatized to preserve unstable species

Cloudwater sample by mission types

	Cross Section	POC	Non-POC	Mixed POC*	Sawtooth	Comparison
Sample #	48	6	5	2	3	Ron H. Brown (3) G1 (1) BAe 146 (2)

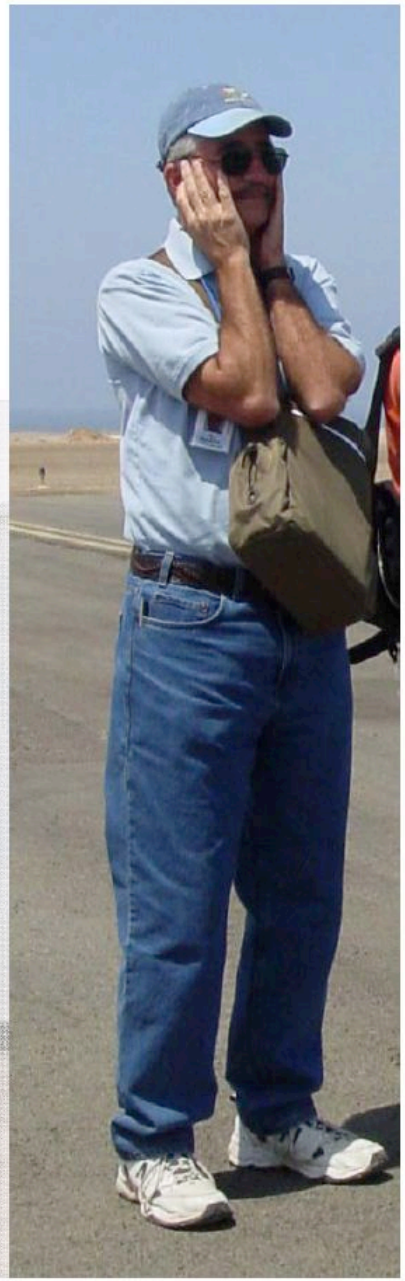
* : Mixture of POC and Non-POC regions

pH measurements of cloudwater



The Team

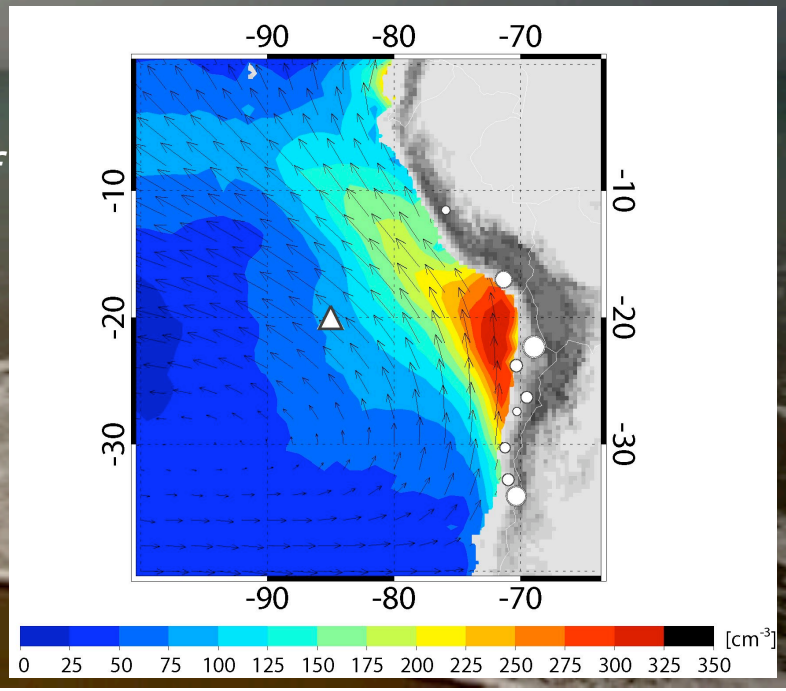
- C-130 Ground and Air Crew
- NCAR Research Aviation Facility
- C-130 PIs and Instrument operators
- Mission scientists
- Operations center
- Field catalog support



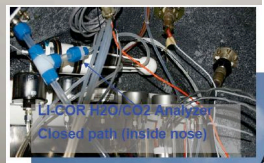
VOCALS CIRPAS Twin Otter Scientific Objectives

