VOCALS-REx
Status of funding and participants

Robert Wood, University of Washington
many contributors

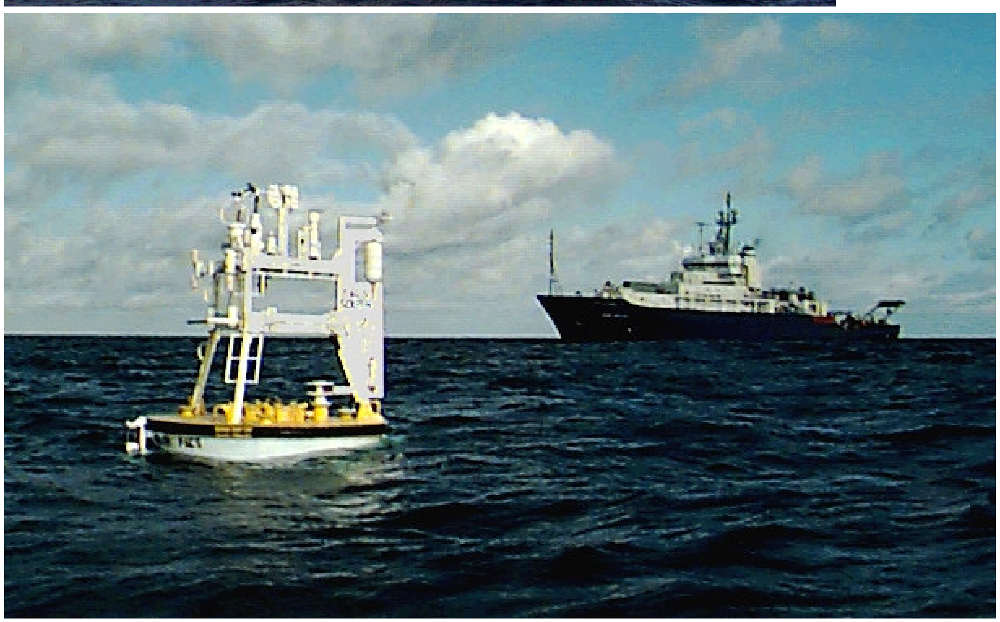
Research Projects

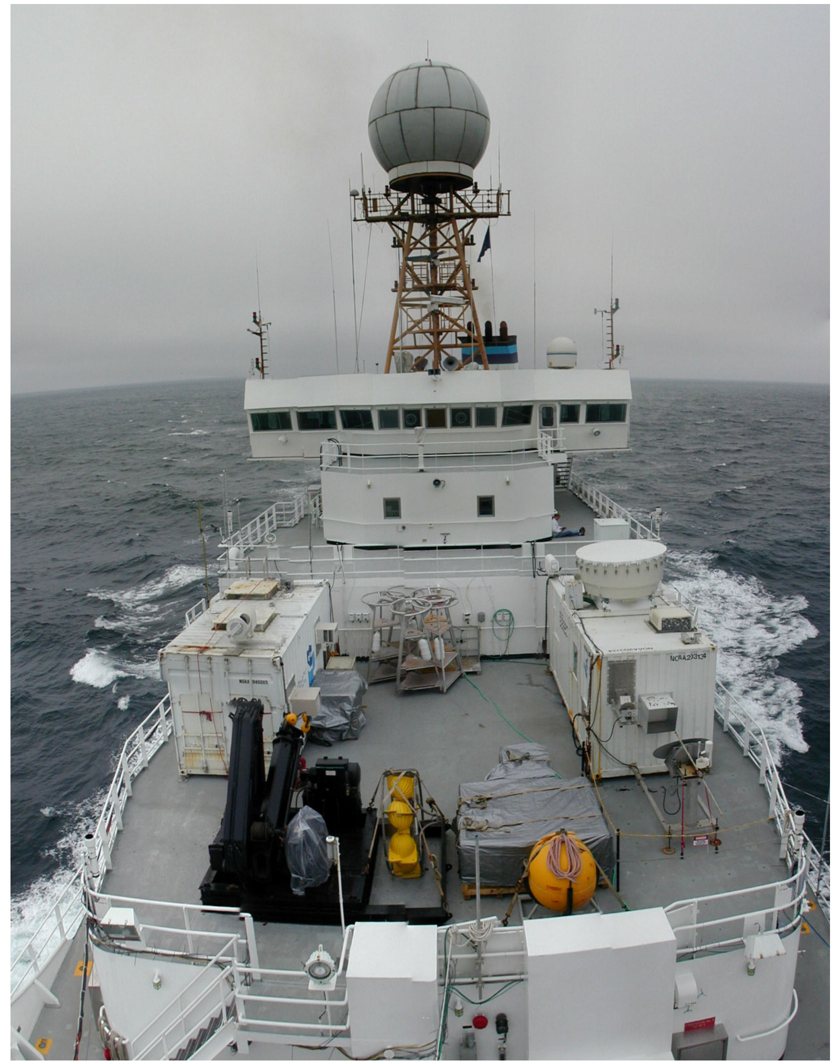
Ronald H Brown activities

- *Fairall*: fluxes, cloud optical properties
- *Yuter*: C-band radar, drizzle
- *Brewer*: Scan Doppler Lidar
- *Feingold*: lidar-cloud radar aerosol-LWP
- *Norman*: Aerosol isotope analysis
- *Huebert/Matrai*: DMS flux
- *Albrecht*: cloud drizzle/aerosol interactions
- *Covert/Bates/Quinn/Russell*: aerosol characterization
- *Volkamer*: remote sensing of trace gases
- *Zuidema*: cloud remote sensing

Observation Systems

Air-sea Fluxes, Clouds, Precipitation





Cloud Radar and Microwave
Radiometer

Fairall – Yuter Plans for VOCALS-Rx

- We will operate several ship-base observing systems on the ***RHB***. The observations are designed to address issues in cloud forcing of surface radiative flux through both individual cloud droplet/albedo relationships and through mesoscale structure of clouds associated with drizzling organized structures (POCs). These data will be used in our own research but will also be strategic observations for many VOCALS researchers.

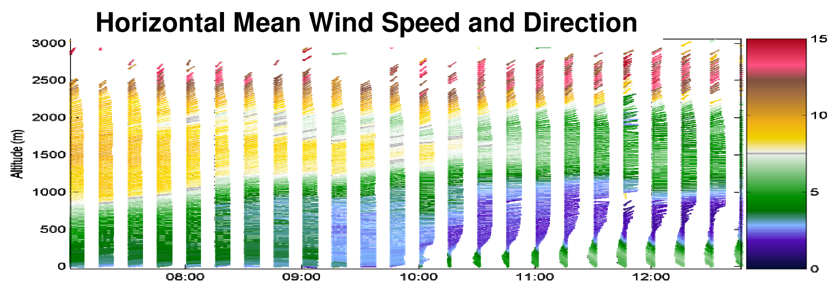
Table 1. Instruments proposed for the VOCALS field program.

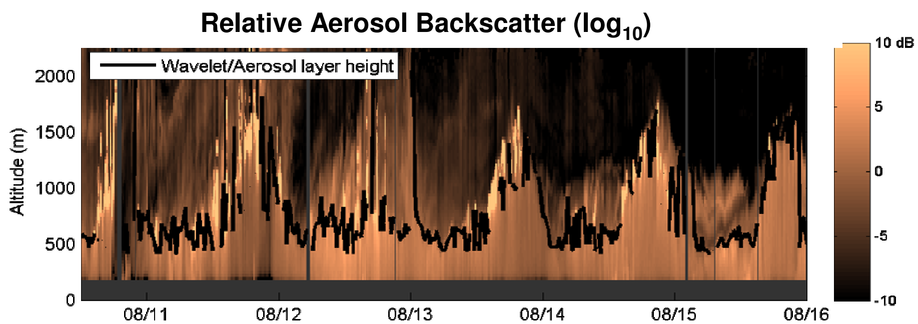
System	Measurement
Fast Turbulence sensors	Direct covariance turbulent fluxes
Mean SST, air temperature/RH	Bulk turbulent fluxes
Pyranometer/Pyrgeometer	Downward solar/ IR radiative flux
Ceilometer	Cloud-base height
0.92 GHz Doppler radar profiler	Cloud-top height, MBL Winds
Rawinsonde	MBL wind, T, RH profile.
DMT CIP Precipitation spectrometer	Drizzle droplet size spectra
94 GHz Doppler cloud radar	Cloud microphysical properties
Microwave radiometer	Integrated water liquid/ vapor
RHB C-band radar	Precipitation spatial structure
RHB Satellite receiver	Cloud and SST fields
MicroRainRadar (NCSU)	Profiles of drizzle
Lasair-II aerosol spectrometer	Aerosol size spectra

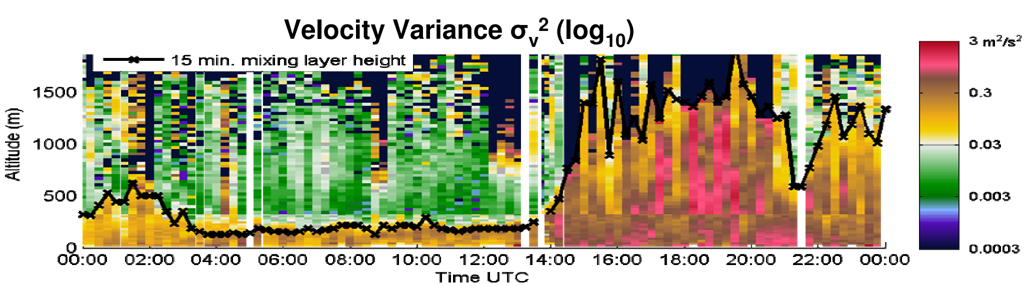
ESRL Scanning High Resolution Doppler Lidar (HRDL)

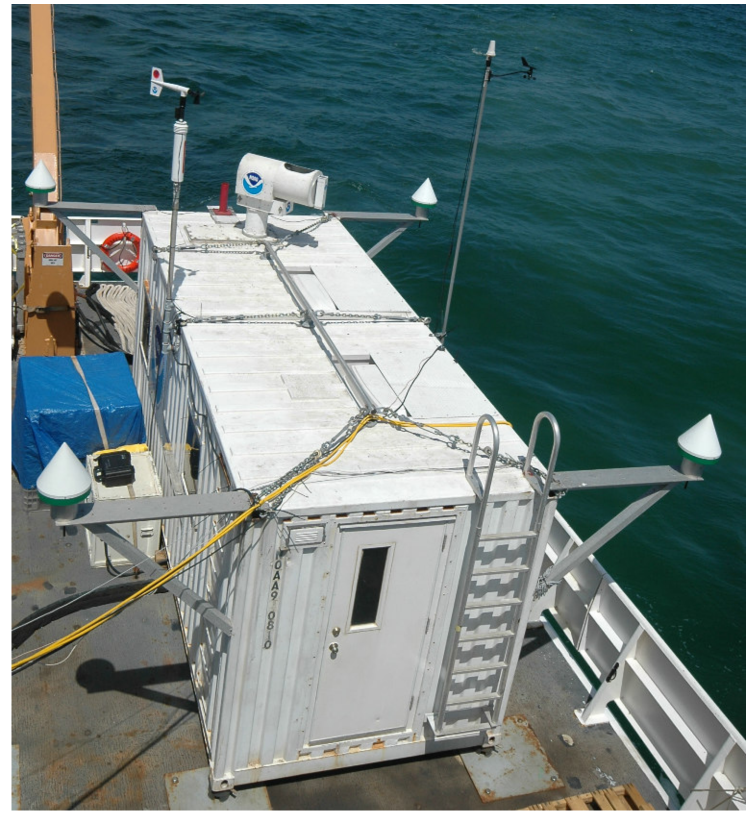
Continuous profiles of:

- Mean wind speed and direction
- Average return signal strength
- Small scale mixing strength









HRDL Mounted on the Fantail of the RV Ron Brown during TEXAQS 2006

Motion stabilization allows for:

- Low elevation angle scans
- Zenith stare
- Removal of ship motion from velocity measurement

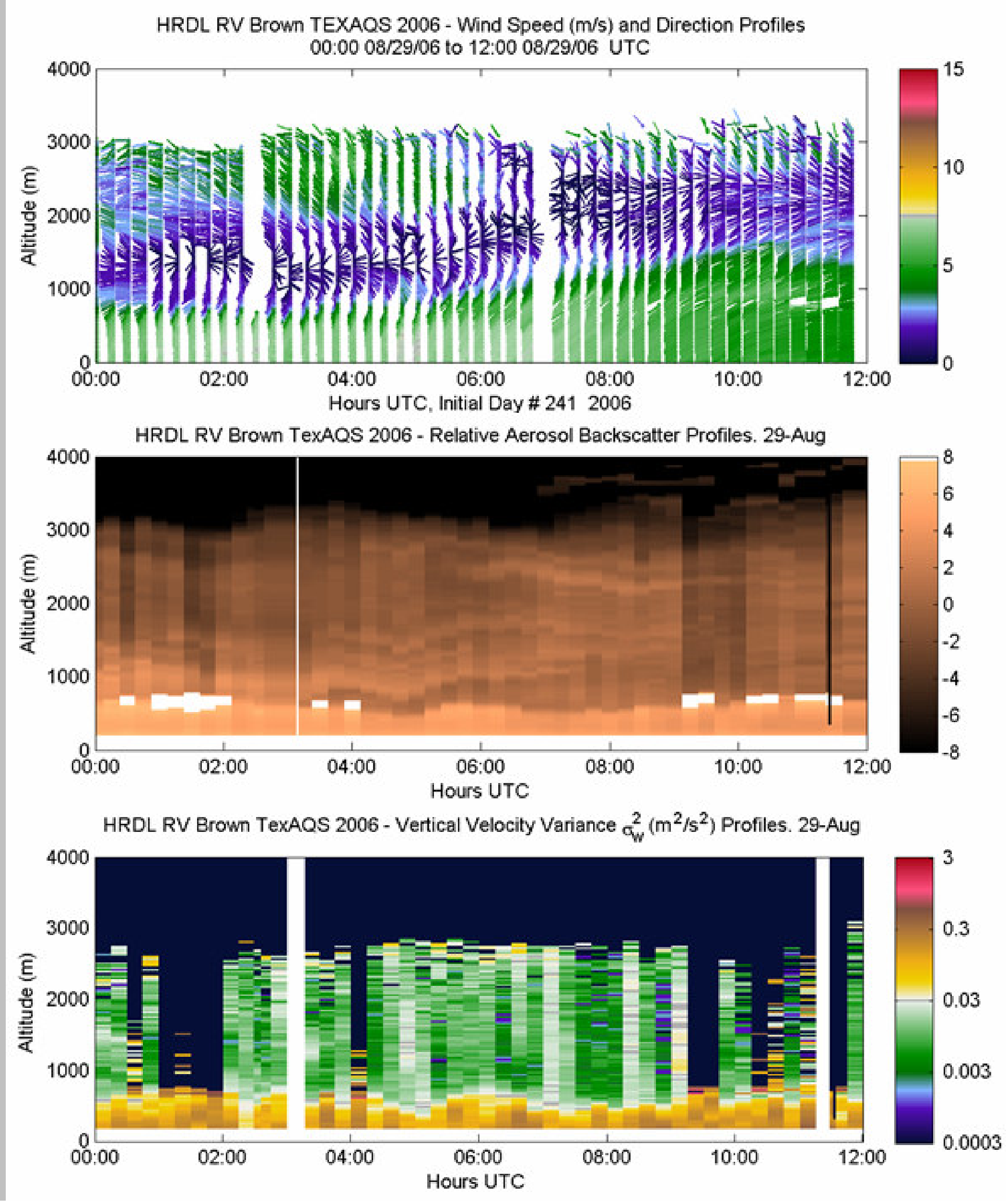
ESRL LIDAR GOAL : Combine modeling and observations to understand how aerosol & dynamics effect precipitating and non-precipitating clouds

