Microphysical Characteristics of DYNAMO Convective Systems using In-Situ Cloud and Precipitation Imaging Probe Data

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Motivation

- Expand on results from airborne radar observations
  - Madden-Julian Oscillation active and inactive periods in Nov – Dec 2011 (NOAA P-3 aircraft)
  - Less linear organization at the mesoscale compared to TOGA COARE aircraft observations
  - Increased stratiform precipitation during active phase
  - Stronger and deeper updrafts during active phase
- Provide microphysical information in the climatological MJO initiation region
- Analysis of droplet spectra can provide insight into precipitation and convective system processes
- Can be used to constrain model results

PMS Optical Imaging Probes

- Water droplet and ice particle images
- Drop size distributions (DSDs) for:
  - Cloud (12.5 µm – 1.55 mm; 25 µm res.)
  - Precipitation (100 µm – 6.2 mm; 100 µm res.)
- Black and Hallett (1986) for data processing
- McFarquhar group at UIUC for processing code

Presented here

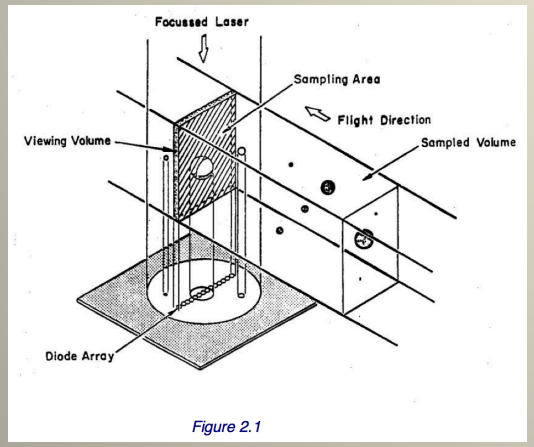


Figure 2.1

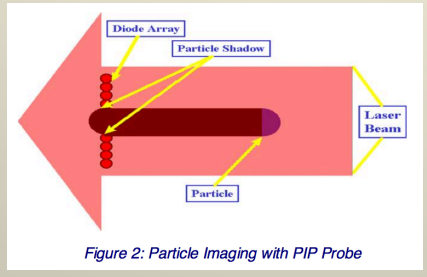
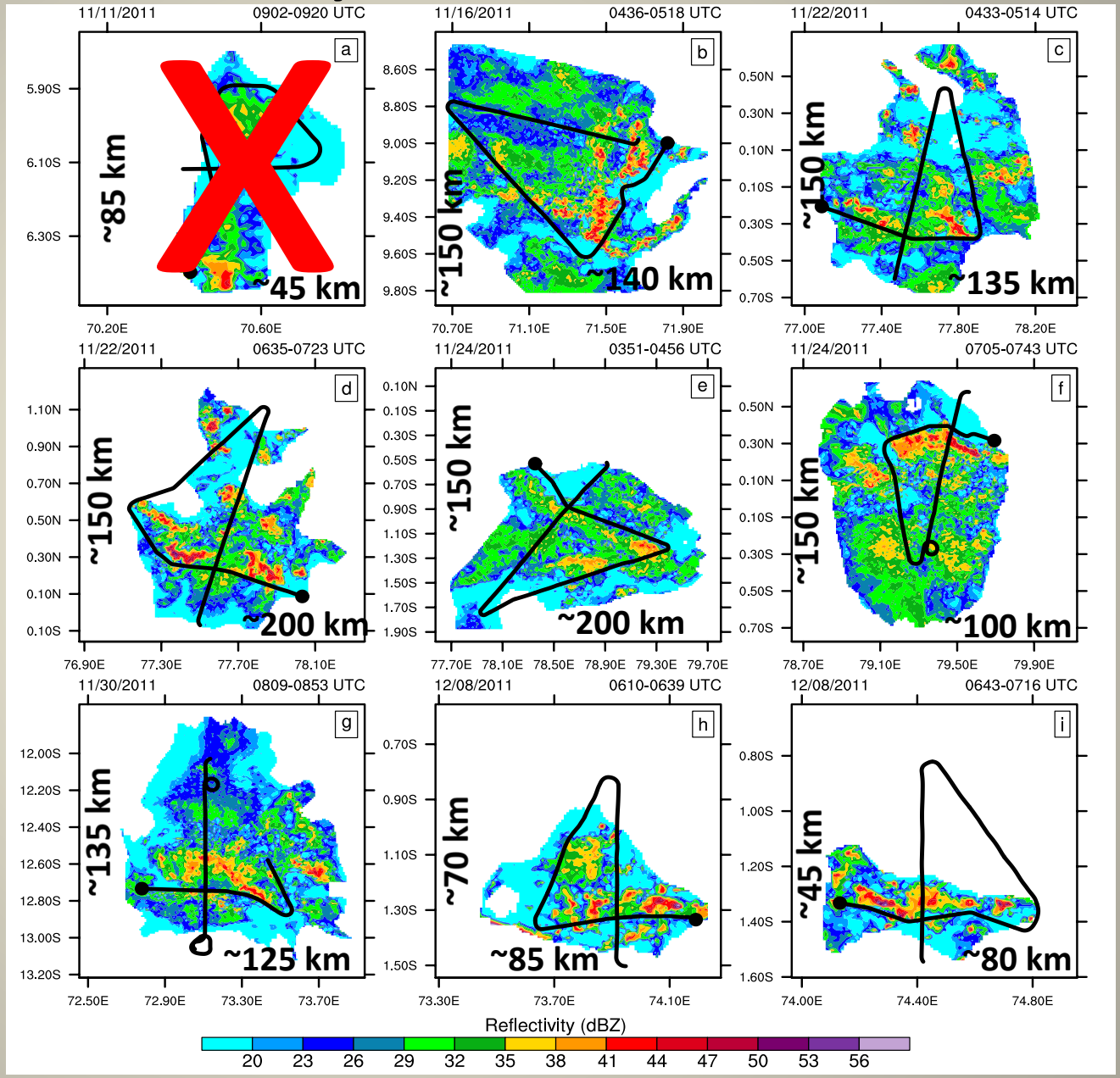


