The TRMM Tropical Cyclone Precipitation Feature (TCPF) Database

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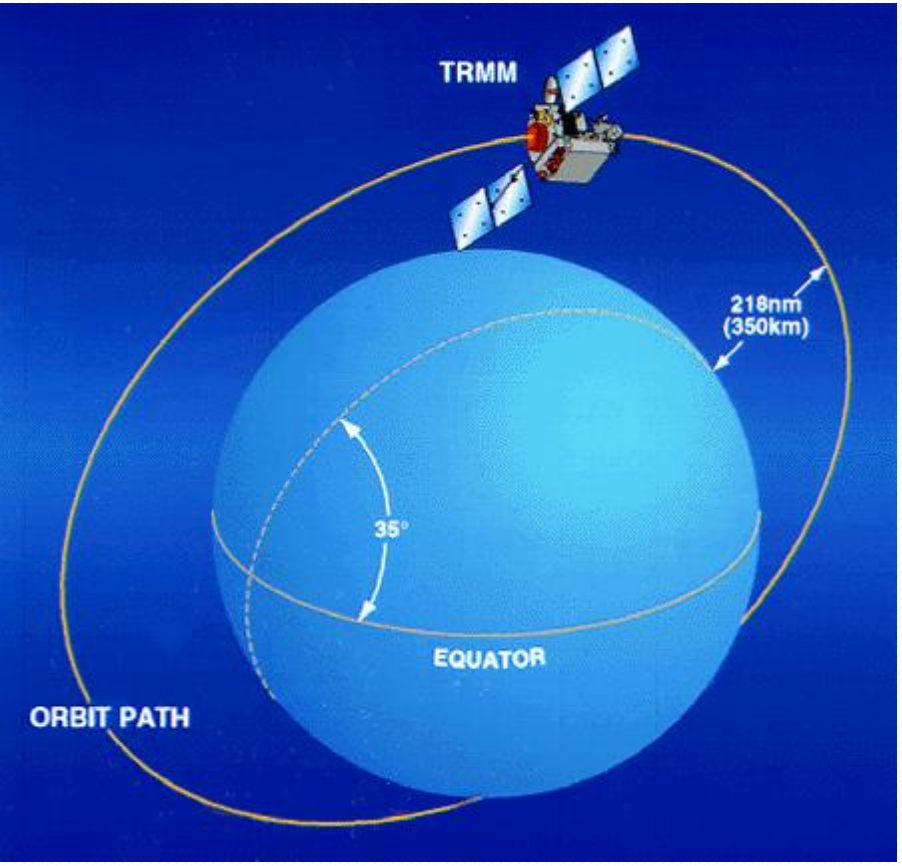
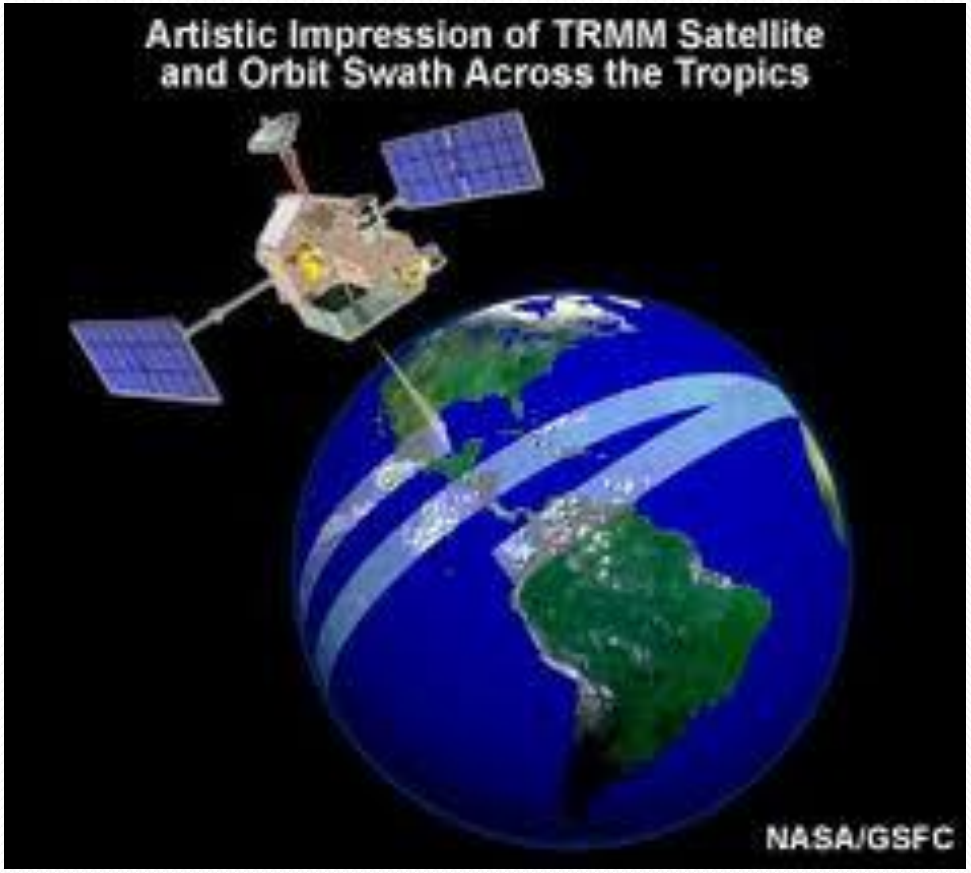
Overview

- A collaborative effort between FIU and Univ. of Utah.
- A Terra-Byte sized database including all tropical cyclones (TCs) observed by the NASA's TRMM satellite since Dec. 1997.
- Images and level-1 data are online at http://tcpf.fiu.edu/
- The entire database is kept at our research group's 80 TB servers

NASA's Tropical Rainfall Measurement Mission (TRMM)

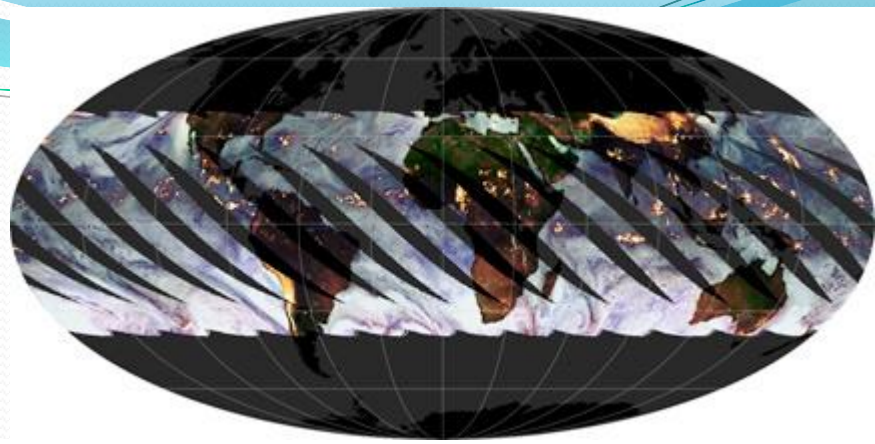
- Launched in Dec. 1997.
- 15+ years (1998-current) of data available, very unique dataset for precipitation and convection studies in tropical cyclones
- TRMM satellite orbit: circular (Non-Sun Synchronous)
- Altitude: 350 km (402 km since Aug. 2001)
- Inclination: 35 degree.
- Observation frequency: 16 times per day.

