Deriving Microphysical Profiles using Active and Passive Observations

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Motivation:

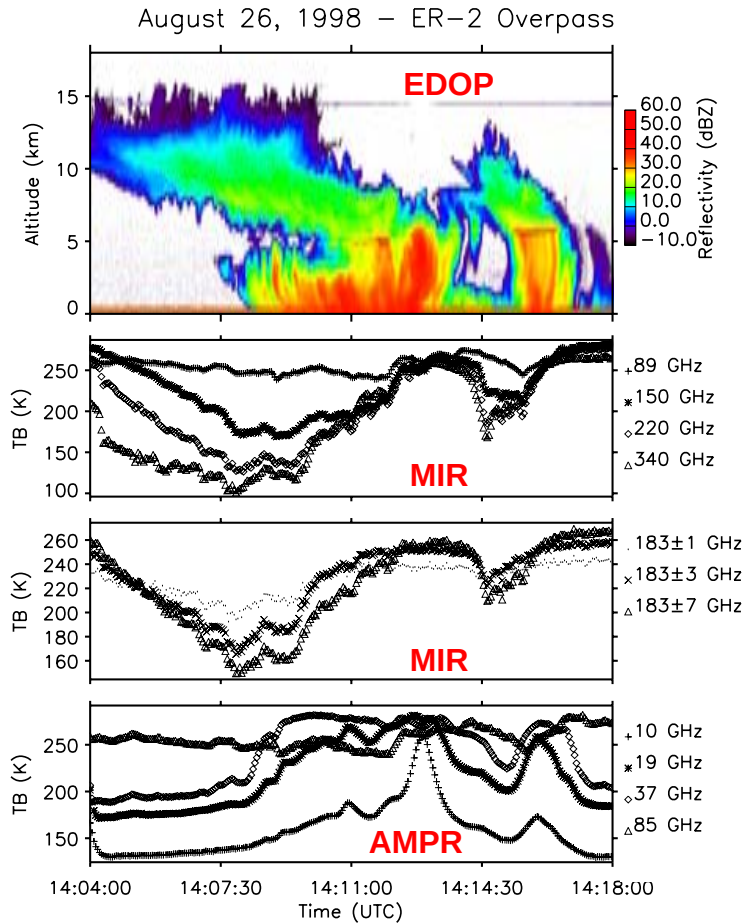
- Build upon the success of TRMM combined algorithms
- Detail frozen particle characteristics using higher frequencies (>= 150 GHz)

Outline:

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

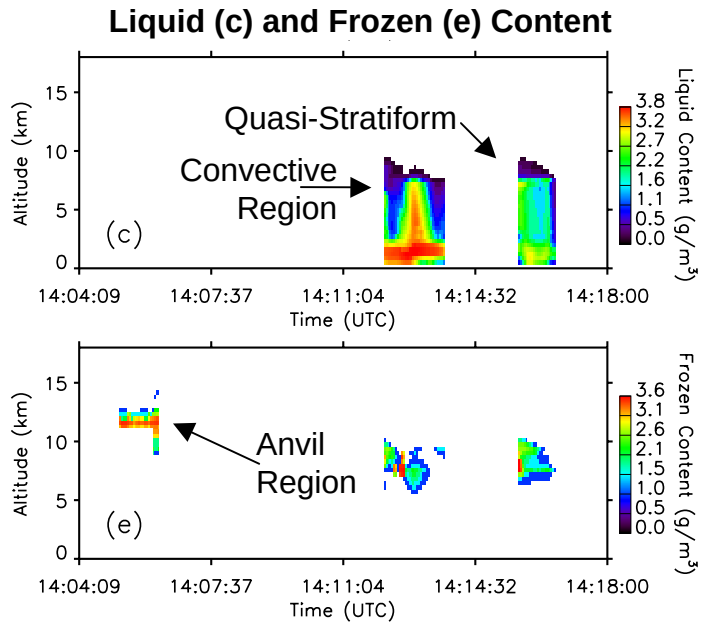
CAMEX-3: Hurricane Bonnie

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.

