

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

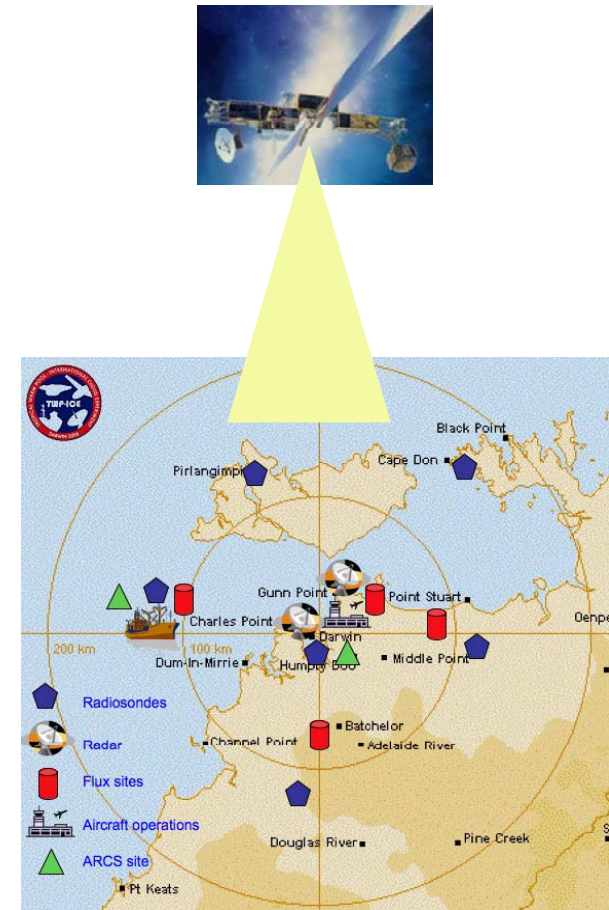
Guosheng Liu & Eun-Kyoung Seo
Florida State University

Motivation

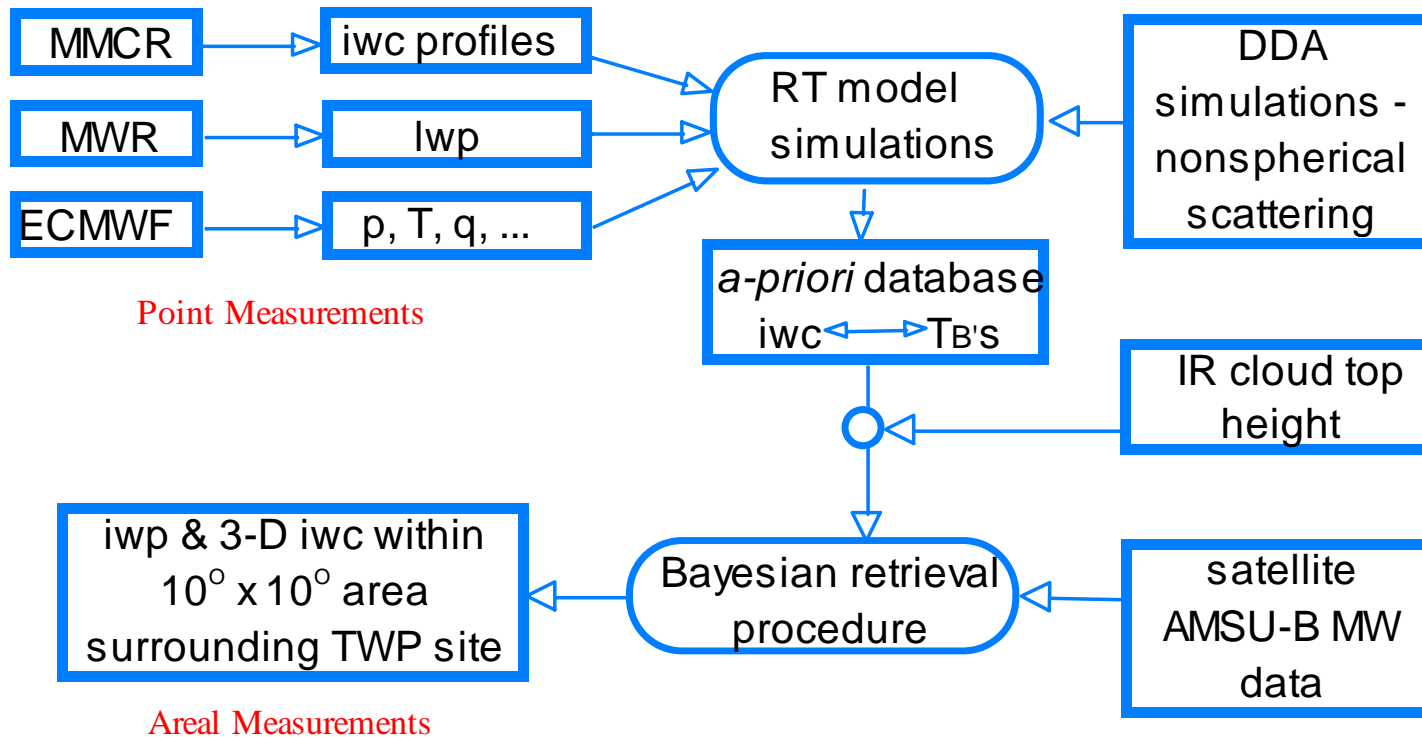
- **LARGE-SCALE** cloud water distribution is needed to
 - derive advective tendency terms for forcing single-column models
 - validate GCMs/CRMs that have grid scale of tens ~ hundreds km
 - understand the microphysical evolution of / the interaction among different cloud cells
- Surface radar observation (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