Figure 2: Particle Imaging with PIP Probe

- Laser diode array along with 64 linear-arrayed photodetectors
- Particle detected by a change in light level
- Size determined by shadowing

Study Cases

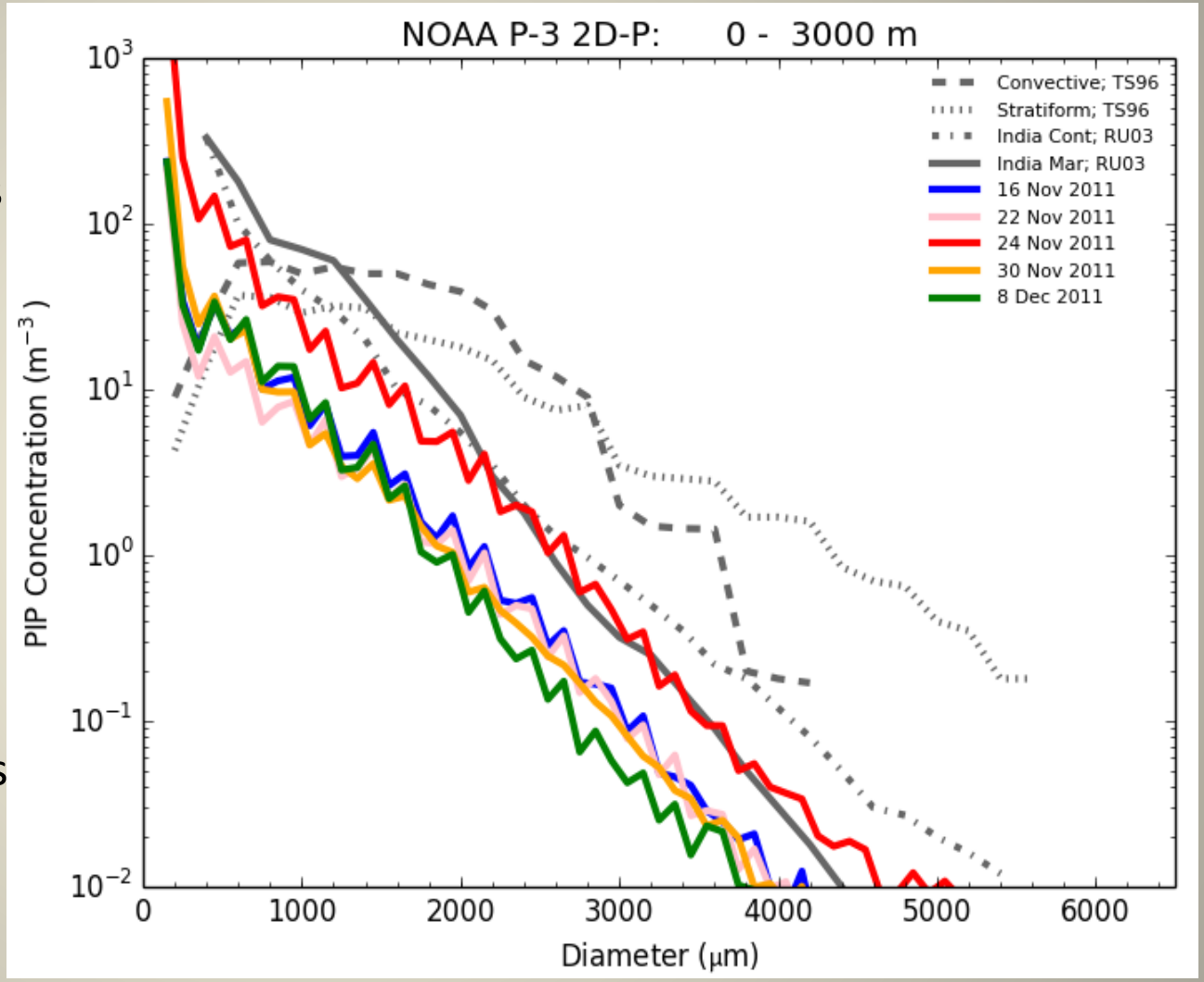
Convective based flight modules – Radar Convective Elements (RCEs)