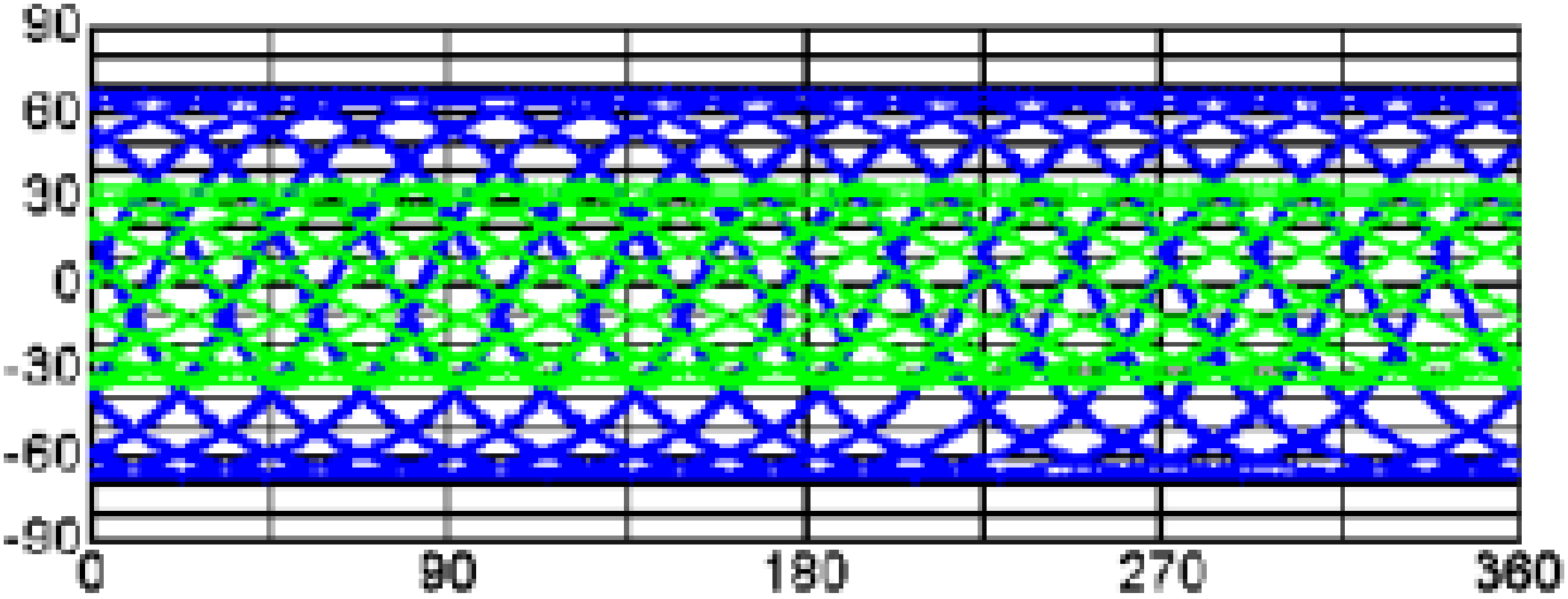




Online animation of TRMM orbit:

http://earthobservatory.nasa.gov/Features/RemoteSensingAtmosphere/remote_sensing7a.php



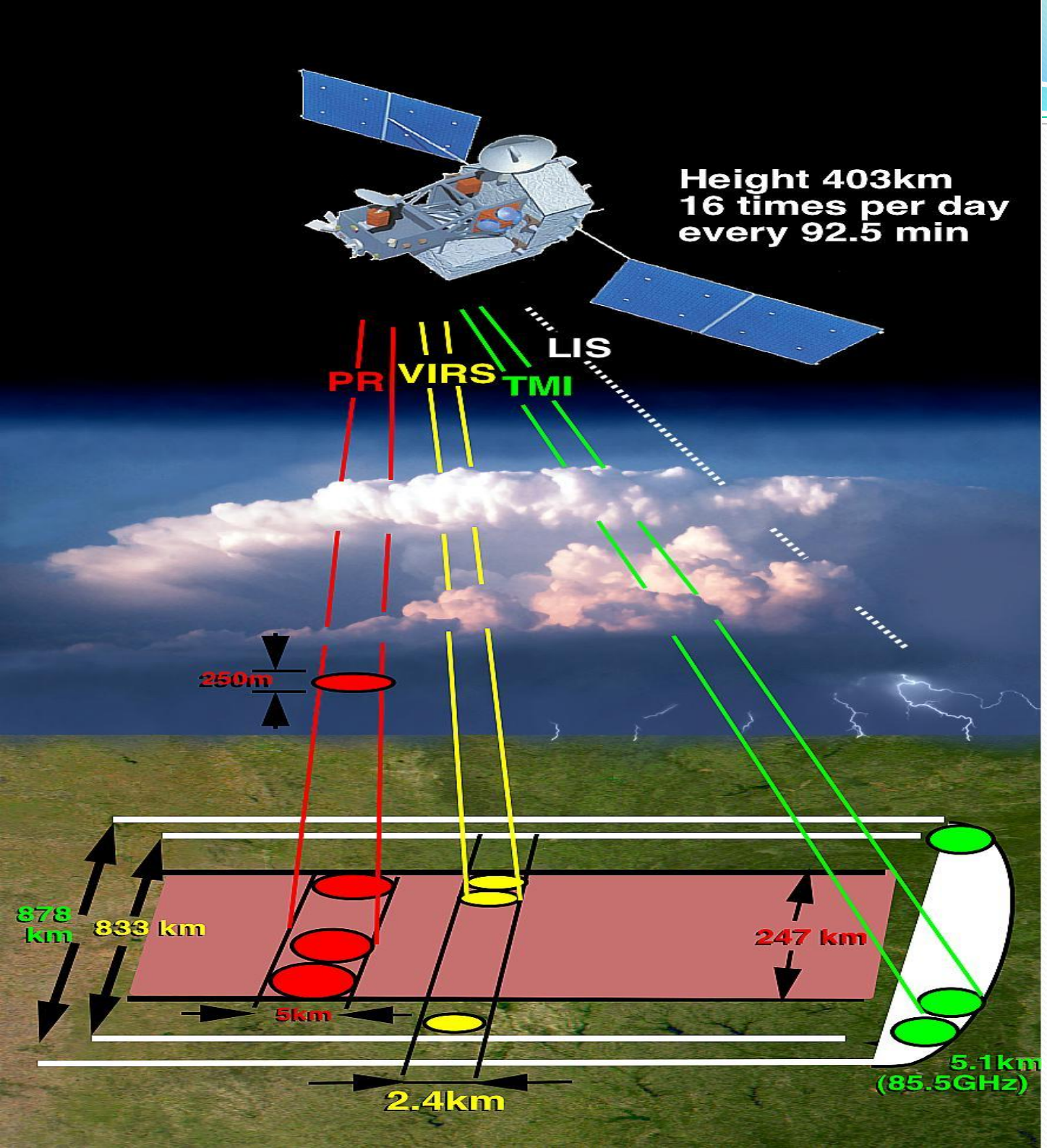


Blue: Inclination ~65º (GPM core)

Green: Inclination ~35º (TRMM)

Instruments on TRMM:

- Precipitation Radar (PR): 13.8 GHz (wavelength: 2.17 cm)
- TRMM Microwave Imager (TMI): 10, 19, 22, 37, and 85 GHz
- Visible and Infrared Scanner (VIRS): 0.63, 1.6, 3.75, 10.80, and 12.0 μm
- Lightning Imaging Sensor (LIS): detects total lightning--flash count & location



Terminology:

1. Orbit
2. Swath
3. Footprint
4. Pixel
5. Nadir

TRMM Major Products

- TRMM 2A25: TRMM PR-based reflectivity and rain rate profiles (Iguchi et al. 2000).
- TRMM 2A23: TRMM PR rain type classification
- TRMM 1B11: TMI Tb's in 10, 19, 22, 37, and 85 GHz
- TRMM 1B01: VIRS Tb's in Channel 1-4.
- TRMM 2A12: TMI-based surface rain rates (Kummerow et al. 1996).
- LIS Flash count, location and view time.
- TRMM 3B42: A multi-satellite product which uses GOES IR rain retrieval to fill in the holes of all available microwave estimates from TMI, SSM/I, AMSR-E, AMSU-B, etc. 0.25x0.25 degree lat/lon resolution, global coverage (50 S-50 N), 3-hourly (Huffman et al. 2007).

