

# Large-Scale 3-D Cloud Ice Water Features Determined by Combining Satellite and Surface Measurements during TWP-ICE

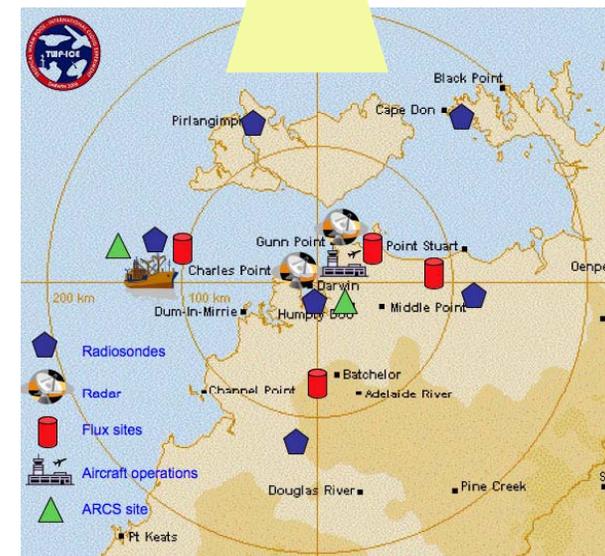
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Florida State University

# Motivation

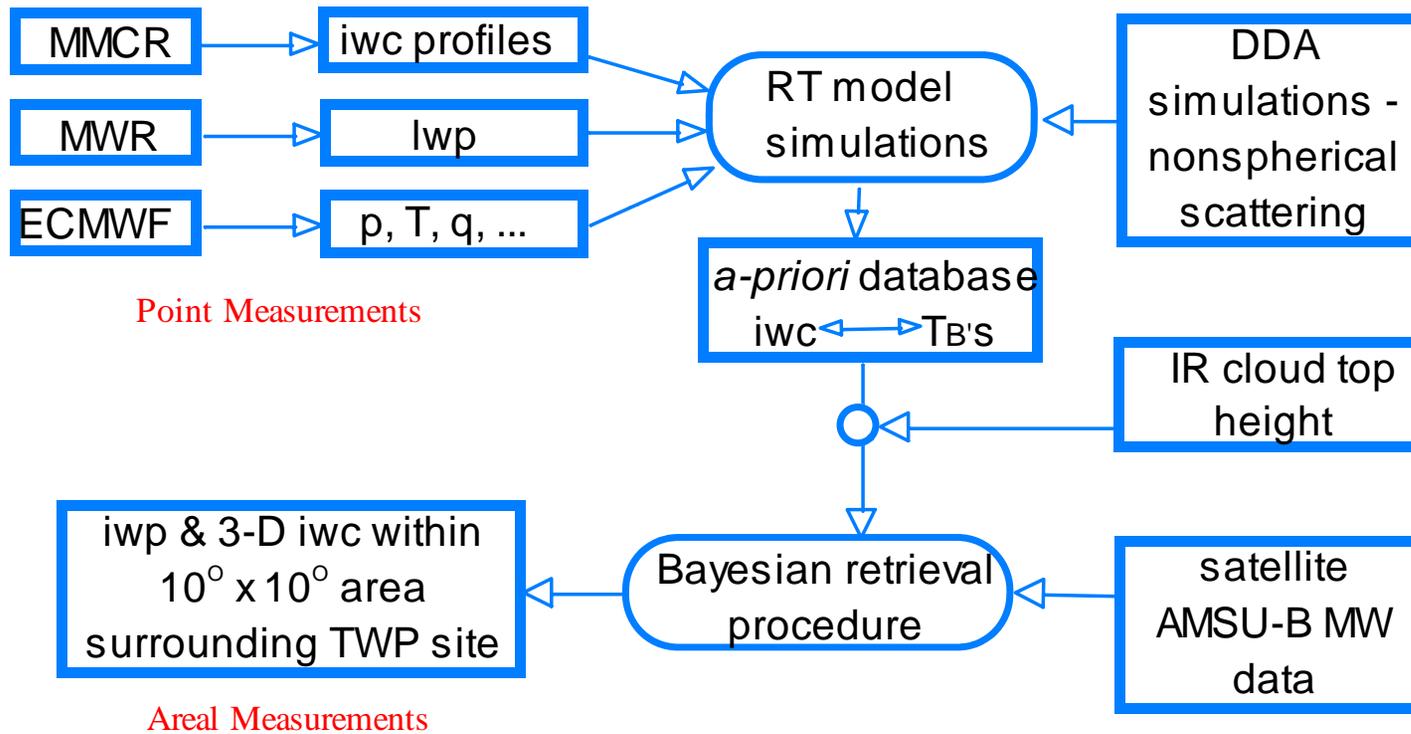
- **LARGE-SCALE** cloud water distribution is needed to
  - derive advective tendency terms for forcing single-column models
  - validate GCMs/CRMs that have grid scale of tens ~ hundreds km
  - understand the microphysical evolution of / the interaction among different cloud cells
- Surface radar observation (MMCR) is a point measurement, do not provide the area coverage required for the above studies

# Objectives & Works Done

- The advantage of combining surface and satellite obs.
  - surface: better cloud vertical structural measurements;
  - satellite: better areal coverage
- Ice water retrieval method:
  - MMCR + Satellites + Surface Met Obs.
- Validation:
  - Time series
  - Mean vertical structure
  - Histograms
- Ice water over  $10^{\circ} \times 10^{\circ}$  area centered Darwin
  - Mean distribution
  - vs. cloud temperature
  - vs. SGP March 2000



