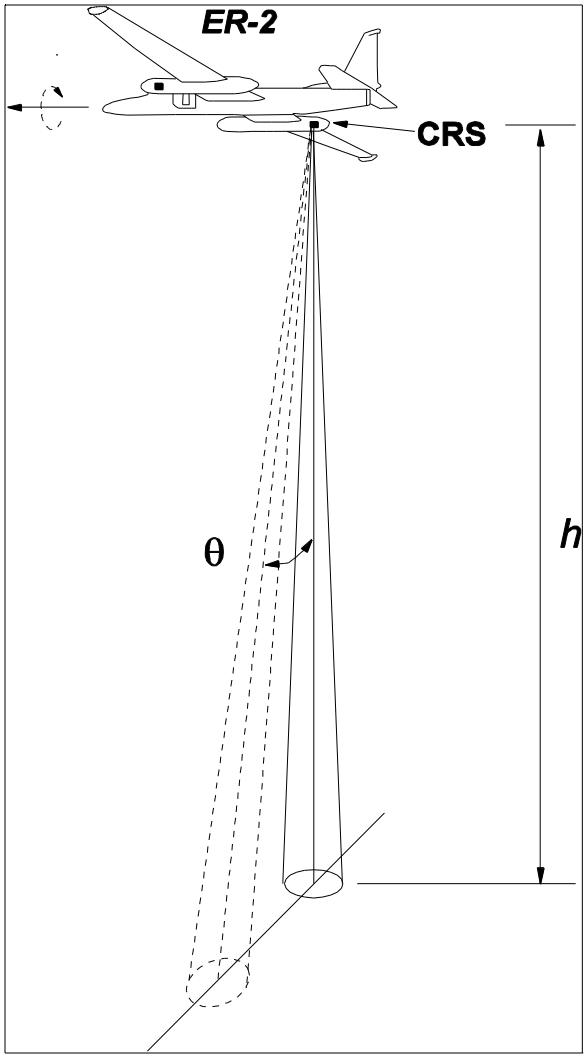
# CRS and EDOP Measurements During TC4

Gerald Heymsfield *Goddard Space Flight Center*
Lihua Li & Lin Tian *Goddard Earth Sciences and Tech. Ctr, UMBC*

- Instrument Summary
- Derived Products
- Science Goals
- CloudSat Validation

# ER-2 Cloud Radar System (CRS)

## CRS Specifications




- Frequency: 94.155 GHz
- RF Peak Power: 1.7 KW
- Antenna Beamwidth: 0.6°x0.8°
- Range Resolution: 37.5 (oversampled 75 m)
- PRF: 4/5 KHz
- Avg. Interval 0.5 s (100 m along-track)
- Sensitivity: -28 dBZe (10 km range & averaging)

***CRS provides validation for CloudSat***

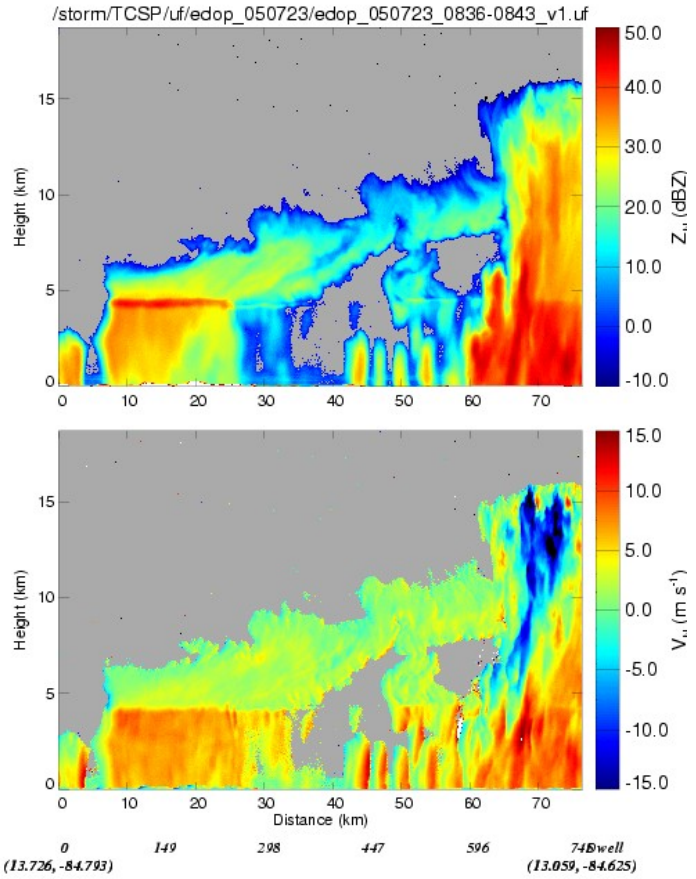
CRS website:

