Regional comparisons of marine stratocumulus (Sc) characteristics

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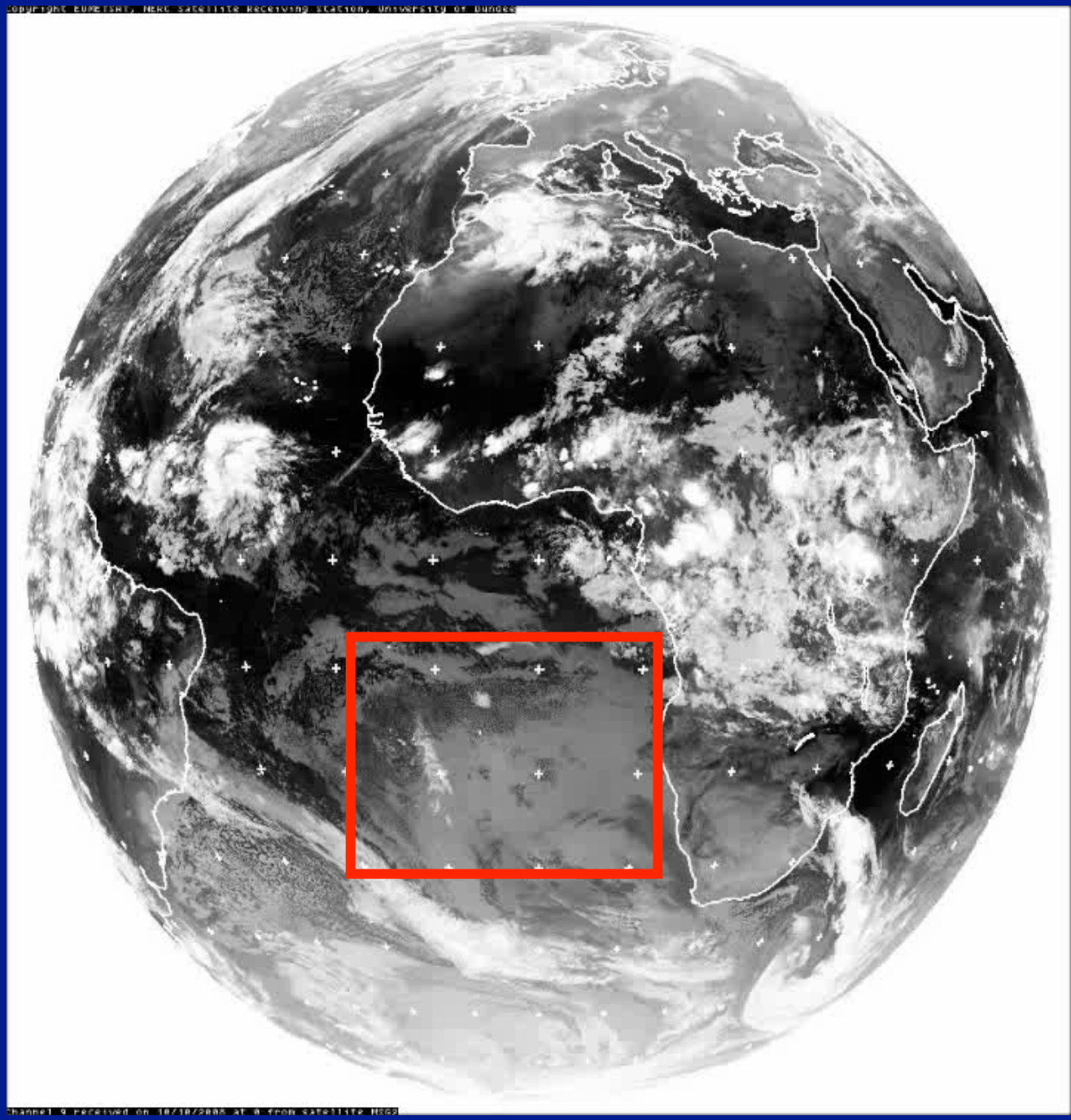
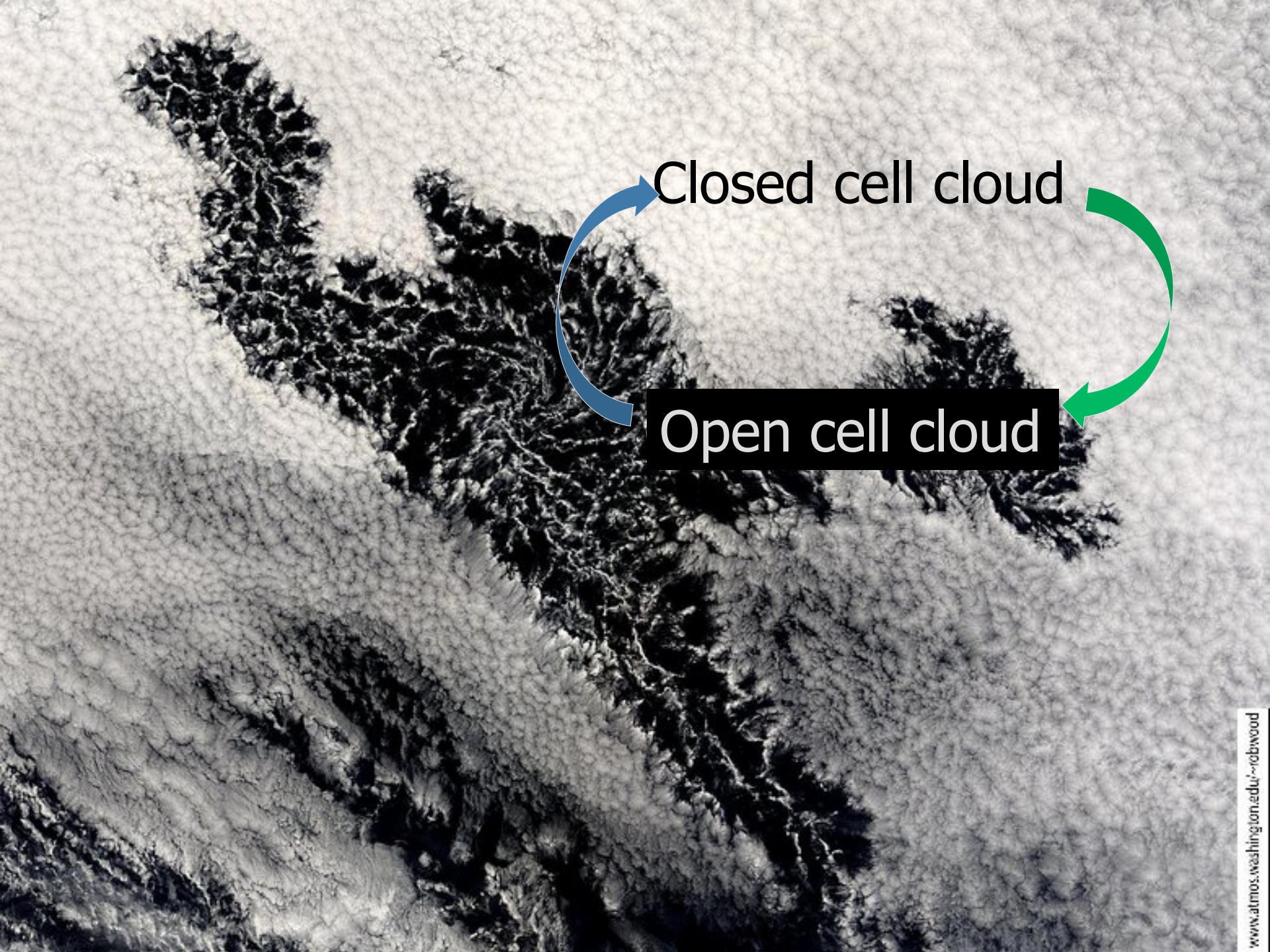
Variations in marine Sc clouds

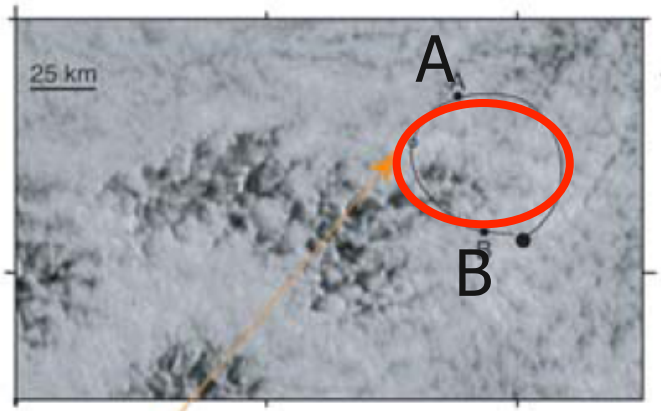
- Characterize variability
- Understand processes