# Ice Water Retrieval Flow Chart

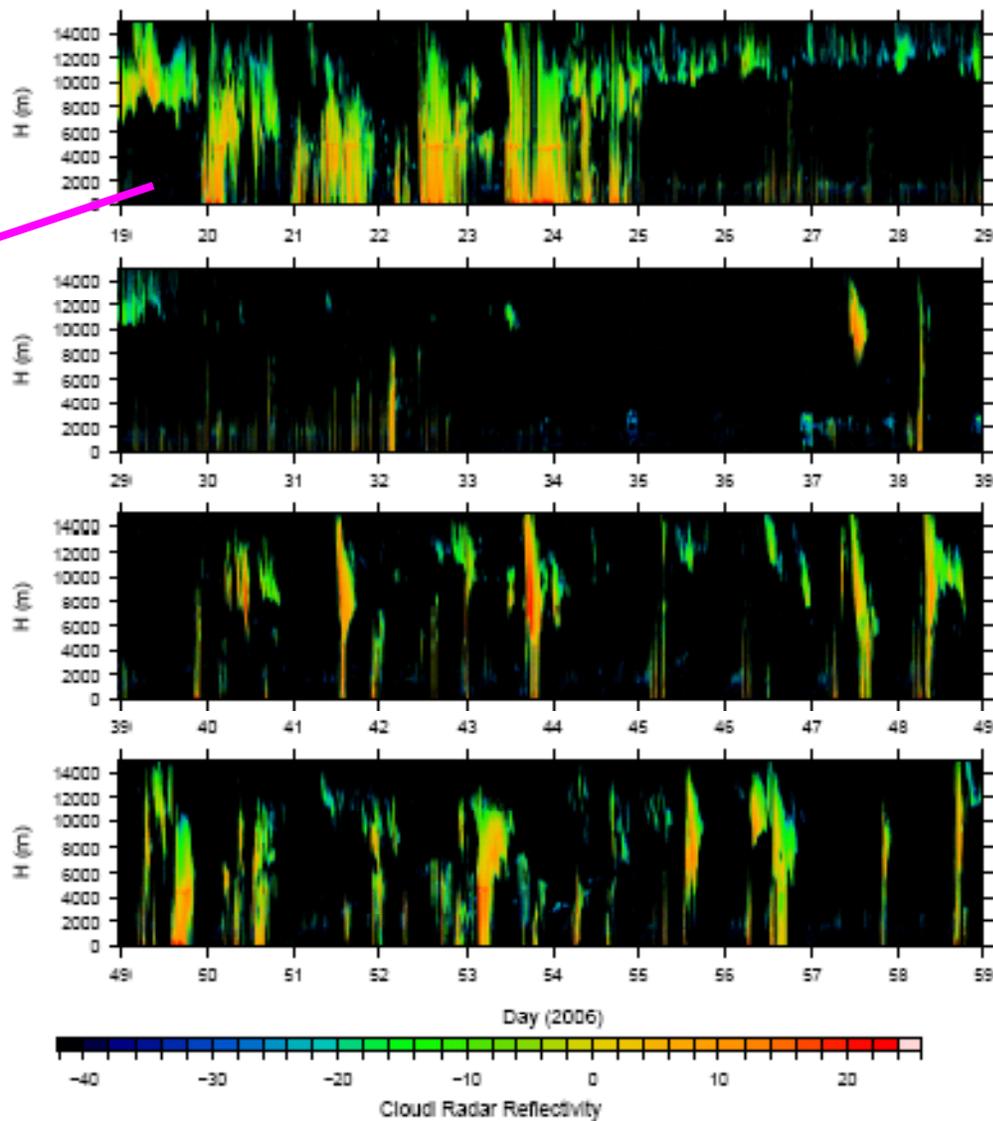
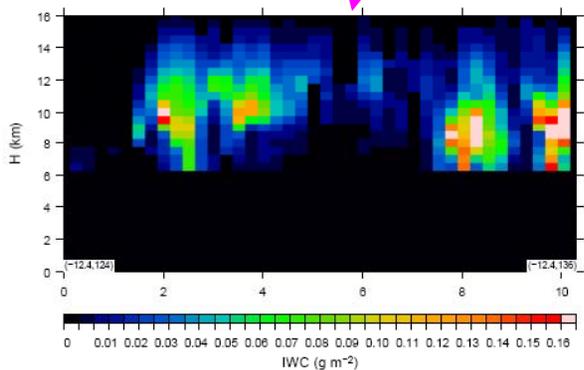
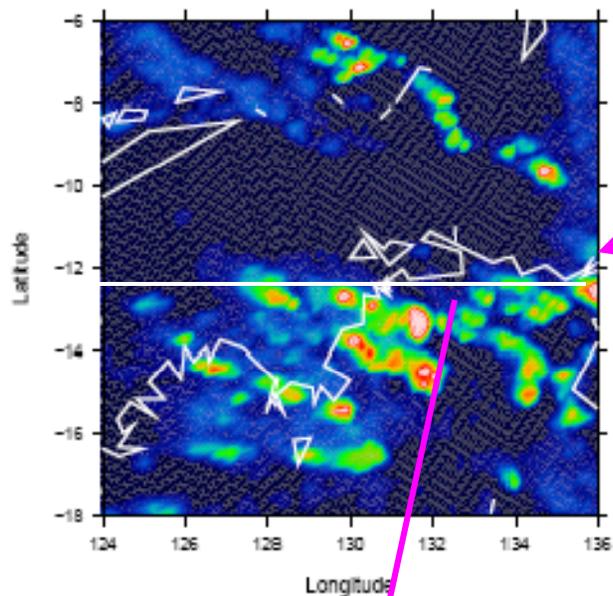


