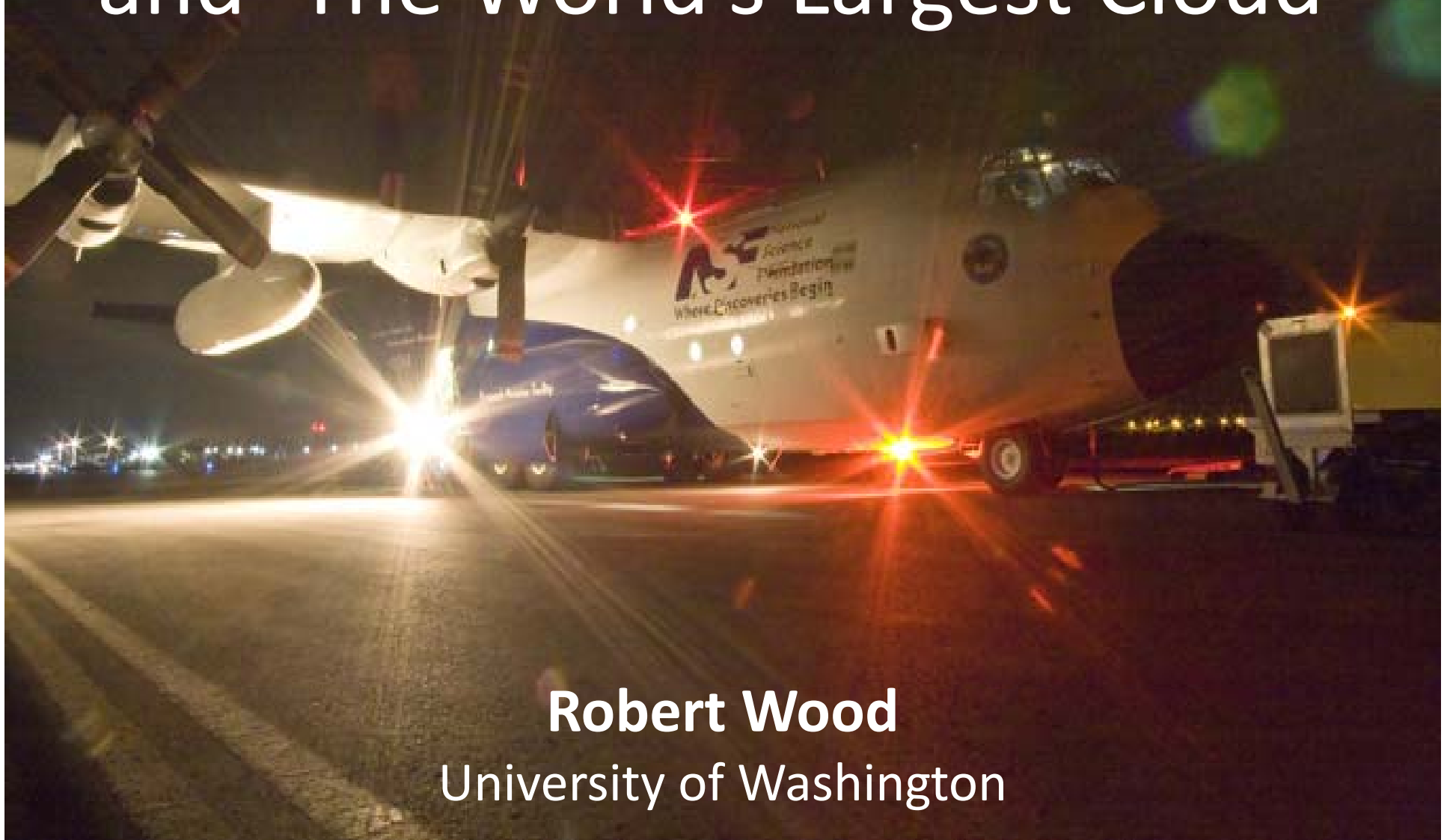


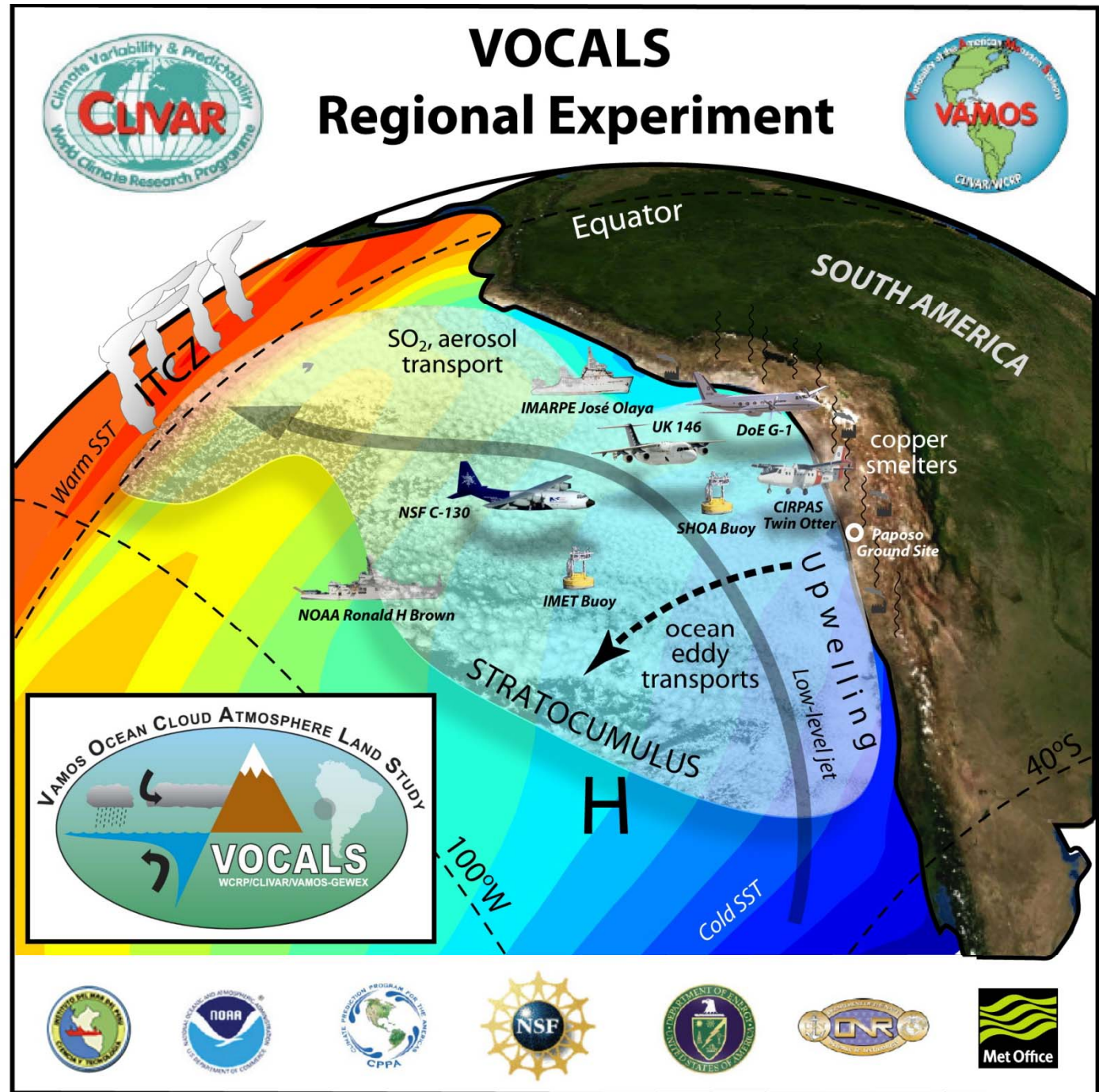
VOCALS REx: Drizzle, Aerosol, and 'The World's Largest Cloud'



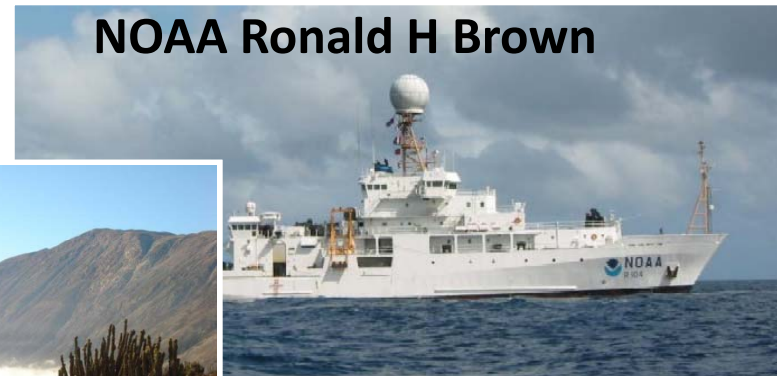
Robert Wood
University of Washington

October-
November
2008

SE Pacific



VOCALS-REx Platforms



VOCALS-REx Platforms and Sampling

Oct-Nov 2008

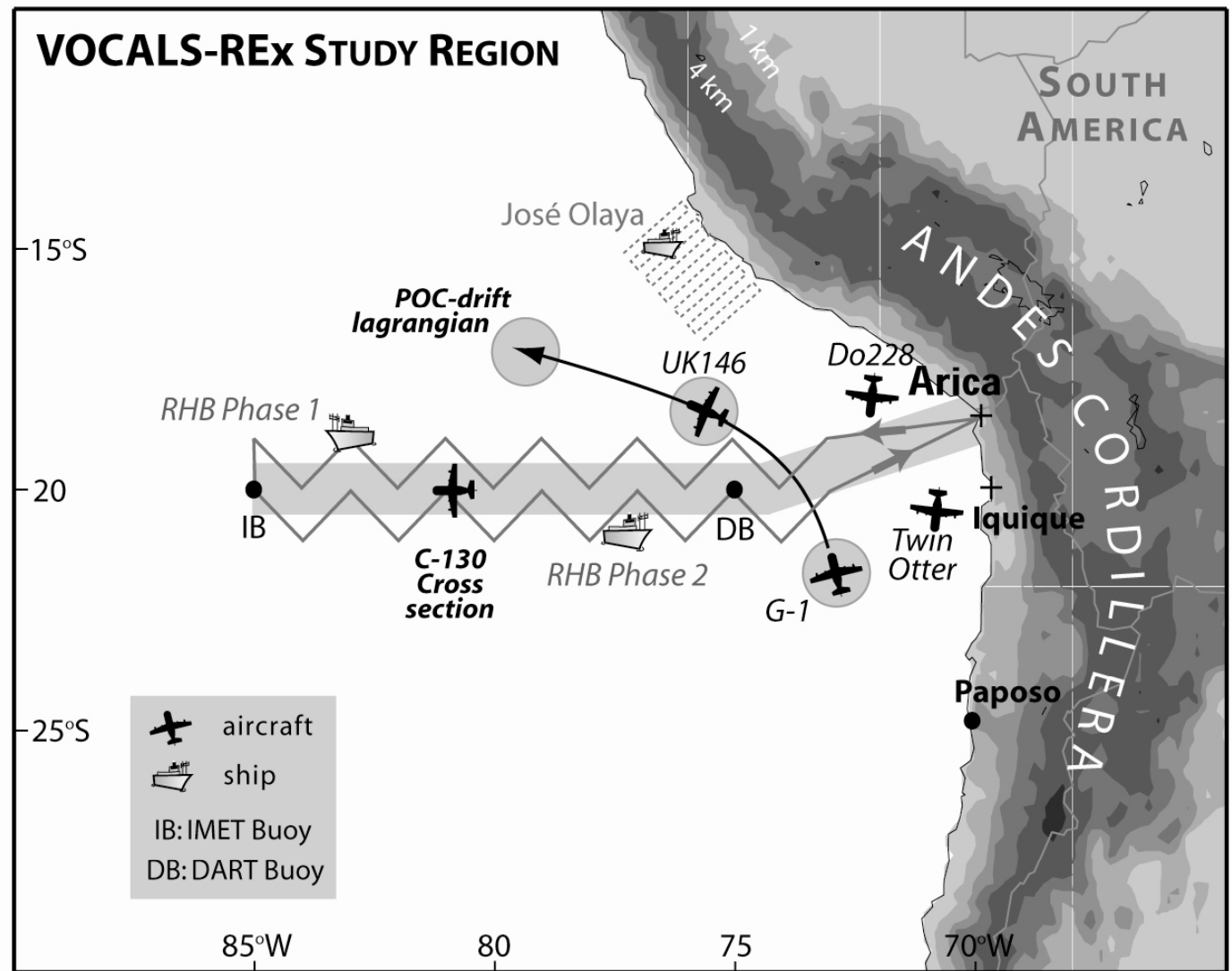
Aircraft:

NSF C-130
CIRPAS Twin Otter
DoE G-1
UK BAe-146
UK Dornier 228

Ships:

NOAA Ronald H
Brown
Peru - Jose Olaya

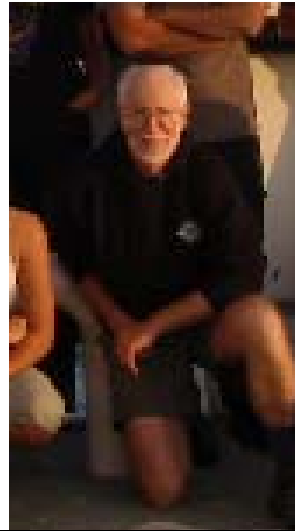
Paposo and
Iquique land sites



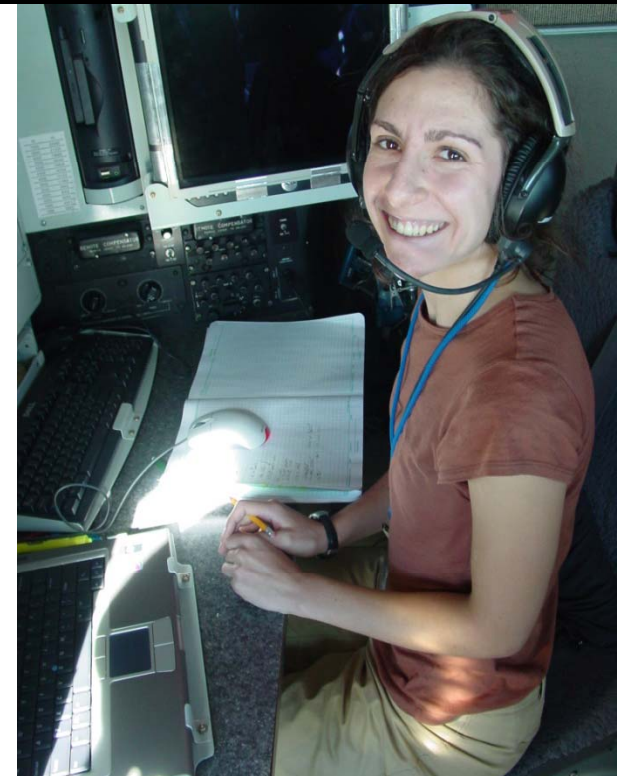


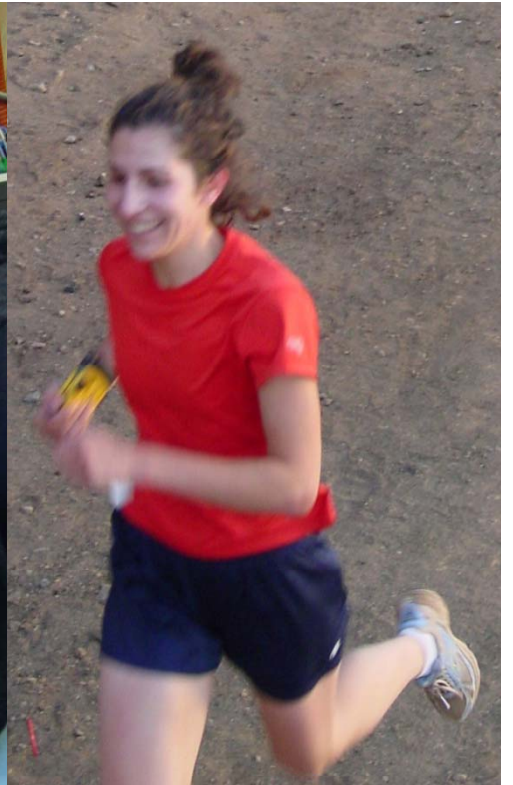
NSF/NCAR C-130





UW VOCALS Participants

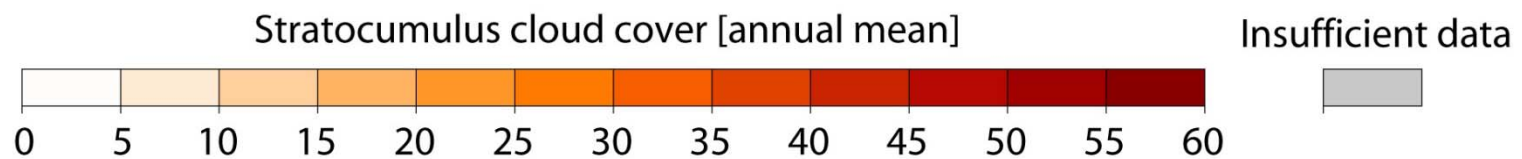
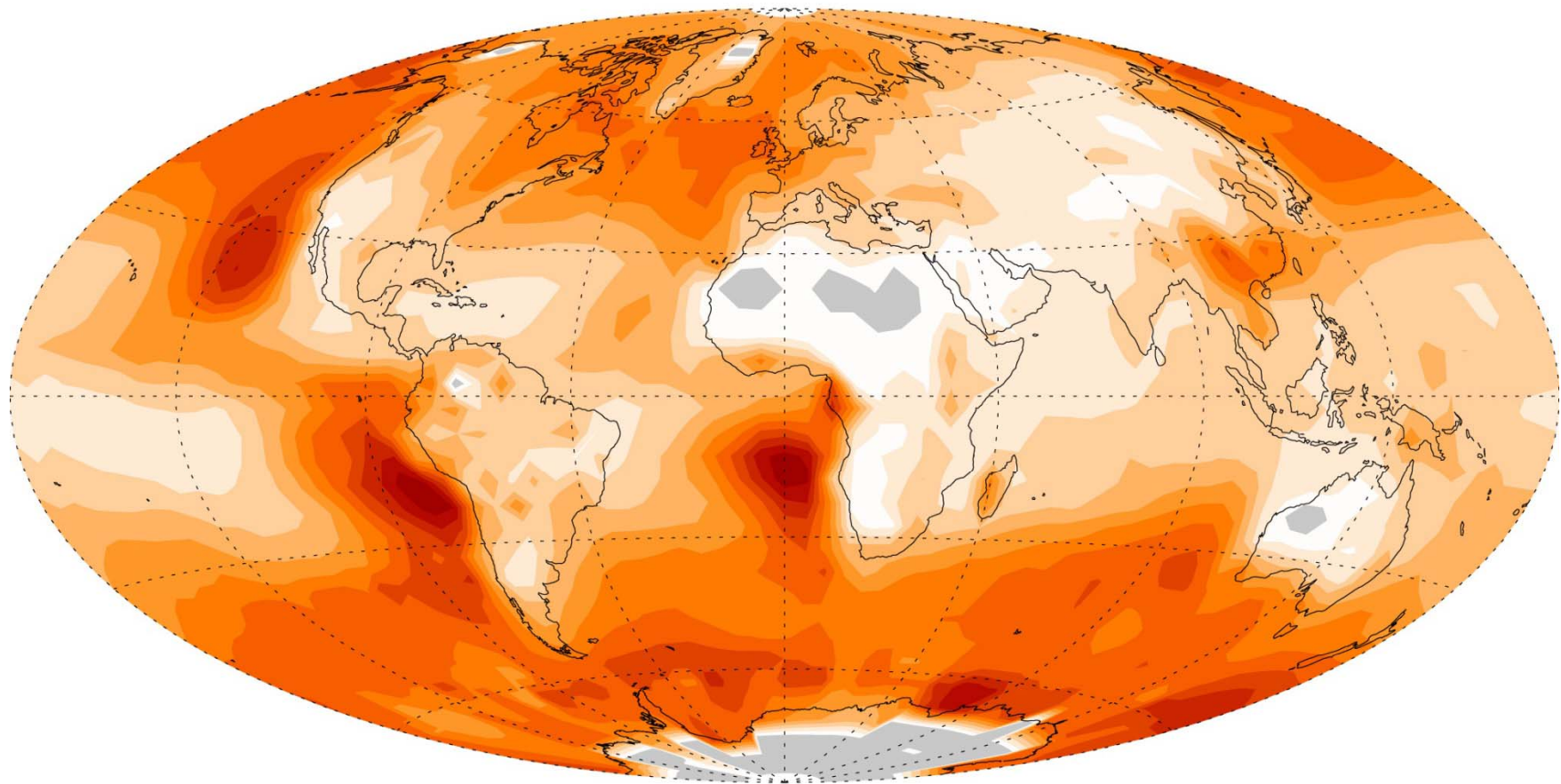