Univ. Of Utah (UU) TRMM Precipitation Feature (PF) Database

- An event-based analysis method, which groups the adjacent pixels with TRMM measured properties in certain criteria.
- Starting with Level-1 data:

  1. Collocated by using nearest neighborhood method
  2. Parallax correction

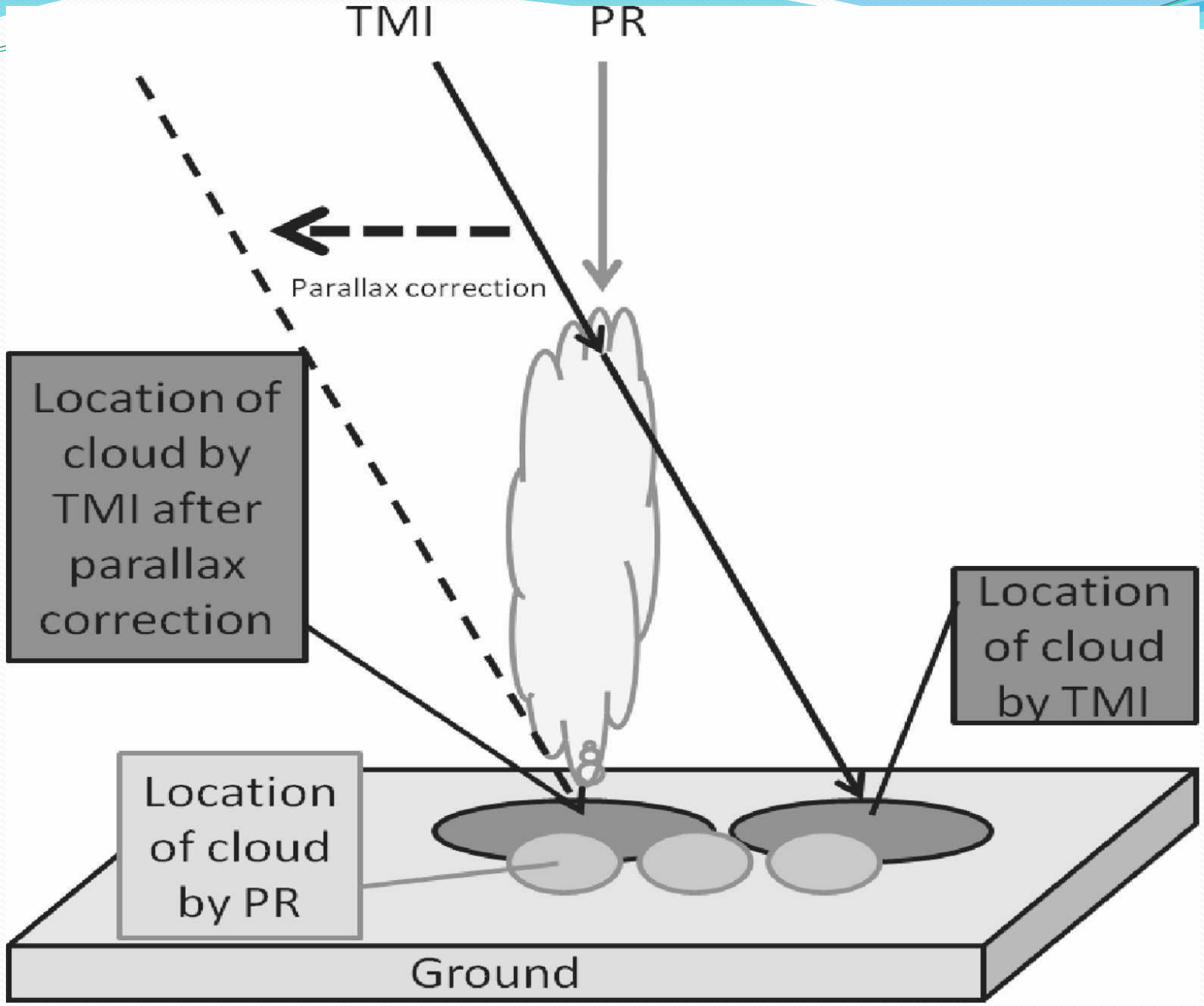
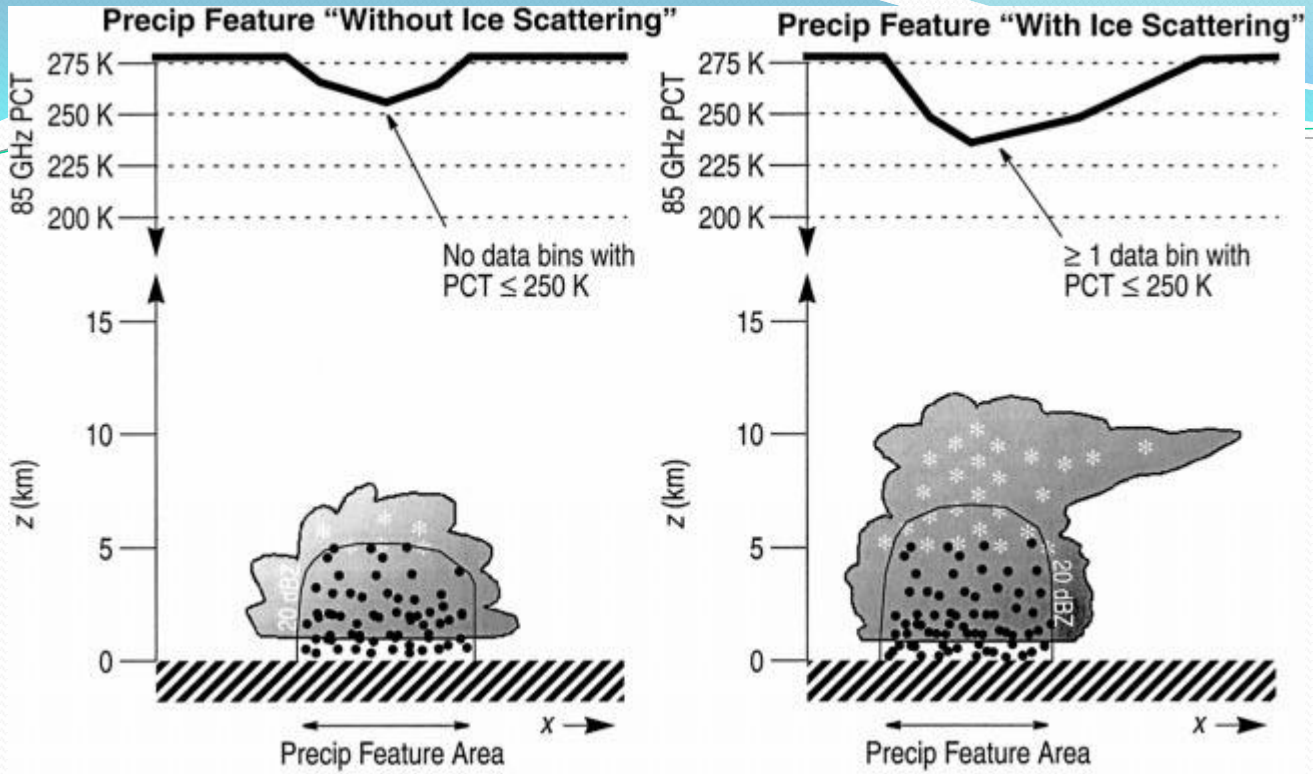