# Primary data source

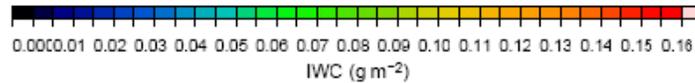
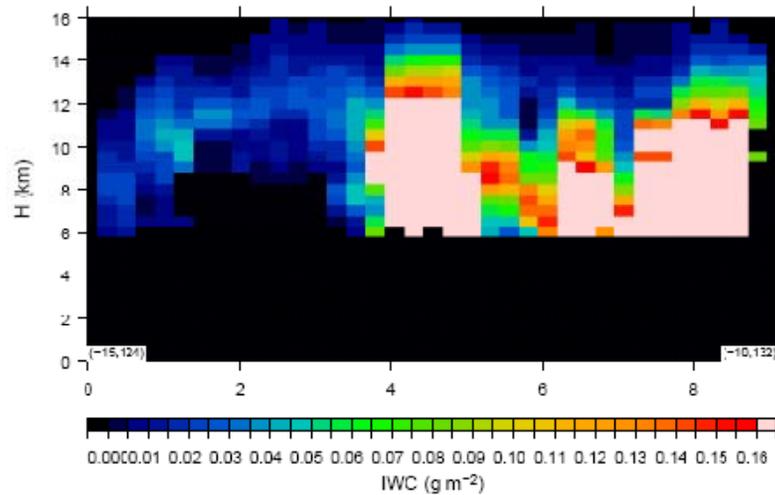
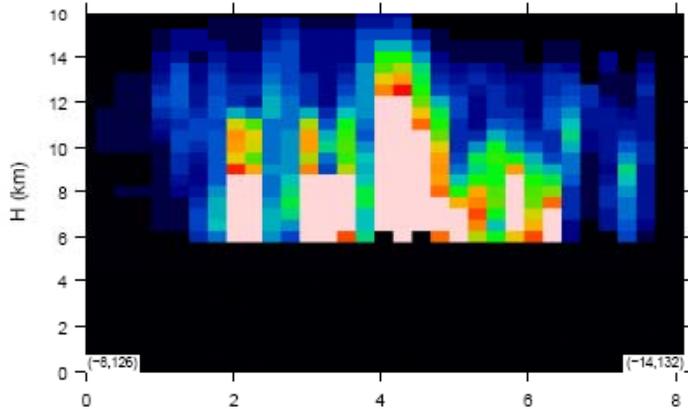
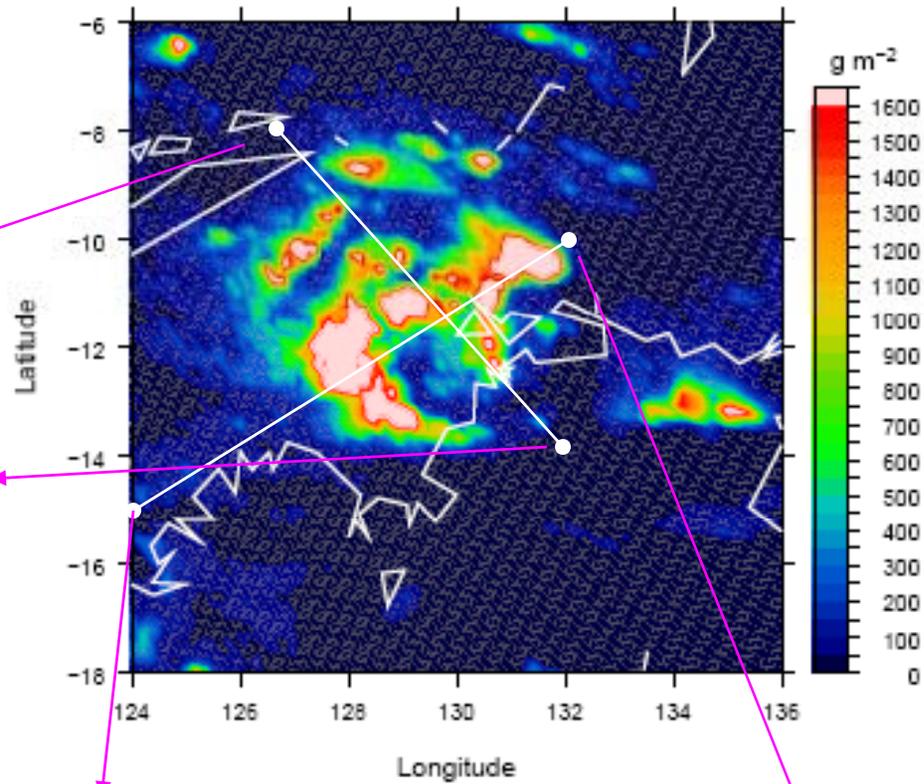
- Radar – MMCR
  - 35 GHz (8.6 mm)
  - Vertical pointing
  - Reflectivity&Doppler
  - Data from surface to 20 km ALT
  - Continuous observation
- Satellite – AMSU-B
  - 89, 150, 183.3 $\pm$ 1, 183.3 $\pm$ 3, 183.3 $\pm$ 7 GHz
  - 16 km resolution at nadir, ~2000 km swath width, cross scan
  - Twice daily coverage per satellite (During TWP-ICE 4 NOAA satellites)