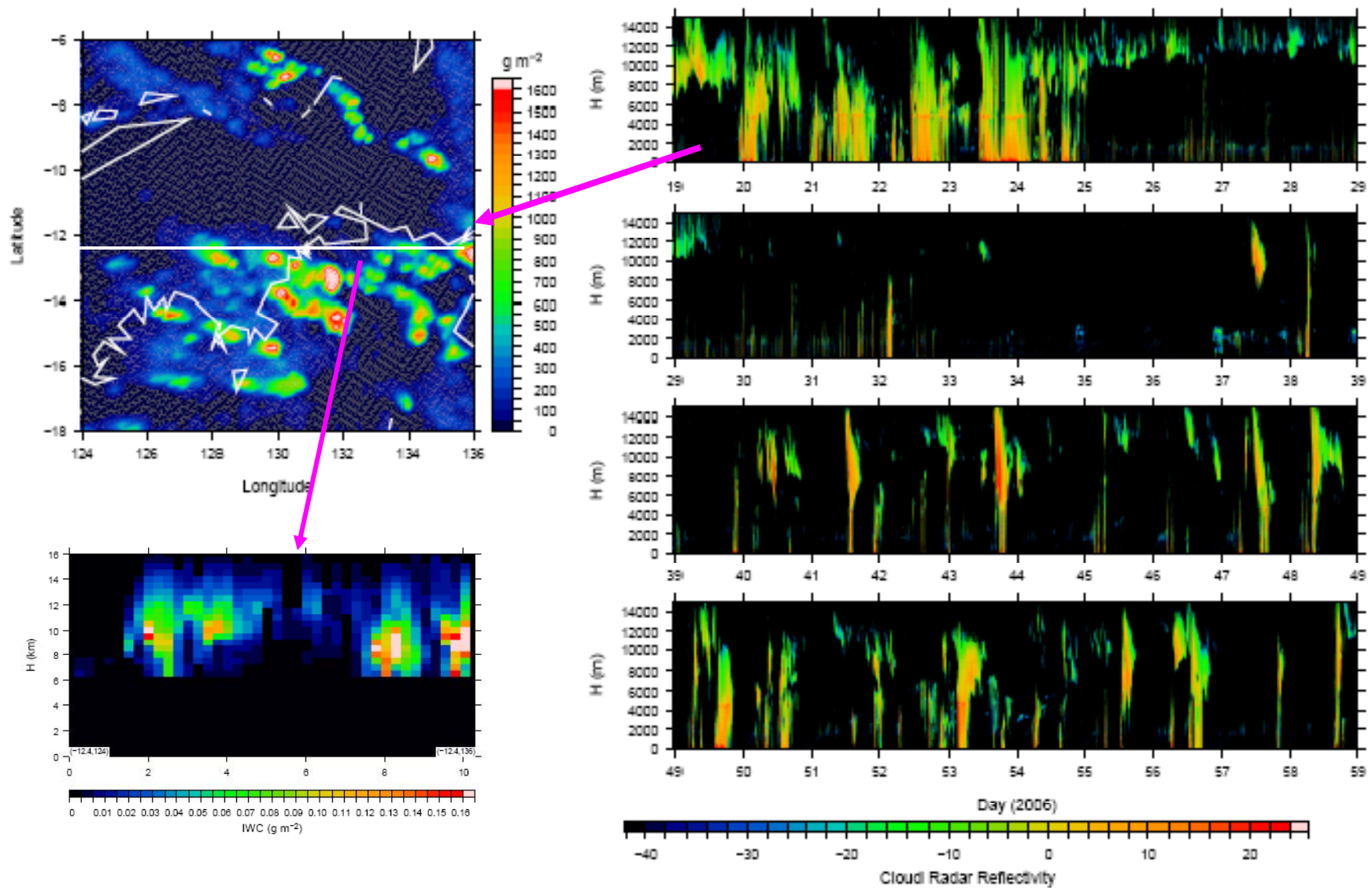


Primary data source

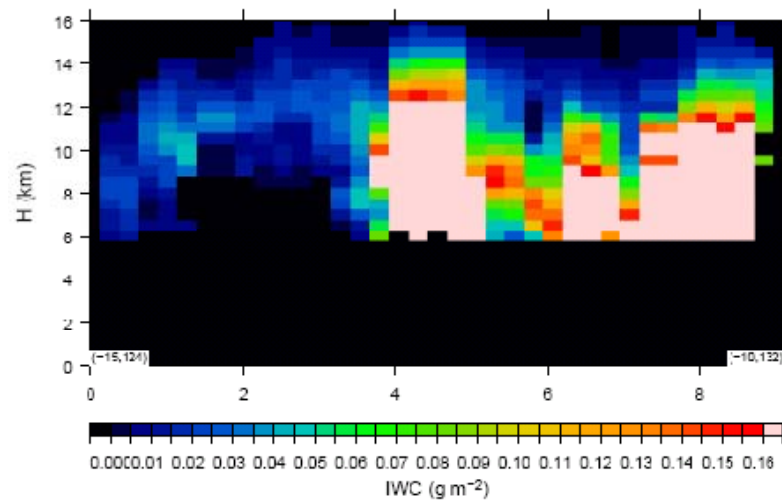
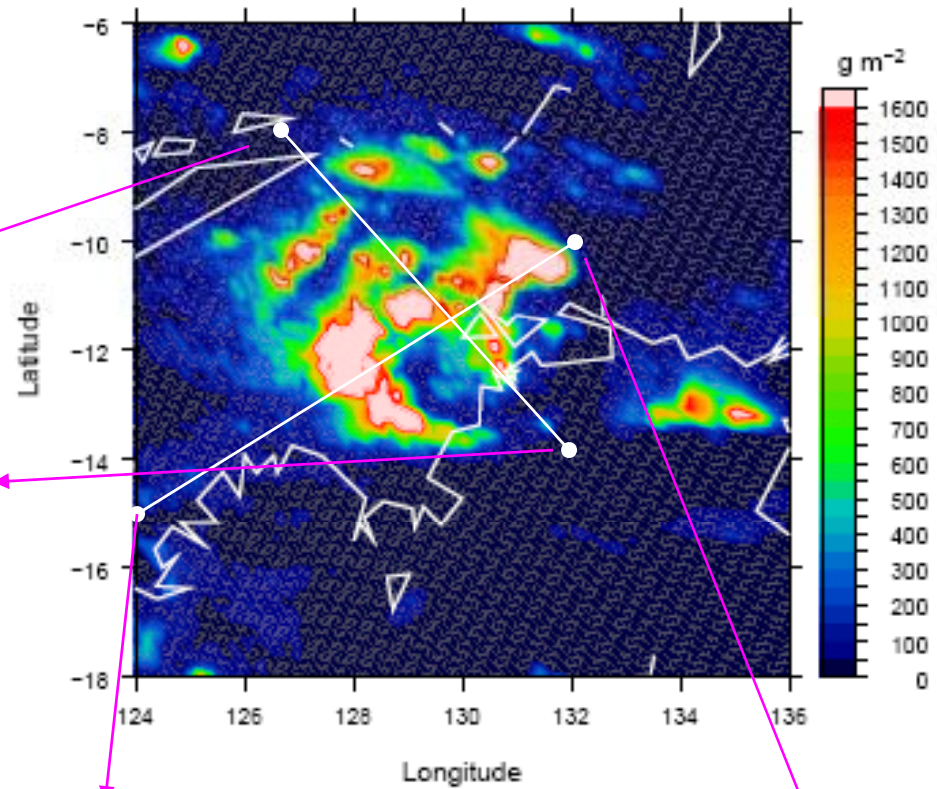
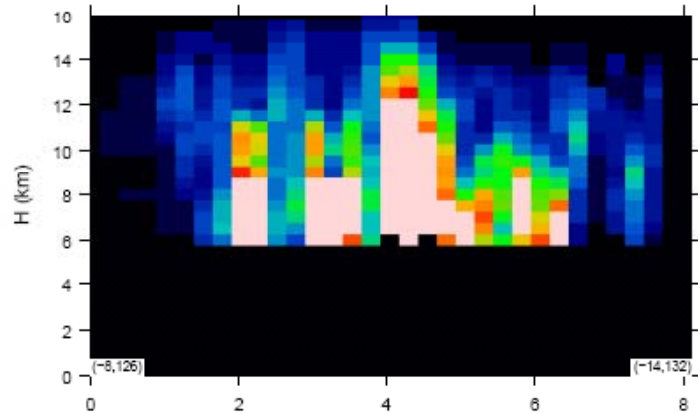
- Radar – MMCR
 - 35 GHz (8.6 mm)
 - Vertical pointing
 - Reflectivity&Doppler
 - Data from surface to 20 km ALT
 - Continuous observation
- Satellite – AMSU-B