http://rsd.gsfc.nasa.gov/912/edop/crs_id_descriptor.htm

# ER-2 Doppler Radar (EDOP)

- *Frequency:* 9.6 GHz
- *Location:* SLR Nose
- *Antenna:* 3° fixed nadir

  3° fixed forward (33°)
- *Measurements:* reflectivity
  Doppler
  Doppler width
  Linear Depol. (LDR)
- *Resolution:* 37.5 m vertical
  ~1.1 km footprint at surface
- *Sensitivity:* MDS ~ -15 $dBZ_e$
  (4.4 kHz PRF, 0.5 s average, 10 km range)




Thunderstorm east of Yucatan, MX

Web Site:
http://rsd.gsfc.nasa.gov/912/edop/system_specs.htm

# CRS and EDOP Data and products

## Field:

- *Quicklook images all flight legs (Z, v) with preliminary calibration*
- *ASCII files (Gaines-Hipskind format) of subsetted reflectivity (EDOP, CRS), IWC using simple Z-IWC relation (CRS)*

## Post-Mission:

- *Universal Format (UF) files readable with IDL libraries.*
- *Aircraft motion corrections*
- *Reprocessed ASCII files*
- *Analysis products for selected cases:*
  - *Cloud layer and cloud top heights*
  - *IWC using dual-freq radar algorithms*
  - *Vertical air motions*
  - *Along-track (2D) winds.*
  - *Attenuation correction, Etc.*