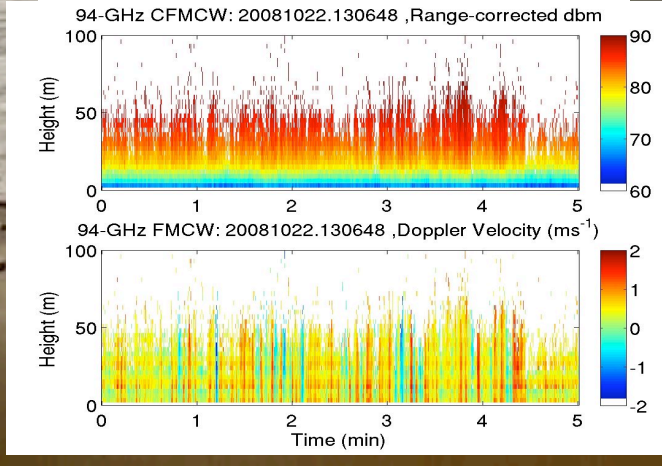
VOCALS--Hypothesis 1a: Variability in the physicochemical properties of aerosols has a measurable impact upon the formation of drizzle in stratocumulus clouds:

- Aerosol-Cloud-Drizzle Interactions
  - Process Studies
  - Gradients and Variability in Clouds and Aerosols
- Coastal Processes
  - Diurnal Cycle
  - Stagnation Effects



Twin Otter Instrumentation



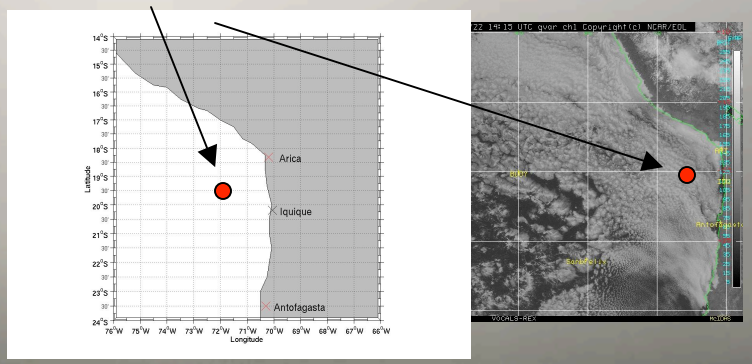


Instrument	Observations/Purpose
Standard met	Winds, temp, dewpoint, cloud liquid water, sfc temp
Turbulence Probes	High speed wind, temp, and moisture (Djamal Khelif)
94 GHz Doppler FMCW radar	Cloud properties; in-cloud turbulence
CPCs	Ultrafine aerosols
PCASP	Aerosols 0.1-3 μ m
FSSP	Clouds 2-40 μ m
CIP	Drizzle 25-1500 μ m
CCN-200	CCN (fast-2-point; slow-6 points)
Phased Doppler Interferometer (Patrick Chuang)	Cloud-drizzle 2-150 μ m
Photo-Acoustic Soot Spectrometer	Bulk soot absorption
SP2-Black Carbon; DMT	BC mass and ratio to total particles;

