A TRMM-based Tropical Cyclone Precipitation Feature Database and Its Usage on Intensification Study

PI: Haiyan Jiang

Co-Is: Edward Zipser and Chuntao Liu

Department of Atmospheric Sciences, University of Utah

Collaborators: Jeff Halverson, UMBC

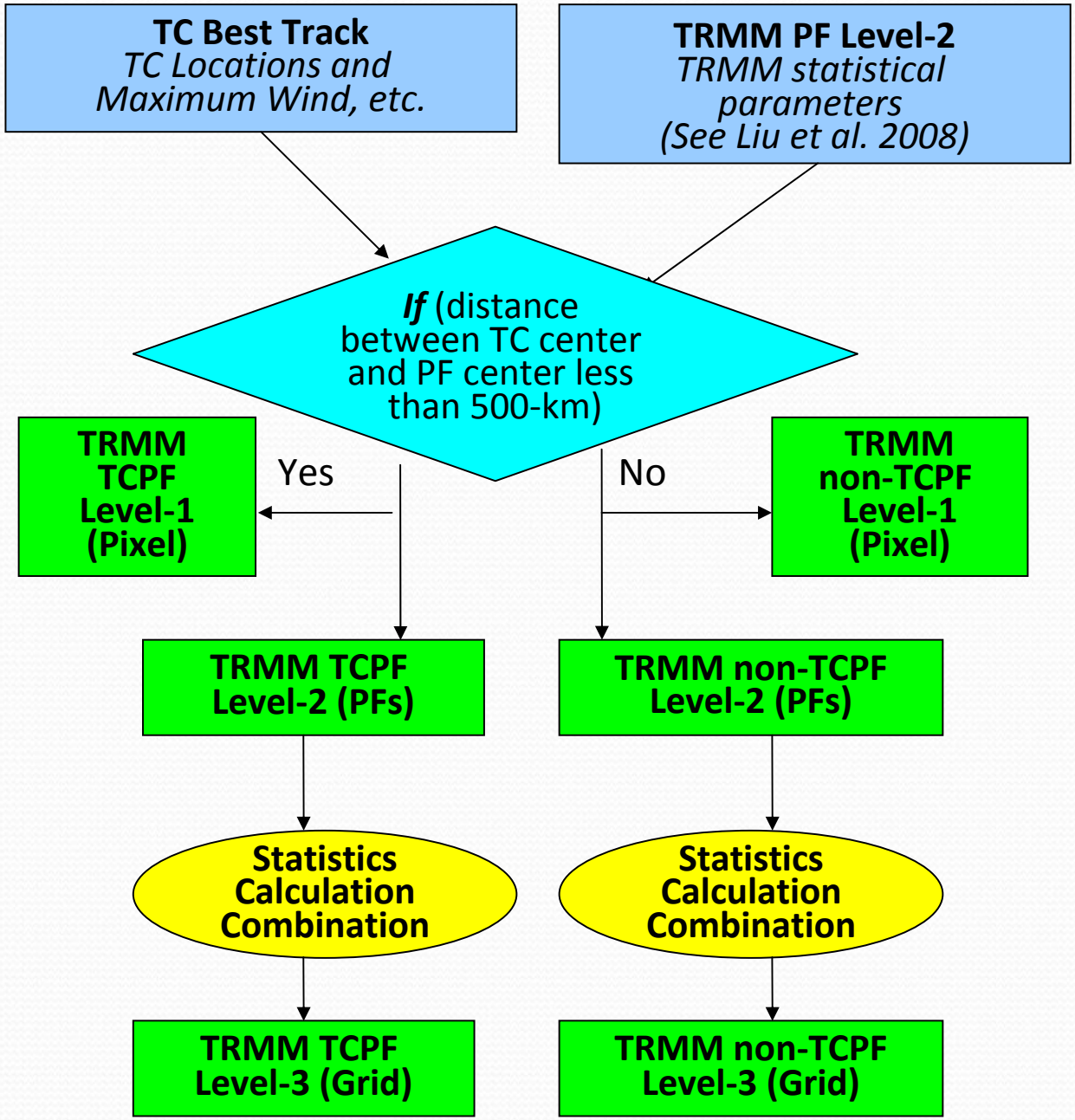
Tim Liu, JPL

Hurricane Science Research Program Science Team Meeting
Florida State University, Tallahassee FL
April 6-8, 2009

Univ. Of Utah TRMM Tropical Cyclone Precipitation Feature (TCPF) Database

- UU TRMM PF database is an event-based analysis method, which groups the adjacent pixels with TRMM measured properties in certain criteria. Very useful for regional and global climatology studies (Nesbitt et al. 2000, 2003, Cecil and Zipser 2002, Liu and Zipser 2005, Zipser et al. 2006, Liu et al. 2008.....).
- TCPF Database is a subset of the UU TRMM PF database. About 0.2 million PFs over 837 TCs during 1998-2007. TRMM PR, TMI, LIS, VIRS,3B42, NCEP reanalysis /NOGAPS analysis; will add TMI SST, QuikScat winds, NASA MERRA reanalysis data
- Will be online soon. Will provide data to the science team members based on request.