Now, focusing on TWP-ICE IOP

# TWPICE (Point View to 3D View)

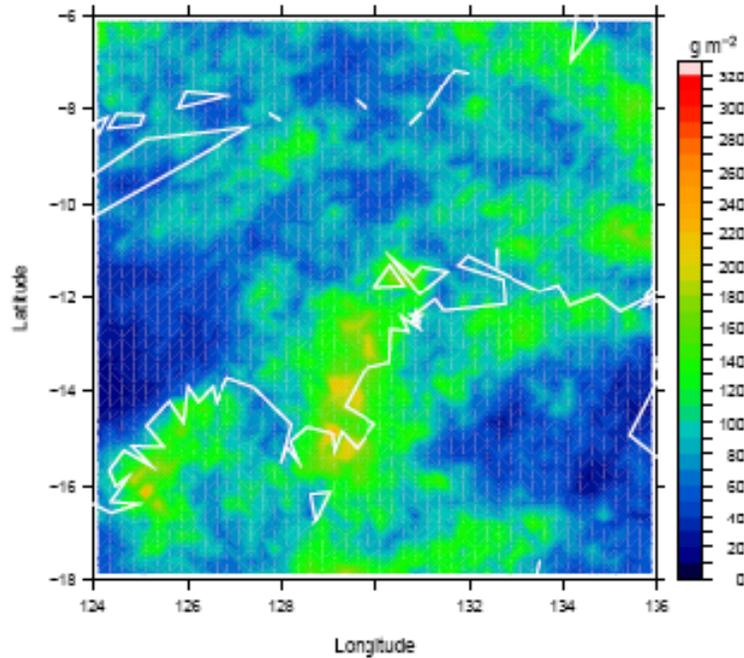


# Cross-Section View (01/24/2007 0140Z)

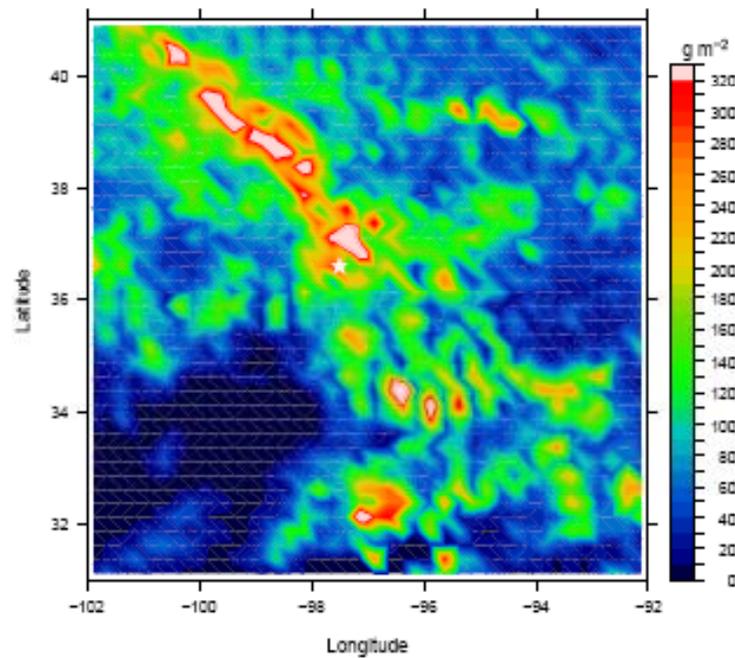


# Horizontal IWP Distribution - TWP-ICE & SGP 32k

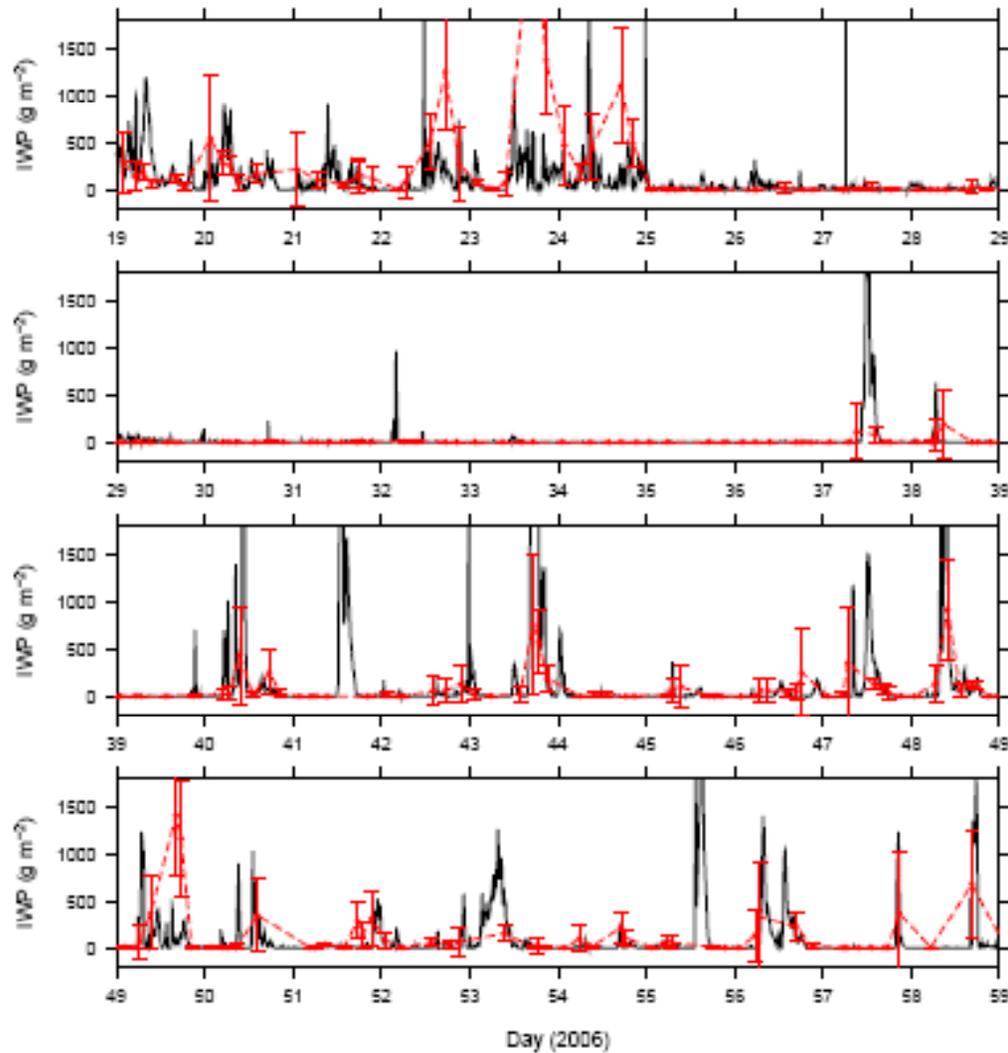
TWP-ICE 40-Day Mean



SGP-32k 30-Day Mean



# Comparison with MMCR (TWP-ICE) - IWP Time Series



Radar:

$\text{dBZ} \rightarrow \text{IWC} \rightarrow \text{IWP}$

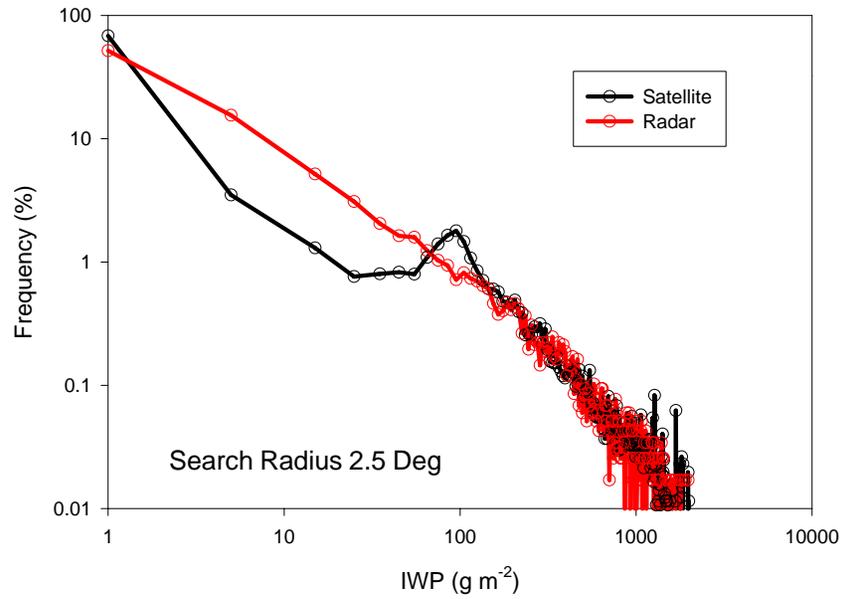
Satellite:

$\text{TB} \rightarrow \text{IWC\&IWP}$

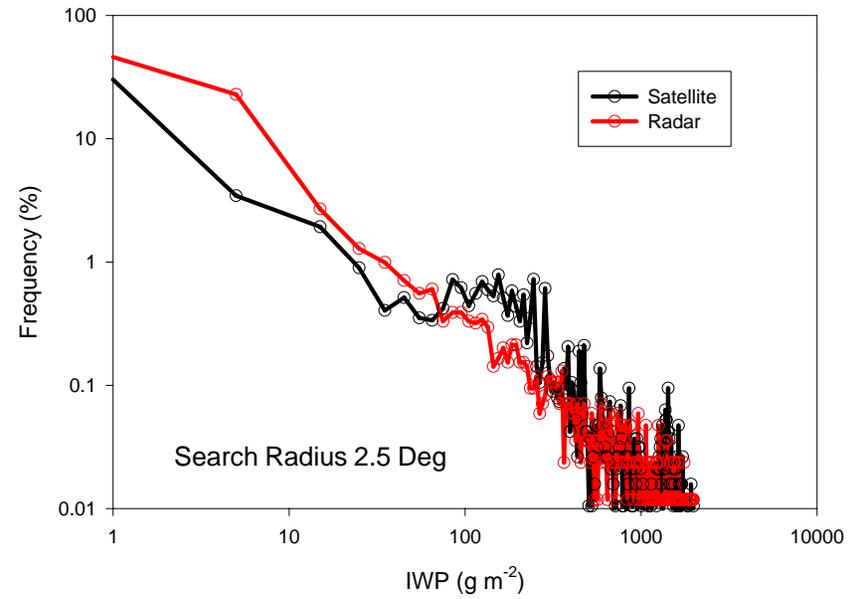
0.5 Deg. Ave.

# Comparison with MMCR - IWP PDF

## TWP-ICE (40 Days)

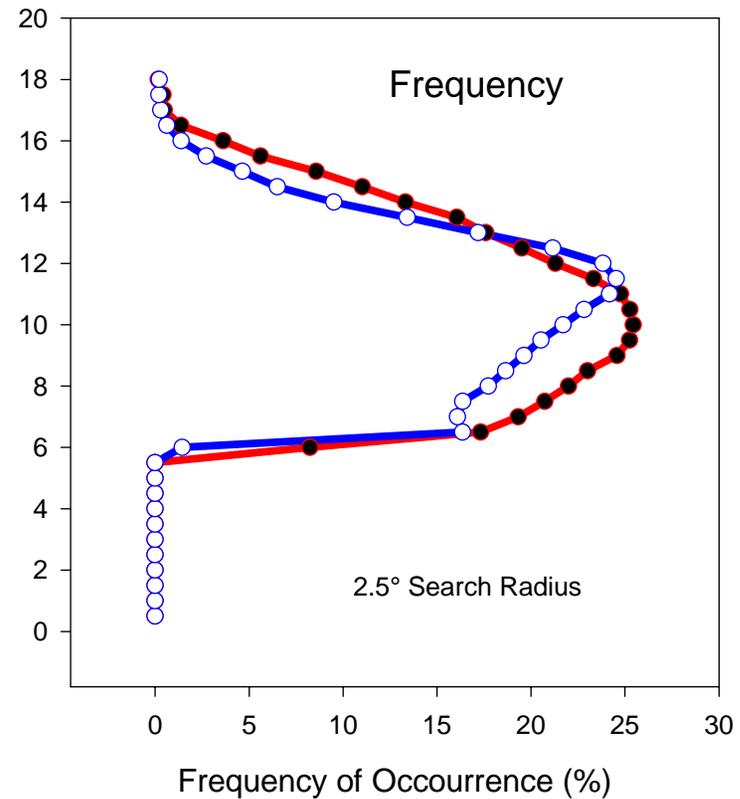
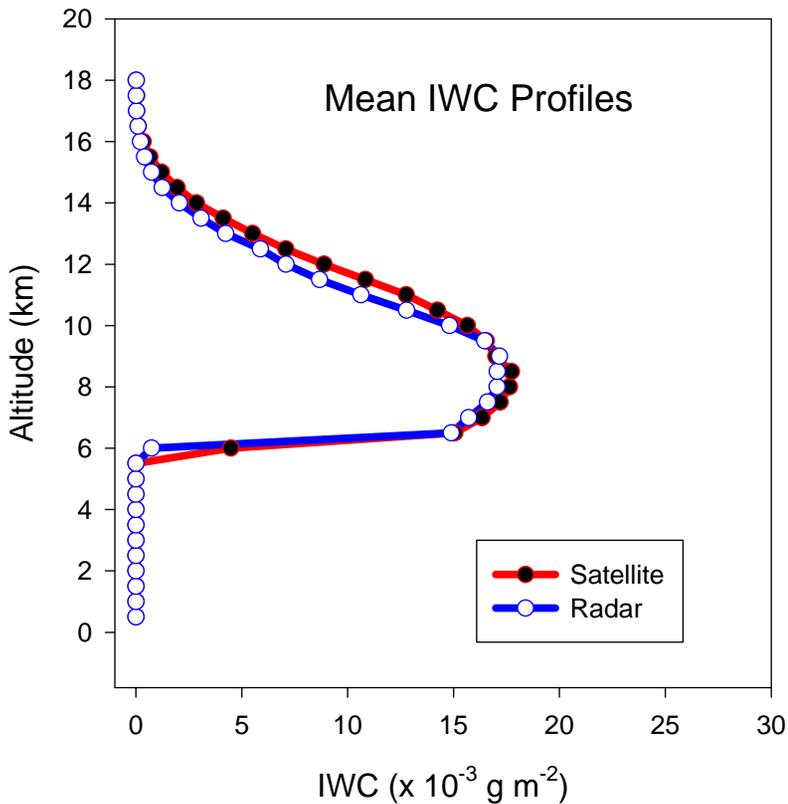