TMI
PR
Parallax correction
Location of cloud by TMI after parallax correction
Location of cloud by TMI
Location of cloud by PR
Ground

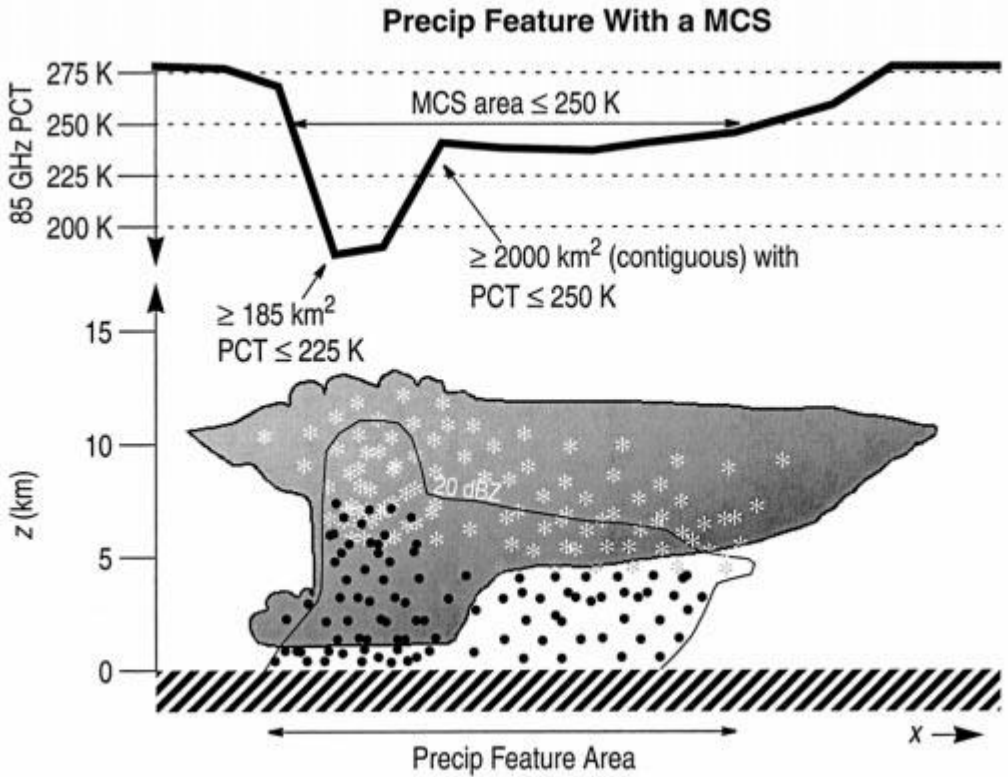
TABLE 1a. Criteria used to classify the three TMI–PR-identified precipitation features from Mohr and Zipser (1996).

Category name	Data	Criteria
PF without ice scattering (≤250 K)	PR near-surface reflectivity and nearest neighbor TMI 85-GHz PCT (within the PR swath)	• 4 or more contiguous data bins (area ≥75 km^2) with a PR near-surface reflectivity ≥20 dBZ • No data bins contain PCTs ≤250 K
PF with ice scattering and without an MCS	PR near-surface reflectivity and nearest neighbor TMI 85-GHz PCT (within the PR swath)	• 4 or more contiguous data bins (area ≥75 km^2) with a PR near-surface reflectivity ≥20 dBZ or a PCT ≤250 K • At least one data bin with PCT ≤250 K • Does not meet the PF with an MCS criteria below
PF with an MCS	PR near-surface reflectivity and nearest neighbor TMI 85-GHz PCT (within the PR swath)	• 108 or more contiguous data bins (area ≥2000 km^2) with PCT ≤250 K *with associated PR rain area* • 10 or more data bins (area ≥185 km^2) with PCT ≤225 K

Nesbitt et al. 2000

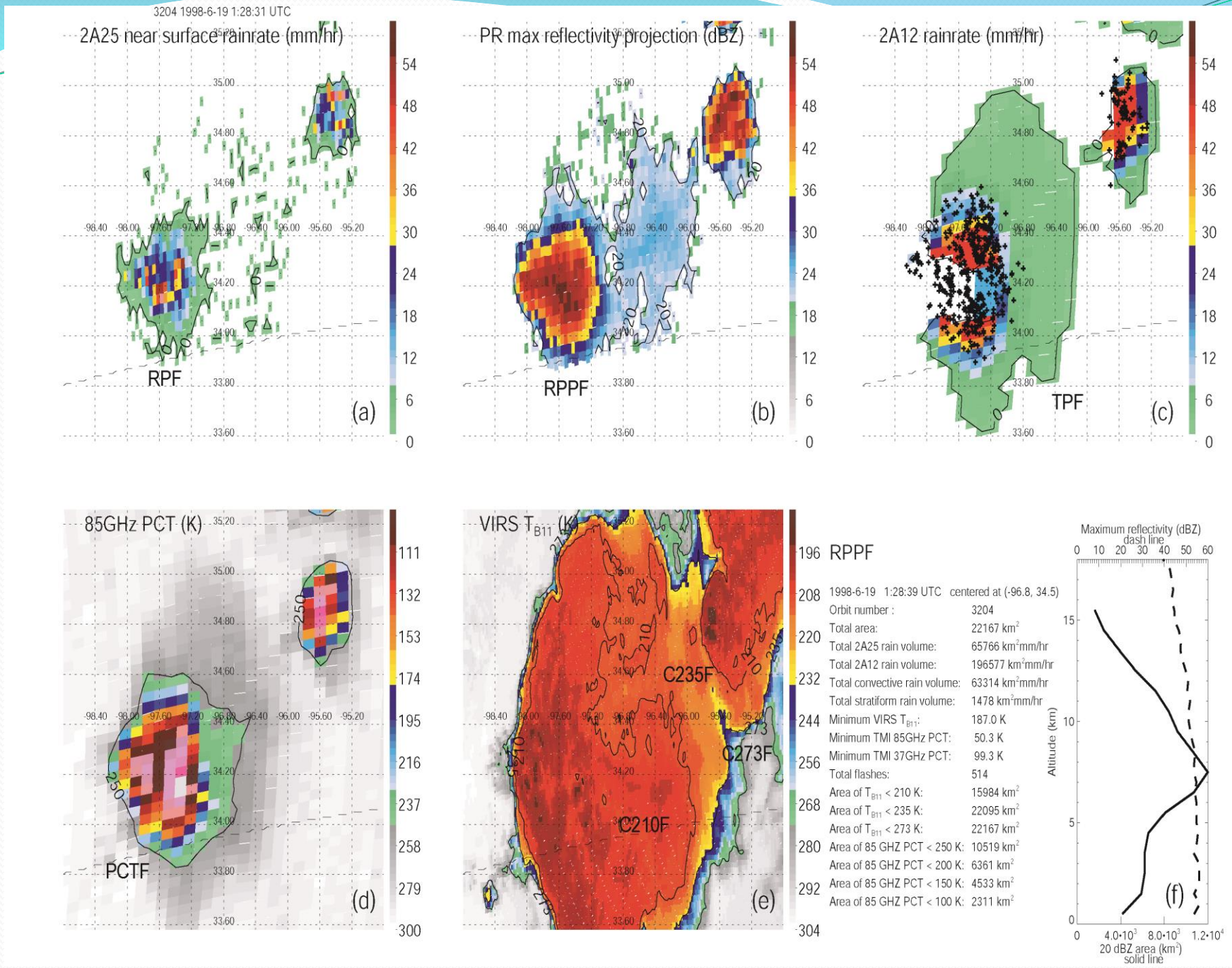
(J. of Climate)