Guy and Jorgensen (2014)

Mean Drop Size Distributions

- Maritime environment characterized by a larger number of small droplets and smaller number of large droplets than continental
- Measurements exhibit similar distributions
  - Higher concentrations during peak MJO
- Concentrations show less larger drops in comparison to previous studies (though this could be instrument bias)

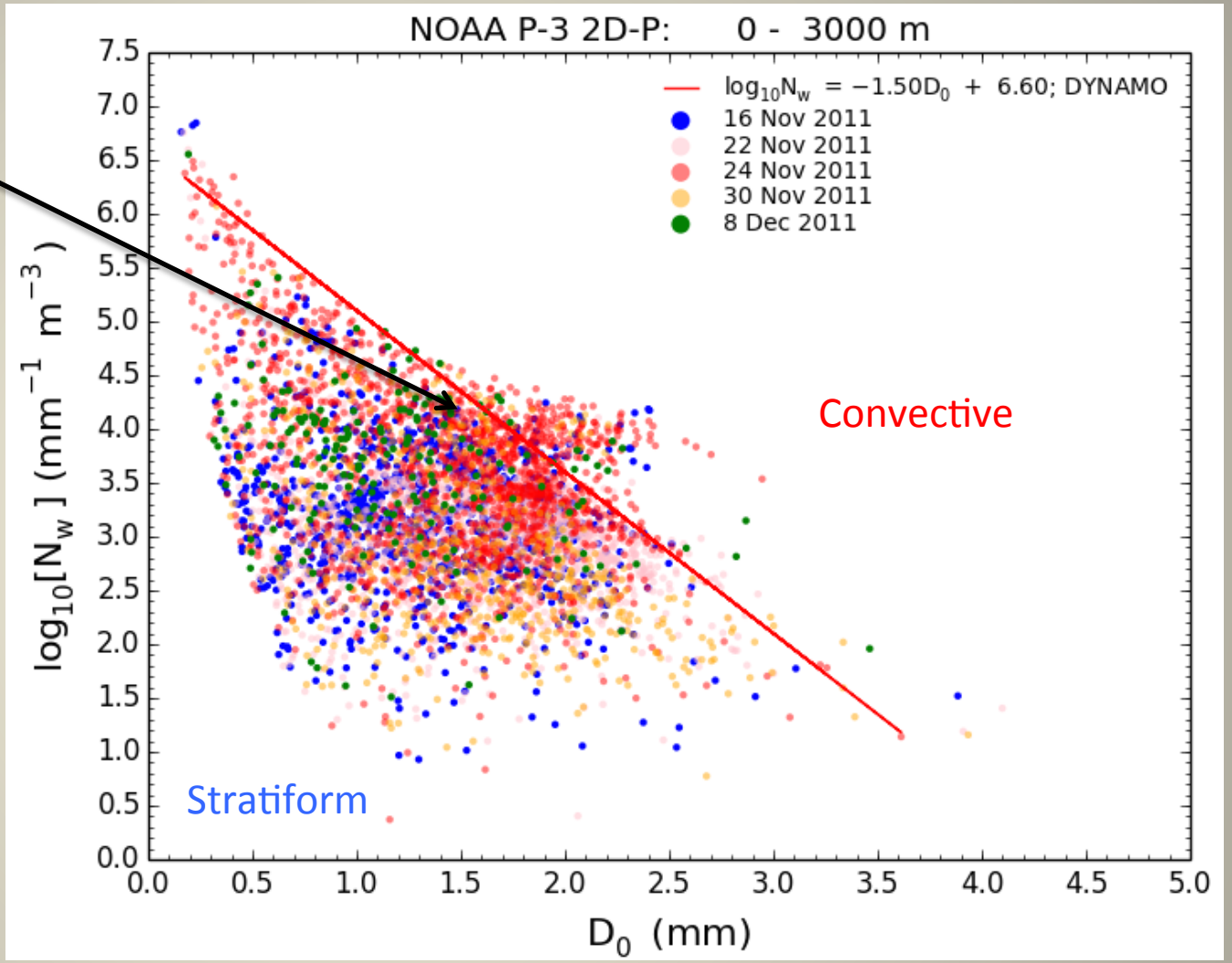