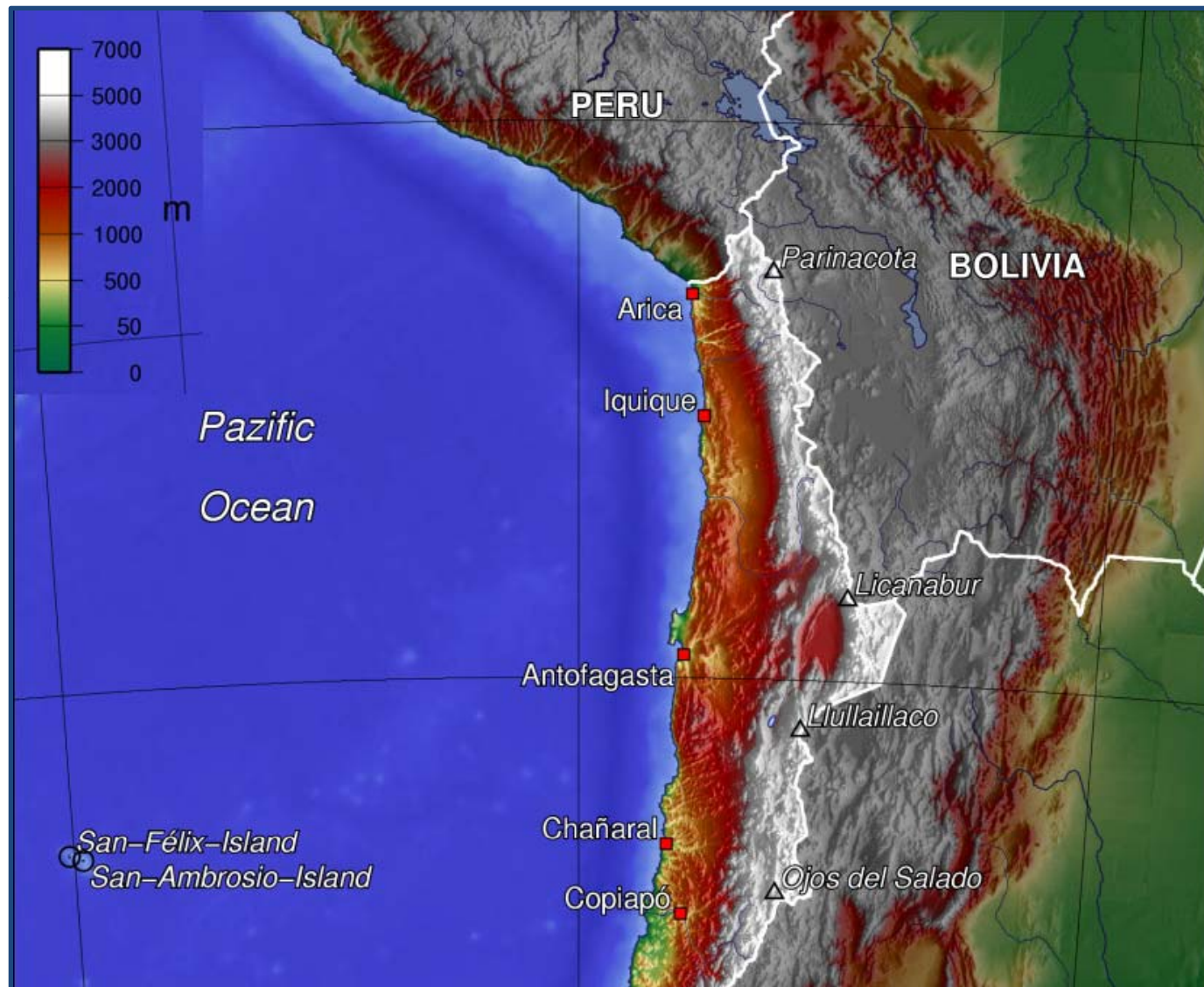
At the end of a 9 hour flight



Stratocumulus cloud cover [annual mean]



The orography of the SE Pacific rim



The Southeast Pacific

Click and discover how this system works.

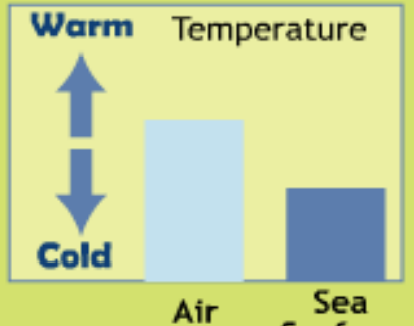
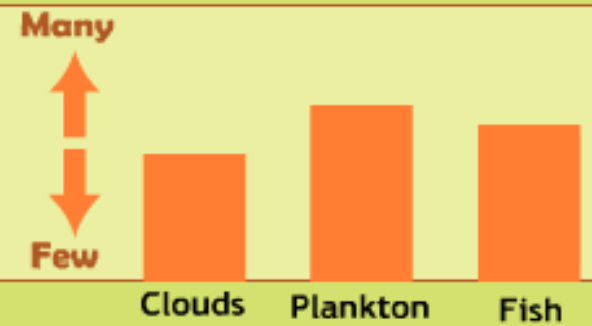
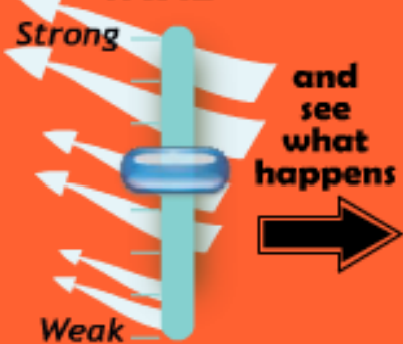
Credits



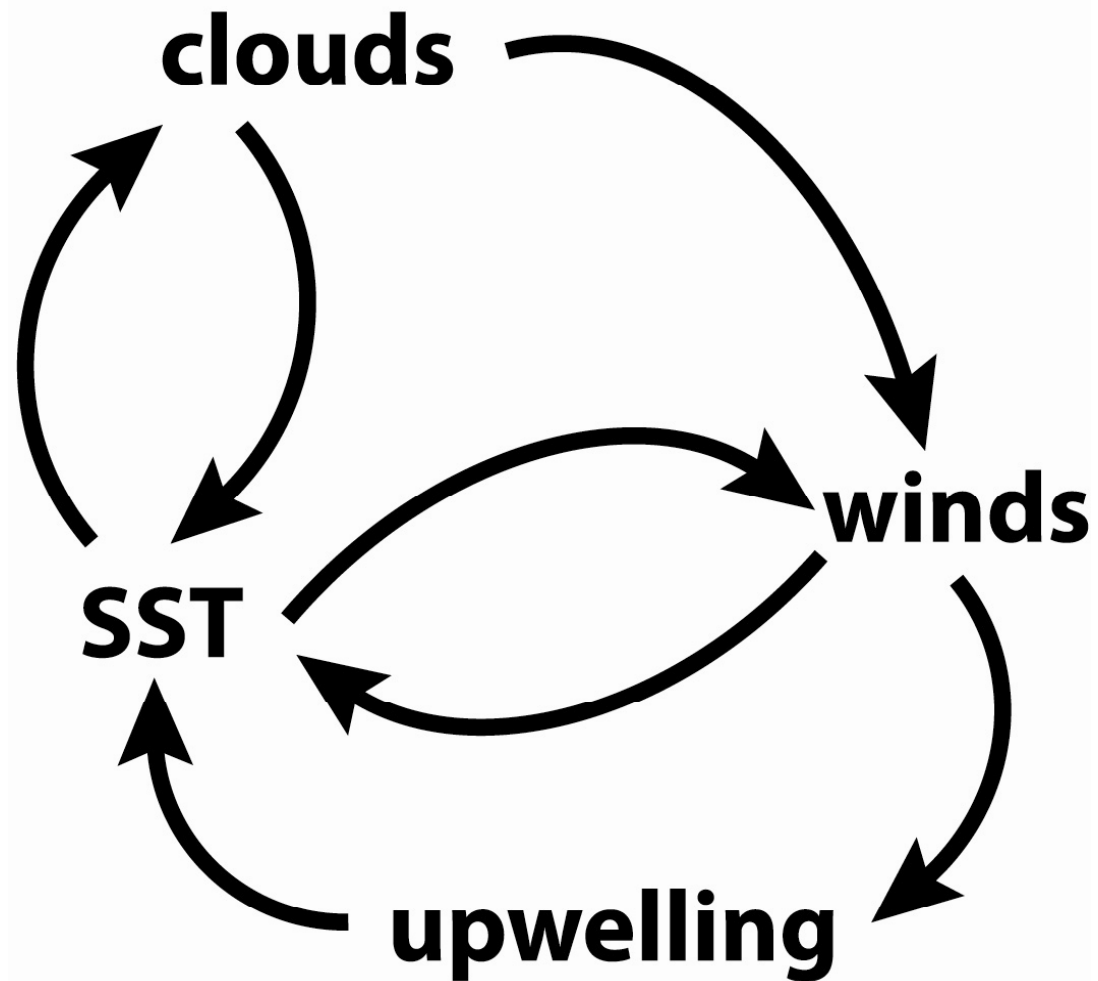
Where in the World



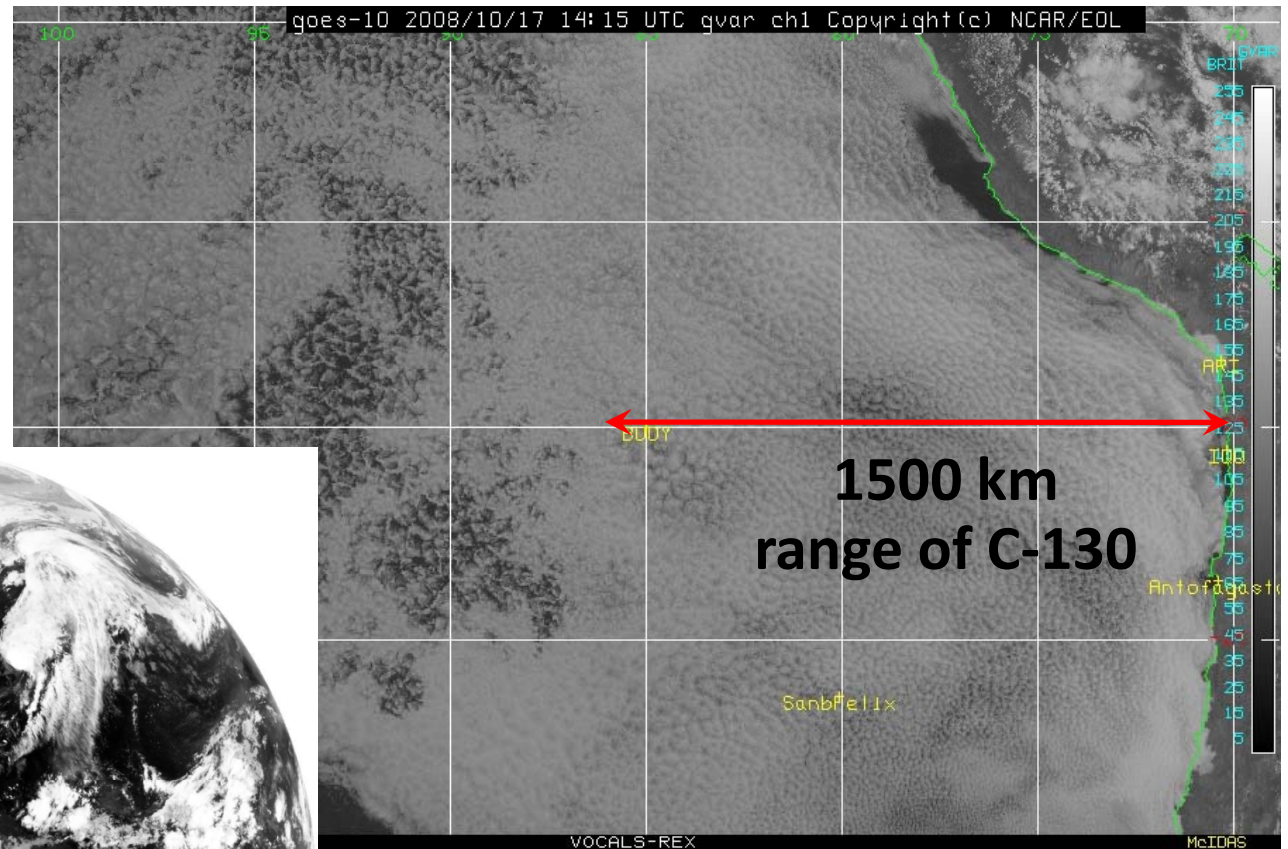
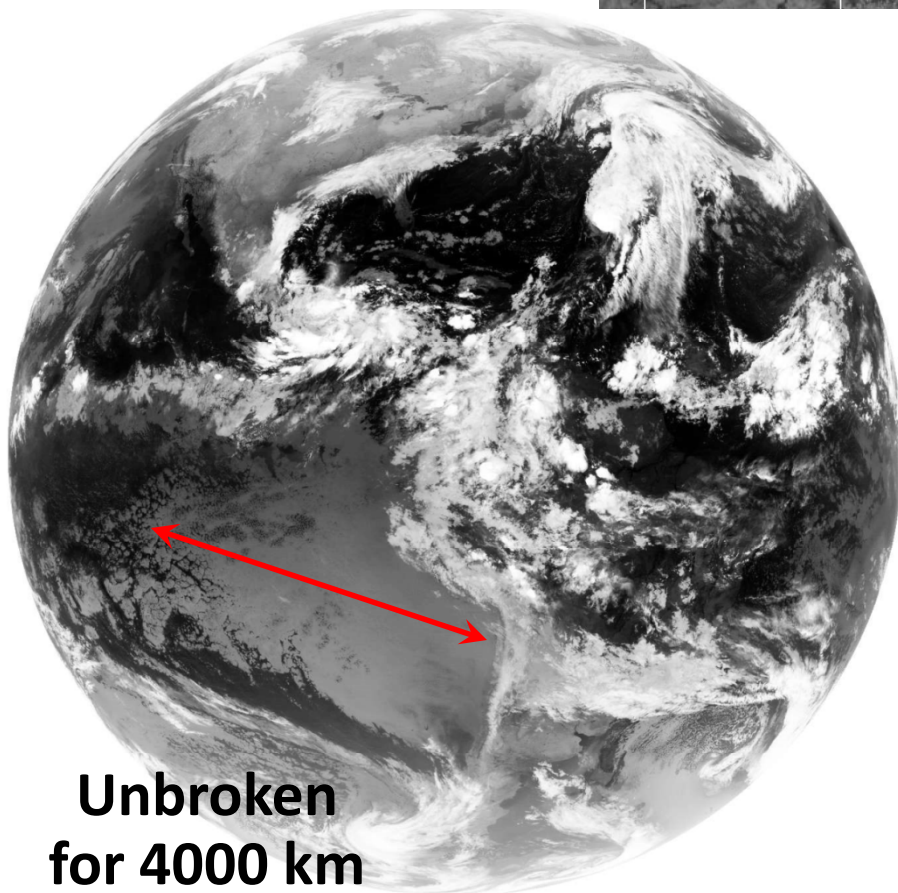
Change the WIND



The SEP Coupled System



Big clouds

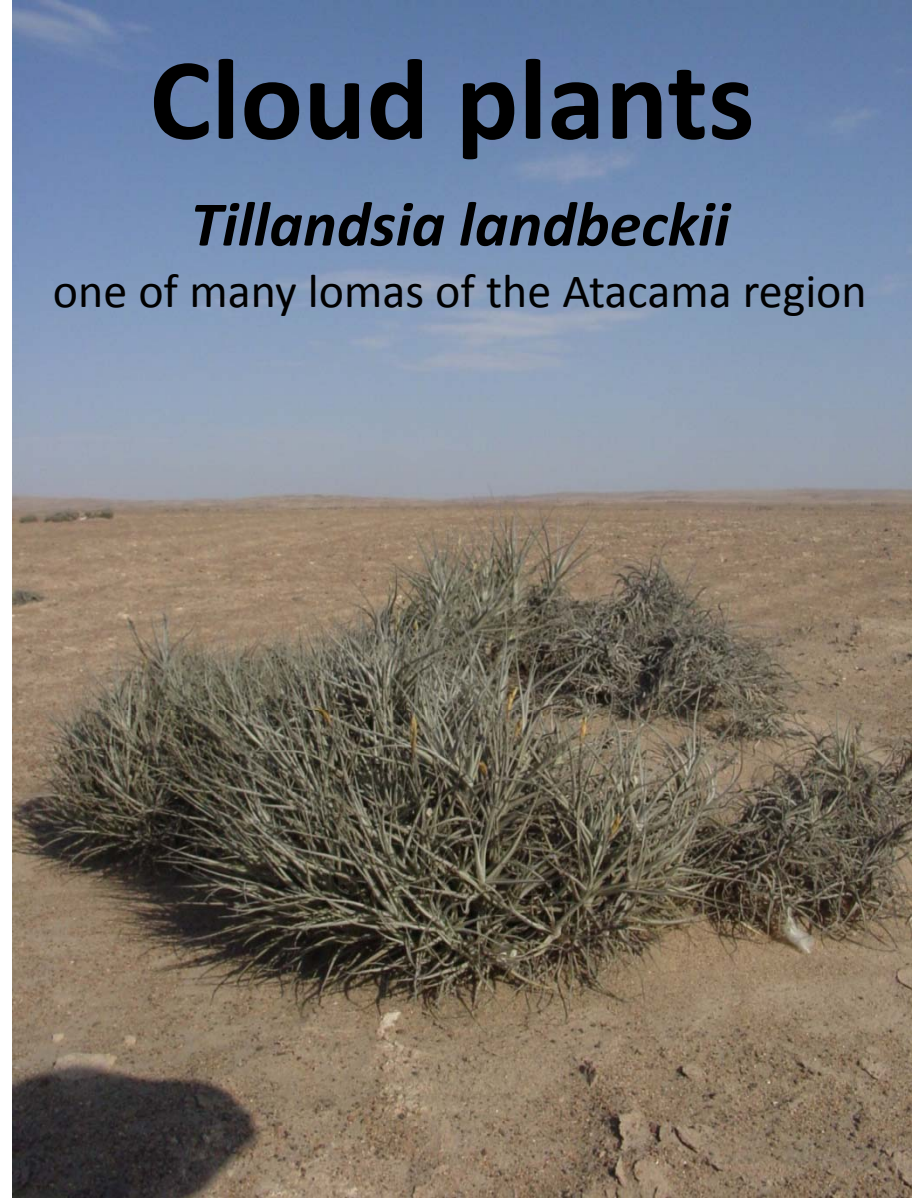




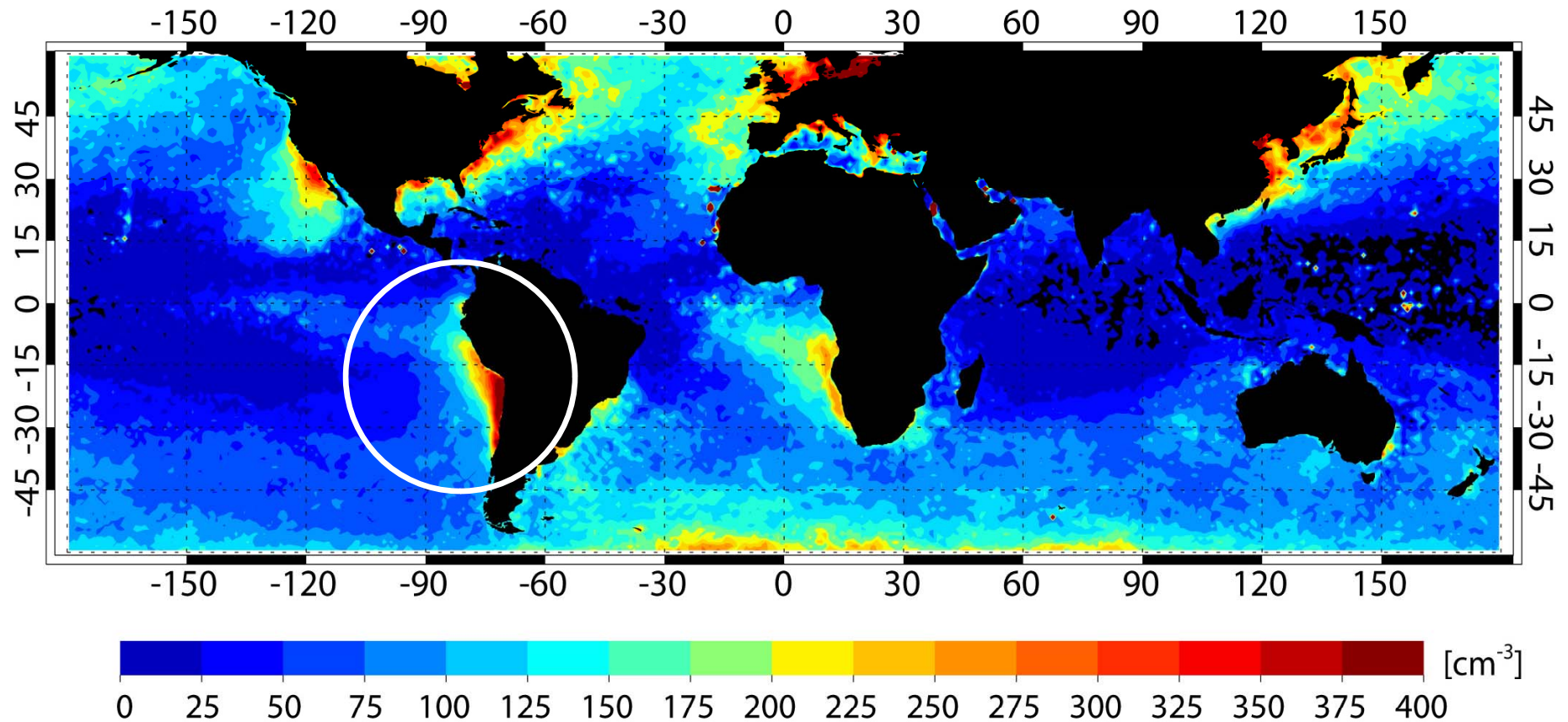
Cloud plants

Tillandsia landbeckii

one of many lomas of the Atacama region



Global cloud droplet concentration (MODIS, annual mean 2001-2004)

