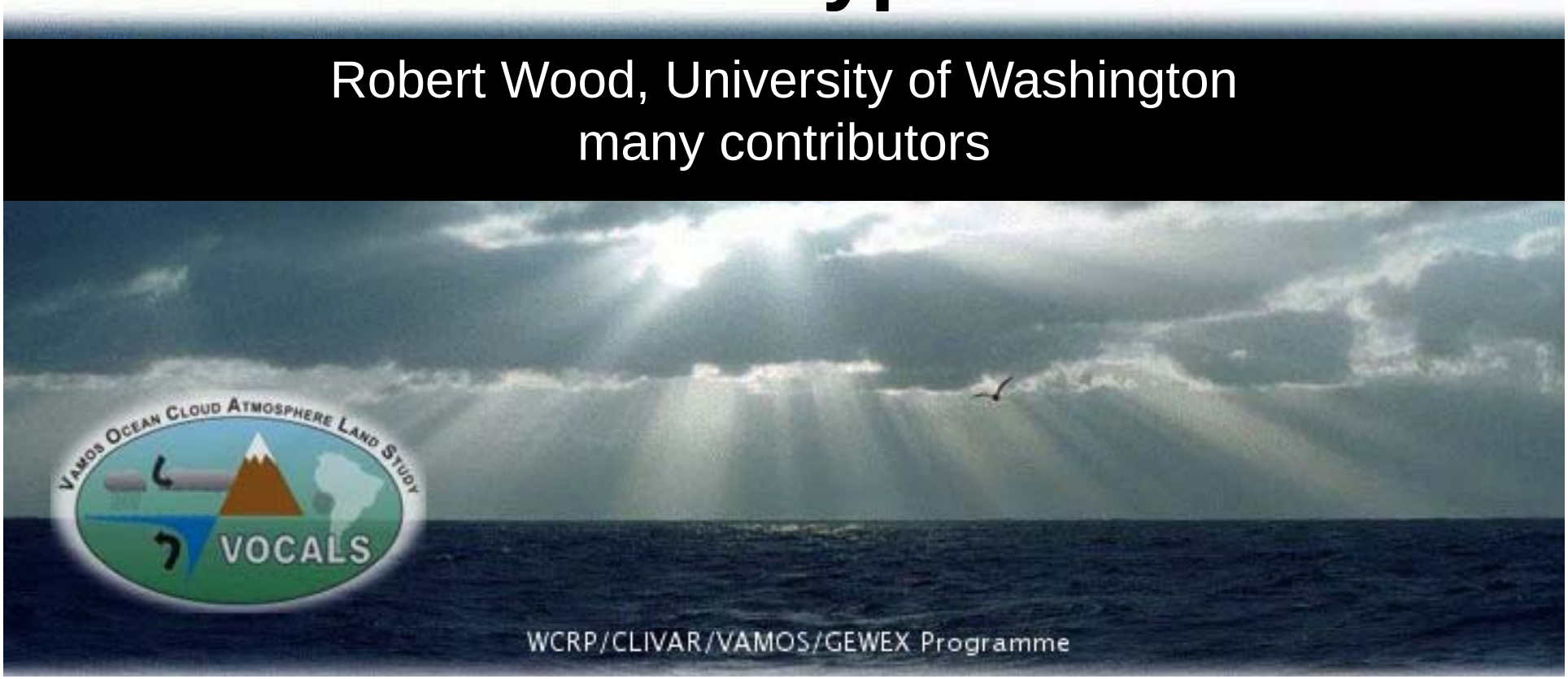
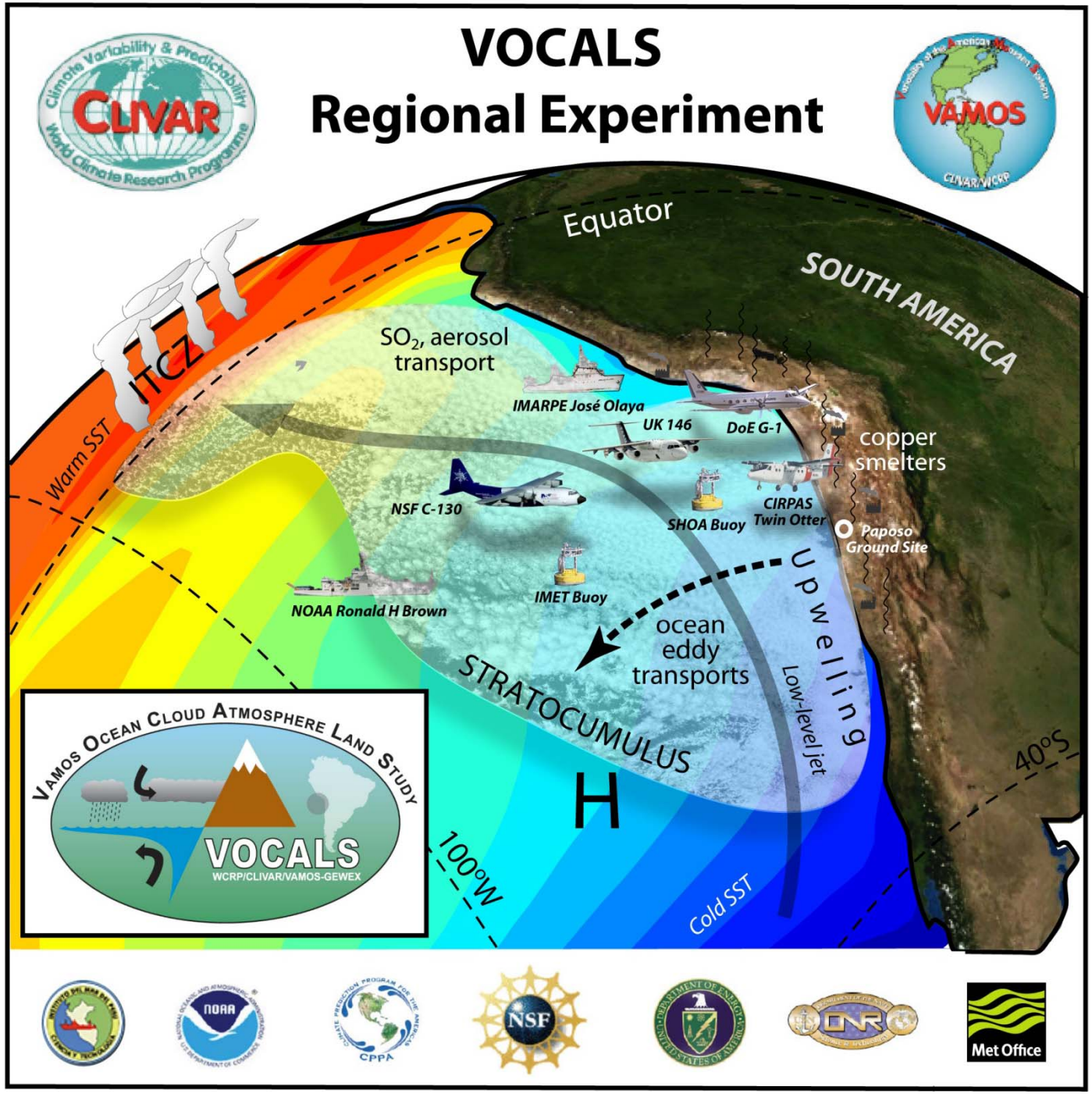
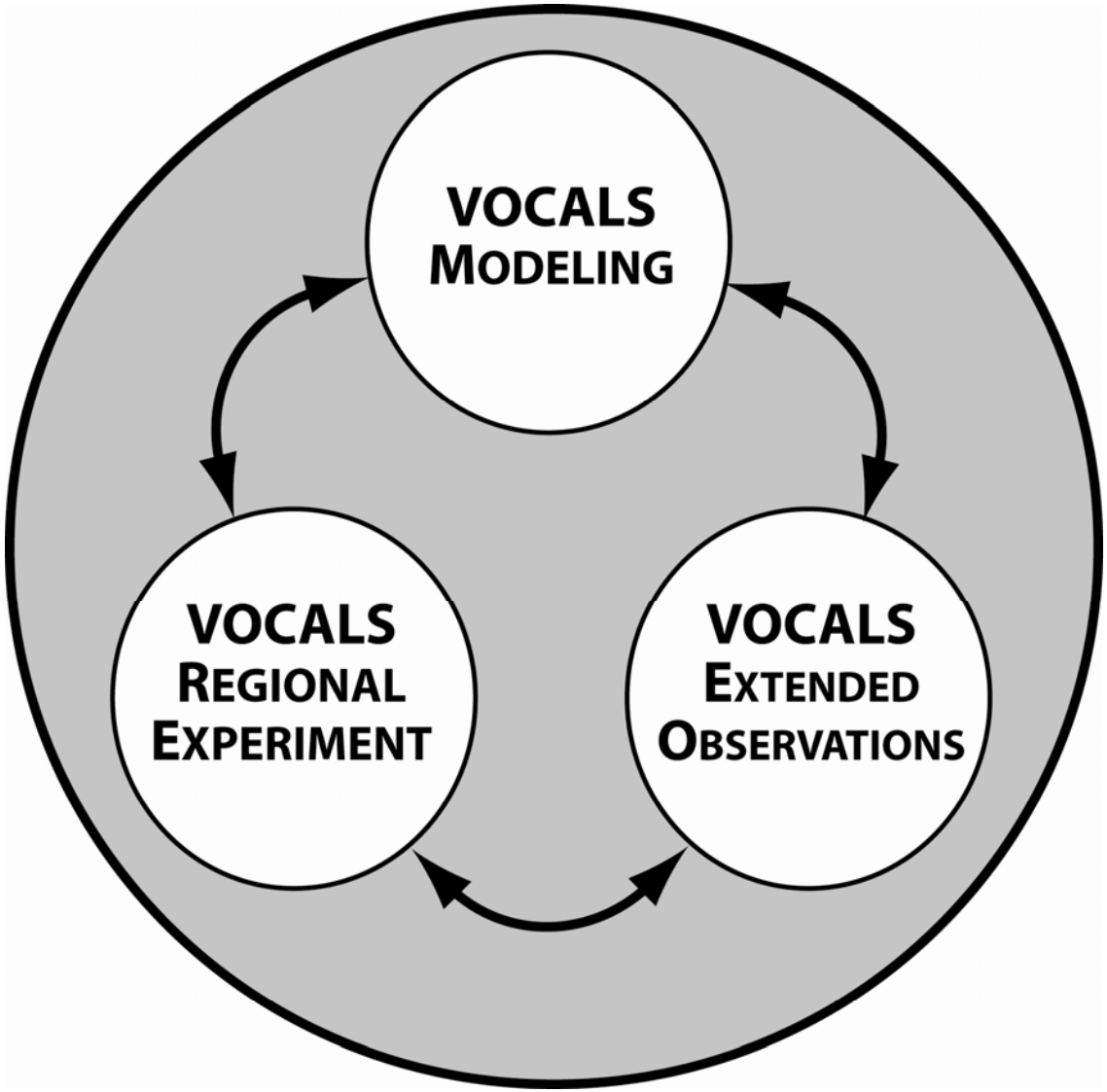
VOCALS Regional Experiment (REx) Goals and Hypotheses