Use continuous measurements of clear air wind fields from the RV Ron Brown using a scanning Doppler lidar to study:

- Time evolution of surface convergence fields and compare these to model output (combine with C-band and in-situ aerosol meas)

- Sub cloud base vertical air motion and aerosol distribution and how this impacts cloud evolution, precipitation initiation and maintenance (combine with W-band and in-situ aerosol meas)

- Measure wind, aerosol and turbulence profiles, to determine
    - *dynamical parameters in support of model evaluation (w,TKE,..)*
    - *Boundary layer depth and degree of vertical mixing*
    - *Aerosol Transport*



Collaborative research: Biological and physical controls on DMS production and emission during VOCALS

Patricia Matrai (Bigelow) & Barry Huebert (UHawaii)

a) how far does the biogeochemical impact of upwelling on DMS production and air-sea flux extend offshore?

b) how do fewer clouds affect biological DMS production and SW concentrations?

c) how do spatial gradients of SW DMS concentration and flux-controlling factors (e.g., winds) affect DMS fluxes to the atmosphere?

and, ultimately,

d) to determine the significance of biotic feedbacks in controlling the radiation budget of the Southeast Pacific

a) NOAA R/V Ron H. Brown; shipboard sampling during VOCALS REx Phases 1&2

b) Variability in DMS and DMSP net production and DMS flux in the marine upper mixed layer, within an eddy or filament, before, during and after a POC event, as a function of irradiance

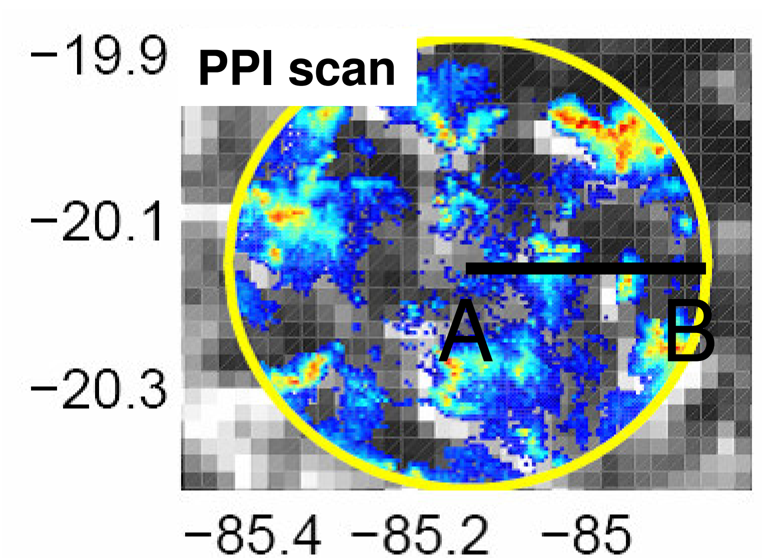
c) During experimental periods, we will measure:

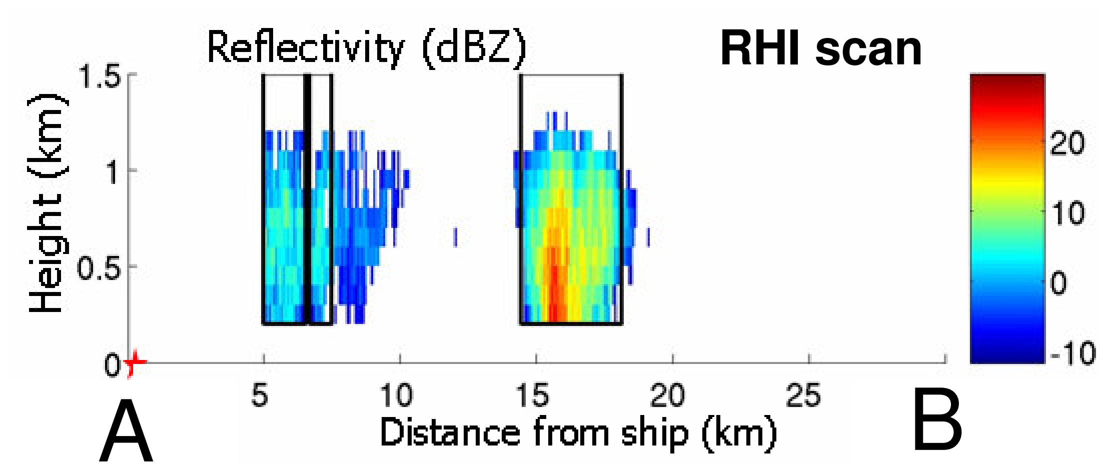
- Continuous DMS flux, chl *a* conc., PAR
- Continuous SW DMS conc. by Bates et al. (PMEL);
- Discrete DMS & DMSP concs., DMS & DMSP net production, nutrients;

Sandra Yuter

NC STATE UNIVERSITY
Clouds and Precipitation Processes and Patterns Group

Goal: Drizzle cell lifecycles
Key data set: RHB scanning C-band radar
Methodology: Cell identification and tracking





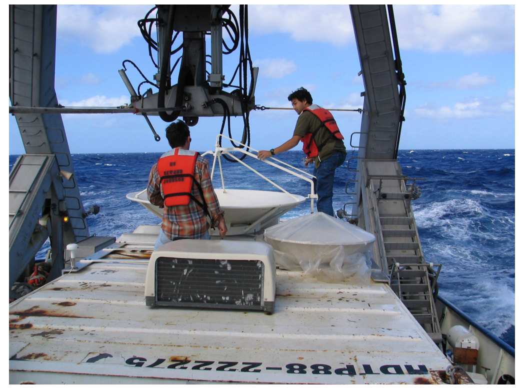
"Studies of Cloud, Drizzle, Turbulence, and Boundary Layer Variability over the Eastern Pacific in Support of the VOCALS Regional Experiment"

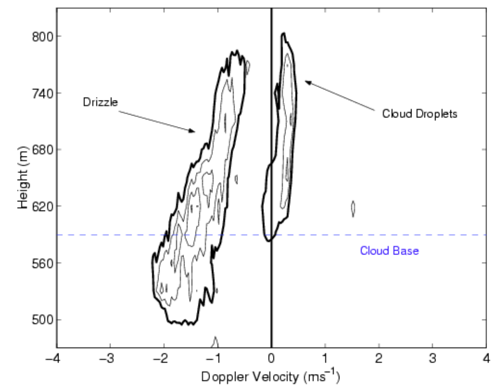
P.I.: Bruce Albrecht (University of Miami)
Agency: NOAA

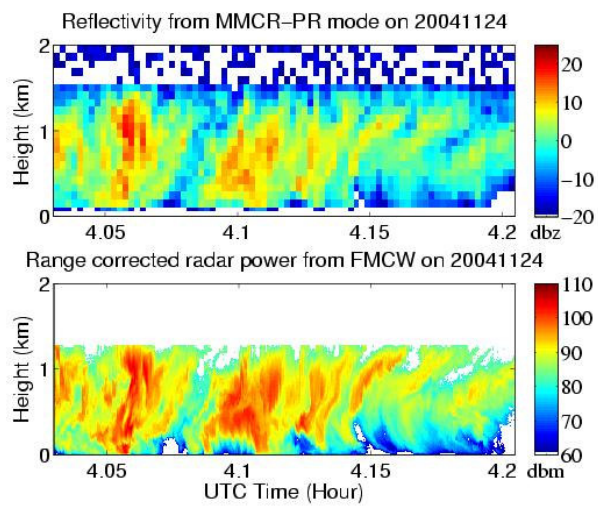
- ***VOCALS-REX Science Foci***: *Hypotheses 1a, 1b, and 1d:*
  - *Variability of the turbulence structures in marine stratocumulus clouds*
  - *Aerosol-cloud-drizzle-turbulence characterizations and interactions*
- ***Approach***: Collaborative efforts (process studies) using observations from *in situ* and remote sensing systems operating on the *R/V Ronald H. Brown* (*RHB*)
- **Principal Observations**: Doppler radar measurements
  - Radars: Doppler mm-wavelength cloud radars (EOL and UM); Doppler X-Band (UM)
  - Observations: Reflectivity; Doppler moments and spectra
- ***Collaborators***: *Chris Fairall, Sandra Yuter*

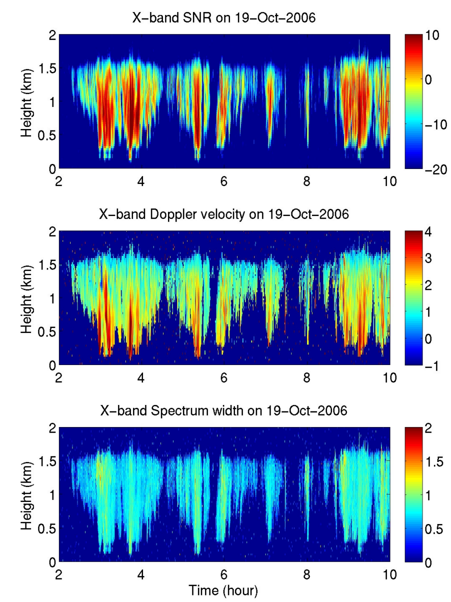
VOCALS UM (RB) Radar Measurements

- UM W-Band—Bistatic Mode (no dead zone) –Reflectivity and Doppler Spectra
  - Radar returns from cloud top to within 30 m of surface
  - Drizzle characterization (size distribution retrieval)
  - Sub-cloud drizzle evaporation
  - Turbulence—Resolved and within radar sampling volume
  - Back up for ESRL/ETL cloud radar
- UM X-Band—Reflectivity and Doppler Spectra
  - Dual-wavelength drizzle characterizations









Upper Ocean Response under the Stratus Deck

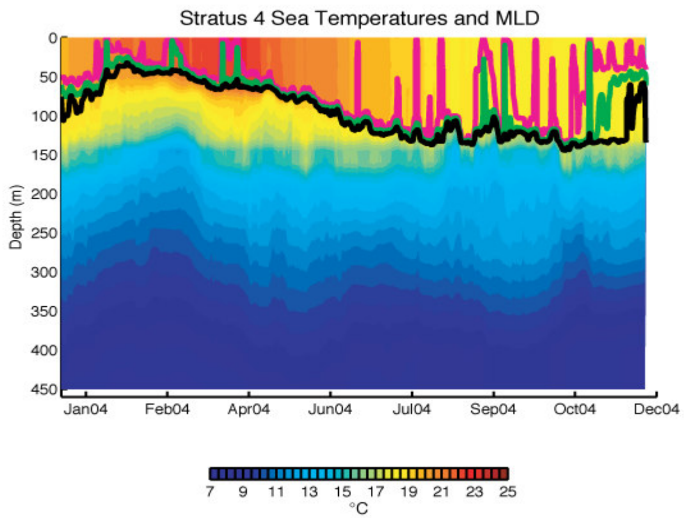
Bob Weller and Fiamma Straneo, WHOI

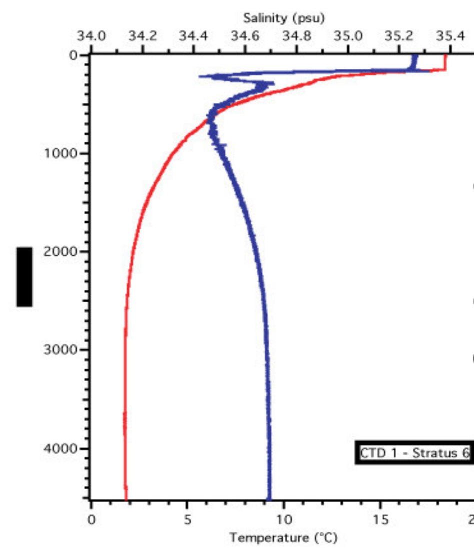
Objective: investigate upper ocean response under the persistent stratus cloud deck to forcing by air-sea fluxes, by the gyre-scale circulation, by fluxes associated with westward propagating eddies, and by vertical mixing.

Method: quantify and better understand:

- the surface meteorology and air-sea fluxes across the region,
- the space/time variability of the upper ocean and of sea surface temperature, and
- the oceanic and coupled processes that govern the state and evolution of the upper ocean.

using two moorings, shipboard sampling, and profiling ARGO floats during VOCALS-Rex and analysis of historical and remotes sensing data and collaboration with modelers.