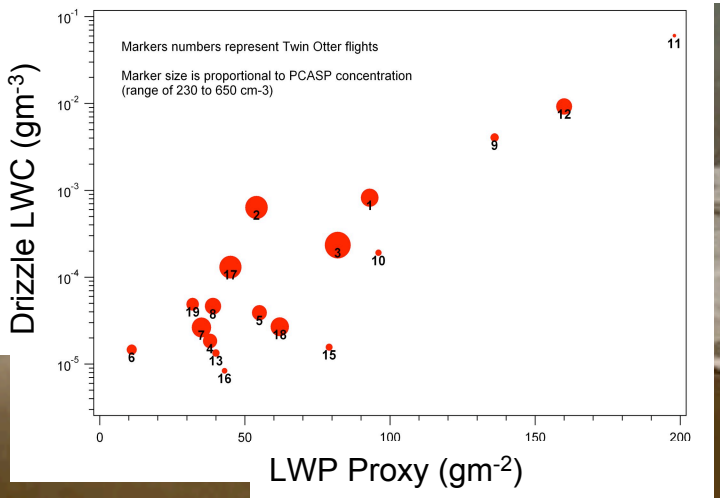
VOCALS--Twin Otter Research Flights

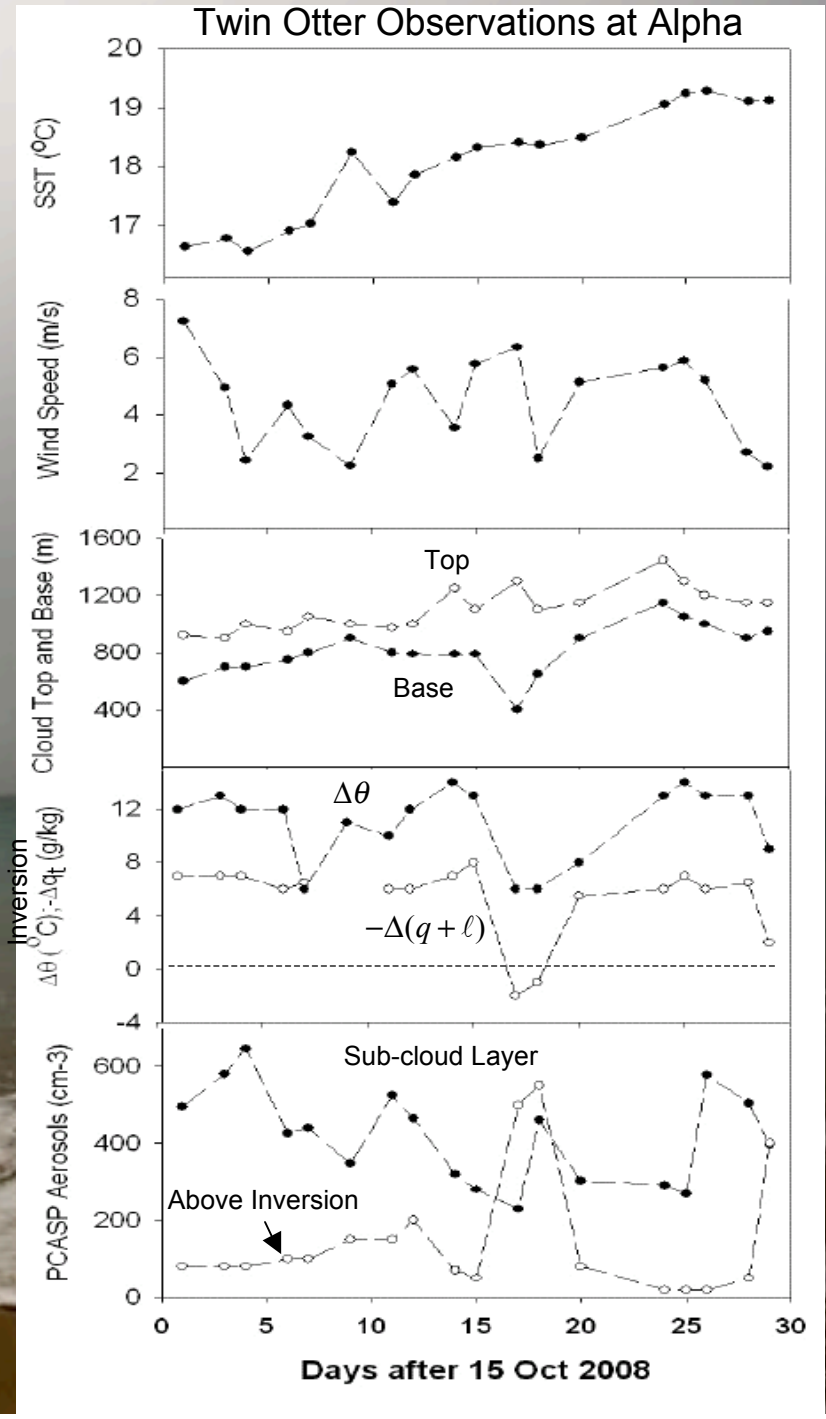
19 flights (93 flight hours) from 16 Oct to 13 November 2008

Boundary layer, turbulence and microphysical measurements were made at Point Alpha (20ºS; 72 ºW) for all 19 flights.