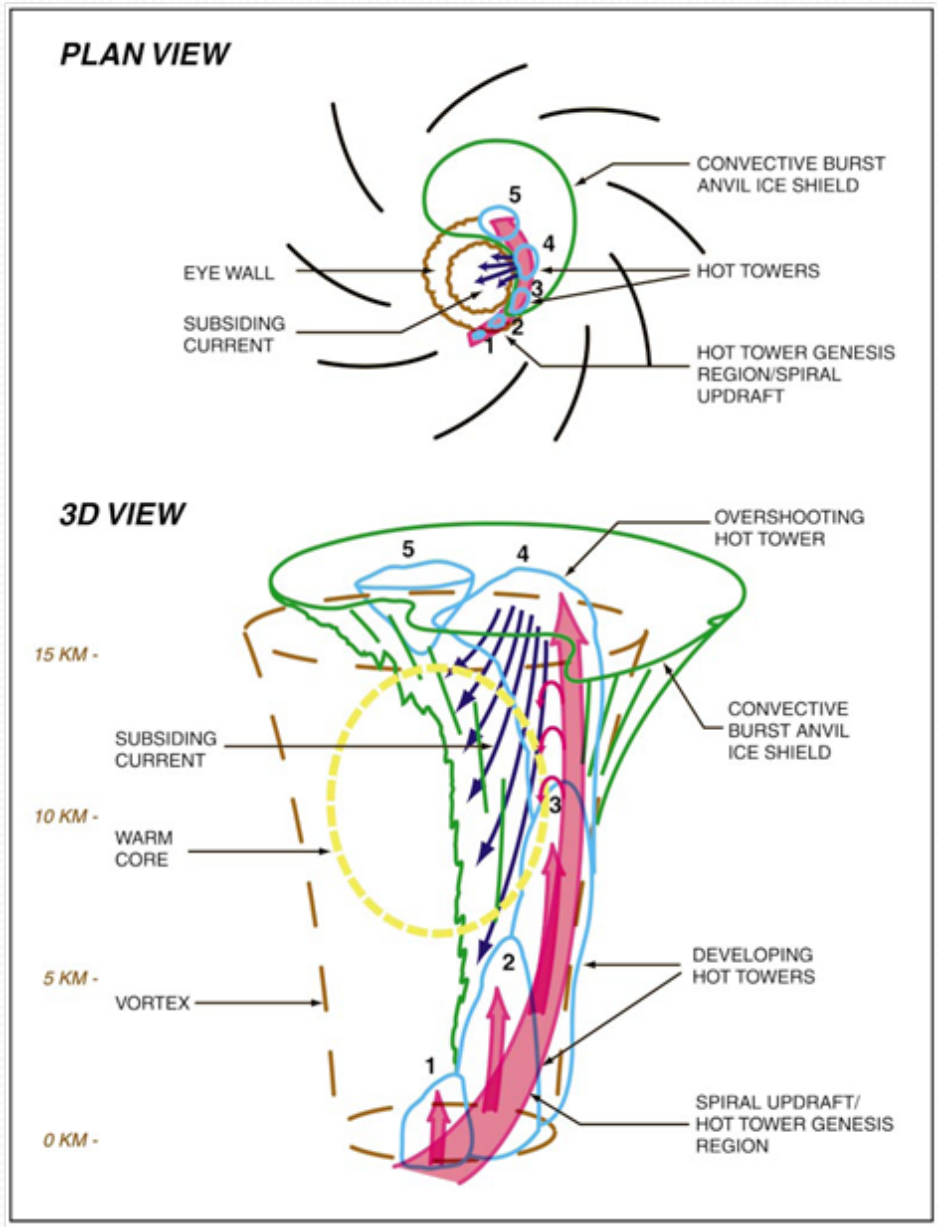
TRMM TCPF Database Flow Chart



Motivation of This Study

- Early studies suggest that hot towers *(--Simpson et al. 1998, Meteorology and Atmospheric Physics*) and convective bursts *(--Steranka et al. 1986, Monthly Weather Review*) near the eye can be related to TC intensity change.

- Hot towers: tall cumulonimbus towers which reach or penetrate the tropopause. *--Malkus and Riehl 1960, Tellus*.



Heymsfield et al. (2003) *Journal of Applied Meteorology*

Objectives

- Rank the strength of TC's convection in the eyewall (EW) in terms of the TC's maximum wind speed intensity

- Rank the strength of TC's convection in the eyewall (EW) stratified by the TC's intensity change: *i.e.*, non-intensifying (NonIN) and intensifying (IN) including rapid intensifying (RI, 24-h maximum wind speed increase 30 kt or greater) and slow intensifying (SI, 24-h maximum wind speed increase 30 kt or less) stages.

- Evaluate the probability of RI/IN when the TC's eyewall (EW) contains one or more hot towers or a closed ring of precipitation exists surrounding the eye.