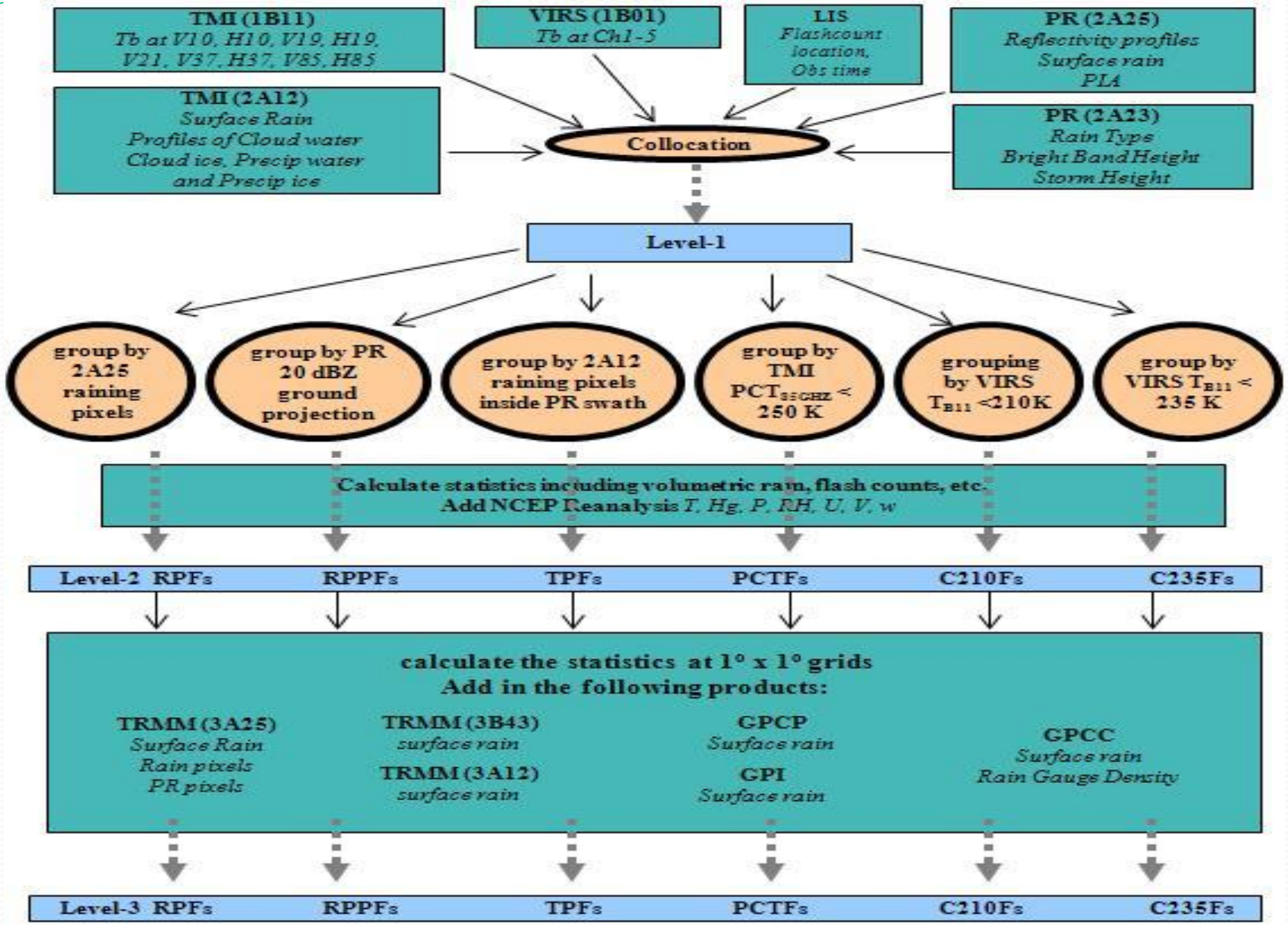
Nesbitt et al. 2000

(J. of Climate)



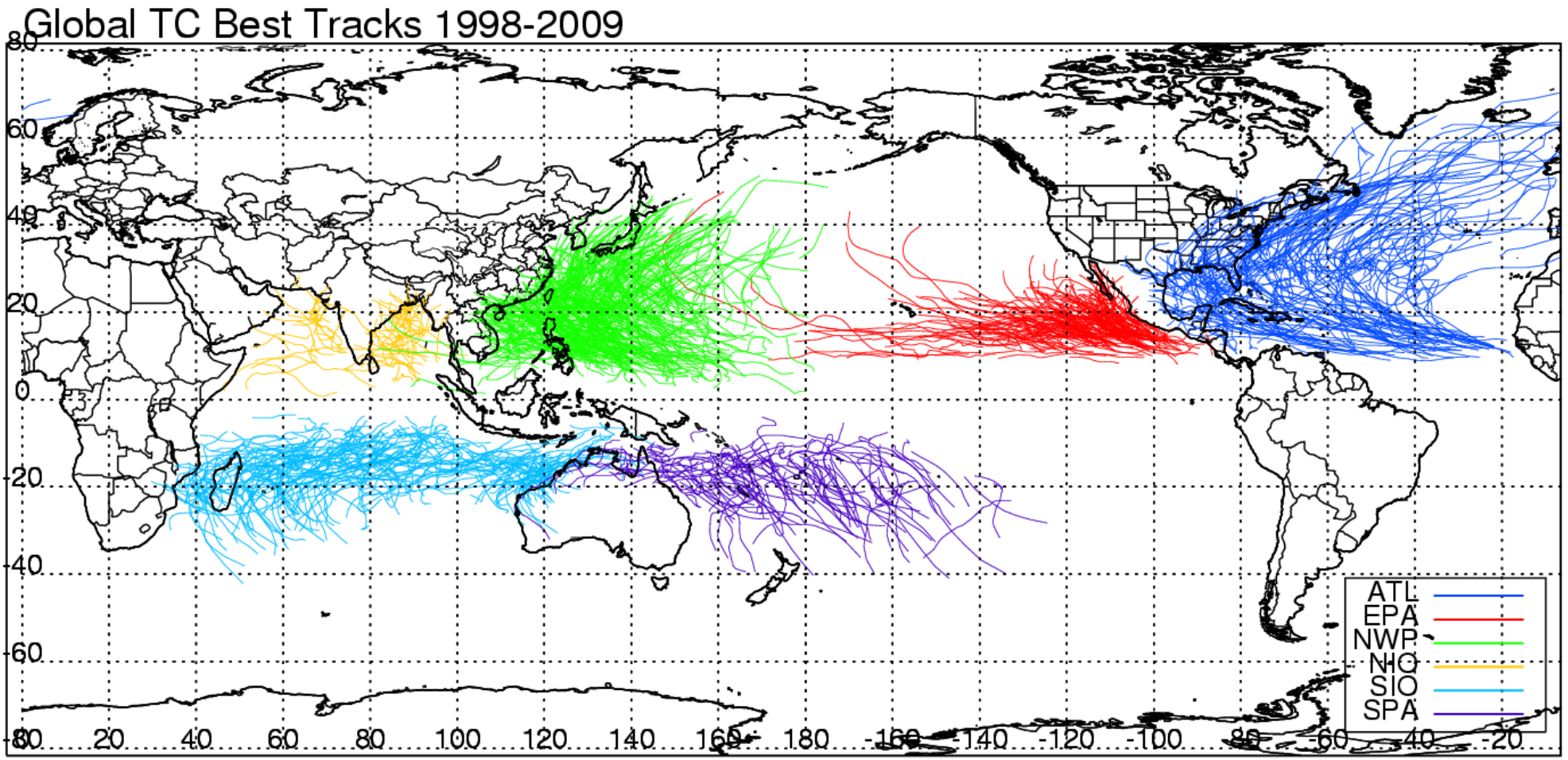
Liu et al. 2008 (J. of Climate)

