

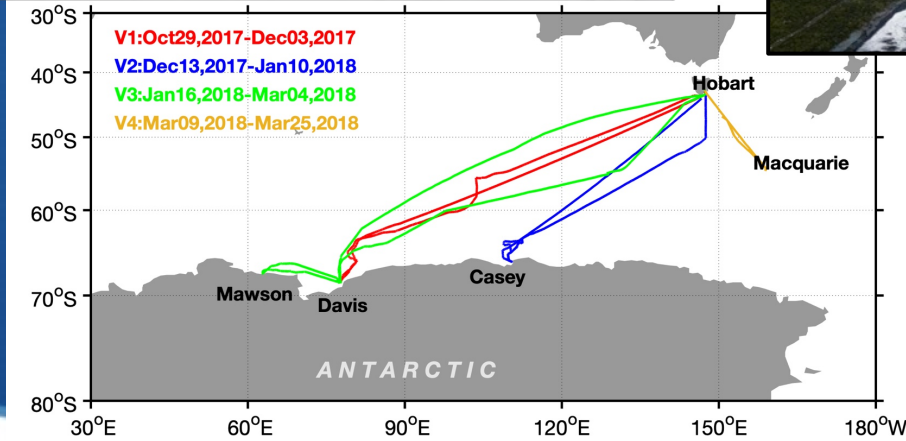
# MARCUS & MICRE

Measurements of Aerosols, Radiation and  
CloUds over the Southern ocean (MARCUS)

Macquarie Island Clouds and  
Radiation Experiment (MICRE)



Aurora Australis (AA)



**Roger Marchand, Emily Tansey, Litai Kang, Laura Hinkelman (U. Washington),  
Greg McFarquhar (Oklahoma), Saisai Ding (Peking University),  
Simon Alexander (AUS Antarctic Div.), and Alain Protat (AUS BOM/CAWCR),  
... and with many thanks to the ARM infrastructure.**

# Related Experiments

Southern Ocean Clouds, Radiation,  
Aerosol Transport Experimental Study  
(SOCRATES)

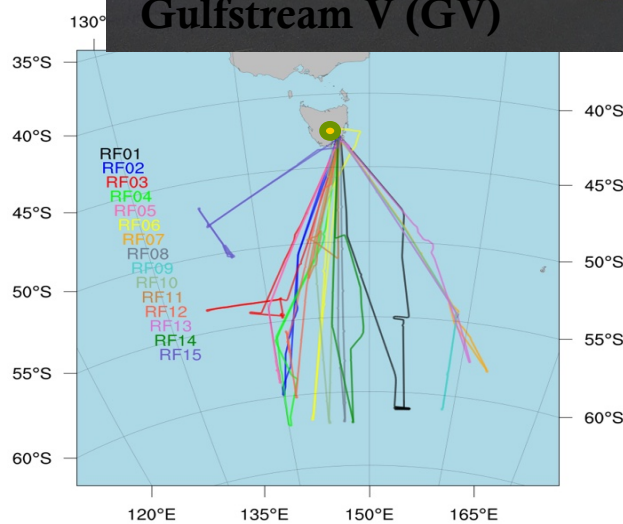
Clouds, Aerosols, Precipitation, Radiation,  
and Atmospheric Composition  
over the Southern Ocean II (CAPRICORN II)



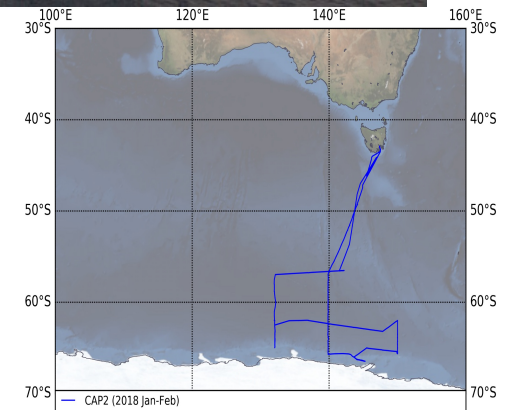
Gulfstream V (GV)



RV Investigator



- **GV: 15 research flights representing 118 flight hours**
- **3 flights over R/V Investigator; 2 over Macquarie Island**
- **RV-I: Step and Stare (occupied specific positions for ~6-18 hours)**



<b>MARCUS (4 cruises 2017-2018)</b>	<b>MICRE (April 2016-March 2018)</b>
<b>Instrumentation</b>	<b>Instrumentation</b>
94 GHz Radar (MWACR)	94 GHz Radar (BASTA) (Apr 2016-Mar 2017)
MicroPulse Lidar (MPL, pol. V3 & V4 only)	AAD Polarization Lidar
Vaisala Ceilometer	Vaisala Ceilometer
Microwave Radiometers - 3 channel MWR3C - 2 channel MWR2C	Microwave Radiometers - 3 channel MWR3C - 2 channel MWR2C
Disdrometer (Parsivel) (did not work well)	Disdrometer (Parsivel)
Broadband SW & LW fluxes (AMF PRP on left and right side) CIMEL sun photometer Total Sky Imager	Skyrad & Gndrad (MFRSR present but worked poorly) CIMEL sun photometer
Radiosondes & Surface Met	Radiosondes & Surface Met
Marine AERI	
Aerosol Observing System (AOS) : CCN, CPC, HTDMA, Nephelometer, PSAP, UHSAS	
Radar Wind Profiler	
DeMott: Aerosol Filter Samples Schnaiter: WIBS4	DeMott: Aerosol Filter Samples Humphries: CPC, CCN AAD: Radiometers, Skycamera (year 2) UC: Ceilometer

# SOCRATES/MARCUS/MICRE/CAPRICORN Themes

Theme 1: Synoptically-varying vertical structure of SO boundary layers and clouds

Theme 2: Variability of SO CCN and INPs and role of local biogenic sources

Theme 3: Supercooled liquid clouds over SO

Theme 4: Satellite Retrievals of SO aerosol, cloud, and precipitation properties.

# Products and Analysis

## Environment & Aerosol Properties

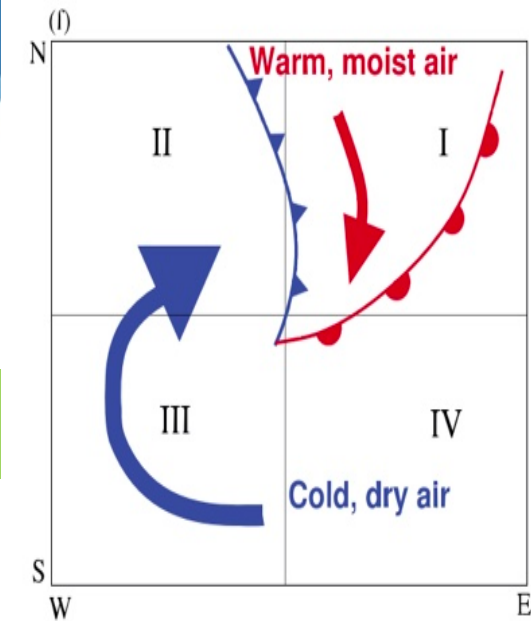
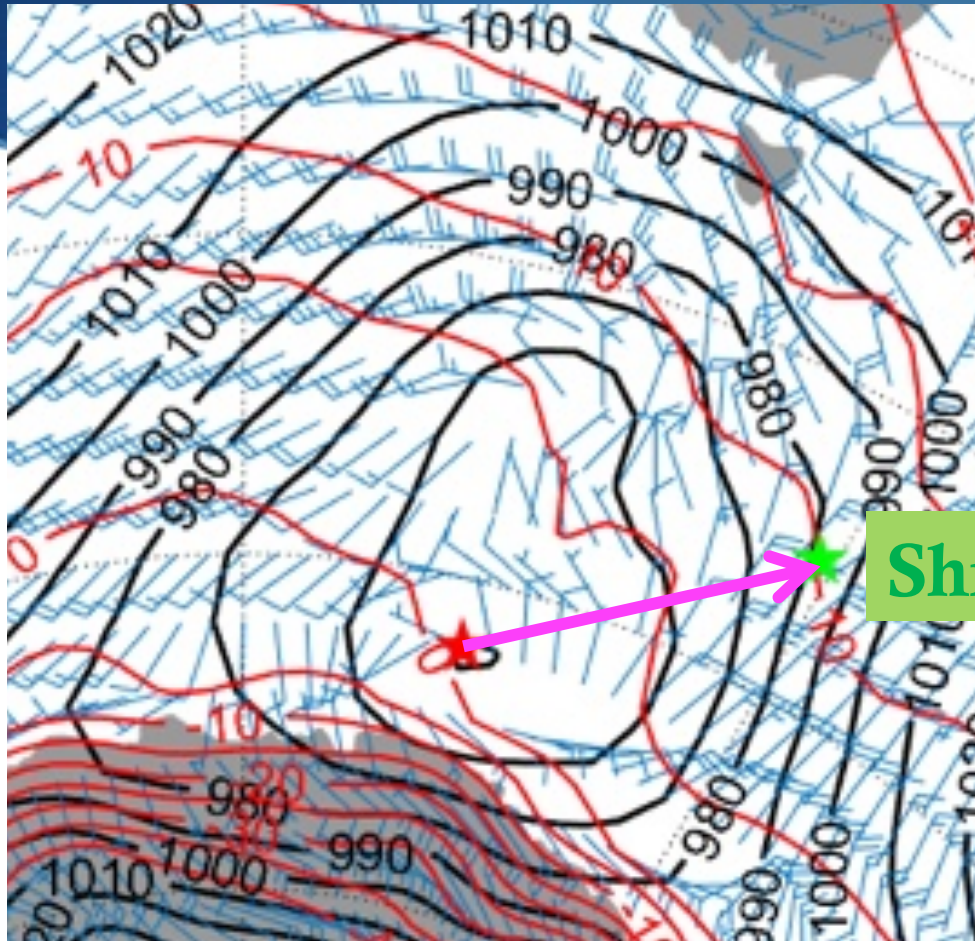
- ◆ Environmental Parameters:
  - ◆ Lower tropospheric stability (LTS)
  - ◆ Degree of Boundary layer Coupling (Cp)
  - ◆ Cyclone Distance/Quadrant
  - ◆ Air mass origin
  - ◆ SST
  - ◆ Precipitating Flag/Type
- ◆ Aerosol properties
  - ◆ CPC, CCN