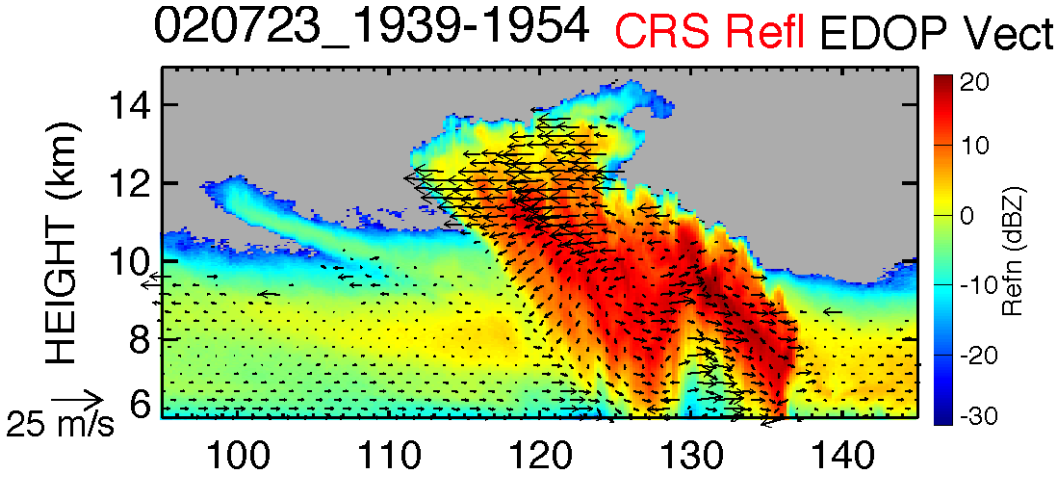
# Science Objectives/ Flight Lines

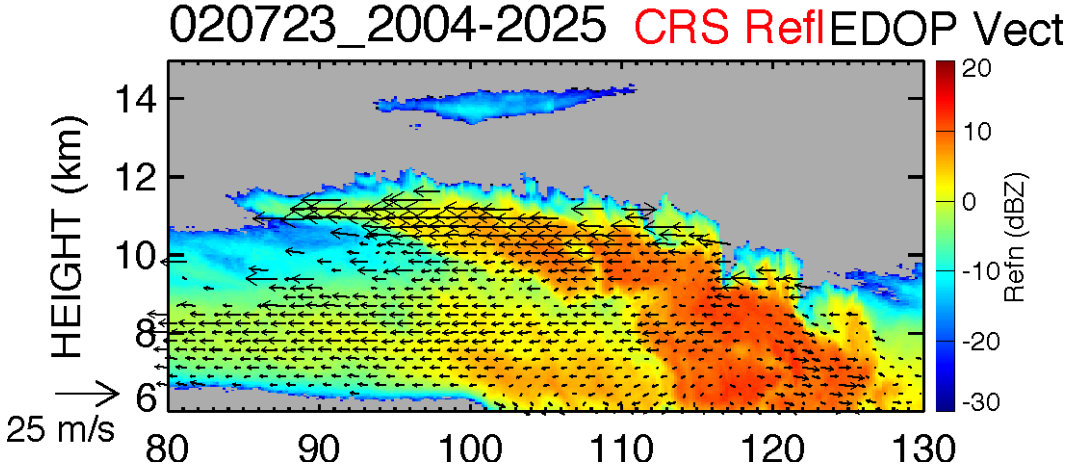
- Evolution of of convective systems in varied shear environments and through all stages of development (growth, mature, dissipating)
  - Initial emphasis on convective tower vertical motions and hydrometeor structure with repeated passes over tower with short legs.