Robert Wood, University of Washington
many contributors




VOCALS
Regional Experiment
Equator
SOUTH AMERICA
ITCZ
Warm SST
SO_2, aerosol transport
IMARPE José Olaya
UK 146
DoE G-1
copper smelters
NSF C-130
SHOA Buoy
CIRPAS Twin Otter
Paposo Ground Site
IMET Buoy
NOAA Ronald H Brown
ocean eddy transports
Upwelling
Low-level jet
STRATOCUMULUS
H
40°S
100°W
Cold SST
VAMOS Ocean Cloud Atmosphere Land Study
VOCALS
WCRP/CLIVAR/VAMOS-GEWEX
Met Office

THE VOCALS STRATEGY

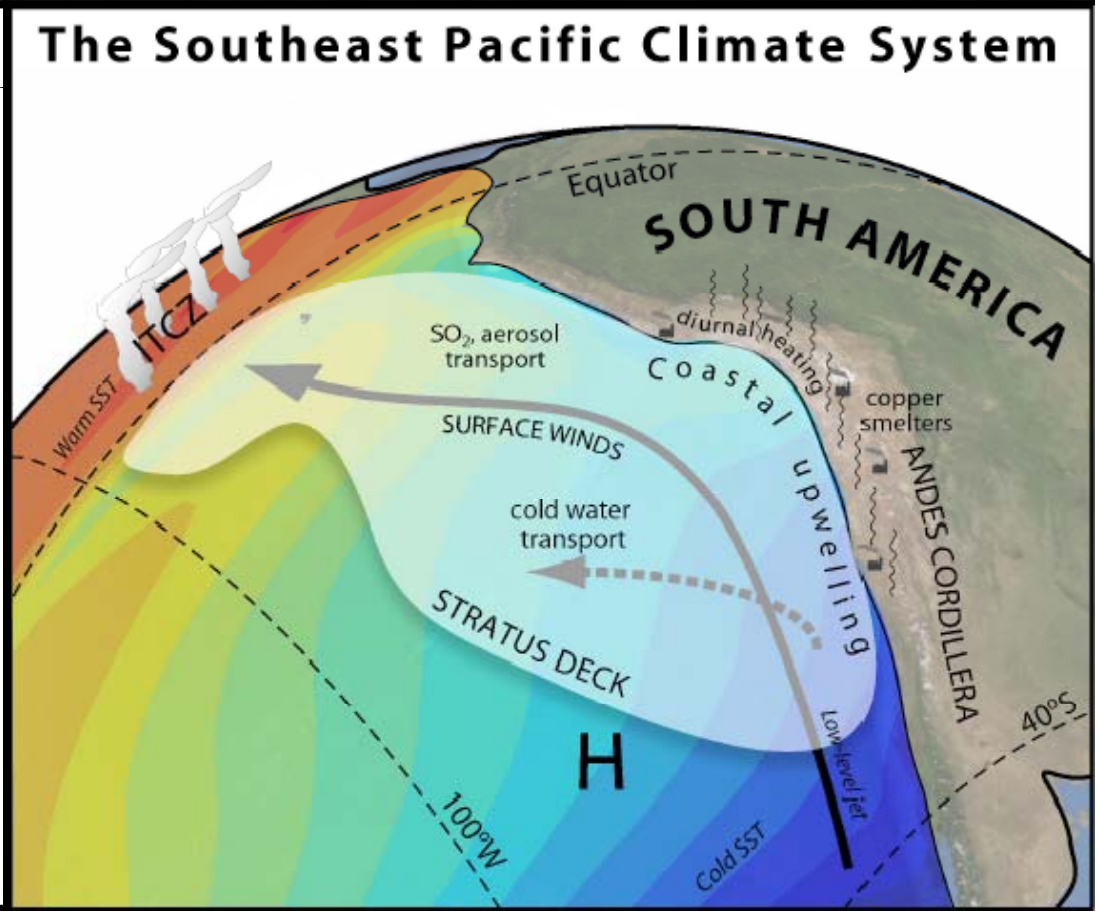


VOCALS Regional Experiment (REx)

- Joint NOAA/NSF funded field program in October/November 2008. Additional support from ONR and DoE and international agencies
- REx will provide observations of poorly understood aspects of the SEP climate system
- Main platforms: NSF C-130, NOAA Ronald H Brown, CIRPAS and Chilean Twin Otter, DoE G-1, FAAM BAe-146, NERC Dornier 228, Chilean land sites, Peruvian ship

The Southeast Pacific Climate

- **Cold SSTs, coastal upwelling, subsidence**
- **Cloud-topped MBLs**
- **Influenced by and influential on remote climates (ENSO)**
- **Unresolved issues in heat and nutrient budgets**
- **Important links between clouds and aerosol**
- **Poorly simulated by atmosphere-ocean GCMs**



VOCALS-REx Platforms and Sampling

Oct-Nov 2008

Aircraft:

NSF C-130

CIRPAS Twin Otter

DoE G-1

UK BAe-146

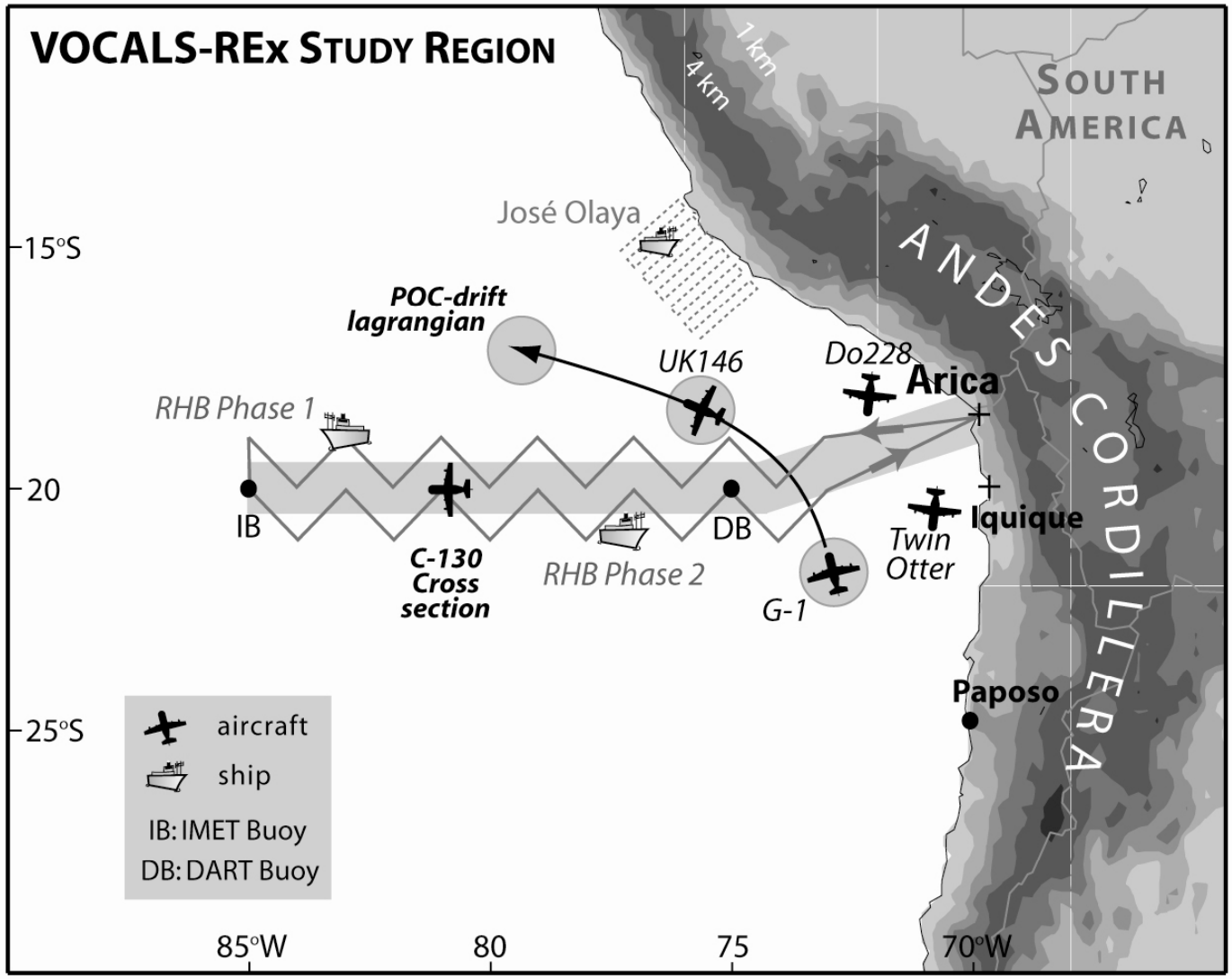
UK Dornier 228

Ships:

NOAA Ronald H Brown

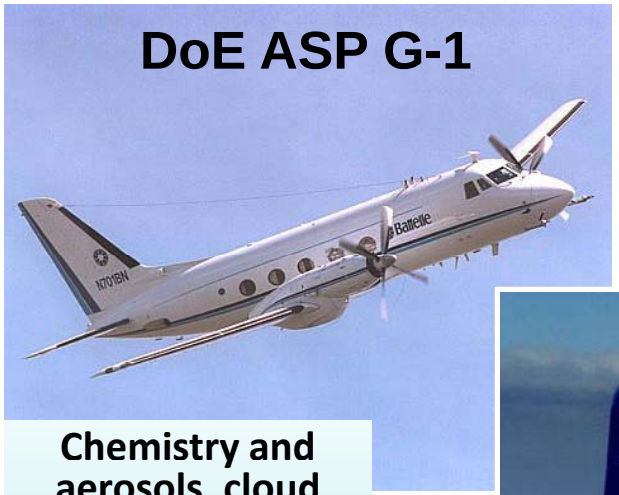
Peru - Jose Olaya

Land sites



The aircraft

DoE ASP G-1

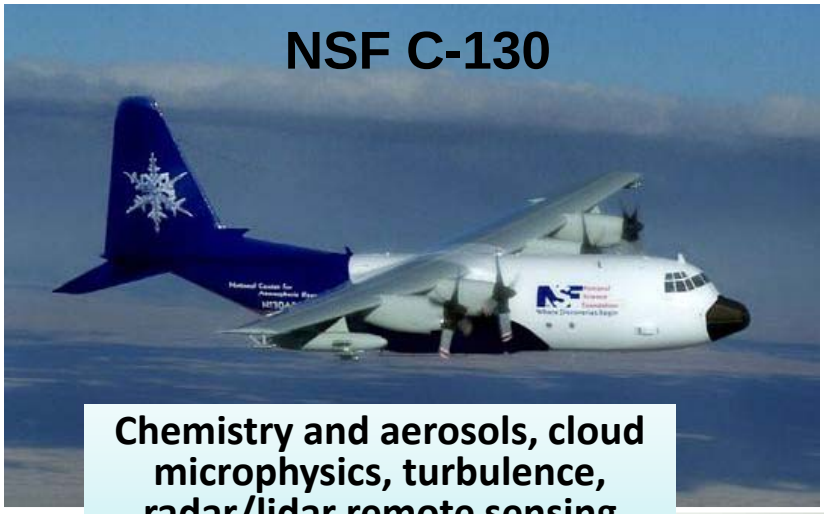


Chemistry and aerosols, cloud microphysics, turbulence

CIRPAS Twin Otter

Radar remote sensing, microphysics, turbulence

NSF C-130



Chemistry and aerosols, cloud microphysics, turbulence, radar/lidar remote sensing

Remote sensing and cloud imaging

NERC Dornier 228

Aerosols, cloud microphysics, radiative measurements

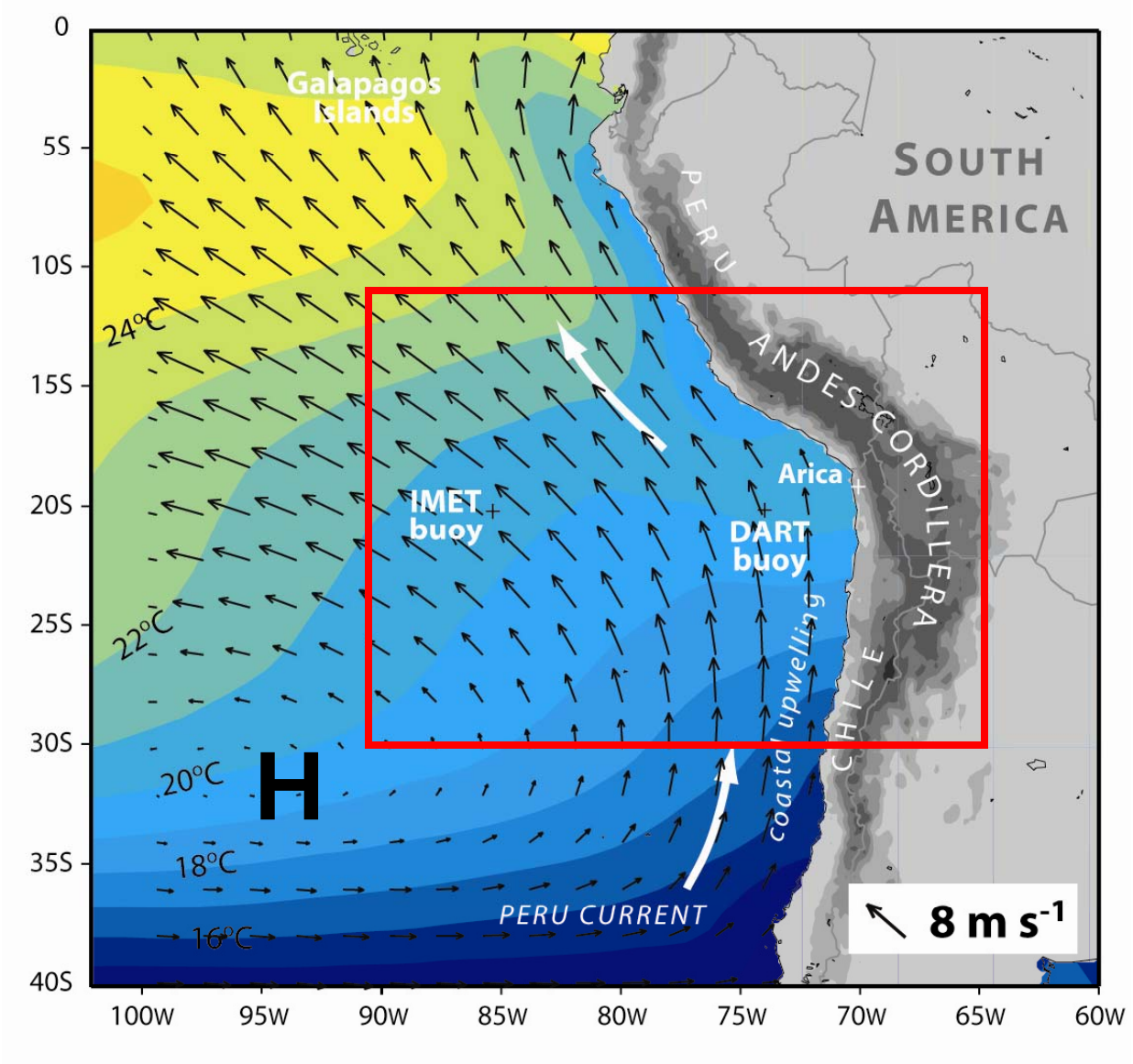
UK FAAM BAe-146

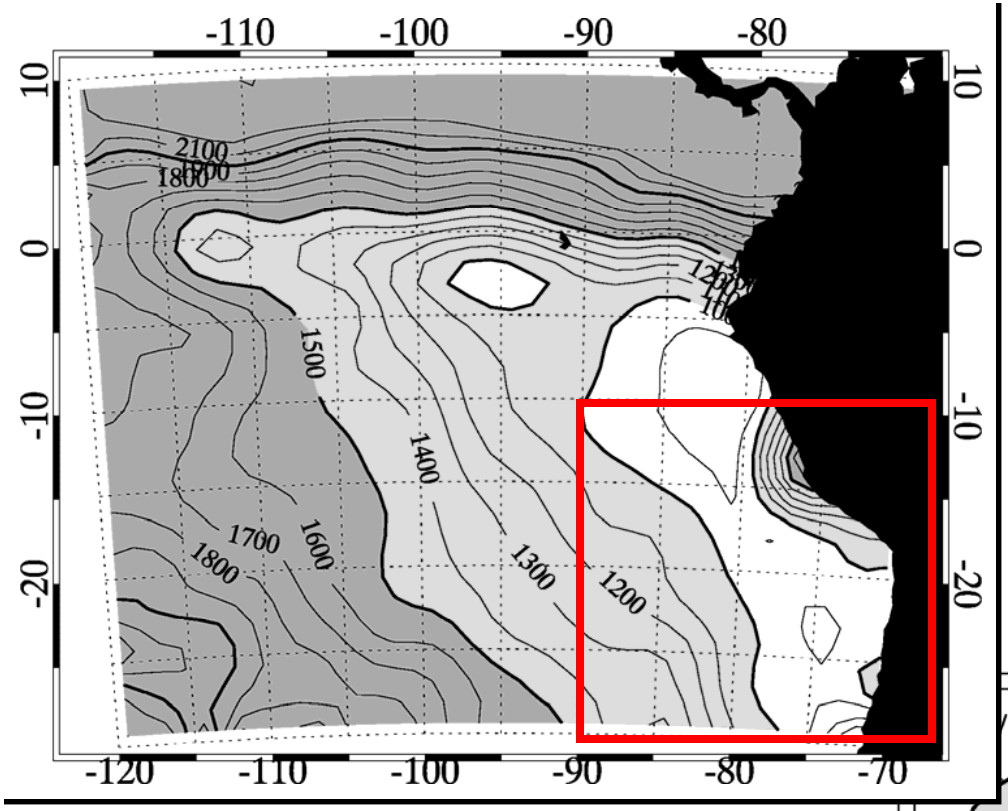
Meteorological context

SST (Reynolds)