UU TRMM PF database Structure

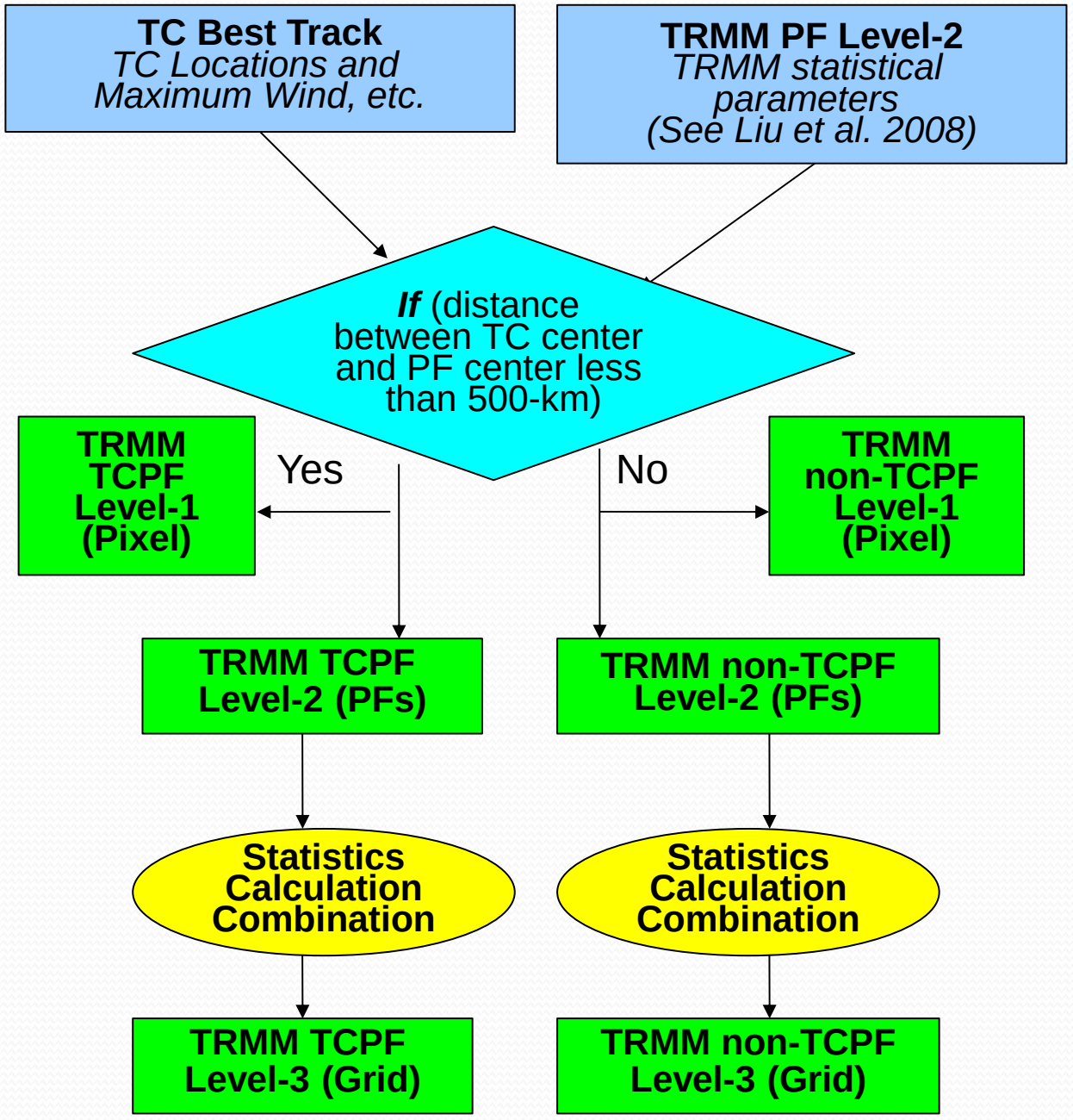


TRMM Tropical Cyclone Precipitation Feature (TCPF) Database: http://tcpf.fiu.edu

- A subset of UU TRMM PF database
- According to TC best track data over global TC-prone basins, all PFs within 500-km distance to the TC center are defined as TCPFs and separated with non-TCpfs
- Collocated TRMM observations (PR, TMI, LIS, & VIRS) in TCs **(Liu et al. 2008, Jiang et al, 2011).**
- The TCPF database is updated yearly according to best track data: now 14 years of data *(1998-2011)*