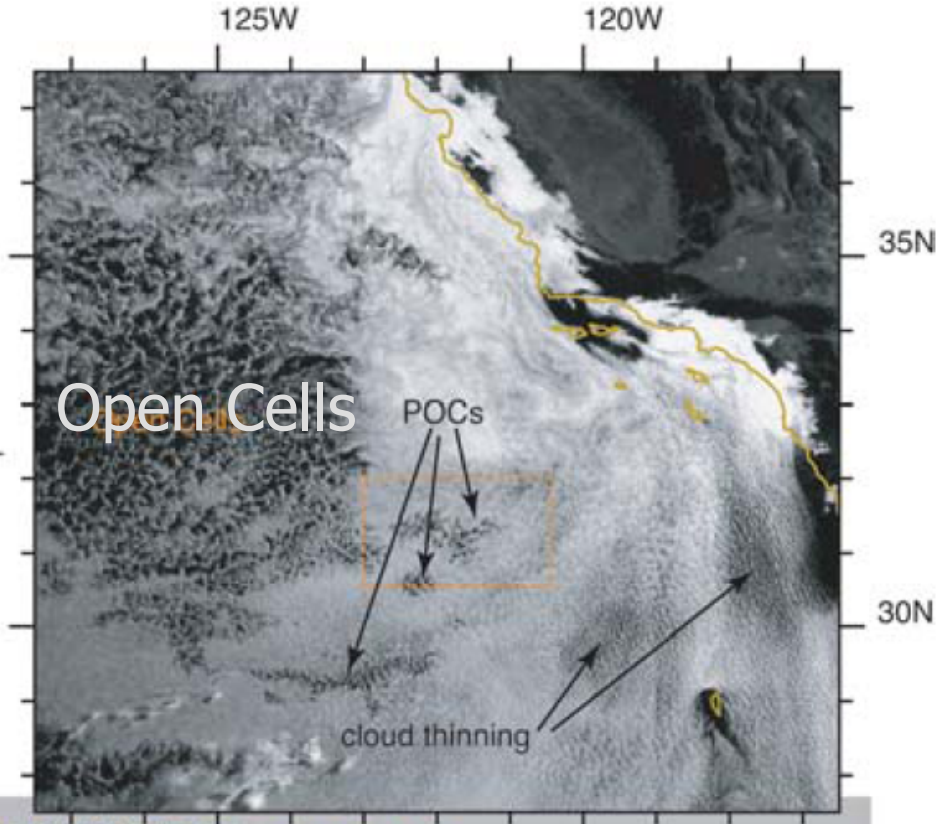
- Develop parameterizations



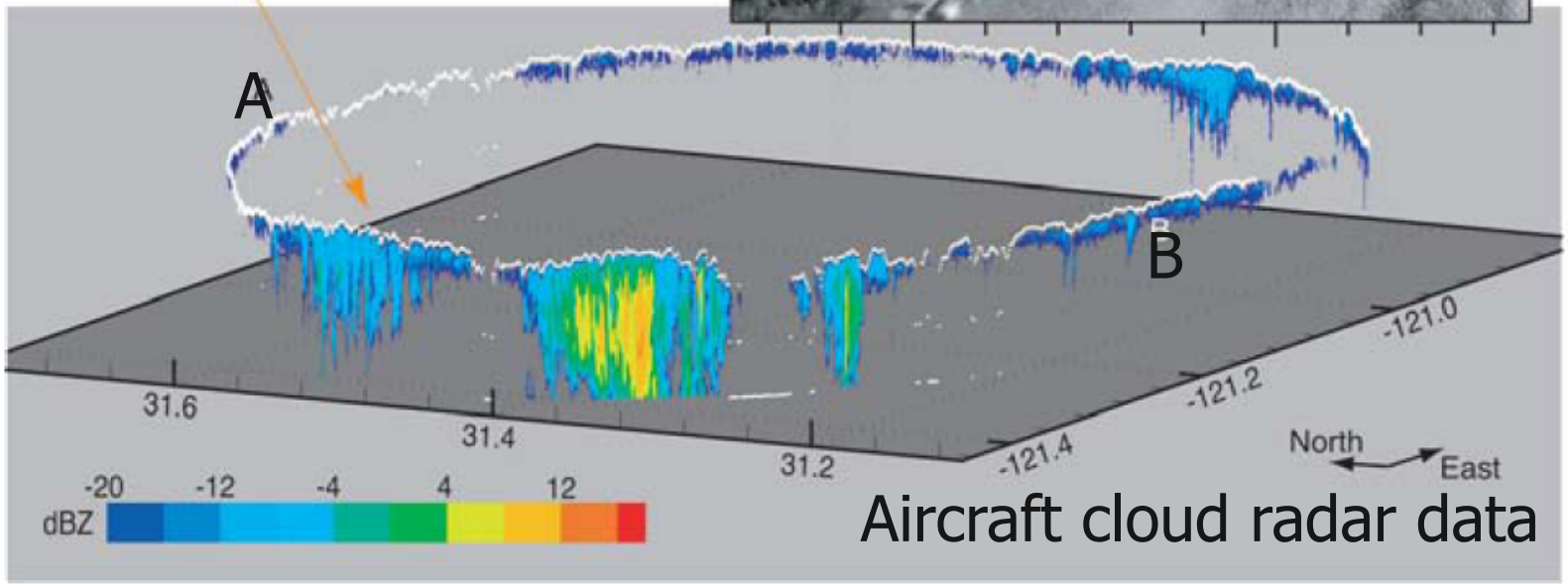

Closed cell cloud
Open cell cloud
www.atmos.washington.edu/~robwood

Stevens et al. 2005, data from DYCOMS II July 2001



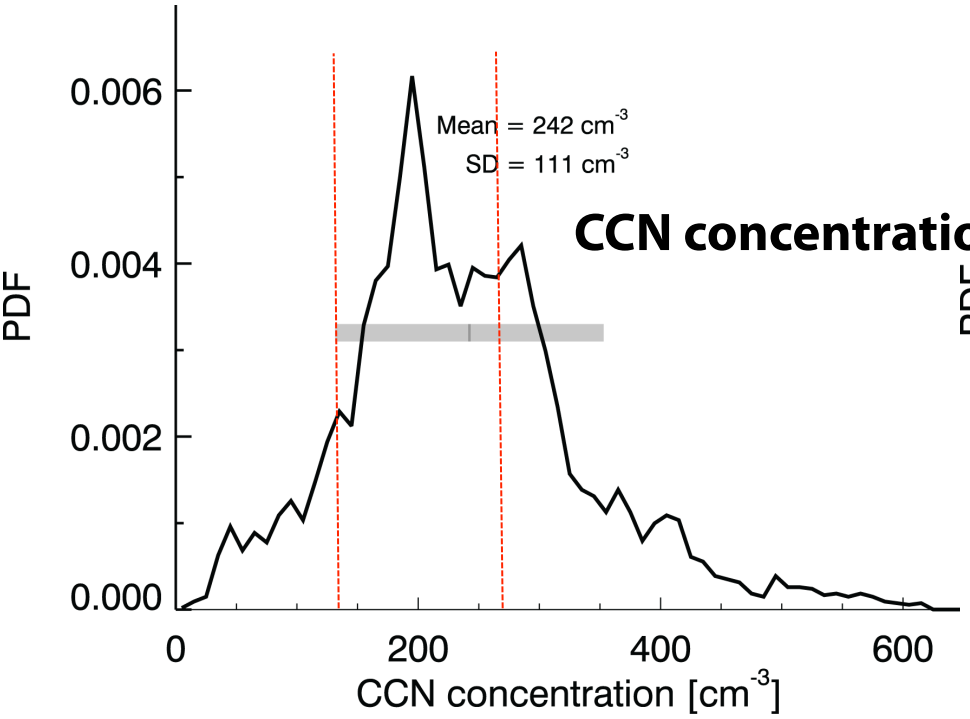


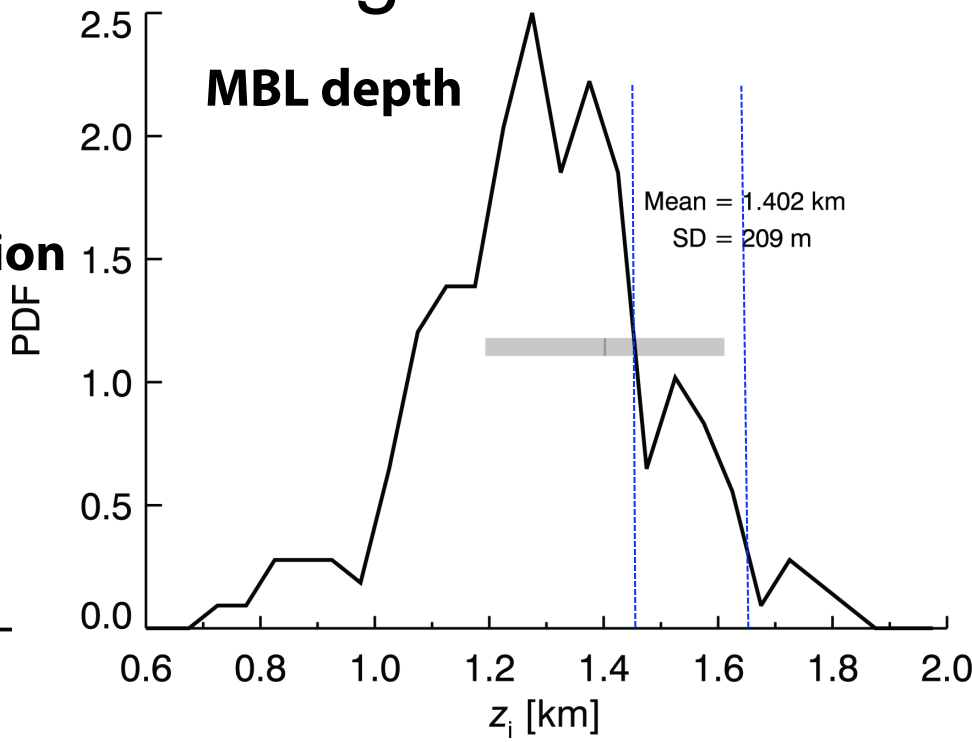
07:30



Aircraft cloud radar data

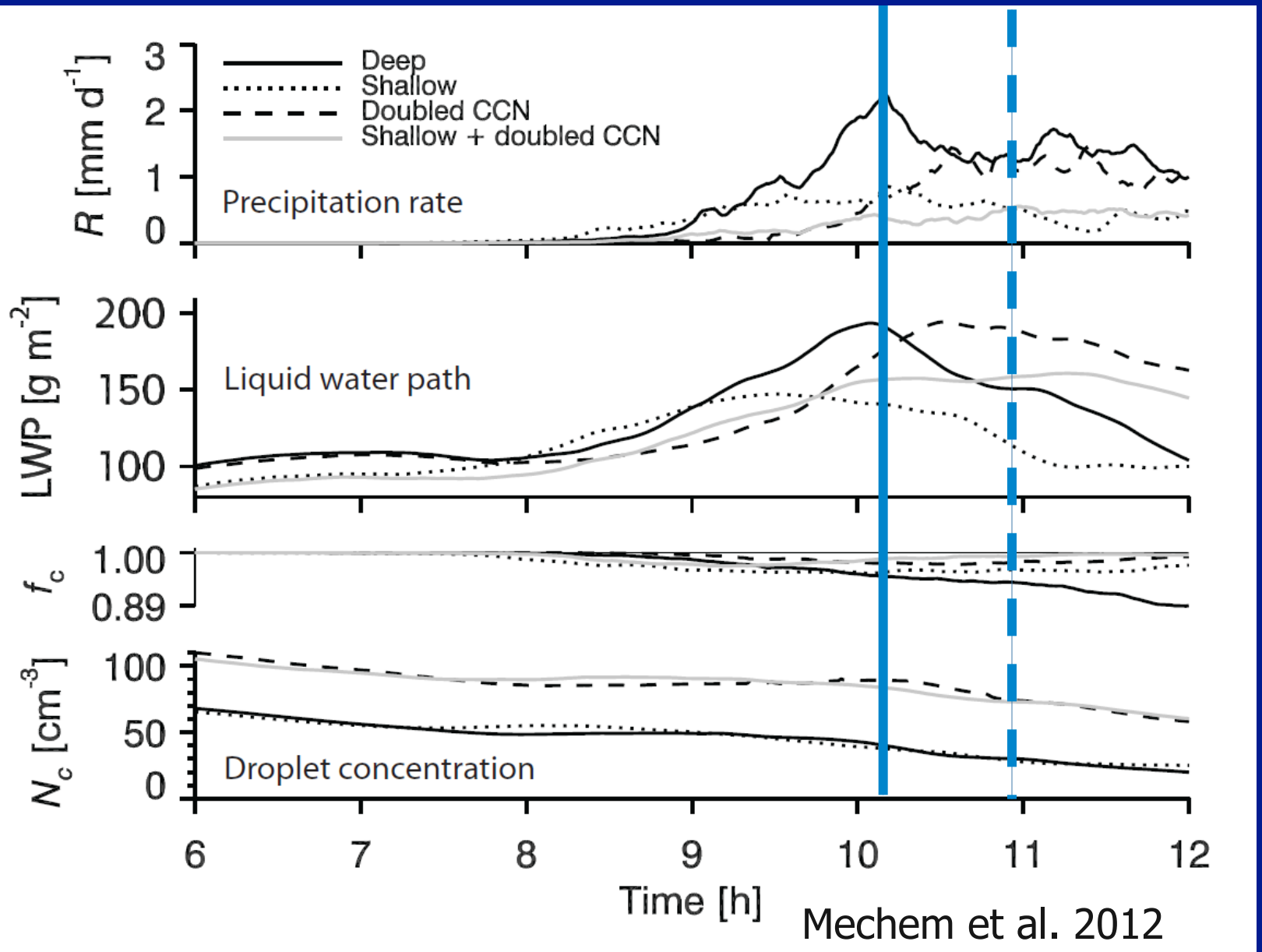
Mechem et al. (JAS, 2012) LES sensitivity study: Sc drizzle variations with BL height and CCN





Simulation	MBL depth [m]	CCN concentration [cm^{-3}]
Deep (control simulation)	1650	135
Shallow	1450	135
Doubled CCN	1650	270
Shallow + Doubled CCN	1450	270