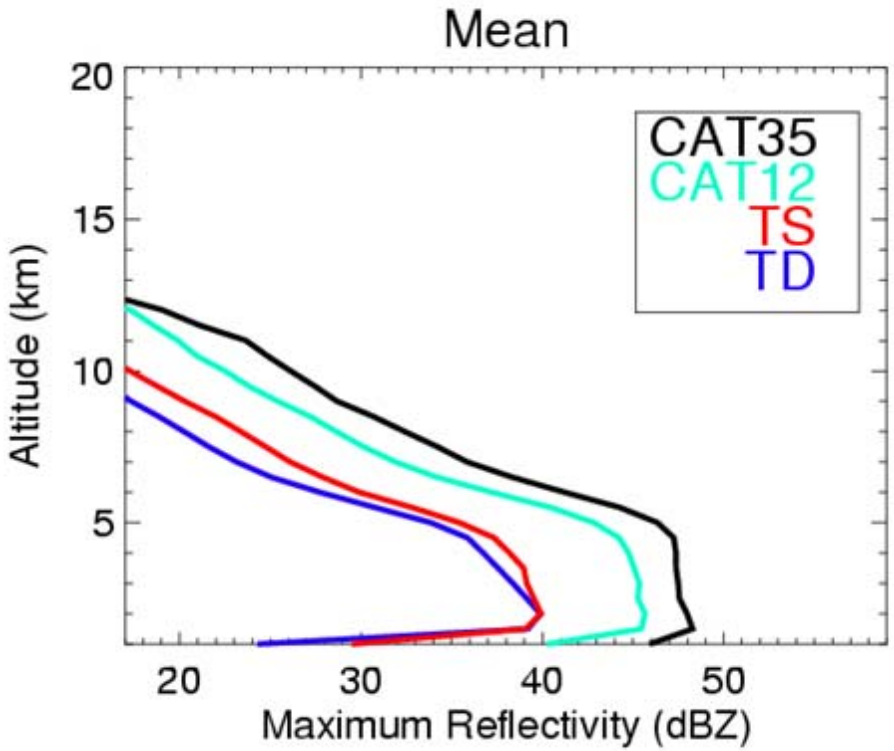
Data and Methodology

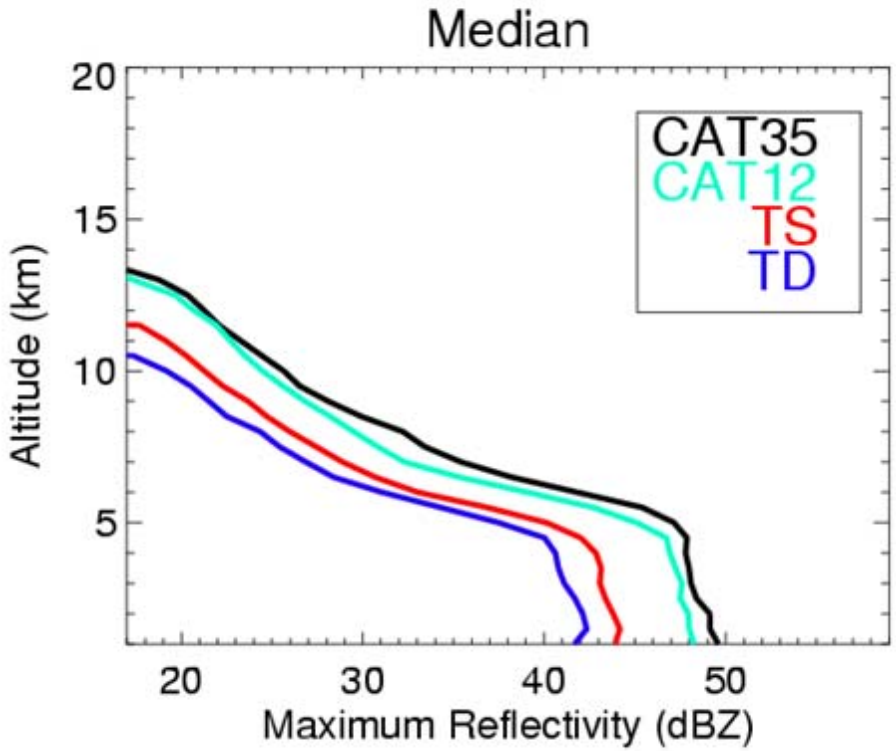
- 9 years (1998-2006) of UU TRMM TCPF data
- Manually select TRMM orbits in which TC EW is well-observed. For multiple EWPFs per orbit, we only select the strongest EWPF in terms of PR Max 20 dBZ height.

Intensity	CAT35	CAT12	TS	TD	Total
EWPFs	74	162	448	54	1233

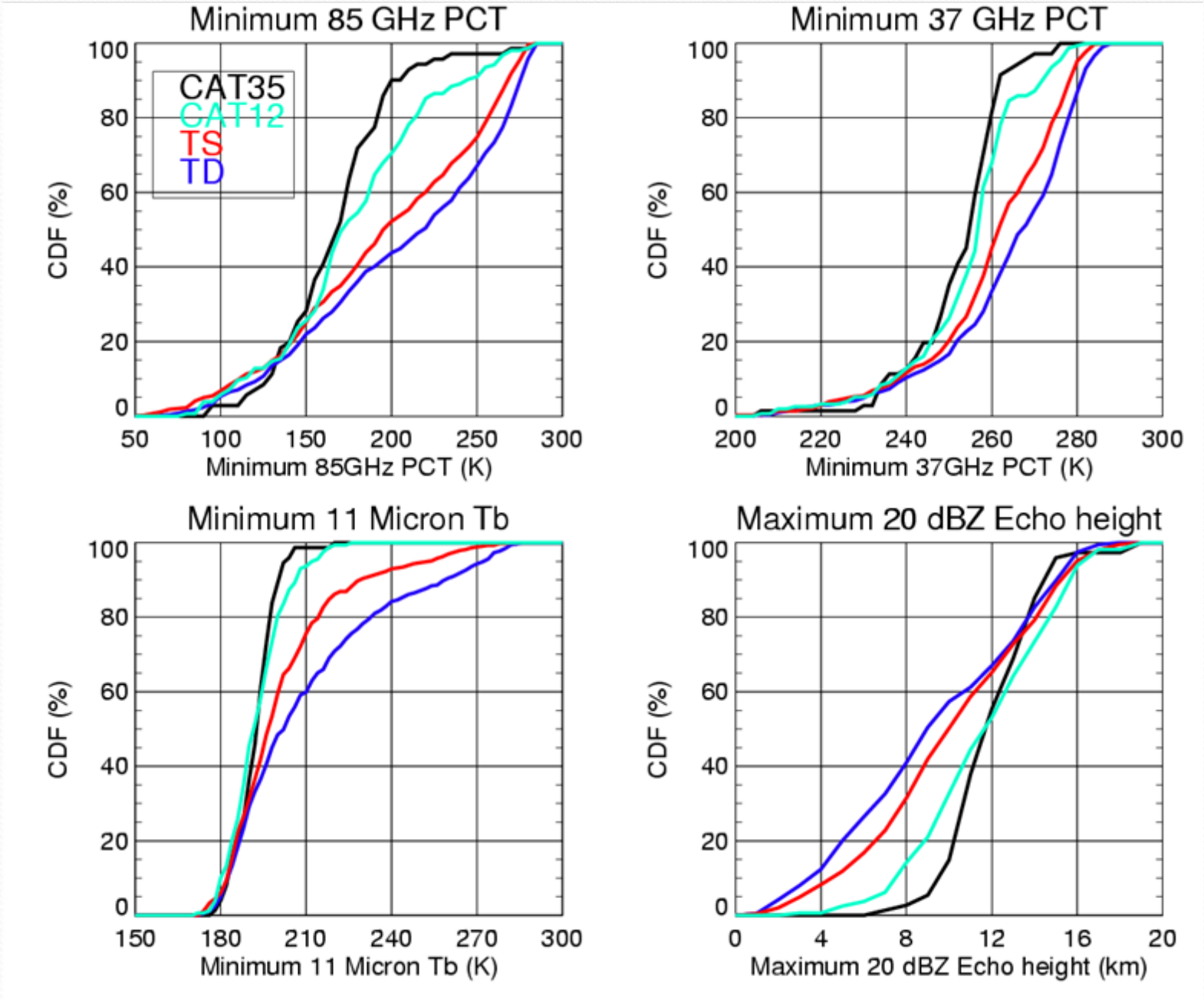
Intensity Change	RI	SI	IN	NonIN	Total
EWPFs	58	532	590	475	1065