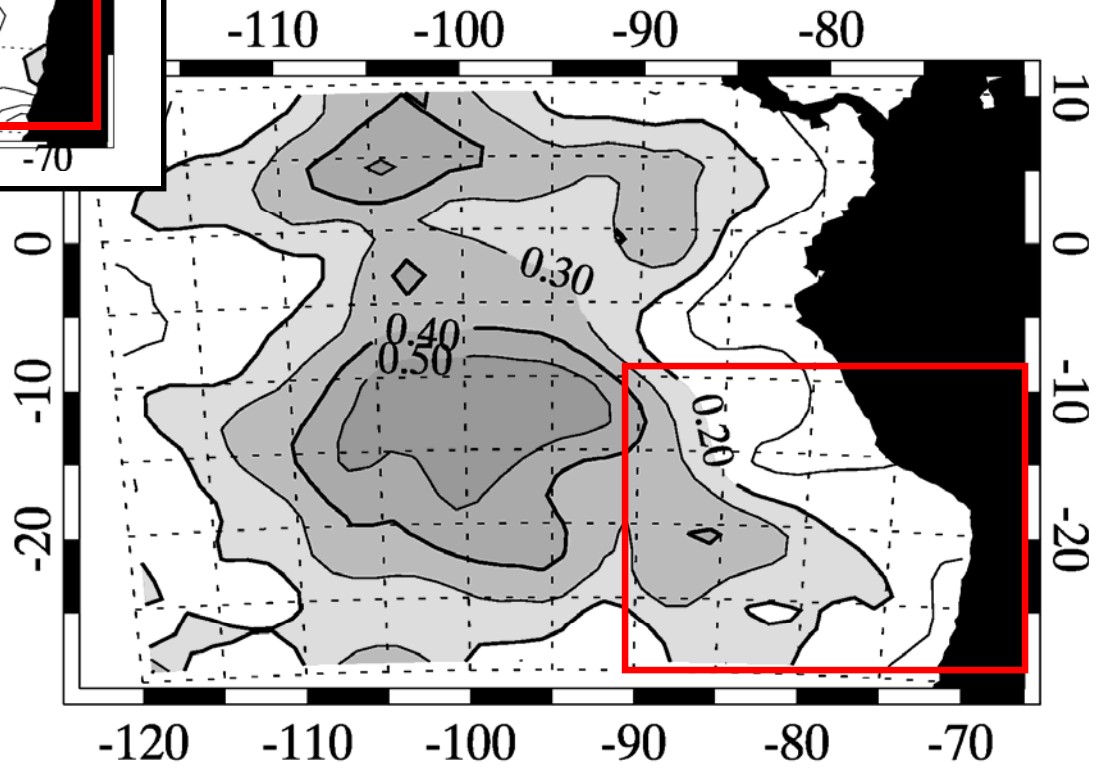
Surface winds (Quikscat)