  - Transition to microphysics of anvil structure using dual-frequency radar and lidar algorithms using longer legs covering full extent of anvil.

**Special Requirements:**

- DC-8 underflight of ER-2 when possible for providing critical in situ and radar (APR-2) measurements

# Decaying Towers and Cirrus Generation



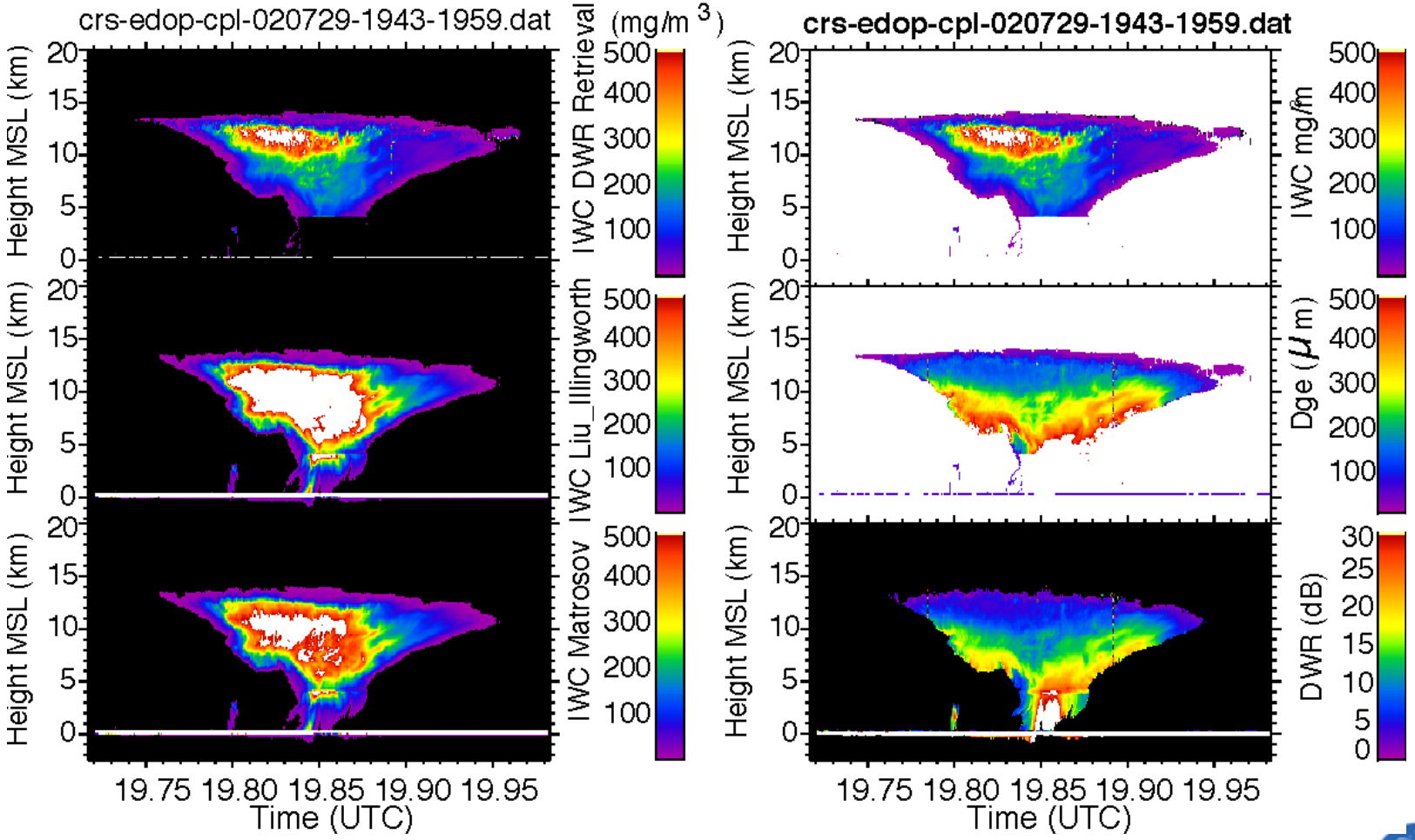
# Science Objectives/ Flight Lines (cont'd)