Mean and Median Profiles of Maximum Reflectivity for Different TC Intensities

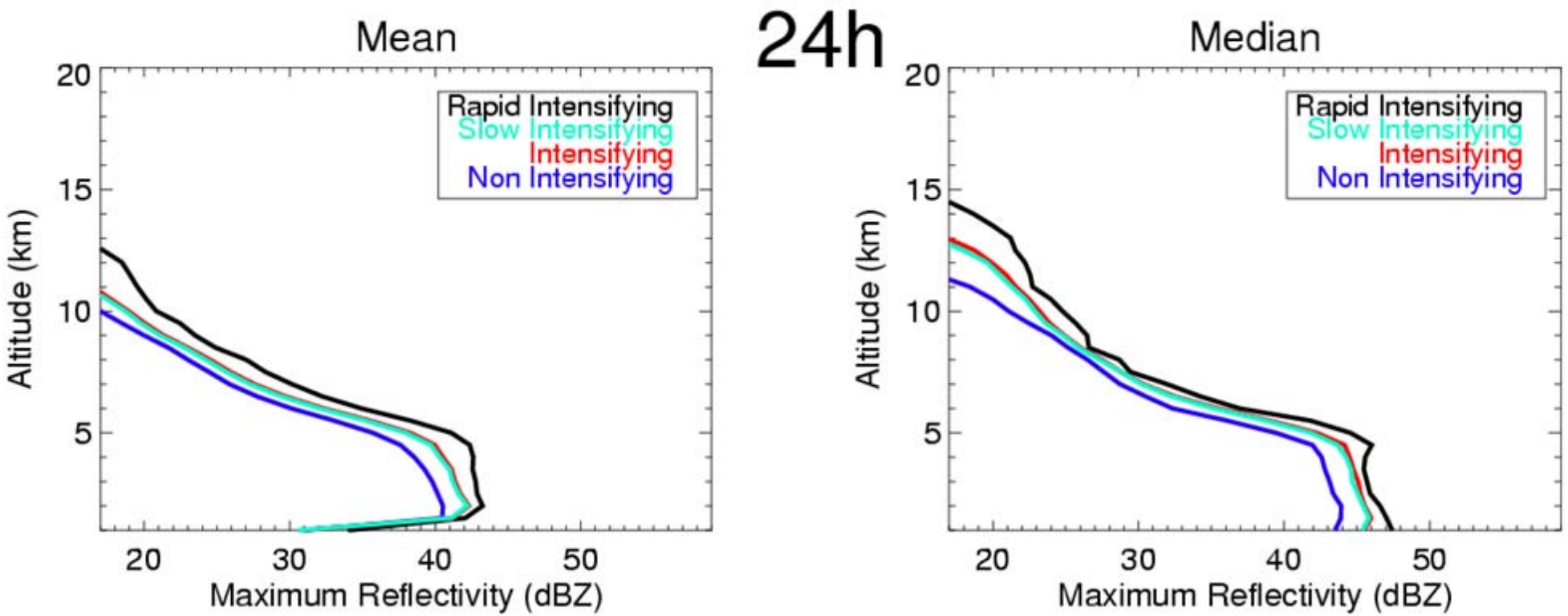




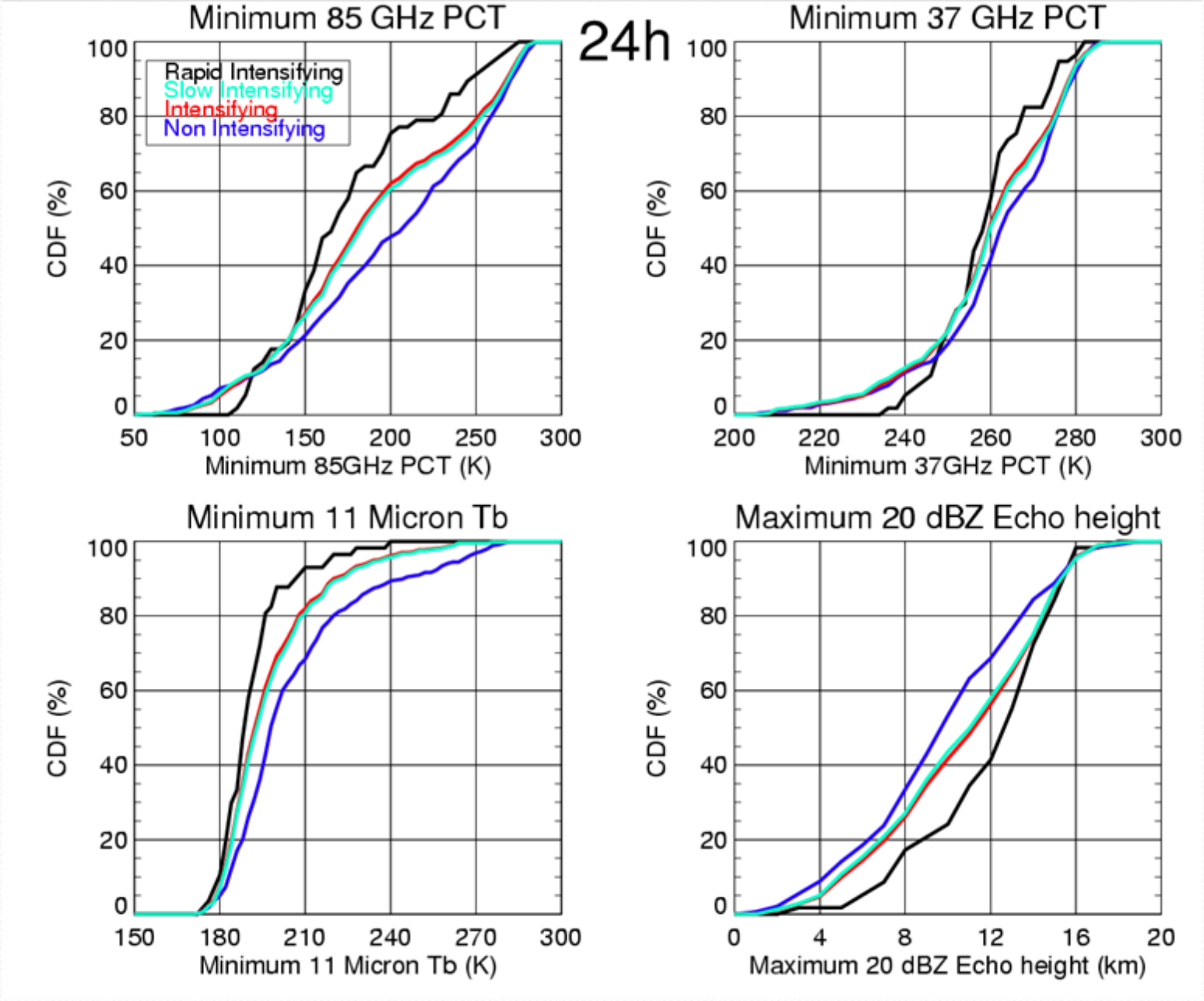
CDFs of Min. 85GHz PCT, Min. 37GHz PCT, Min. Tb11, and Max. 20 dBZ Echo Height for Different Intensities



Mean and Median Profiles of Maximum Reflectivity for Different Future 24-h Intensity Change Stages

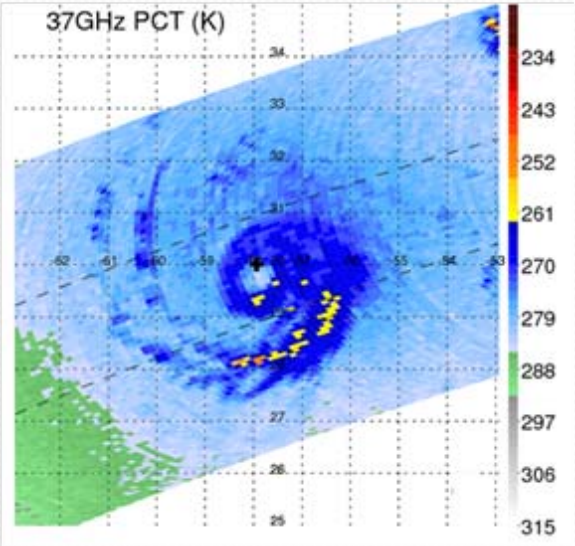


CDFs of Other Convective Properties for Different Future 24-h Intensity Change Stages



Chance of RI/IN When Hot Tower (HT) or Closed Ring Eyewall Exists

- Define HT: Maximum 20 dBZ echo height > 14.5 km (same as Kelley et al. 2004)
- Define closed EW: From the EWPF dataset, we select those with a feature of closed ring of precipitation surrounding the eye in terms of TMI 37 GHz PCT (polarization corrected brightness temperature) and attribute these subset of EWPFs as closed EWPFs.



	EWPFs with HT	Closed EWPFs	Total EWPFs
RI	20	14	58
SI	154	51	532
IN	174	65	590
NonIN	90	51	475
Total	264	116	1065
Chance of RI	8%	13%	5%
Chance of IN	66%	56%	55%

Summary

- A relationship does exist between TC intensity/intensity change and the strength of convection in the eyewall based on analyzing 9 years of TRMM observed convective proxies.
- The chance of RI/IN increases when a hot tower exists, but not substantially. A hot tower is neither a necessary nor a sufficient condition for RI. The role of hot tower on TC intensification needs to be further examined.
- The chance of RI/IN increases when a closed precipitation ring exists surrounding the eye.