 - 89, 150, 183.3 ± 1 , 183.3 ± 3 , 183.3 ± 7 GHz
 - 16 km resolution at nadir, ~2000 km swath width, cross scan
 - Twice daily coverage per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

Now, focusing on TWP-ICE IOP

TWPICE (Point View to 3D View)

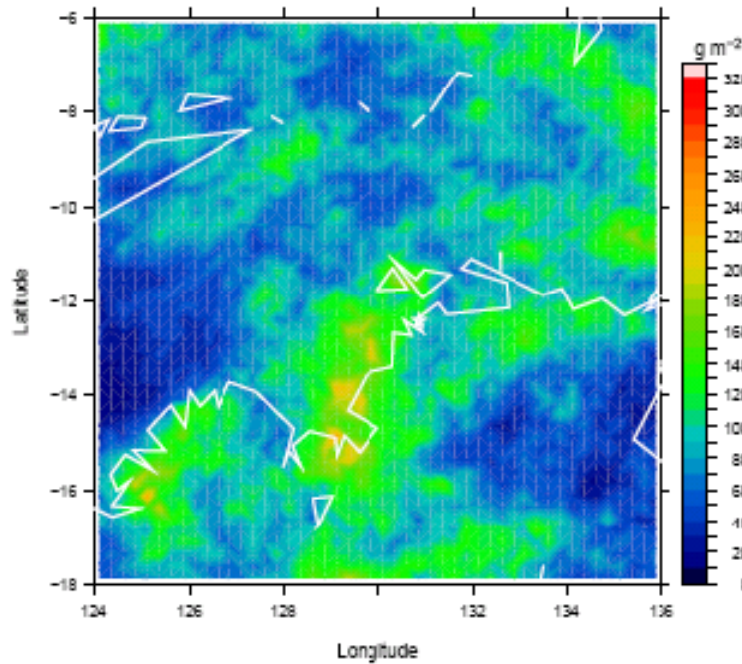


Cross-Section View (01/24/2007 0140Z)

