CLOWD's use of BBHRP to Evaluate Liquid Water Retrieval Algorithms

Jennifer Comstock and Chaomei Lo (PNNL)
Tim Shippert and Sally McFarlane (PNNL), Eli Mlawer (AER)
David Turner (Univ. Wisconsin)
Andy Vogelmann (BNL)
Mandy Khaiyer (SSAI/NASA LaRC)
Retrieval Participants

ARM Working Group Meetings Nov. 2008

Participants

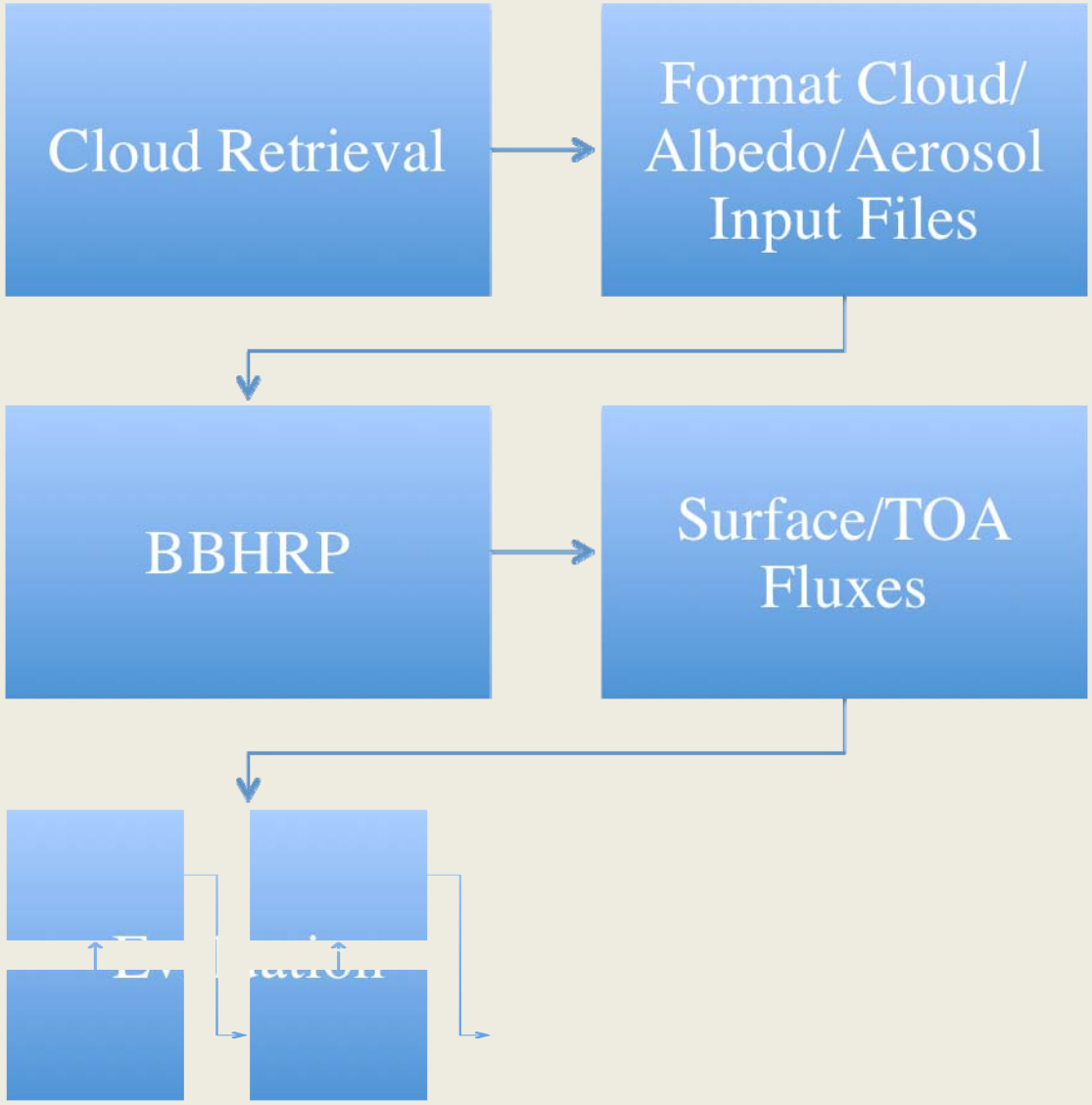
- Dave Turner – MIXCRA, MWRRET
- Sasha Marshak and Christine Chiu – 2NFOV
- Chuck Long – Radiative Flux Analysis
- Qilong Min – MFRSR
- Mandy Khaiyer and Pat Minnis – VISST (satellite based)

- More participants are welcome!