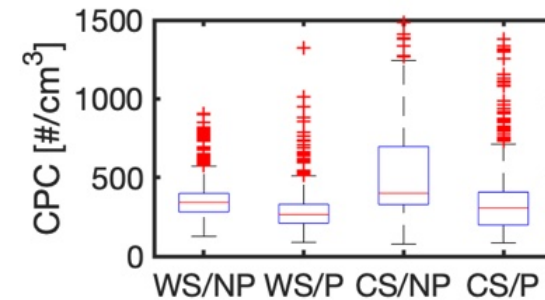
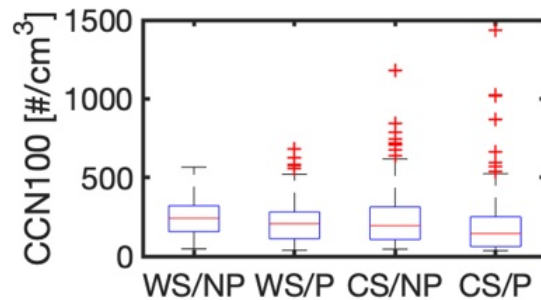
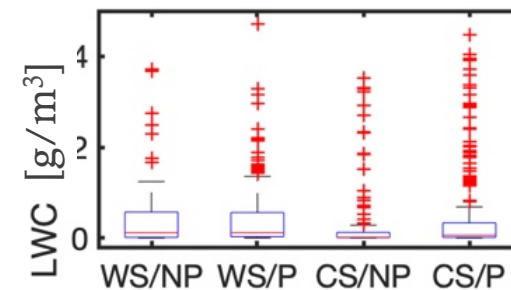
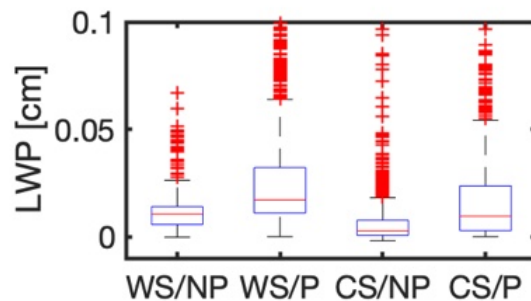
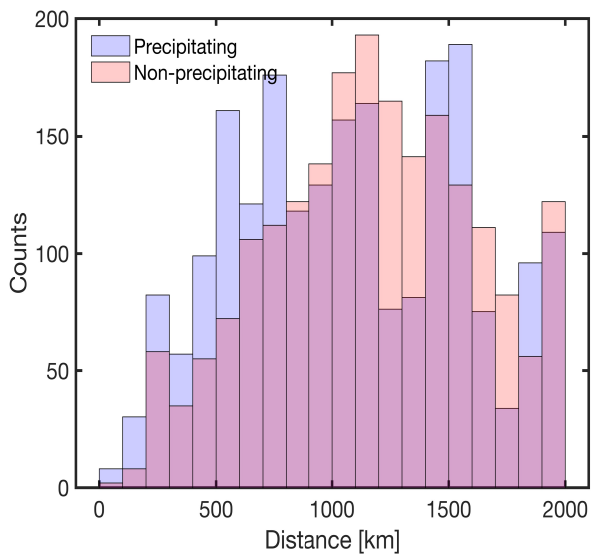
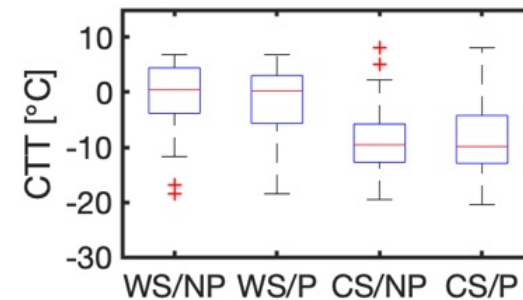
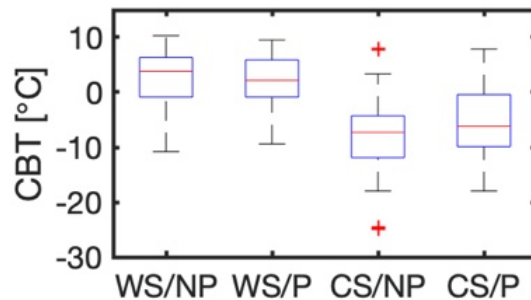
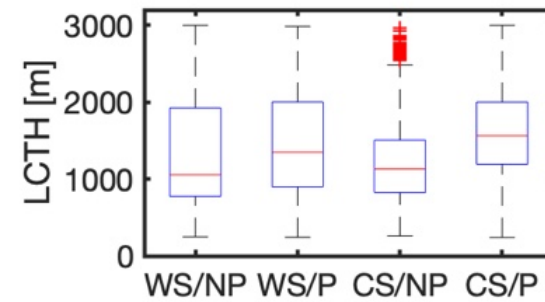
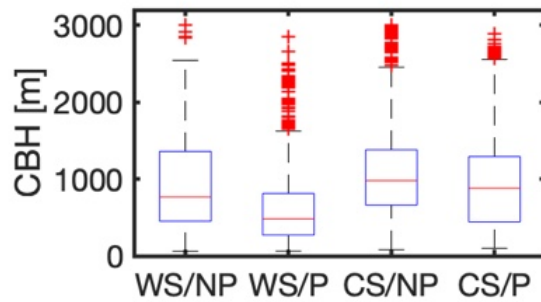
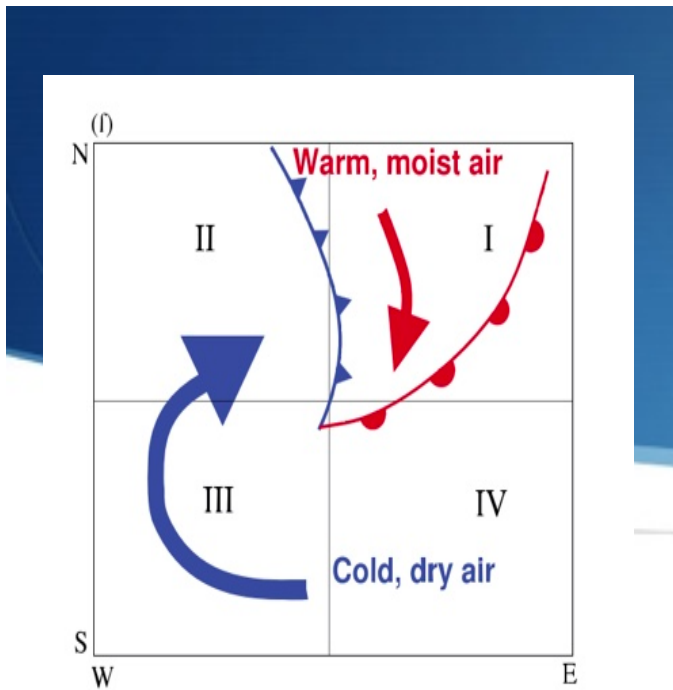
## Cloud & Precipitation Properties

- ◆ Radar-Lidar Boundaries & Phase
- ◆ Precipitation Retrievals
  - ◆ Radar Reflectivity–Velocity (ZV) Light Precipitation Retrieval (below cloud)
  - ◆ Parsivel Disdrometer Phase / Precipitation Type
  - ◆ Blended Precipitation Rate
- ◆ Physical-Iterative Microwave Radiometer (MWR) Retrieval
- ◆ Radar-MWR (Z-LWP) Retrieval for Cloud Re and Nd

The above include expanded **data quality flags/information**

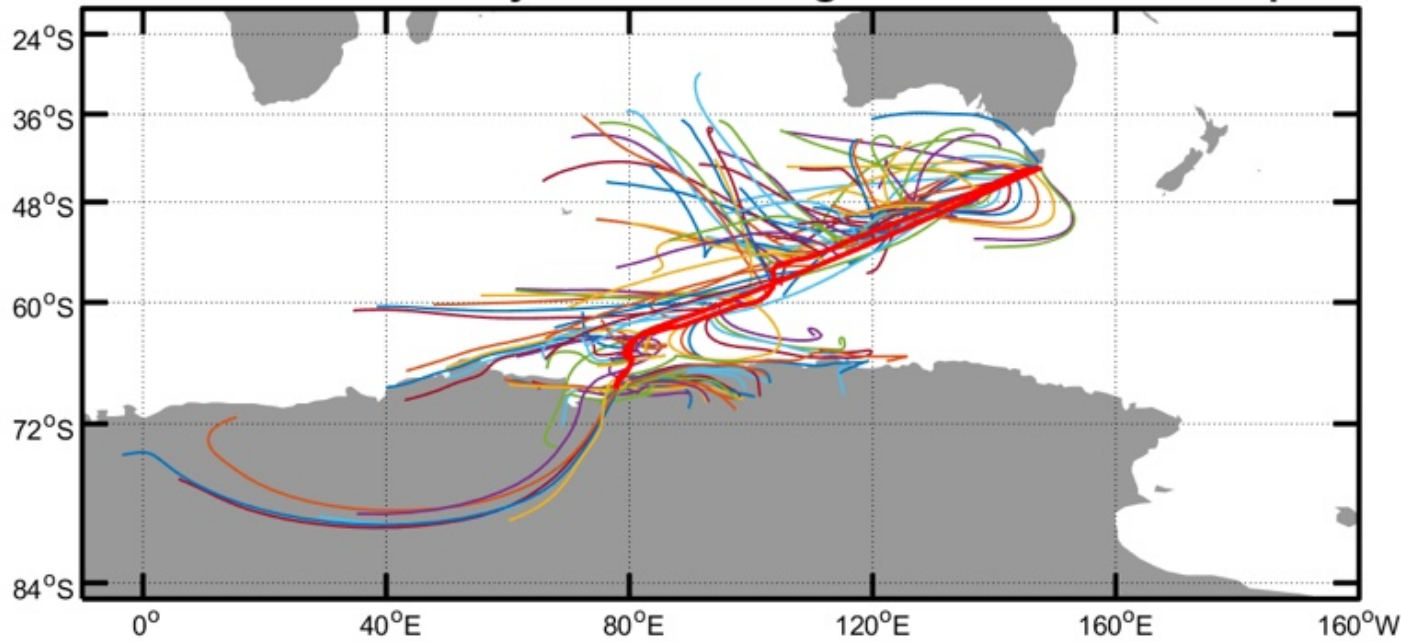
# Cyclone Distance / Quadrat :