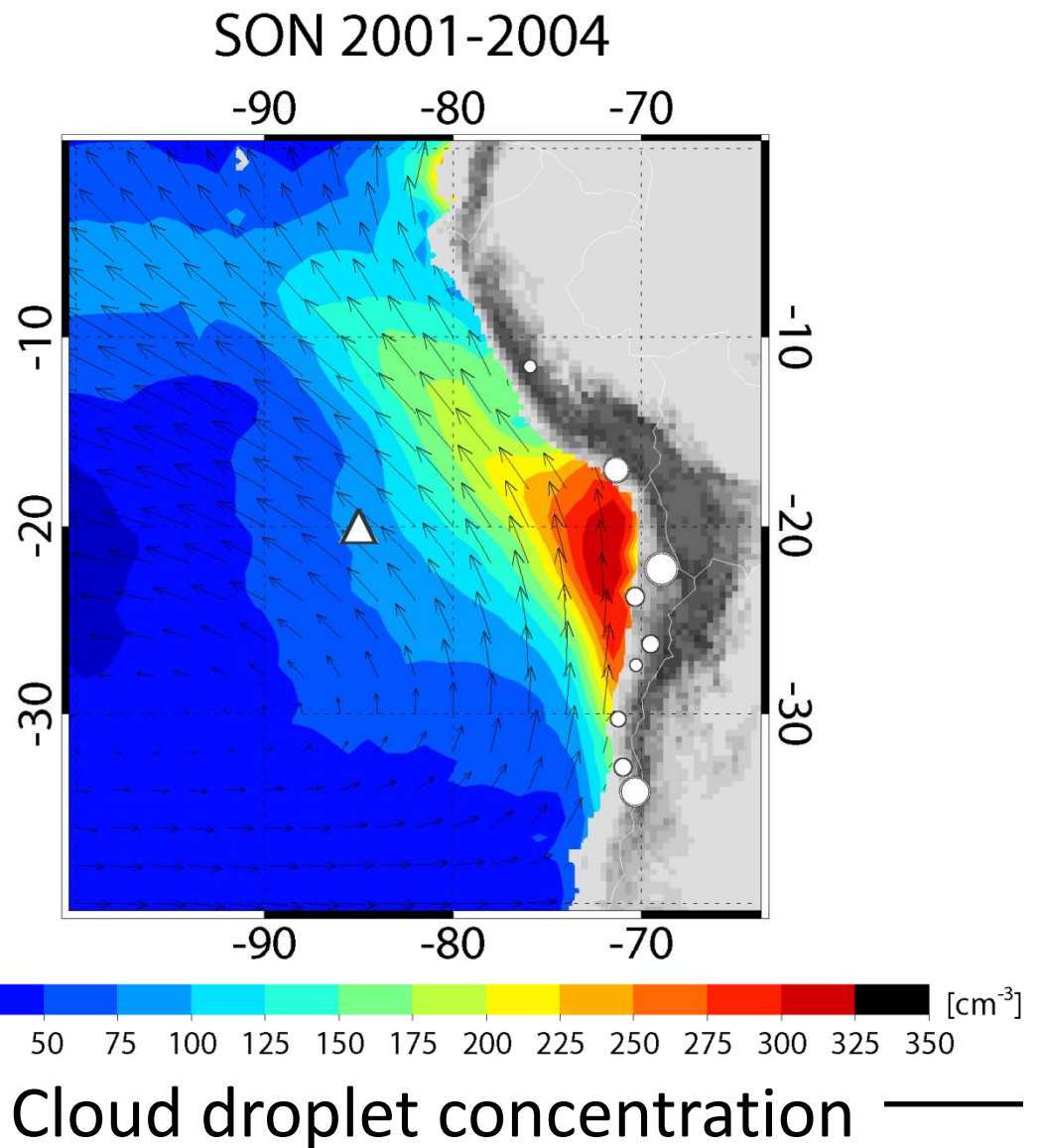


Aerosols and clouds

Chuquicamata, Chile

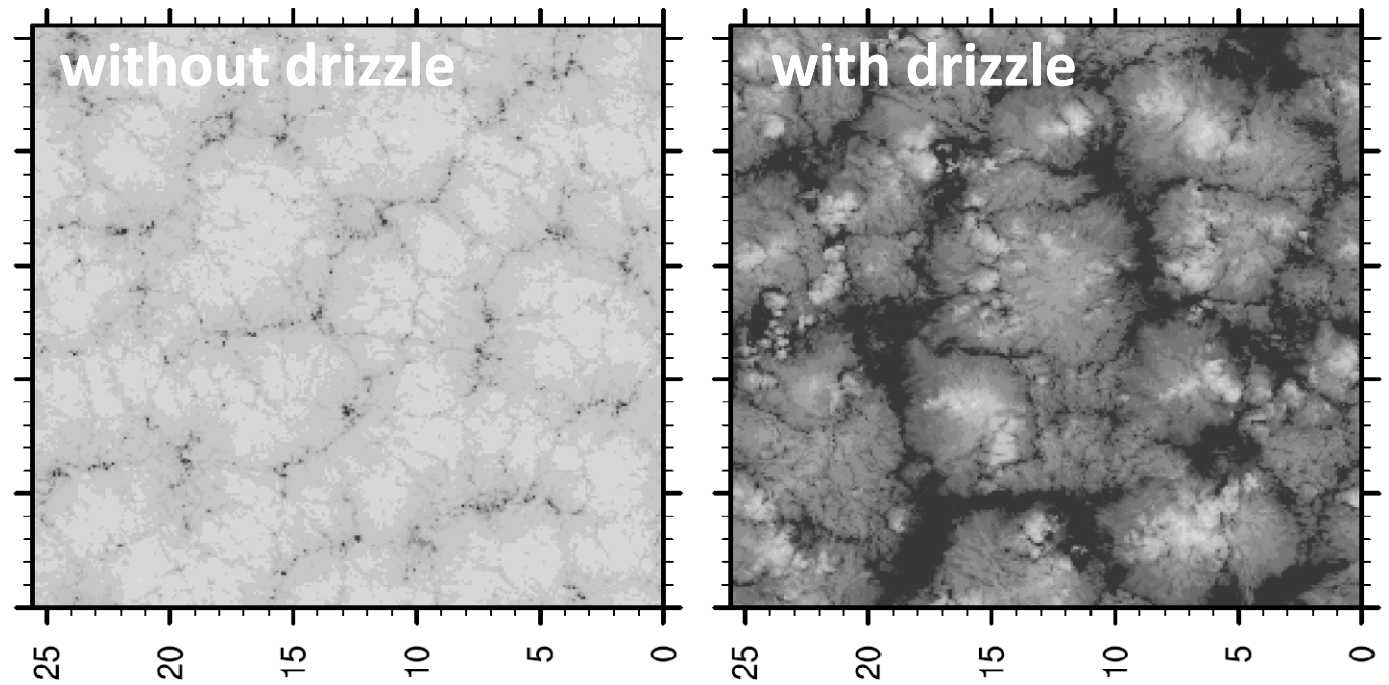


**VOCALS-REx: DMS
concentrations
insufficient to explain
high aerosol/CCN
concentrations**

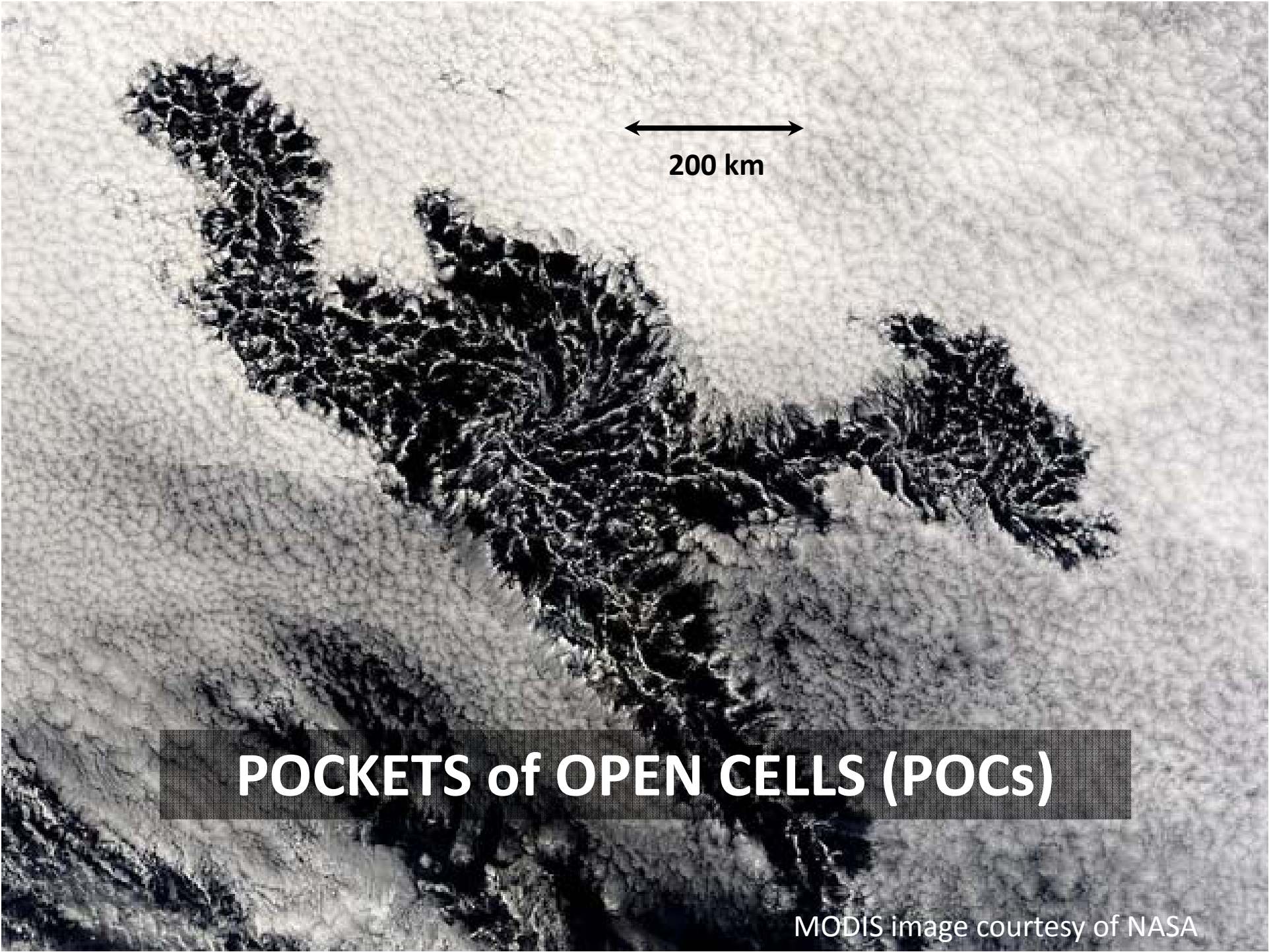




Drizzle



Savic-Jovcic and Stevens (2007)



200 km

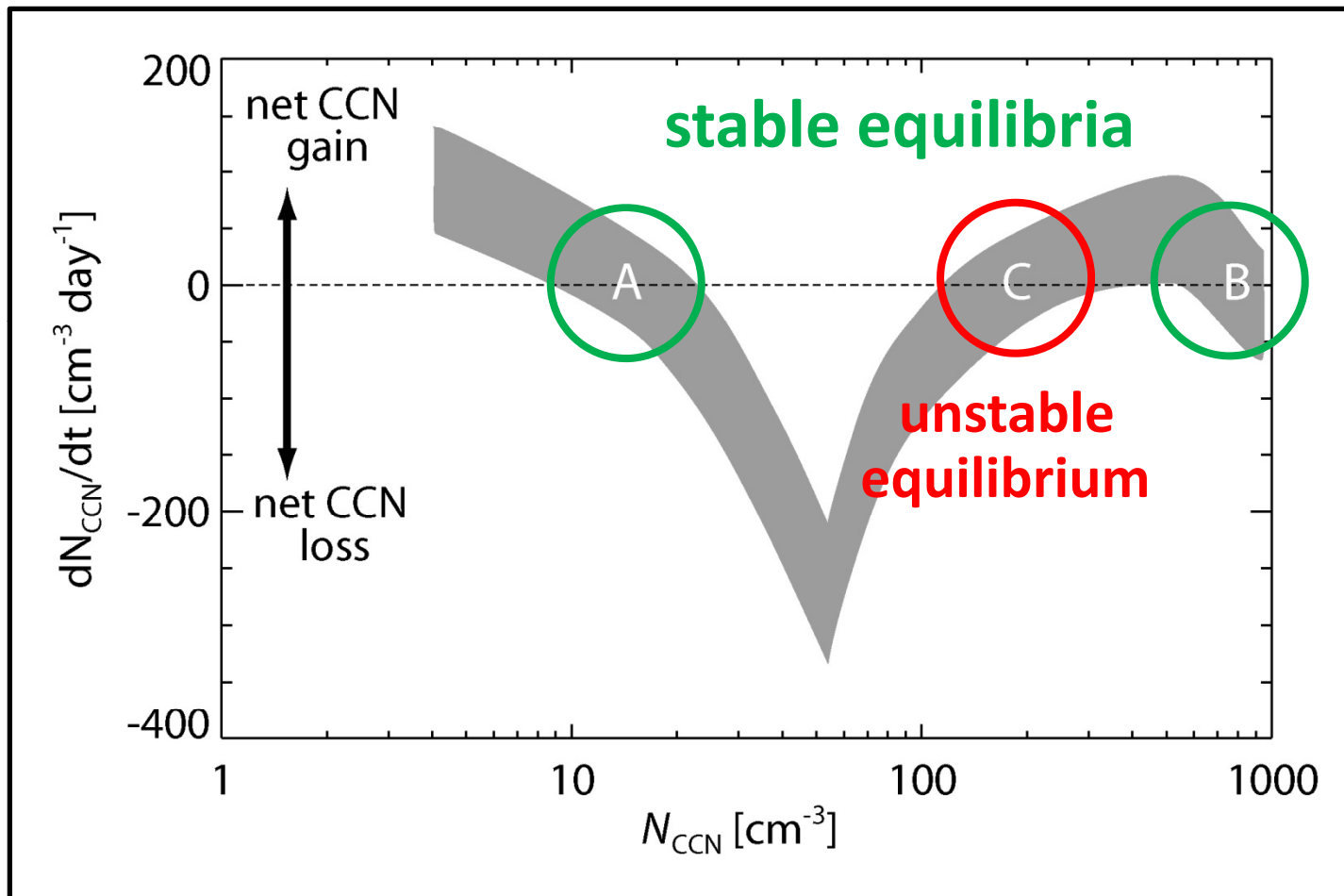
POCKETS of OPEN CELLS (POCs)

MODIS image courtesy of NASA

Bistable regimes for the boundary layer?

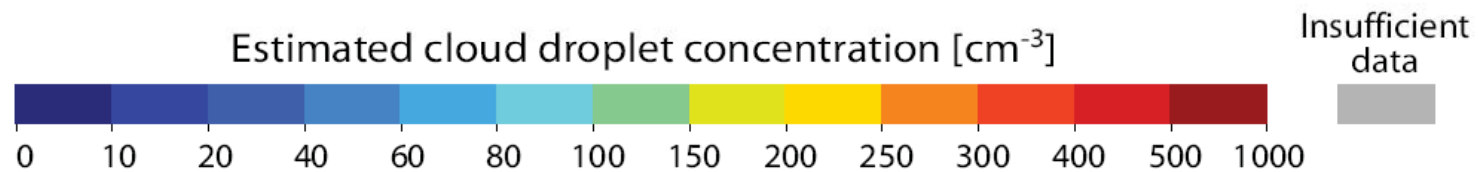
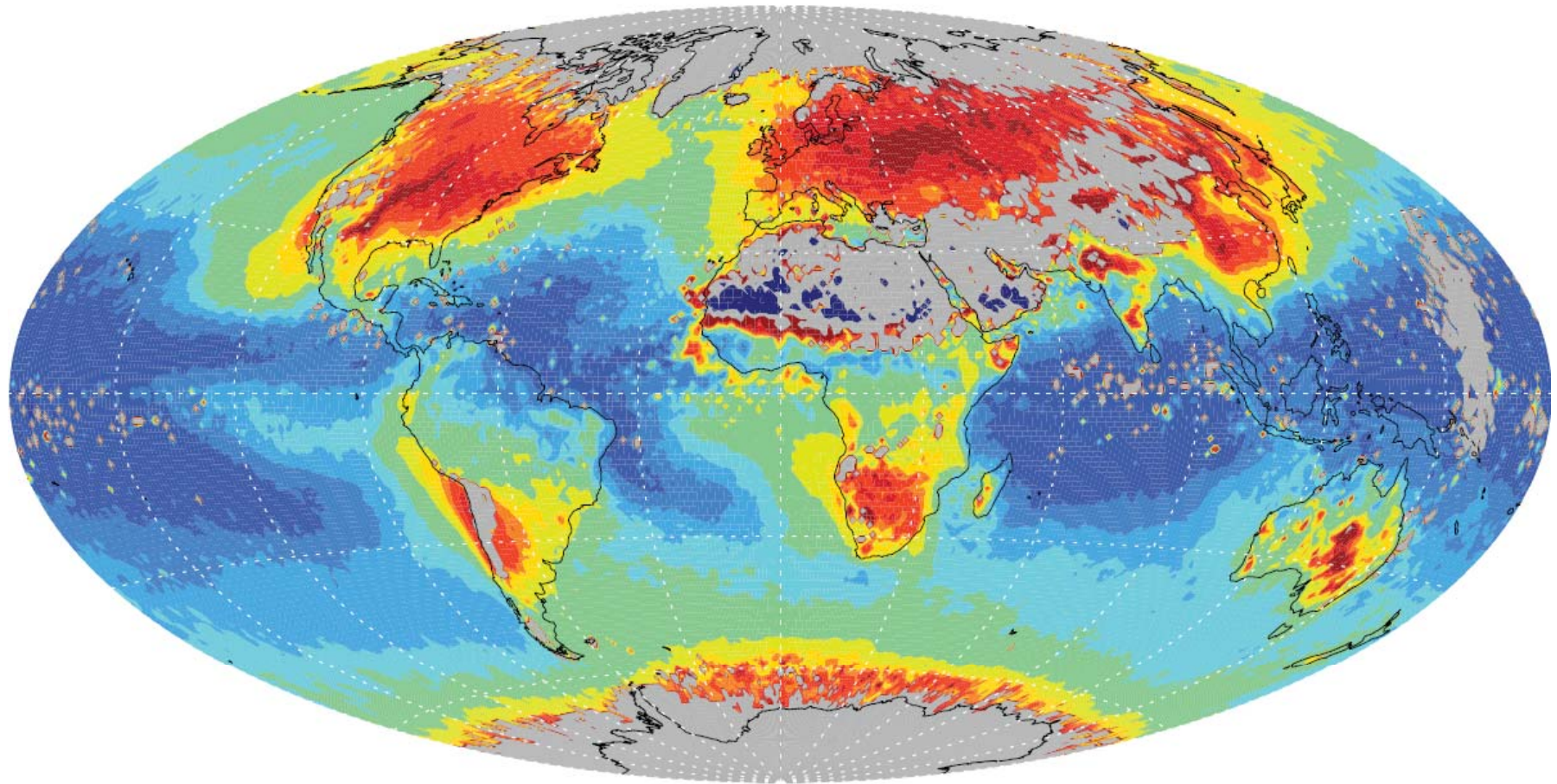
- Baker and Charlson (1990) postulated the existence of **two** stable regimes for the boundary layer:
 - a **low CCN** regime; balance between CCN production and loss by coalescence scavenging
 - a **high CCN** regime; balance between CCN production and Brownian coagulation