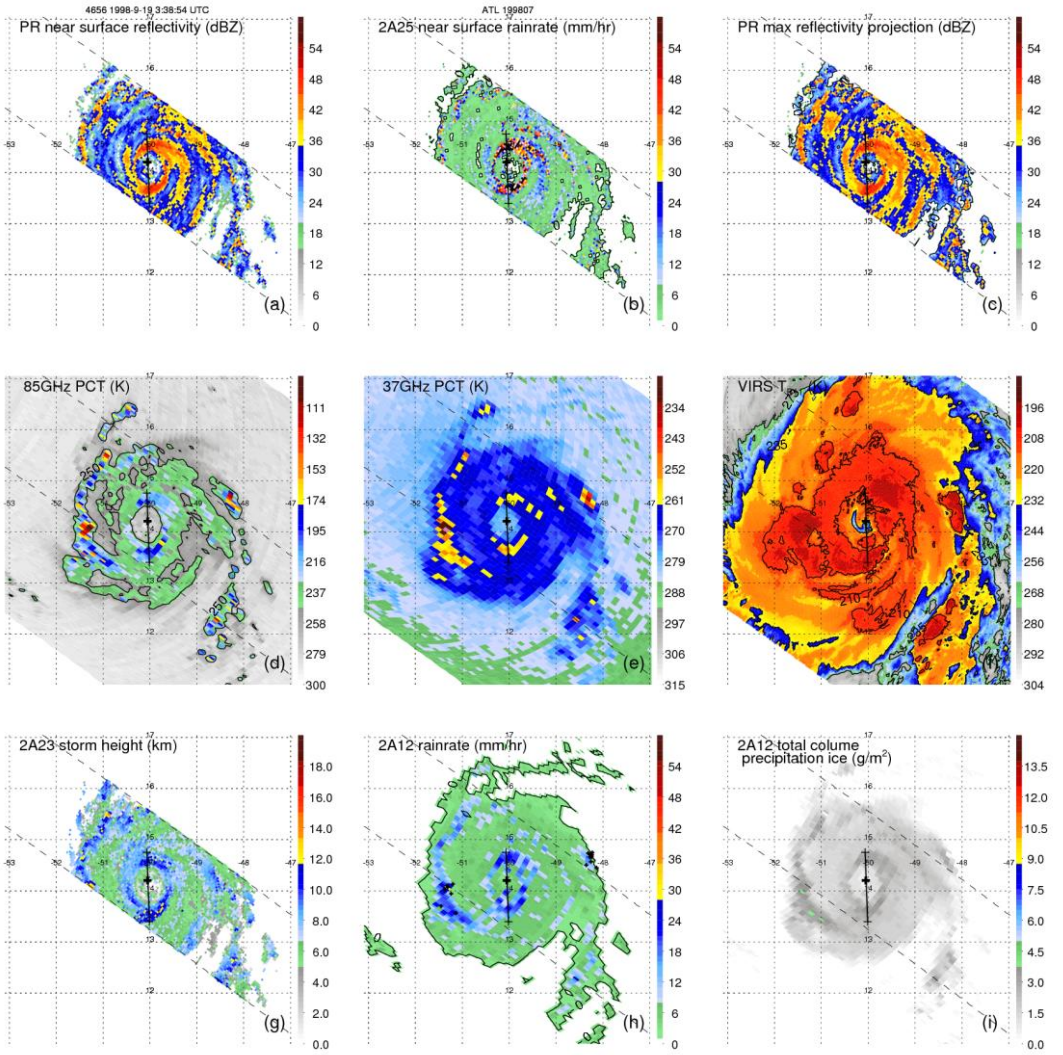

Global TC Best Tracks 1998-2009
80
60
40
20
0
-20
-40
-60
-80
20
40
60
80
100
120
140
160
180
-160
-140
-120
-100
-80
-60
-40
-20
ATL
EPA
NWP
NIO
SIO
SPA