Overview

- CLOWD – Clouds with Low Optical Water Depths
- CLOWD – BBHRP
  - Intercomparison of retrieval algorithms using the BBHRP framework to vet algorithms for a CLOWD VAP
  - Series of surface and TOA radiative flux closure exercises
- Original intercomparison – Turner et al. BAMS (2007)
  - Case studies
- Next Step (what we are doing now)
  - Develop statistical dataset of low LWP clouds (<100 g/m^2) for different CLOWD types
  - Pt. Reyes July-Aug 2005(Stratiform clouds, i.e., single-layer and plane-parallel-ish)

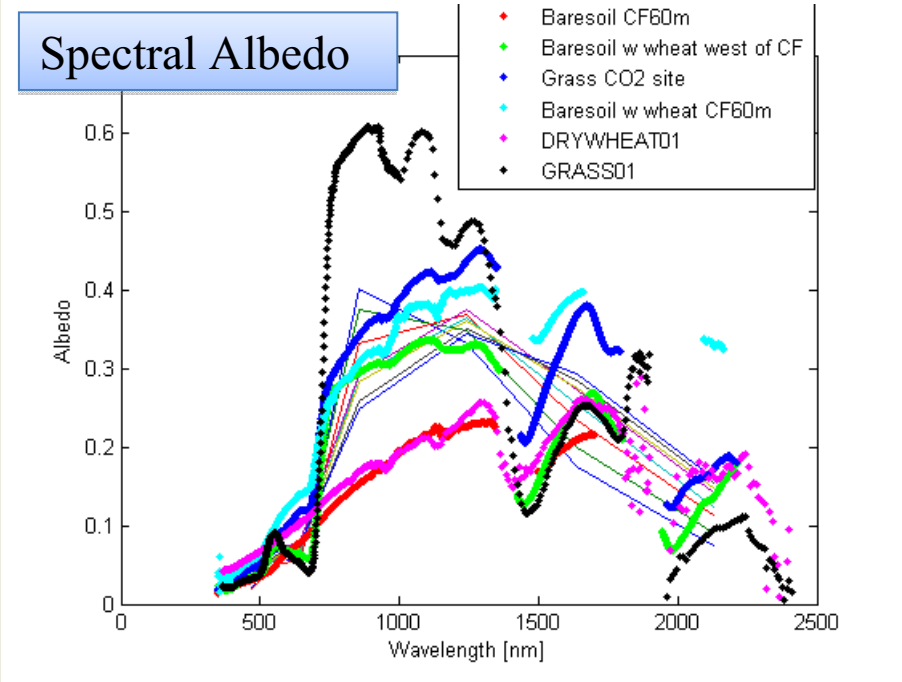
Analysis Steps



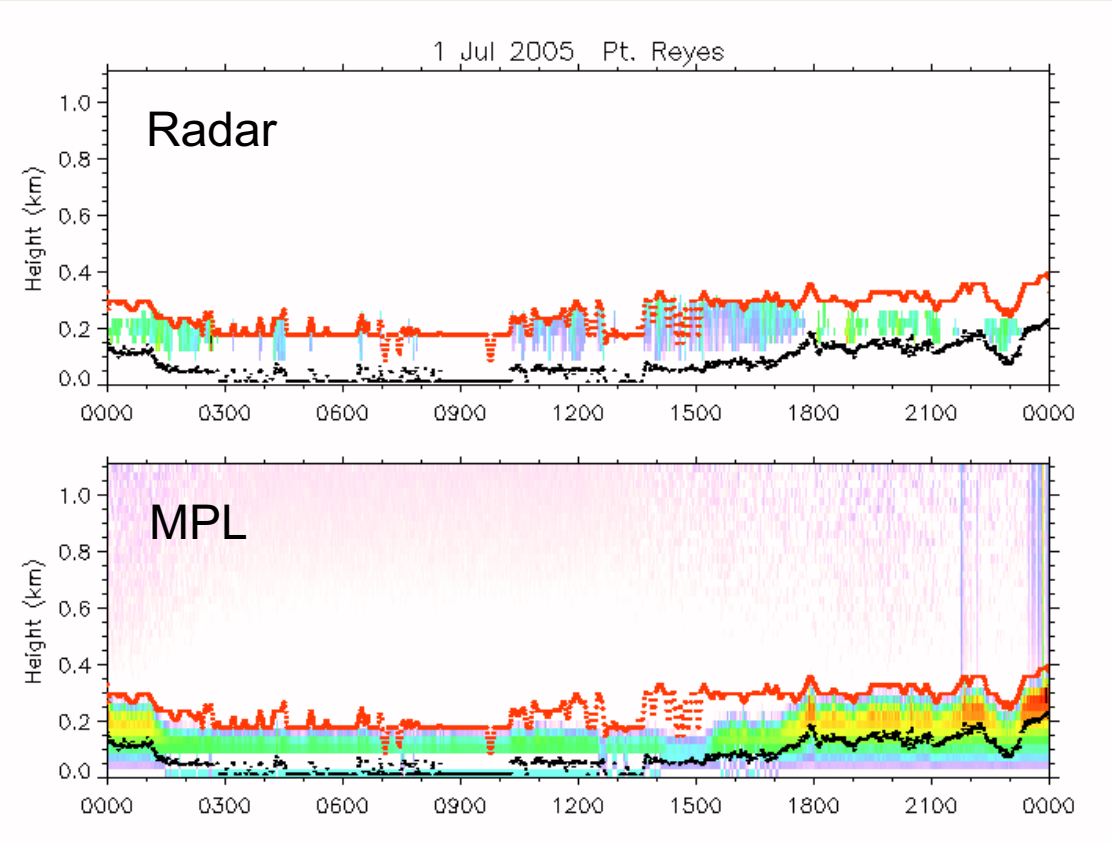
Surface Spectral Albedo

- Compute the broadband surface albedo A_{BB} using surface radiometers