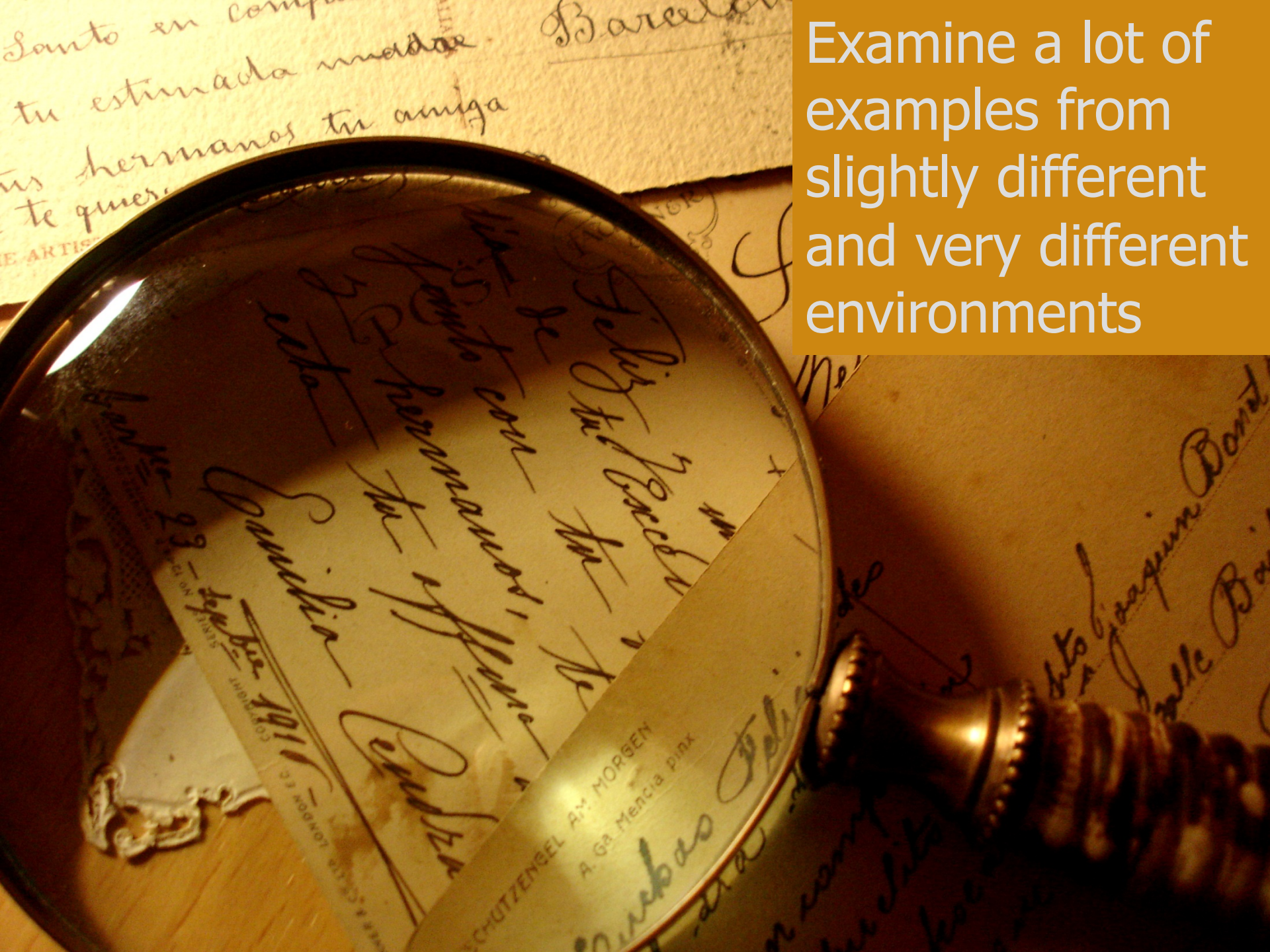
More precip with deeper as compared to shallower BL
Doubling aerosol for deep BL delays precip ~ 1 hr



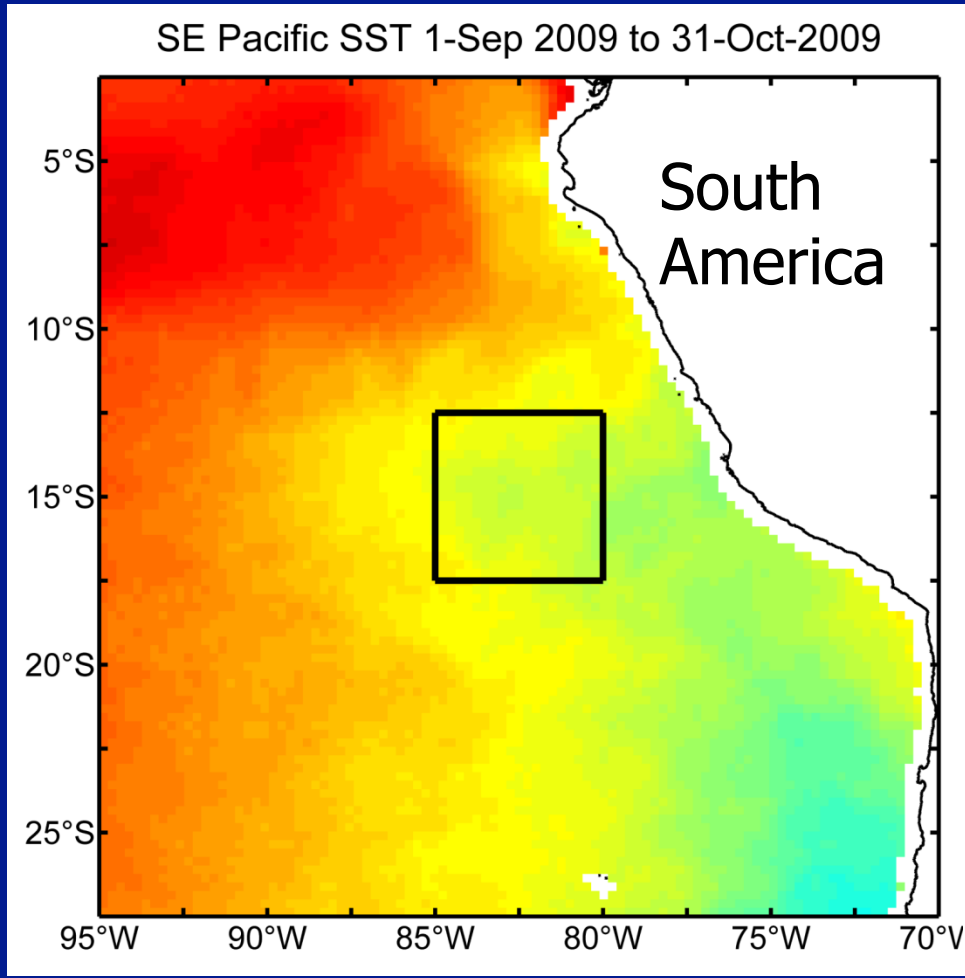
Mechem et al. 2012

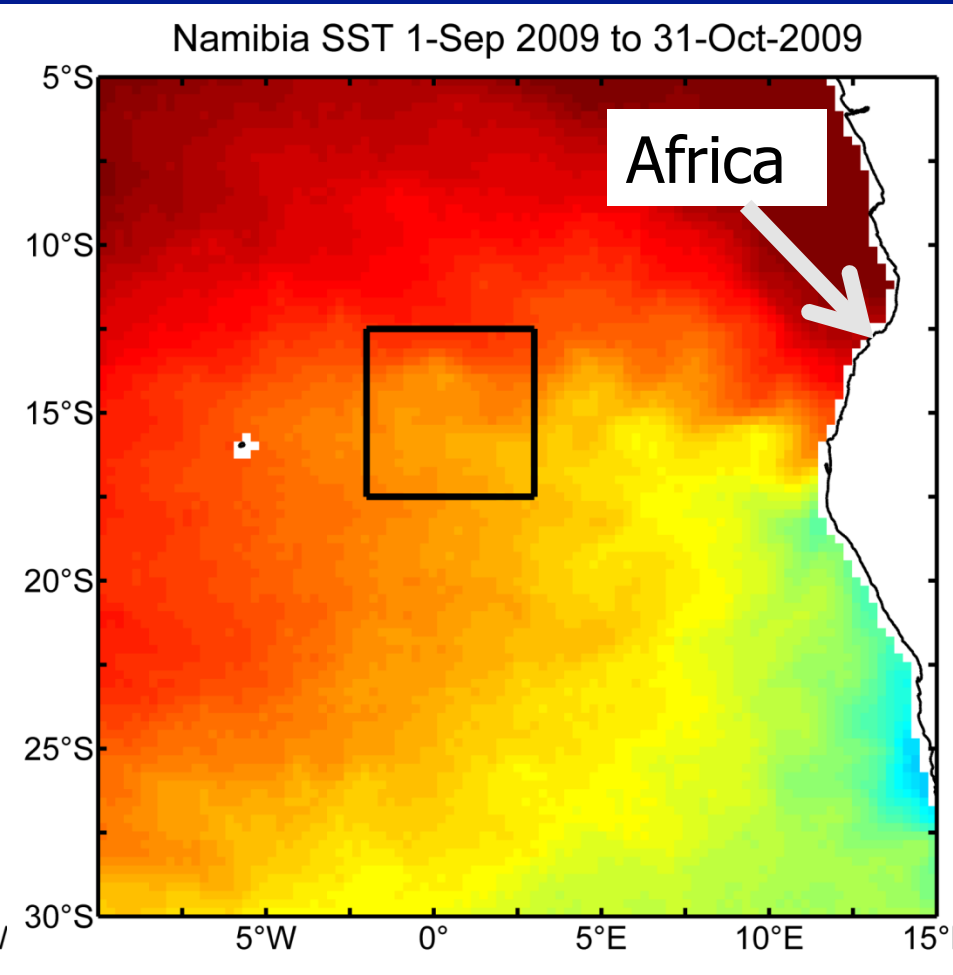
Previous work: Drizzle is a necessary but not sufficient for cloudiness transition

? = environment/process

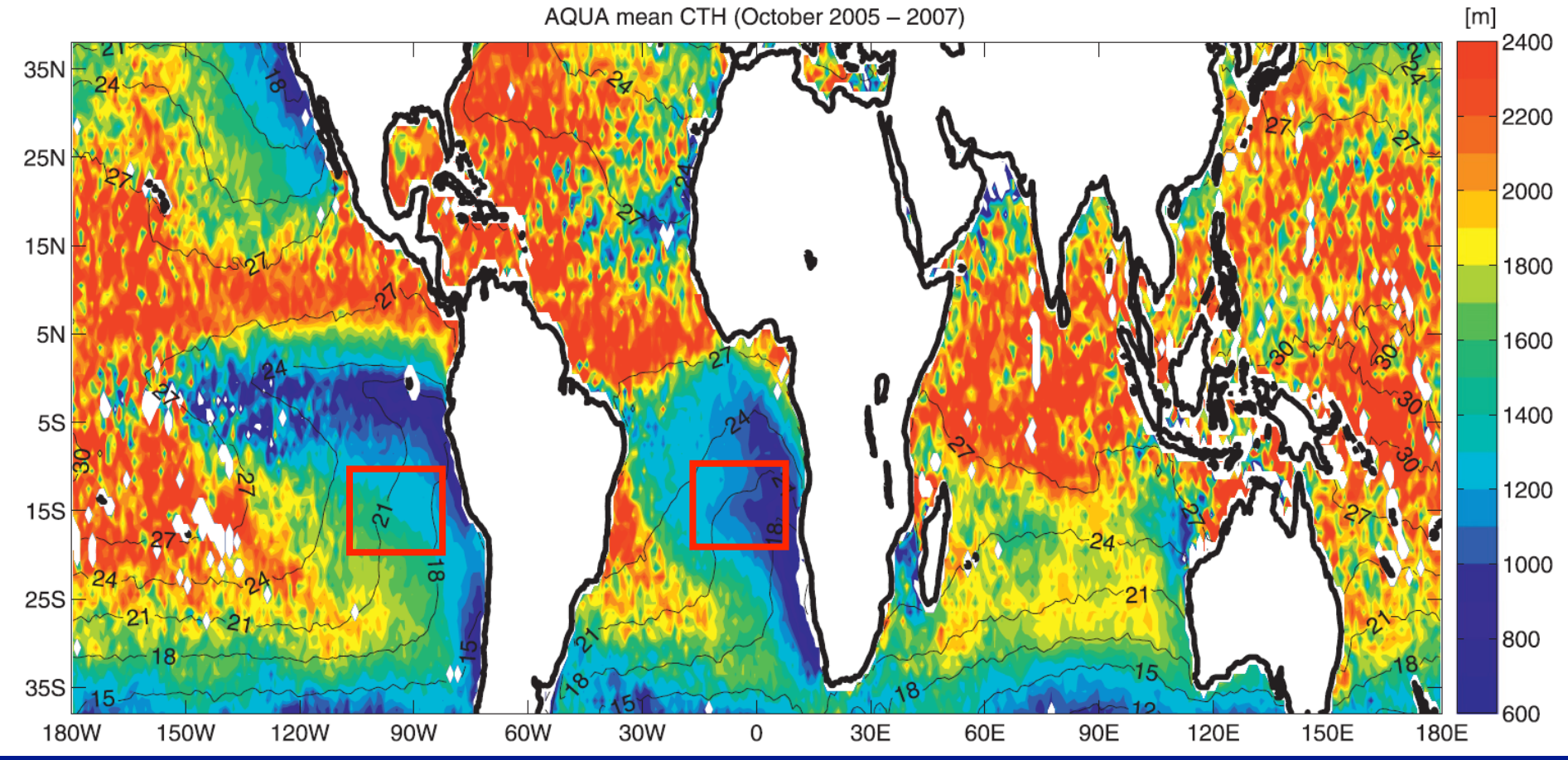

Examine a lot of examples from slightly different and very different environments