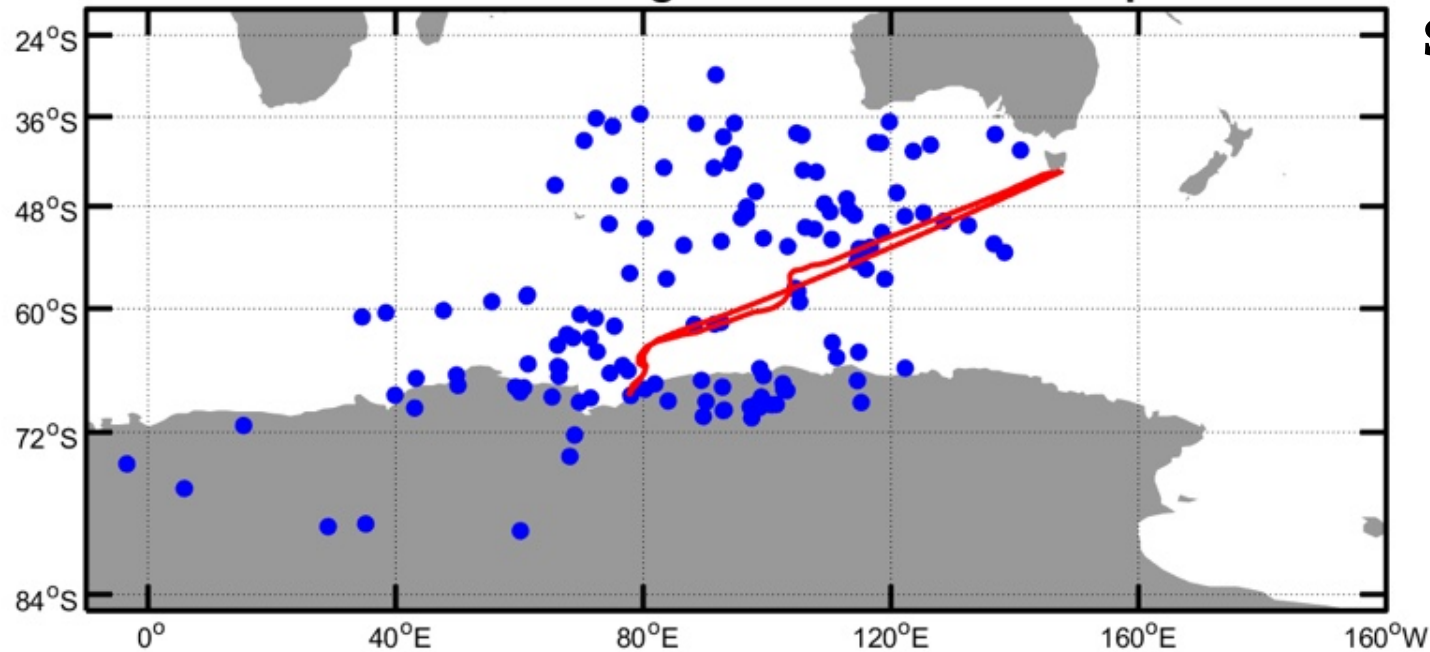


Saisai Ding & Greg McFarquhar

**V1: 48hrs back trajectories ending at 1km above the ship**



**V1: 48hrs air origins 1km above the ship**



**Back  
trajectories  
base on  
HYSPLIT  
simulations**

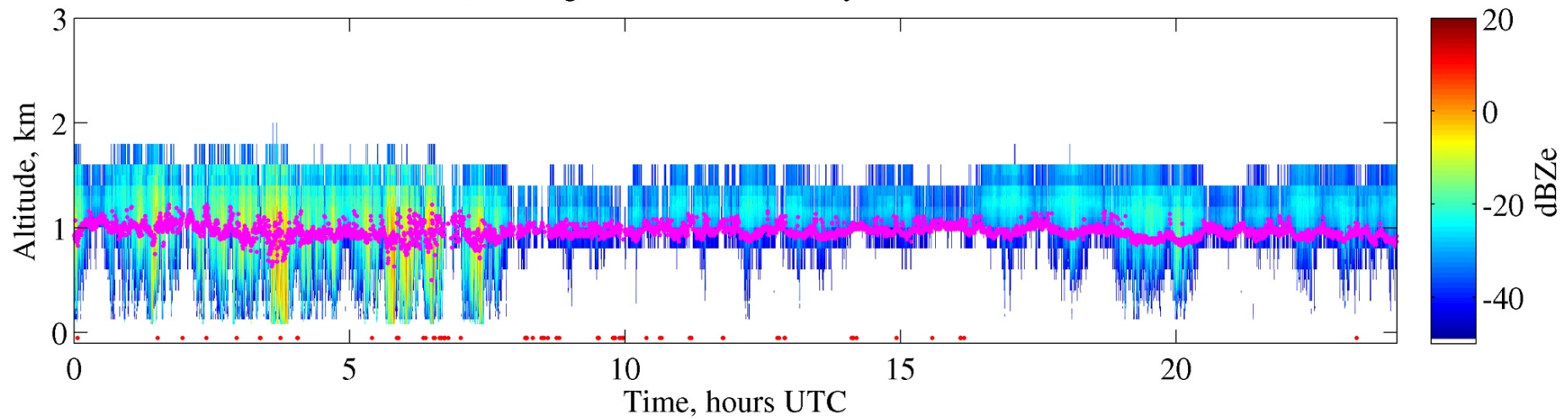




# Cold Postfrontal Clouds ...



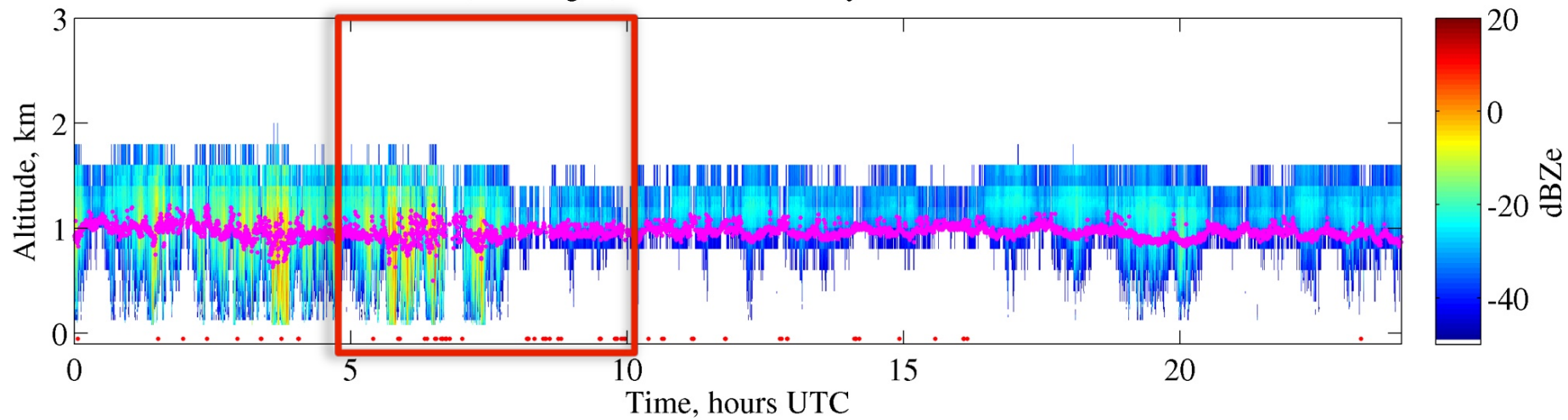
BASTA (L2 merged) Radar Reflectivity Factor on 20160518



# Cold Postfrontal Clouds ...



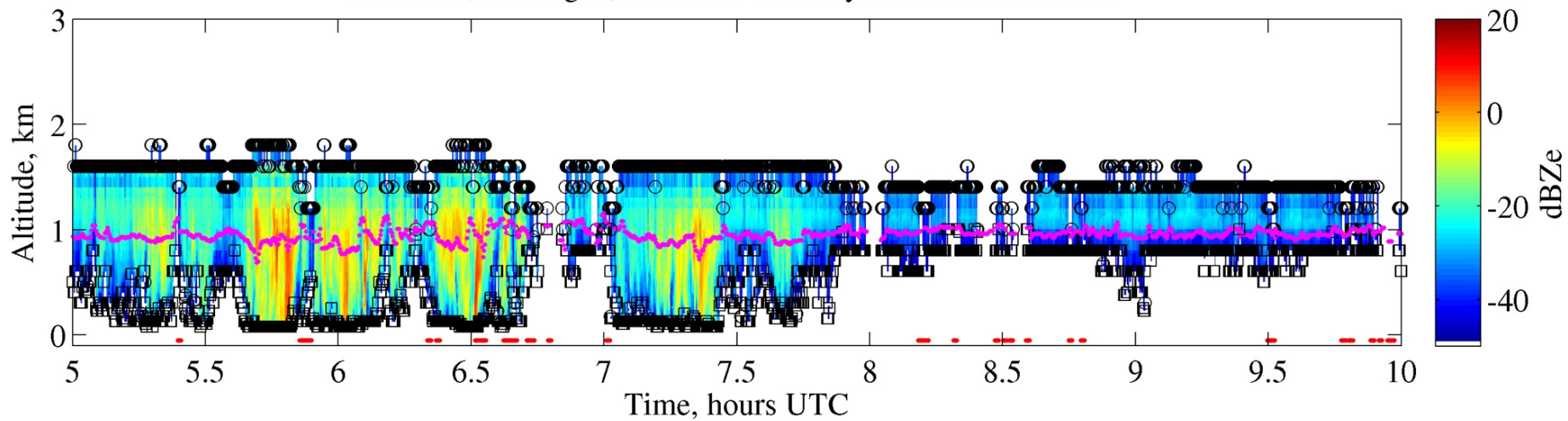
BASTA (L2 merged) Radar Reflectivity Factor on 20160518



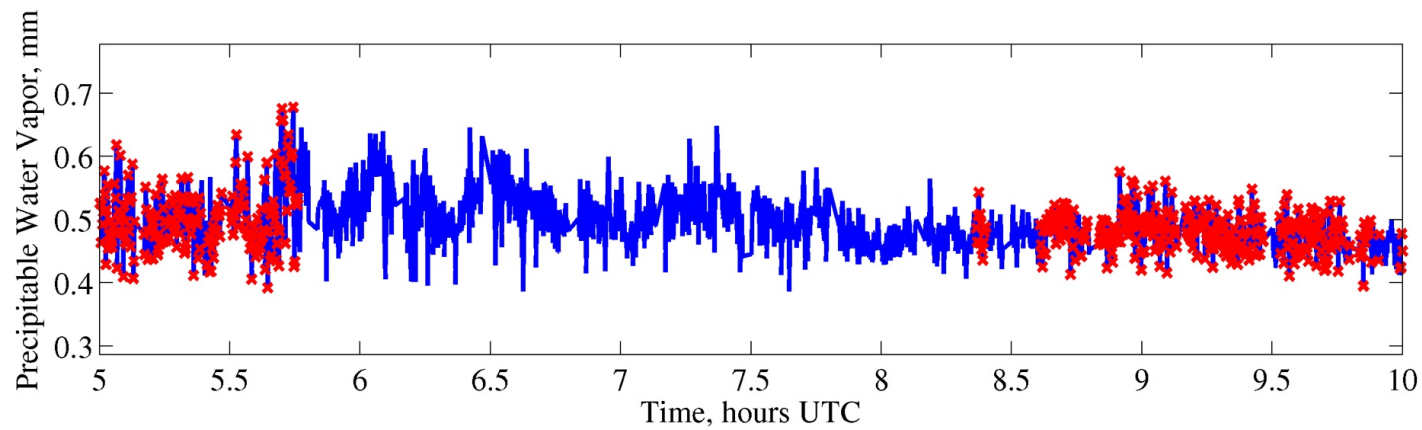
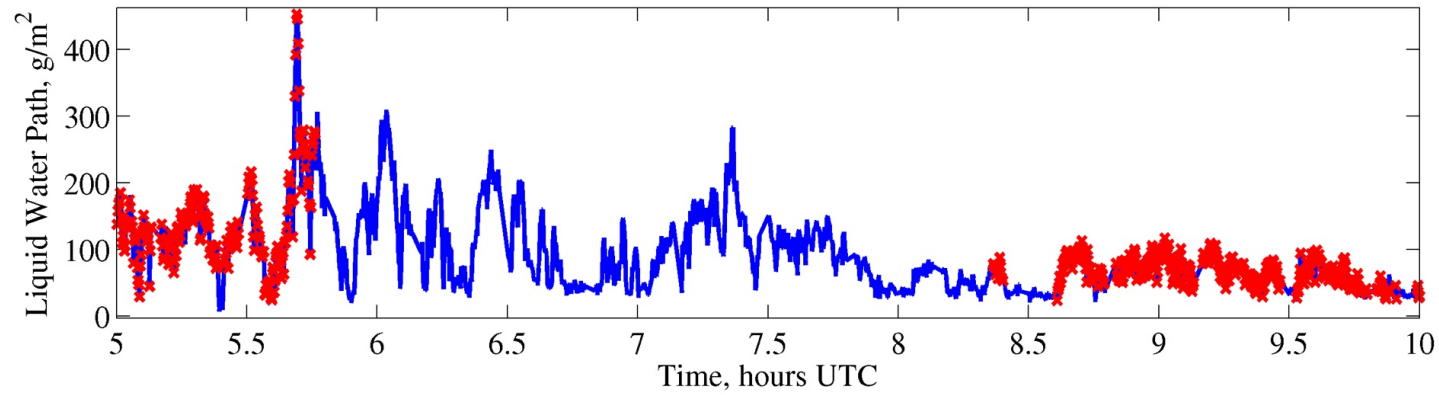
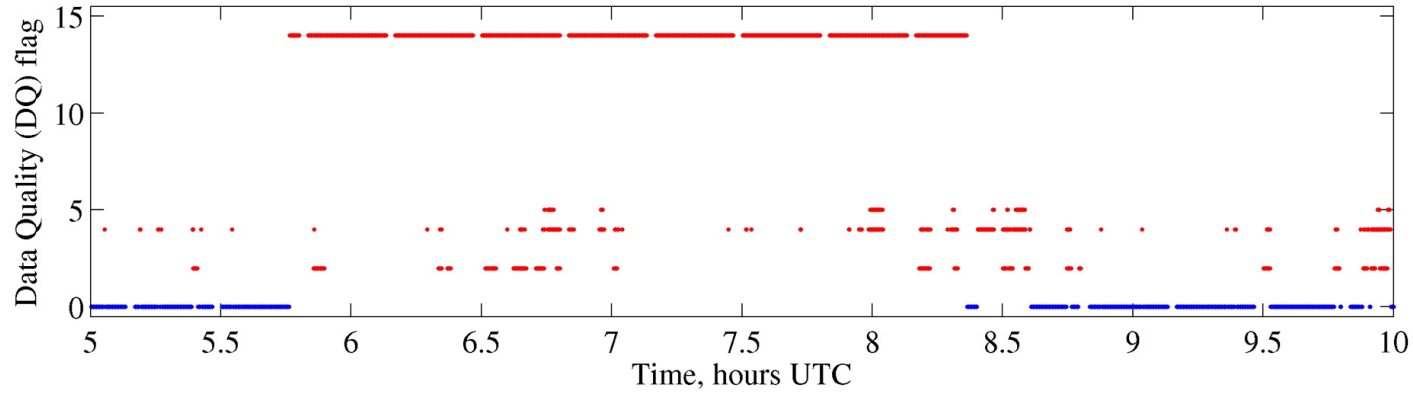
# Cold Postfrontal Clouds ...