TS96 = Tokay and Short (1996)
RU03 = Rosenfeld and Ulbrich (2003)

Convective-Stratiform Separation

Transition

- Transition line comparable to those in literature
- Highest frequency near the “transition” region
- Likely due to fast convective morphology
- Lack of convective samples due to flight paths

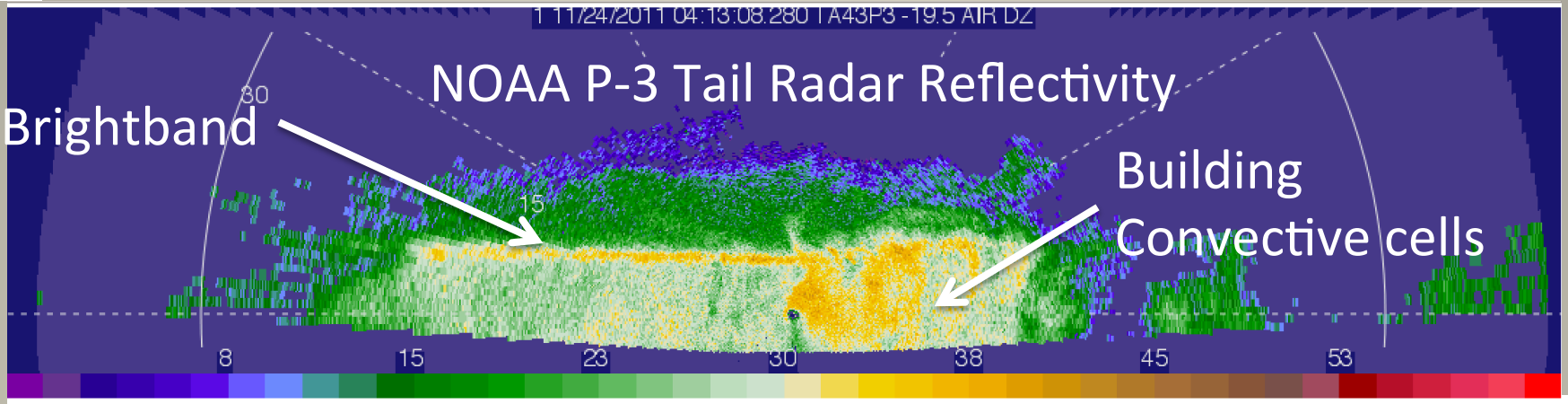


Bringi et al. (2003)
Thurai et al. (2010)