- Obtained MODIS spectral albedo for Pt. Reyes
- Choose corresponding measured spectral albedo (Trishchenko)
- Scale the spectral albedo according to variation in A_{BB}

$$SF = \frac{A_{BB}}{\left(\frac{\sum_{\lambda} A_{RRTM}(\lambda) F_{sol}(\lambda)}{\sum_{\lambda} F_{sol}(\lambda)} \right)}$$



Cloud Boundaries



- Use Ceilometer cloud base
- Determine highest cloud top by comparing MPL and radar

- Checked "adiabatic" assumption

$$LWP = \int_0^h q_L dz = \tfrac{1}{2} f_{ad} \Gamma_{ad} h^2$$

f_{ad}=degree of adiabaticity
Γ_{ad}=adiabatic lapse rate

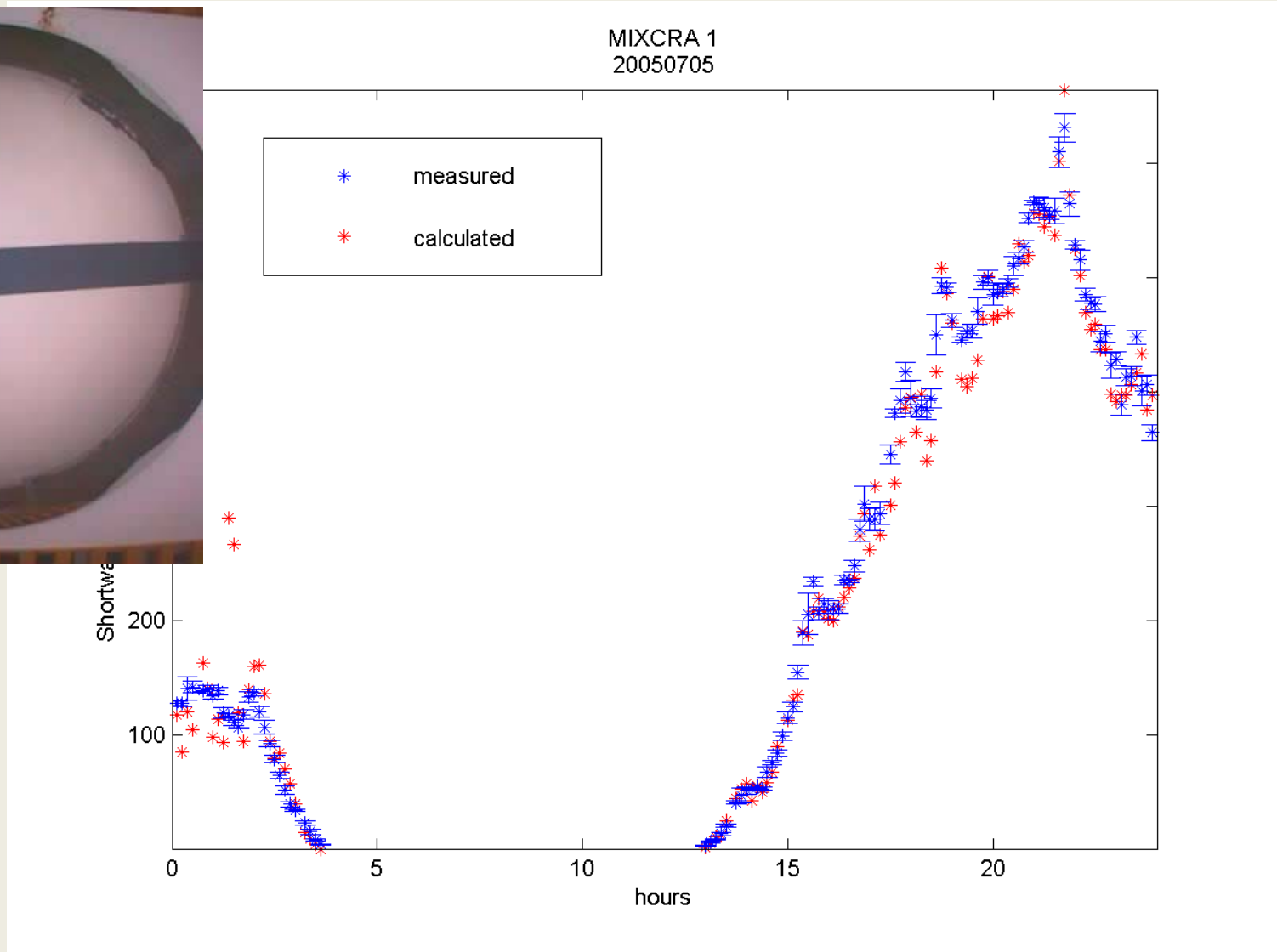
- Remotely sensed cloud top always greater than the adiabatic assumption
- Clouds were sub-adiabatic