Shallow mixed layer; cool, fresh water below; seasonal cycle in SST, MLD; diurnal restratification

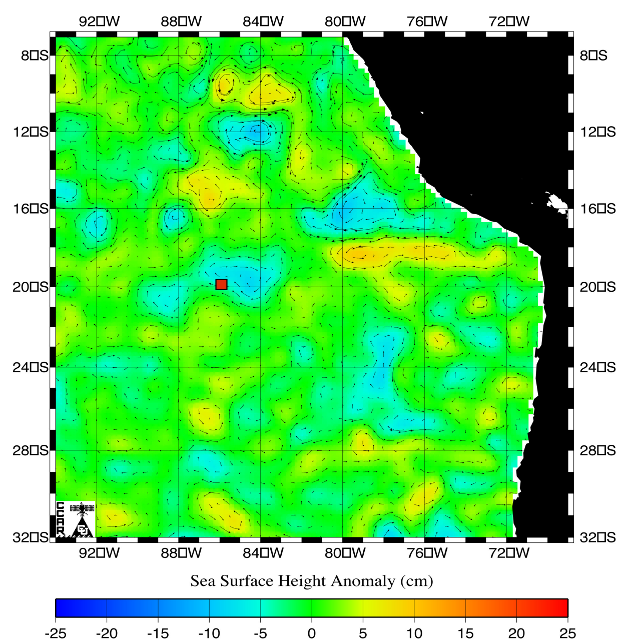
Upper Ocean Response under the Stratus Deck

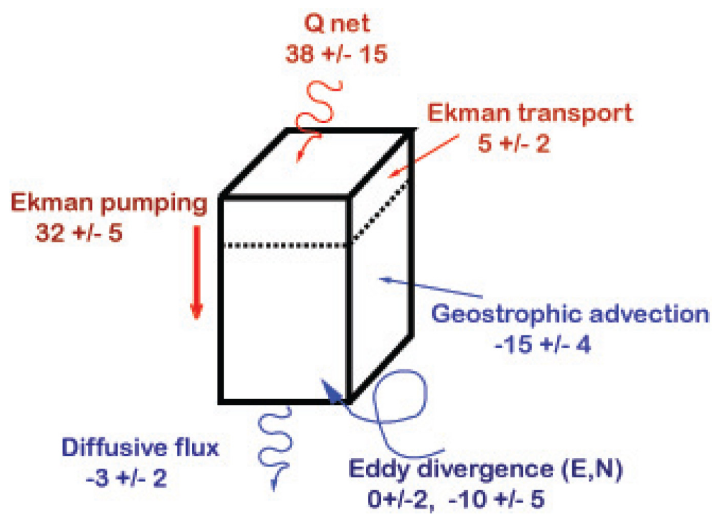
Weller and Straneo, WHOI

Goals:

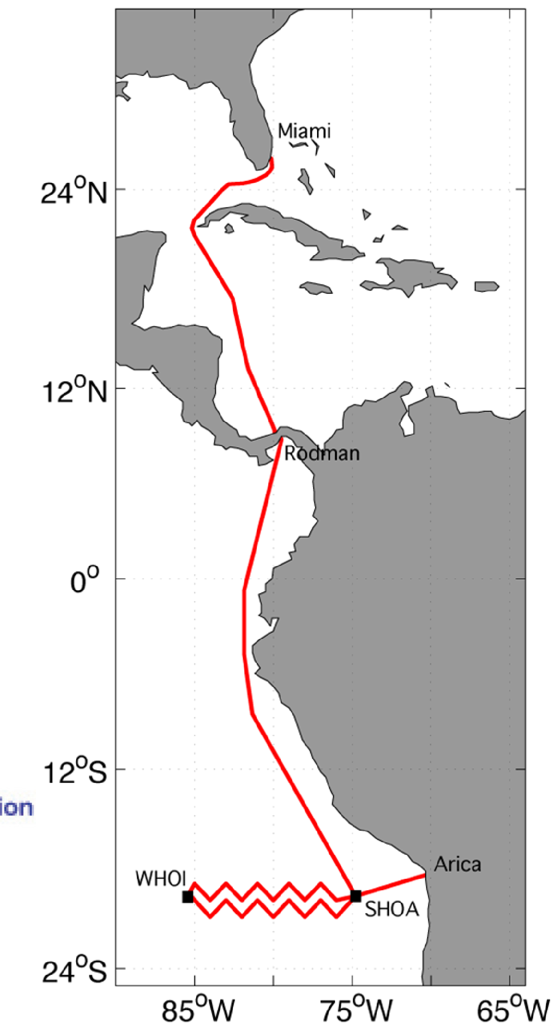
- observe with good vertical and temporal resolution at the two moorings surface meteorology, air-sea fluxes, and structure and variability of the upper ocean,
- assess the spatial homogeneity of the SST and upper ocean structure, the representativeness of the temporal evolution at the moorings,
- assess the spatial variability of the surface meteorology and air-sea fluxes,
- map the mesoscale ocean variability and locate a feature that will be the focus of joint ship and aircraft studies in VOCALS REx,
- quantifying horizontal advective fluxes of heat and salinity, and
- collect shipboard data while on station (for 6 to 14 days) at each of the two moorings and at the selected mesoscale feature

Historical Mesoscale Altimetry - Mar 17, 1998





Leg 1 VOCALS R H Brown



Aerosol measurements on Ronald H. Brown

Tim Bates, Trish Quinn, NOAA PMEL, Seattle, Washington
David Covert, University of Washington, Seattle, Washington
Coordinating with Lynn Russell, Scripps Institute of Oceanography,

Goals:

- Measure physical, chemical, optical and cloud nucleating properties of particles;
  - Particulate number-size distribution and concentration, 20 nm to 10 μm,
  - Impactor sampling and analysis of particulate mass concentration, major inorganic and organic ion concentration, organic carbon, trace metals,
  - Light scattering coefficient of coarse and fine aerosol at 25, 60 and 85% RH and light absorption coefficient of coarse and fine aerosol,
  - Cloud condenstion nuclei concentration at 0.2% and 2% supersaturation.
- Focus on parameters relevant to cloud droplet formation in warm stratocumulus;
  - particulate concentration, size, solubility and chemical composition, marine and continental source signatures.
- Analyze the above in the context of atmospheric chemistry reactions and particle dynamics, and synoptic to mesoscale meteorology and meteorological models.
- Contribute to testing hypotheses:

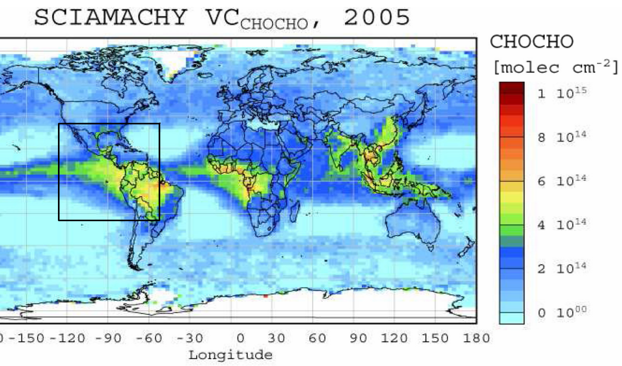
    H1c, "The small effective radii … are primarily anthropogenic…",
    H1d, "Depletion of aerosols by coalescence scavenging is necessary…",
    H2b, "Regions of upwelling … effect … eventually MBL aerosol".

MAX-DOAS for VOCALS-REx

PI: Rainer Volkamer, CU Boulder

rainer.volkamer@colorado.edu

a)



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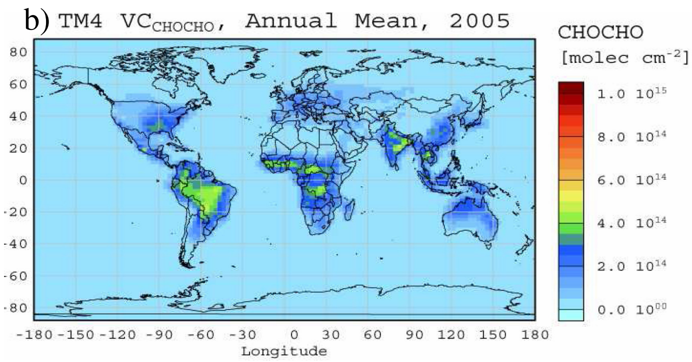

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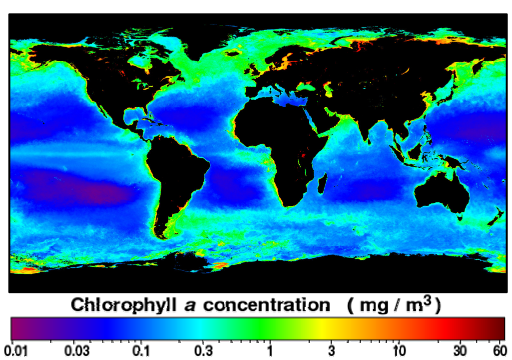
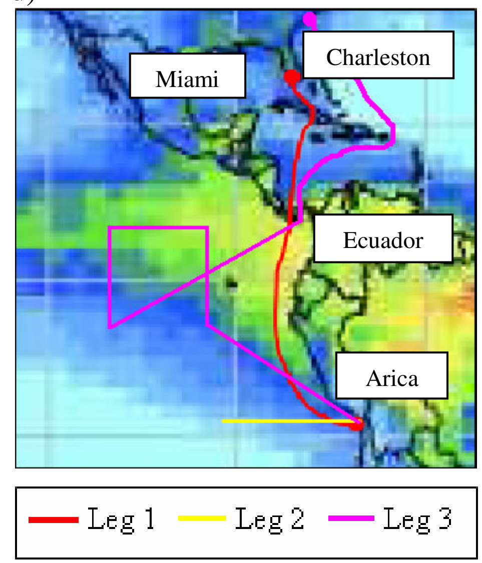


d)



Measured parameters:

- BrO, IO
- NO_2, O_4
- HCHO, CHOCHO
- Slant column densities
- Vertical profiles
- Boundary layer height
- VOC cannisters (NCAR)

Science questions:

- Ocean sources for VOCs and halogens
- Is CHOCHO seen off the coast of Ecuador real or a satellite measurement artifact?

Useful complimentary measurements:

- phytoplankton, marine productivity, ocean color
- aerosol size distributions, (chemical composition?)
- halogen precursor VOCs, photolysis frequencies ?
- parameters related to particle formation

Mooring development

LONG-TERM EVOLUTION AND COUPLING OF THE BOUNDARY LAYERS IN THE STRATUS DECK REGIONS OF THE EASTERN PACIFIC

Weller (WHOI)
(supported by NOAA Climate Observation Program)

Objective: to resolve variability on time-scales from diurnal to interannual and provide the first accurate and complete air-sea flux time series and coincident record of upper ocean structure from this region of critical importance to seasonal to interannual climate variability in the Americas.

Method: maintain a well-instrumented surface mooring at the site of the climatological maximum cloud cover off northern Chile (20°S, 85°W) and recover/redeploy annually with shipboard calibration/comparison of moored sensors and coincident atmospheric observations by C. Fairall (NOAA ESRL)

LONG-TERM EVOLUTION AND COUPLING OF THE BOUNDARY LAYERS IN THE STRATUS DECK REGIONS OF THE EASTERN PACIFIC

Weller (WHOI)

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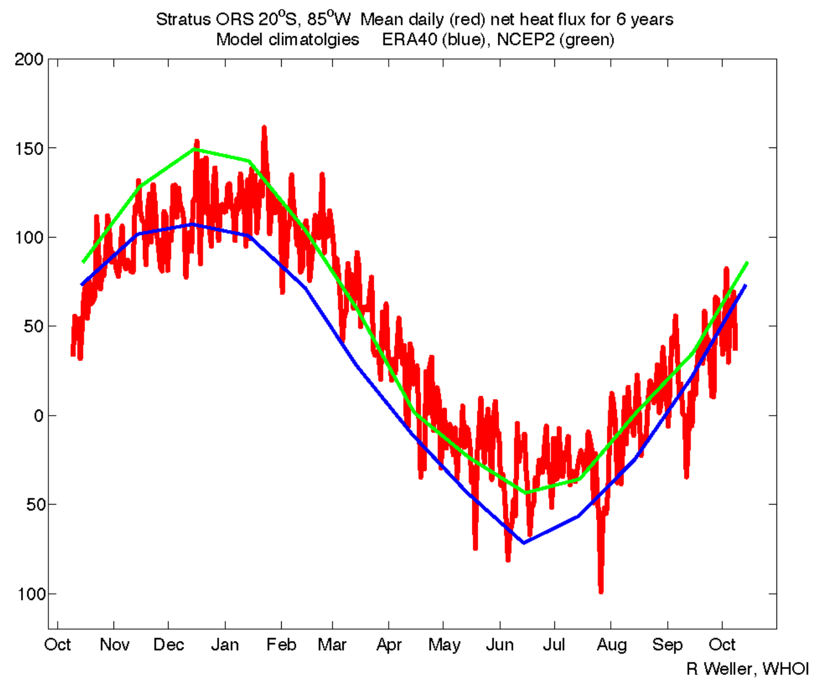
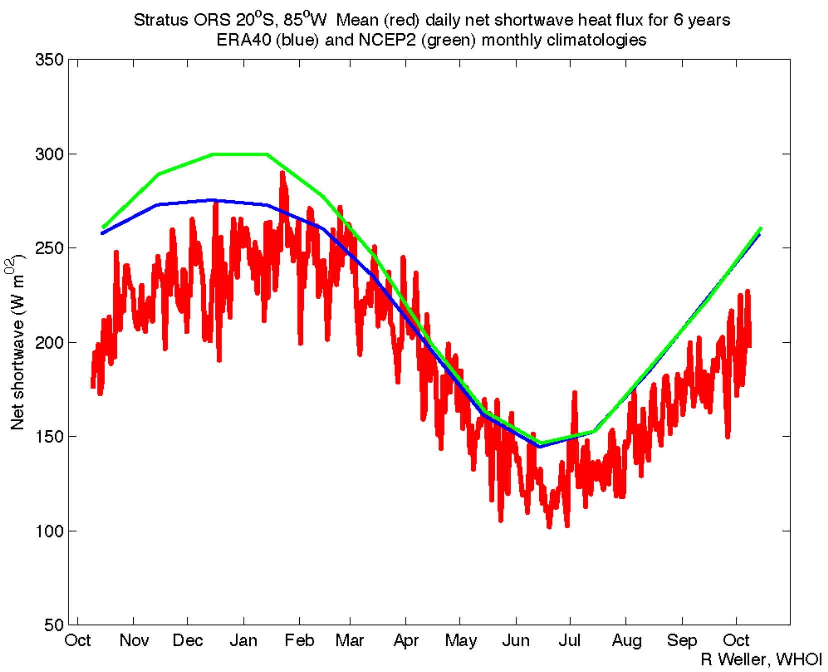


Net heat flux



Net shortwave

Buoy (red – 6-yr daily means) versus ERA40 (blue) verus NCEP2 (green)

Moored turbulence measurements

Zappa (LDEO), Farrar, Weller (WHOI)

Motivation:

- **The time rate of change of upper-ocean heat content does not balance the surface heating measured at the WHOI mooring (e.g., Colbo and Weller, 2008).**
    - **Some cooling of oceanic origin is implied.**
    - **A connected set of upper-ocean processes-- near-inertial internal waves, mesoscale eddies, and vertical mixing-- are hypothesized to be important oceanic influences on the regional SST field.**

Approach:

- Use pulse-coherent ADCPs to measure velocity microstructure (1.3-cm spatial resolution over a 1-m horizontal span) to infer turbulent kinetic energy dissipation at 6 depths on the WHOI mooring.