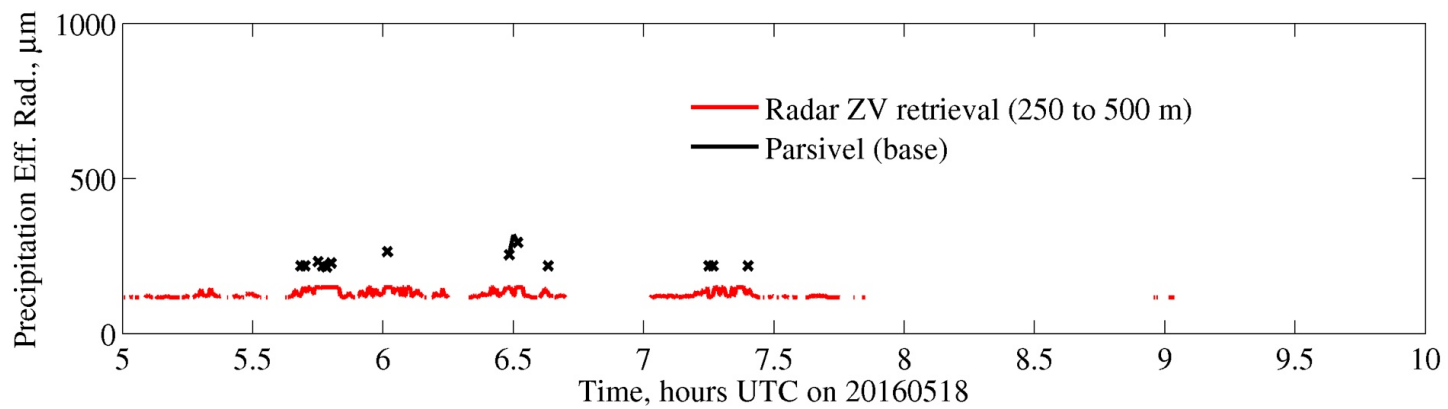
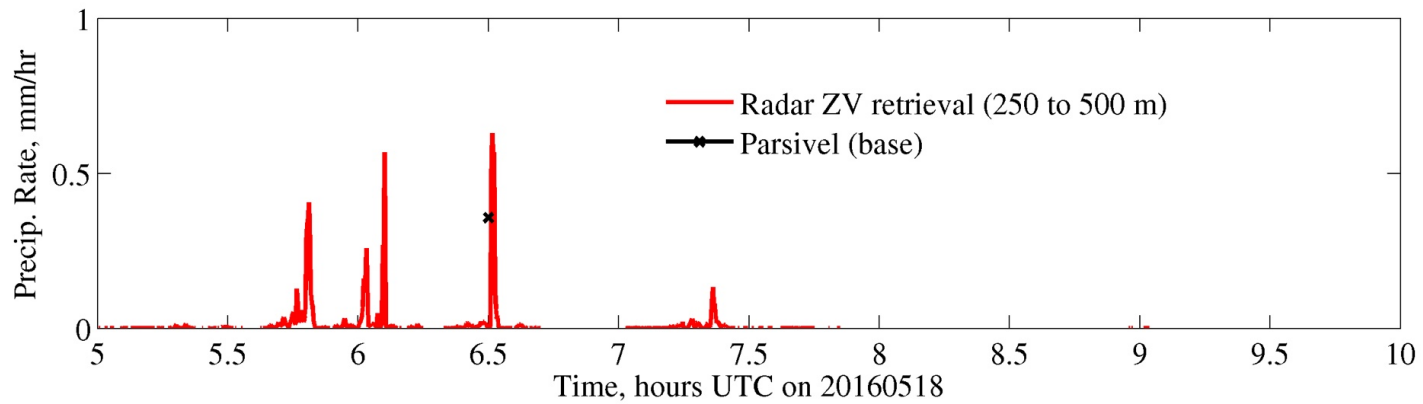
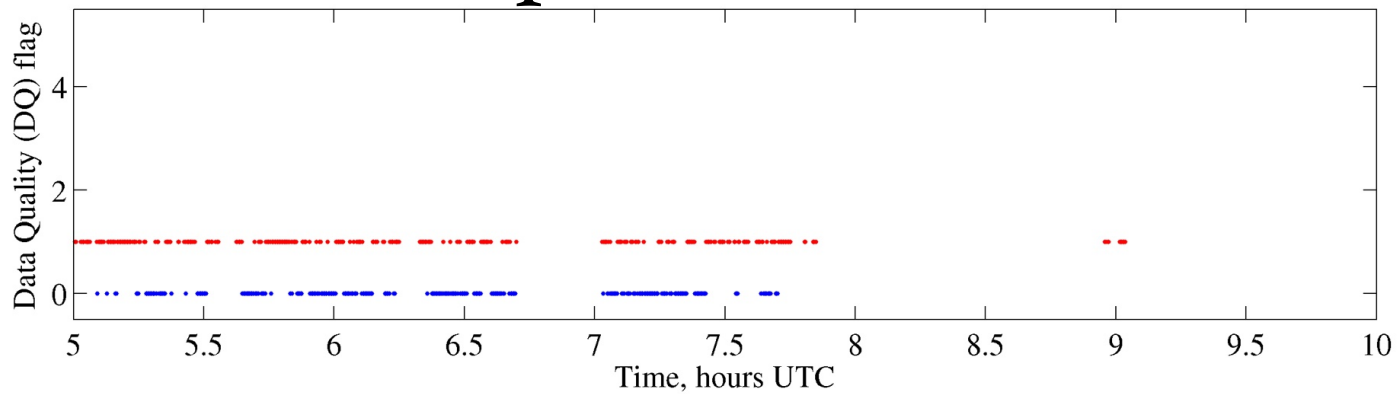
BASTA (L2 merged) Radar Reflectivity Factor on 20160518



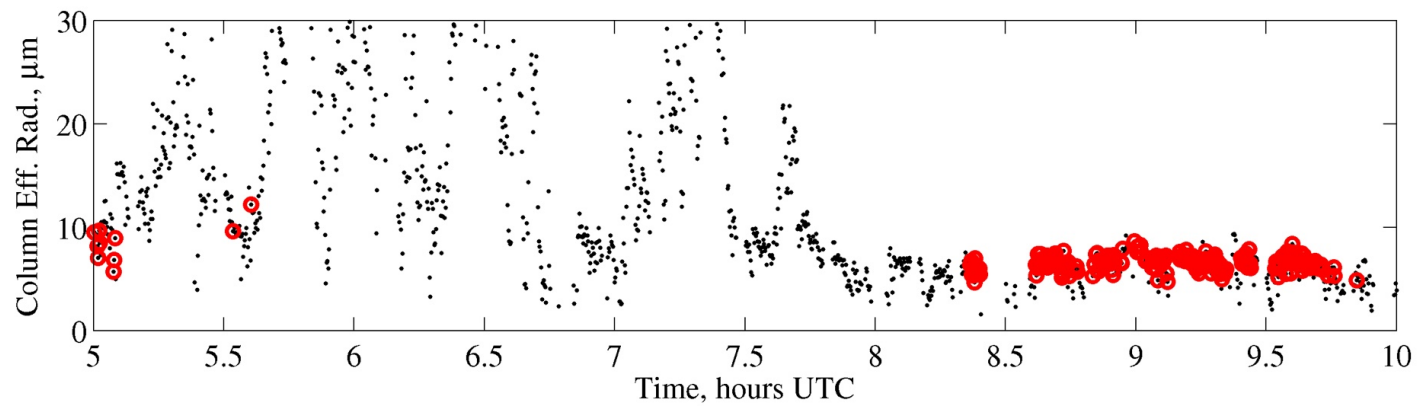
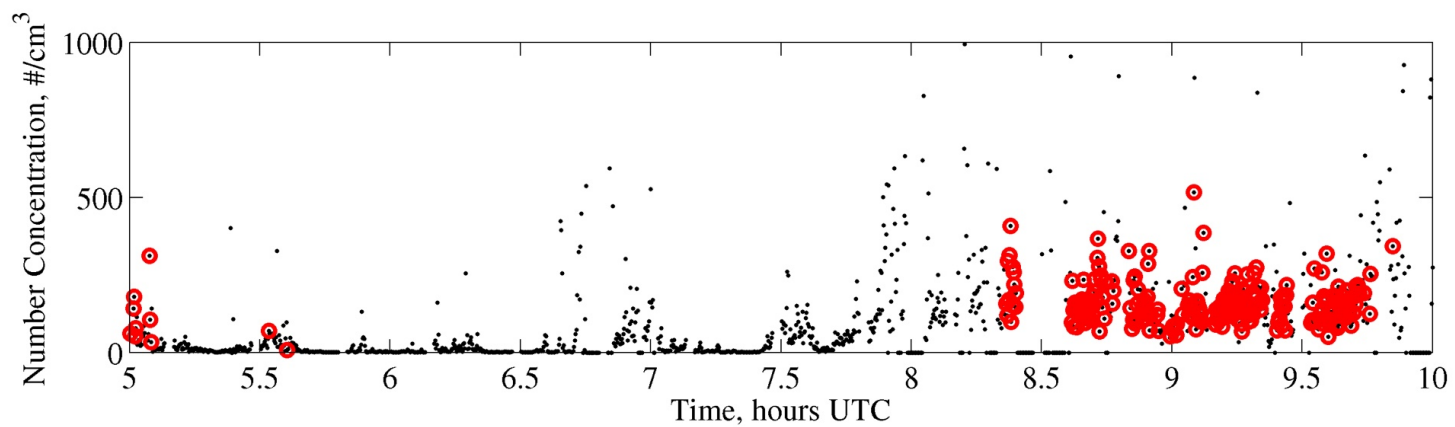
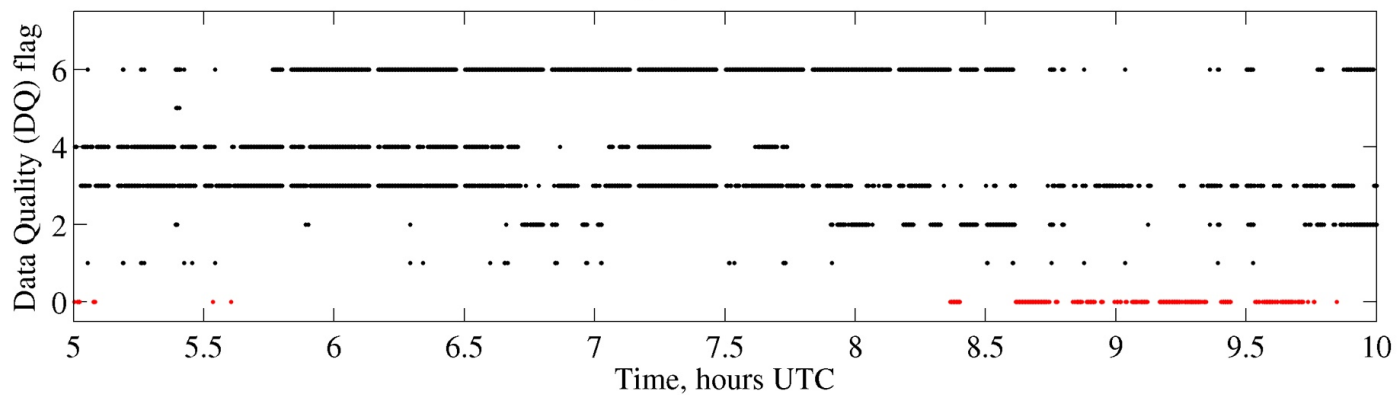
# MWR Physical-Iterative