Sep-Nov climatology



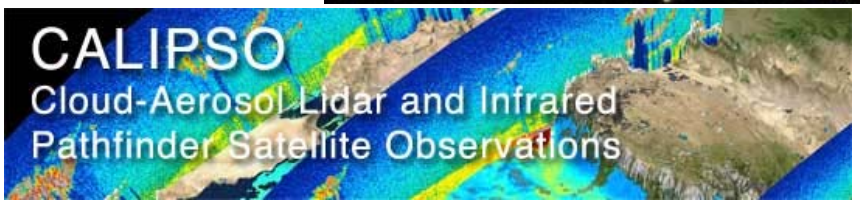


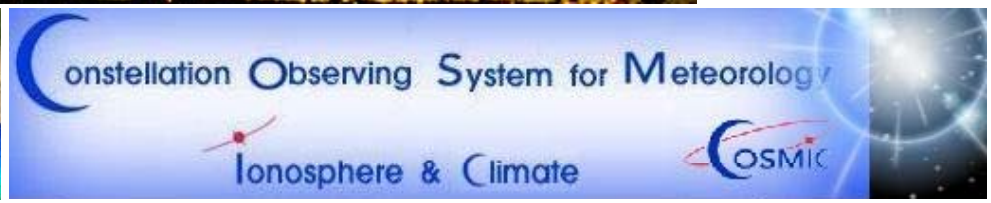
MBL depth

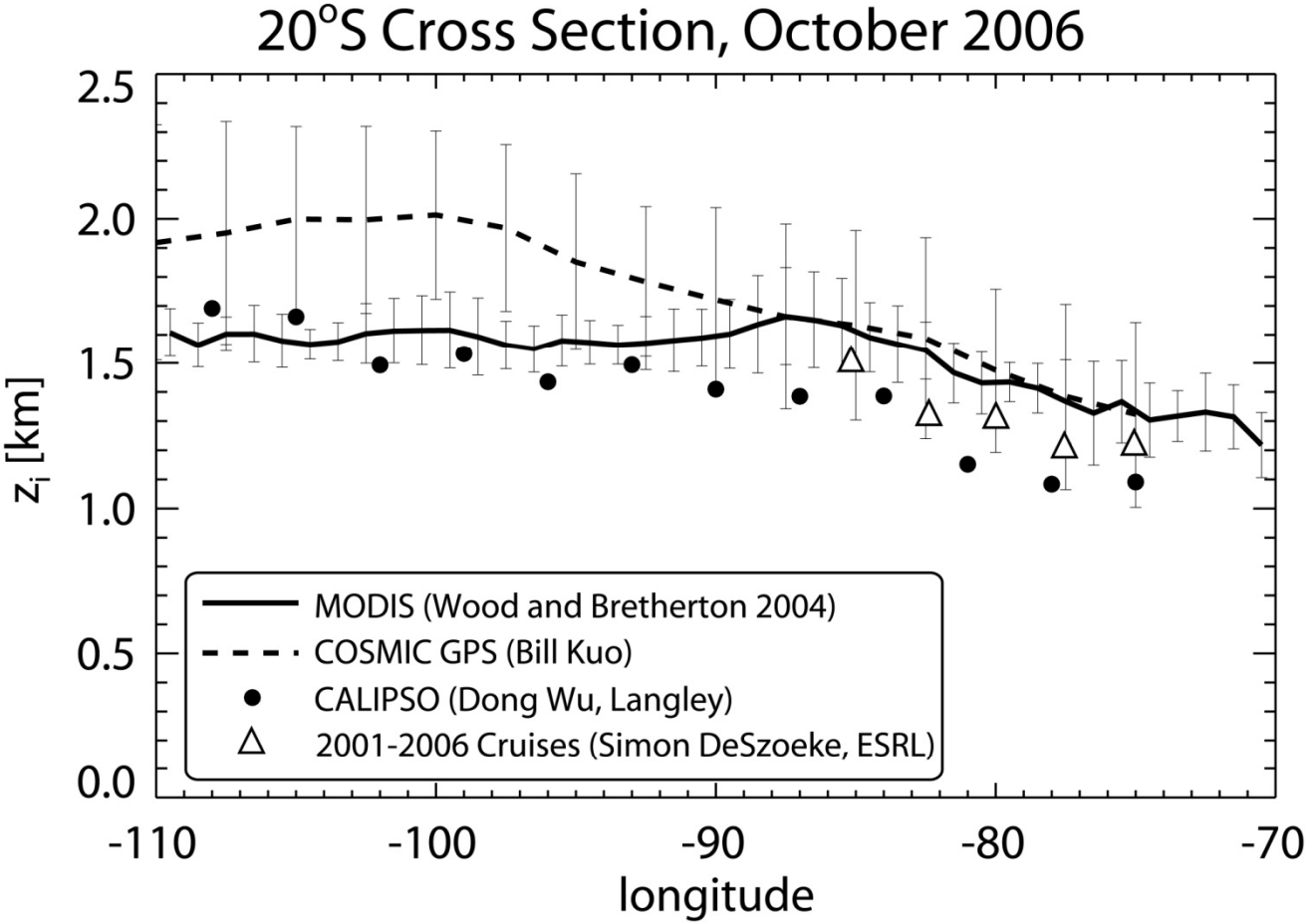


Open cell frequency

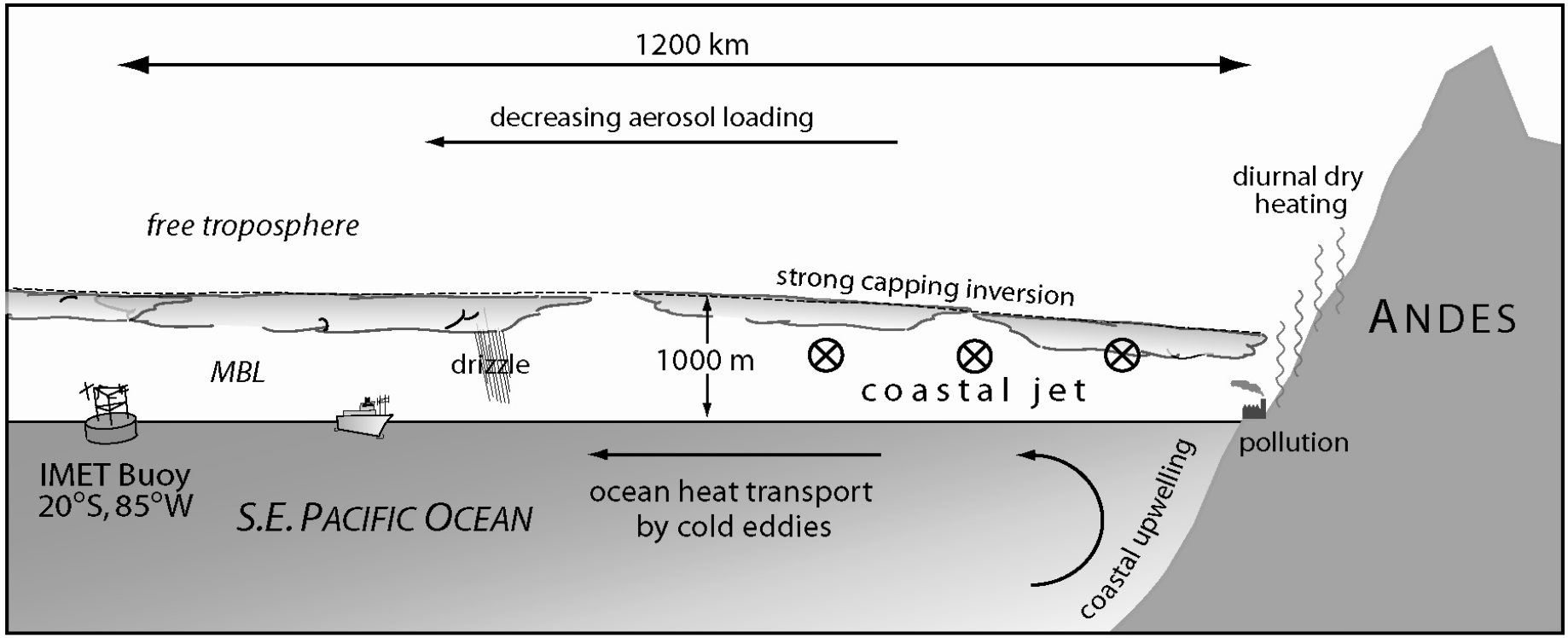
Novel MBL depth estimates







E-W transect 20ºS



VOCALS-REx Science Goals

1. AEROSOL-CLOUD-DRIZZLE GOALS

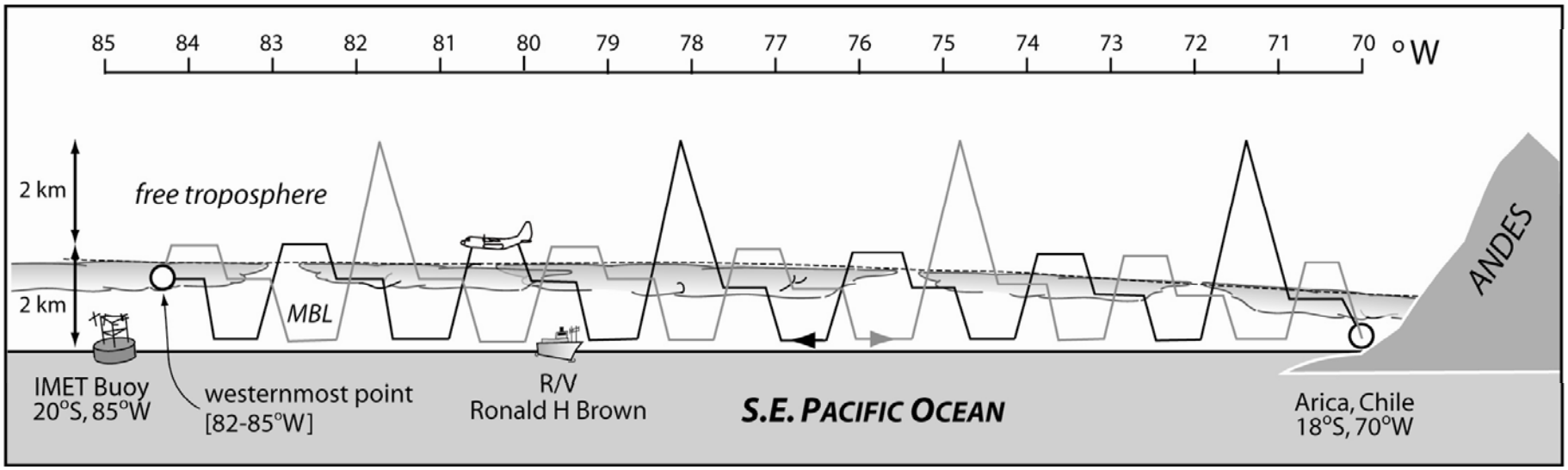
Factors controlling the stratocumulus cloud thickness, cover, and optical properties over the SE Pacific

2. COUPLED OCEAN-ATMOSPHERE-LAND GOALS

Physical and chemical links between the topography, coastal oceanic upwelling and the marine boundary layer

AEROSOL-CLOUD-PRECIPITATION HYPOTHESES	
#	*Hypothesis*
1A	**Variability in the physicochemical properties of aerosols has a measurable impact upon the formation of drizzle in stratocumulus clouds over the SEP.**
1B	**Precipitation is a necessary condition for the formation and maintenance of pockets of open cells (POCs) within stratocumulus clouds.**
1C	**The small effective radii measured from space over the SEP are primarily controlled by anthropogenic, rather than natural, aerosol production, and entrainment of polluted air from the lower free-troposphere is an important source of cloud condensation nuclei.**
1D	**Depletion of aerosols by coalescence scavenging is necessary for the maintenance of POCs.**

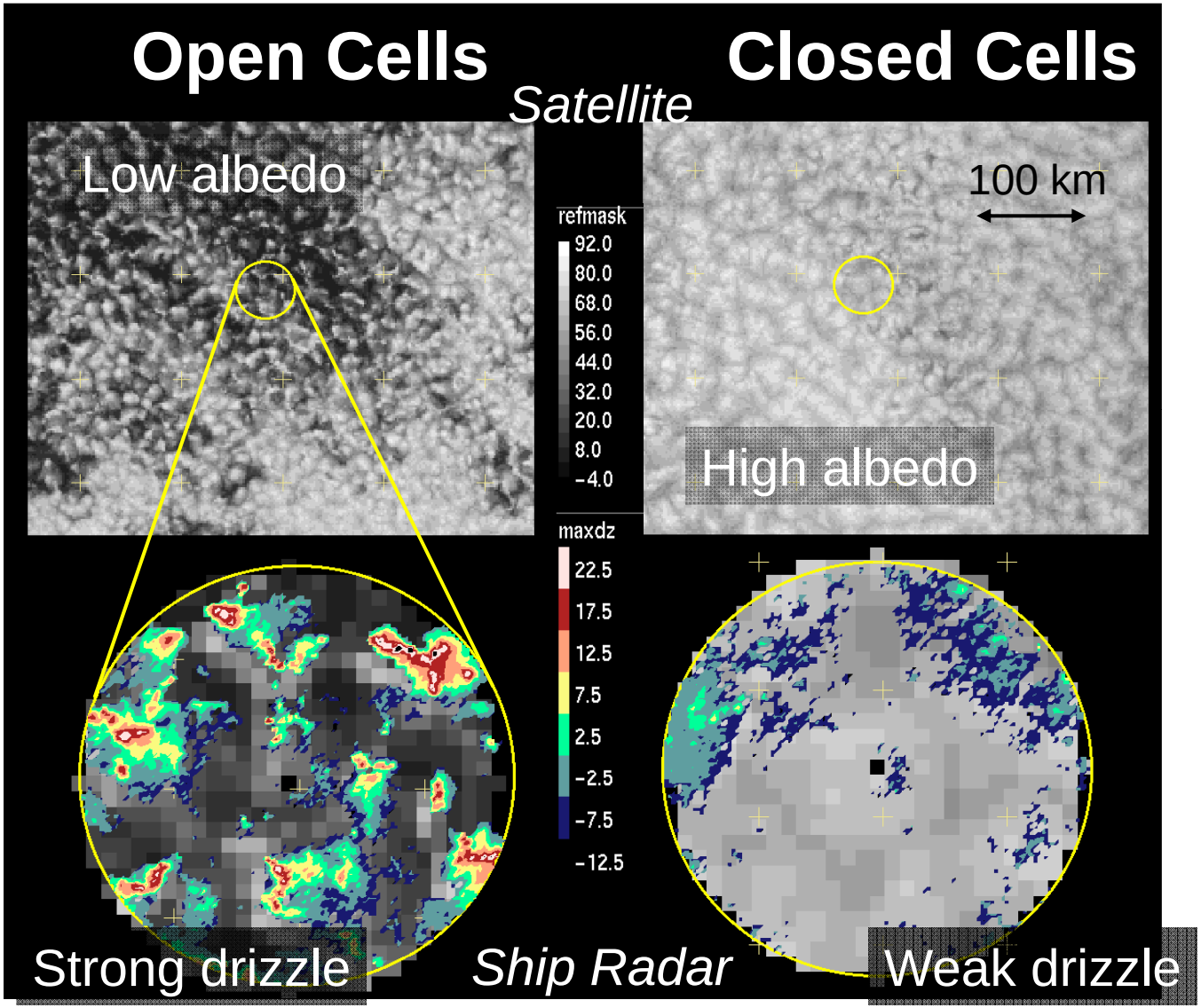
VOCALS-REx Cross-Section Sampling



Combined NOAA Ronald H Brown and NSF C-130 Missions

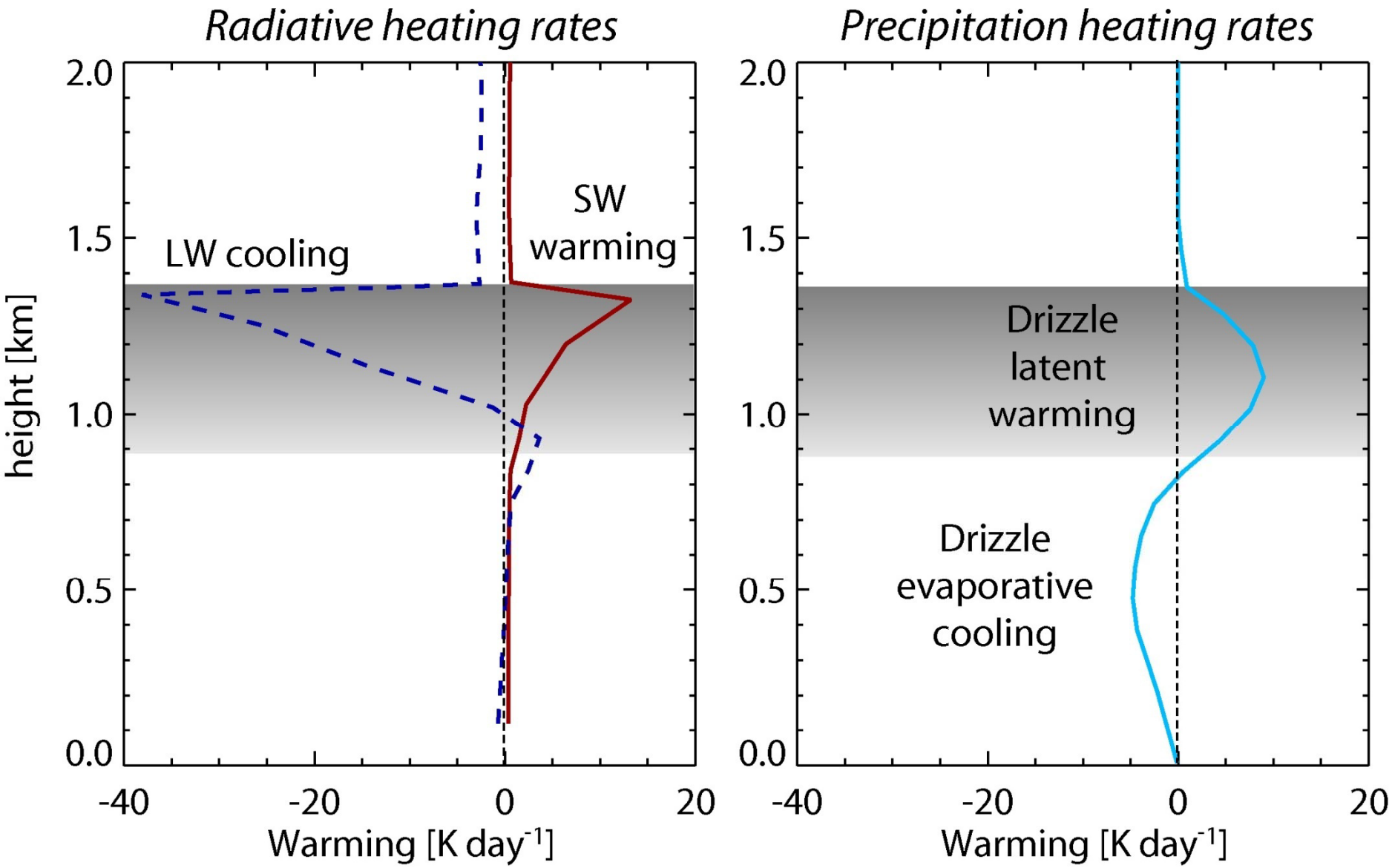
- direct evaluation of GCM lower tropospheric structure