Drizzle Season SSTs





Liquid phase cloud top heights October 2005, 2006, 2007



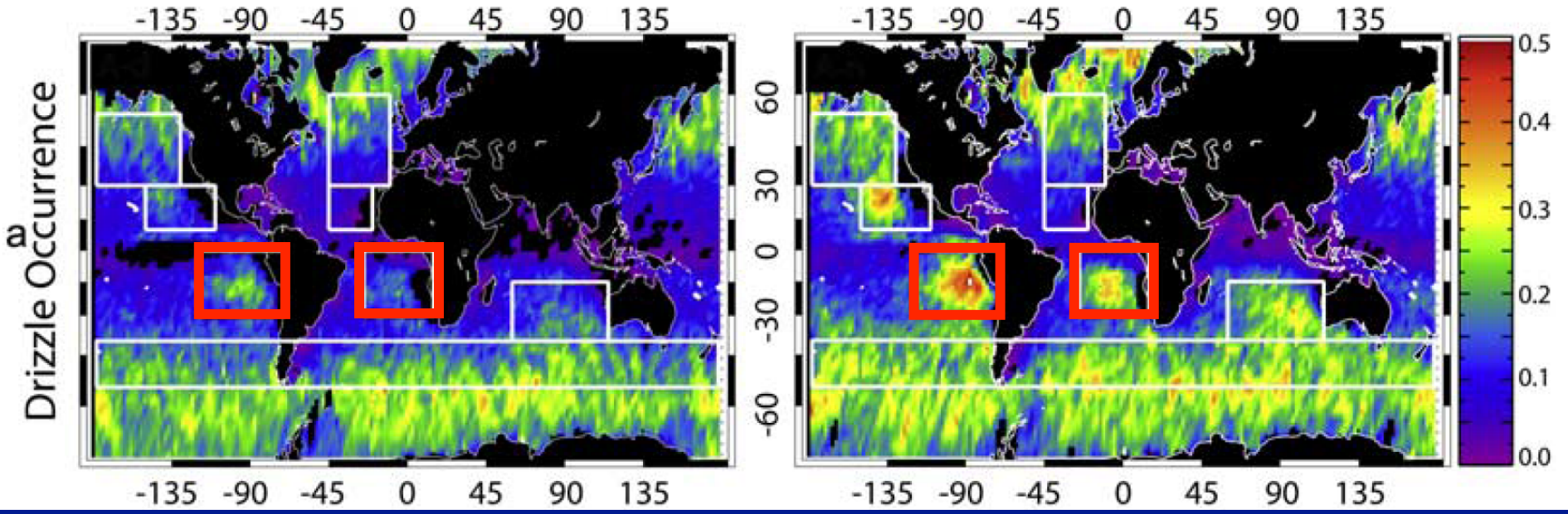
Contours are SST

Zuidema et al. (JGR, 2009)

Leon et al. (JGR, 2008) Drizzle occurrence based on 1 year of Cloudsat/Calipso data

Day

Night

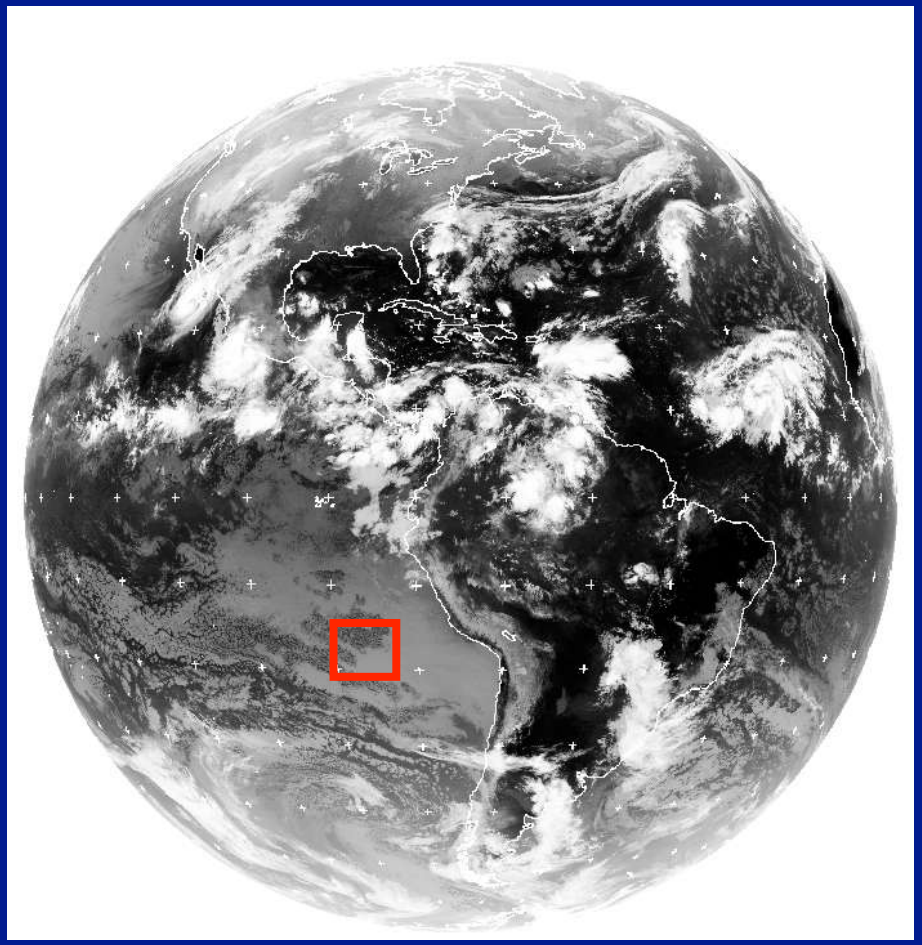


Cloudsat Radar 1.4 km swath width

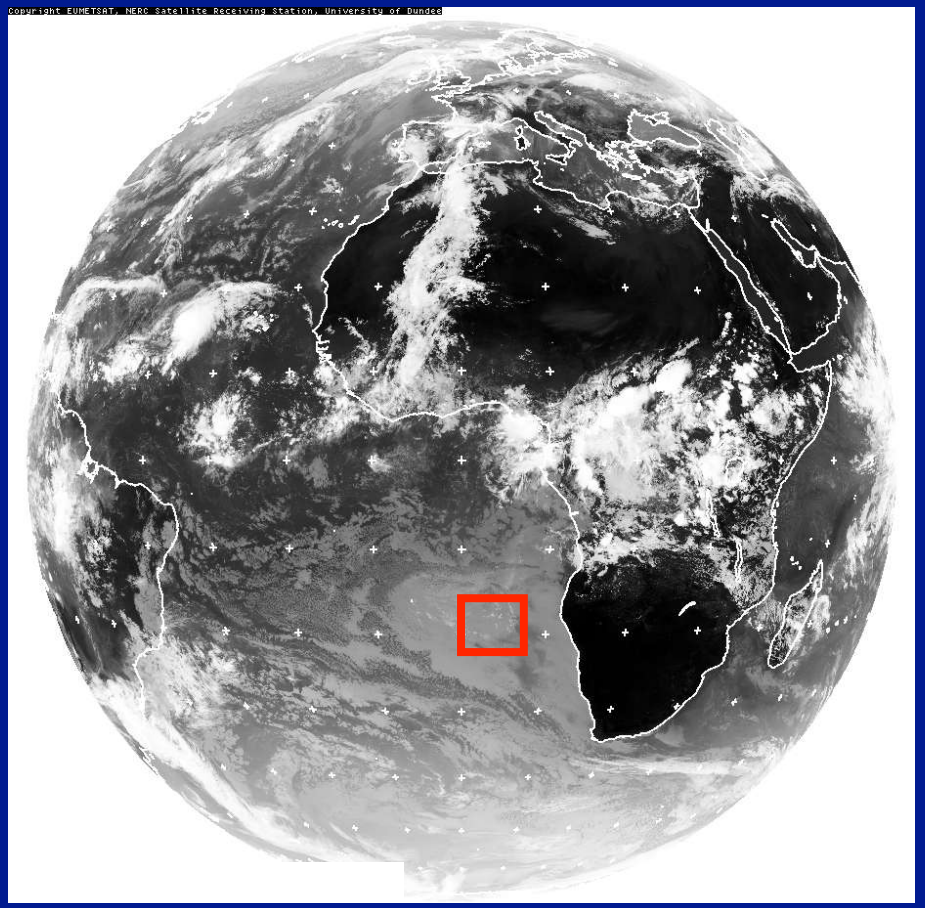
Aqua AMSR-E 1445 km swath width

How do Sc regions compare?

Examine 5° x 5° boxes in Sept, Oct, Nov over 4 years



Southeast Pacific



Namibian

Sept., Oct., Nov.- # of Scenes > 10,000 pixels

Year	SEP	Namibia
2006	99	106
2007	95	103
2008	101	103
2009	103	106

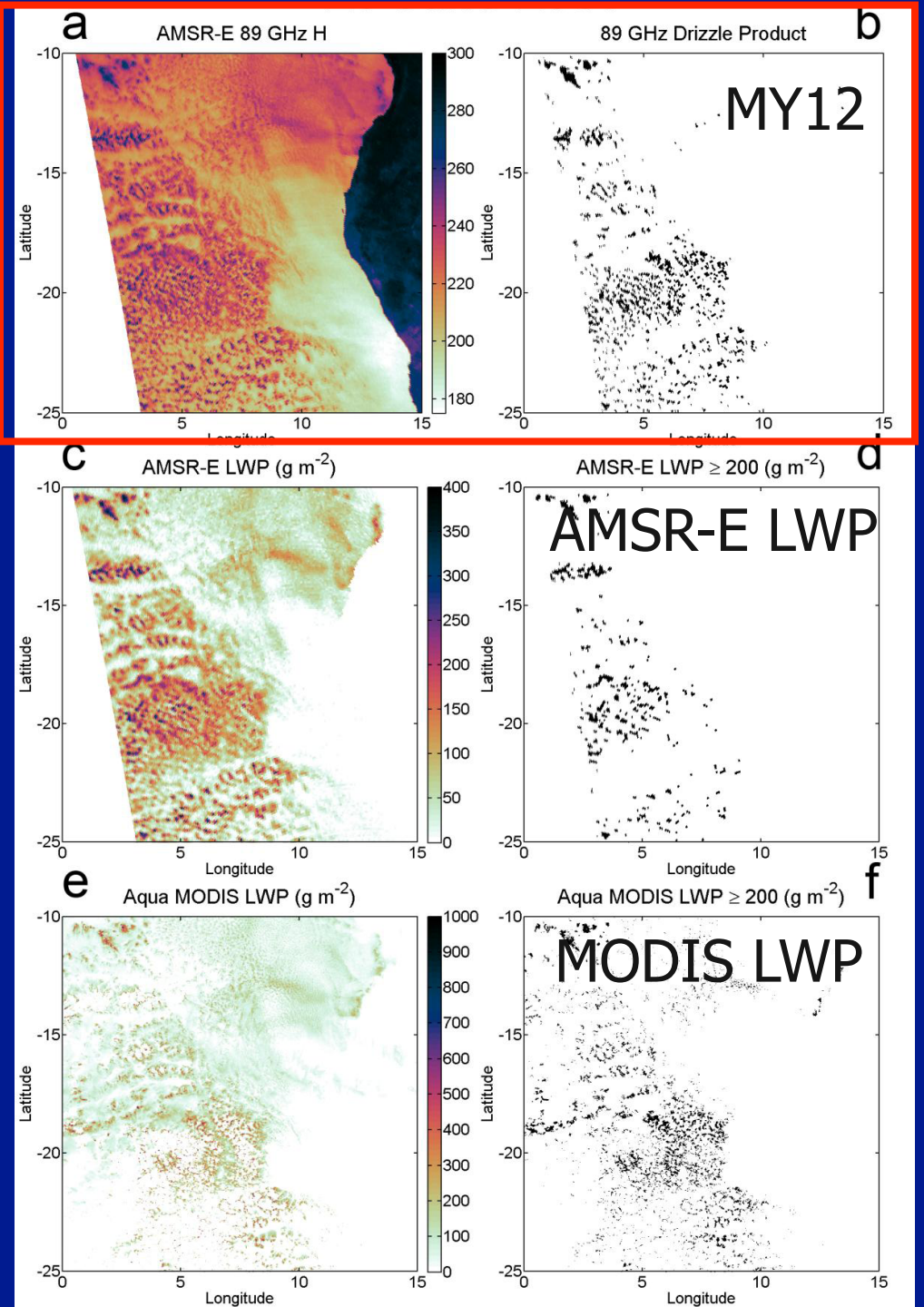
AMSR-E V002

- AE_L2A - AMSR-E/Aqua L2A Global Swath Spatially-Resampled Brightness Temperatures
- AE_Ocean - AMSR-E/Aqua L2B Global Swath Ocean Products derived from Wentz Algorithm

