TRMM Accomplishments After 15 Years

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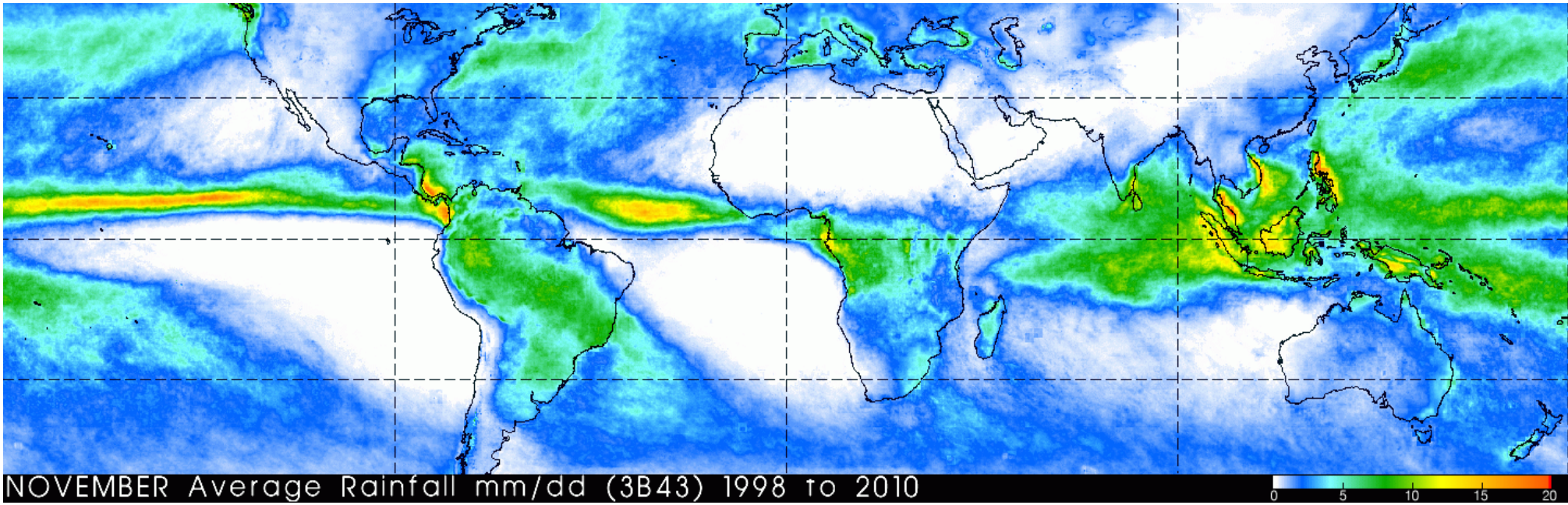