Baker and Charlson's regimes



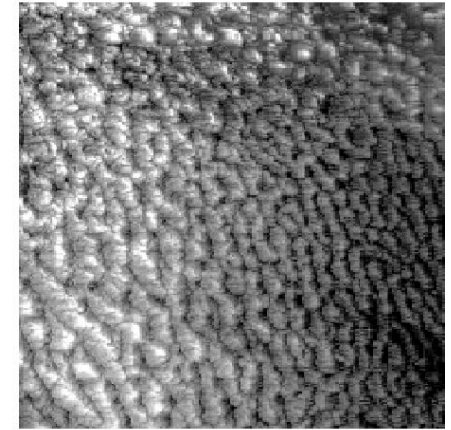
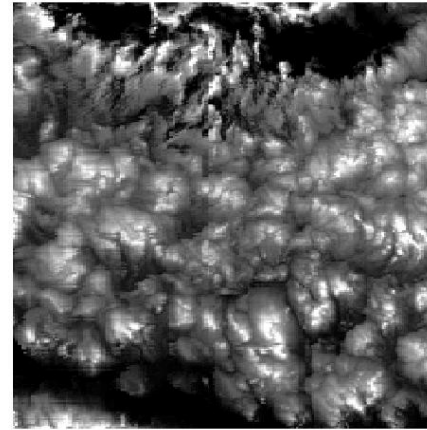
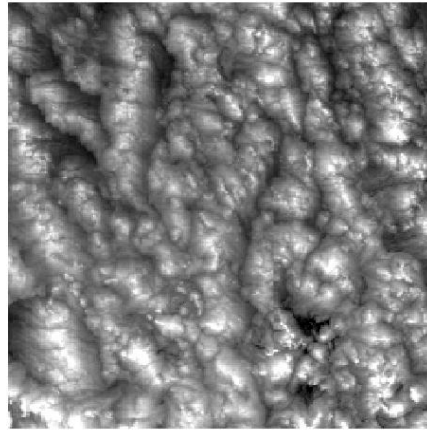
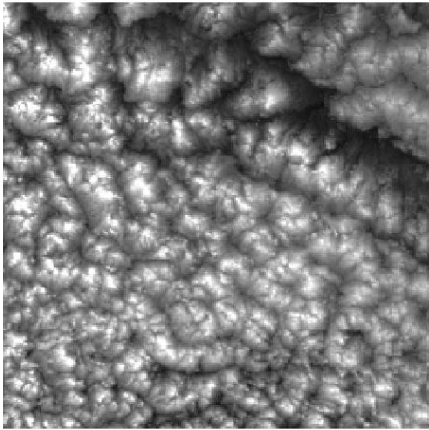
reproduced from Baker and Charlson,
Nature, **345**, 142-145, 1990

Mean cloud droplet concentration (MODIS)

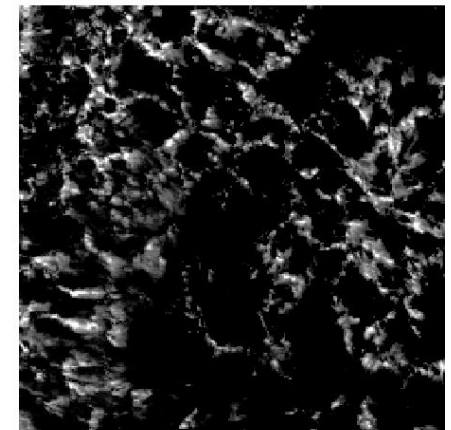
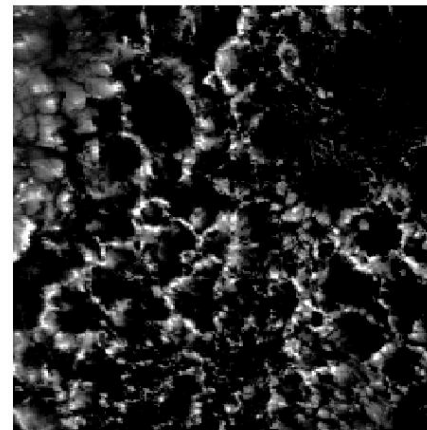
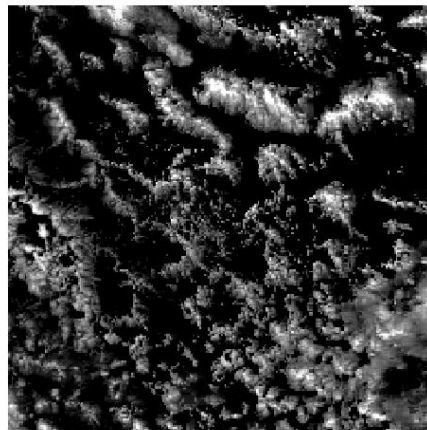
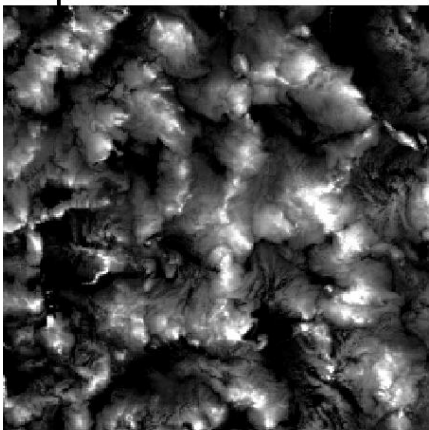


Shallow convection modes in the subtropical MBL

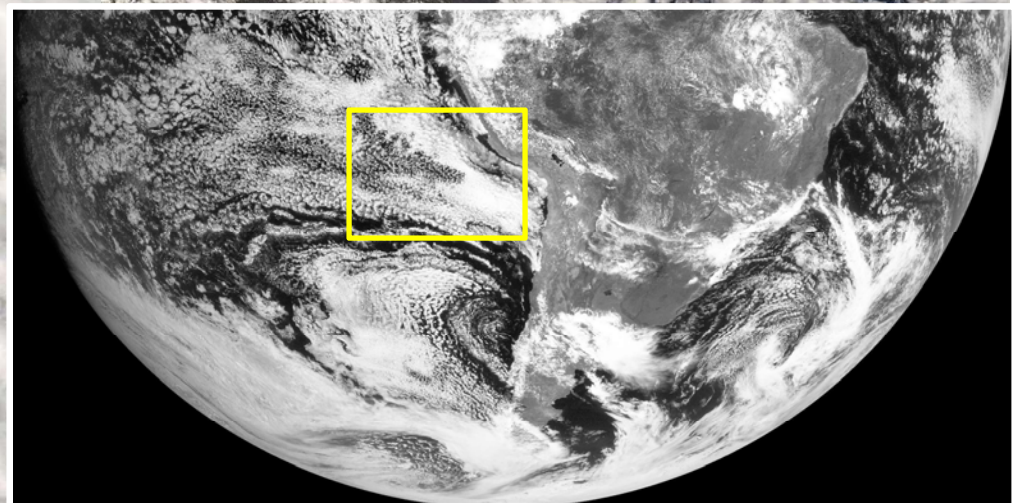
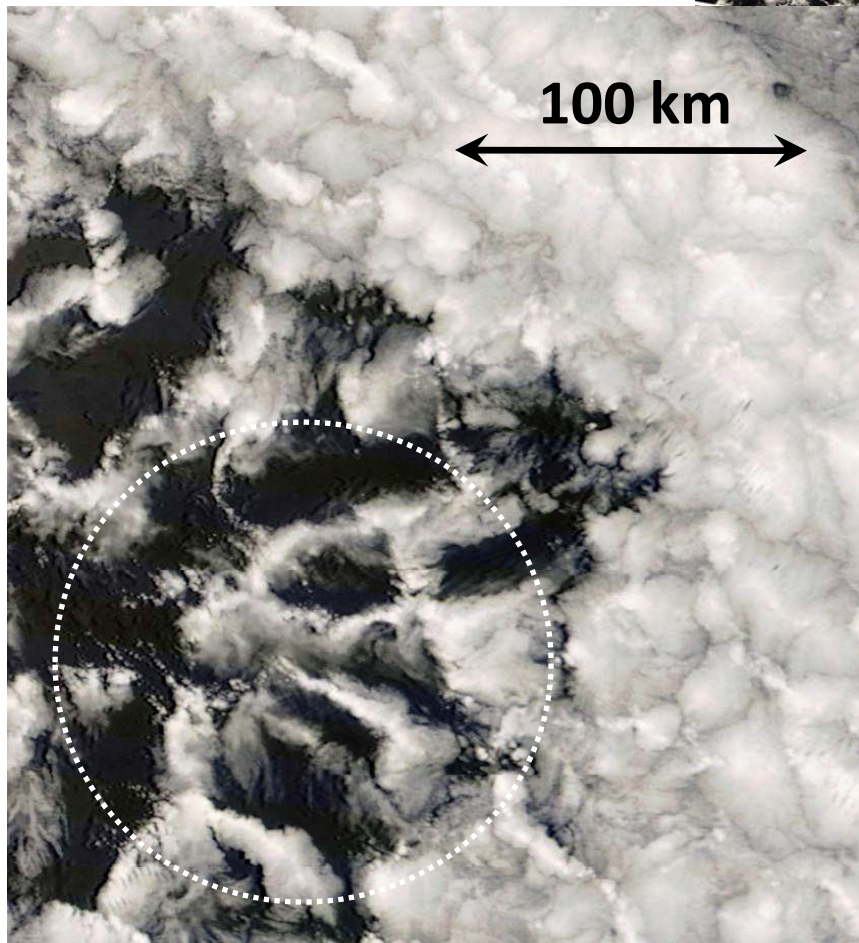
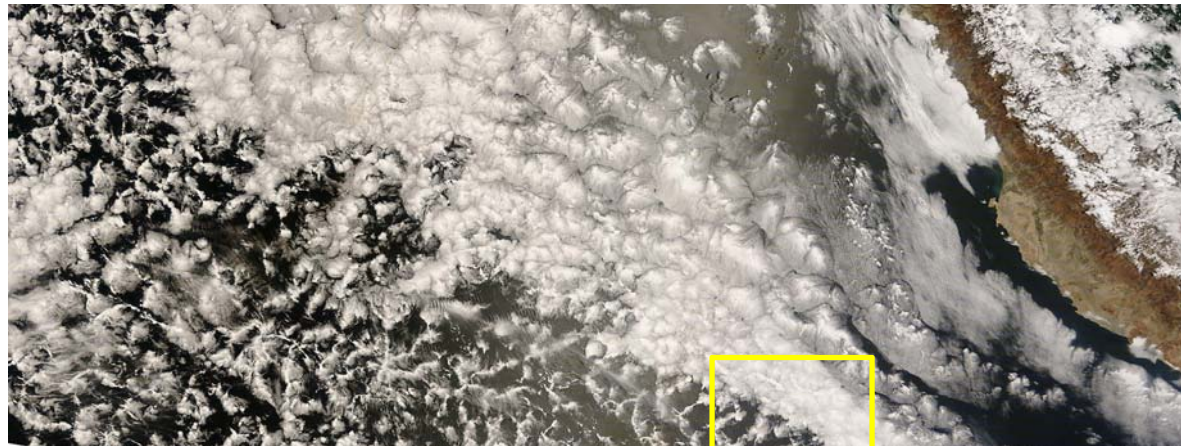
Closed MCC



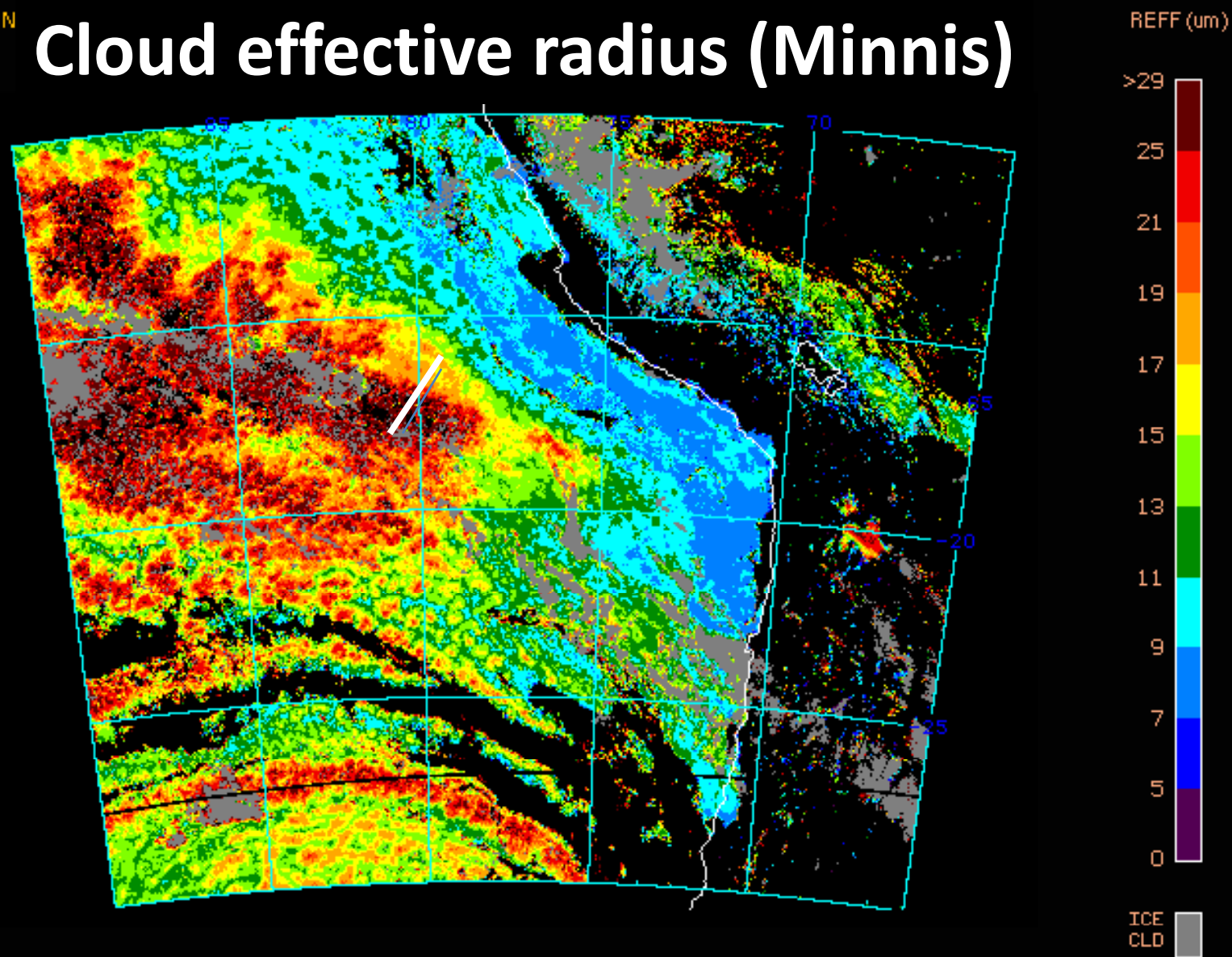
Open MCC



October 27/28th 2008
POC Lagrangian -
BAe-146 & NSF C-130

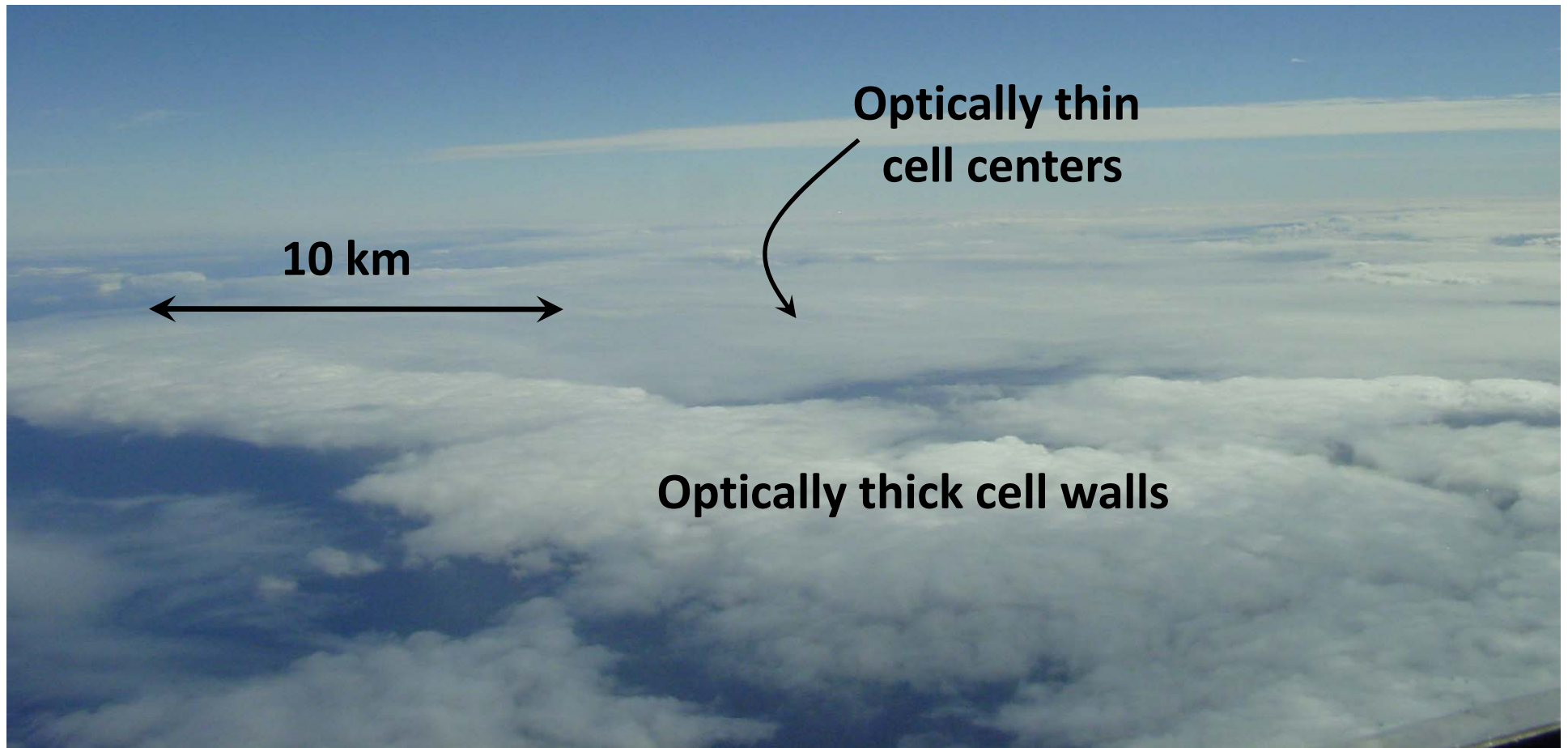


Cloud effective radius (Minnis)