Future Work

- Complete the TCPF database and put it online
- Select a larger subset in terms of TMI and VIRS observations to analyze hot towers and convective bursts; lightning data
- Examine the role the environmental factors such as SST, shear, total precipitable water, horizontal moisture convergence, etc.
- Combined effects of convective intensity and environmental factors on rapid intensification
- Case studies

My Wish List for the Field Program

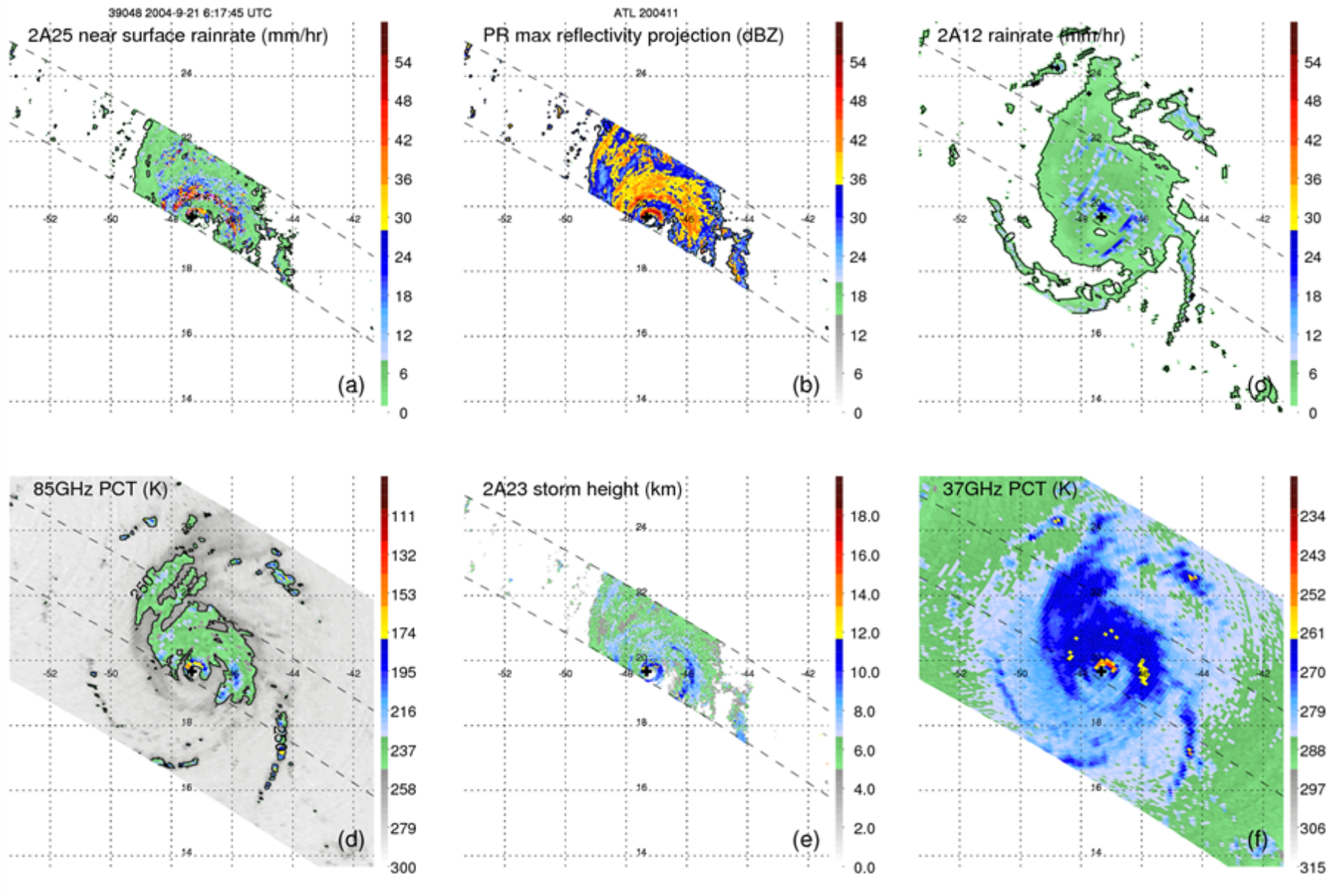
- RI cases with/without hot towers/convective bursts
- RI cases with/without closed eyewall feature
- Hot tower/convective burst cases without RI
- Closed eyewall cases without RI
- Radar and radiometer measurements
- Dropsonde data to obtain large scale environment factors
- Vertical velocity and microphysics measurements inside the eyewall