TRMM TCPF Database Flow Chart

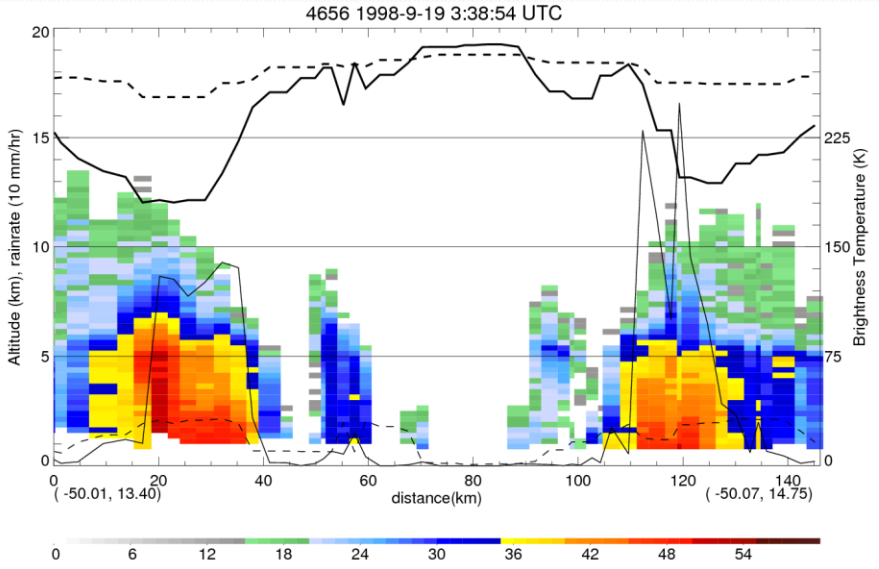


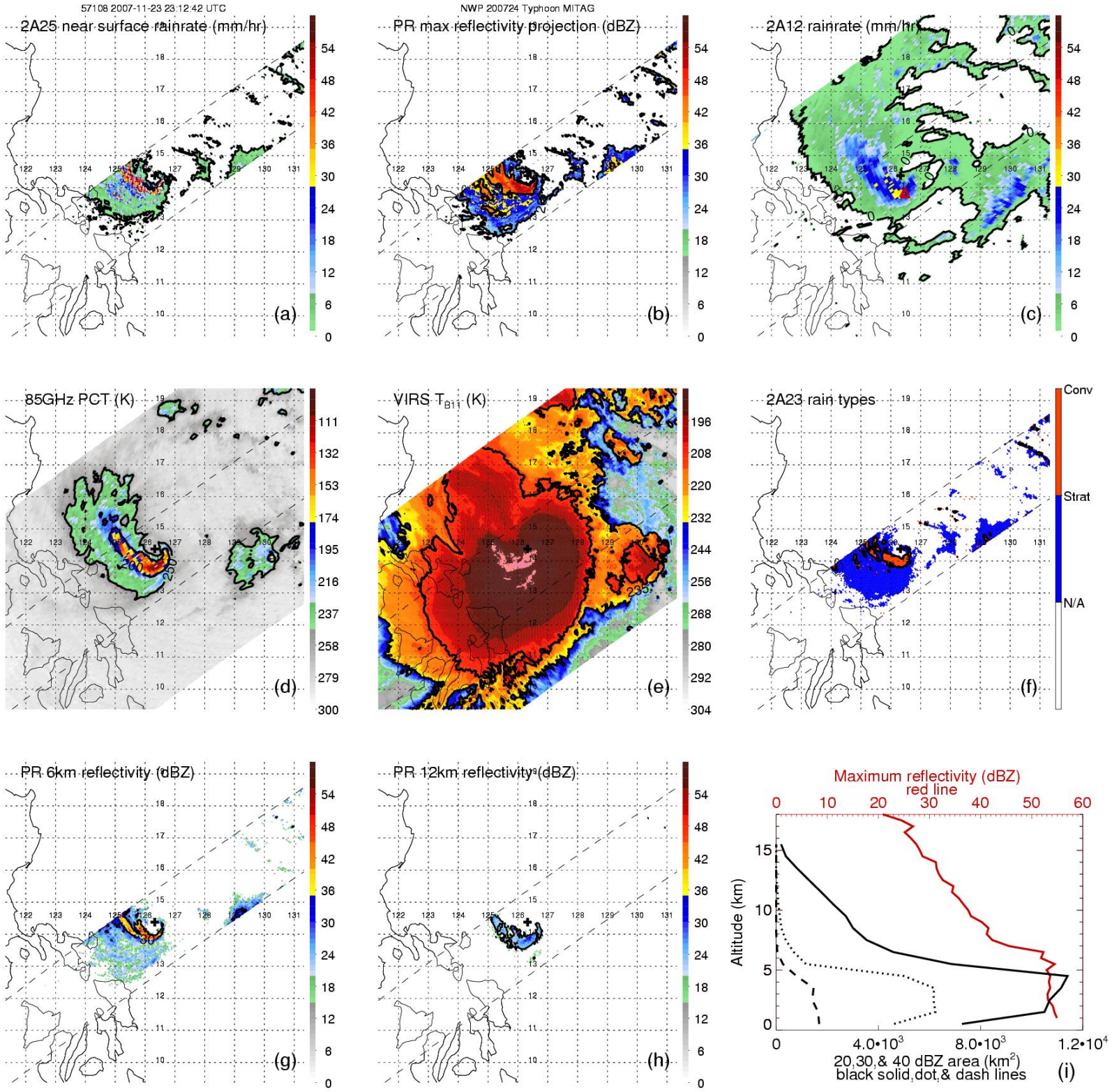
An Example

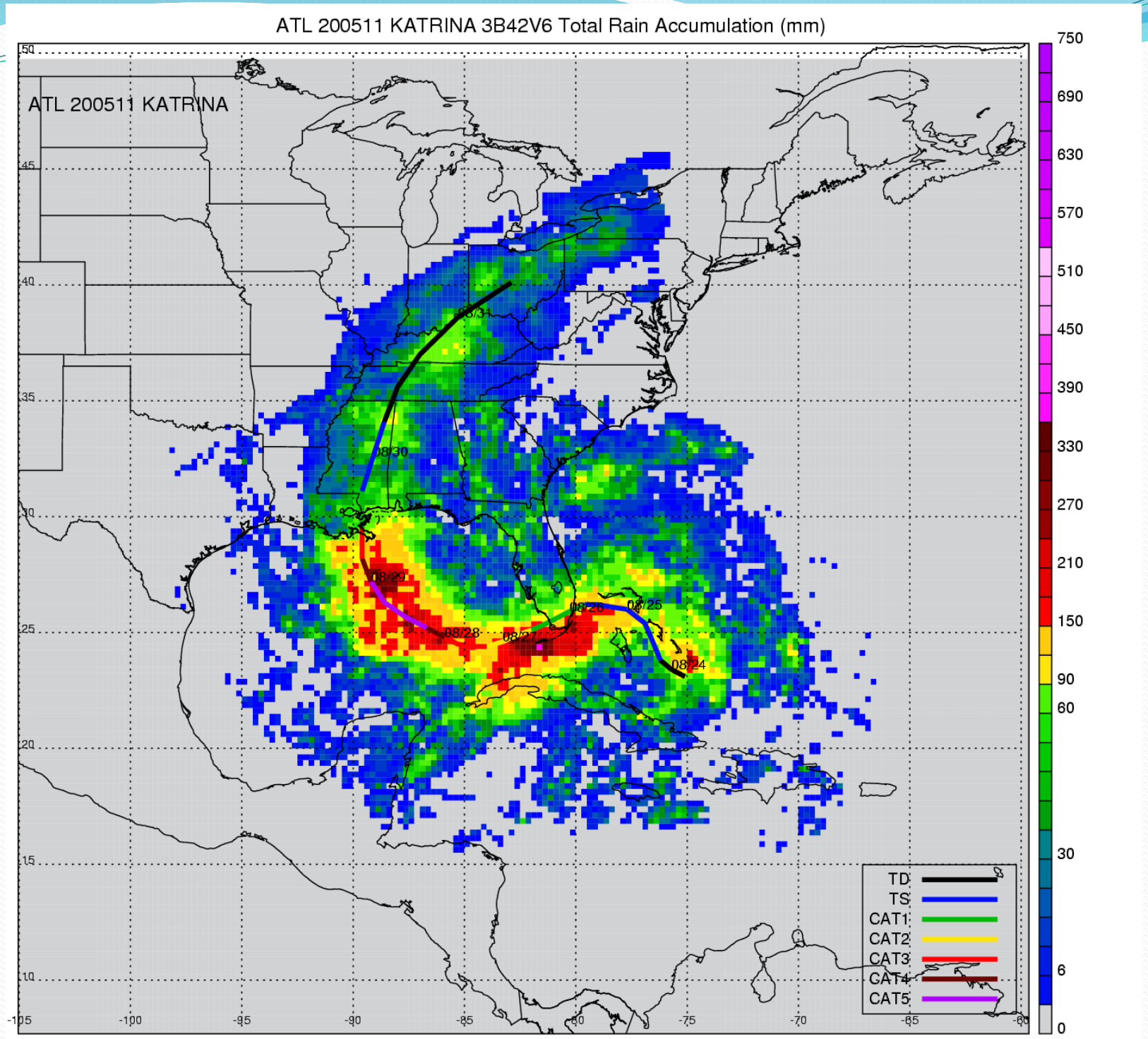
Hurricane Georges (1998)



Vertical Radar Cross Section




57108 2007-11-23 23:12:42 UTC
2A25 near surface rainrate (mm/hr)
(a)
NWP 200724 Typhoon MITAG
PR max reflectivity projection (dBZ)
(b)
2A12 rainrate (mm/hr)
(c)
85GHz PCT (K)
(d)
VIRS T_{B11} (K)
(e)
2A23 rain types
Conv
Strat
N/A
(f)
PR 6km reflectivity (dBZ)
(g)
PR 12km reflectivity (dBZ)
(h)
Maximum reflectivity (dBZ)
red line
Altitude (km)
20,30,& 40 dBZ area (km^2)
black solid,dot,& dash lines
(i)


ATL 200511 KATRINA 3B42V6 Total Rain Accumulation (mm)
ATL 200511 KATRINA
08/31
08/30
08/29
08/28
08/27
08/26
08/25
08/24
TD
TS
CAT1
CAT2
CAT3
CAT4
CAT5
750
690
630
570
510
450
390
330
270
210
150
90
60
30
6
0
50
45
40
35
30
25
20
15
10
-105
-100
-95
-90
-85
-80
-75
-70
-65
-60

Research Using TCPF database

- Necessary conditions for tropical cyclone rapid intensification as derived from 11 years of TRMM data.
- Quantifying rainfall, convection, and latent heating distributions in rapidly intensifying storms according to environmental shear
- Published journal papers:

- Zagrodnik, J., and H. Jiang, 2013: Investigation of PR and TMI Version 6 and Version 7 Rainfall Algorithms in Landfalling Tropical Cyclones Relative to the NEXRAD Stage-IV Multi-sensor Precipitation Estimate Dataset. J. Appl. Meteor. Climatol., accepted.
- Jiang, H., and E. M. Ramirez, 2013: Necessary conditions for tropical cyclone rapid intensification as derived from 11 years of TRMM data. J. Climate., in press.
- Tao, C., and H. Jiang, 2013: Global Distribution of Hot Towers in Tropical Cyclones Based on 11-year TRMM Data. J. Climate, 26, 1371–1386.
- Zagrodnik, J., and H. Jiang, 2013: Properties of Tropical Rainfall Measuring Mission (TRMM) Precipitation Radar (PR) and Microwave Imager (TMI) Rainfall Retrievals in Tropical Cyclone Inner Cores and Rainbands. J. Geophys. Res.,118 ,29-42.
- Jiang, H., E. M. Ramirez, and D. J. Cecil, 2013: Convective and rainfall properties of tropical cyclone inner cores and rainbands from 11 years of TRMM data. Mon. Wea. Rew., 141, 431-450.
- Kieper, M., and H. Jiang, 2012: Predicting tropical cyclone rapid intensification using the 37 GHz ring pattern identified from passive microwave measurements. Geophys. Res. Lett.,39, L13804.
- Jiang, H., 2012: The relationship between tropical cyclone rapid intensification and the strength of inner-core convection. Mon. Wea. Rew., 140, 1164-1176.