## SGP-32k (31 Days)

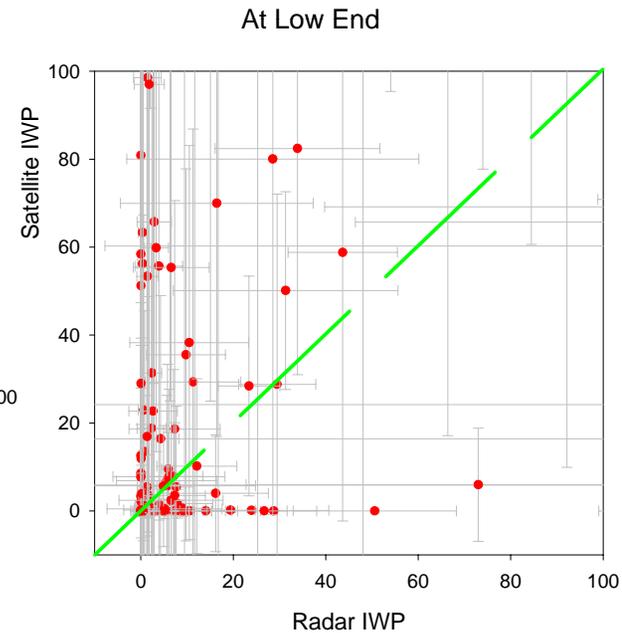
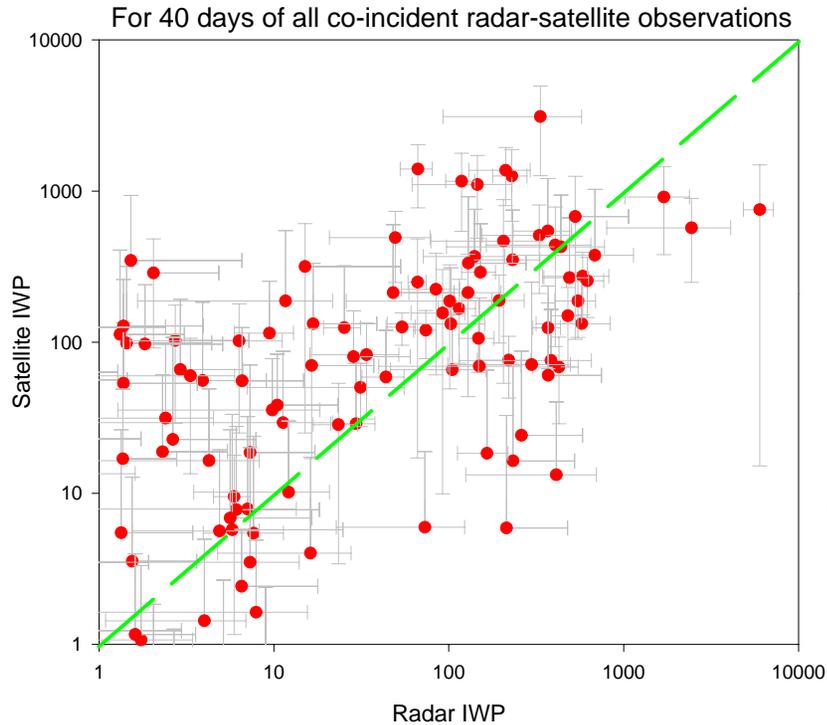