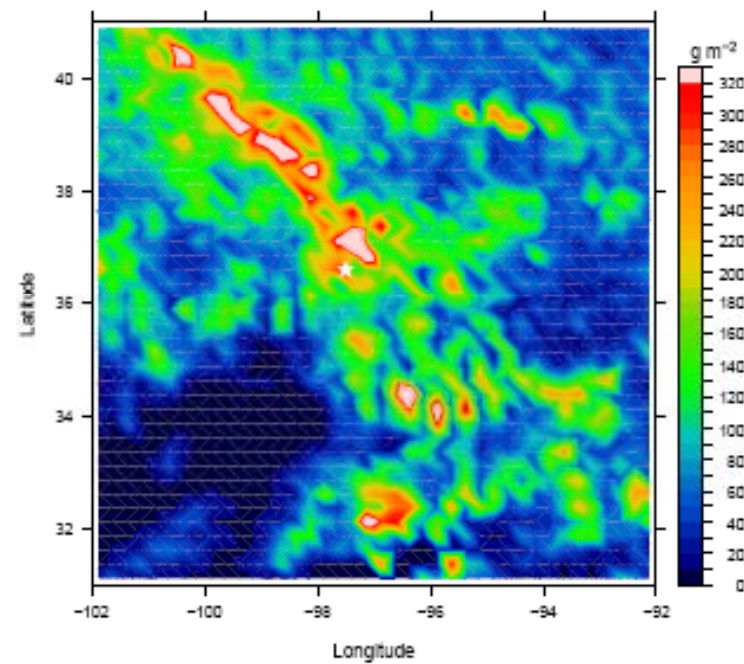


Horizontal IWP Distribution - TWP-ICE & SGP 32k

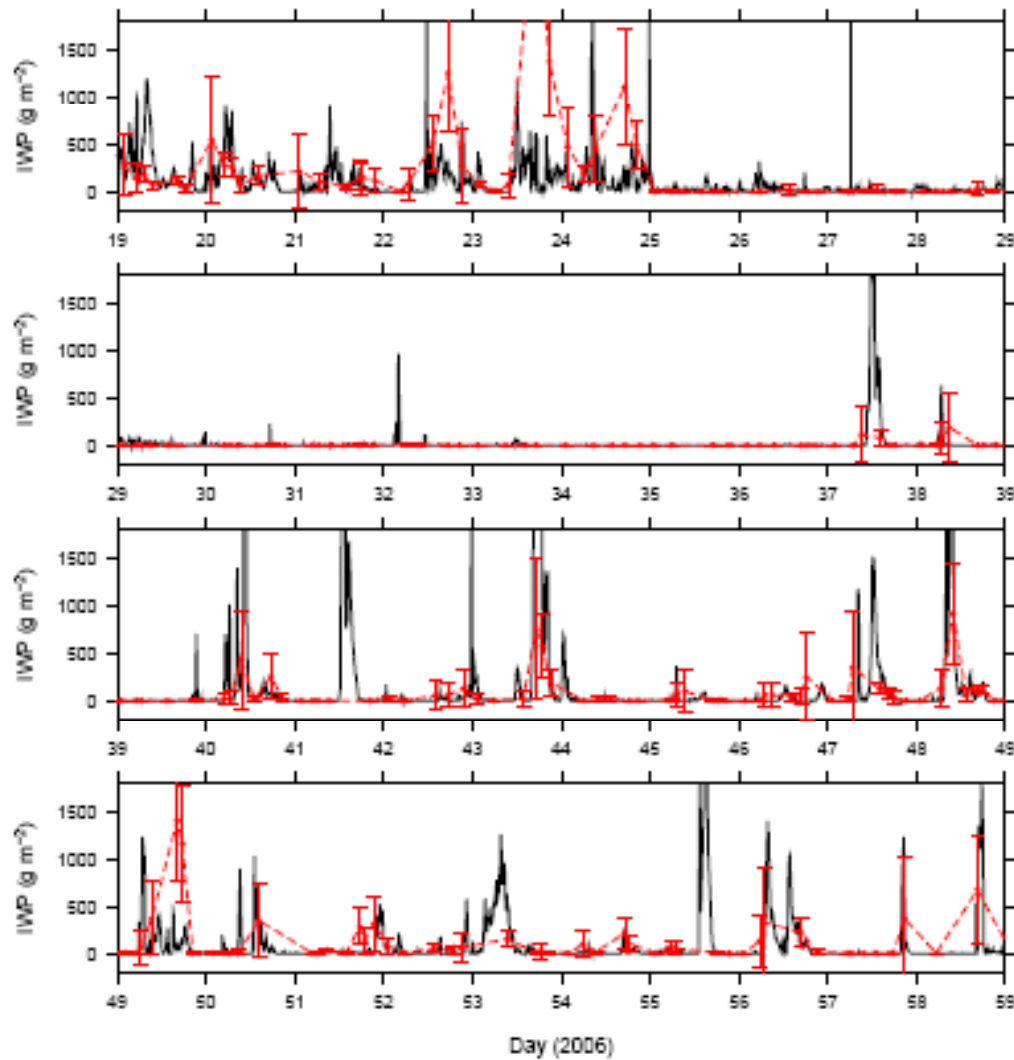
TWP-ICE 40-Day Mean



SGP-32k 30-Day Mean



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



Radar:

dBZ \rightarrow IWC \rightarrow IWP

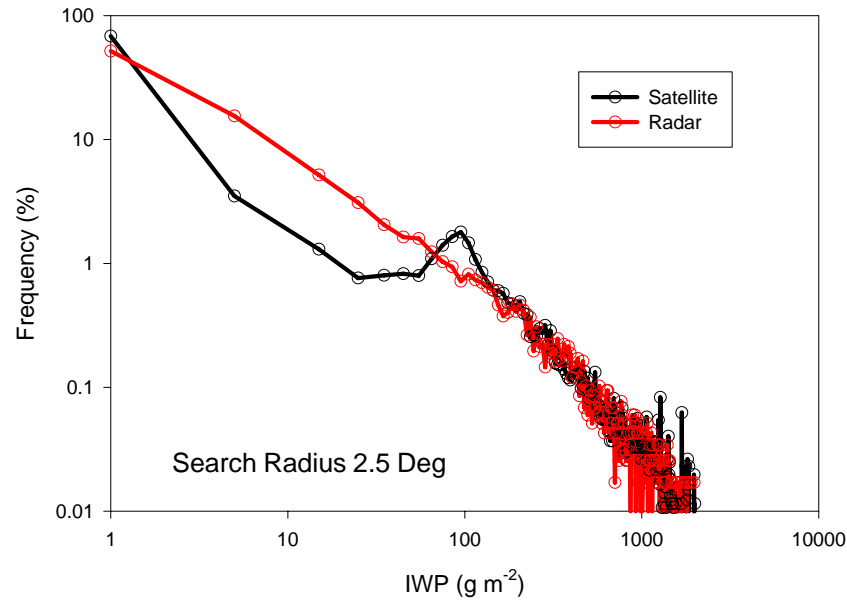
Satellite:

TB \rightarrow IWC&IWP

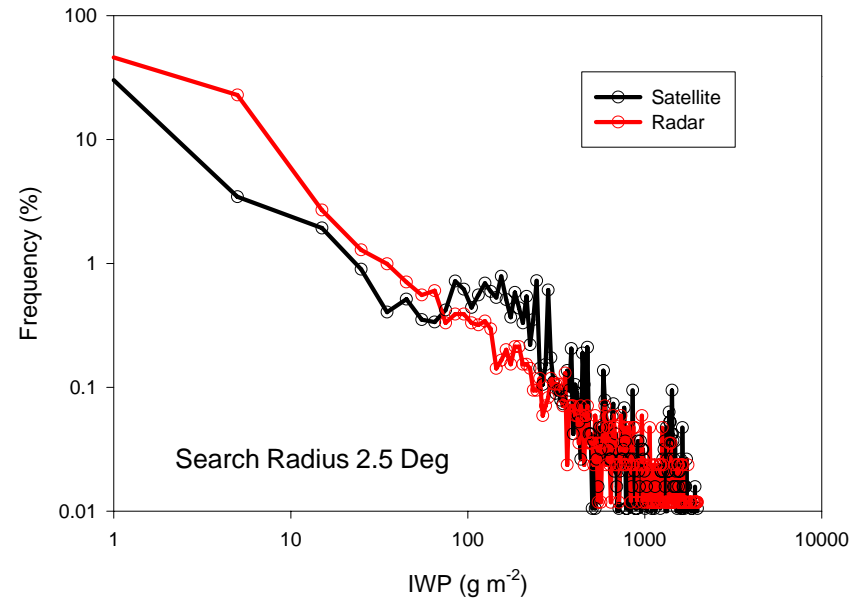
0.5 Deg. Ave.

Comparison with MMCR - IWP PDF

TWP-ICE (40 Days)

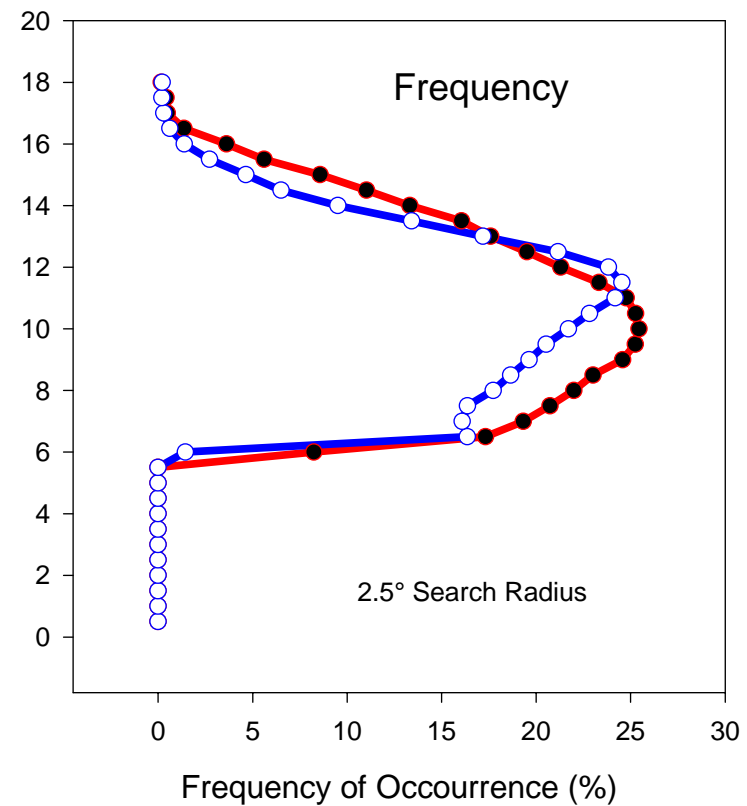
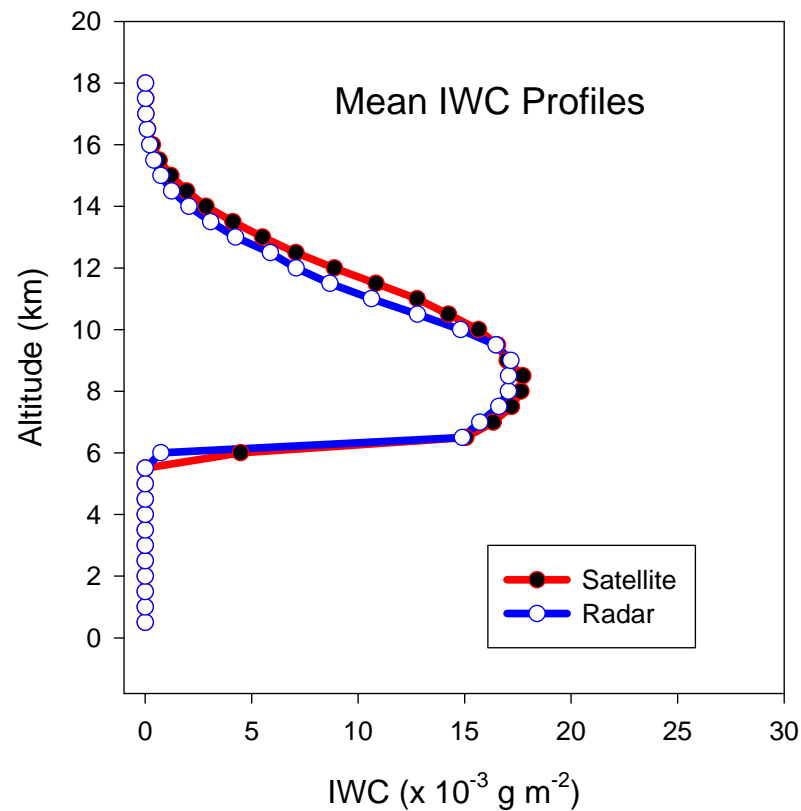