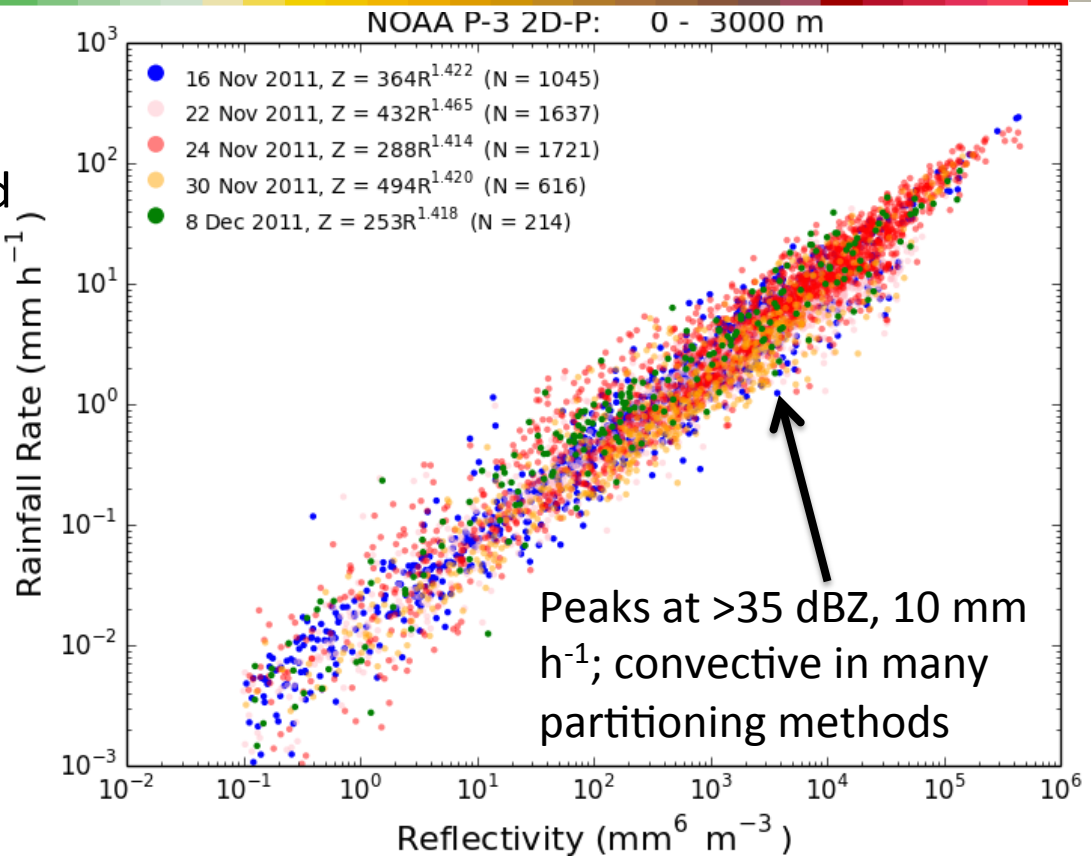
Separation Index:

$$I_{CST} = \log_{10}\left(N_w^{Obs}\right) - \log_{10}\left(N_w^{Sep}\right)$$

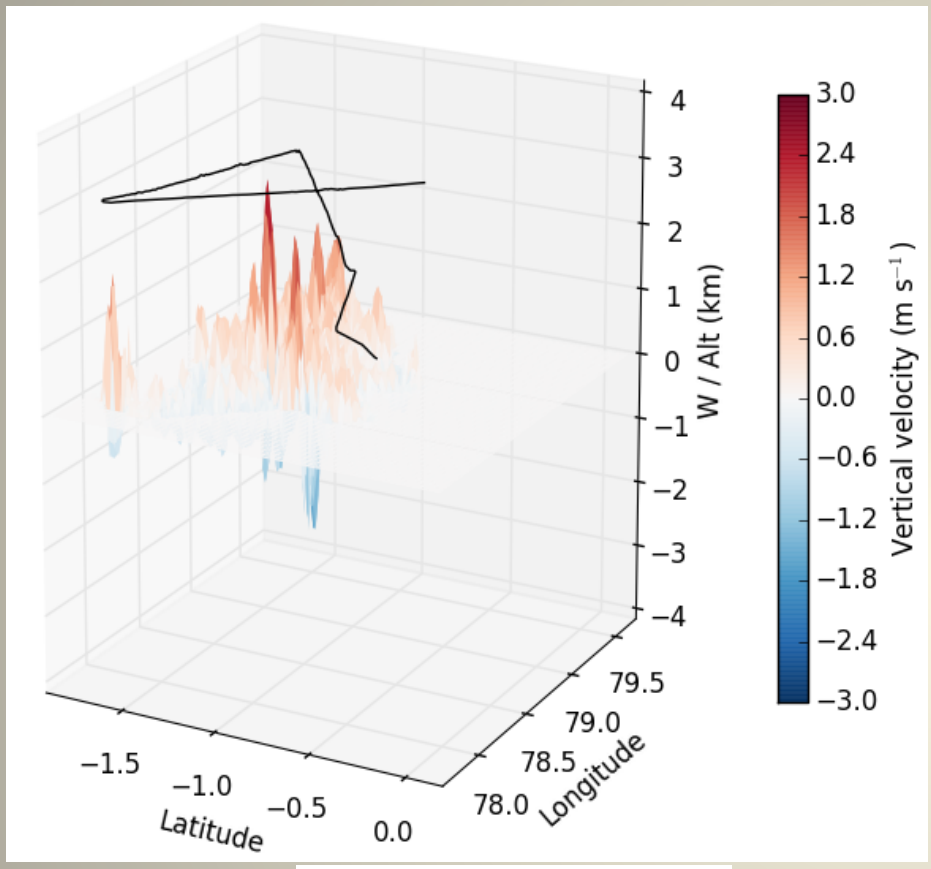
Precipitation Structure and Distribution