MODIS Series 51

- MYD06_L2 - Aqua MODIS Level 2 Cloud Product

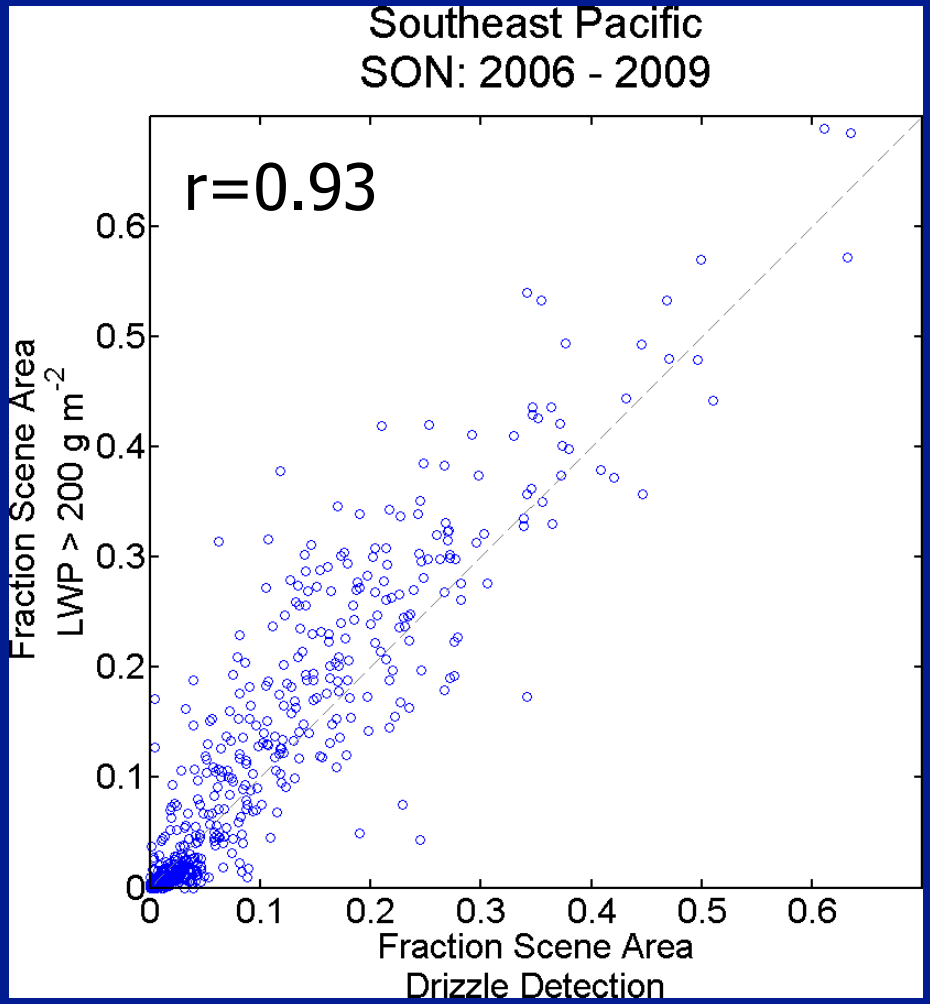
IR --- NCEP/CPC 4-km Global (60°N - 60°S) Merged IR Dataset

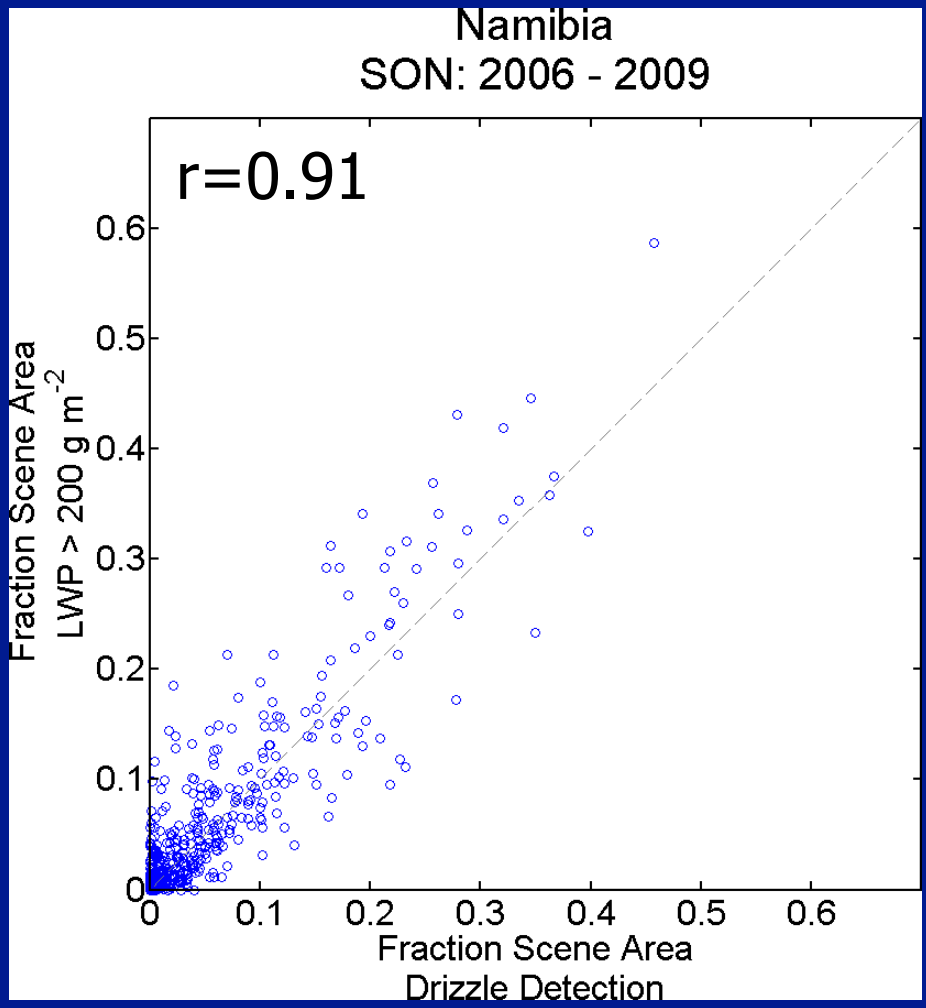


Method: detect drizzle in AMSR-E data

- 89 GHz drizzle detection algorithm (Miller and Yuter, 2012)
- Finer spatial resolution than AMSR-E LWP
- Works both day and night