# Comparison with MMCR (TWP-ICE)

## - Mean IWC Profiles & Frequency of Occurrence (40 Days)



# Comparison with MMCR – TWP-ICE



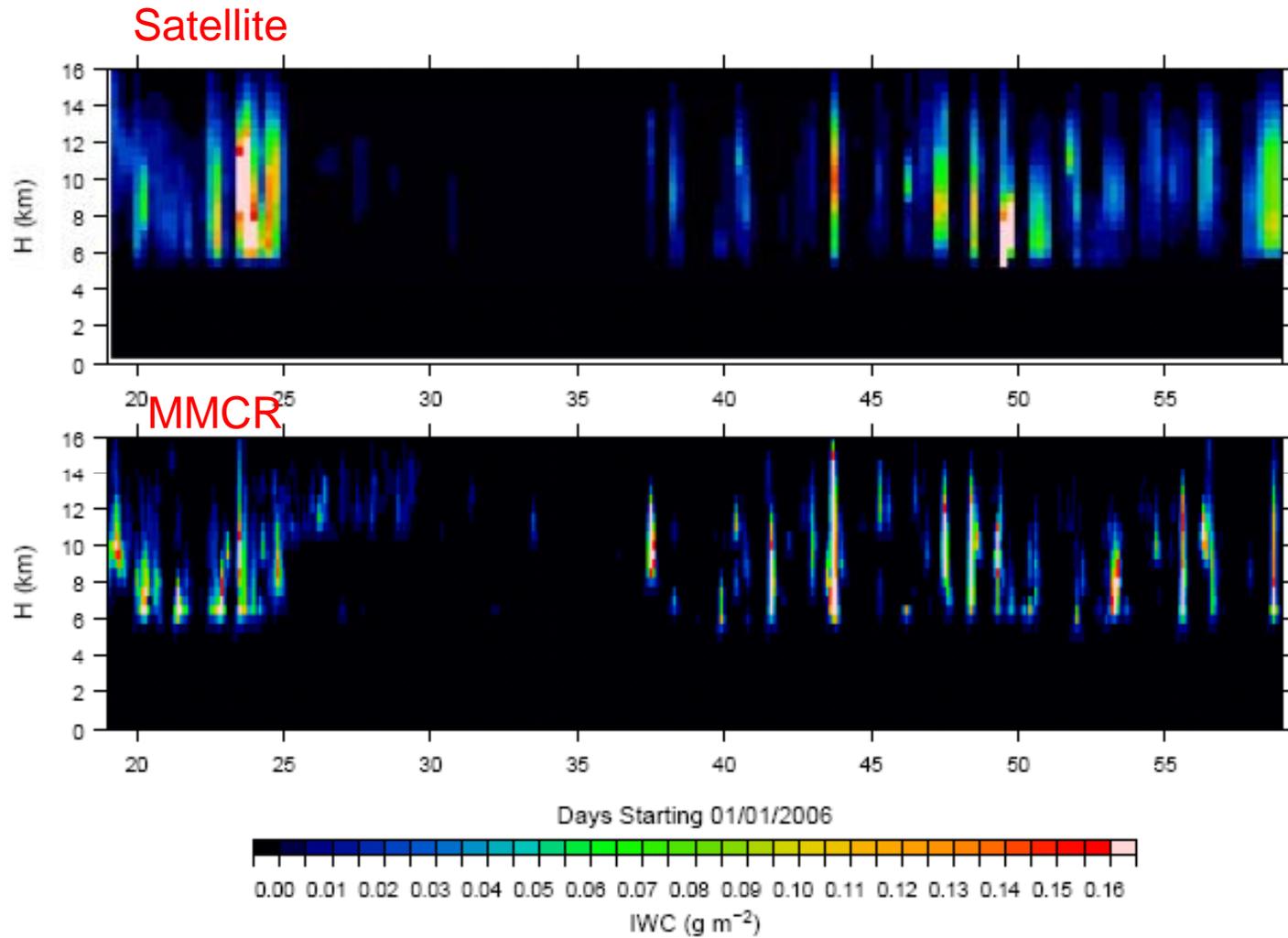
## Compare Radar and Satellite

Radar: Average of 1 hours

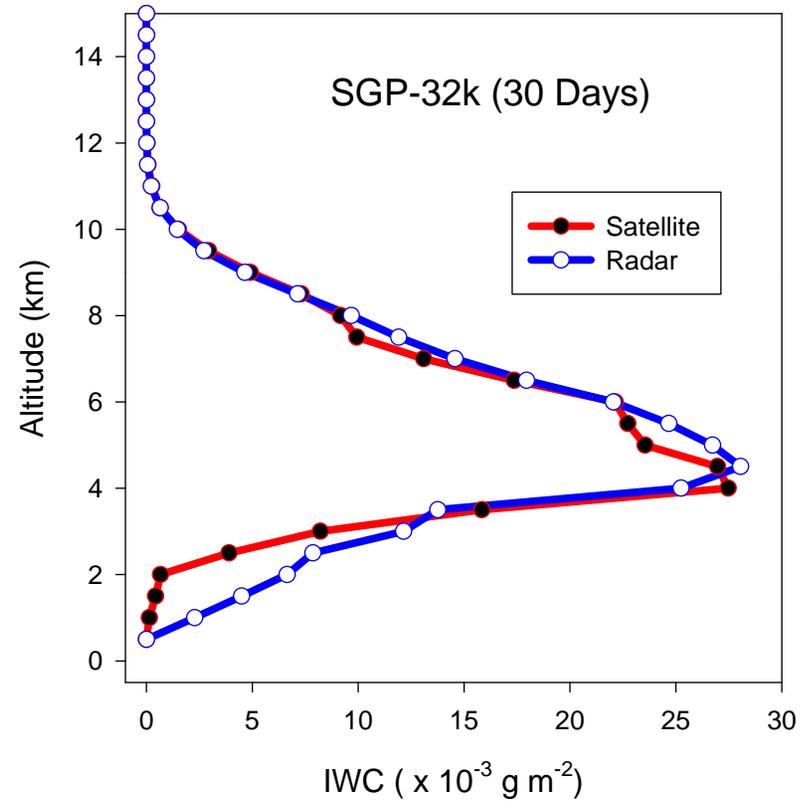
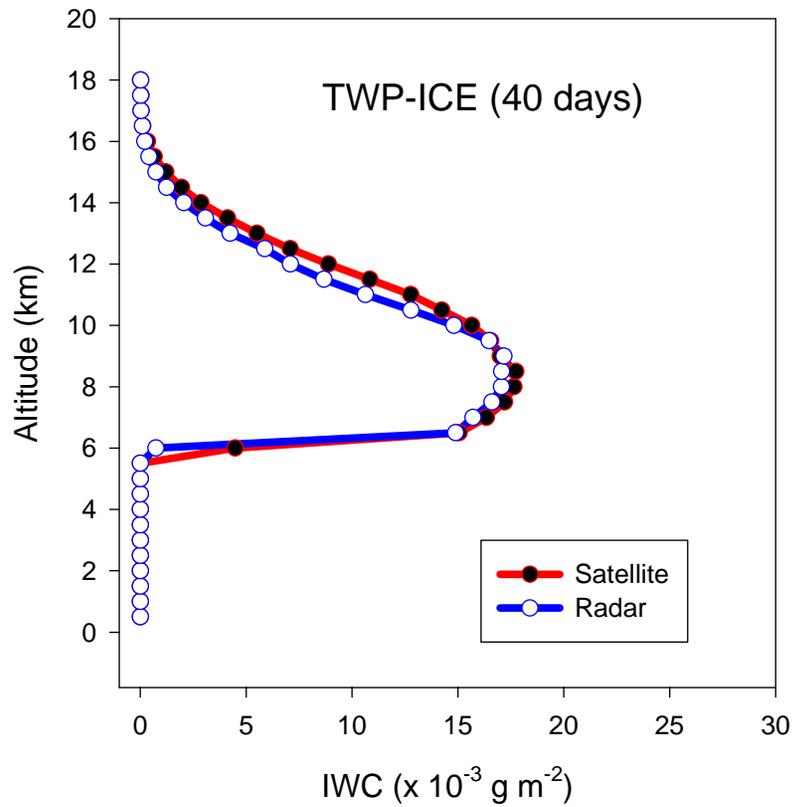
Satellite: Average of 0.5 degree (60 km) radius