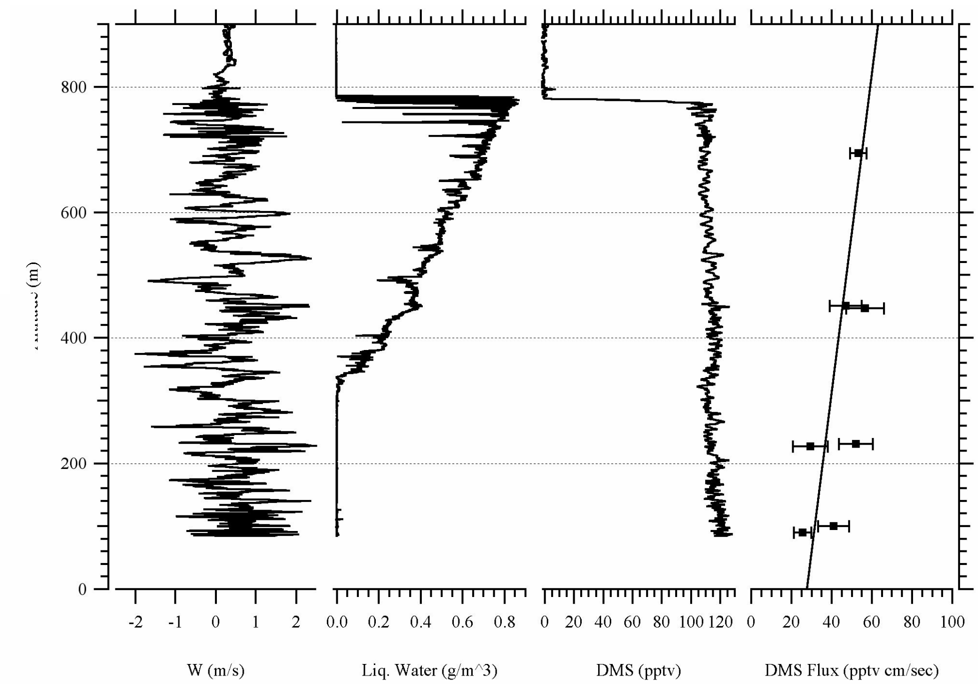
- Use dissipation with other moored WHOI measurements to:
    - produce more direct estimates of subsurface vertical turbulent heat flux (for understanding SST)
    - examine kinetic energy balance of near-inertial waves, including forcing, dissipation, and vertical propagation
    - examine dissipation and vertical mixing associated with eddies

C-130
Chemistry/Aerosol Characterization

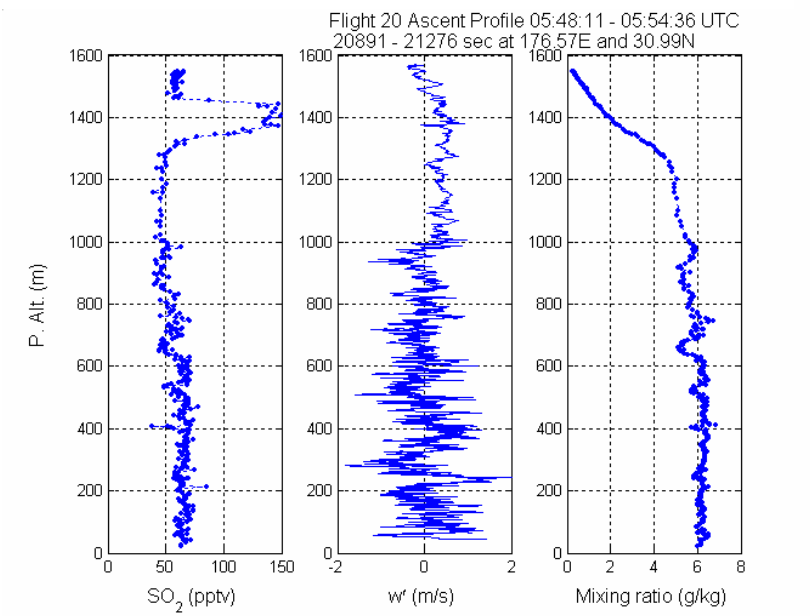
APIMS for DMS and SO_2 on the C-130

Alan Bandy, Drexel University

San Diego Stratocumulus
(DYCOMS, 2001)

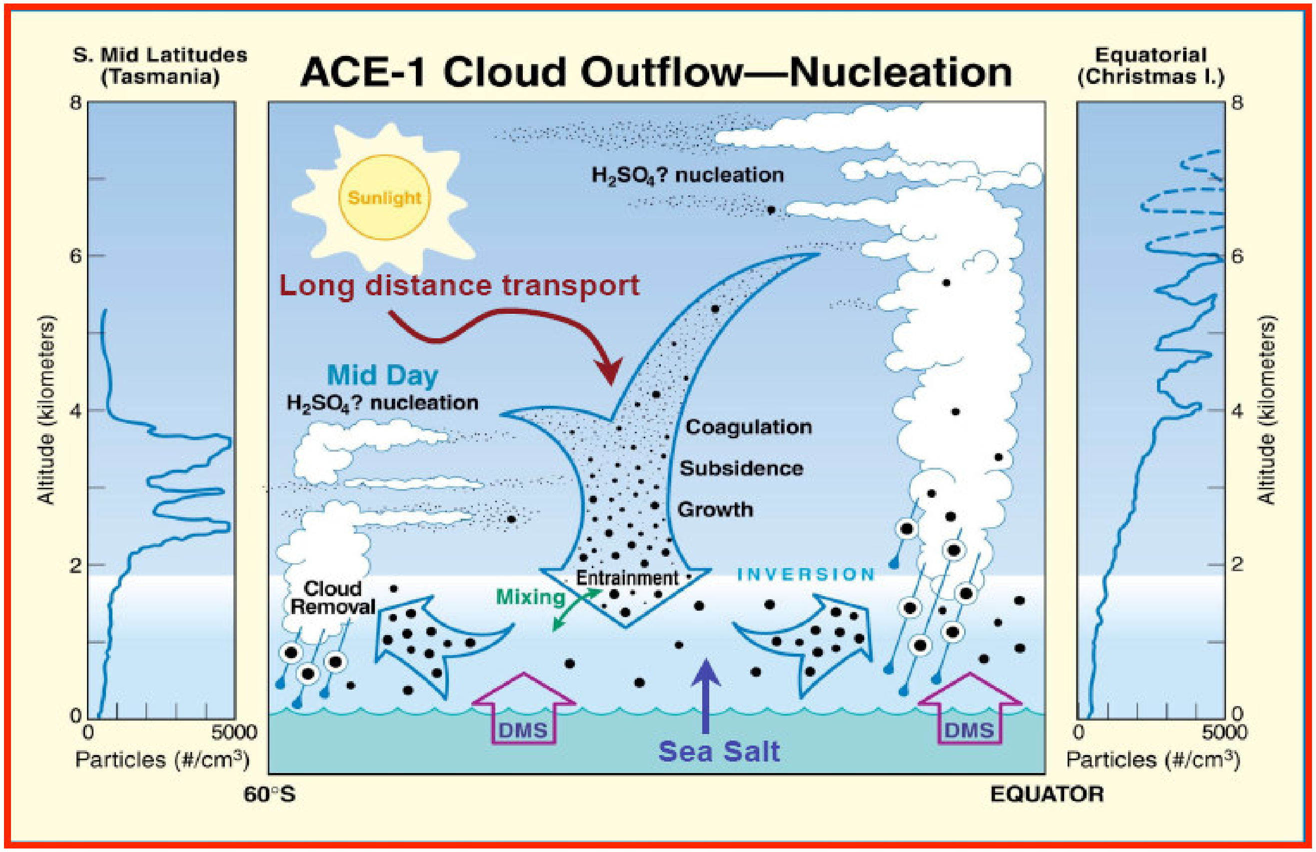


North Pacific SO_2



Hawaii Aerosol Group Major Goal:

What sources control the number of particles in the clean marine boundary layer and how do they influence CCN ?



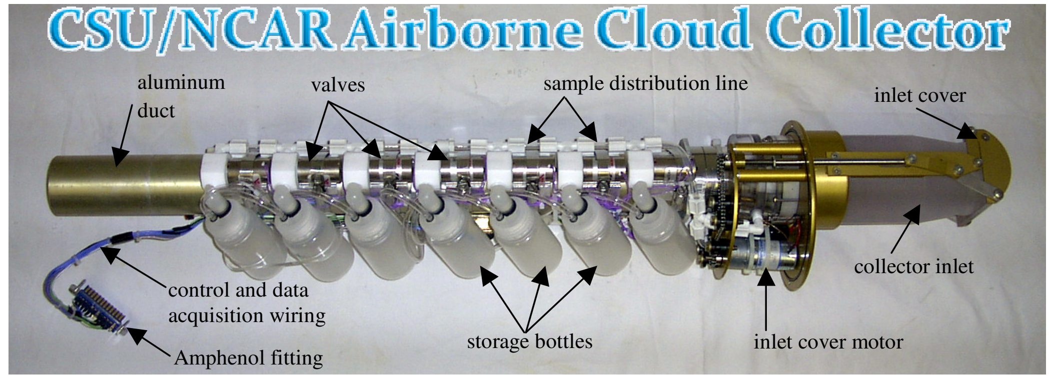
- Nucleation in cloud outflow
- Particle growth in MBL
- Seasalt aerosol production
- Long Range transport
- Removal in MBL clouds
- Nucleation in POCs?

UH Methodology Outline

- Composition and size reveal origins and CCN effectiveness
  - Size distributions 3 to 5000 nm
  - Black and organic carbon, SO4, NH4, NO3
  - Mixing state from tandem DMA and volatility
  - Rely on ASU for seasalt and dust (plus mixing)
- Flights over and under MBL boundary to characterize layers and measure exchange rates
  - FT contribution to MBL
  - Complicated by layering in FT
- 3 very different environments provide contrasts: Polluted coastal, clean marine, and POCs

CSU Cloud chemistry study

- **Study goals**
  - Determine chemical composition of marine clouds present in the VOCALS-REx study region.
  - Use cloud composition measurements, together with other VOCALS-REx measurements, to
    - Determine the extent of anthropogenic influence on cloud composition
    - Characterize the magnitude of the SO_2 sink represented by SE Pacific regional clouds
    - Provide a set of key cloud chemistry measurements in support of both specific VOCALS modeling efforts and other regional and global scale modeling efforts



- **Methodology**
  - Collect cloud water during in-cloud flight legs to analyze for chemical composition
  - 7 independent samples possible per flight using CSU/NCAR airborne cloud collector
    - 10 min cloud penetrations needed
  - Samples to be analyzed for inorganic ions, Fe, Mn, H_2O_2, S(IV), TOC, organic acids
  - Composition differences examined w/longitude
  - Trace gas + cloud data used to assess rates of S(IV) oxidation by various oxidants

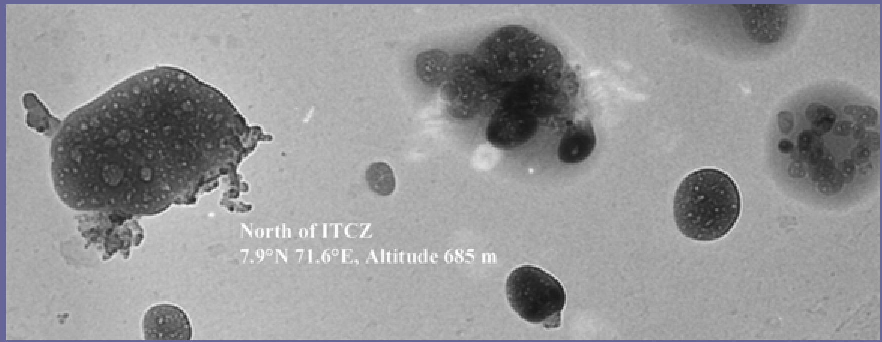
Physical and Chemical Analysis of VOCALS Ambient Aerosol and Cloud Droplet Residual Nuclei

- Individual aerosol particles and droplet residual nuclei will be analyzed by electron microscopy & X-ray analysis
- Then combined with cloud microphysical measurements to study aerosol indirect effects on cloud optical properties and lifetime

Counterflow virtual impactor (CVI) separates and evaporates droplets

Optical Particle Counter
Size Distribution

Filters, Impactor
Composition from Electron Microscopy



Ex: sulfates mixed with organics and black carbon in polluted Indian Ocean

Cindy Twohy (Oregon State), Jim Anderson (Arizona State)

C-130 Remote Sensing

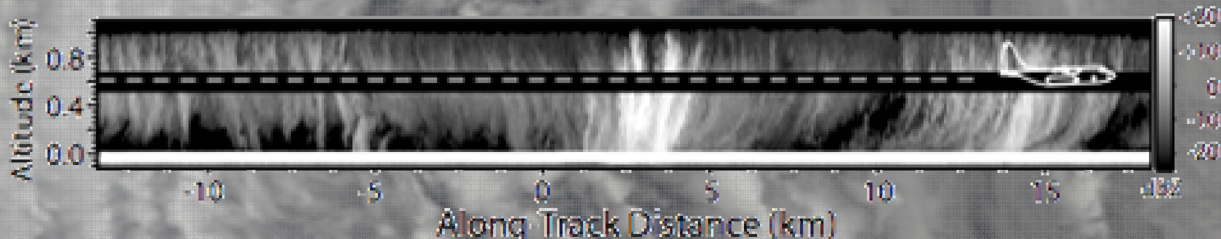
Comprehensive Studies of Marine Sc during VOCALS-REx using Airborne Radar, Lidar, and In Situ Measurements

David Leon and Jefferson Snider, University of Wyoming

Instruments:

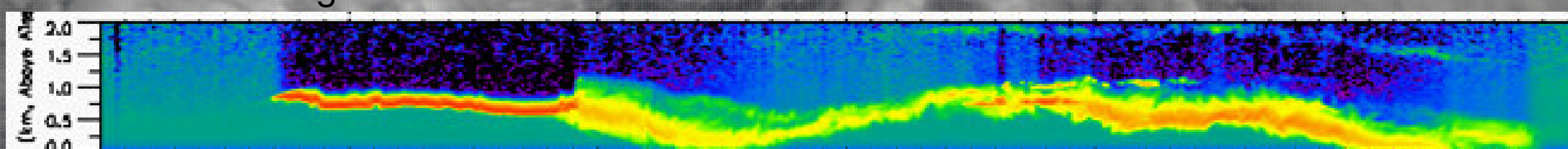
•WCR: 95 GHz Doppler Radar. Upward + Downward Looking

– Products: Vertical-plane Reflectivity/Doppler Velocity, Precipitation Rate, Cloud Top Height



•WCL: Elastic-Scattering Lidar. Upward-Looking Only

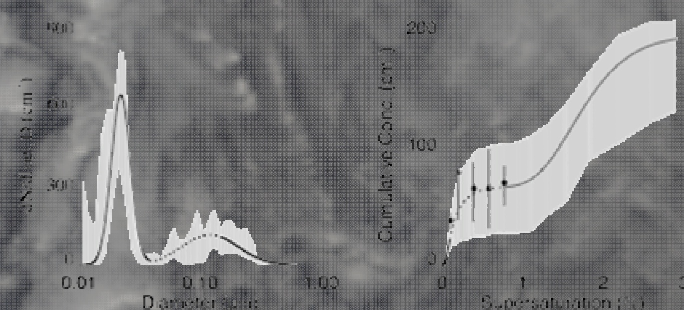
– Cloud Base Height



•In Situ Aerosol:

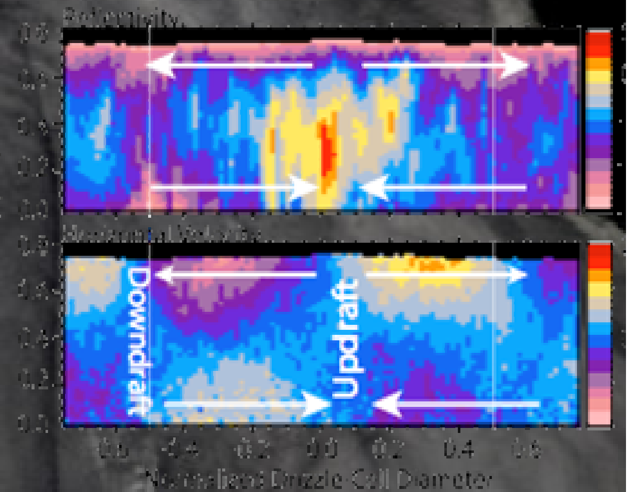
– Synthesis of aerosol spectra (RDMA/PCASP/F300 etc.)