Contact: hjiang@utah.edu

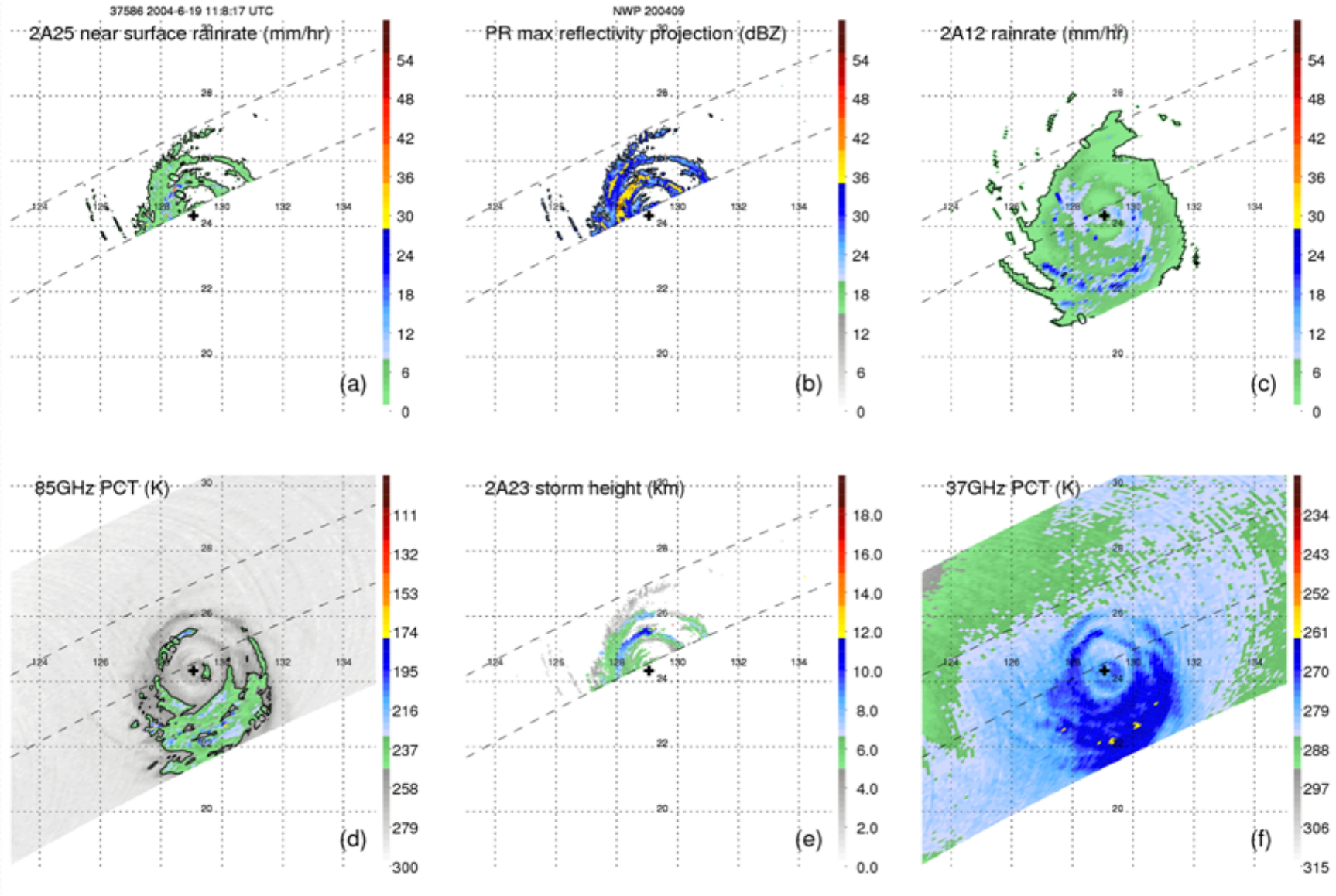
Webpage:

http://trmm.chpc.utah.edu

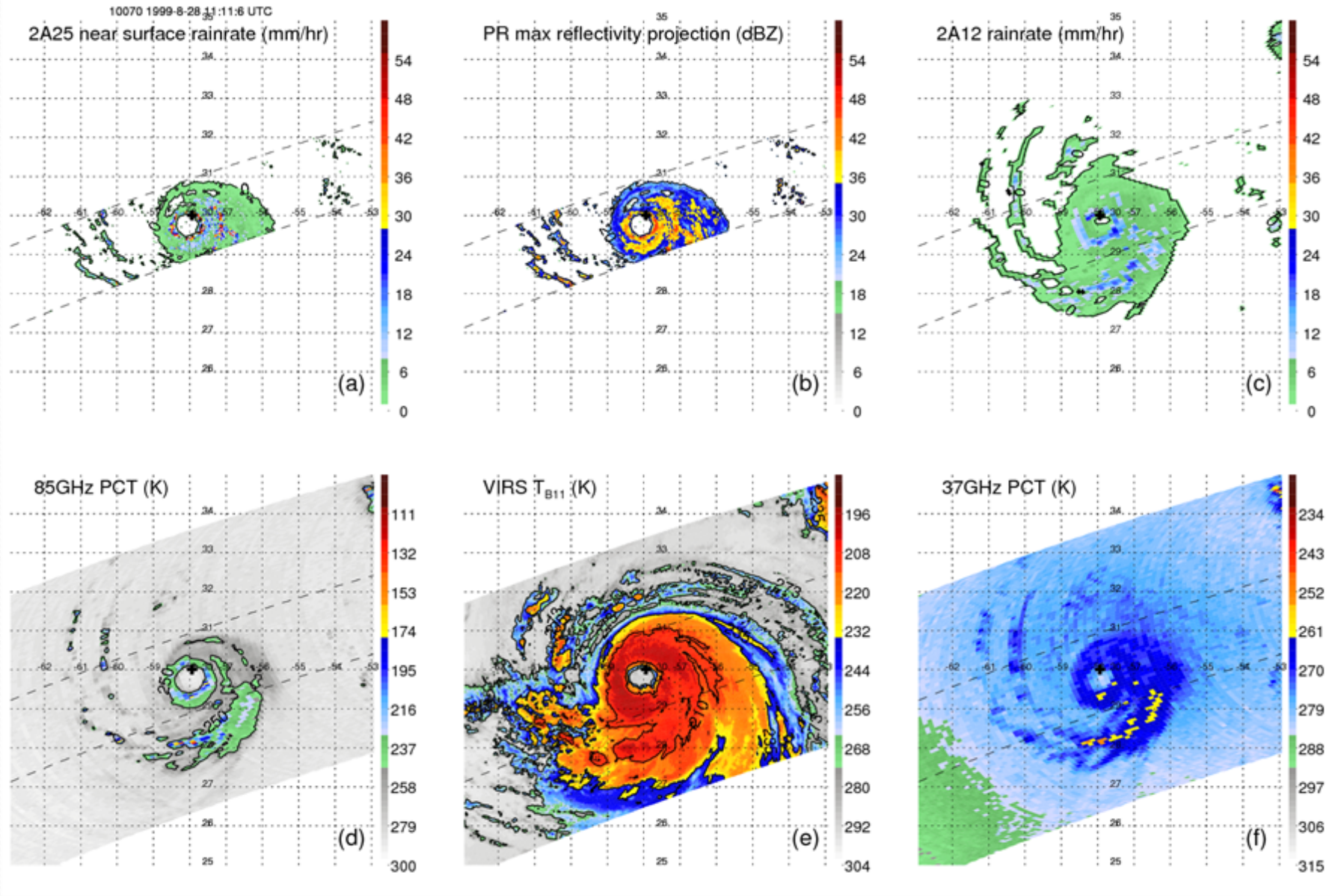
Accepted EWPF Example: TRMM Observations of Atlantic Hurricane Karl (2004)