The wide range of aerosol, cloud, and boundary layer conditions observed at site will facilitate both process and modeling studies.

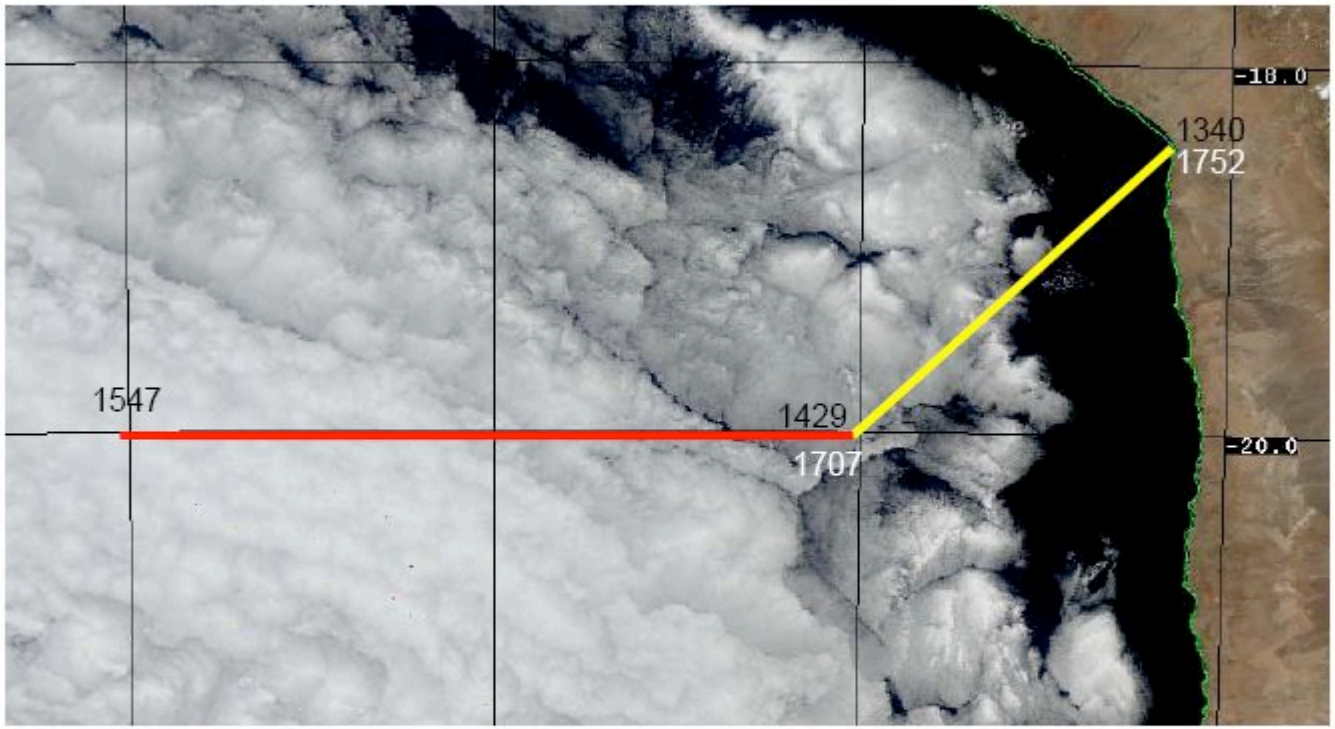




VOCALS Twin Otter IQQ Science Participants

- **U. Miami**
  - **Bruce Albrecht, Shaunna Donaher, Virendra Ghate**
- **UC Santa Cruz**
  - **Patrick Chuang, Dione Rossiter**
- **UC Irvine**
  - **Djamal Khelif , Jesus Ruiz-Plancarte**
- **UM/NASA Goddard**
  - **J. Vanderlei Martins, Roberto Fernandez-Borda, Steven Buczkwoski, Eric Wilcox**
- **NOAA/ESRL**
  - **Graham Feingold**
- **CIRPAS**
  - **Haf Jonnson**

VOCALS Nov 9 2008 – VA10



Terra MODIS overpass at 1440 UTC

Rendezvous with BAe146 west of 20S 72W during the outbound leg

Courtesy Harshvaradan, Purdue University