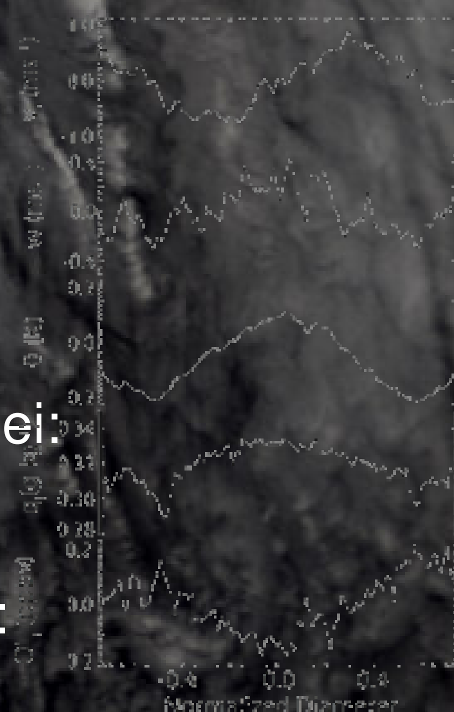
– CCN spectra in the subcloud-layer



Leon/Snider Research Objectives

- Estimate Precipitation Rate
  - Precipitation Rate at Cloud Base and Ocean Sfc.
    - Accretion/Evaporation Profiles
- Estimate Coalesence-Scavenging Rate
  - Function of Accretion Profile and Cloud Droplet Spectra
- Document Mesoscale Organization Within the BL:
  - POCs vs Closed-Cells
  - Interaction between Drizzle and Mesoscale Organization
- Characterize Physical Properties of the Droplet Nuclei:
  - Water Soluble Mass Fraction
- Document Occurrence of Ultrafine Aerosol Particles:
  - Connection to Coalescence-Scavenging





Cloud remote sensing in support of VOCALS-REx

Paquita Zuidema, U of Miami

liquid water path measurements

are key for distinguishing aerosol indirect effects, forming drizzle parameterizations, model validation, linking cloud optical properties to aerosol and precipitation variability

2 platforms:

1. C-130: 4-channel upward-viewing 183 GHz microwave radiometer (only)
2. R/V Ron Brown: 183 GHz MWR (on loan from ARM)+ 20,30 GHz MWR

ship-based retrieval has technical advantages, aircraft-based retrieval more experimental but important to VOCALS objectives

to foster success of the aircraft-based retrievals:

1. C-130 overflights of Ron Brown,
2. one high-altitude C-130 flight measurement of blackbody “space” radiation

VOCALS Peru

FIELD PARTICIPANTS

Peru Marine Research Institute/ IMARPE:

Carmen Grados, Luis Vasquez (Surf. Met, Physical Oceanography), Michelle Graco, Jesús Ledesma, Miguel Sarmiento/Carlos Robles (O_2, Chl-a,Nutrients, pCO_2), Sonia Sanchez (Fitoplankton), Patricia Ayon (Zooplankton), Salvador Peraltilla (Hydroacoustics)

Laboratoire d'Etudes en Géophysique en Océanographie Spatiales (LEGOS), CNRS/CNES /IRD/Université Paul Sabatier:

Boris Dewitte, Gérard Eldin, Yves du-Penhoat (Phys. Oceanography)

Laboratory of Ocean, Climate and Numerical Analysis/ LOCEAN:

Alexis Chaigneau, Vincent Echevin (Phys. Oceanography)

Upwelling Ecosystems/ ECO UP

Arnaud Bertrand (Marine Ecology)

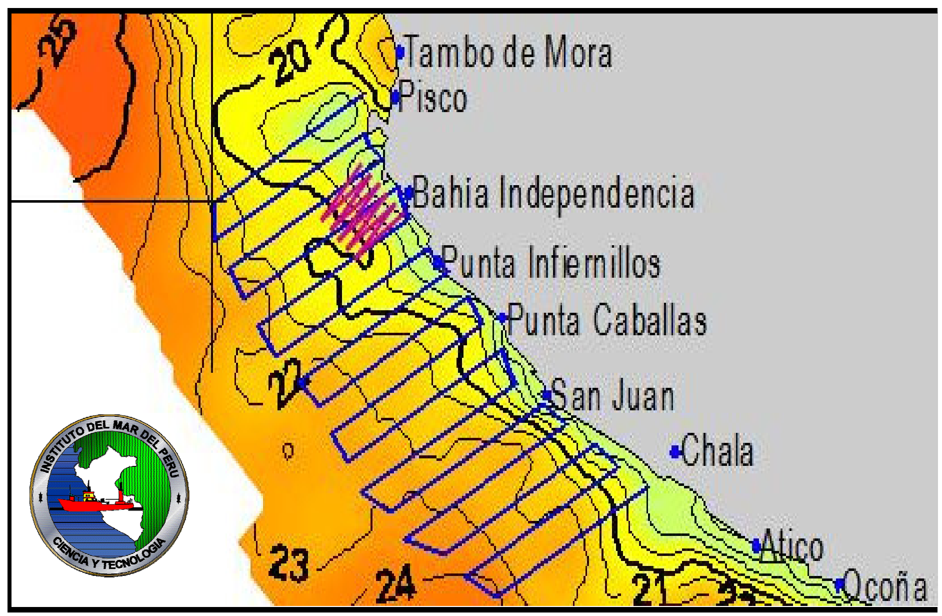
Instrumentation, Moyens Analytiques, Observations en Géophysique et Océanographie/ IMAGO, IRD US191

Jacques Grelet (Engineer)

Main Objective and Hypothesis

The main objective of the Peru VOCALS Coastal Component is to investigate the meso and submesoscale ocean-atmosphere interaction in the upwelling cell off southern Peru (Pisco-San Juan) and to determine the associated biogeochemical responses. Two main hypotheses are considered:

- There is a strong feedback/ interaction between the variability of the atmospheric coastal wind, the upwelling cell and the instabilities of the associated thermic front and cloud clearing between Pisco-San Juan.
- Mesoscale eddies play an important role in the transport of coastal upwelled water properties to offshore regions.



Observation of the upwelling plume and front by a glider (magenta line). (Color shaded corresponds to SST observed in February of 2007, the Peru VOCALS cruise is indicated by blue lines).

Specific questions and Approaches

This project address (through modeling and from the available observations) **specific questions** that are believed to be relevant to the understanding of the variability in the Pisco-San Juan region. These are:

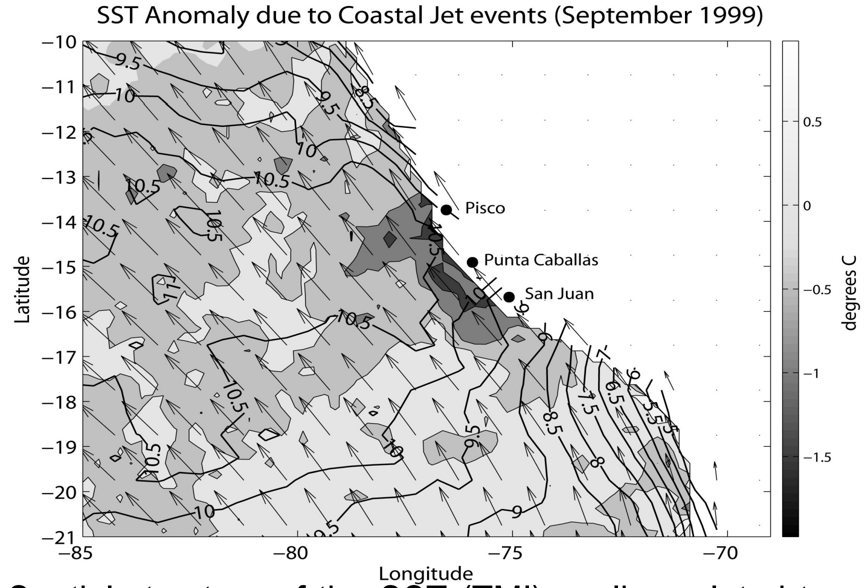
SQ1. Spatial structure of the low-level atmospheric circulation (15°S)

SQ2. Quasi-permanent coastal clearing (~15ºS)

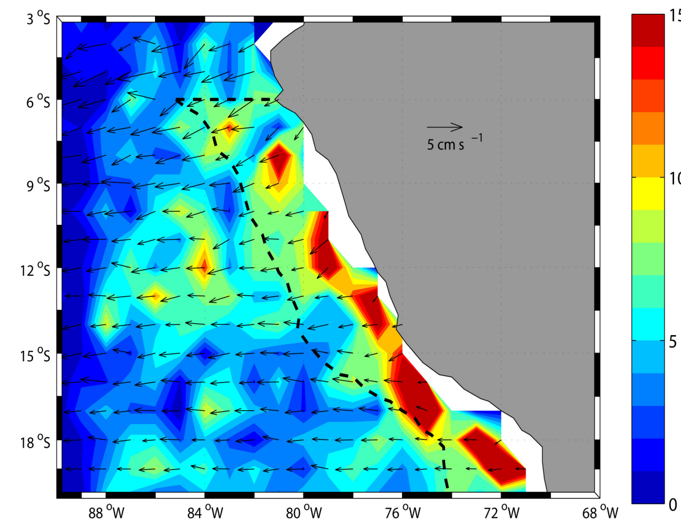
SQ3. Strongest coastal upwelling and eddy activity

SQ4. Coastal Jet events and their impacts on the vertical oceanic variability

SQ5. 4-D Structure of mesoscale features and related cross-shore transports



Spatial structure of the SST (TMI) cooling related to a well defined CJ (about 7 days) which occurs at the beginning of September 1999 [Renault, et al, 2007].



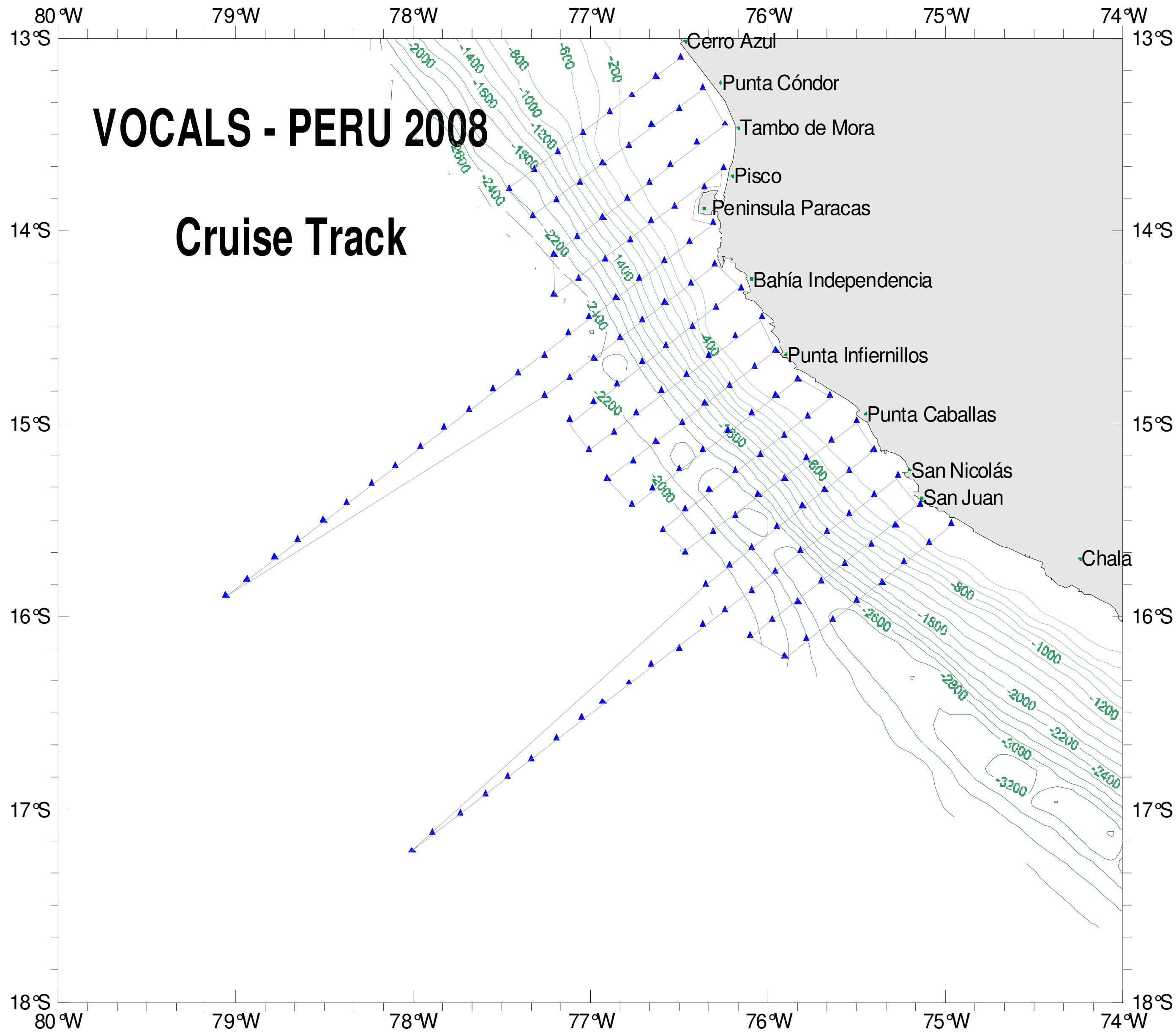
Mean regional climatology of eddy genesis occurrence for the time period October 1992-August 2006 [Chaigneau, et al, 2007, submitted].