Microphysical Properties

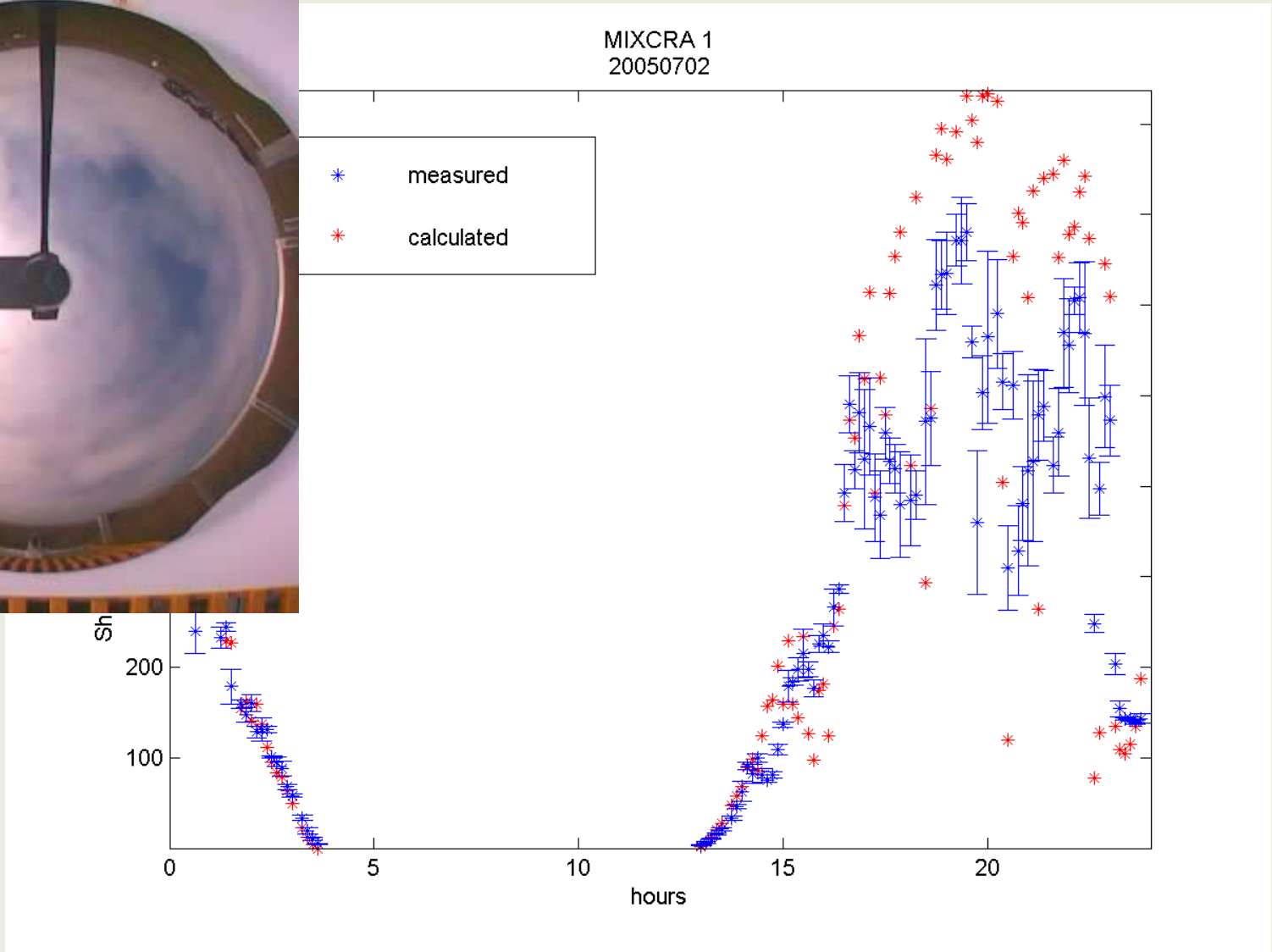
- Algorithms retrieve some combination of:
  - LWP, effective radius (r_{eff}), and cloud optical depth
- If no r_{eff} is submitted:
  - Database of stratus cloud droplet size distribution measured *in situ* (Miles et al. 2000) as a function of height in cloud
  - Maritime clouds mean r_{eff}~7.0 microns
  - Normalized height $H=(z-z_b)/(z_t-z_b)$
  - $r_{eff}=(7.5H+10.0)/2.0$ (r_{eff}=5 at base and 8.75 at top)
  - Slope and size range from Miles et al. (2000) for maritime clouds
- If only Optical Depth is submitted, use above r_{eff} and compute LWP:

$$LWP = \frac{5}{9}\rho_w \tau r_{eff}$$

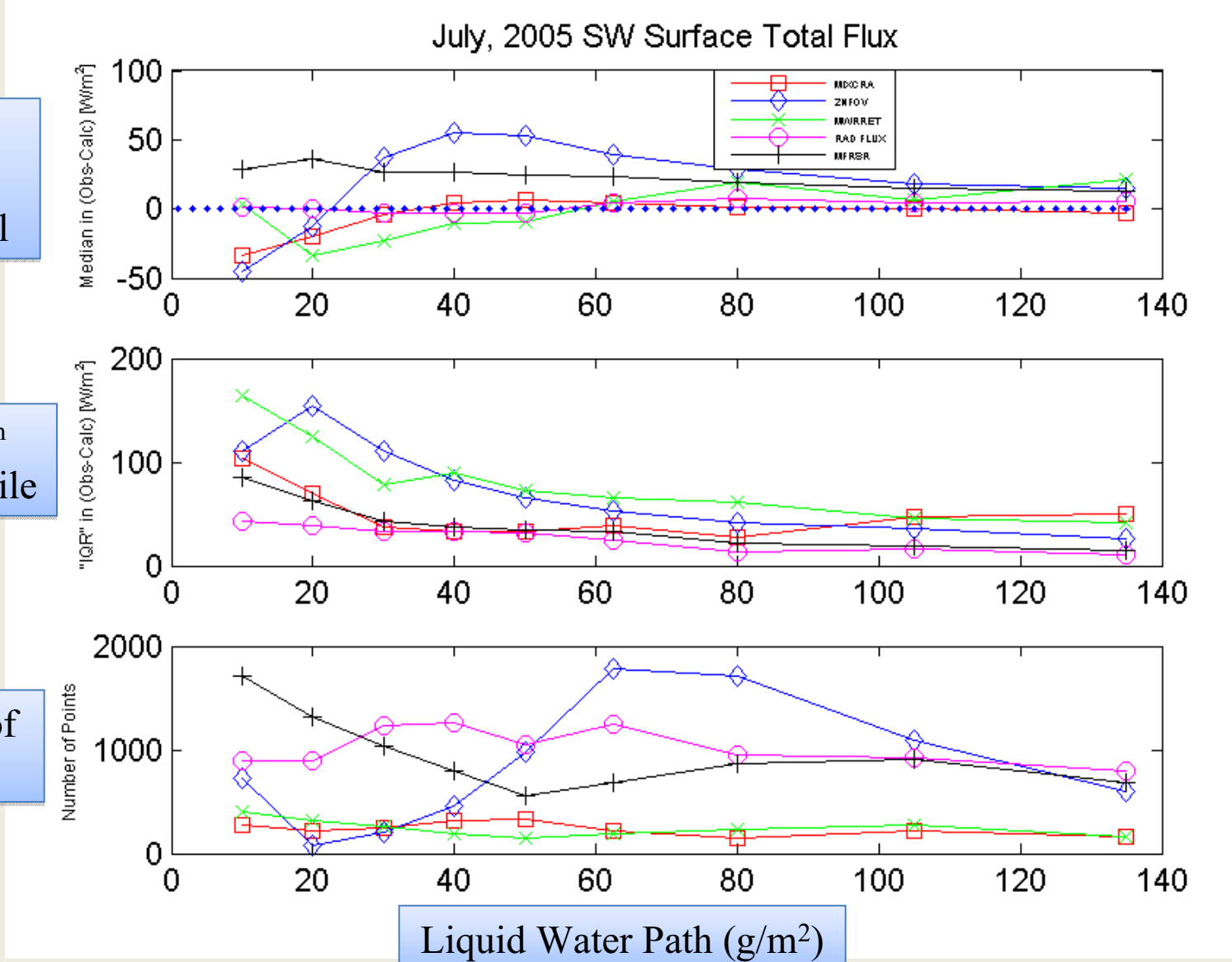
Results – Shortwave Diffuse Flux



Results – Shortwave Diffuse



Results – Shortwave Total



Median Flux Residual

75th-25th Interquartile

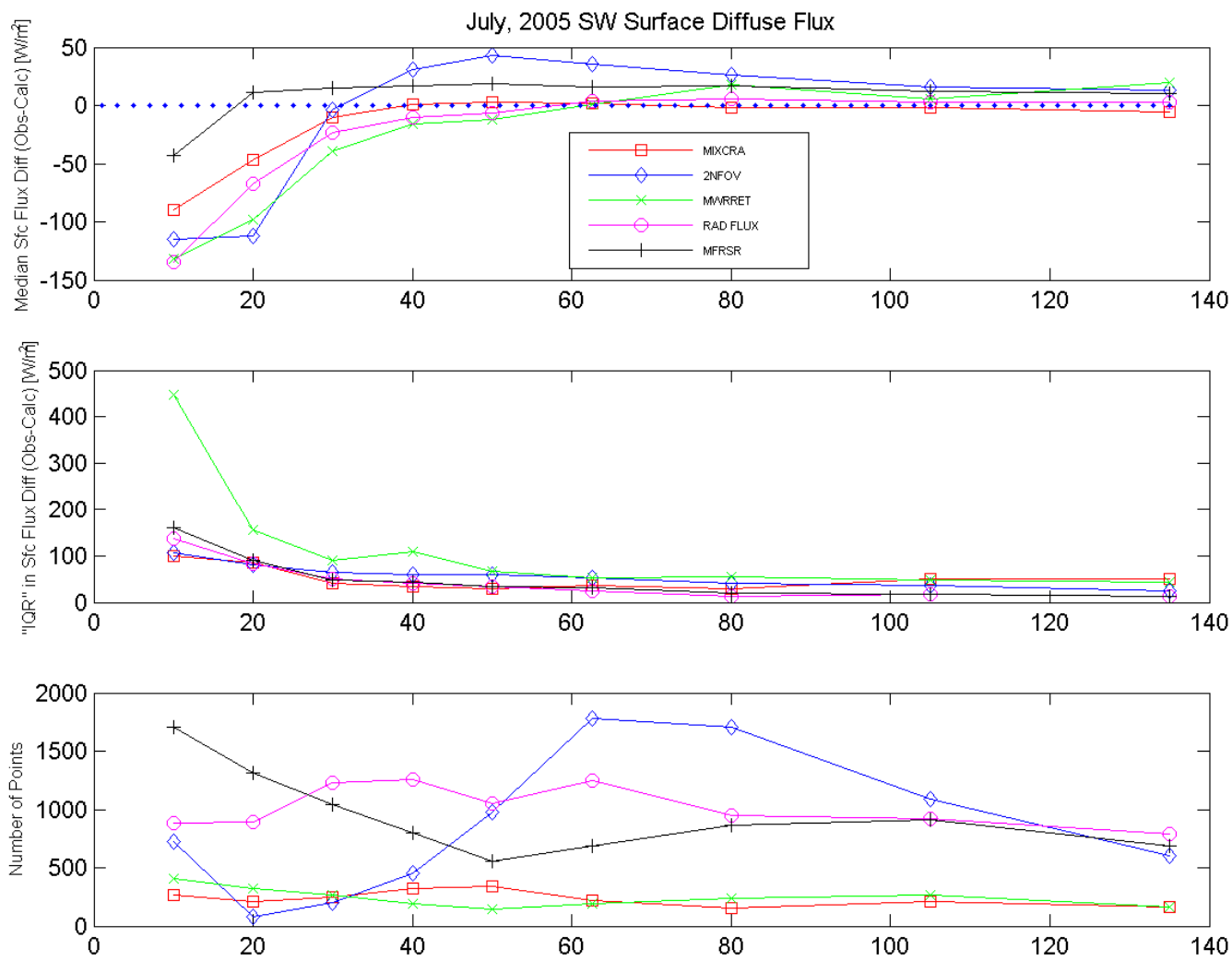
Number of Points