SGP-32k (31 Days)

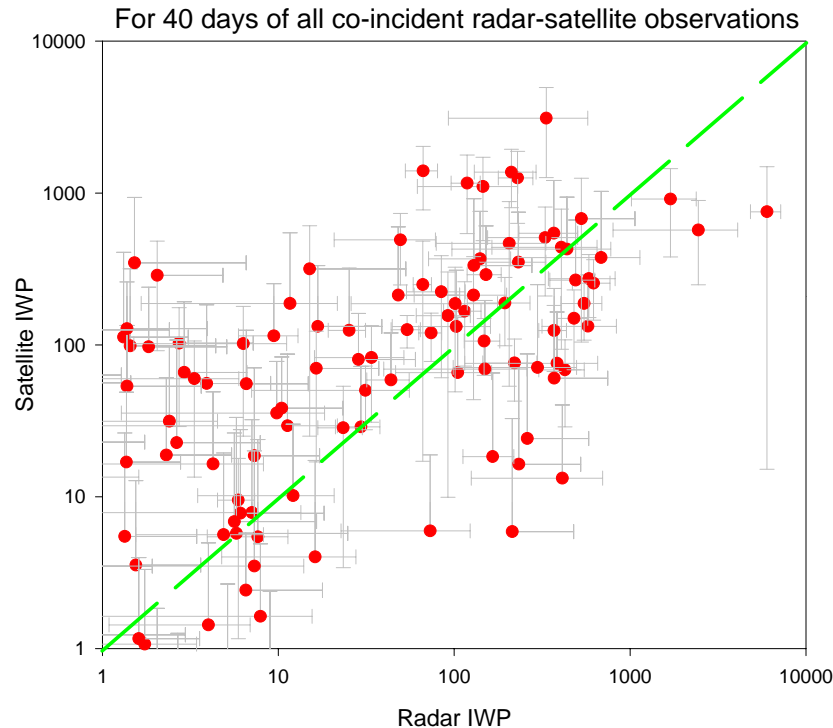


Comparison with MMCR (TWP-ICE)