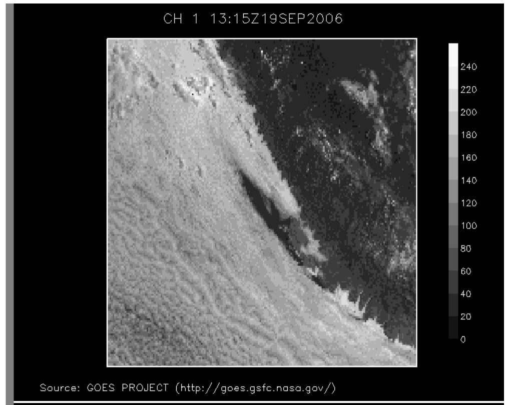
Summary of atmospheric, oceanographic, biogeochemical and fishery observations

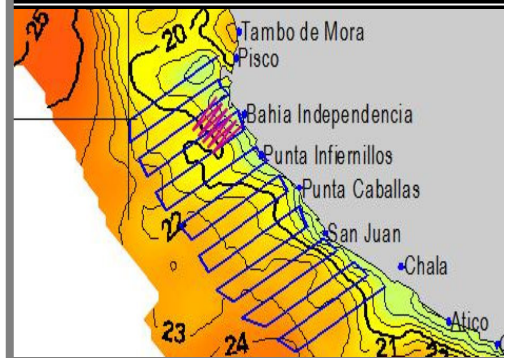
ATMOSPHERIC	In land	Surface measurement	Ta, Humidity, SLP, Wind speed/direction, Cloudiness (cloud cover, types), Weather conditions
		Vertical profile	Ta, Humidity, Pressure, Wind speed/direction
	On cruise	Surface measurement	Ta, Humidity, SLP, Wind speed/direction, Cloudiness (cloud cover, types), Long /Short Wave Radiation, Weather conditions
		Vertical profile	Ta, Humidity, Pressure, Wind speed/direction

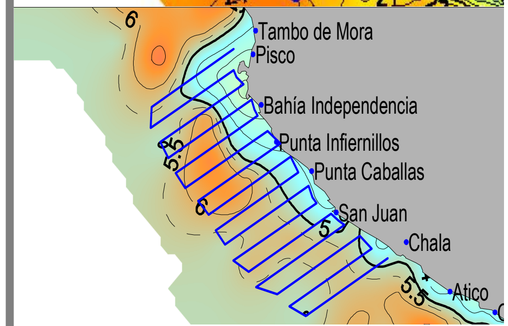
OCEANOGRAPHIC & BIOGEOCHEMISTRY COMPONENTS	Coastal stations	Surface measurement	SST, SSS, O_2, Phyto & Zooplankton
	On cruise	Surface measurement	Tw, Salinity, Horizontal Velocities, O_2, Fluorescense, Chlor-a, pCO_2 Nutrients (NO_3, PO_4, SiO_3, SiO_4), Phyto & Zooplancton (eggs-larvae)
		Vertical profile	Tw, Salinity, Vertical Velocities O_2, Fluorescense, Chlor-a, pCO_2 Nutrients (NO_3, PO_4, SiO_3, SiO_4), Phytoplankton, Zooplancton (eggs-larvae)
FISHERY RESOURCES	Acoustic measurements		Ecotraces of fish distribution and abundance, zooplancton
	Laboratory Analysis		Post processing of acoustic data If trawl sampling: fish biology and stomach content analysis

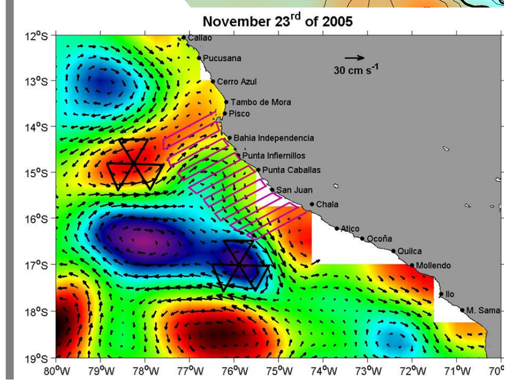
VOCALS Peru Cruise track- Cr. Olaya 2008/10











No	Hypothesis	Obs.	Models	PI Teams obs/modeling/both	IDs
2A	Oceanic mesoscale eddies play a major role in the transport of heat and fresh water from coastally upwelled water to regions further offshore.	Olaya	ROMS CGCMs	Grados Chaigneau Graco Ayon Dewitte	To be defined
2C	The diurnal subsidence wave ("upsidence wave") originating in northern Chile/ southern Peru has an impact upon the diurnal cycle of clouds and provides a useful framework for analysis of numerical model performance on diurnal time scales.	Olaya	MM5 WRF GCMs	Silva Takahashi Renault	Diurnal composite lower tropospheric and MBL structure at 5 distances (100-1500 km) from the Andes
2D	The entrainment of cool fresh intermediate water from below the surface layer during mixing associated with energetic near-inertial oscillations generated by transients in the magnitude of the trade winds is an important process to maintain heat and salt balance of the surface layer of the ocean in the SEP.	Olaya	Parcel Model LES	Vasquez Chaigneau Eldin	To de defined

Project: Ocean-Land-Atmosphere interaction and its impact in the atmospheric circulation in the central-south peruvian coast

IGP

PIs: Yamina Silva (IGP), Ken Takahashi (GFDL/IGP)

Main objective: Study the 3-dimensional structure in the lower atmosphere and understand its interaction with the ocean and land in the coastal zone of central-southern Peru, with emphasis in the causes of the intensity of low level winds (coastal jet) and the coastal clearing.

Observations:

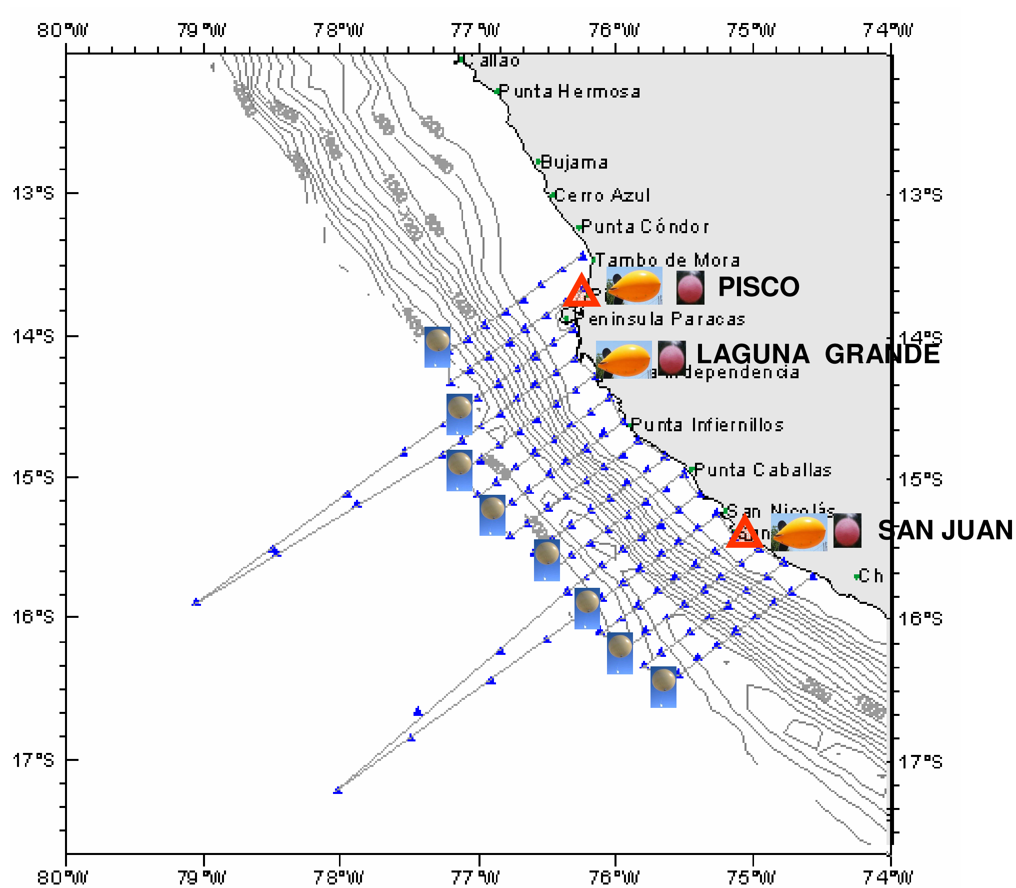
Atmospheric observations in the central-southern coast of Peru (simultaneous with oceanic observations by IMARPE).

Cruise observations:

- Radiosoundings: 6 x transect (4 near the coast & 2 off shore)
- Automatic Meteor. Station, Radiometers

Land observations

- Air temp. & humidity by tethered balloons up to 2km height, every 3 hours
- Wind profile with pilot balloons, every 3 hours
- Automatic Meteor. Station (DCP)



Twin Otter

Aerosol-Cloud-Drizzle-Turbulence Interactions in Boundary-Layer Clouds

P.I.: Bruce Albrecht (University of Miami)
Agency: ONR

- *VOCALS Science Foci: REX -- Hypotheses 1a, 1b, and 1d; Coastal:*
  - *Aerosol-cloud-drizzle-turbulence characterizations and interactions*
  - *Role of continental aerosols generated along the coast of Chile in modifying cloud-precipitation processes in this area*
  - Coastal process studies: Diurnal cycle and stagnation effects
- *Approach:* Collaborative efforts (process studies) using observations from *in situ* and remote sensing systems operating on CIRPAS Twin Otter and coordinated flights with other aircraft
- Principal Observations:
  - Doppler mm-wavelength cloud radar
  - Aerosol and cloud physics
  - Turbulence
- Collaborators: Patrick Chuang, Carl Friehe

UC Santa Cruz @ VOCALS

- **Phase-Doppler Interferometer (PDI)** has been developed for airborne measurements (*photo left*).
- Measures cloud drop:
  - ***size distribution***
  - ***velocity distribution***
  - ***inter-drop spacing***
- Size range: 3 to 150 µm

Objectives:

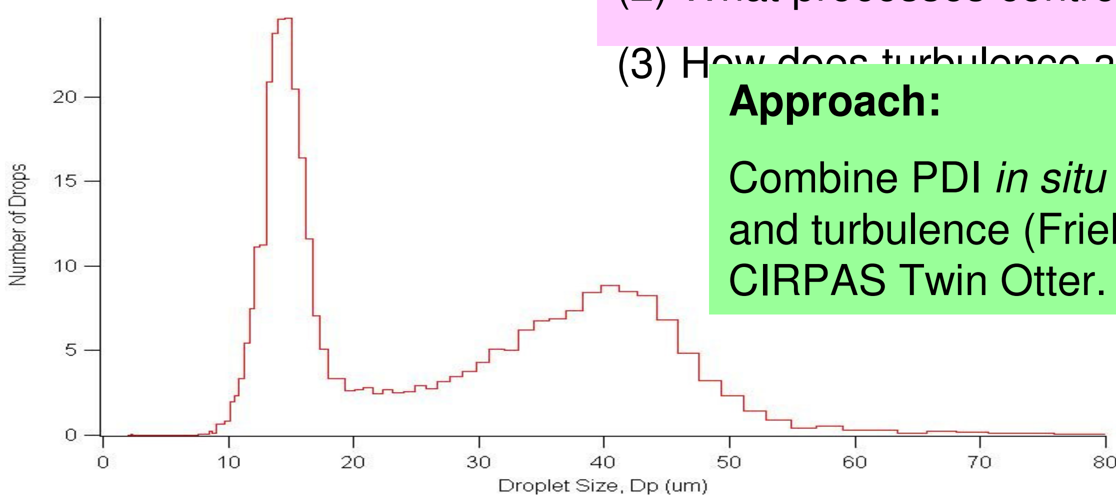
(1) What is the observed nature of drizzle in the VOCALS region?

(2) What processes control these observed drizzle properties?

(3) How does turbulence affect cloud microphysical properties?

Approach:

Combine PDI *in situ* data with airborne radar (Albrecht) and turbulence (Friehe) measurements, all on the CIRPAS Twin Otter.



Left: PDI measurements in stratocumulus near Santa Cruz, CA showing two drop modes.

VOCALS UK

Natural Environment Research Council (NERC) CONSORTIUM

• Manchester –	Coe, Choularton, Bower, Vaughan, Gallagher, McFiggans, Connolly	measurements; cloud process studies aerosol composition
• Leeds -	Blyth, Gadian, McQuaid	cloud and regional process studies
• Reading -	Slingo, Shaffrey, Toniazzo	climate studies

- The NERC Consortium is at the proposal stage
- The assessment panel meet on April 21
- Outcomes should be known in May
- **The MO Commitment is now confirmed**

Proposed VOCALS-UK measurement activities:

• Two aircraft are planned:

BAe-146 – the participation of the BAe-146 in VOCALS is now confirmed through participation of the Met Office, though additional instruments will be supported through the NERC Consortium (AMS; SP-2; filters; DMA; CAPS; CDP; 2DS)

NERC Do-228 – This is solely a remote sensing platform fitted with an aerosol backscatter lidar and two hyperspectral imagers. Participation contingent on NERC

The NERC VOCALS-UK project will close collaborate with the Met Office’s activities and extend them through additional measurements and use of a suite of aerosol-cloud and regional cloud models.

In addition, VOCALS-UK is interested in:

• Assessing aerosol and CCN characteristics across the region.