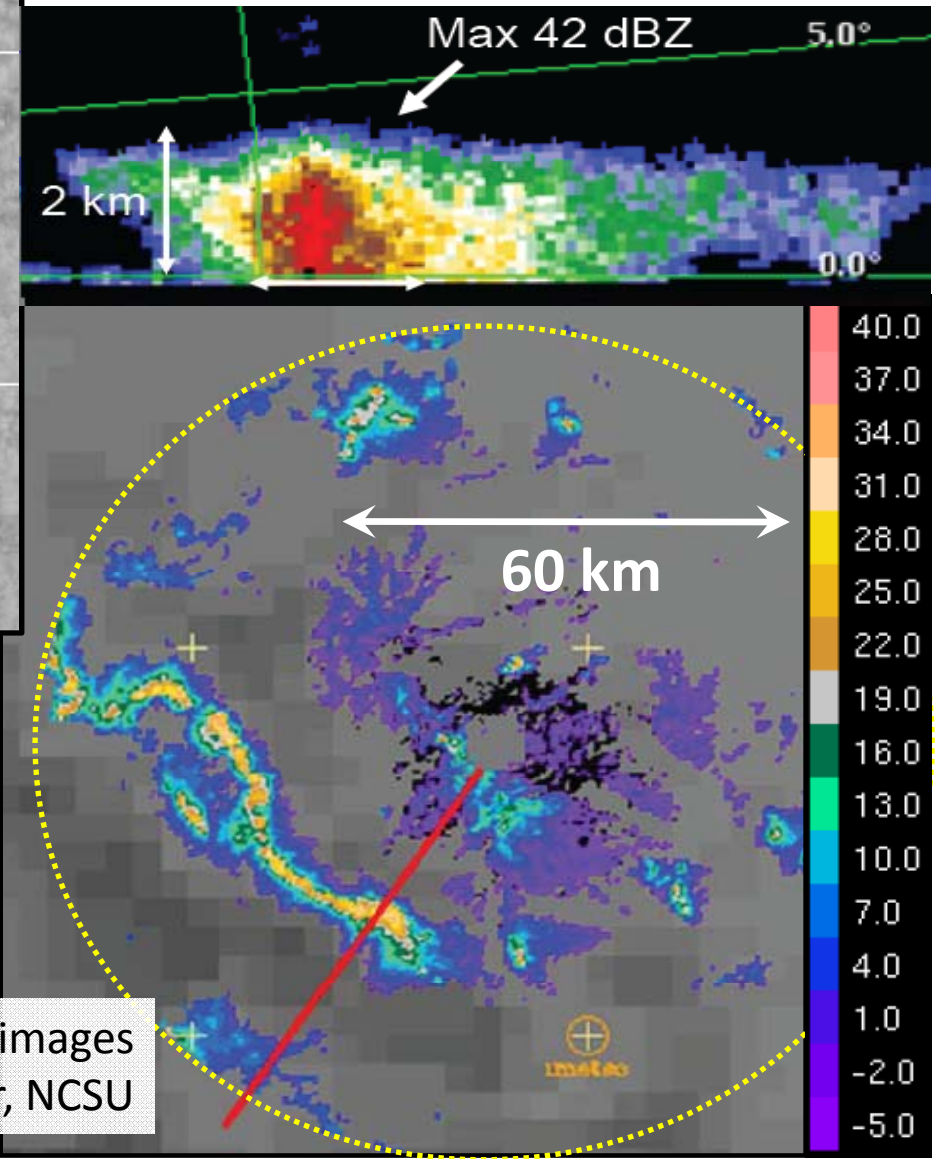
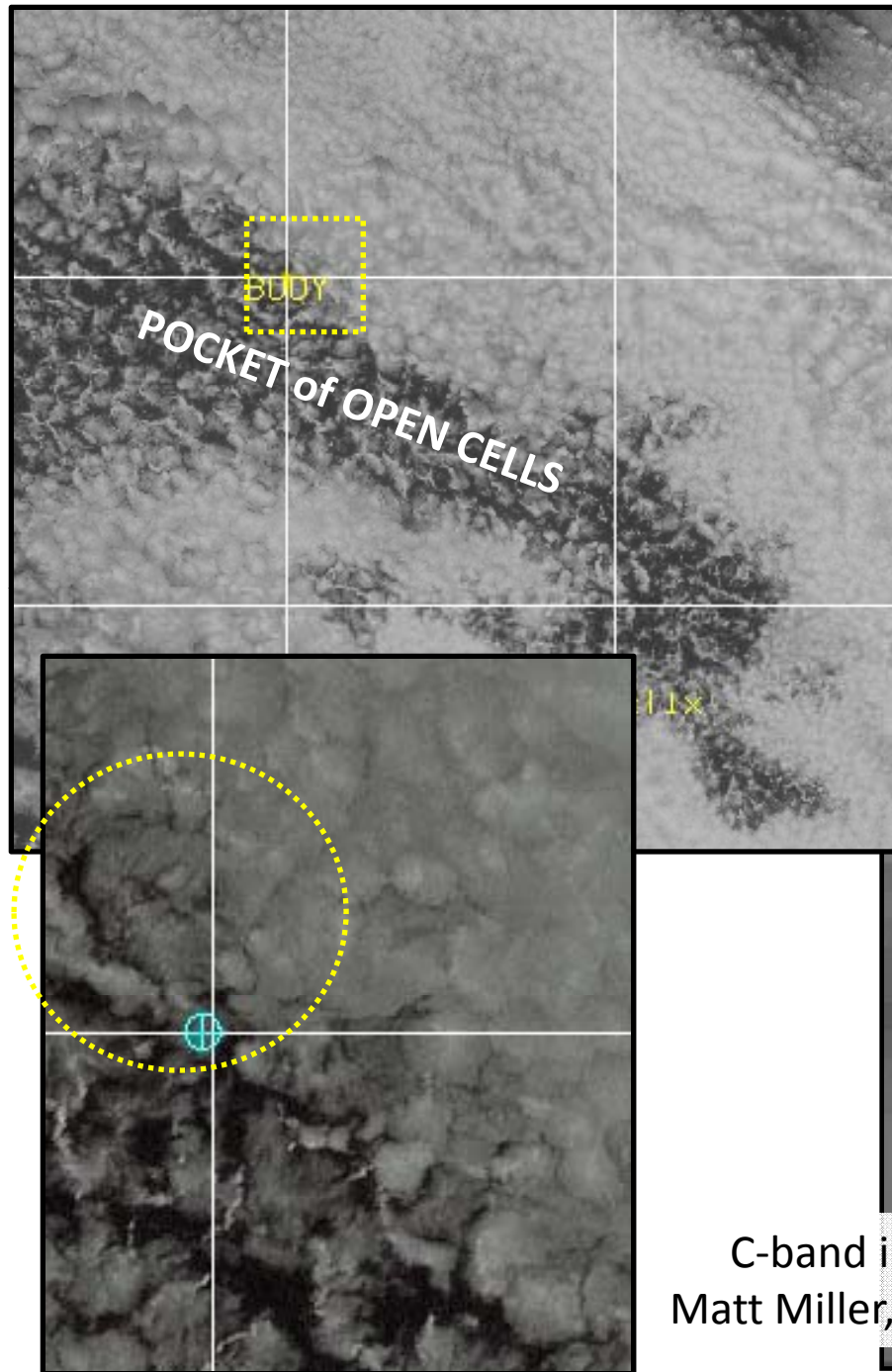


G10 EFFECTIVE WATER RADIUS OCT 28, 2008 14:15Z NASA LARC

OPEN CELL MORPHOLOGY

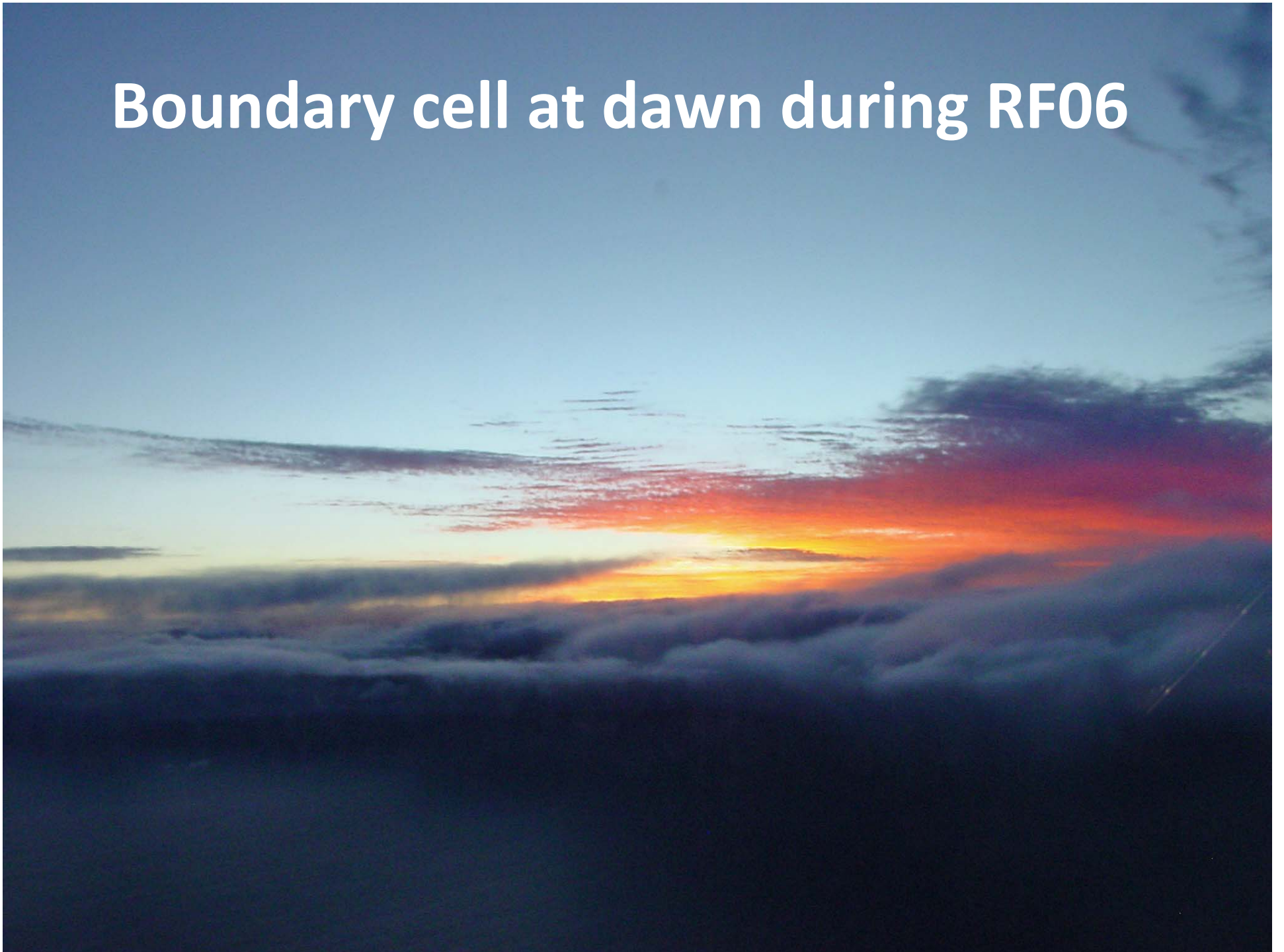


Boundary cells

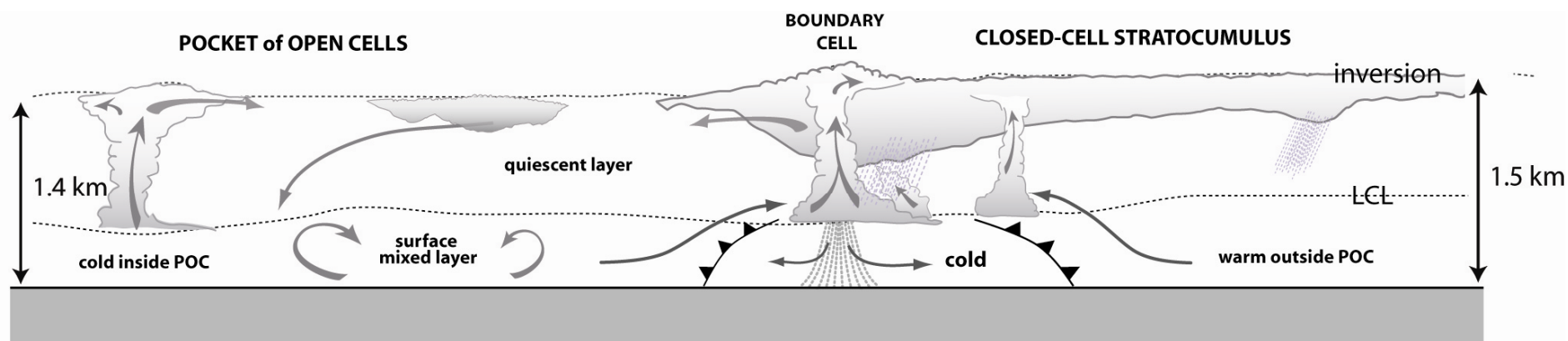


C-band images
Matt Miller, NCSU

Boundary cell at dawn during RF06



Conceptual model of POC edge



Decoupled MBL

Relatively well-mixed MBL

Extremely clean

[CN = 20-50 cm⁻³, CCN = 5-20 cm⁻³]

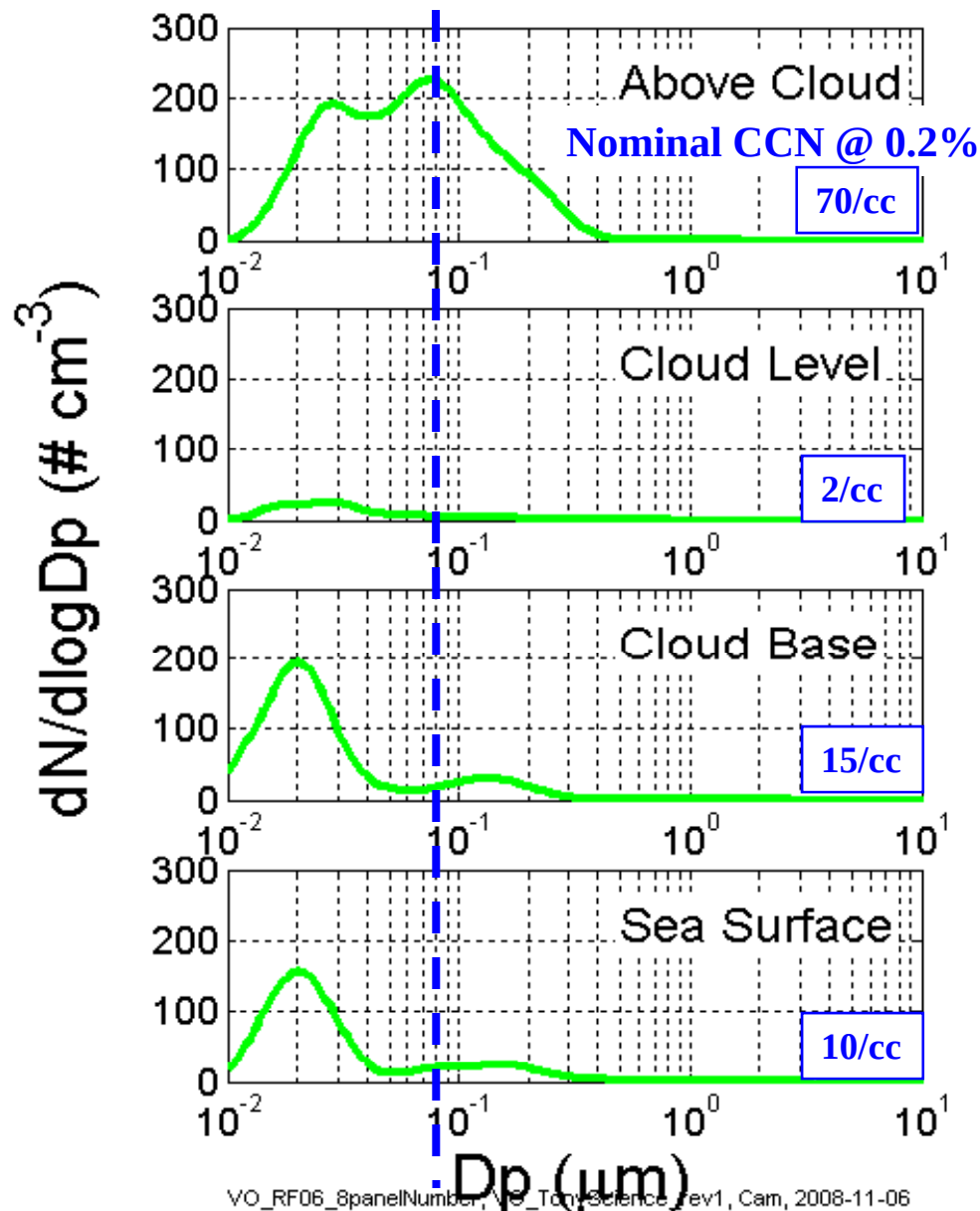
Moderately polluted

[CN = 500-1000 cm⁻³, CCN = 100 cm⁻³]