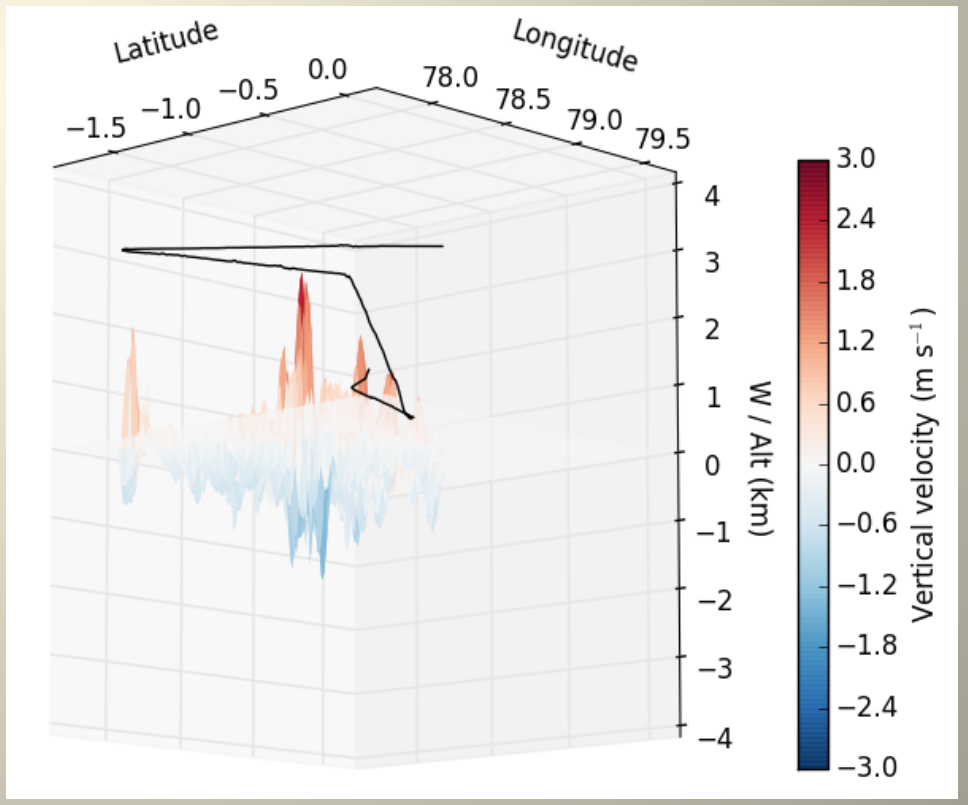
- MJO active (warm colors) dominated higher reflectivity and rainfall rate space
- MJO inactive (cool colors) less concentrated
- Average Z-R relationship
  - $Z = 366R^{1.43}$