- Cloud albedo strongly dependent upon open/closed cells
- Strong precipitation associated with open cell structure
- **In-situ aircraft measurements of the mesoscale dynamics needed**



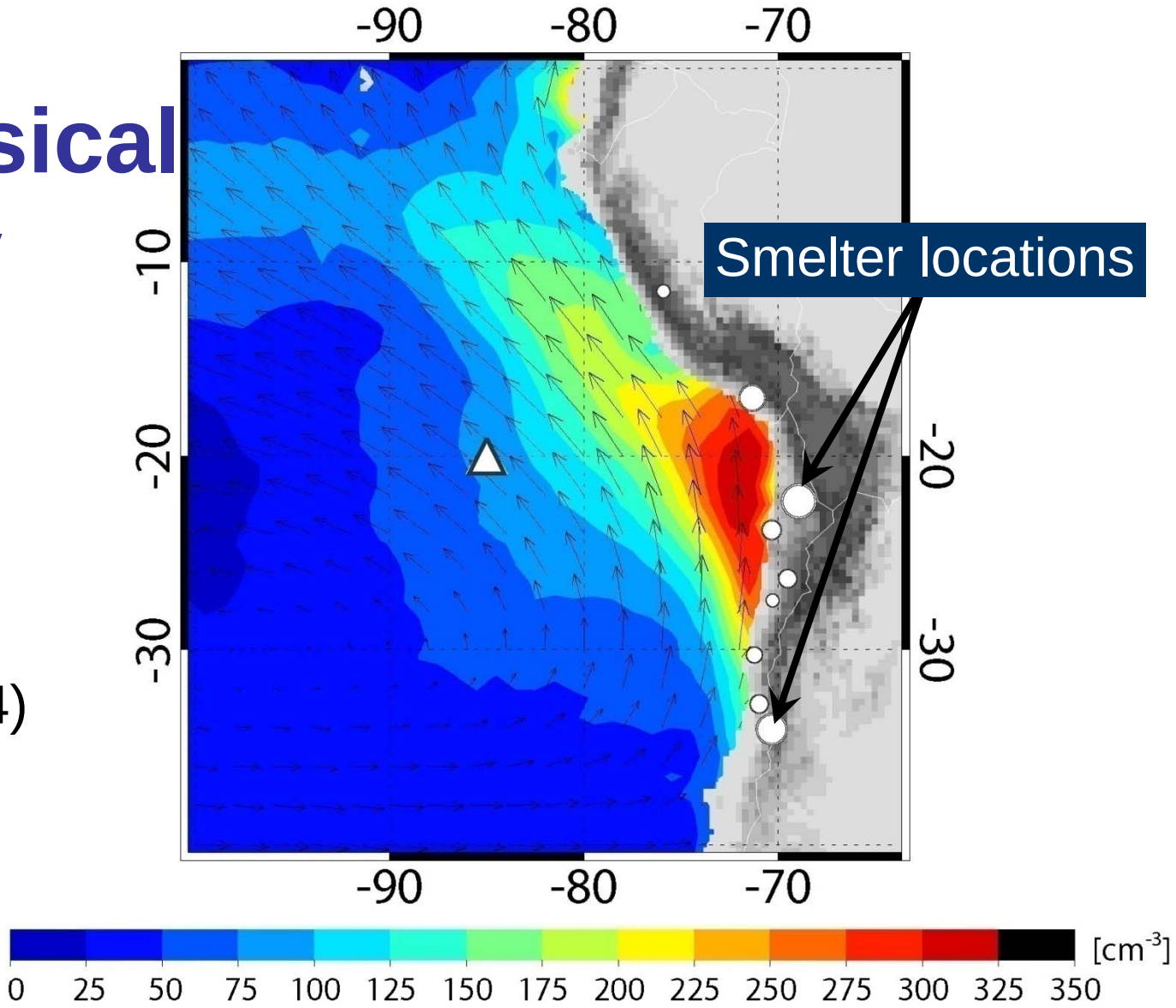
Sandra Yuter, NCSU

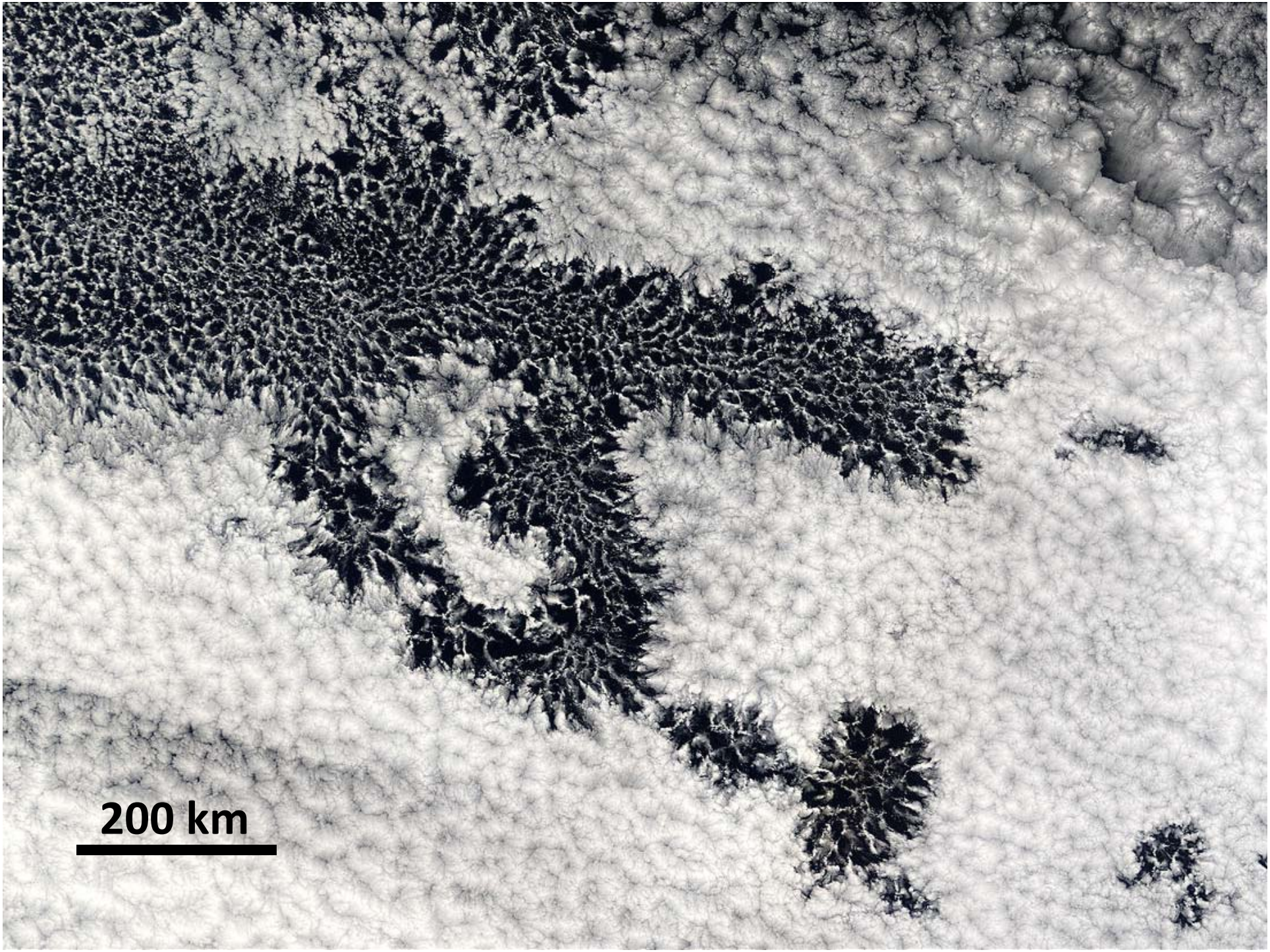
Drizzle is important over the SEP



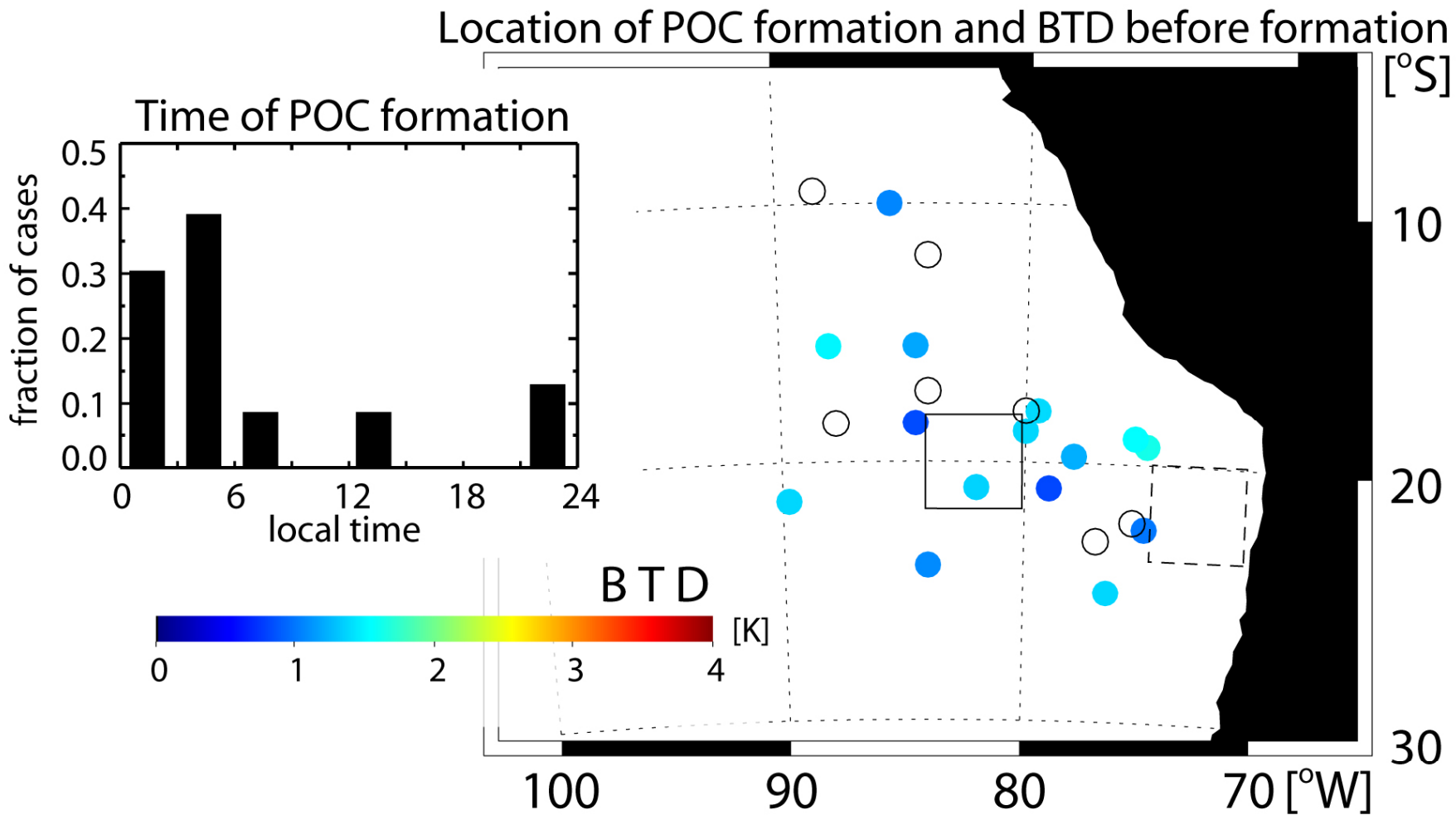
Cloud Microphysical Variability

MODIS
Cloud Droplet
Concentration