Water for Life: Symposium on the Role of Space Data
November 12, 2012

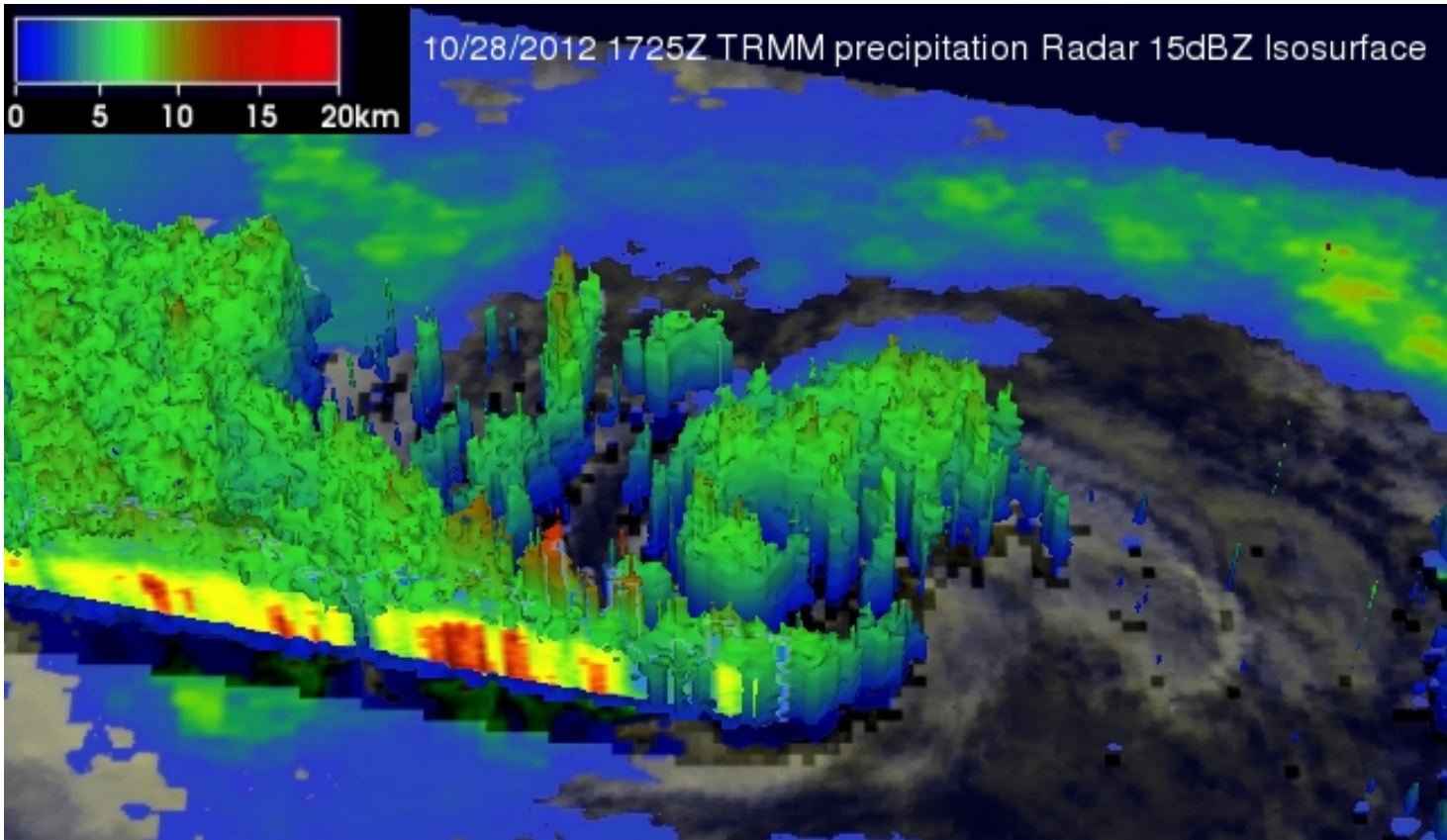
Tropical Rainfall Measuring Mission

Joint NASA/JAXA mission launched in Nov. 1997

Instrument Payload:

- **TRMM Microwave Imager (TMI)— 10, 19, 37, 86 GHz, conical scanning**
- **Precipitation Radar (PR) [Japan]— 14 GHz, cross-track scanning**
- **Lightning Imaging Sensor (LIS)— Staring optical array [MSFC]**
- **Visible IR Scanner (VIRS)— 5-channel, cross-track scanning**
- **Clouds and Earth's Radiant Energy System (CERES)**