Error Bars: Standard Deviation within averaged profiles/pixels

# Comparison with MMCR - IWC Time-Height Cross-Section

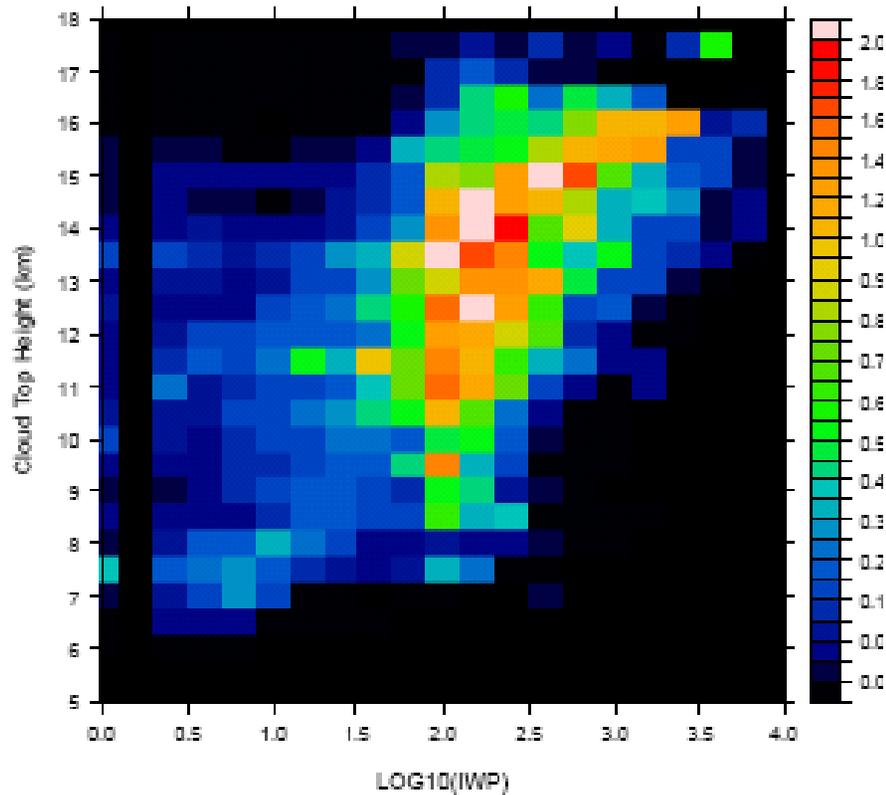


# Comparison with SGP-32k - Mean IWC Profiles

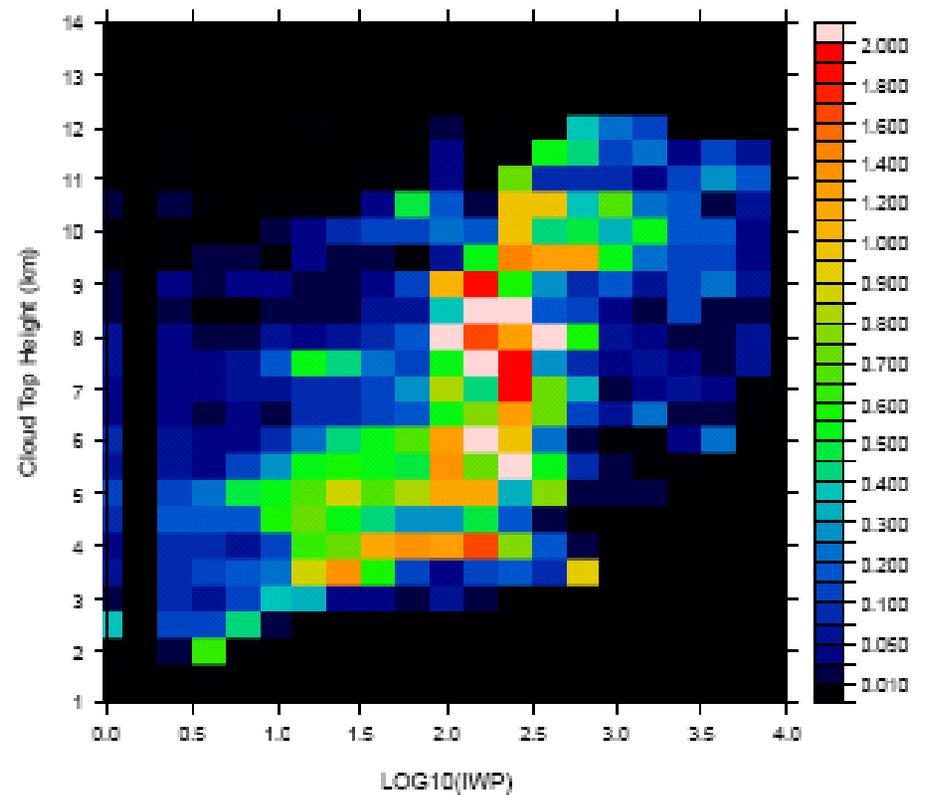


# IWP vs. Cloud Height - TWP-ICE & SGP-32k

TWP-ICE 40-Day 10° x10°



SGP-32k 30-Day 10° x10°



# Data Status

- Ver.1 of IWP/IWC retrievals available for entire TWP-ICE period, 10x10 deg. centered at Darwin. Downloadable from <http://cirrus.met.fsu.edu/data/armdownload.html>
- Continued Validation/Improvement, Will archive as PI-product (March 2000 SGP data have been archived)
- Want to know needs from modeling group.
- Please use our data. email me: [liug@met.fsu.edu](mailto:liug@met.fsu.edu)

# Objectives & Approach

- **Objectives**

By combining surface radar and satellite data, we derive

- Ice water path over a large area ( $10^\circ \times 10^\circ$ )
- Vertical ice water content distribution over a large area
- The above two combined is 3-D ice water content distribution
  - **Can be used to calculate ice water advection terms for single column model inputs**

- **Approach**

- Surface radar (MMCR) provides detailed, high-quality characteristics of ice water content vertical distribution
- Satellite (NOAA AMSU-B/MHS) provides broad horizontal coverage
- Use surface radar data to generate database for satellite retrievals, use satellite data to broaden the area coverage
  - **From point-measurement to area measurement**