- ER-2-based retrievals of cirrus properties using new approaches: dual-wavelength radar (CRS-EDOP), radar-radiometer (CRS-CosSir), cloud radar-lidar (CRS-CLS), and radar-vis/NIR (CRS-MAS) (collaborative effort). [No special flight requirements except variety of cloud types]

**Special Requirements:**

-WB-57 and/or DC-8 underflight of ER-2 when possible for providing critical insitu information for algorithm validation

# Dual Wavelength Airborne Radar Measurements Can Help Understand Convective Cirrus




Z. Wang et al. (2006)

# Science Objectives/ Flight Lines (cont'd)

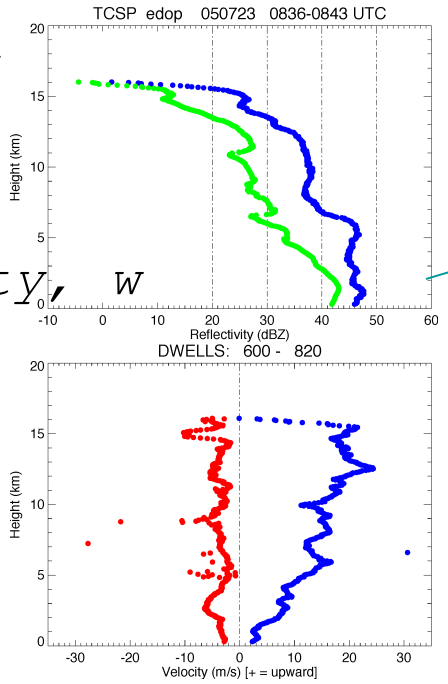
- Statistics on vertical motions in intense convection.