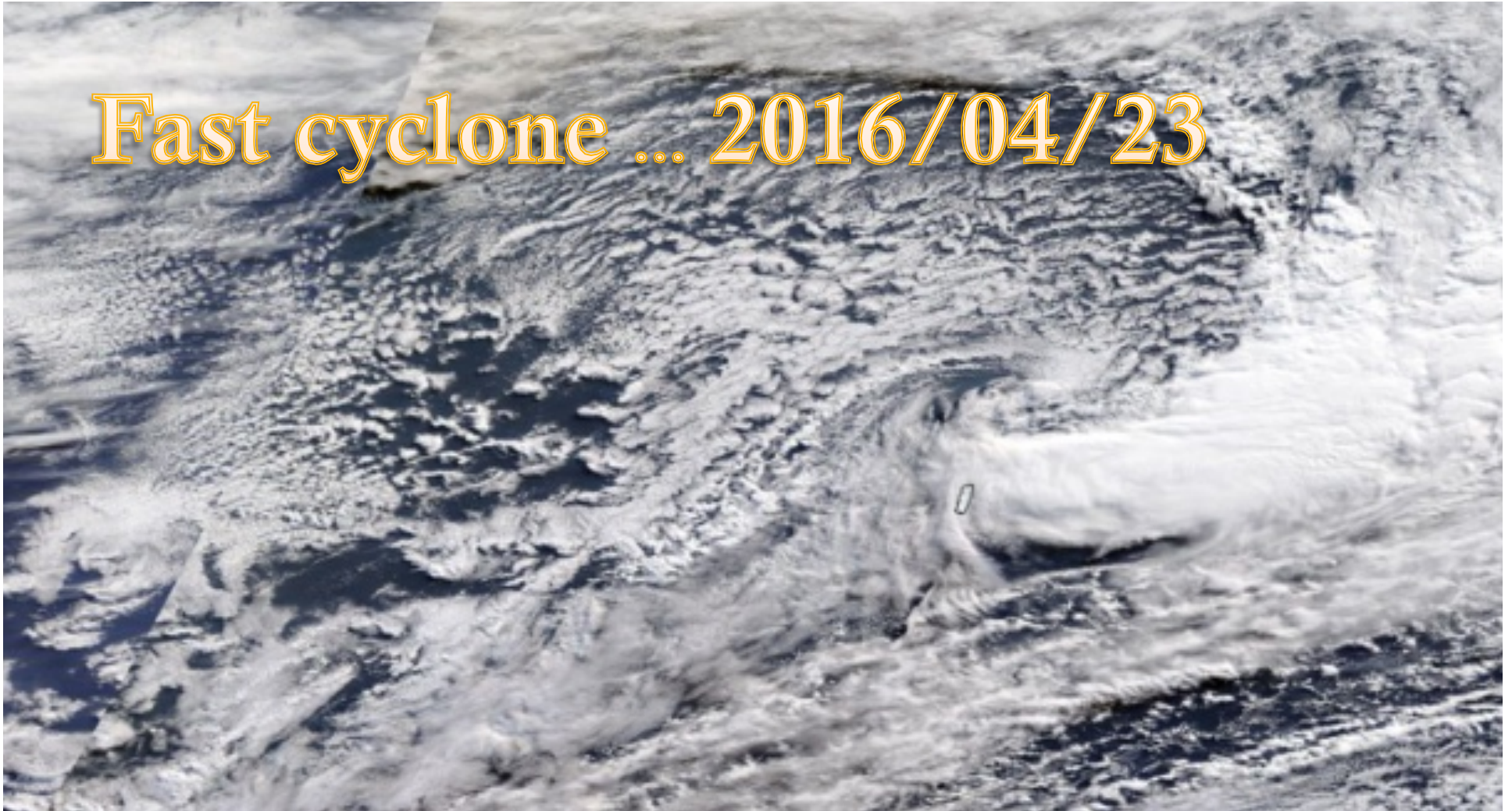
# ZV Precipitation Retrieval



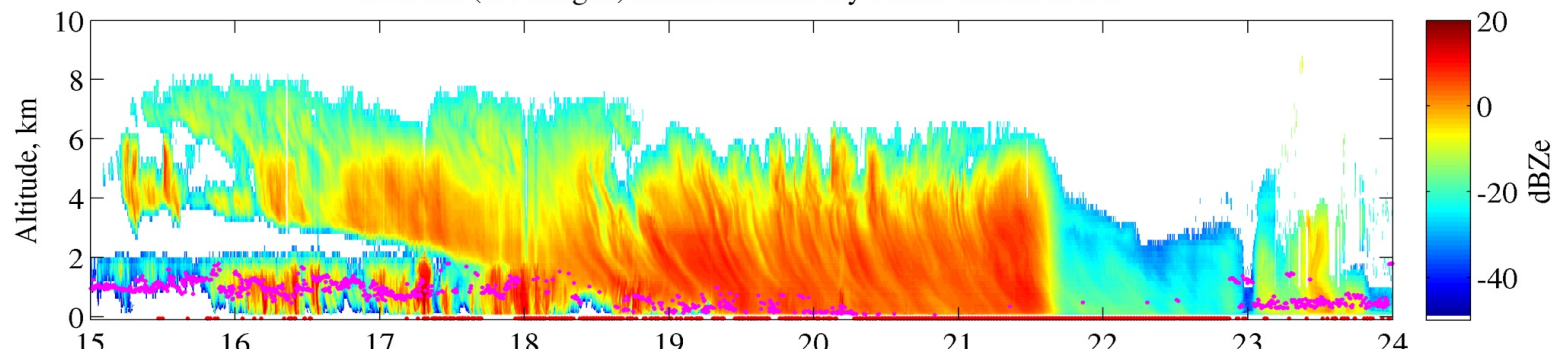
# Z-LWP Retrieval



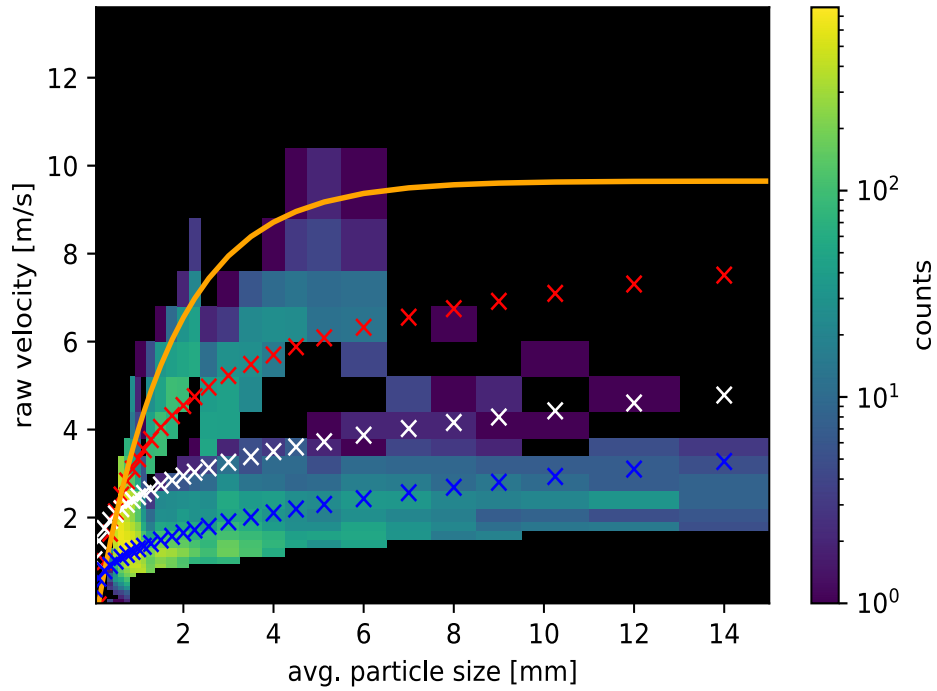
# Fast cyclone ... 2016/04/23



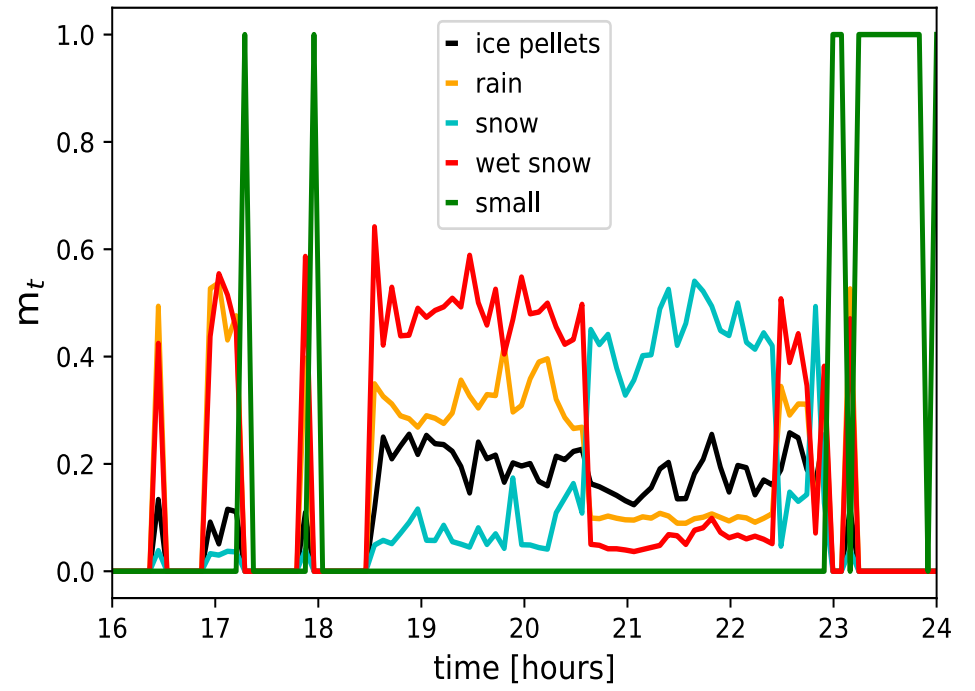
BASTA (L2 merged) Radar Reflectivity Factor on 20160423



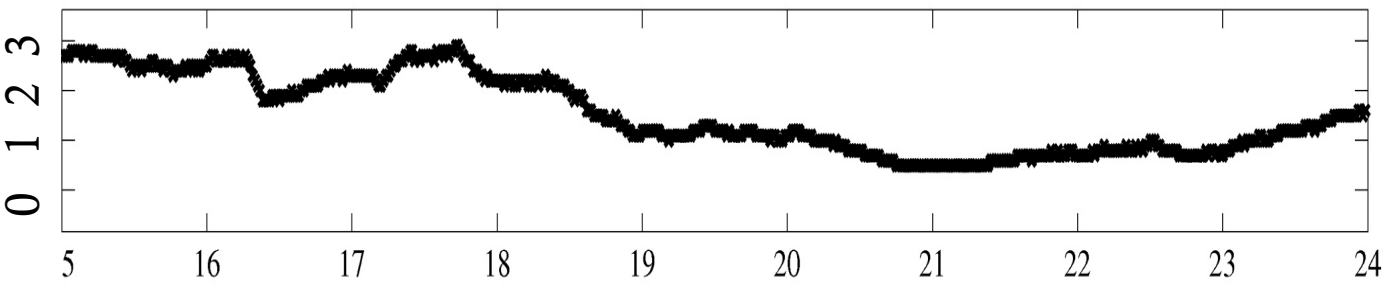
Parsivel spectrum (2016-04-23)



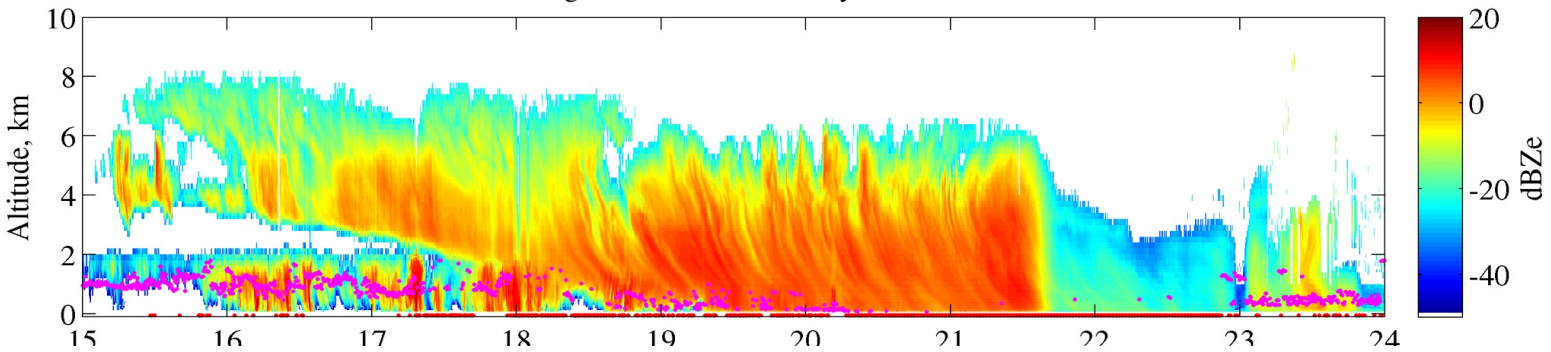
$m_t$  metrics (5-min) (2016-04-23)