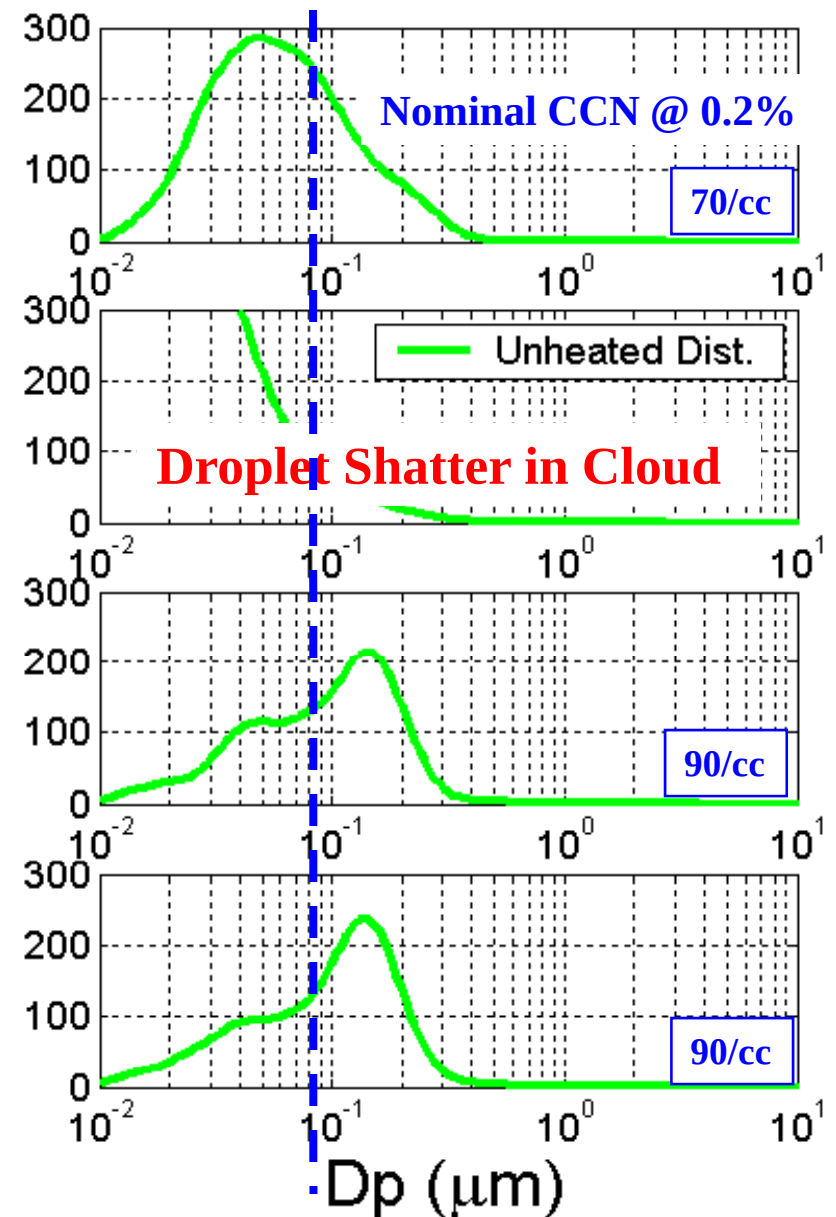


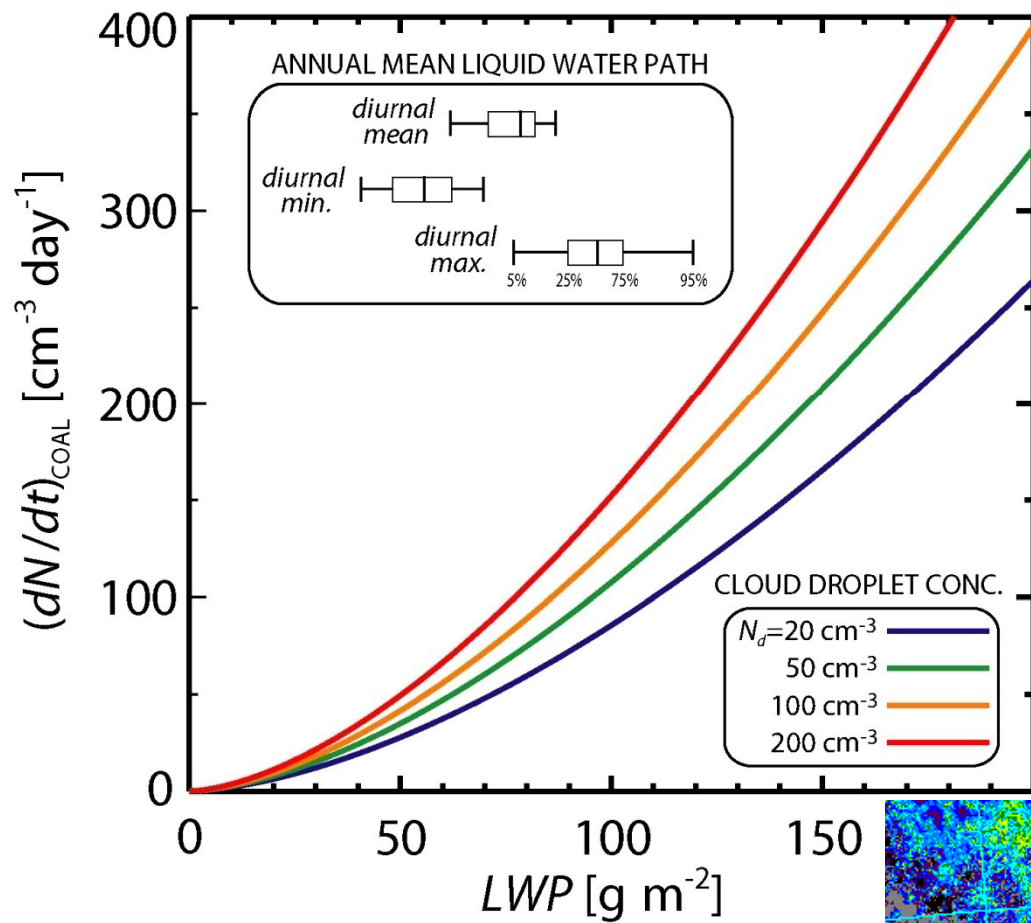
AEROSOL NUMBER DISTRIBUTIONS

Inside POC



Outside POC

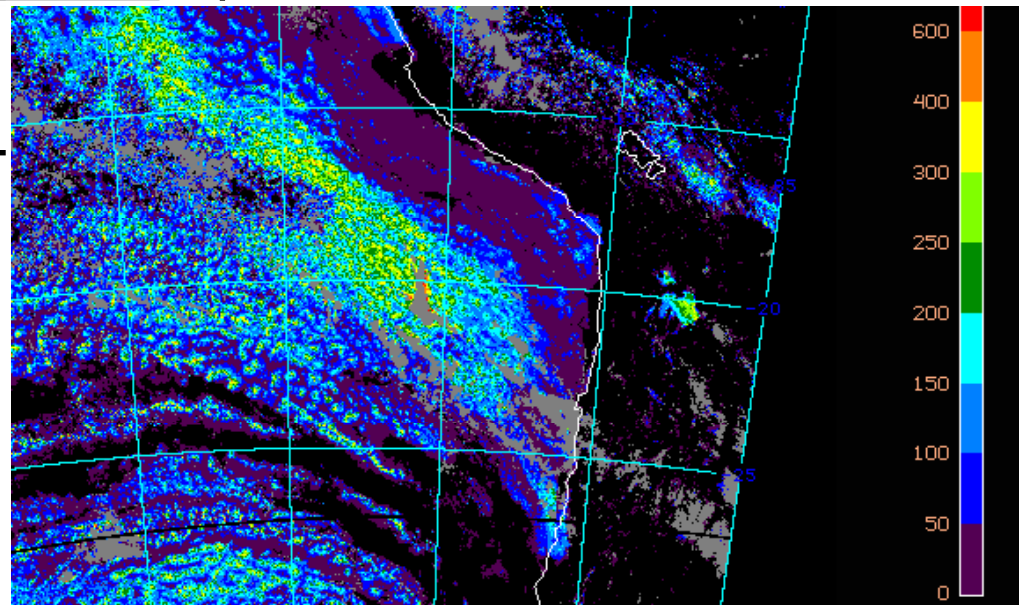




Coalescence and CCN depletion

- Loss rate of CCN number concentration through coalescence

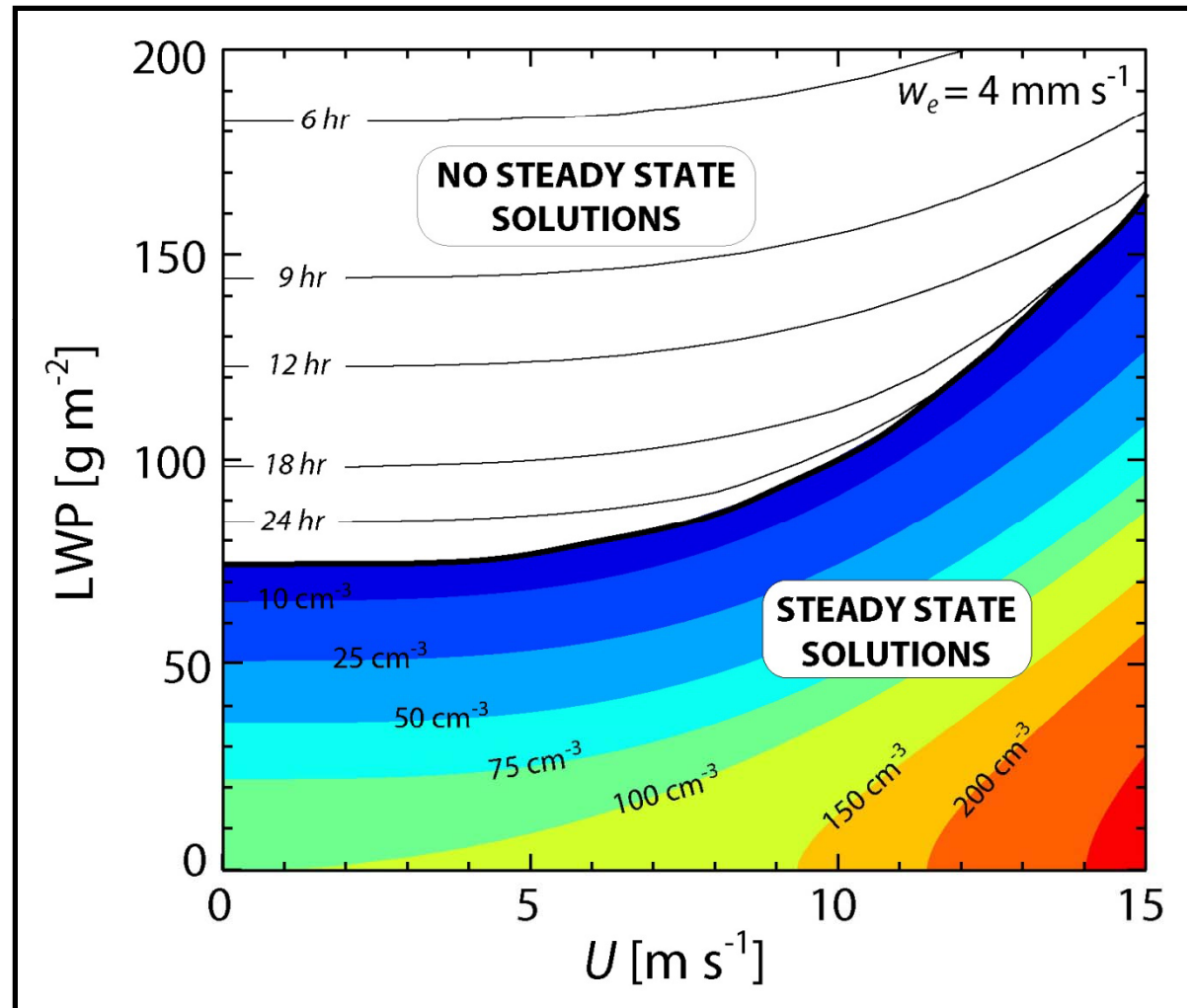
$$\propto LWP^2$$



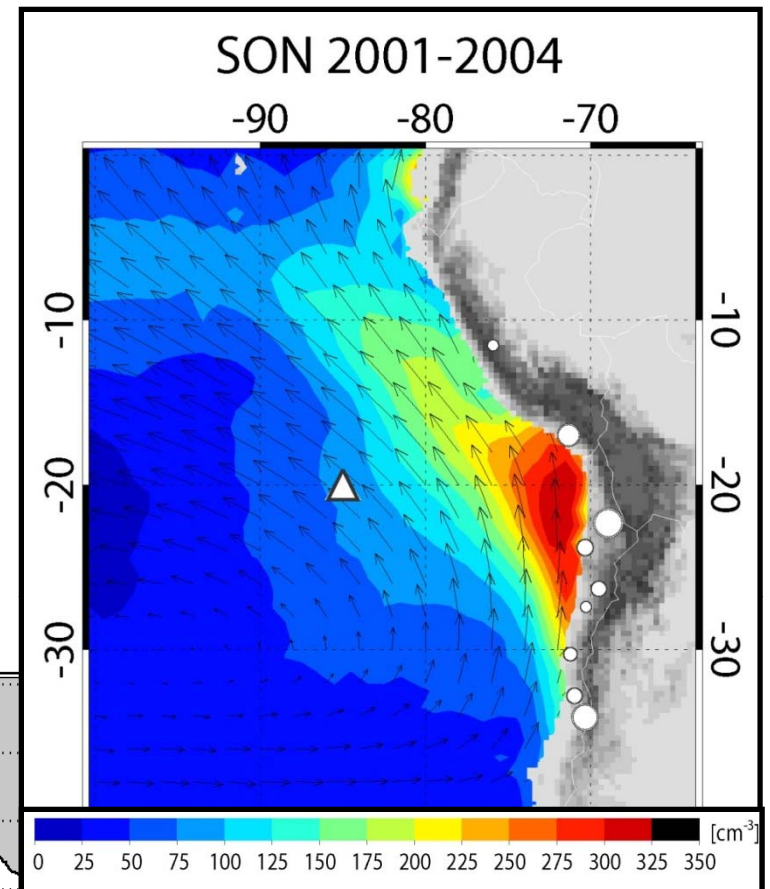
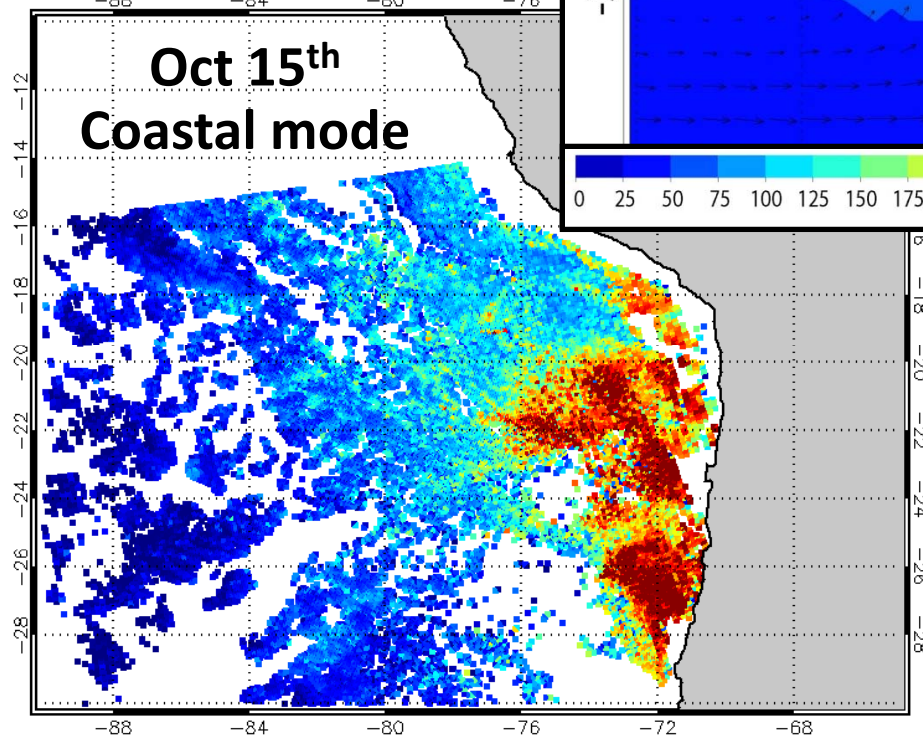
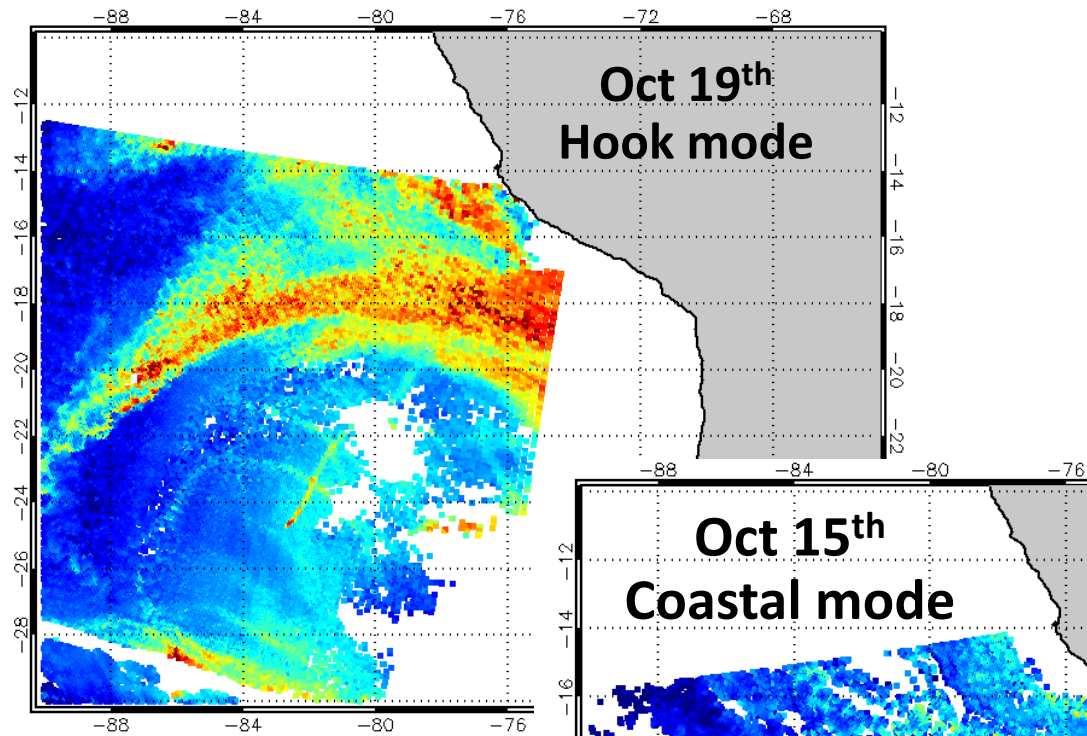
Steady-state cloud condensation nucleus (CCN) model

Assumptions:

1. Wind-driven sea-salt production and entrainment of 100 cm^{-3} from free-troposphere are only aerosol sources.
2. Coalescence scavenging is the only loss term
3. Examine steady state solution for CCN concentration

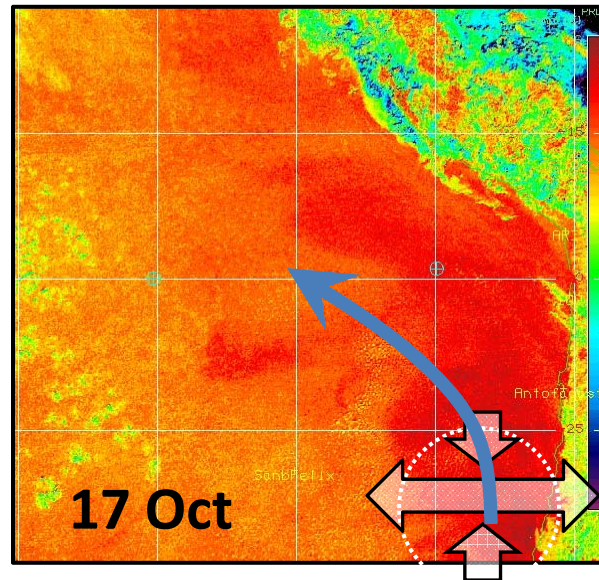
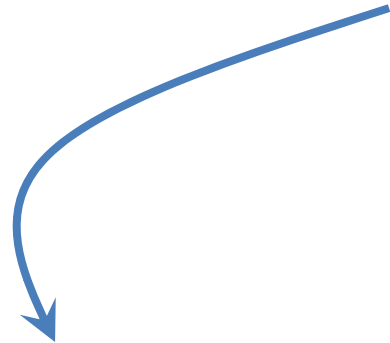


Pollution sources



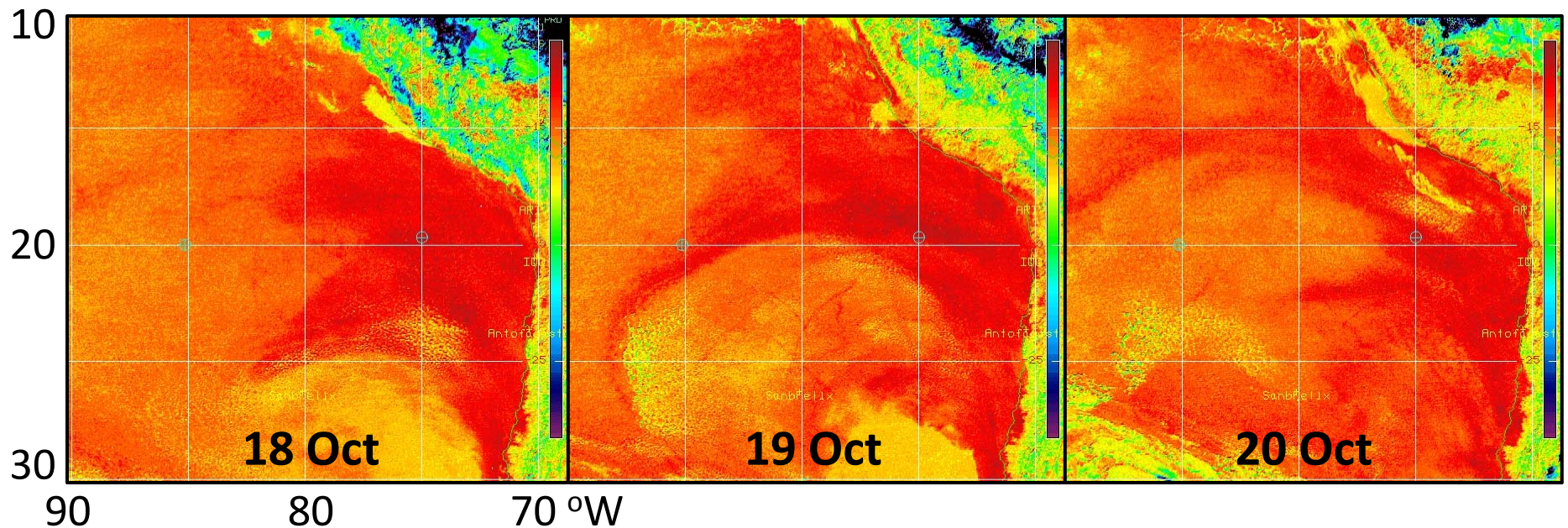
Two “modes”

Hook origin



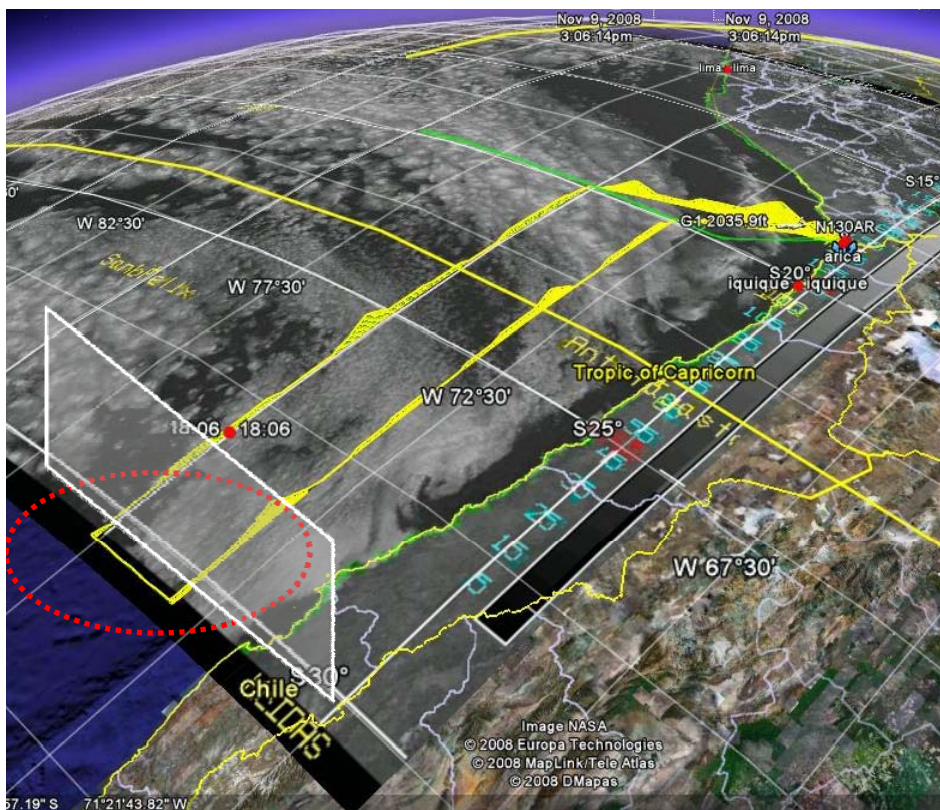
Night-time brightness
temperature
difference (Ch4-Ch2)