Hurricane Sandy on Oct. 28, two days prior to landfall



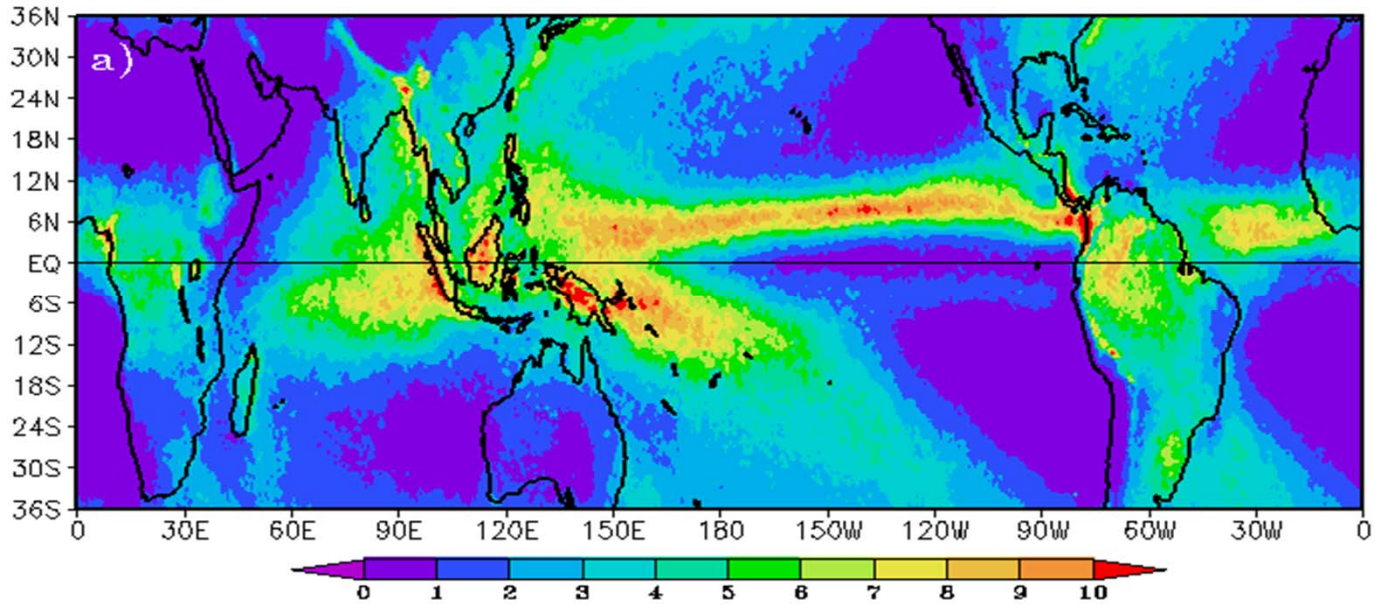
TRMM Science Accomplishments

Key focus areas:

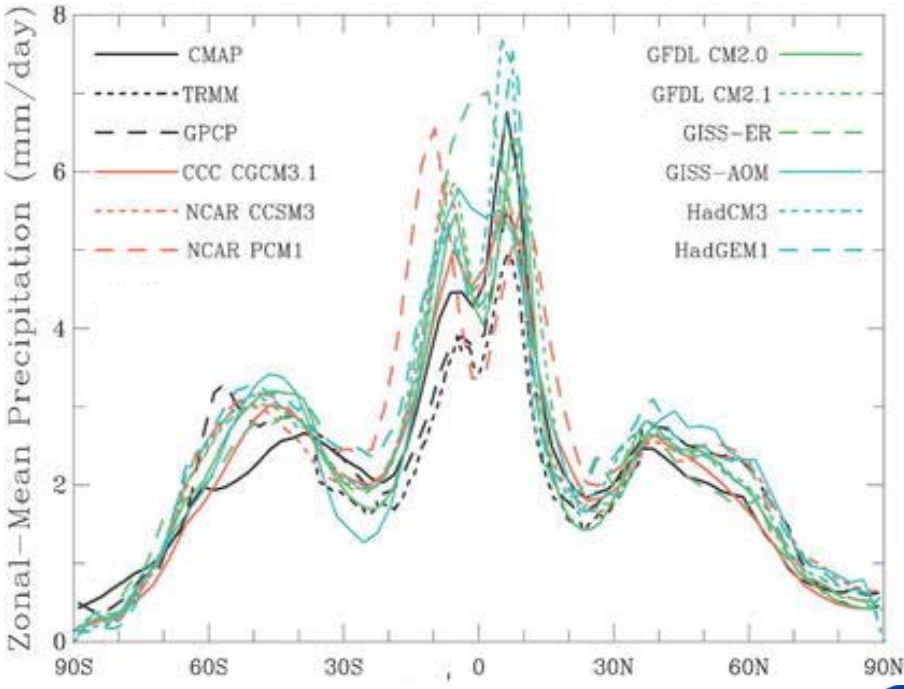
- *Precipitation climatology: Global rainfall, diurnal cycle, latent heating*
- *Convective systems research: The University of Utah Precipitation Feature Database*
- *Floods: Science and applications*
- *Tropical cyclones: Science and applications*