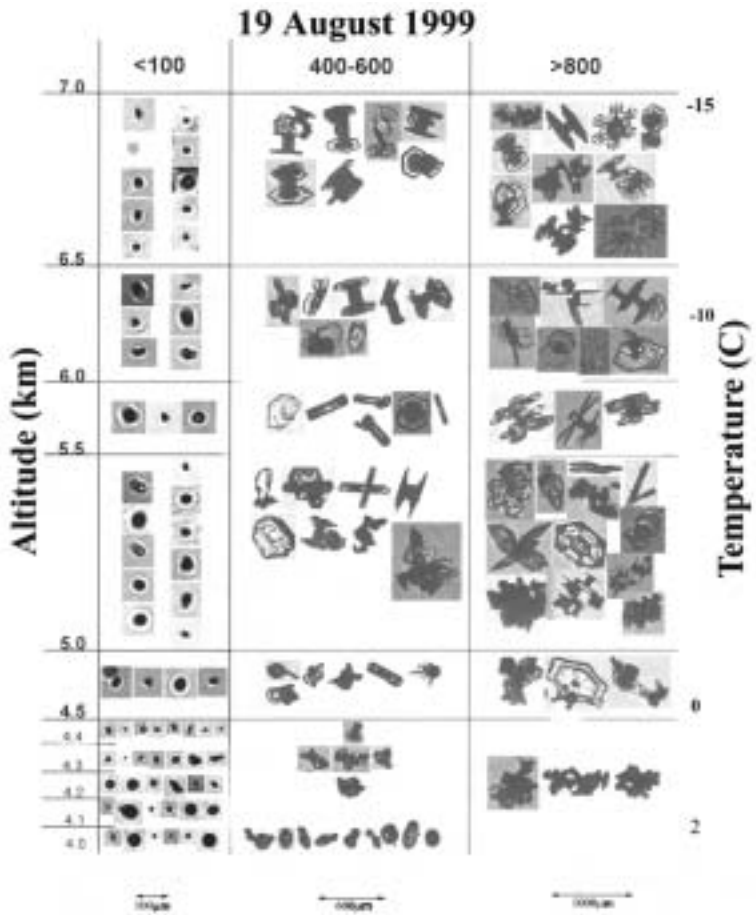
Retrieved Profiles



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

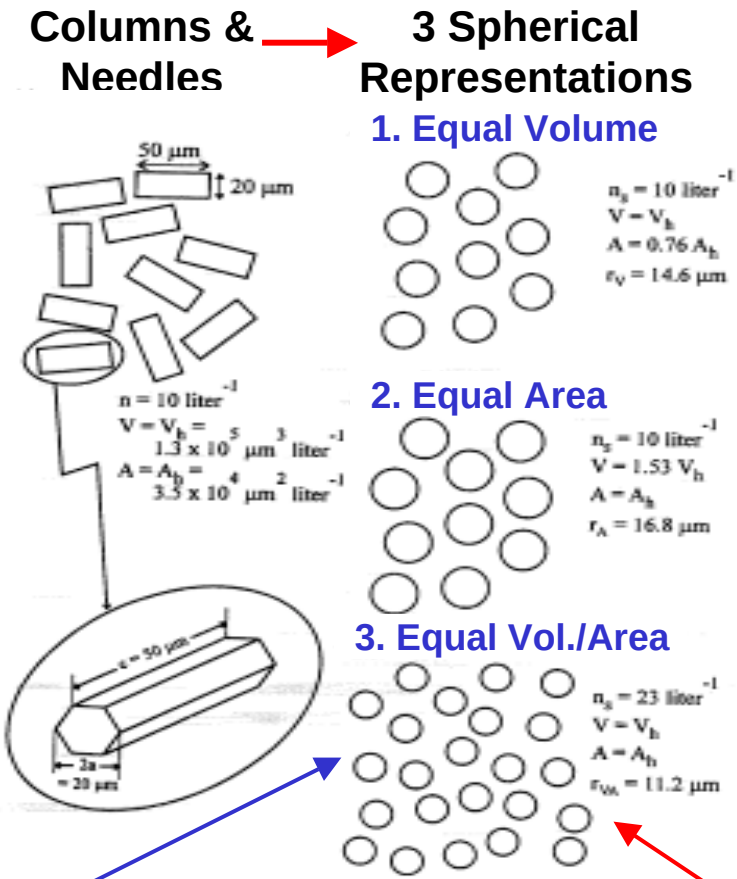
- Macro Variability
  - Over vertical heights
  - Over horizontal dimensions of cloud
- Micro Variability
  - Size
  - Composition (ice-air-water ratios)
  - Bulk content
  - Shape



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?



CAMEX-3 Anvil Ice Retrievals

Range of median radii:

0.9 – 10.0 μm

2D-C Probe on DC-8

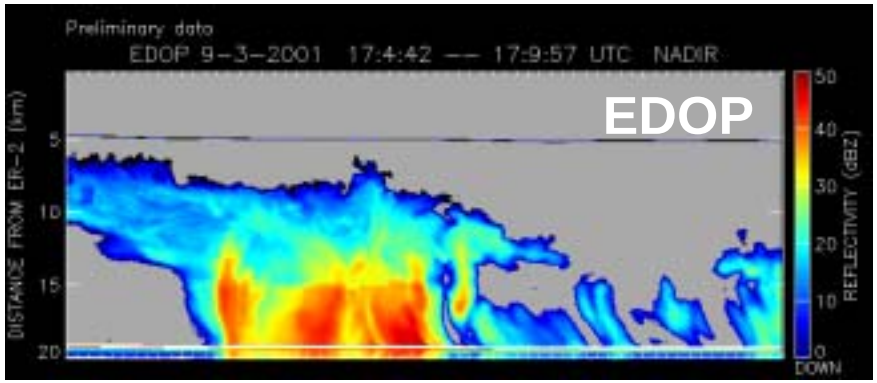
~33 μm avg. radii

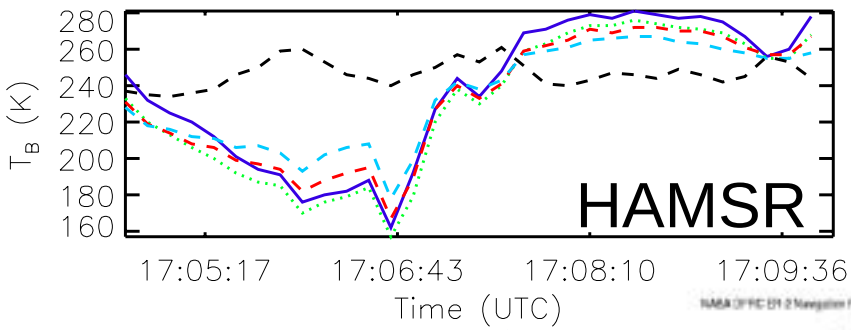
High freq. appear to "see" crystal parts (small dimension of particle).

3. T.C. Grenfell and S.G. Warren, "Representation of a nonspherical ice particle by a collection of independent spheres for scattering and absorption of radiation" JGR, 1999.

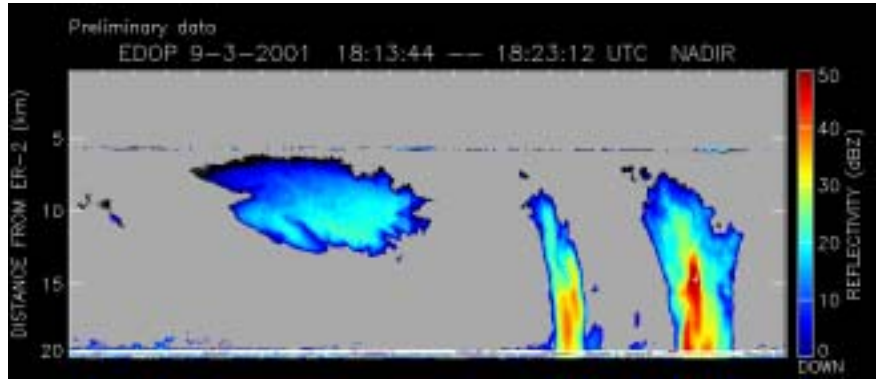
CAMEX-4 September 3, 2001

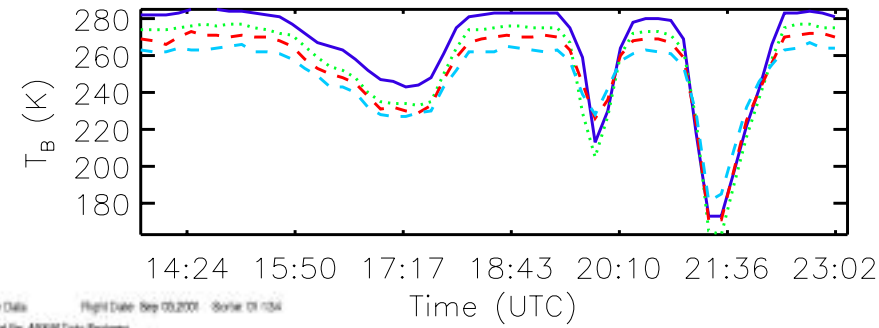
Over Ocean





Over Florida





HAMSR Legend

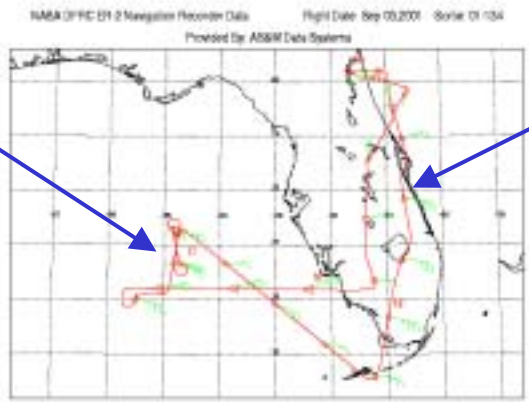
166 GHz

183.3±10.0 GHz

183.3±7.0 GHz

183.3±4.5 GHz

50.3 GHz



Papers, Plans, Other Work

- Papers

  1. G.M. Skofronick-Jackson, J.R. Wang, G. Heymsfield, R. Hood, W. Manning, R. Meneghini, and J.A. Weinman, “Combined Radiometer Radar Microphysical Profile Estimations with Emphasis on High Frequency Brightness Temperature Observations,” **accepted by *JAM***, September 2002.

  2. G.M. Skofronick-Jackson, J.A. Weinman, M.-J. Kim, “Electromagnetic Representations of Frozen Hydrometeors at Millimeter-wave Frequencies,” **in preparation**.

- 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)