- indicative of
microphysical
contrasts

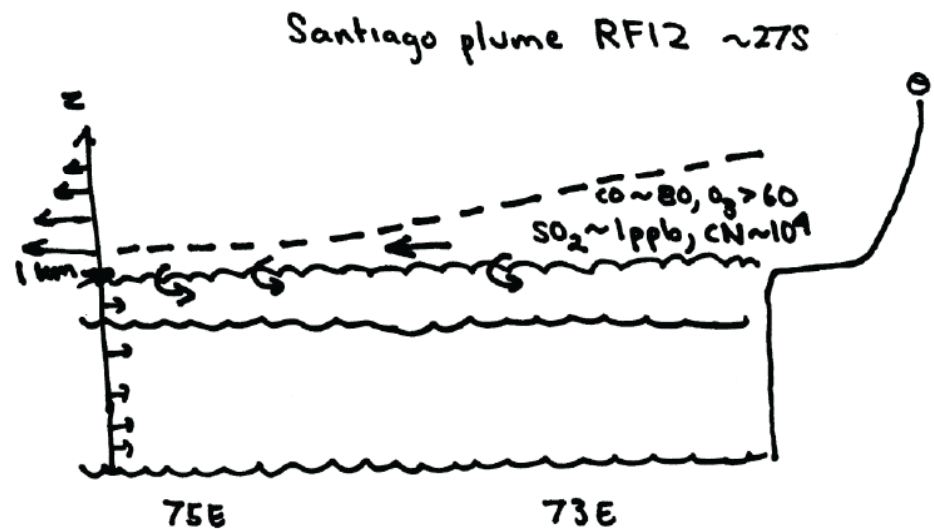
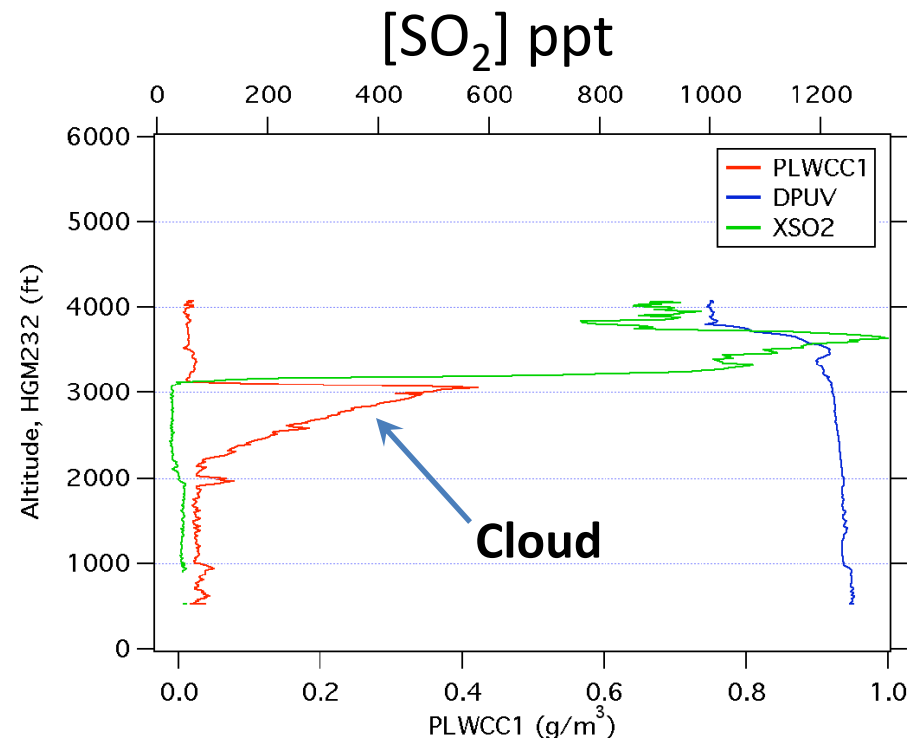


Pollution survey missions

RF12, November 11th 2008



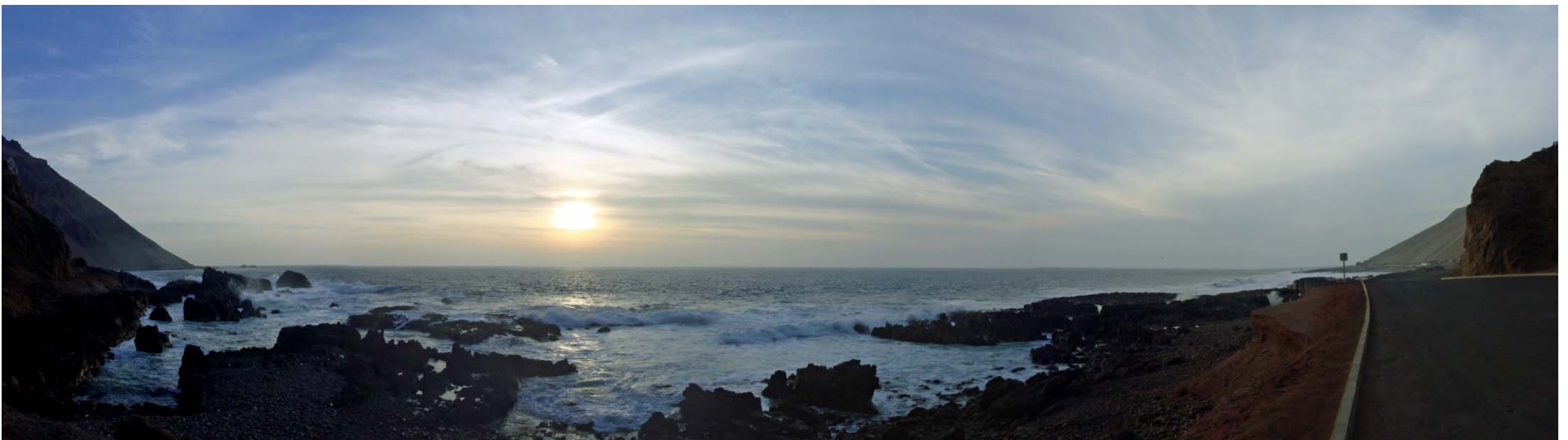
 Santiago



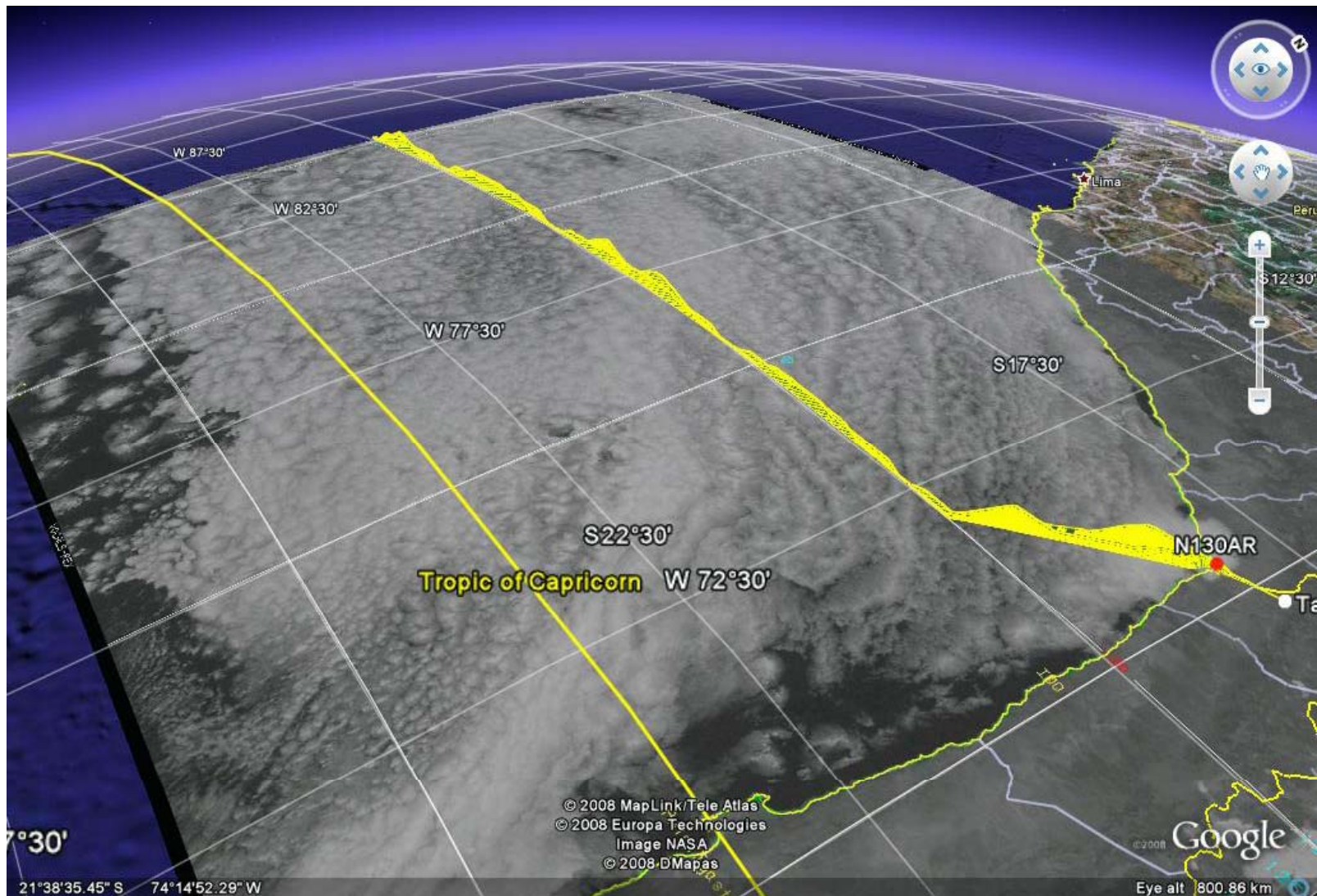
Summary

VOCALS-REx yielding important information to understand

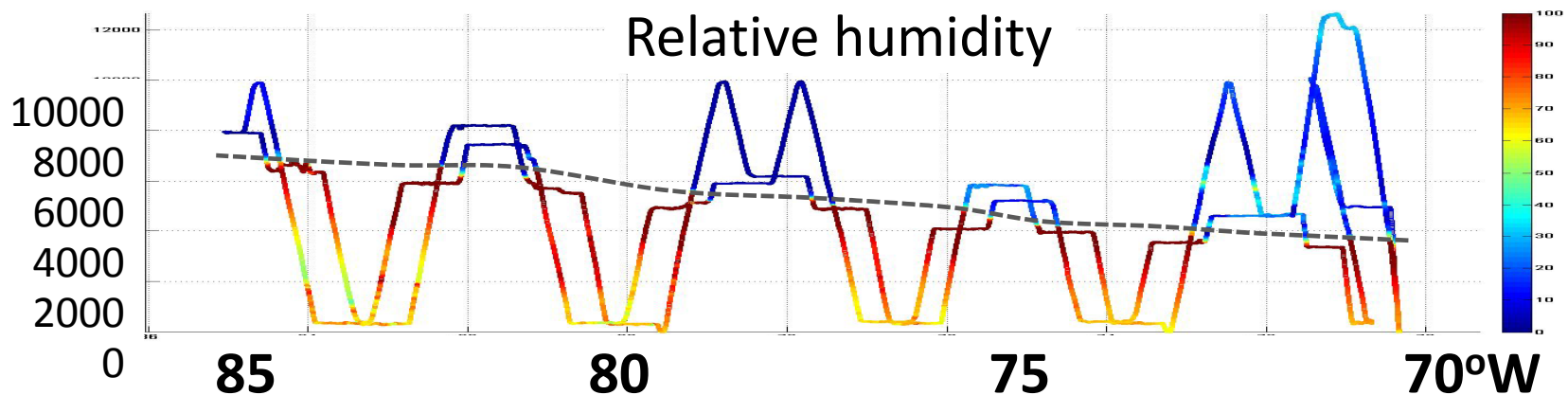
- Role of drizzle in controlling cloud structure and dynamics
- Limits to the stability of marine stratocumulus decks
- Processes controlling distribution of aerosol pollution over the SE Pacific



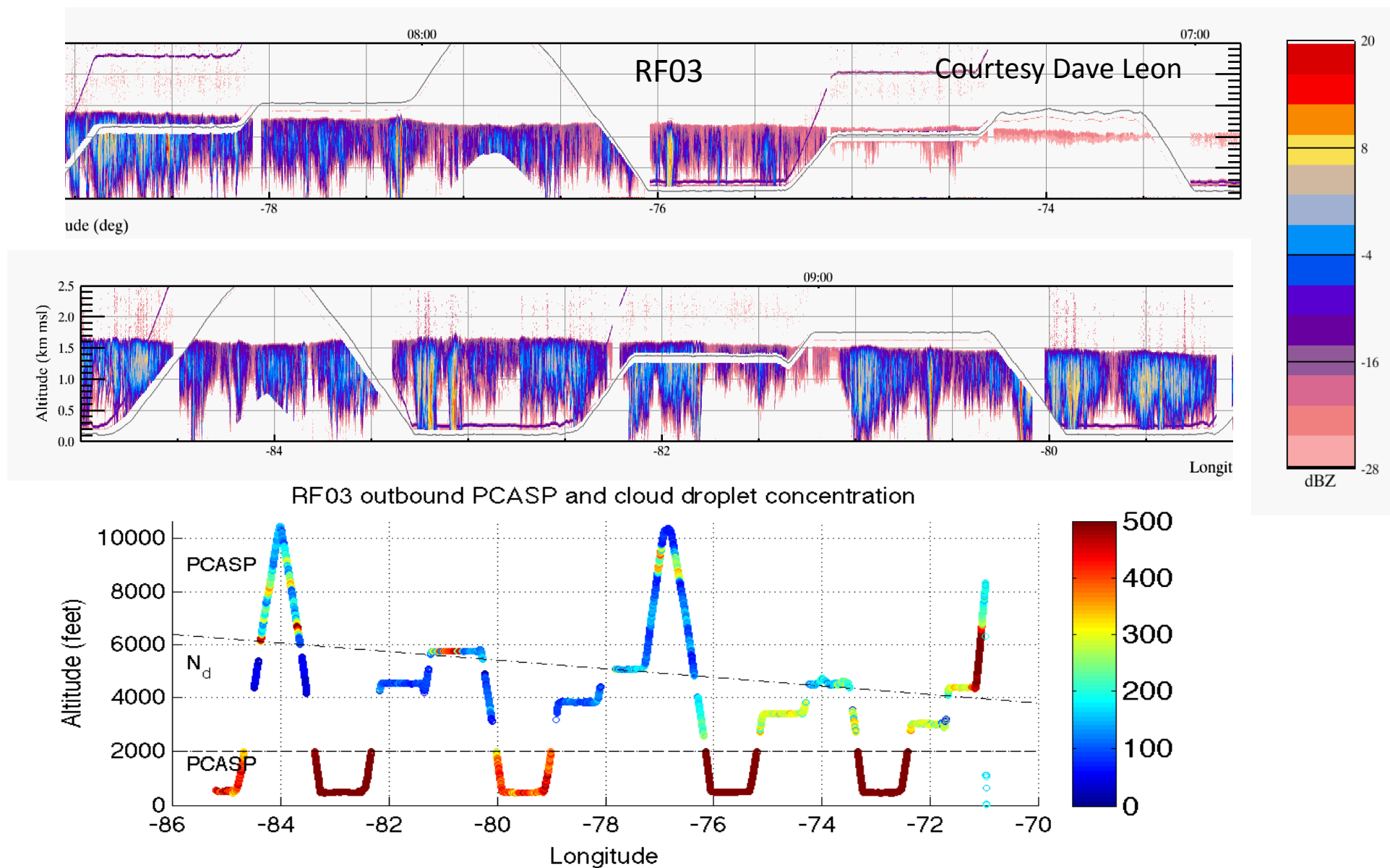
Stratocumulus survey missions (along 20°S parallel)