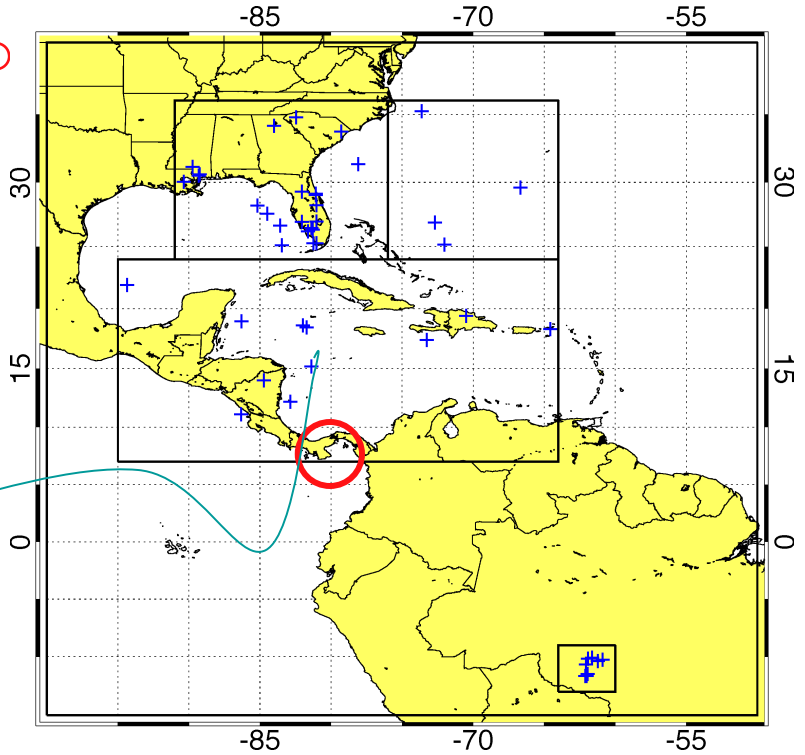
**Special Requirements:**

- Panama Flights

Same as for convective syst

*Min, Max Reflectivity, w*



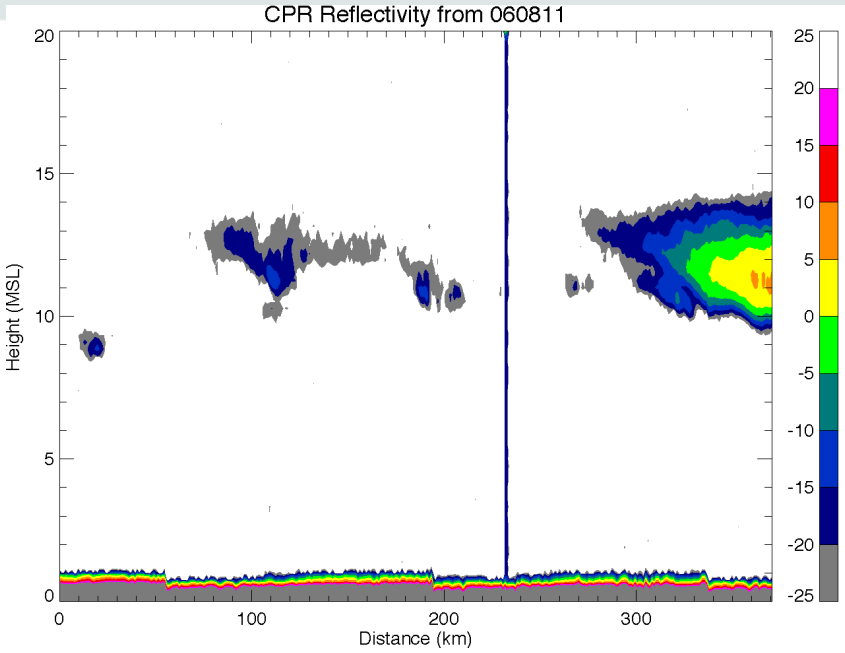



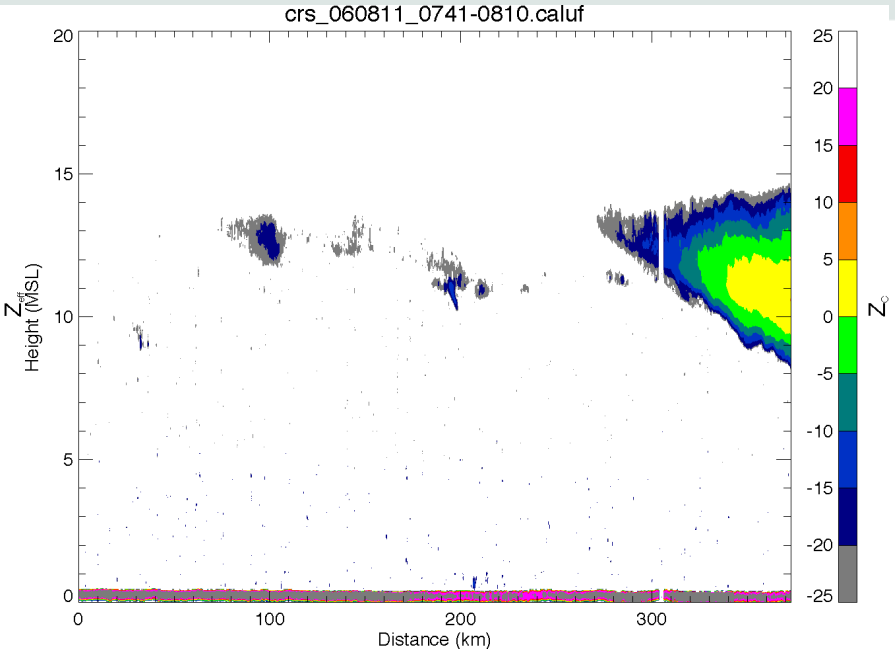
# CloudSat Validation

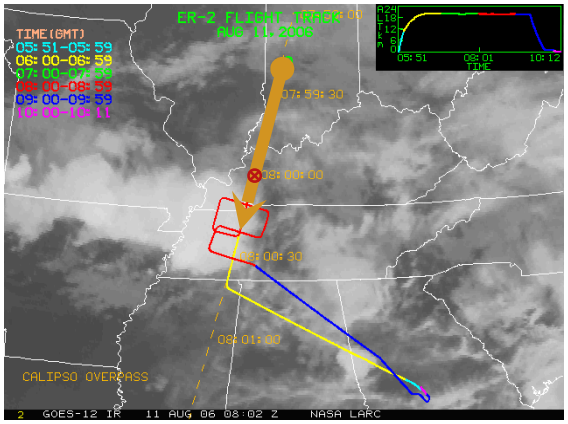
## 1B CPR and 2B Geoprof Products

- **Calibration** Establish to within 2 dB.
  - ***Approach:*** *Comparison with CRS and comparison to in situ data.*
- **Navigation** Are we exactly where we think we are?
  - ***Approach:*** *Average CRS to CloudSat resolution and compare.*
- **Sensitivity** – -28dBZ detection threshold needs to be established.
  - ***Approach:*** *Comparison to CRS, CPL*
- **Cloud Mask** Are we identifying all clouds in the cloud mask?
  - ***Approach:*** *Comparison to CRS and CPL.*