Results – Shortwave Diffuse

Median Flux Residual

75th-25th Interquartile

Number of Points



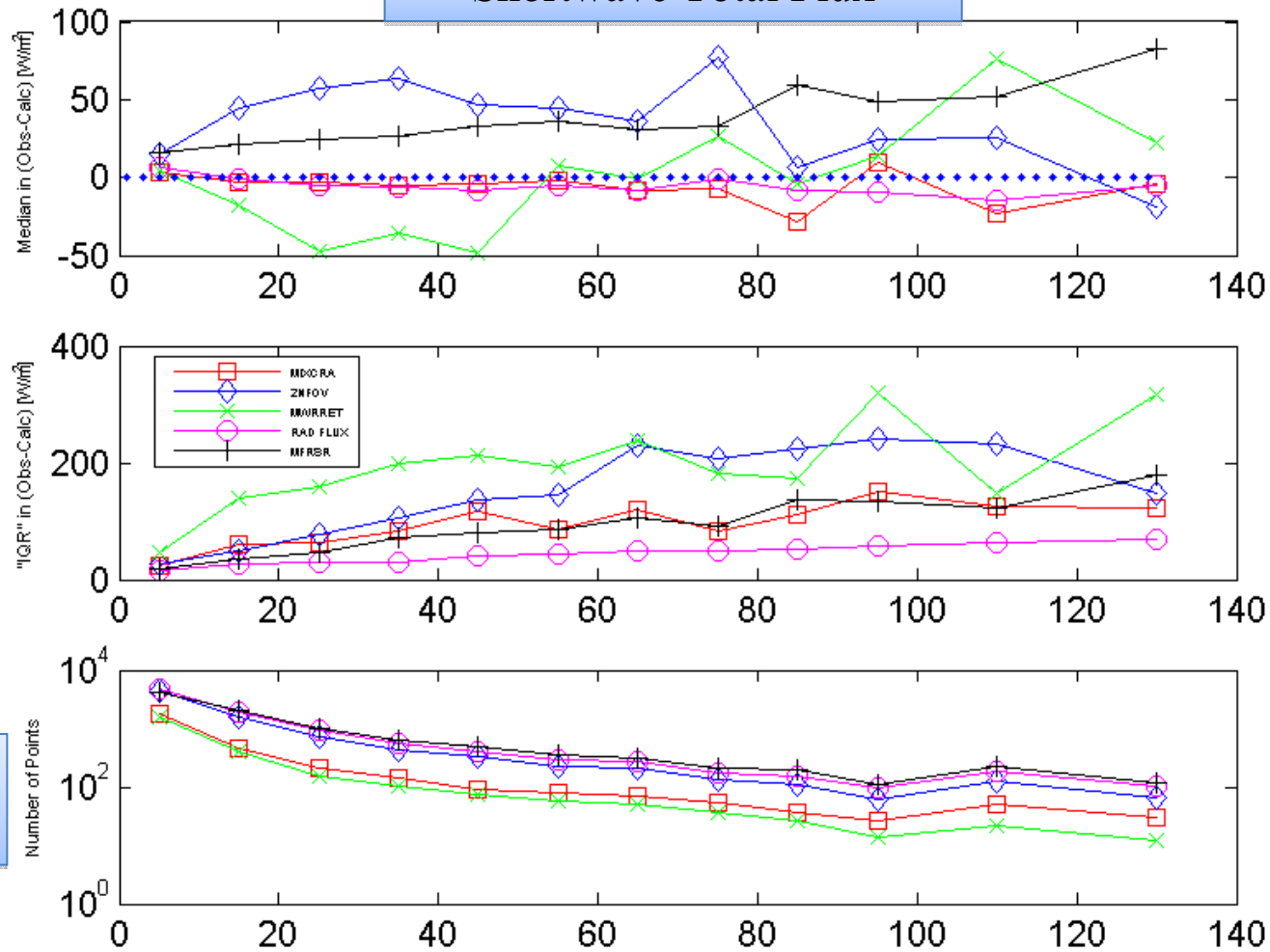
Results – Standard Deviation

Shortwave Total Flux

Median Flux Residual

75th-25th Interquartile

Number of Points



Measured Total Flux Standard Deviation