MY12 drizzle detection vs. AMSR-E LWP > 200 g/m^2

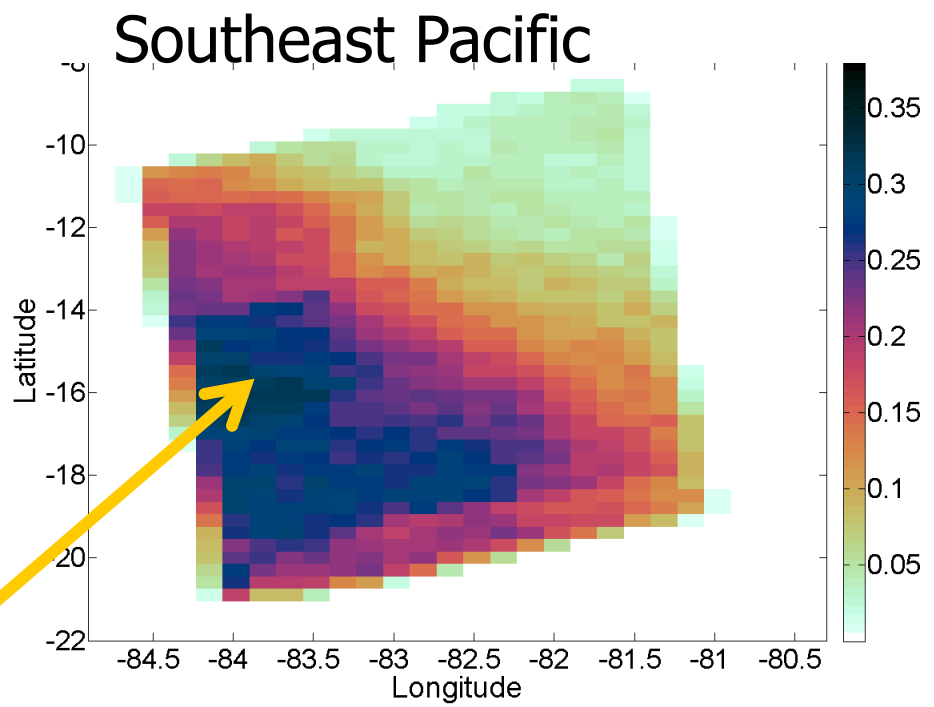


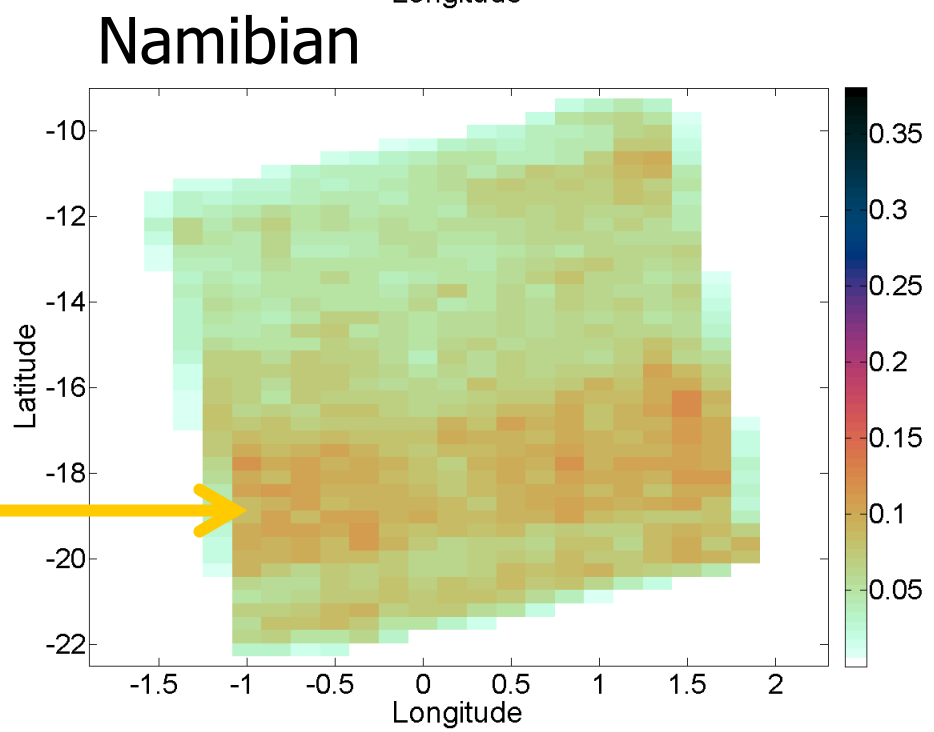


Drizzle Frequency at Night

Drizzling 35% of time during SON

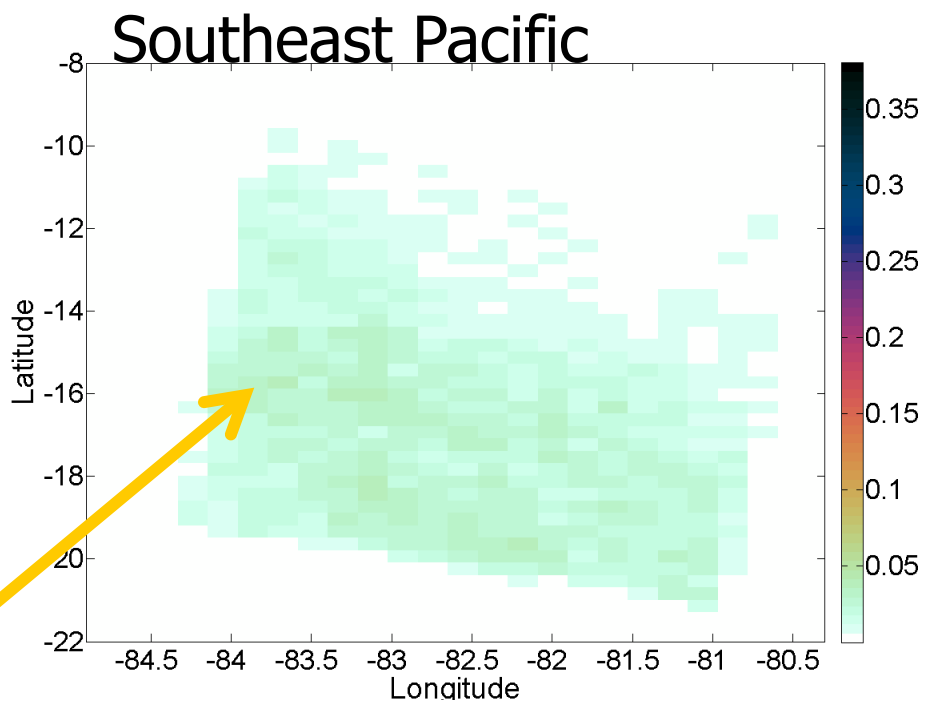
Drizzling 10% of time during SON

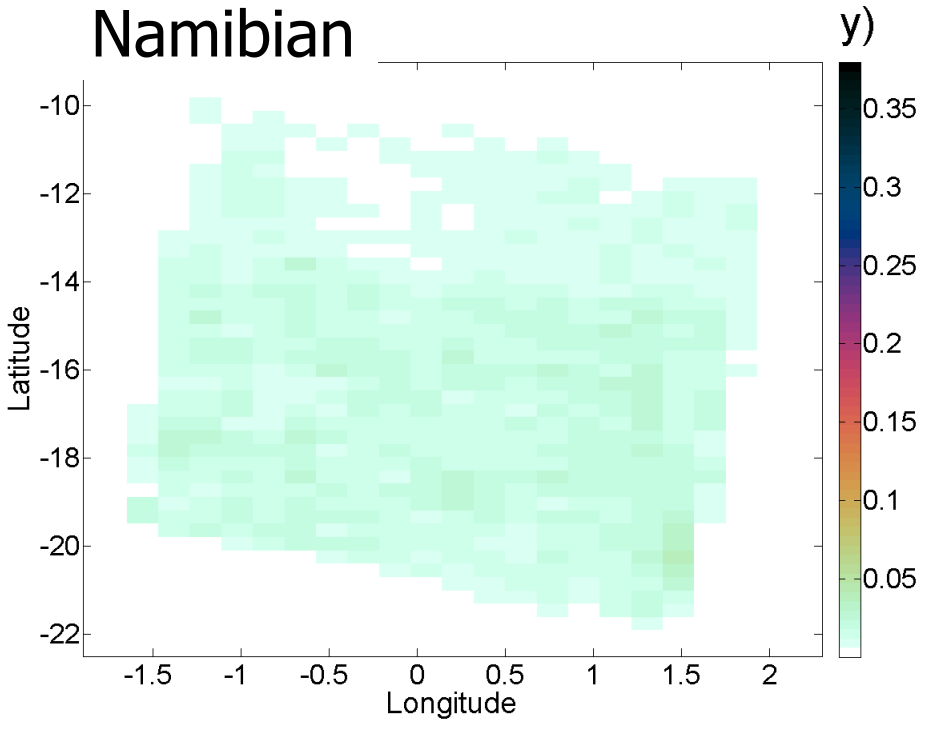




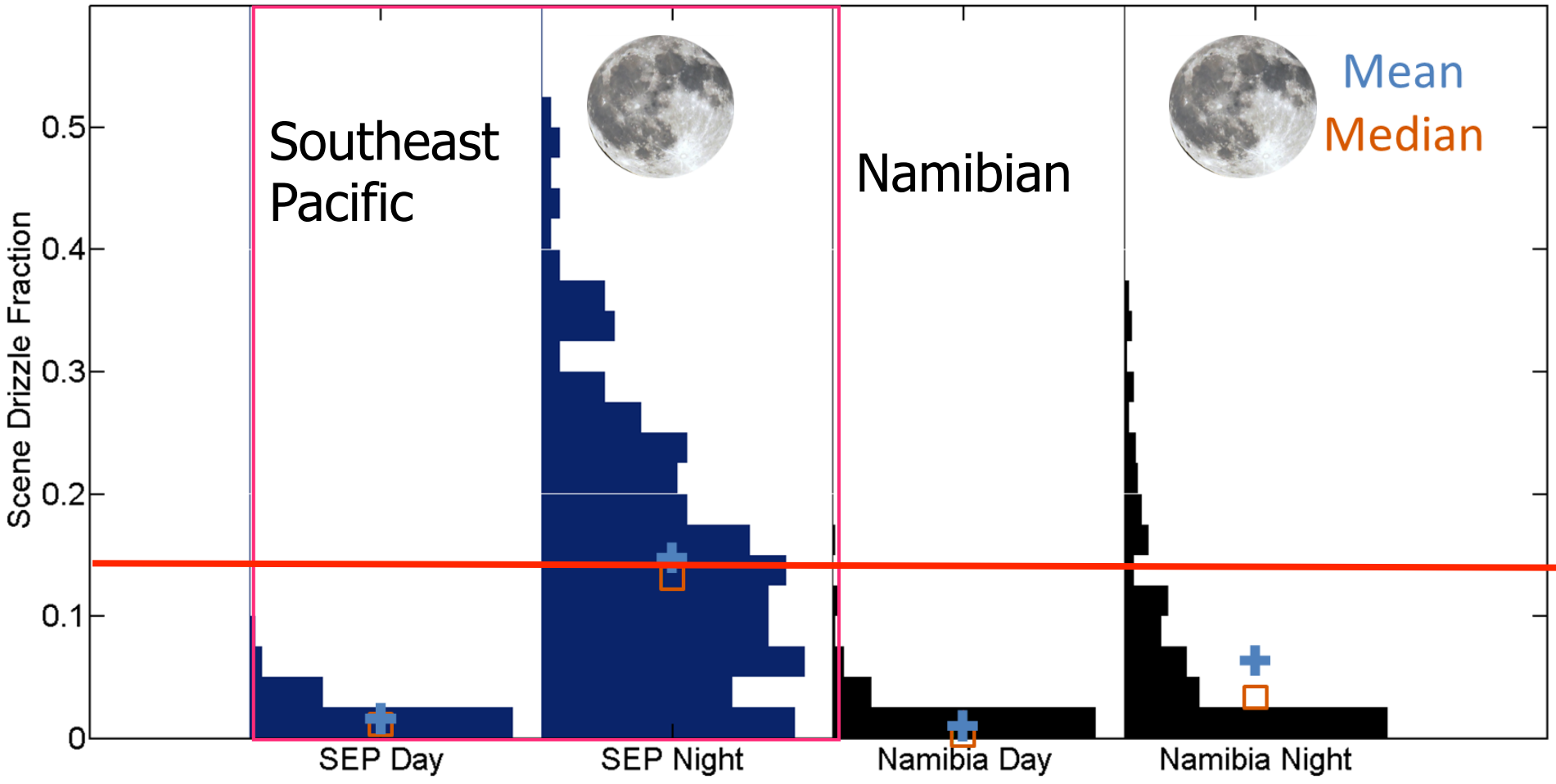
Drizzle Frequency during the Day

Drizzling ~5% of time during SON