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



Comparison with MMCR – TWP-ICE

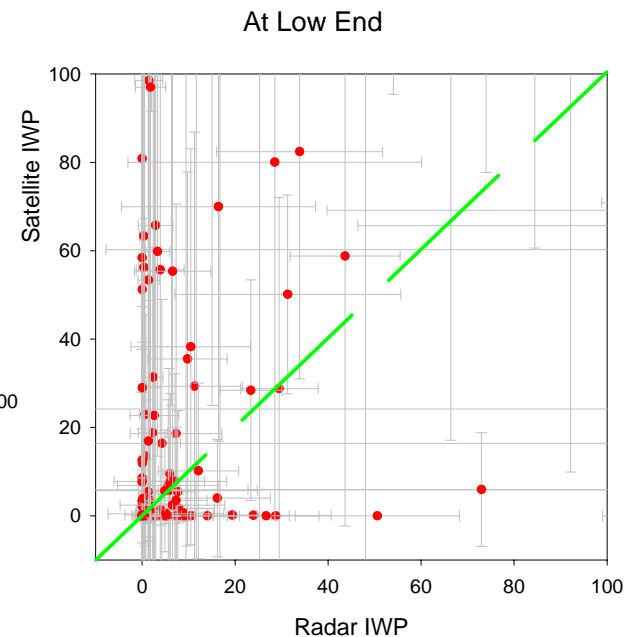


Compare Radar and Satellite

Radar: Average of 1 hours

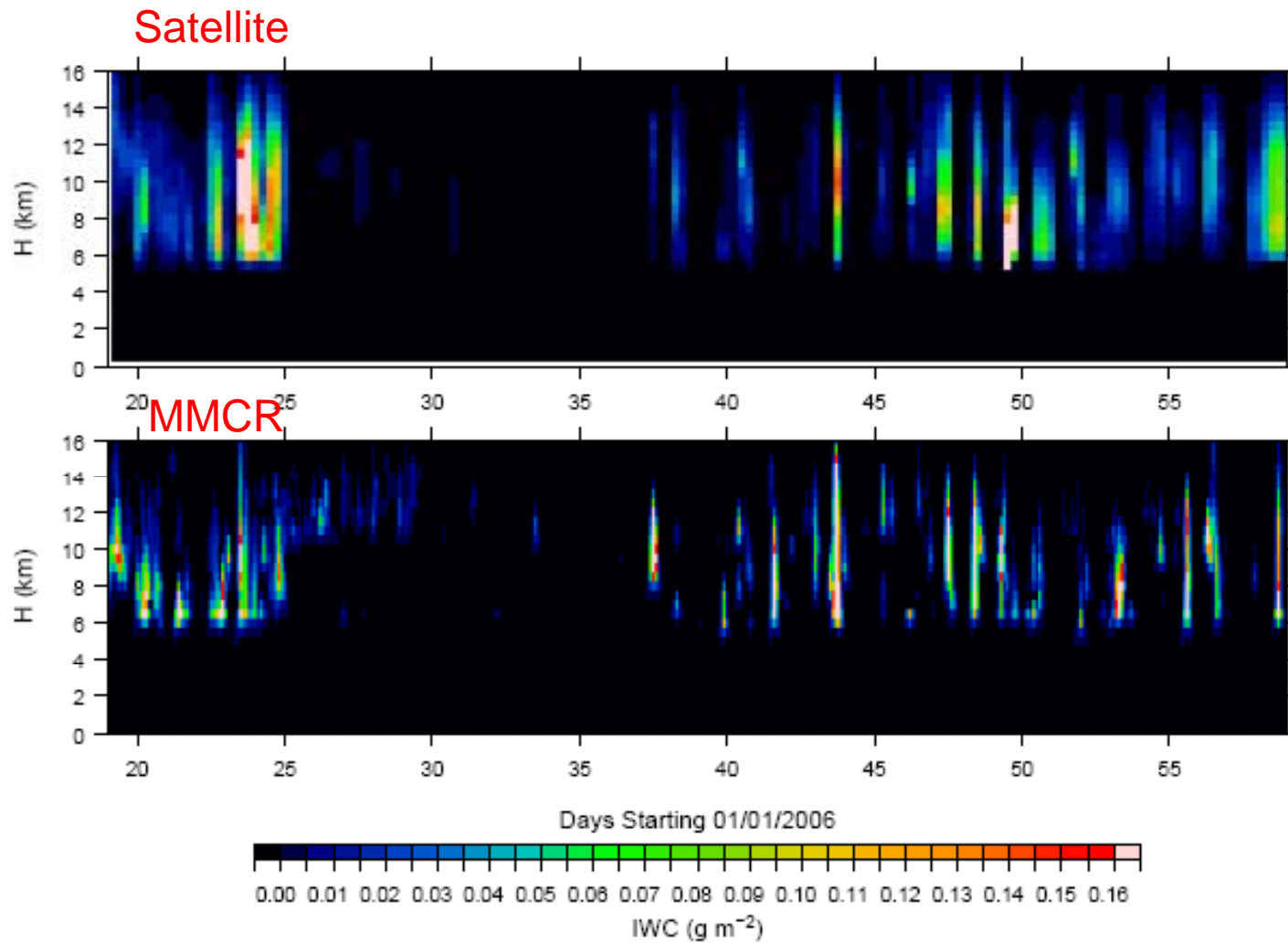
Satellite: Average of 0.5 degree (60 km) radius

Error Bars: Standard Deviation within averaged profiles/pixels

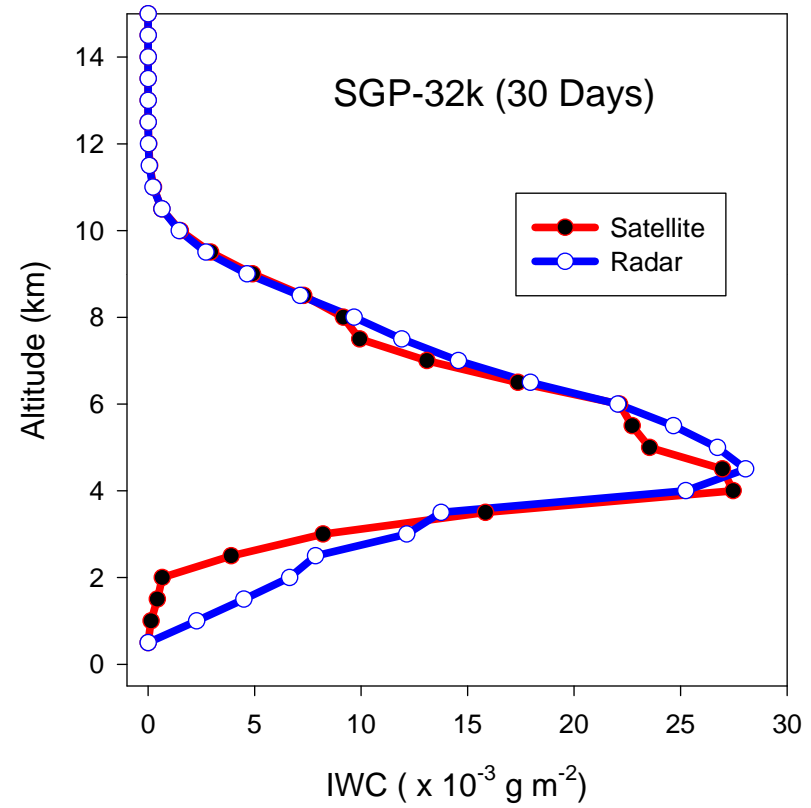
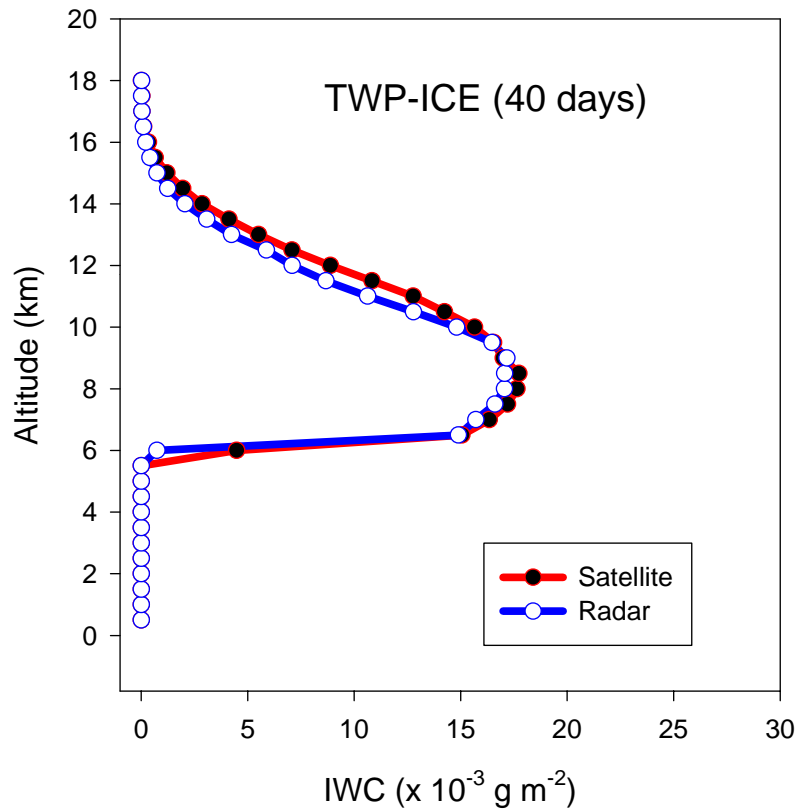