Surf. Temp, °C



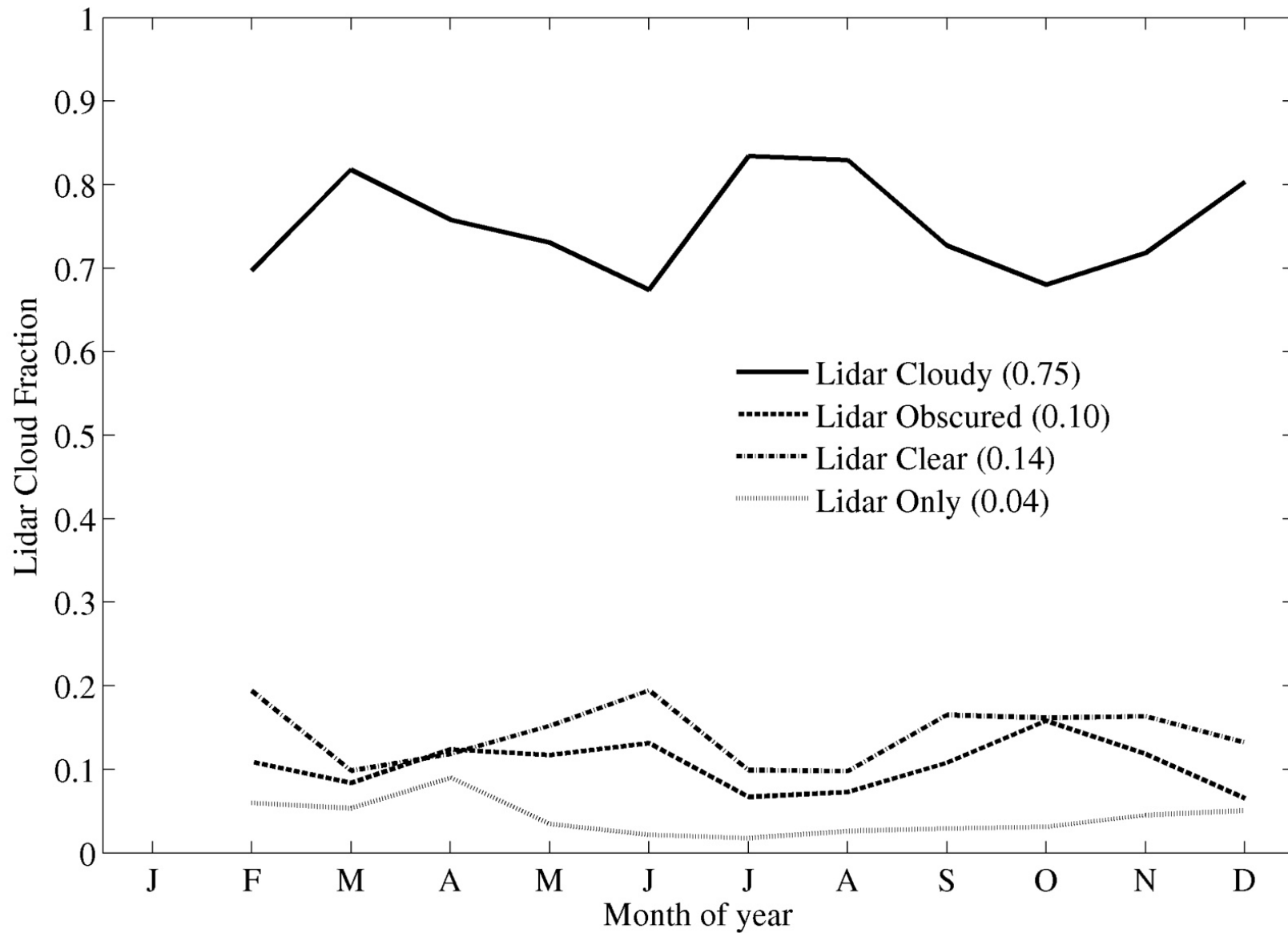
BASTA (L2 merged) Radar Reflectivity Factor on 20160423



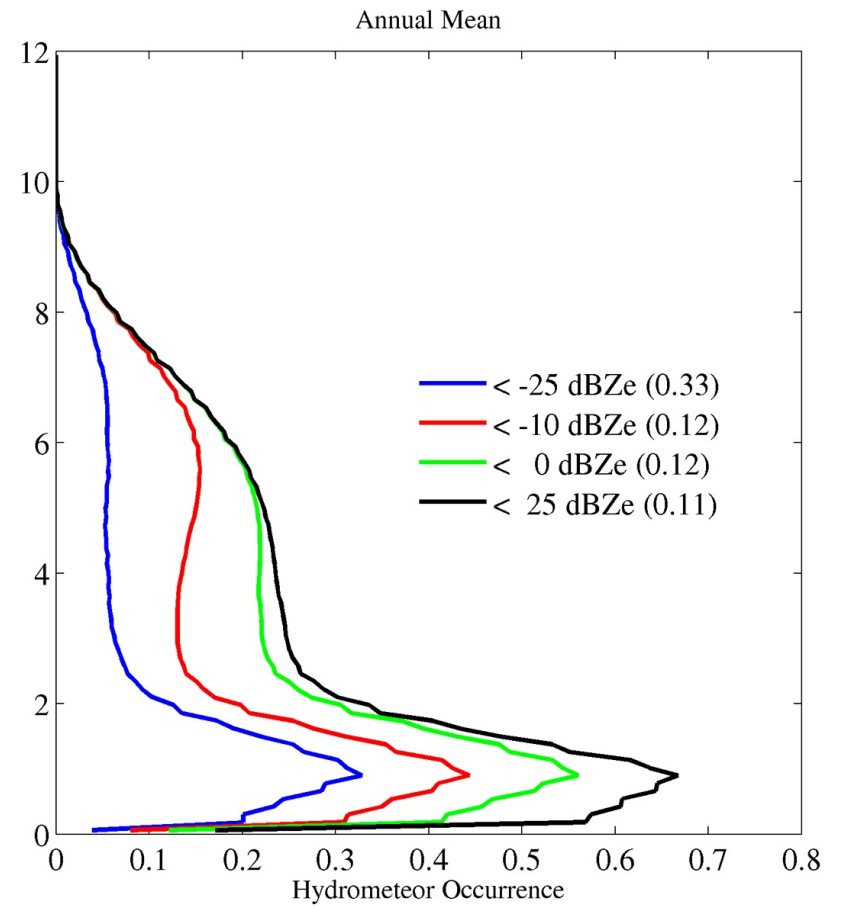
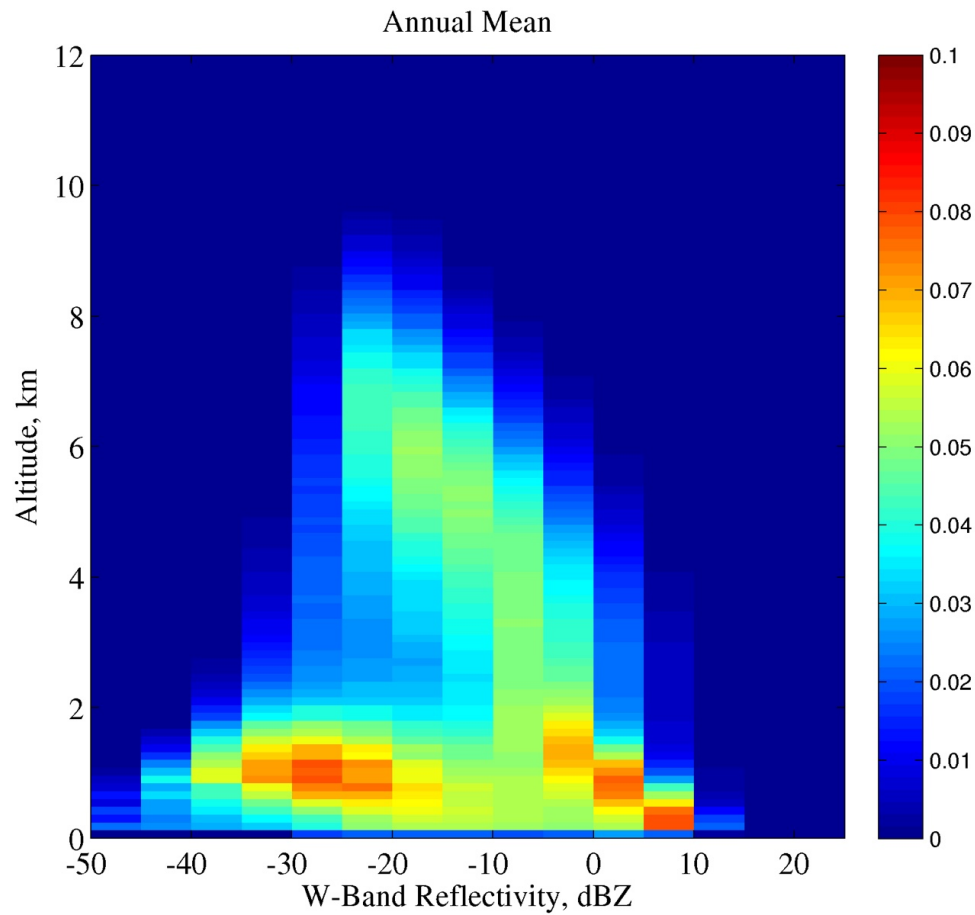
Emily  
Tansey

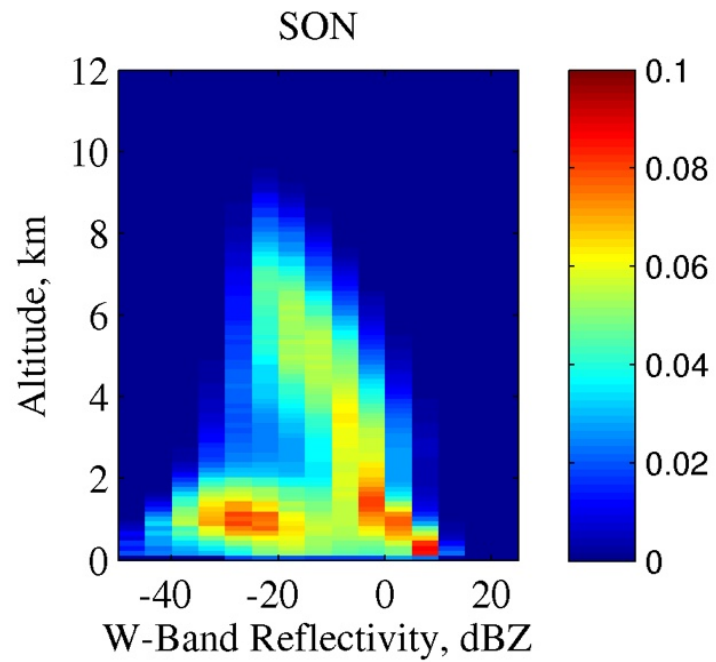
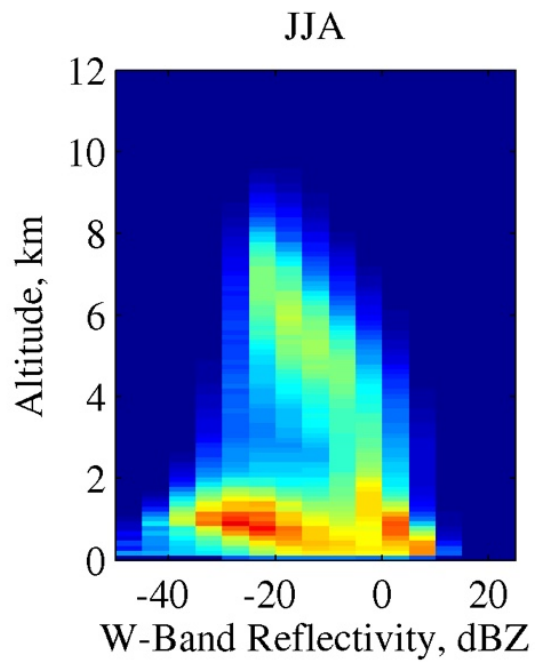
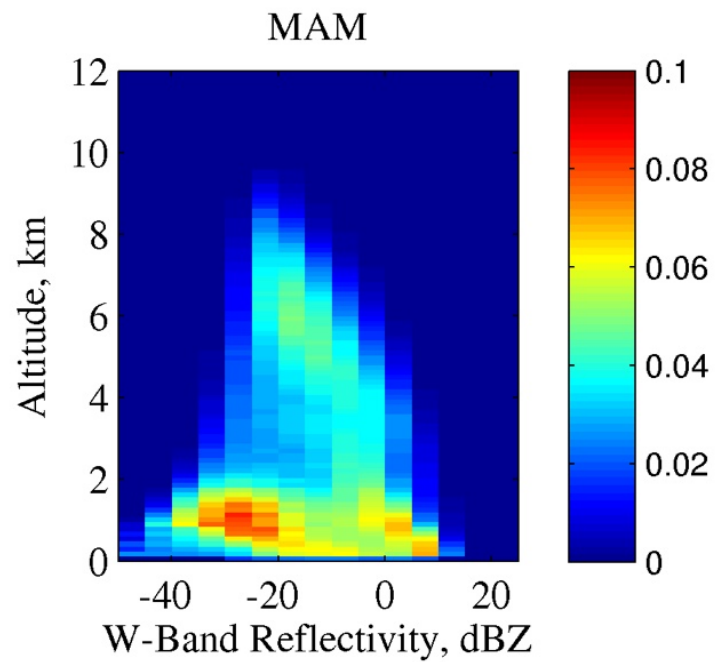
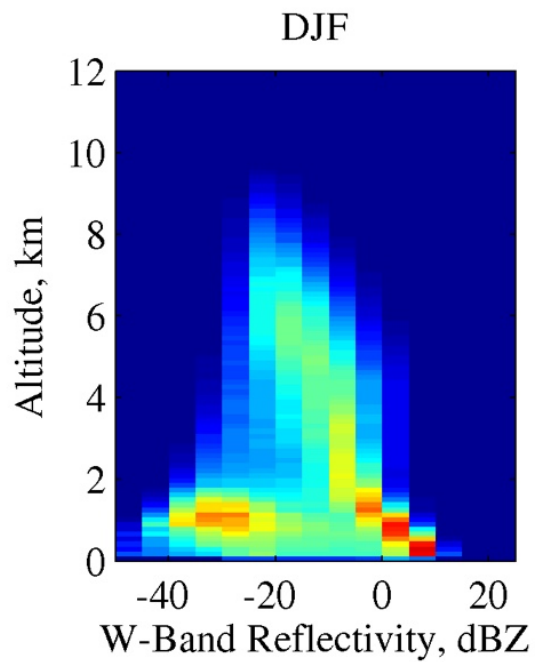