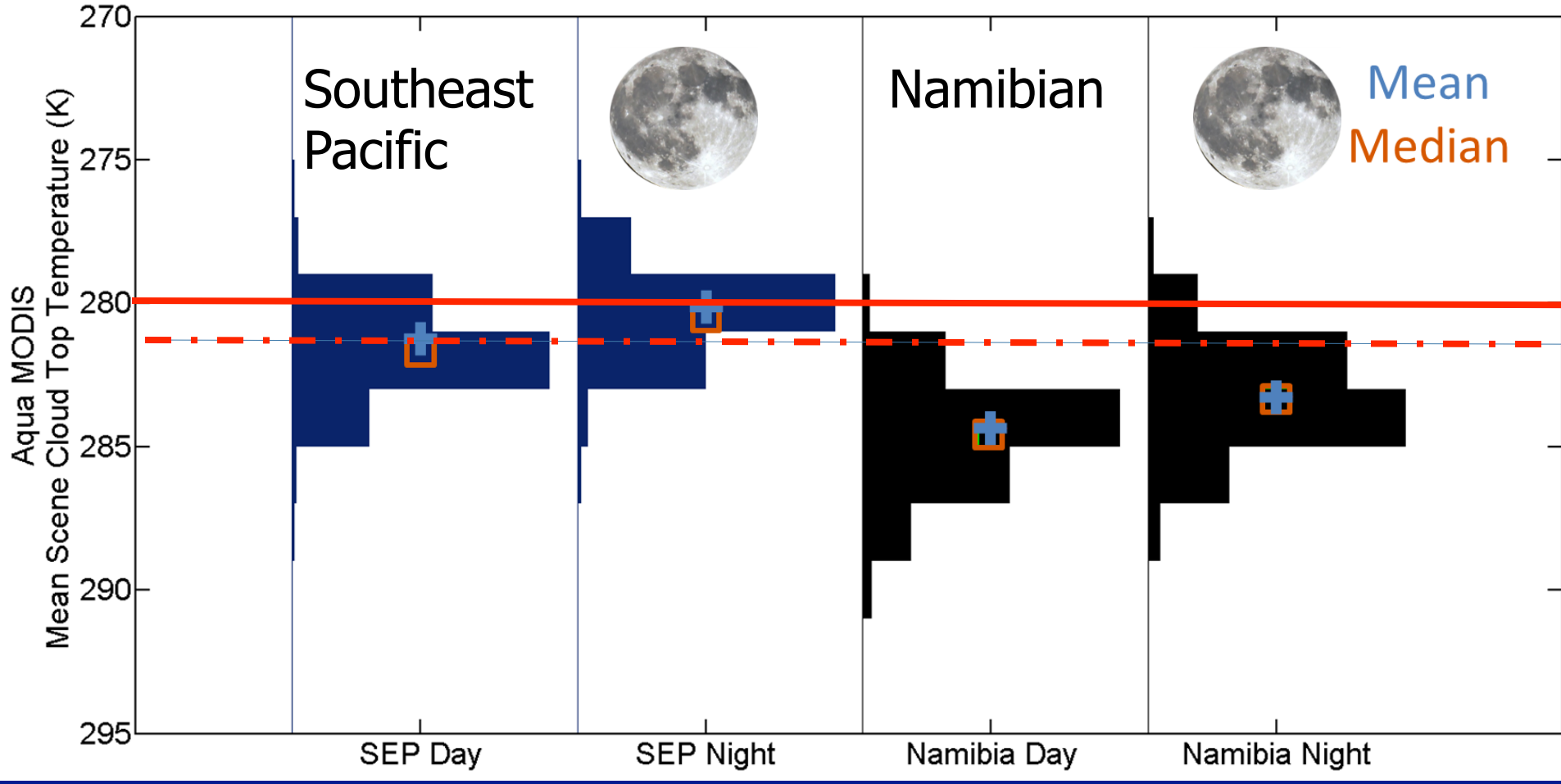




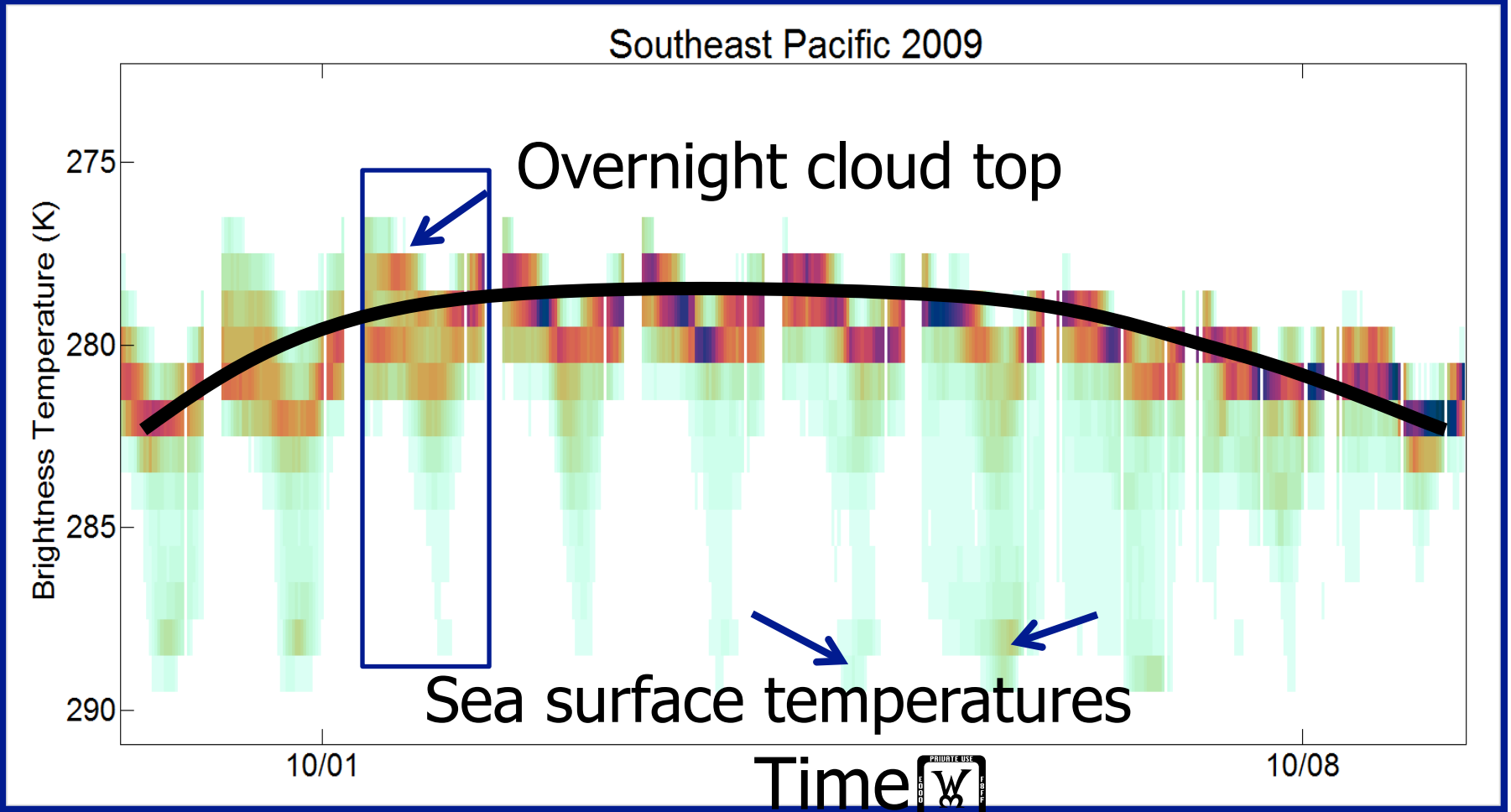
Overnight, Southeast Pacific data includes larger drizzle areas/scene



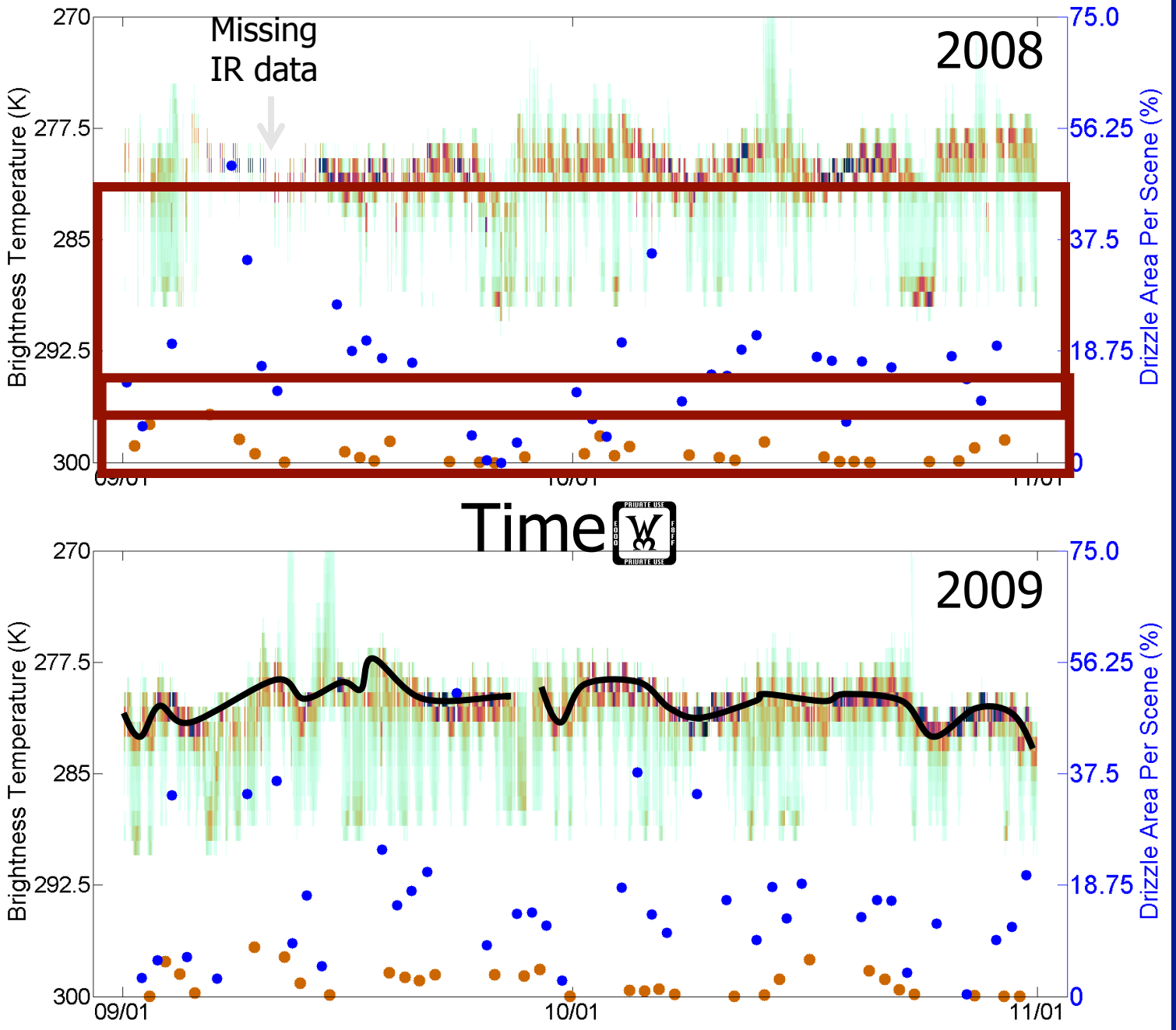
Overnight, Southeast Pacific cloud top IR is about 3 K colder than Namibian clouds



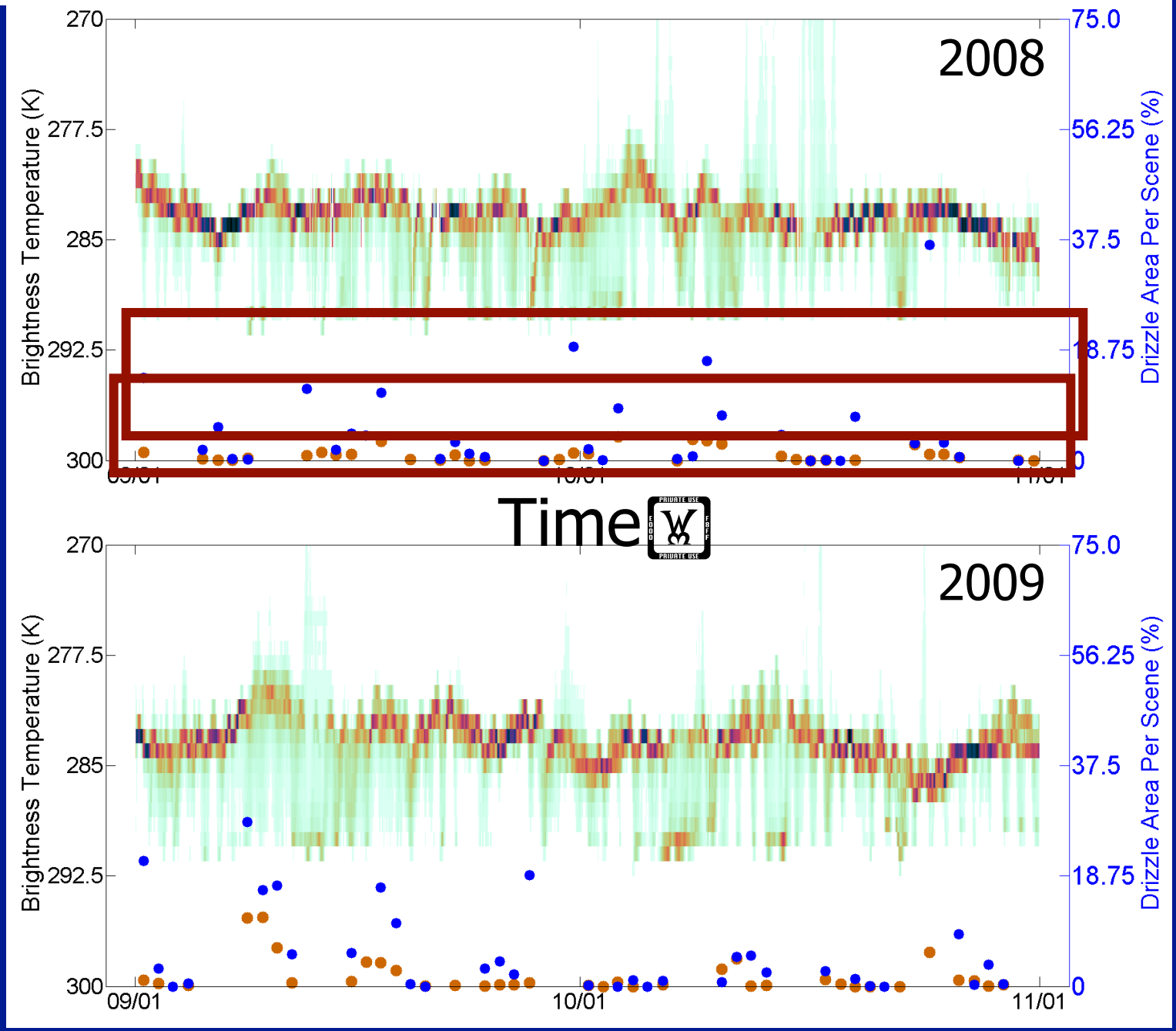
Context: diurnal and multi-day variations distribution of IR cloud top temps