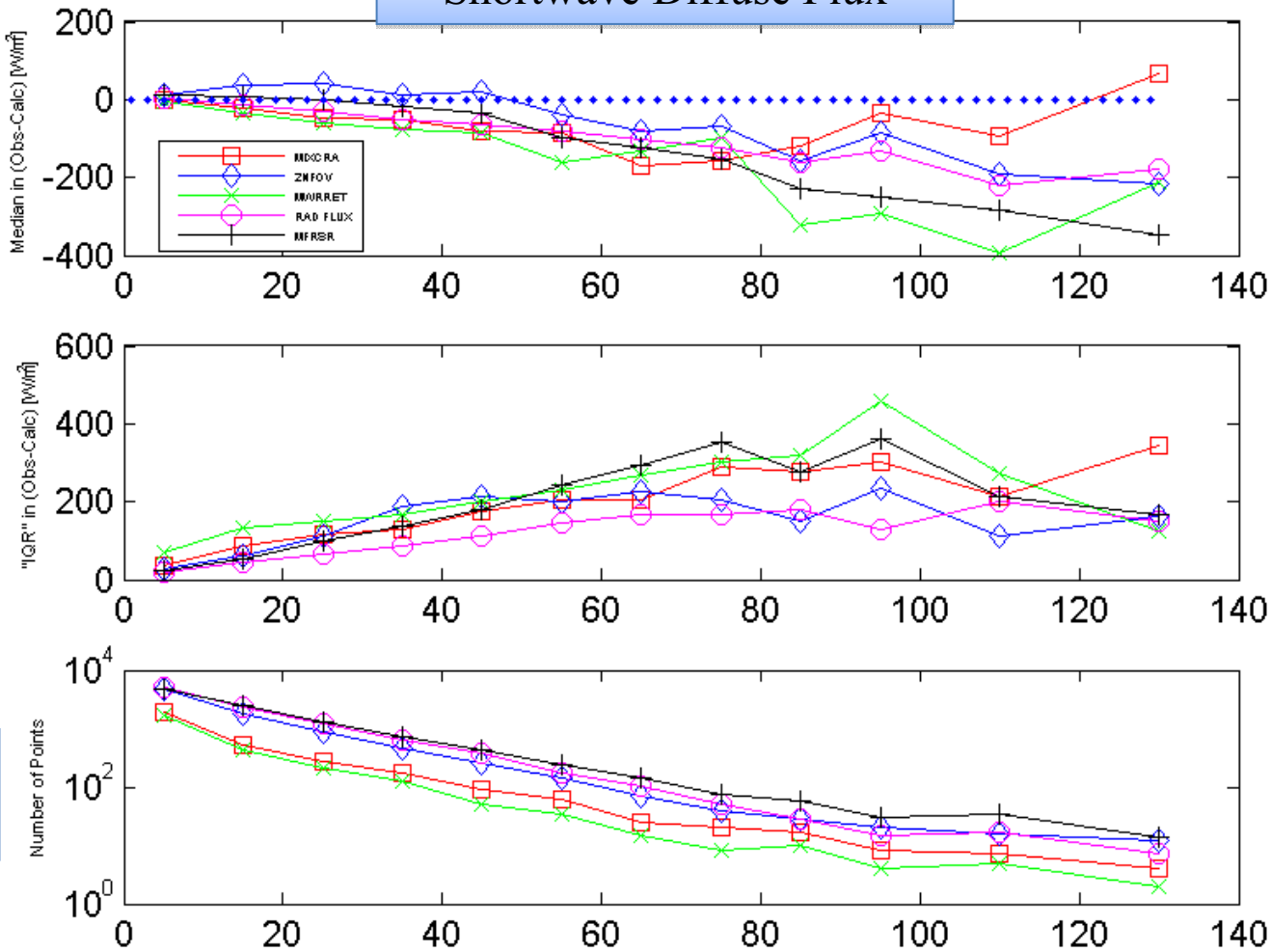
Results – Standard Deviation

Shortwave Diffuse Flux

Median Flux Residual

75th-25th Interquartile

Number of Points



Measured Diffuse Flux Standard Deviation

Future Work

- Run remaining retrievals through BBHRP
  - Min – MFRSR
  - Minnis/Khaiyer – VISST
- Compare surface and TOA Longwave Residuals
  - Mandy Khaiyer agreed to "hand-navigate" several days (July 3, 5, 6, 15, 18, 25, 26)
- We welcome more participants!!!!!
- Prepare and submit manuscript
- Move on to the next cloud type
  - Convective clouds (COPS)
  - Multi-year study at SGP