(SON 2001-2004)



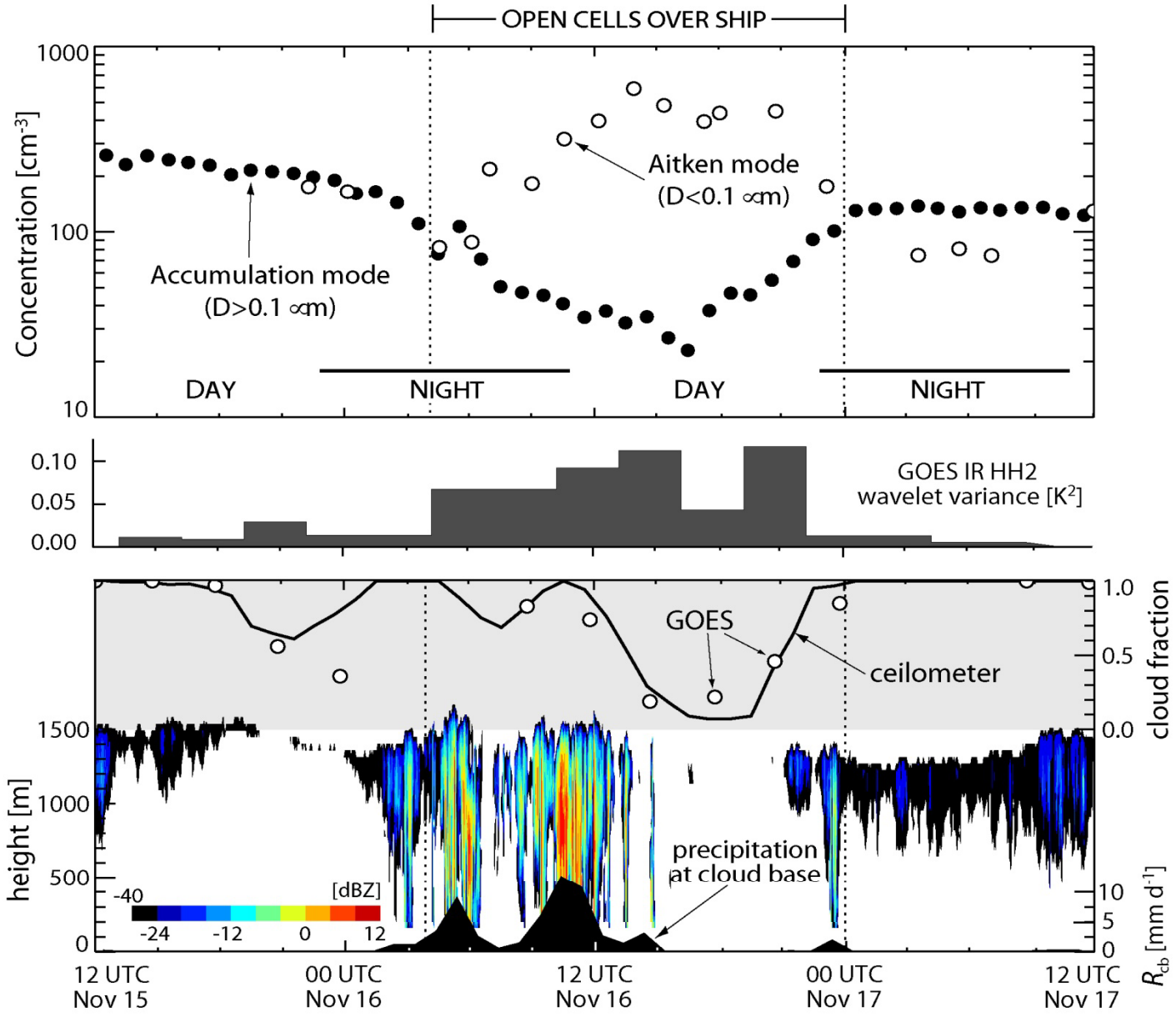

200 km

POC formation

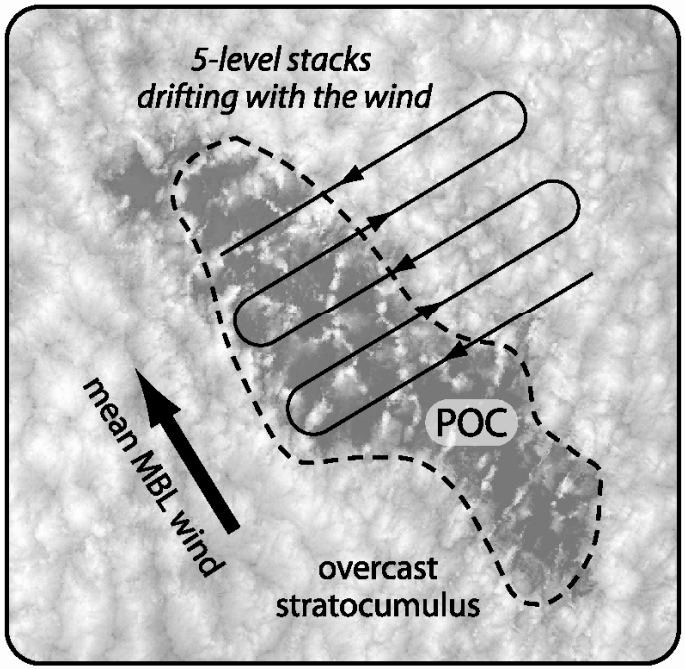


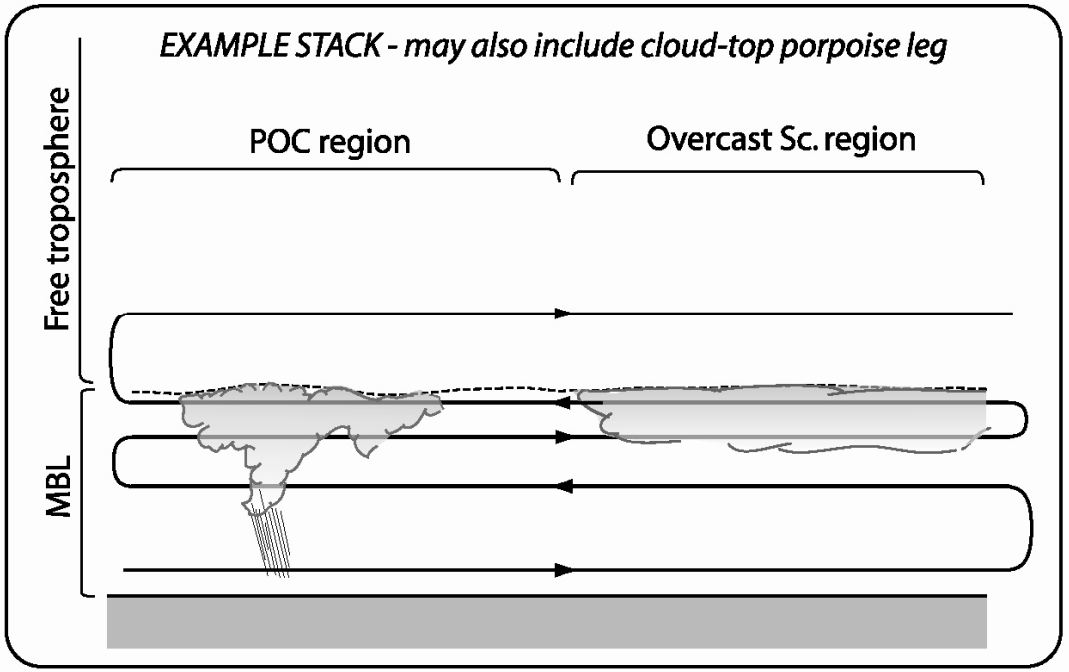
Kim Comstock

Aerosol, cloud, drizzle and POCs



Flight-plan for C-130
POC-Drift missions





Specific research for POST

Determination of entrainment rate

Boundary Layer Depth, Entrainment, and Decoupling in the Cloud-Capped Subtropical and Tropical Marine Boundary Layer