# 11 August 06

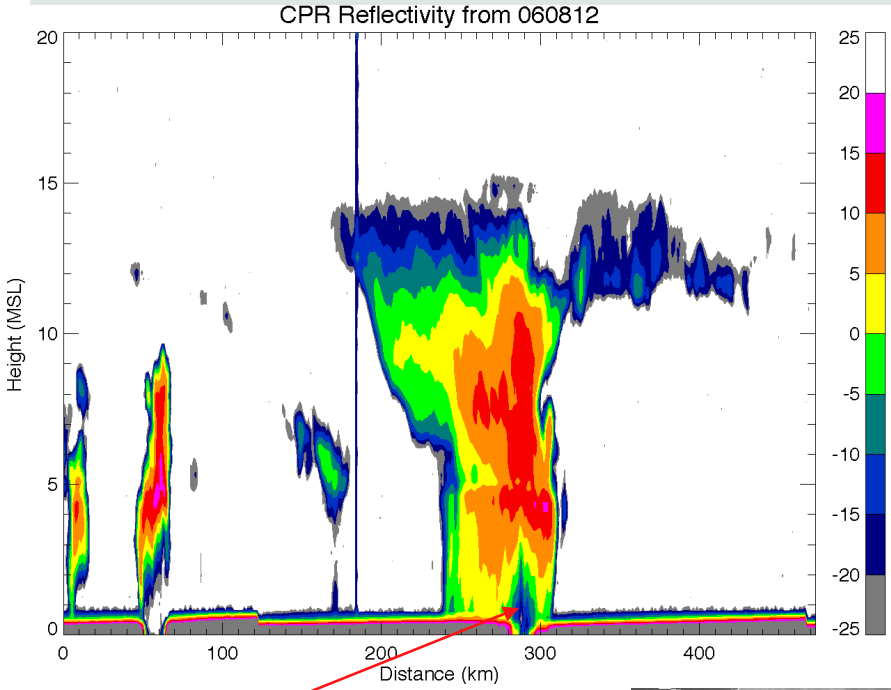


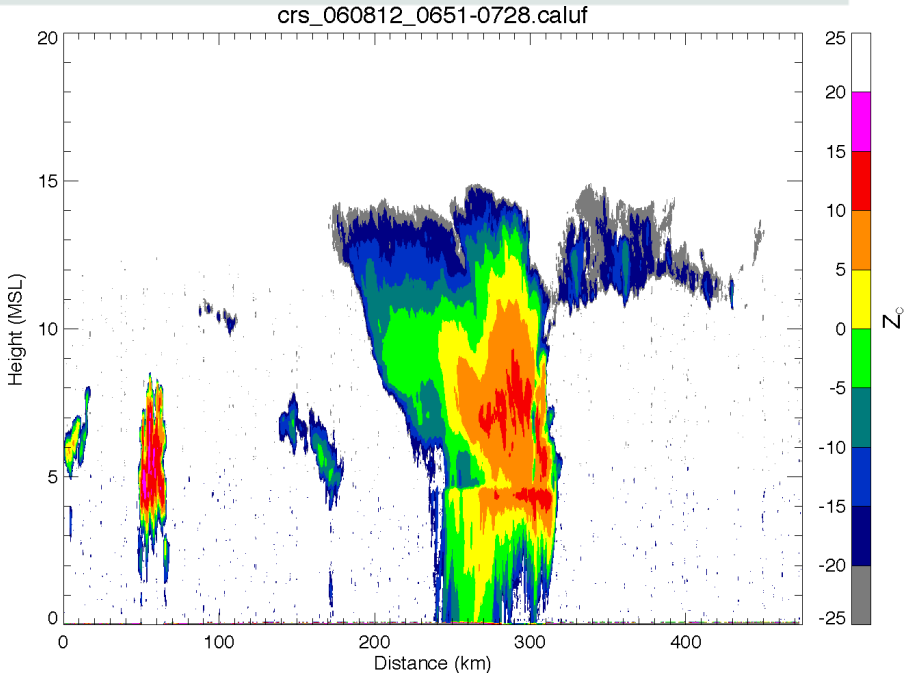



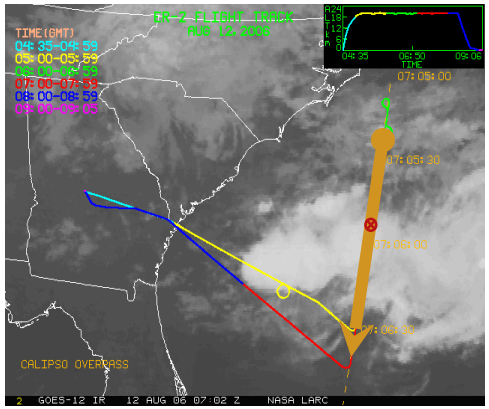

Nighttime
Cirrus anvil over land

# 12 August 06



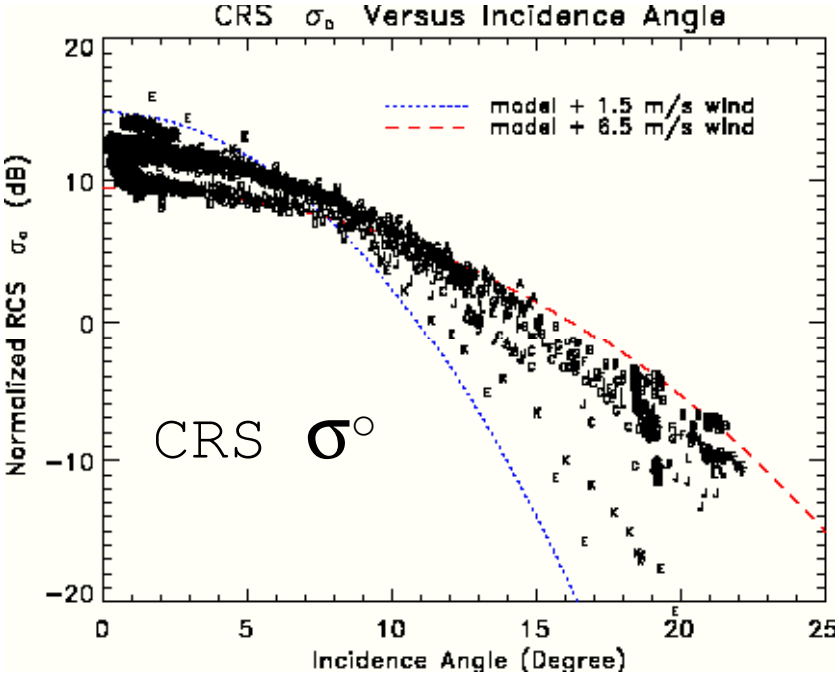

Multiple scattering effects?




Nighttime Deep convection and cirrus over water

# Calibration and σ°

- Ocean surface under clear sky conditions provides calibration information for CloudSat but this requires knowledge of tropospheric water vapor and surface winds.
- Ocean surface scattering models for W-band (94 GHz) also require validation.
- Ocean surface comparisons of CRS and CPR during CC-Vex are forthcoming.




Details in Li et al. (2005)

# Desired CloudSat Validation Coordination

Straight and level flight legs covering variety of cloud types to examine calibration and algorithms.

Desire for deep convection and tropical storms during CloudSat overpasses to examine multiple scattering in CloudSat data.

High priority requirements:

-coincident DC-8 underflight of CloudSat and ER-2 for providing microphysics info under ER-2 and additional frequency radar measurements (APR-2).

-dropsonde release in clear sky ocean region for ocean surface calibration (surface winds, tropospheric water vapor)