TRMM Rainfall: Climatology

From Adler et al. (2009)



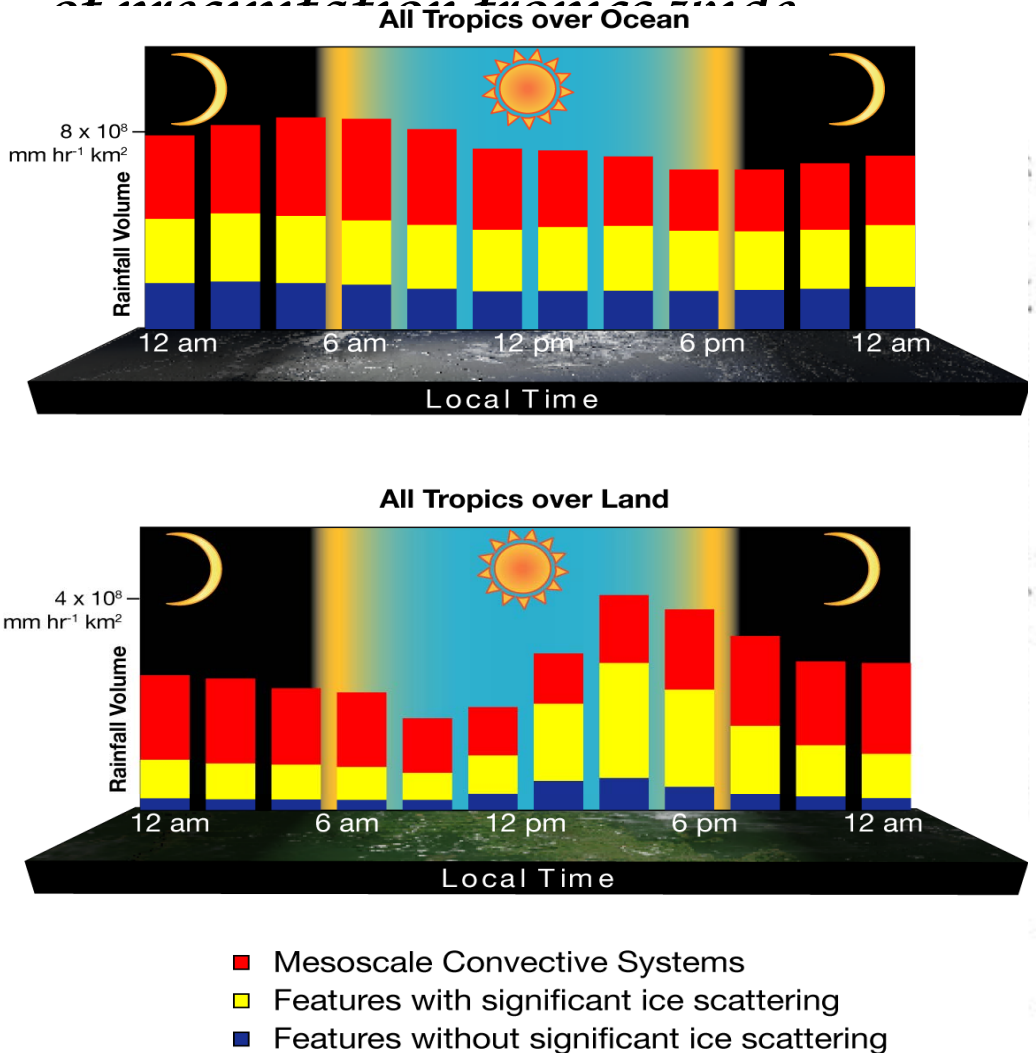
- ***Benchmark 15 year climatology***
- ***Unique monitoring of interannual rainfall variations related to ENSO***
- ***TRMM estimates have become the standard for improving long-term climatologies and for comparison to global climate models***