# Seasonal Statistics (MICRE)

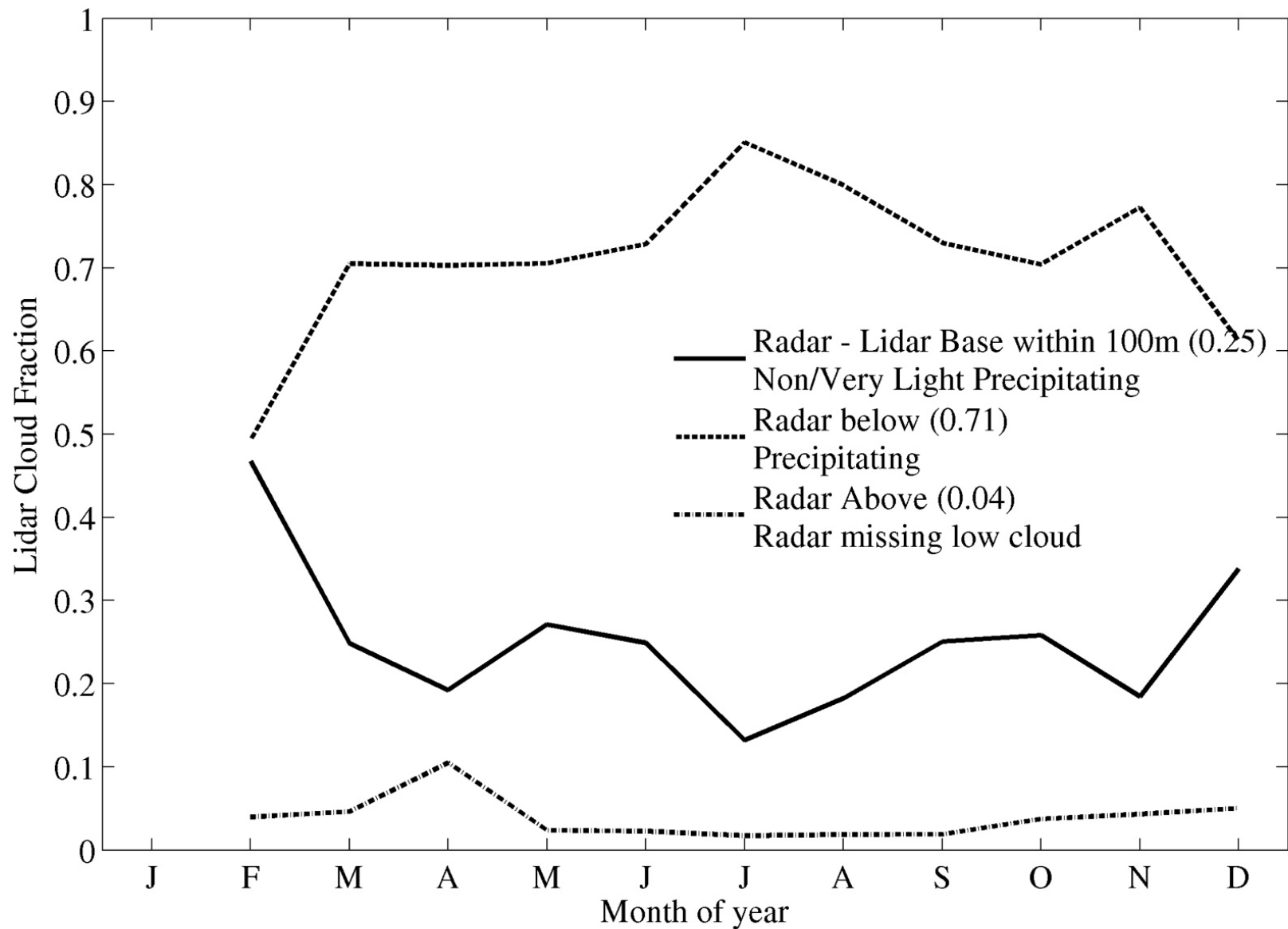


# Reflectivity-Height Histograms



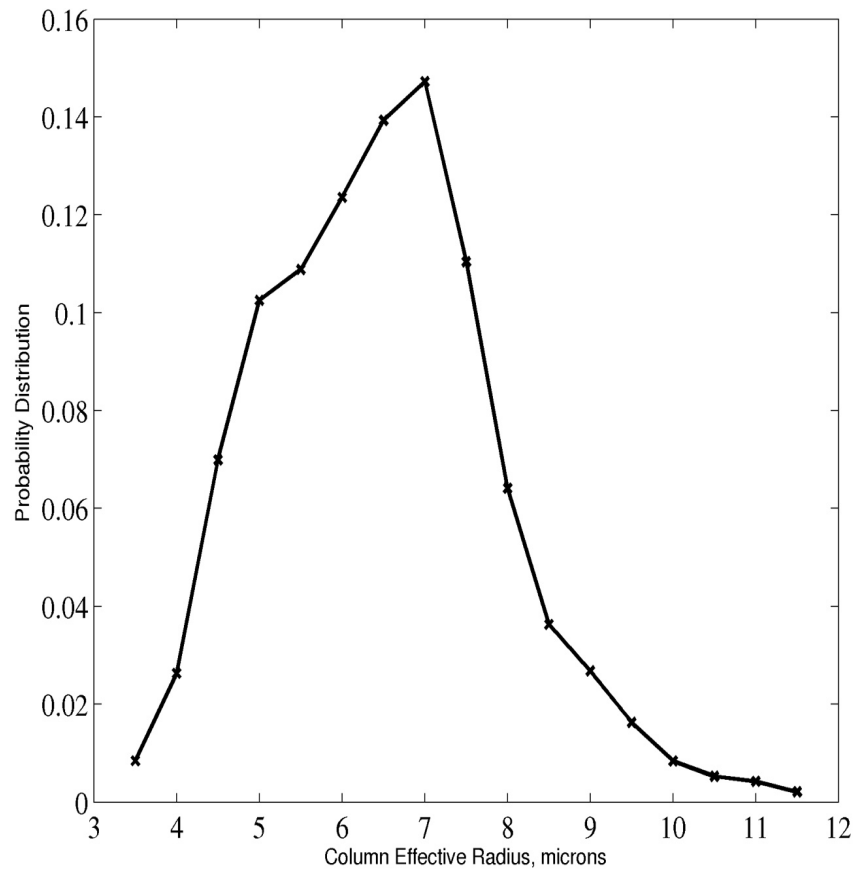


# Precipitating vs. Non-Precipitating

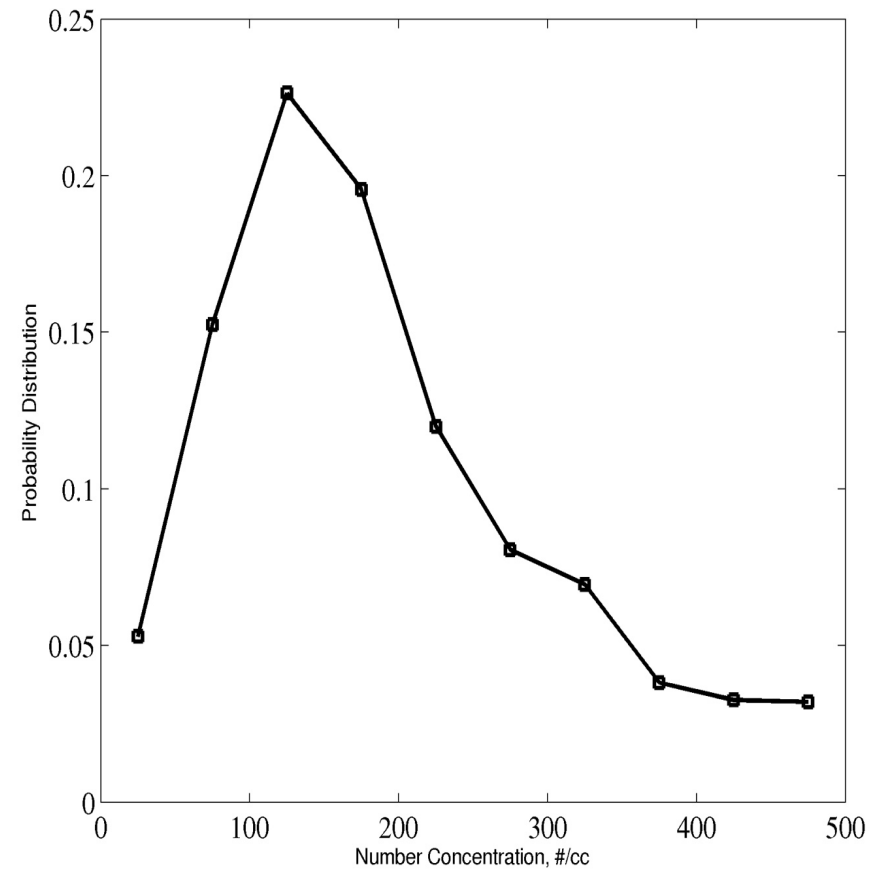


# Re & Nd for Non-Precipitating Cloud

## Distribution of Effective Radius

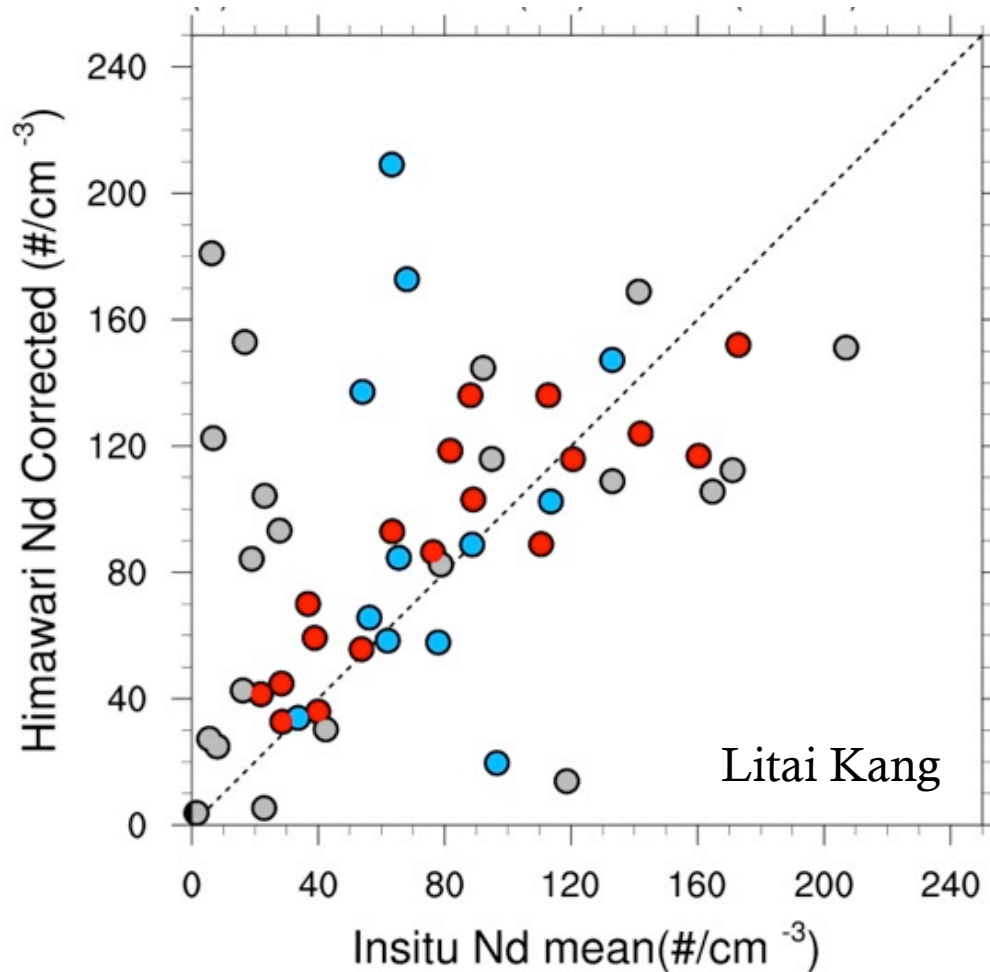


## Distribution of Number Concentration

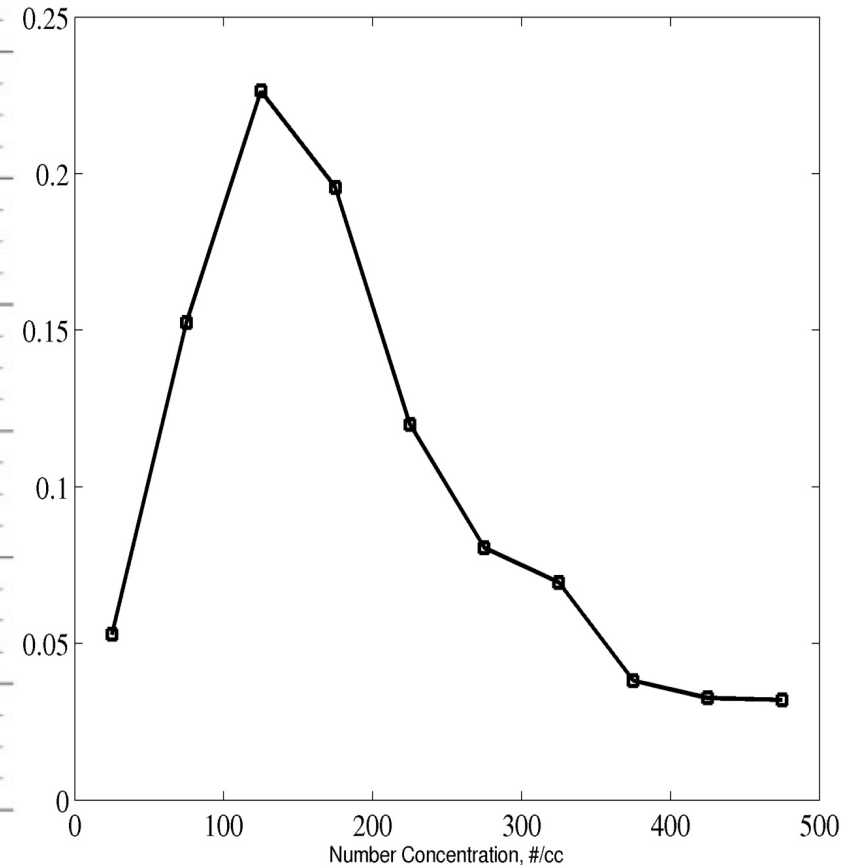


# Re & Nd for Non-Precipitating Cloud

Scatter plot of **In Situ**  
vs. **Himawari-8 Nd**

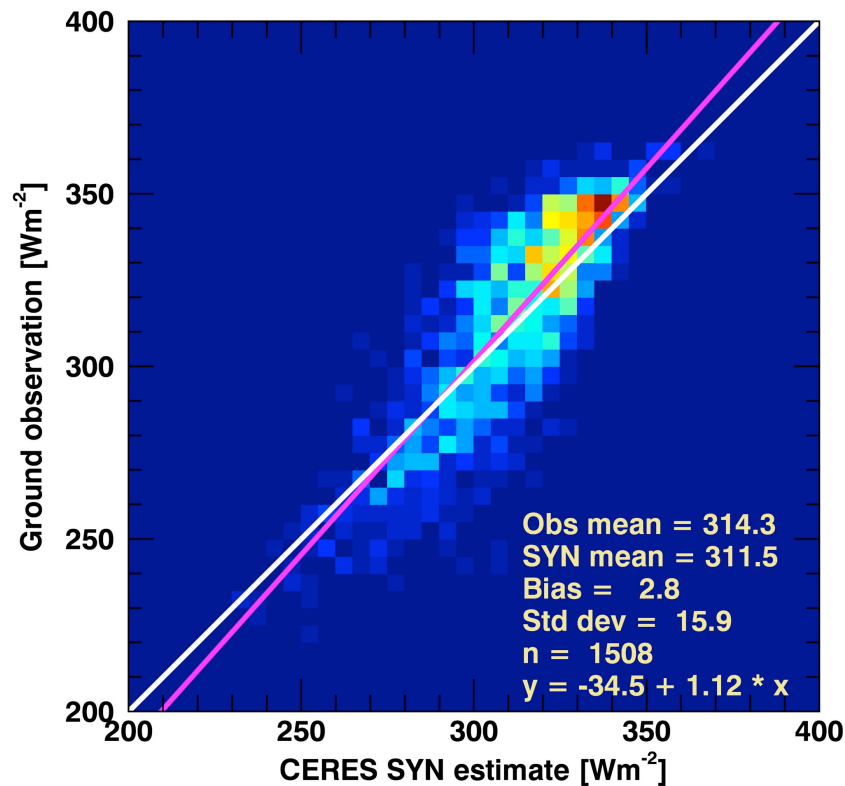


Distribution of  
**Number Concentration**

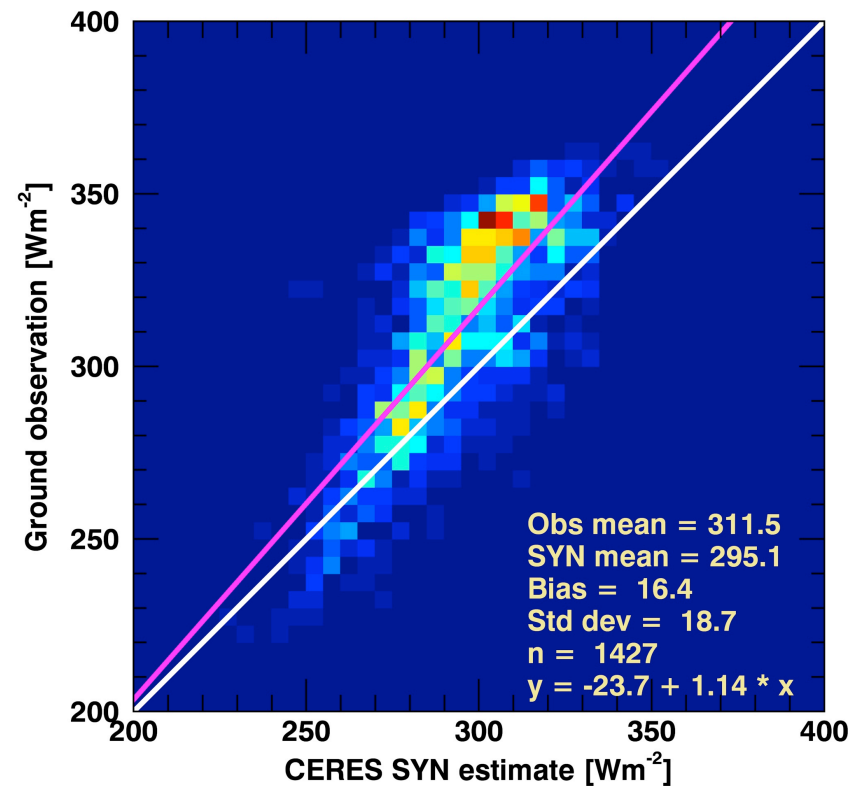


# Comparison with CERES LW Surface Fluxes

## Daytime Downward Srf LW



## Nighttime Downward Srf LW

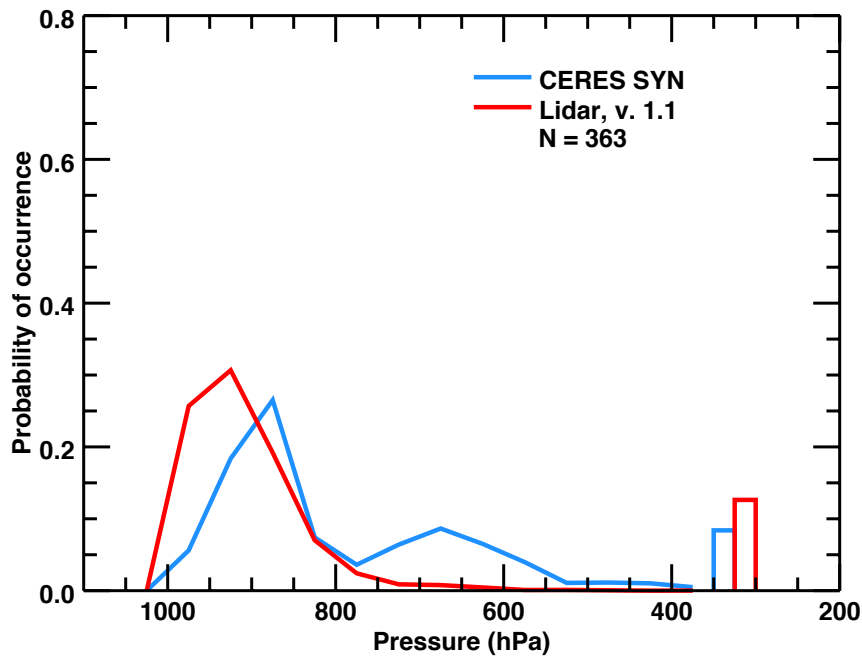


# Comparison with CERES LW Surface Fluxes

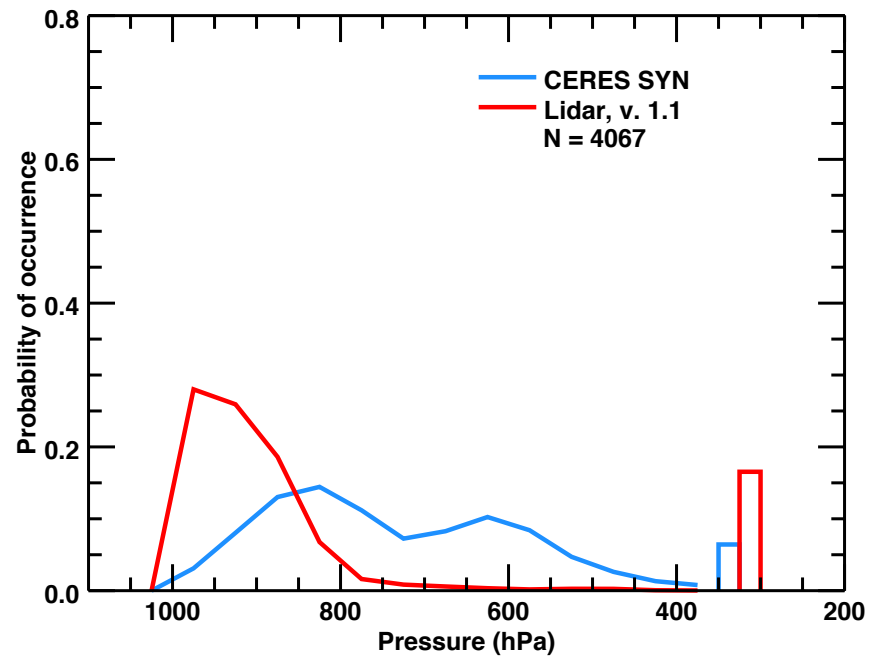
## Daytime Lowest Cloud Base

## Nighttime Lowest Cloud Base

Cloud base distribution, SYN GEO LW+SW retrieval, 20160403–20170313



Cloud base distribution, SYN GEO LW only retrieval, 20160403–20170313





# MARCUS & MICRE: Key Points

- A preliminary set of **Cloud and Precipitation**, as well as **Environmental Properties** datasets are available
  - Includes an extensive set of data quality flags (on going)
  - These data (when mature) will be placed in the ARM PI archive.
- ARM Instrument level data is available from ARM archive :
  - Copies of other (non-ARM) instrument data will eventually be placed in the ARM PI archive.
  - These instrument level data contain only a minimal level of data quality – use with caution.
- **There is much that can / should be done ...**

**Please jump in ... BREAKOUT Session at 1:30 PM**