Comparison with MMCR

- IWC Time-Height Cross-Section

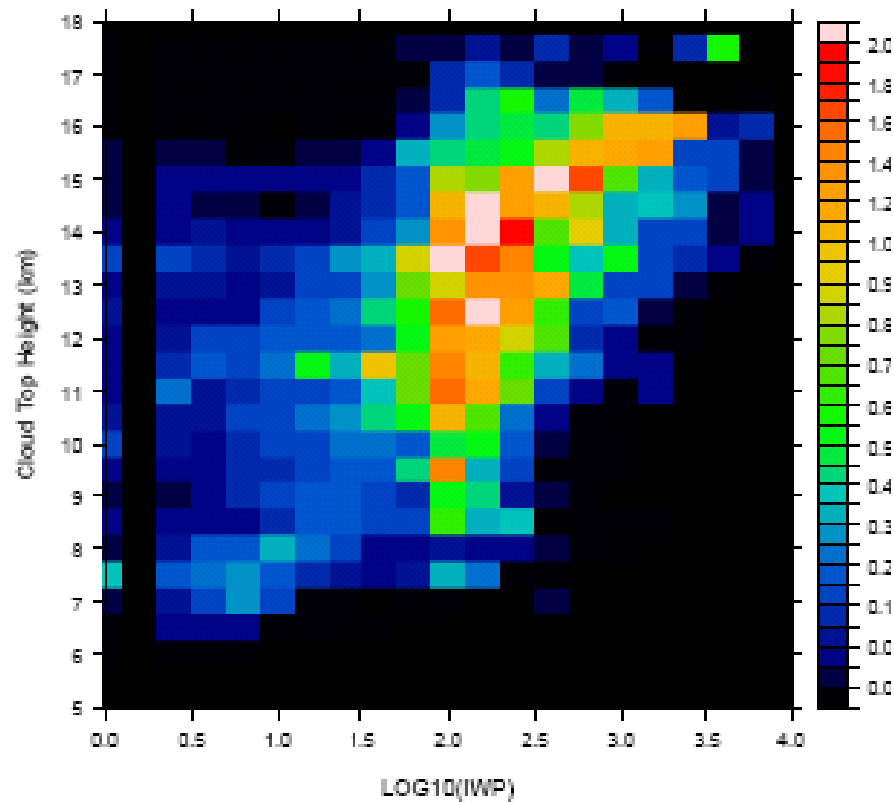


Comparison with SGP-32k - Mean IWC Profiles

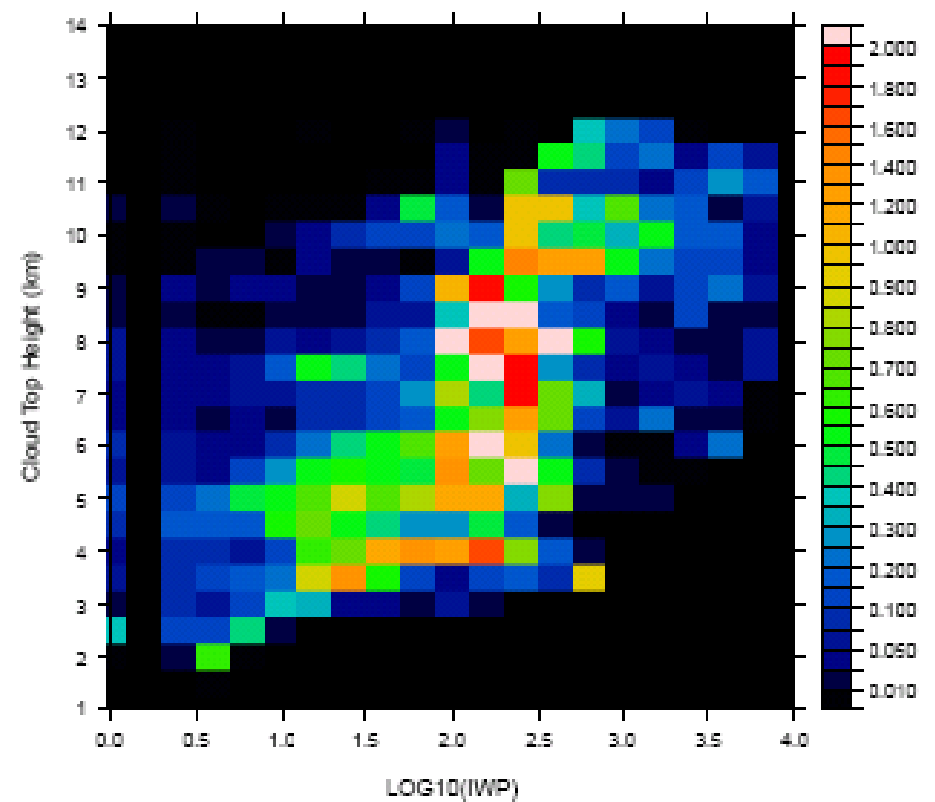


IWP vs. Cloud Height - TWP-ICE & SGP-32k

TWP-ICE 40-Day $10^\circ \times 10^\circ$



SGP-32k 30-Day $10^\circ \times 10^\circ$



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

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**