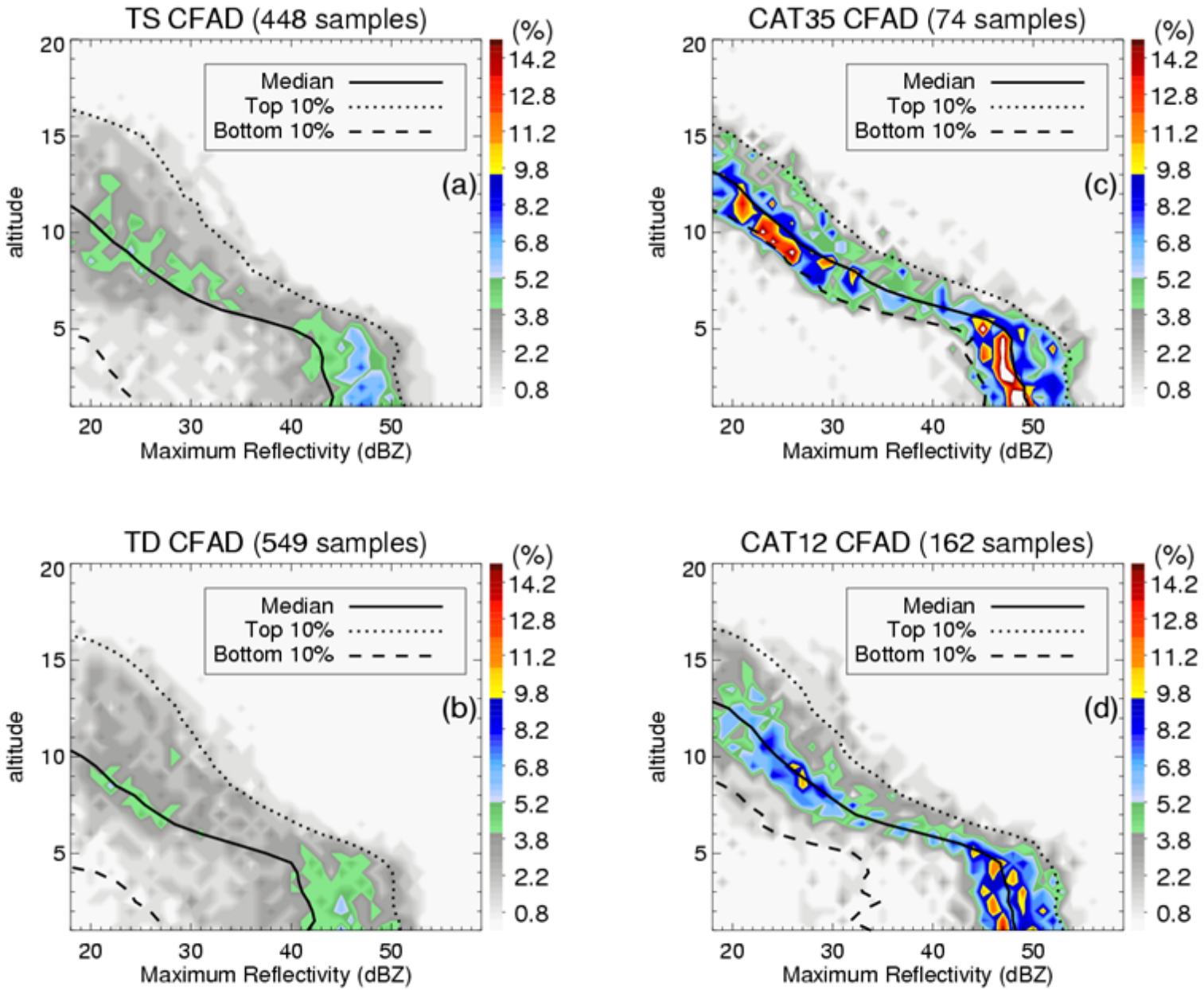
Rejected EWPF Example: North West Pacific Typhoon Dianmu (2004)



Accepted Closed EWPF Example: TRMM Observations of Atlantic Hurricane Cindy (1999)



CFADs of Maximum Reflectivity Profiles in EWPFs for Different TC Intensities



CFADs of Maximum Reflectivity Profiles for Different Future 24-h Intensity Change Stages