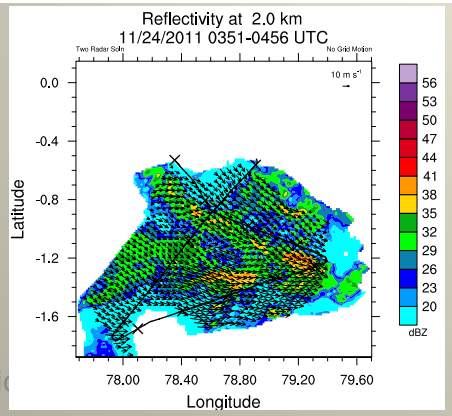


Quasi-dual-Doppler Vertical Motion



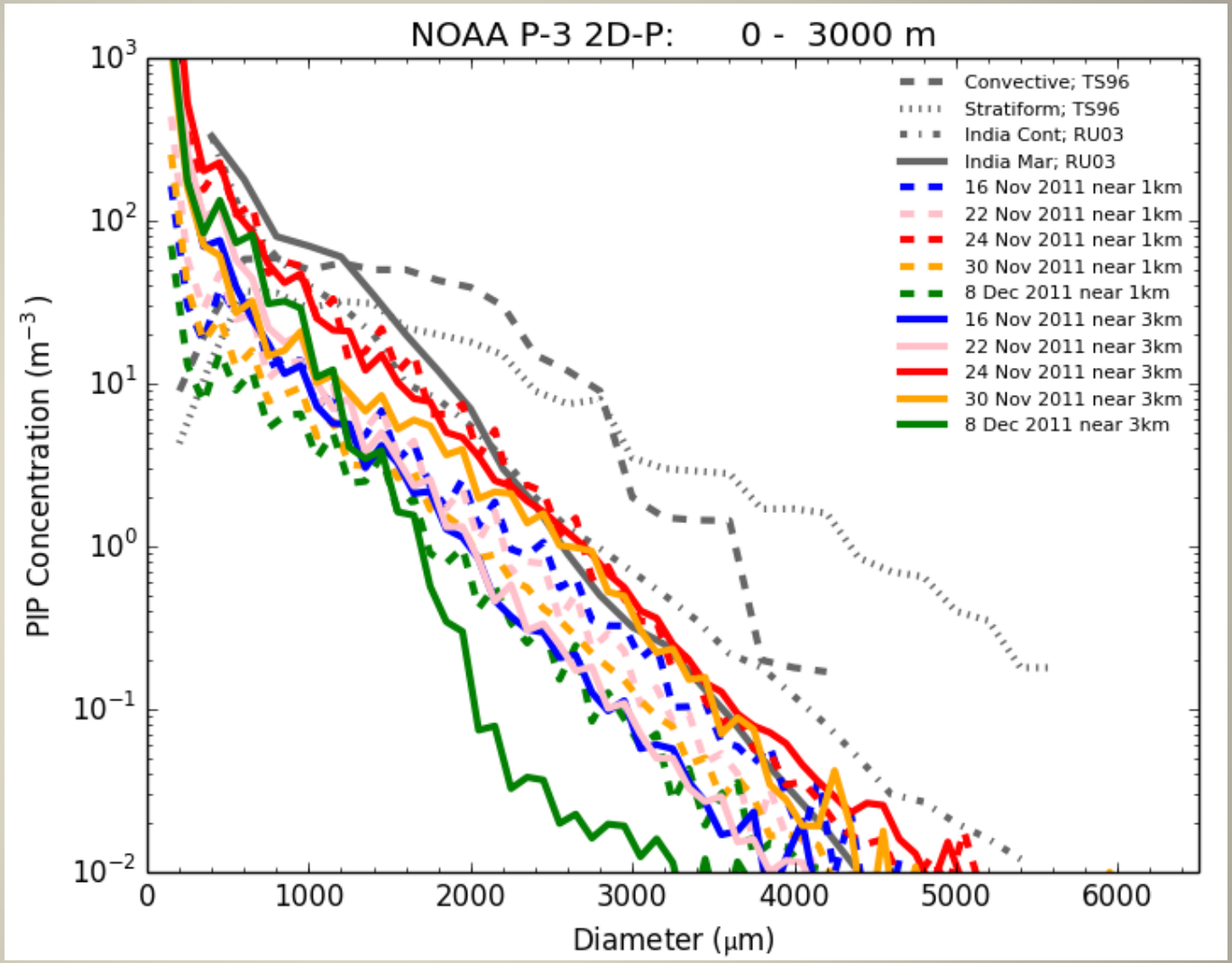
- Large variability in vertical motion field
- Indicative of transition phase