This will involve close coupling between the BAe-146; the Do-228 and the C-130 activities. The Do-228 curtain flights will deliver the vertical distribution of the aerosol

• Assessment of cloud heterogeneity on a wide range of scales –

hyperspectral imaging to determine cloud scales for comparison with LEM

• Extension of cloudy-sky radiance work to include Do-228 information

DoE ASP G-1

Integrated Datasets

Integrated Datasets (IDs)

Wood/Bretherton proposal

ID	*Rationale*	*Space/Time scale; Location; Platforms*	*Parameters*
Combined Drizzle Dataset (CD-ID)	Collocated precipitation, aerosol and cloud micro- and macrophysical properties	~50 km, 10s of mins; All flight locations; C-130, RHB, other a/c	Precip. rate, LWP, cloud thickness, cloud drop conc., subcloud aerosol size distribution and chemistry
Cross-Section Dataset (XS-ID)	Data on E-W cross-section along 20°S from coast to ~1500 km offshore	~250-1500 km, 6 hr; Along 20°S, 70-85°W; C-130, UK 146, RHB	MBL depth, profiles, z_{cb}, LWP, CF, precip. rate, cloud microphysics (drop conc. and r_e), aerosol size dist. and speciation in/above MBL, Anthropogenic indicators (SO_2, CO)
Lagrangian Dataset (Lag-ID)	MBL, aerosol, cloud, drizzle evolution for multiple *POC-Drift* and polluted Lagrangian flights	Function of time C-130 and other a/c	As for XS-ID, including interpolated reanalysis data

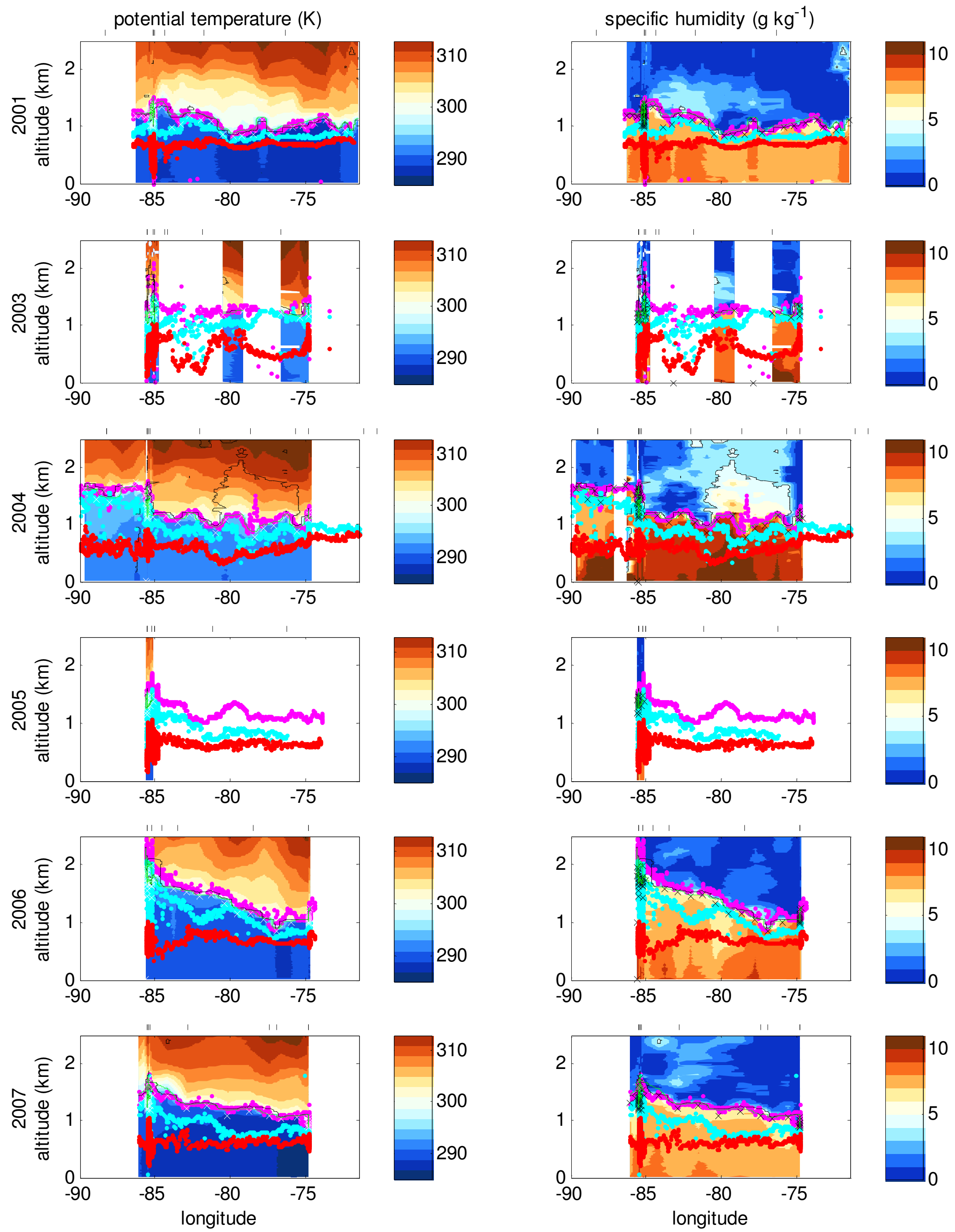
GCSS Case Studies

Integrated datasets:
NOAA/WHOI Stratus ship observations prior to VOCALS REx

Simon de Szoeke and Chris Fairall
NOAA/ESRL Physical Sciences Division
simon.deszoeke@noaa.gov

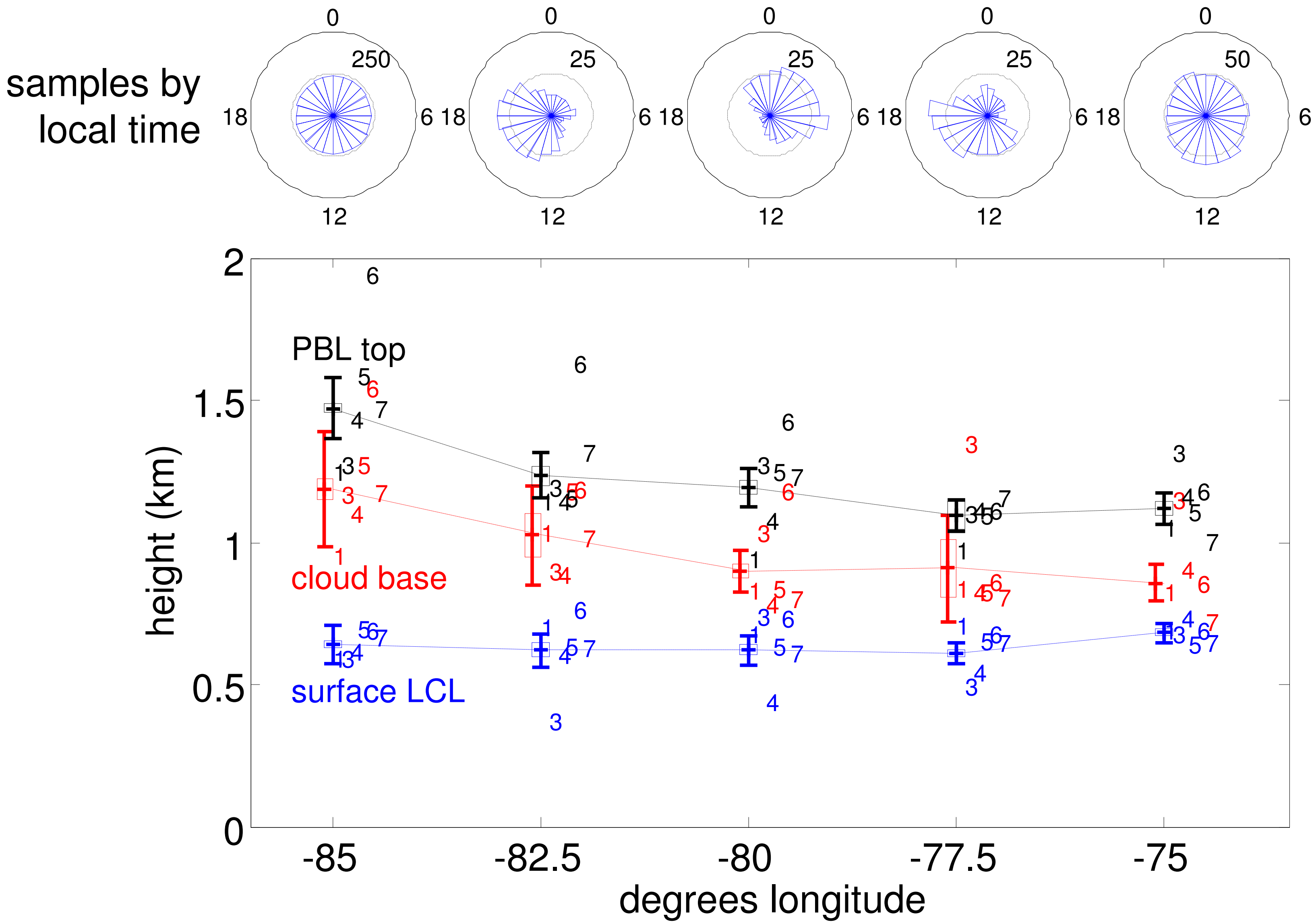
20˚S section

- 6 years of observations 2001, 2003-2007
- Surface meteorology
- Soundings
- Lidar ceilometer
- PBL top from MMCR or 915 MHz radar



longitude-vertical sections

aggregate 20˚S section



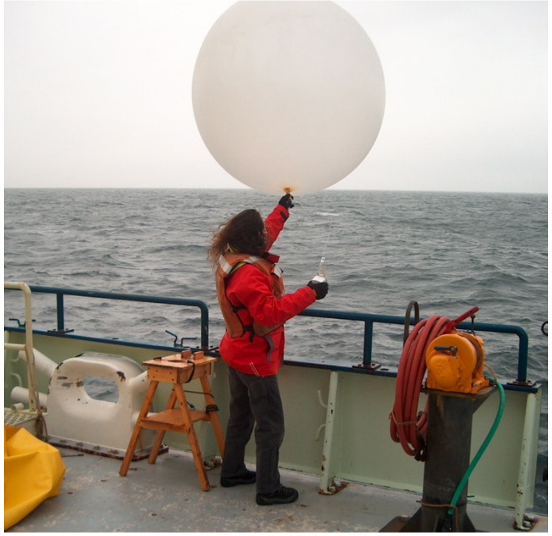
Southeast Pacific Stratus

synthesis data set available at

http://www.esrl.noaa.gov/psd/people/Simon.deSzoeke/synthesis.html

Land Sites

GAUS soundings



- Iquique (Oct 15-Nov 15 2008):
  - **6 per day for 30 days (180 total)**
- R/V José Olaya site (Oct 25-Nov 7th 2008):
  - **8 per day for 15 days (120 total)**

Anthropogenic Effect on Natural Cloud Properties – contribution to VOCALS-REx

PI: Radovan Krejci, Stockholm University, Sweden radek@misu.su.se

Measurements of microphysical and chemical properties of cloud residuals at ground based (Paposso)

Sample air from CVI probe is directed to instrumentation measuring residual droplet density (CPC) and size distribution (DMPS + OPC). In addition, PSAP will be used to measure concentration of light absorbing material in cloud residuals. LWC will be calculated from measurements of evaporated cloud water (Licor LI 7000).

Cloud residual particles will be also sampled on filters for consecutive analysis using Scanning Electron Microscope. There is open possibility of participation of AMS from MPI-Mainz, Germany, but first infrastructure at the site has to be clear and confirmed.

Interstitial aerosol measurements will be also possible through additional aeroso lrack or by switching the sample air stream between CVI and interstitial inlet

Possibility to repeat measurements also one year after VOCALS.

Characterization of the aerosol size distribution at Paposo, Chile

Wood/Thornton, University of Washington

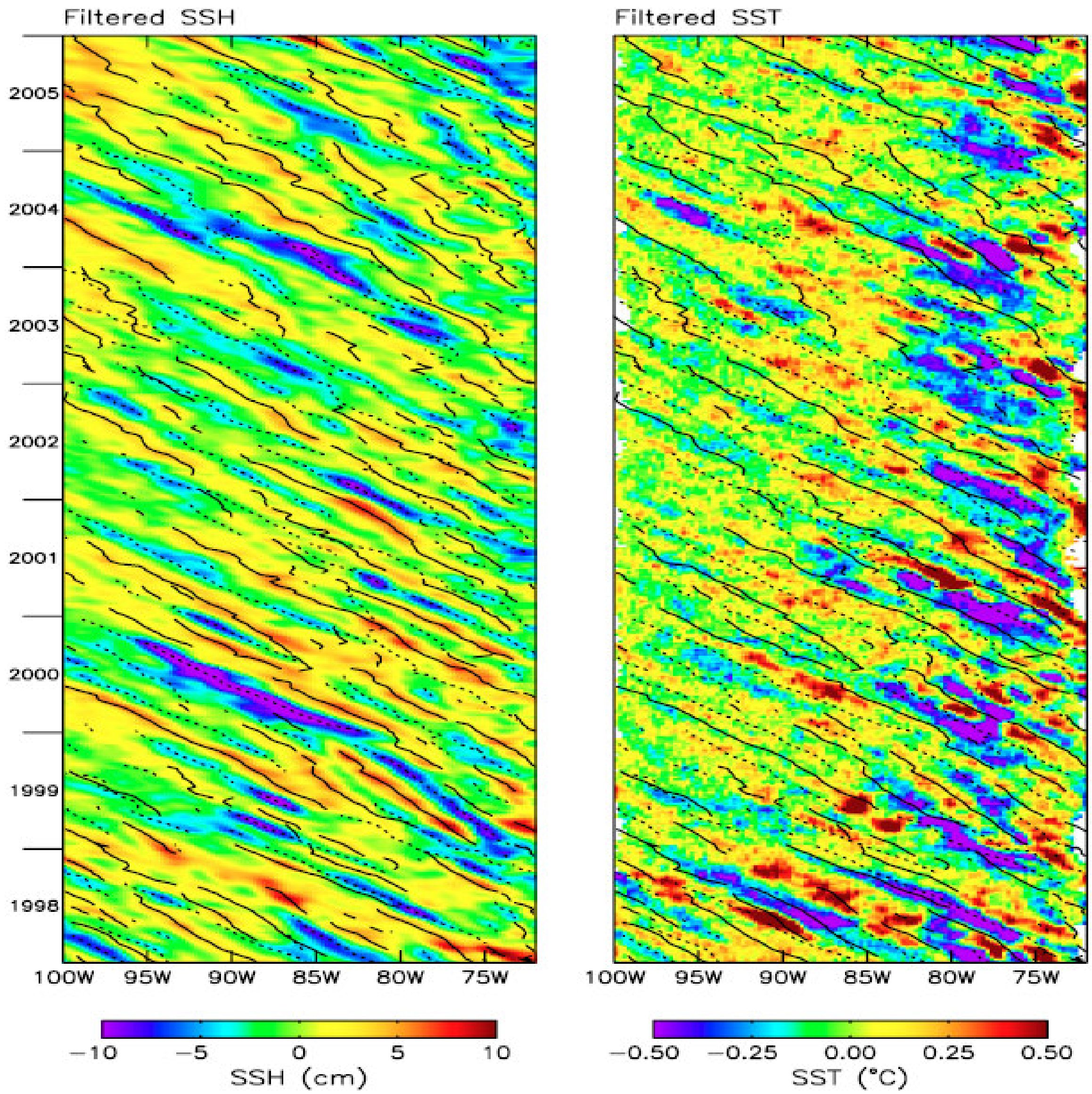
- Continuous SMPS/OPC determination of the aerosol size distribution

