Motivation:
• Build upon the success of TRMM combined algorithms
• Detail frozen particle characteristics using higher frequencies (>= 150 GHz)

Outline:
• CAMEX-3 Hurricane Bonnie retrievals
• Frozen hydrometeor electromagnetic characteristics
• CAMEX-4 September 3, 2001 data
• Papers, plans, recommendations
Hurricane Bonnie Rainbands

EDOP = ER-2 Doppler Radar (HB atten. correction)
MIR = Millimeter-wave Imaging Radiometer
AMPR = Advanced Microwave Precipitation Radiometer
Note sensitivity of 150, 220, 340 GHz to anvil ice cloud.

1. Algorithm: Minimized differences between observations and calculated values using the iteratively estimated profiles.
2. Resolution: 0.5km vertical, <3km horizontal.
3. Surface Wind Speeds: Varied as a function of distance from hurricane eye (about 55 km from right hand side of the EDOP image).
4. Validation: Used in situ measured size distributions and reserved $T_B$ observations.
Frozen Particle Variability

- Macro Variability
  - Over vertical heights
  - Over horizontal dimensions of cloud

- Micro Variability
  - Size
  - Composition (ice-air-water ratios)
  - Bulk content
  - Shape

CPI in situ observations, Figure 13 from A. Heymsfield et. al, to appear in JAS 2002
Electromagnetic Representation

What is the best EM model for irregularly shaped frozen particles?

Columns & Needles 3 Spherical Representations
1. Equal Volume

2. Equal Area

3. Equal Vol./Area

CAMEX-3 Anvil Ice Retrievals
Range of median radii:
0.9 – 10.0 µm
2D-C Probe on DC-8
~33 µm avg. radii

High freq. appear to “see” crystal parts (small dimension of particle).

CAMEX-4 September 3, 2001

Over Ocean

Over Florida

HAMS Legend
166 GHz
183.3 ± 10.0 GHz
183.3 ± 7.0 GHz
183.3 ± 4.5 GHz
50.3 GHz
Papers, Plans, Other Work

• Papers

• Plans
  – Select CAMEX-4 KAMP and Hurricane cases and estimate hydrometeor profiles

• Recommendations
  – CAMEX-5 should have a focus on the frozen hydrometeors (sizes, shapes, densities, EM properties for radiometers and radars)