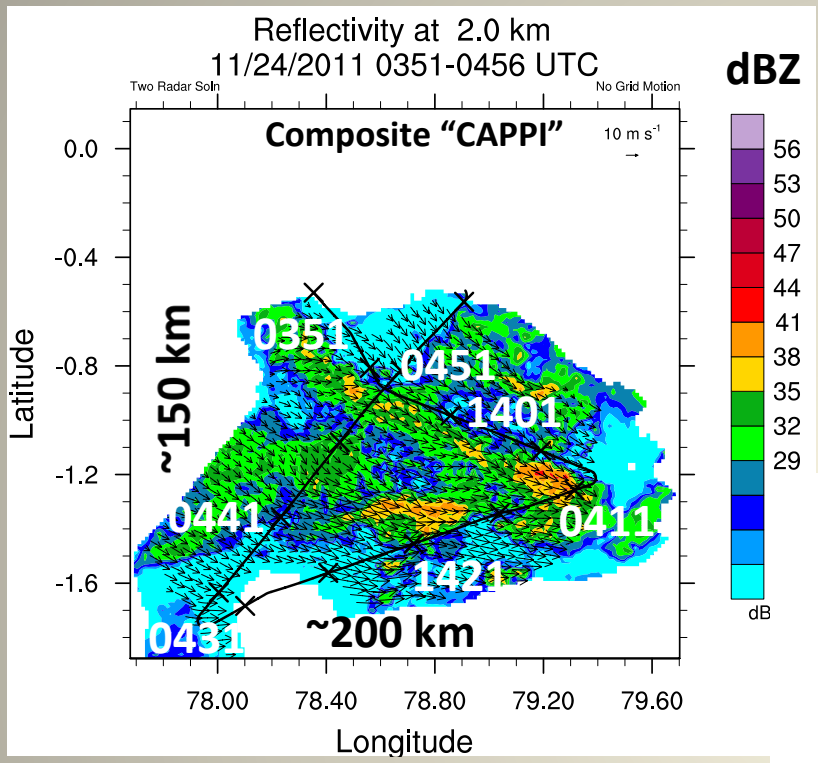
Vertical Variability

- Droplet growth observed in all cases
- 8 Dec case anomaly likely due to the fact that a strong midlevel drying was found
- Need to check the SpolKa dual-polarimetric information



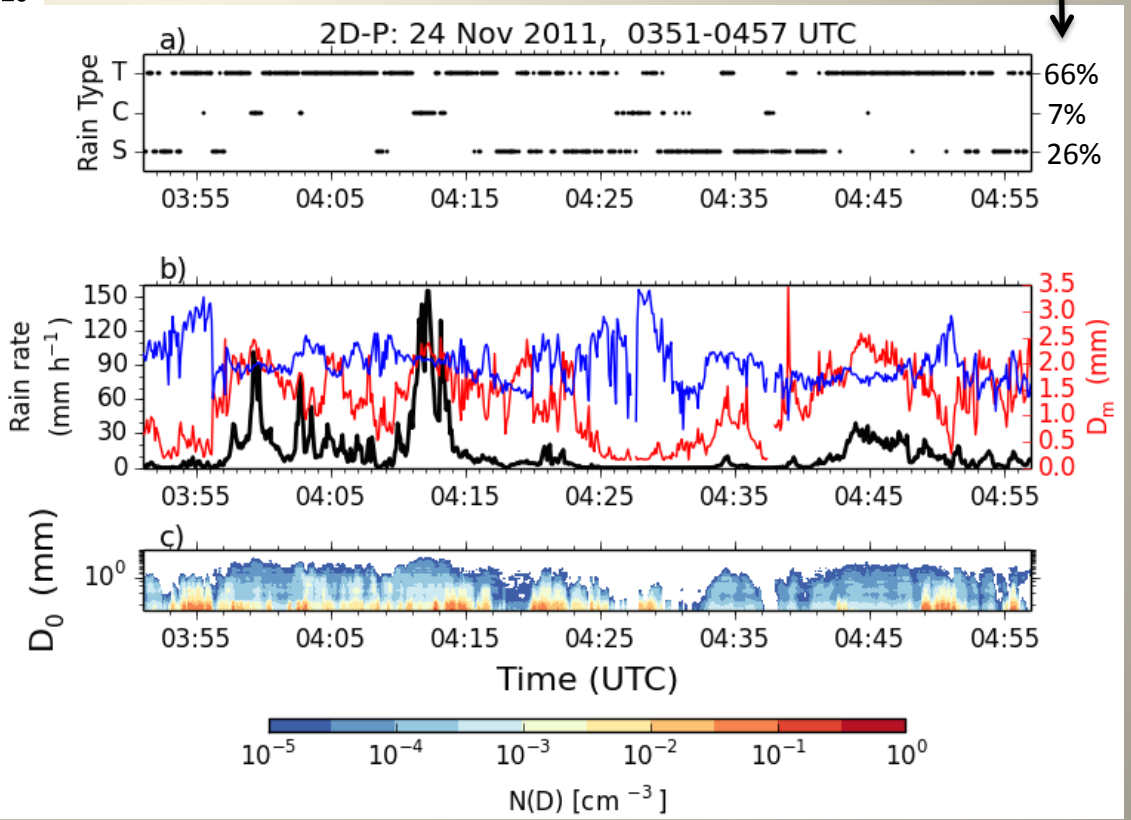
Ajda Savarin 9B.2

Probe Data Compared to Radar



MJO active period
24 November 2011

Frequency (Points below 3 km height)



$\log_{10}[N_w]$ – Droplet Conc

Summary

- Mean distributions similar for all RCE cases, regardless of local MJO phase (i.e. active/inactive)
- Z-R relationships correspond to previous maritime observations
- Probe observations dominated by “transitional” precipitation archetype
- Analysis indicates distributions like other maritime results. Possibly need to evaluate the use of a binary convective-stratiform classification scheme
- Differences in 1 and 3 km distributions indicate droplet growth, except in the dry midlevel (8 Dec) case

Thank You!
Questions/Comments?