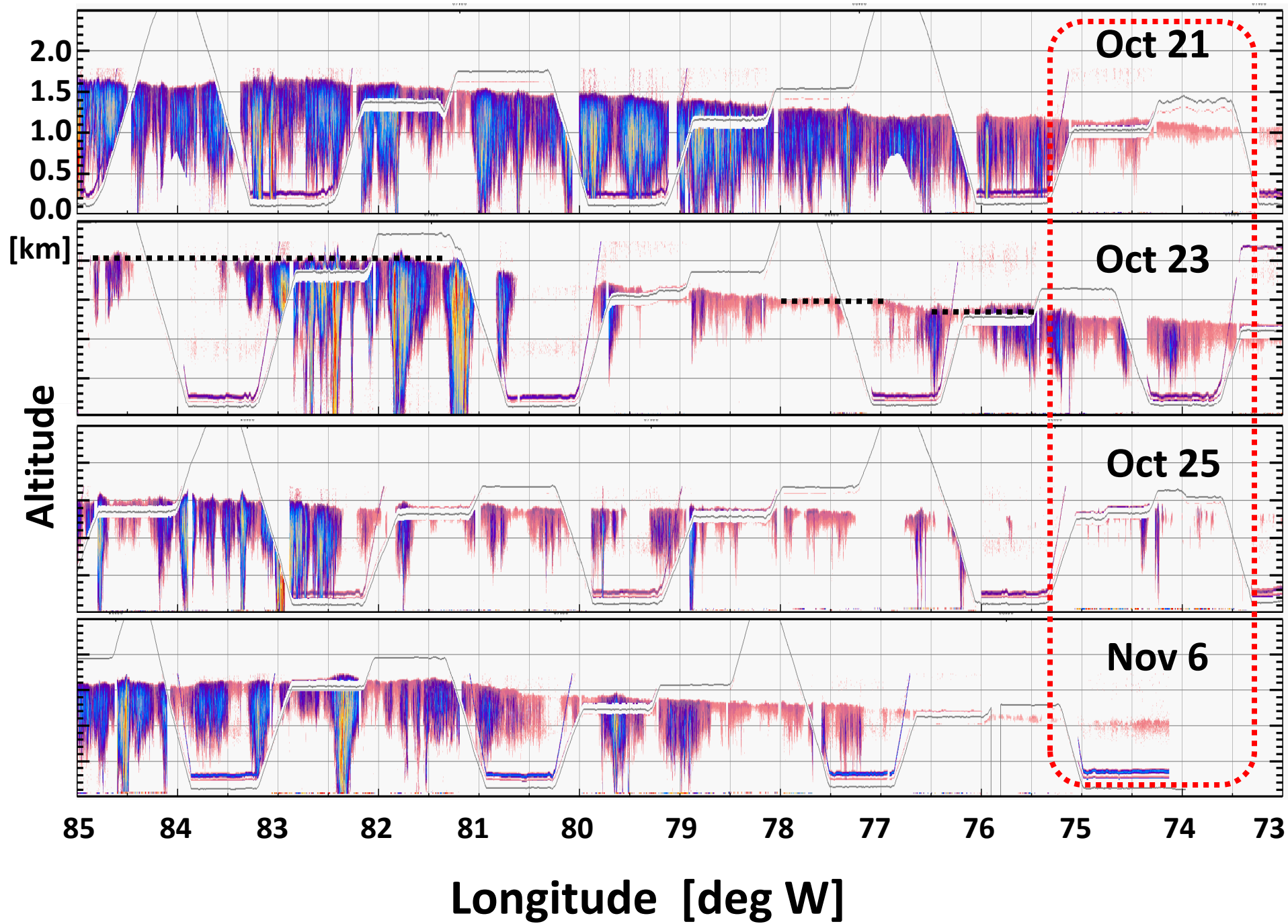


20°S Missions



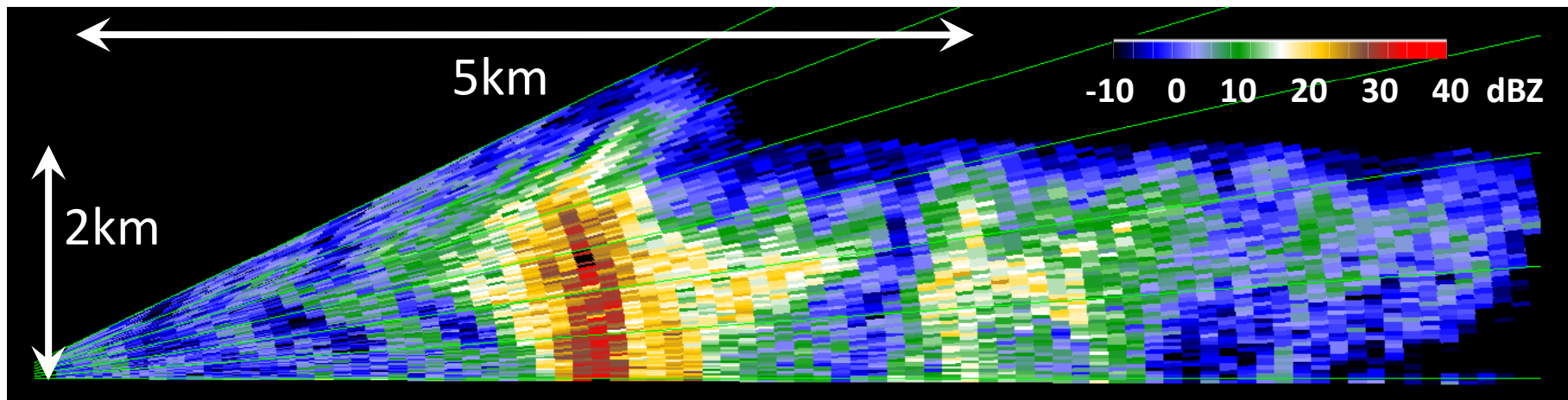
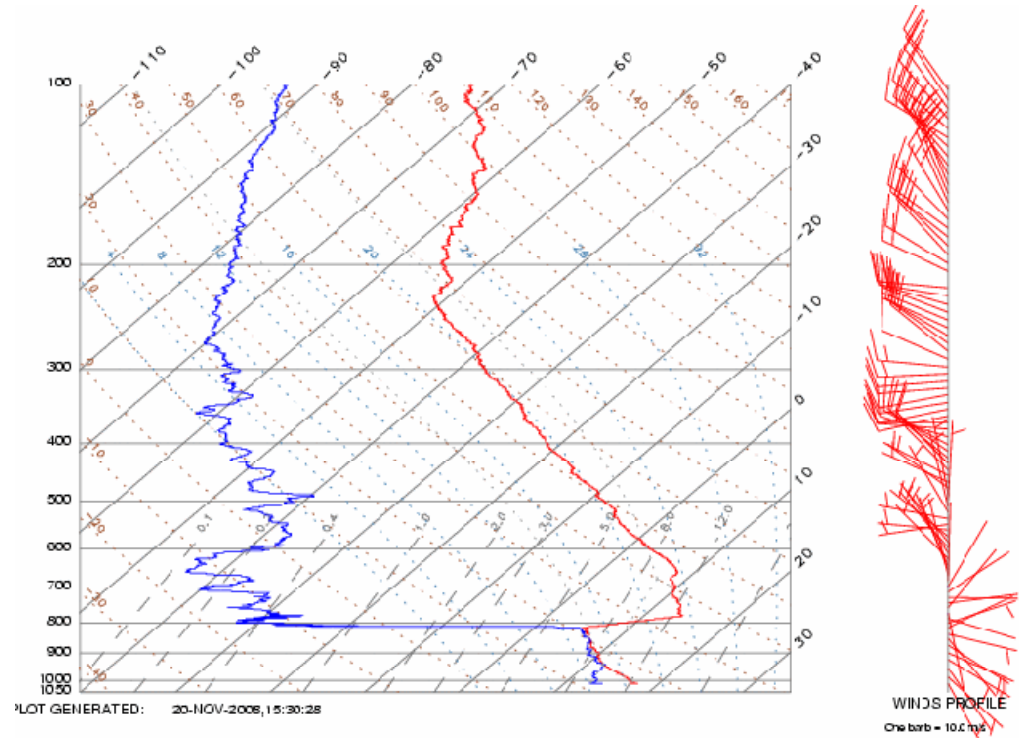
Millimeter cloud radar, microphysics

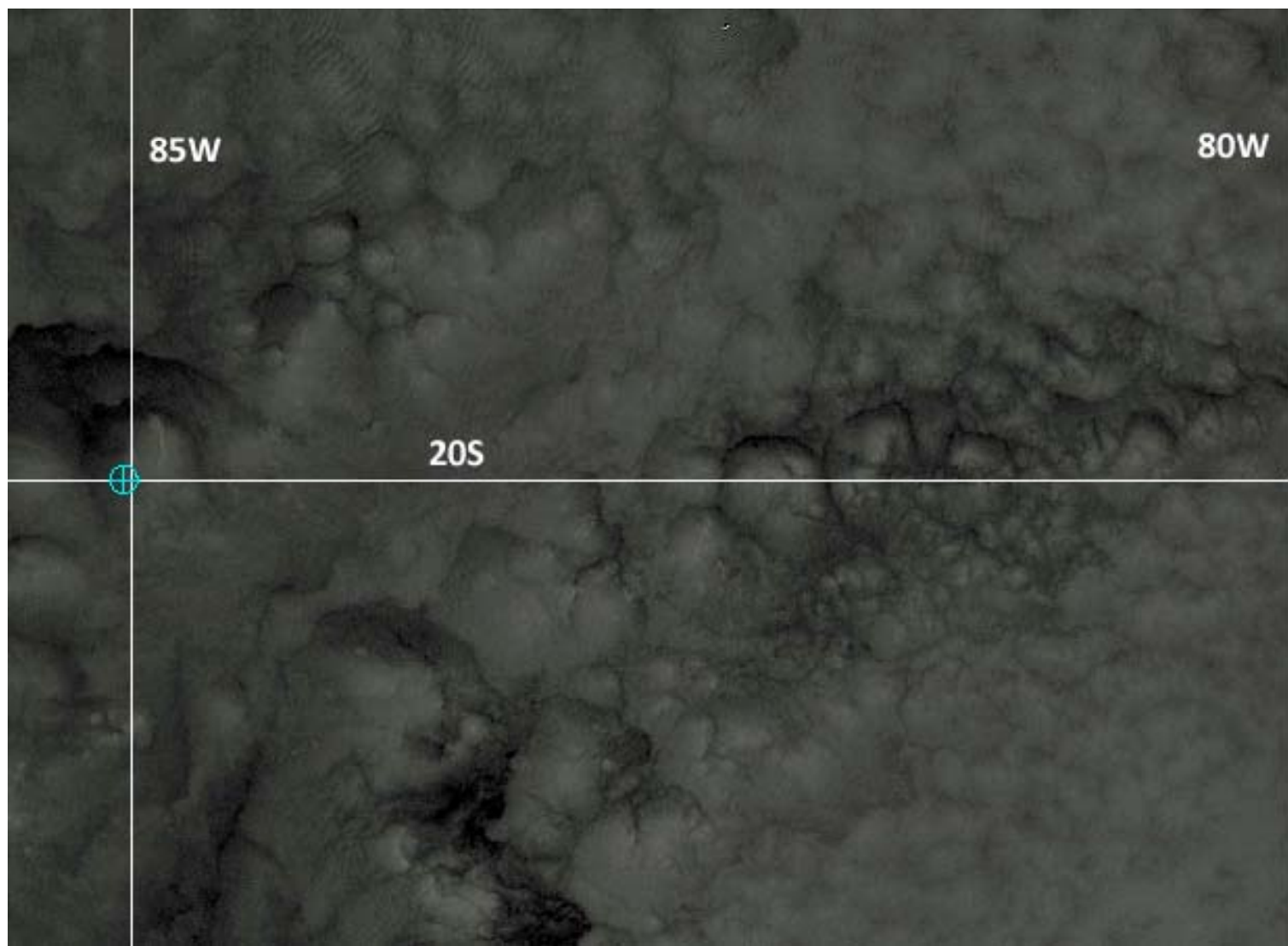




Stratocumulus Funnel Clouds

20 Nov 2008, 85°W 20°S

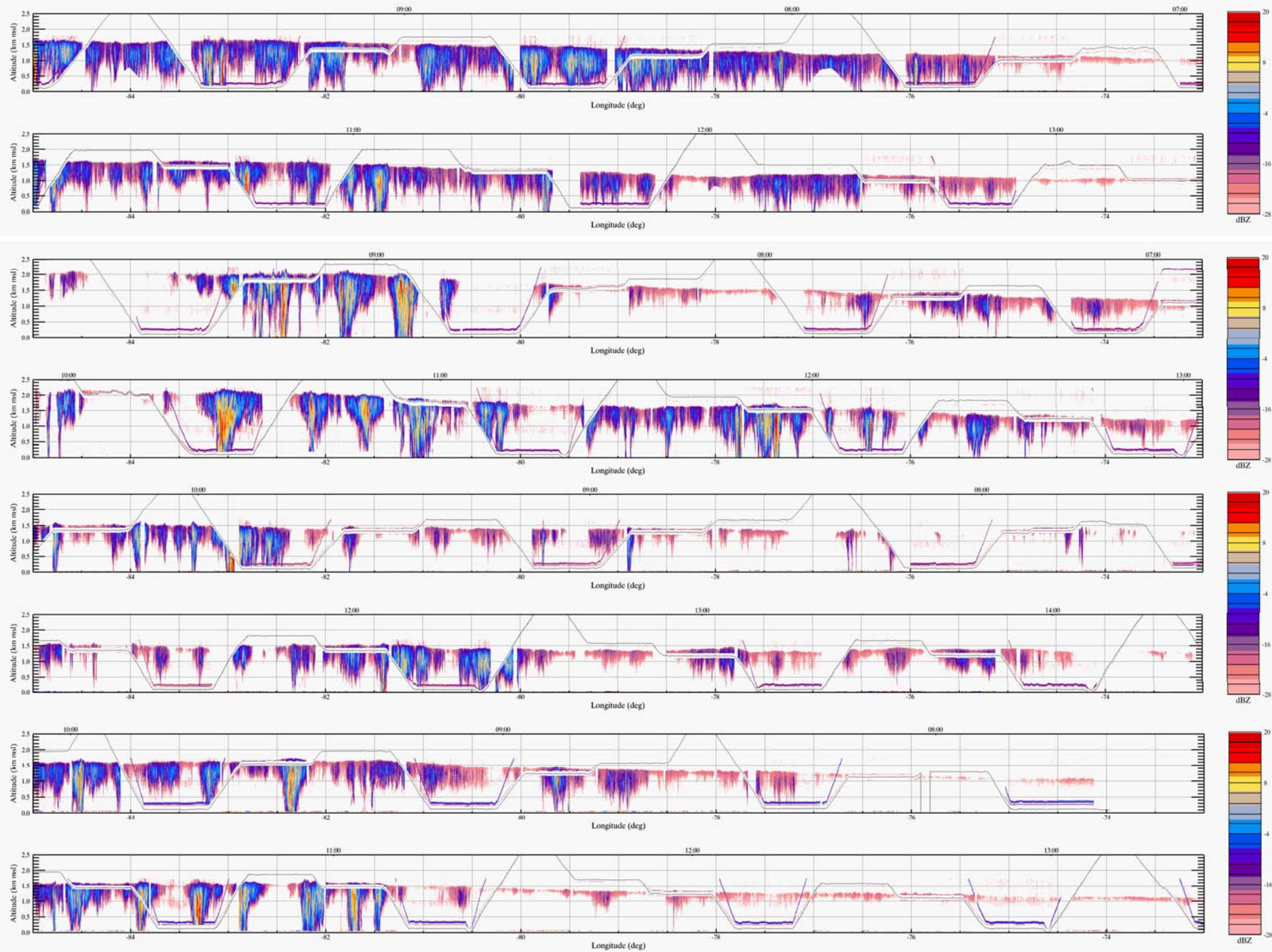




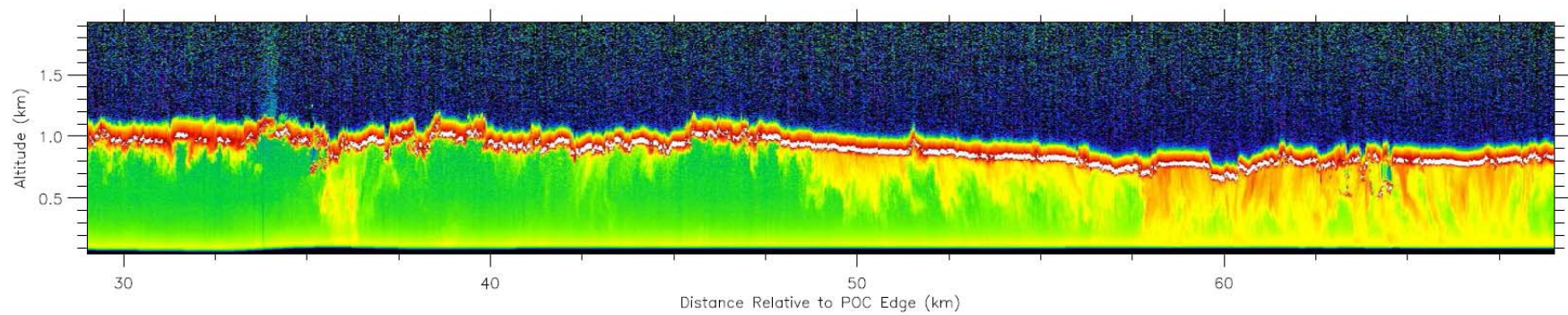
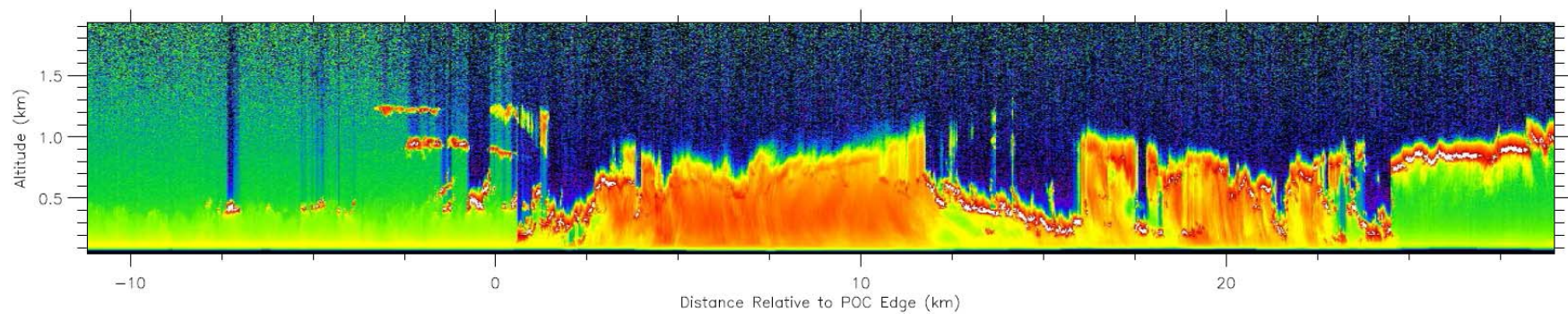
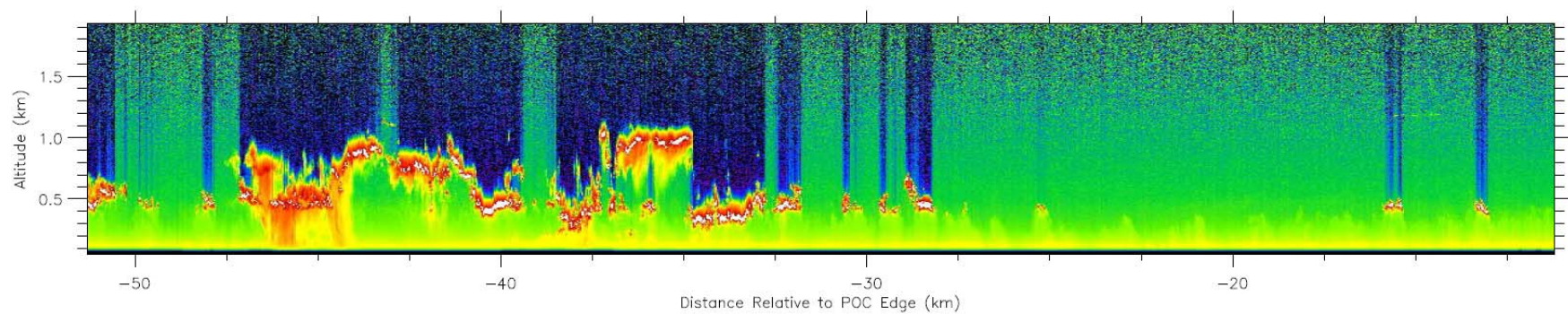


Take-home messages

- Precipitation common in, and energetically important for, shallow marine boundary layers
- Precipitation rate is macrophysically-determined but can be influenced microphysically
- Precipitation important for organization of mesoscale structure in the stratocumulus-topped boundary layer
- Precipitation important for controlling aerosol population within the marine boundary layer

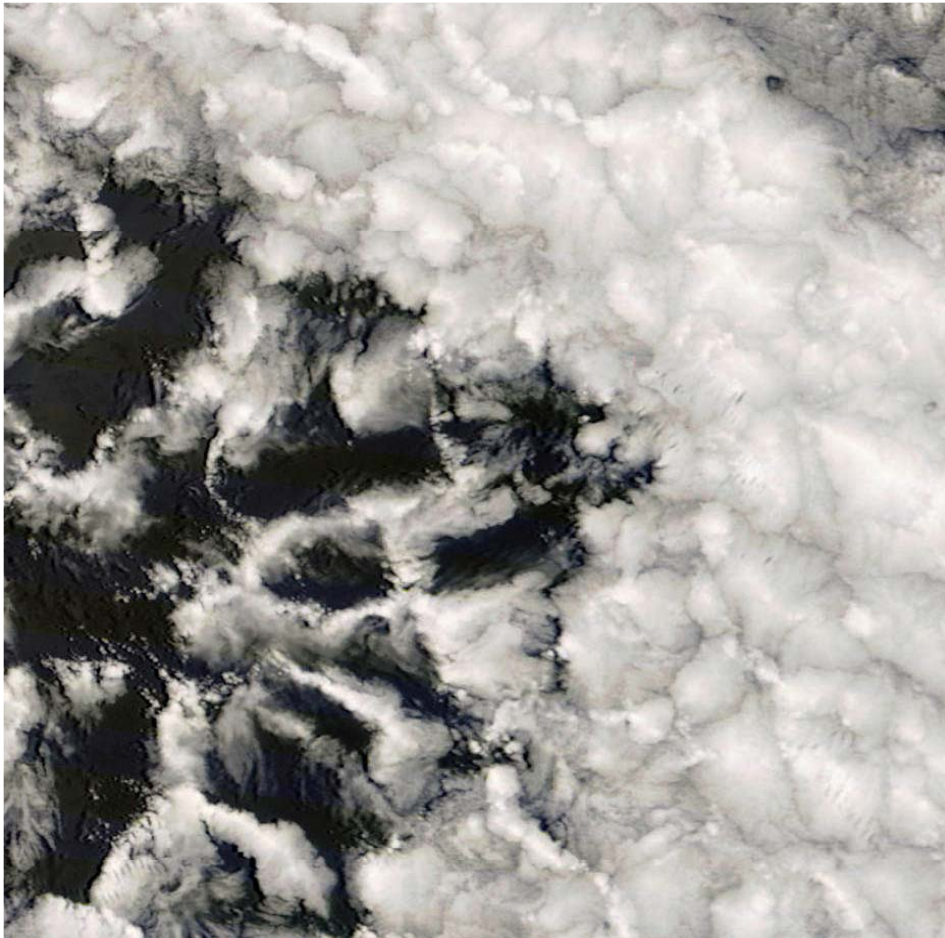






October 27/28th 2008

POC Lagrangian - BAe-146 & NSF C-130



MODIS Terra, 250 m visible image



Photo from BAe-146, Hugh Coe