Satellite Studies

Satellite altimetry of mesoscale ocean eddies

Dudley Chelton, OSU, Funding source: NASA

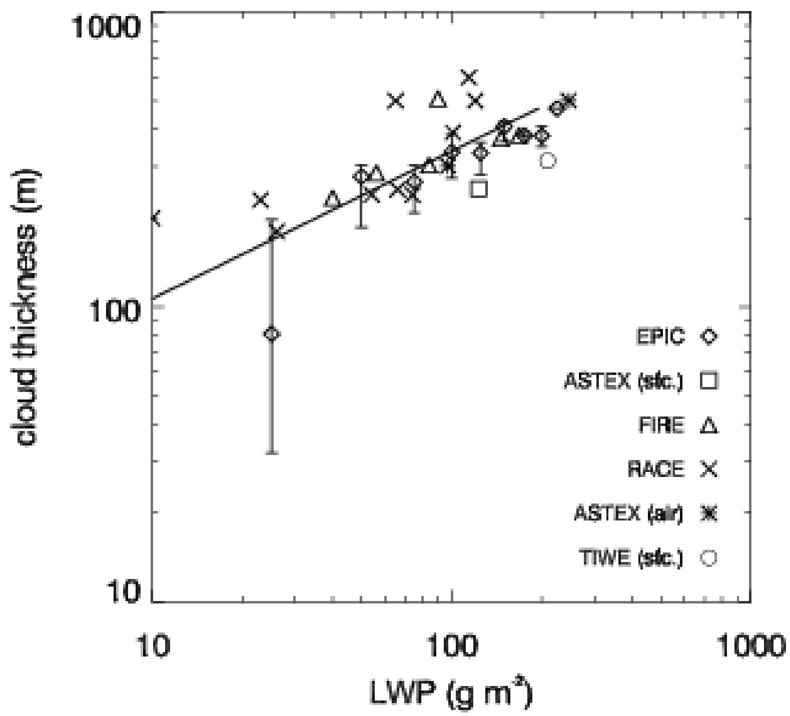
- Altimetry
- SST (AMSR/TMI)
- Quikscat winds



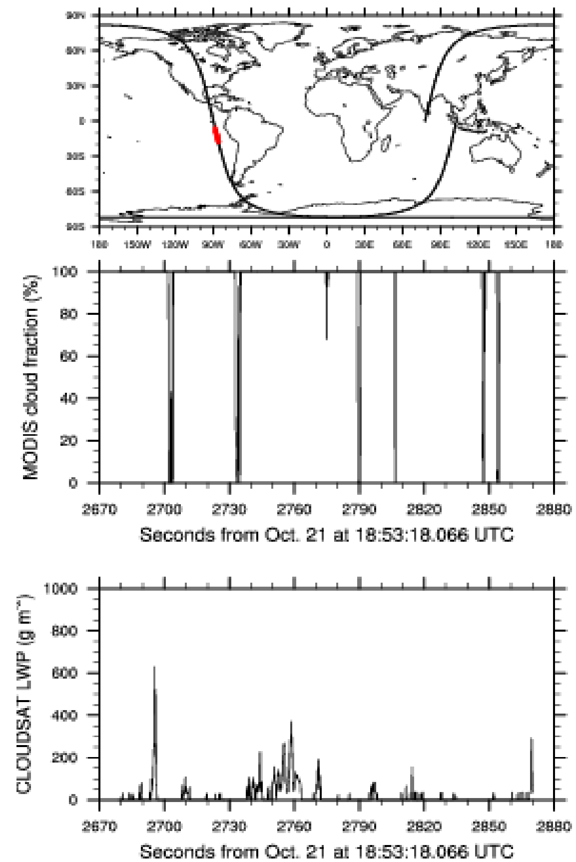
Using VOCALS and Satellite Data to Improve the Treatment of Marine Boundary Layer Clouds and Turbulence

Xubin Zeng and Michael A. Brunke

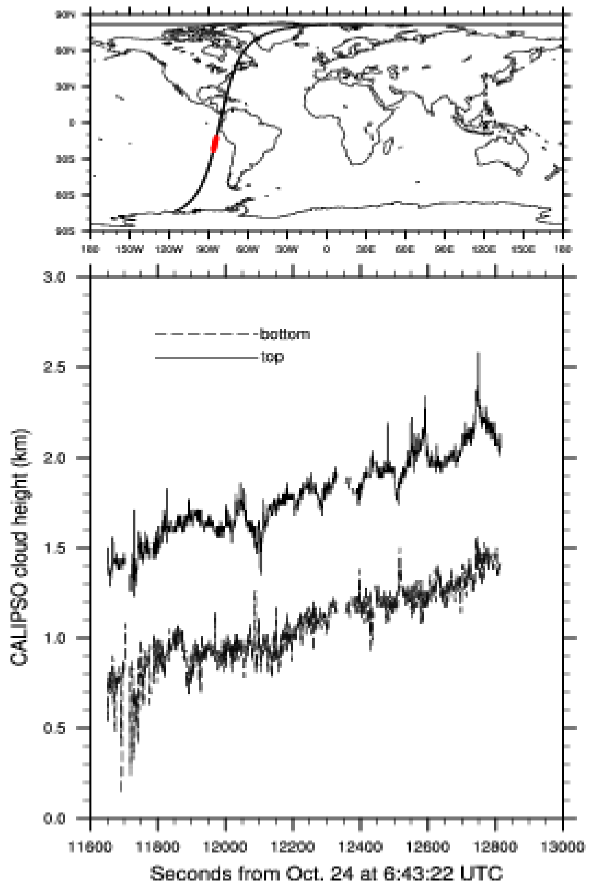
The University of Arizona

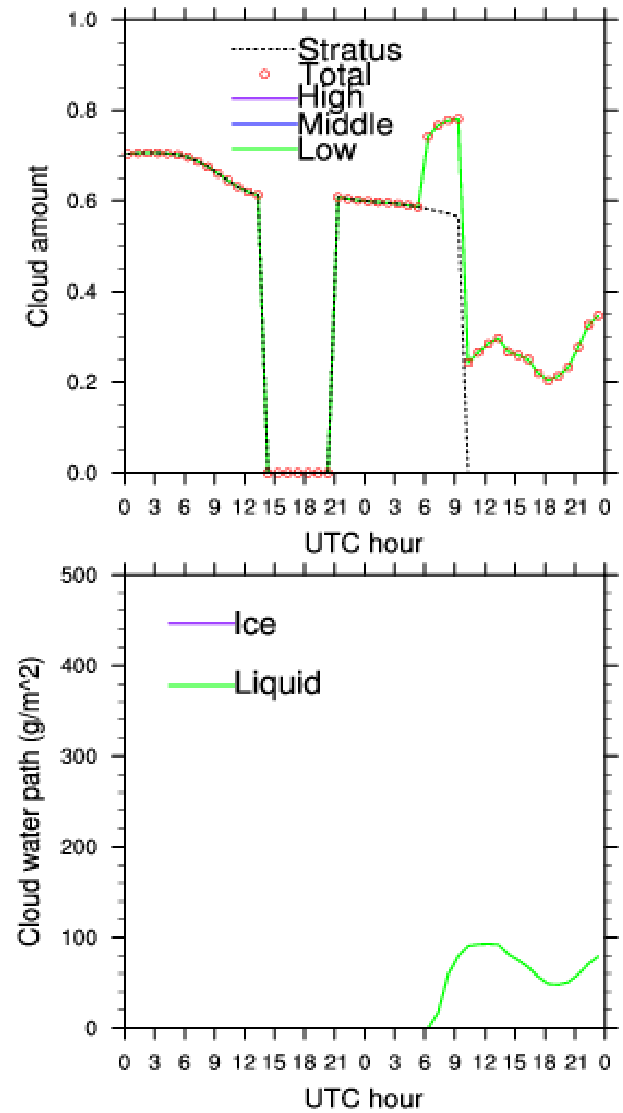


Compare and contrast SEP BL and St observed by VOCALS w/ in-situ data from 16 other cruises.



Evaluate consistency between CLOUDSAT and MODIS data.



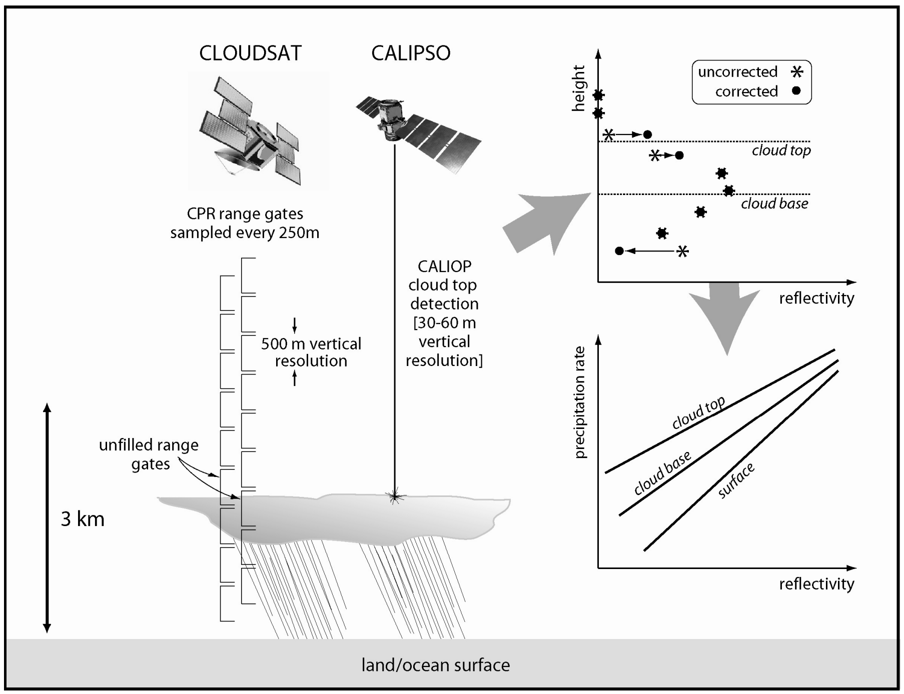


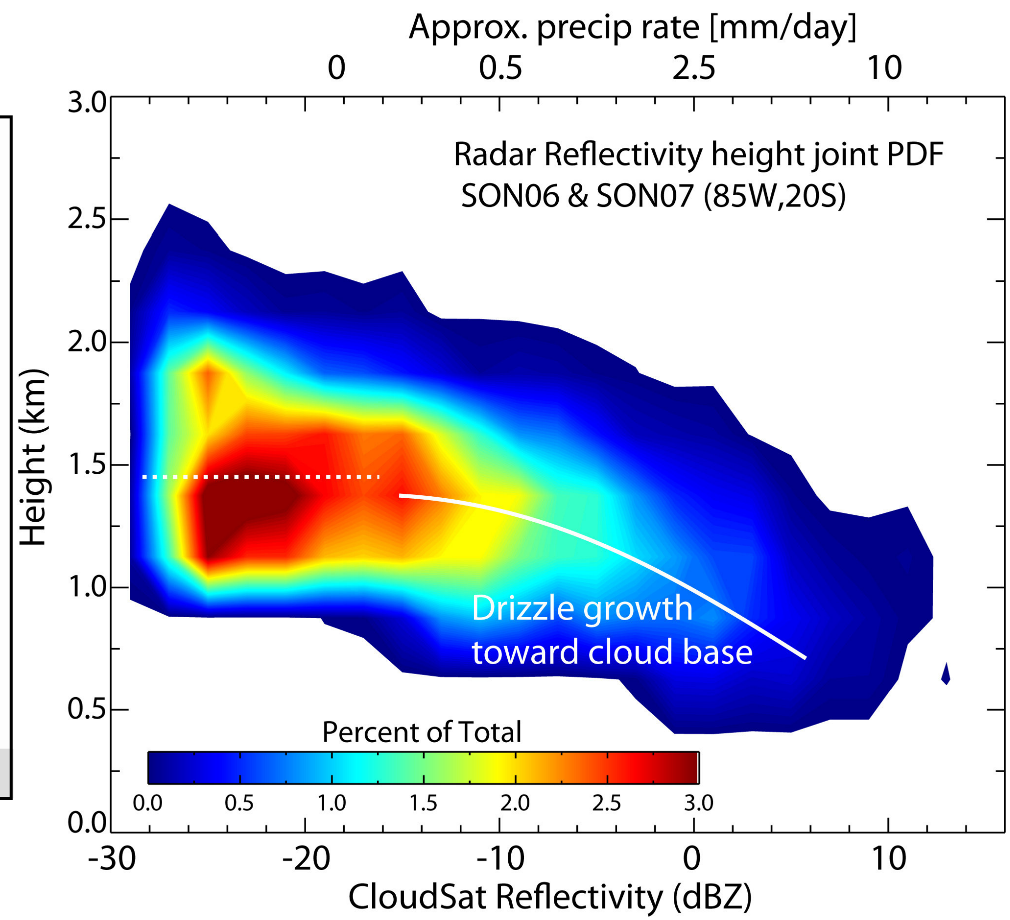
Using satellite and in-situ data, we will evaluate model simulation of cloud properties.

Data will be made available to the VOCALS group.

Observations of precipitation in marine low clouds using CloudSat

Rob Wood, Katie Boyd, Terry Kubar, Dennis Hartmann
University of Washington





Lagrangian observations and modeling of aerosol-cloud interaction

Wood/George/Garreaud

- Composite satellite observations to determine time-resolved synoptic variability of cloud micro- and macrophysical properties
- Use trajectory analysis and modeling to relate these patterns to aerosol and meteorological variability