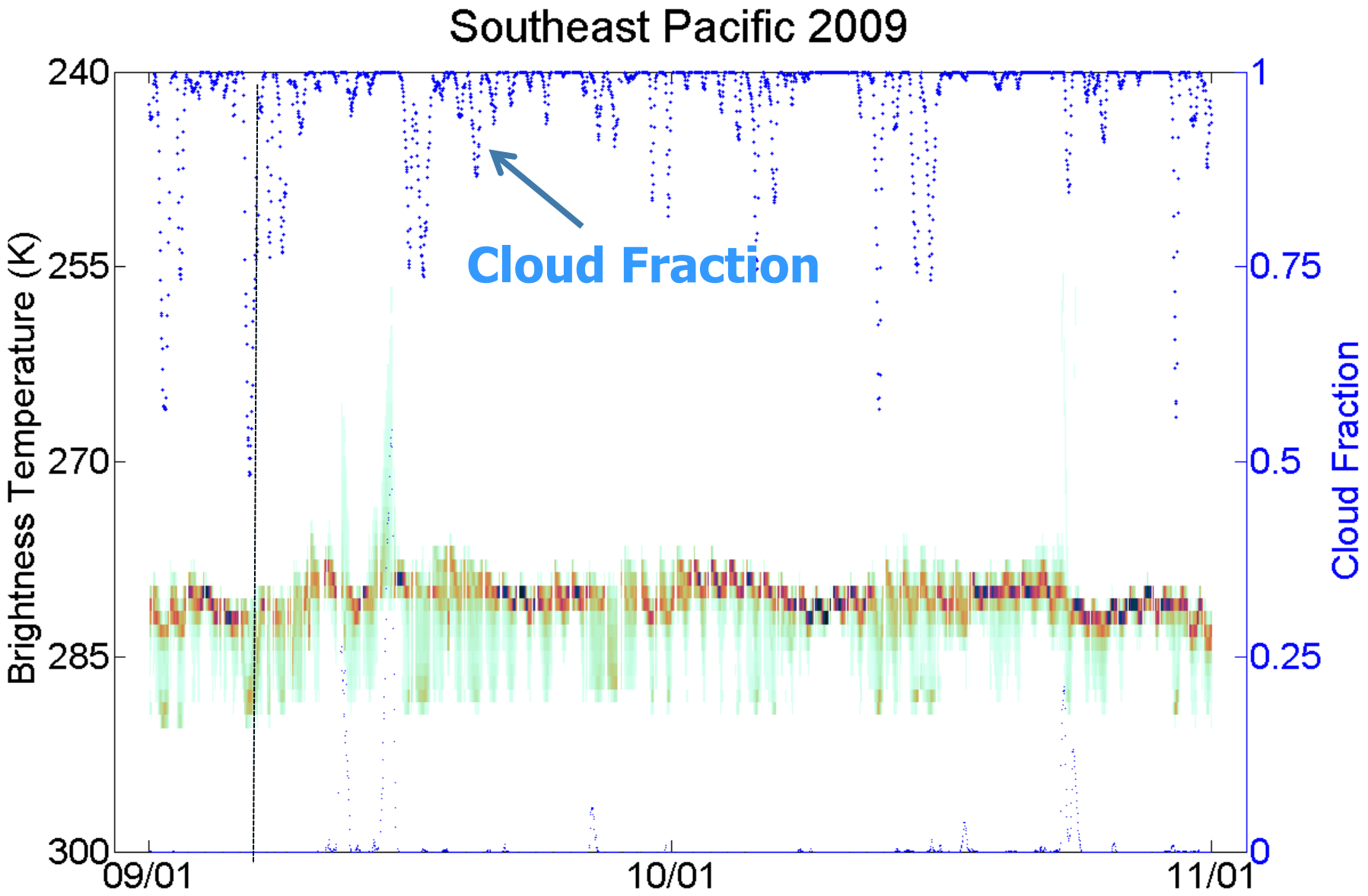
Southeast Pacific cloud deck IR distrib and Drizzle fraction



Namibian cloud deck IR distrib and Drizzle fraction

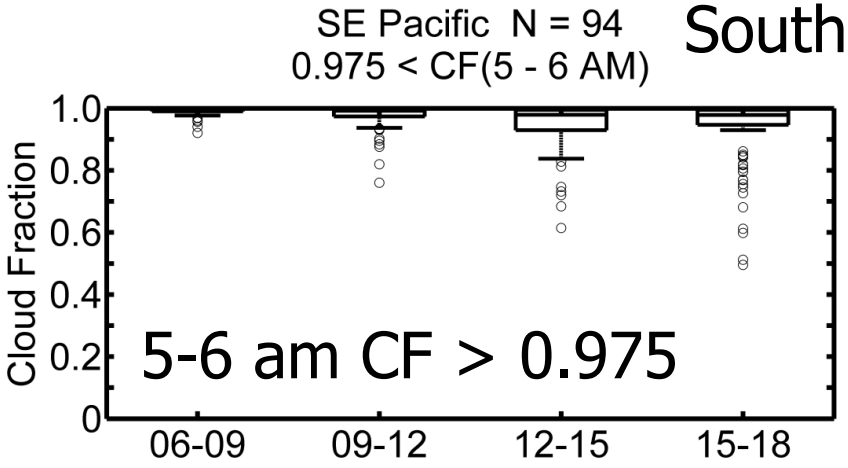


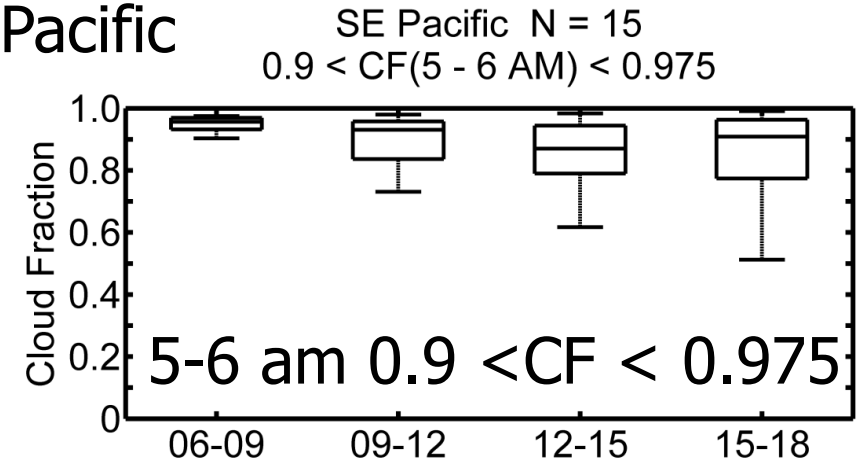
Cloud Fraction based on 30 min IR data



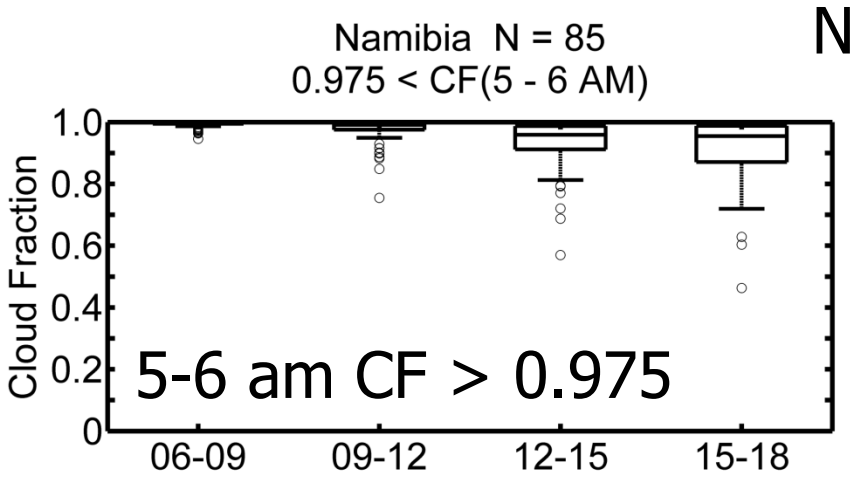
Daytime cloud fraction conditioned on dawn cloud fraction

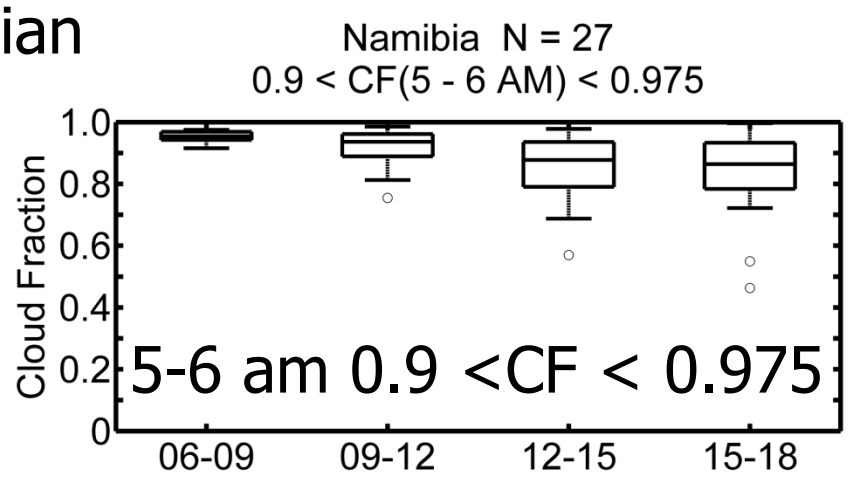
Southeast Pacific





Namibian





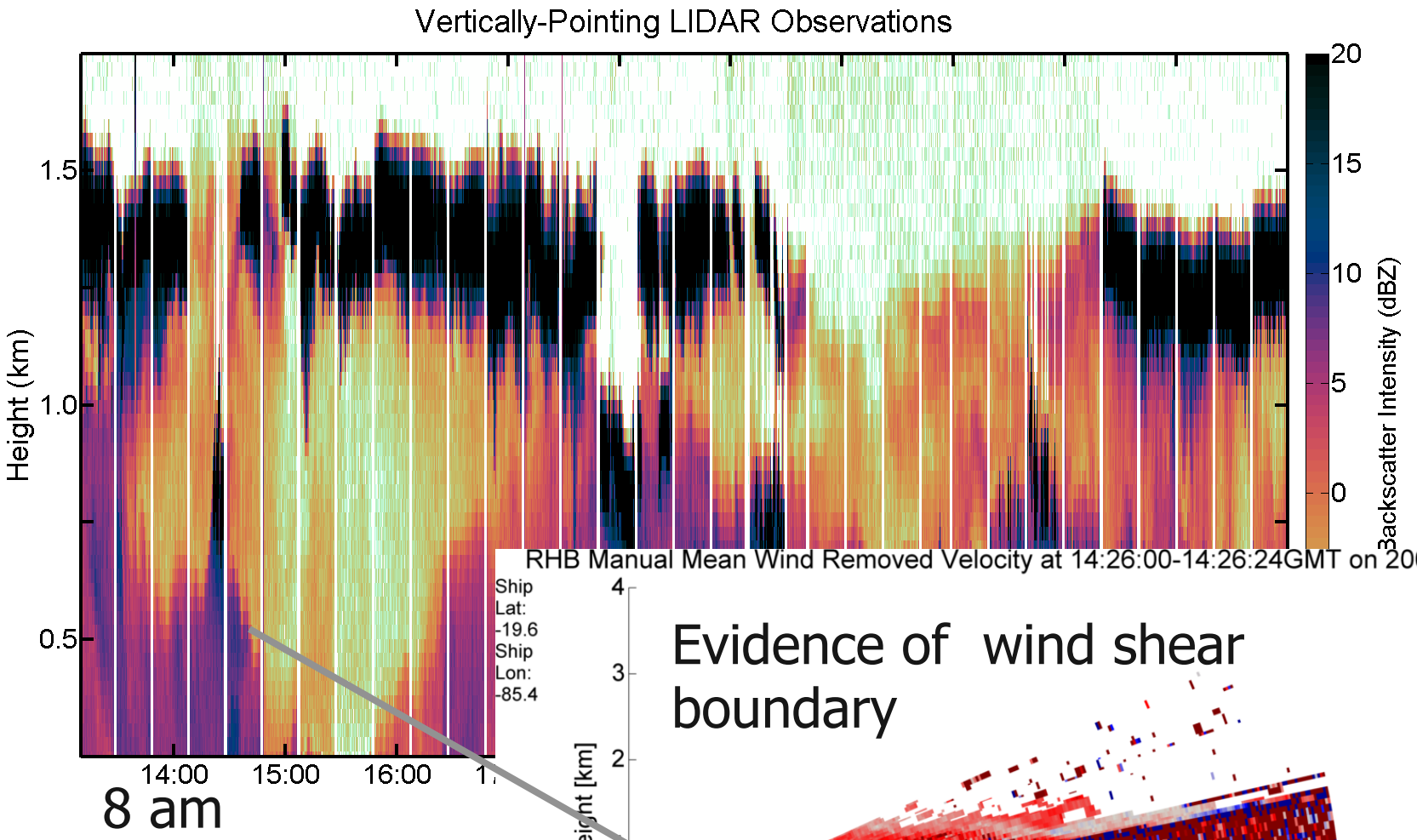
Findings

- The relation between higher BL height and more frequent drizzle holds diurnally and regionally but not apparently over multi-day periods of IR cloud top temp variability.
- Unclear where multi-day IR variability originates
- Occurrence of high drizzle area fractions over several consecutive nights in Southeast Pacific but not in Namibian Sc
- Overcast cloud decks at dawn (CF > 0.975) are less likely to breakup during the day than clouds that have slightly lower cloud fraction (0.9 < CF < 0.975)

Upcoming Work

- Extend analysis to include
  - Northeast Pacific Sc region
  - full AMSR-E data set
- Enlarge analysis area for Lagrangian-like comparisons (air mass at different times)
- Drizzle feature statistics
- Examine effective radius (r_e) in relation to other variables
- Multi-year inventory of Pockets of Open Cells

Complications



Lidar data courtesy of Alan Brewer, NOAA ESRL