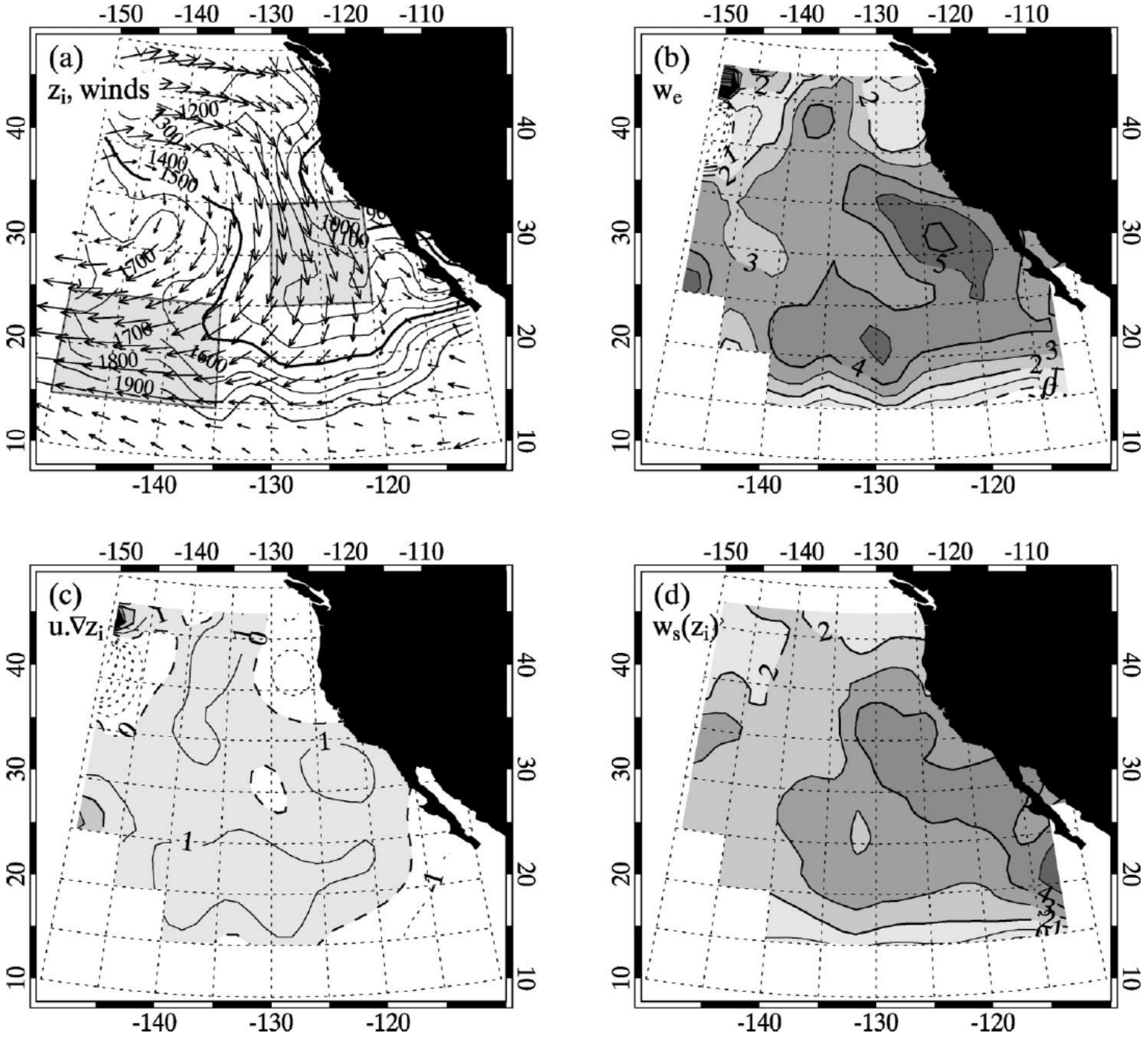
ROBERT WOOD AND CHRISTOPHER S. BRETHERTON
University of Washington, Seattle, Washington

J. Climate (2004)

$$\frac{\partial z_i}{\partial t} + \mathbf{u}(z_i) \cdot \nabla z_i = w_e - w_s(z_i)$$

reanalysis satellite reanalysis

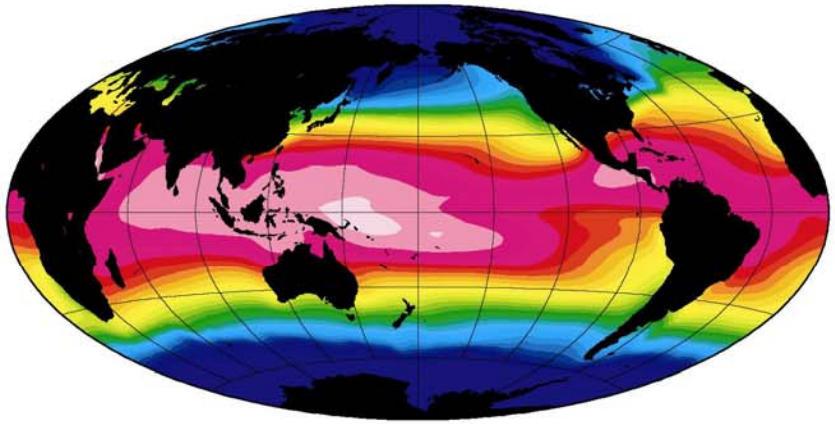
$$\overline{w_e} \approx \overline{\mathbf{u}(z_i)} \cdot \nabla \overline{z_i} + \overline{w_s(z_i)}$$


(a)
z_i, winds
(b)
w_e
(c)
$u.\nabla z_i$
(d)
$w_s(z_i)'$
-150 -140 -130 -120 -110
10 20 30 40

Questions

- Use variety of methods to estimate cloud top height from satellite (MODIS/GOES, COSMIC, CALIPSO)
- Compare with in-situ data (POST/VOCALS)
- Assessment of entrainment rate (time/space variability) using Wood and Bretherton method applied to shorter (how short?) timescales

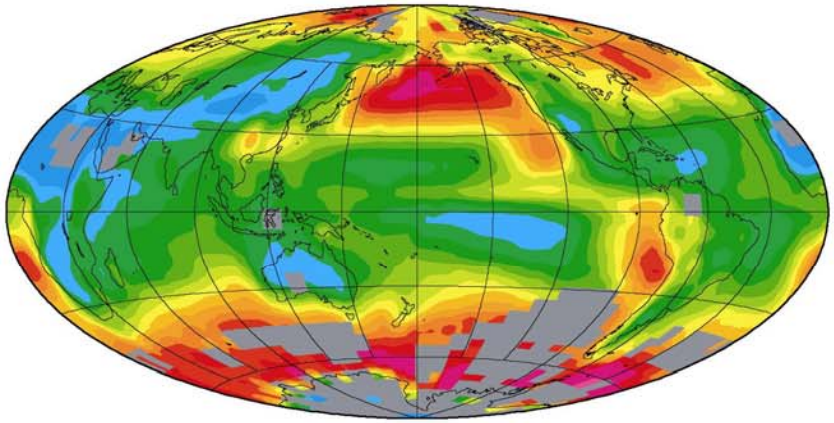
Sea Surface Temperature



NO DATA 0 2 4 6 8 10 12 14 16 18 20 22 24 26 28 30

deg C

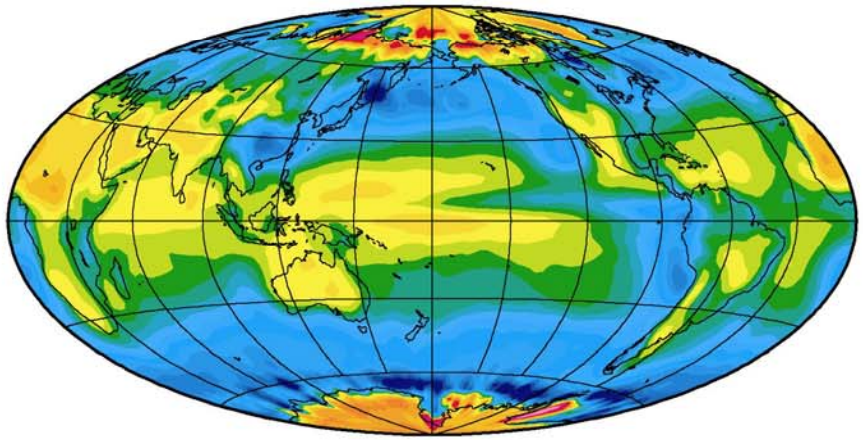
Annual Warren Stratus Cloud Amount



NO DATA 0 10 20 30 40 50 60 70 80

Percent

Net Radiative Cloud Forcing
1985-1986



NO DATA -140 -120 -100 -80 -60 -40 -20 0 20 40 60

W/m**2