From Dai (2006)

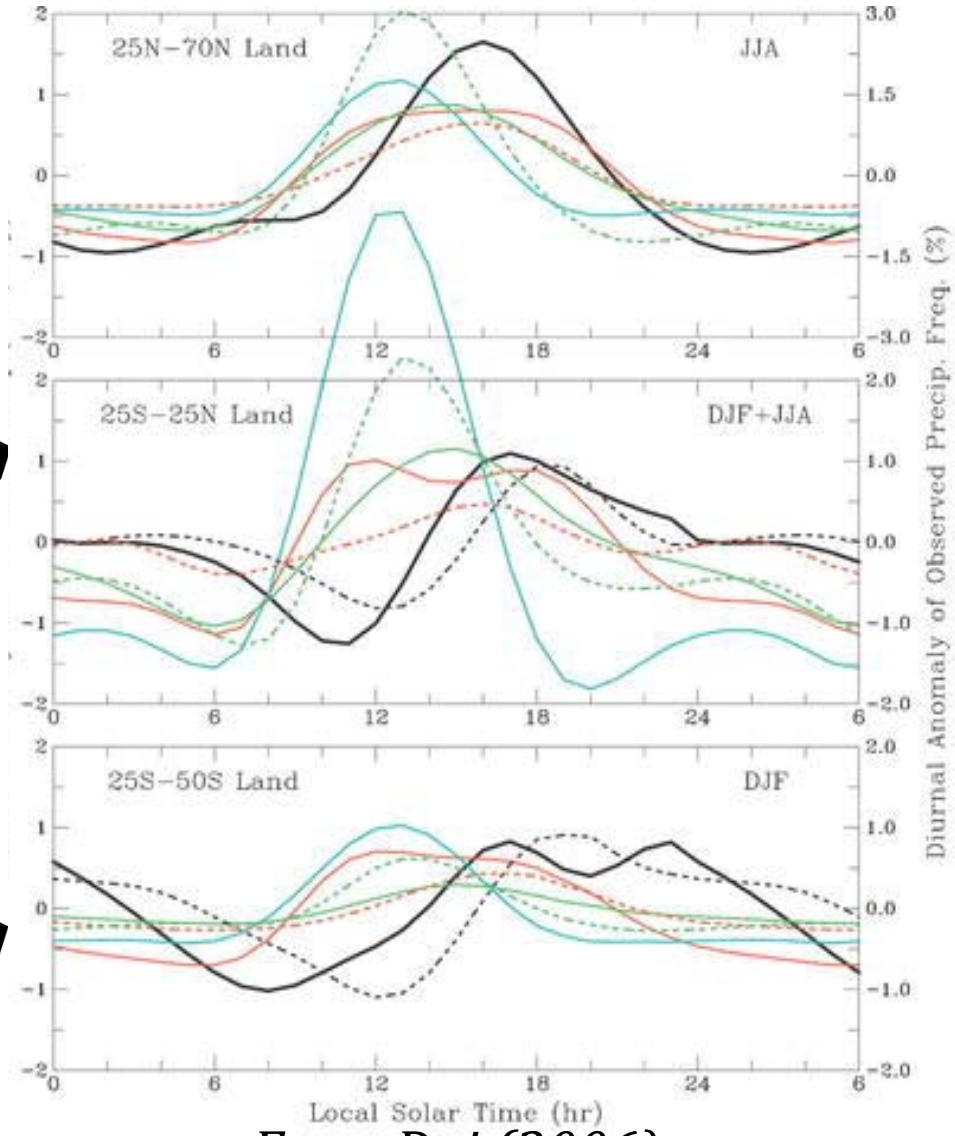
TRMM Rainfall: Diurnal Cycle

- *Low inclination (35°), precessing orbit allows sampling of all local hours over several weeks*
- *Quantification of diurnal cycle of precipitation tropics-wide*



From Nesbitt and Zipser (2003)

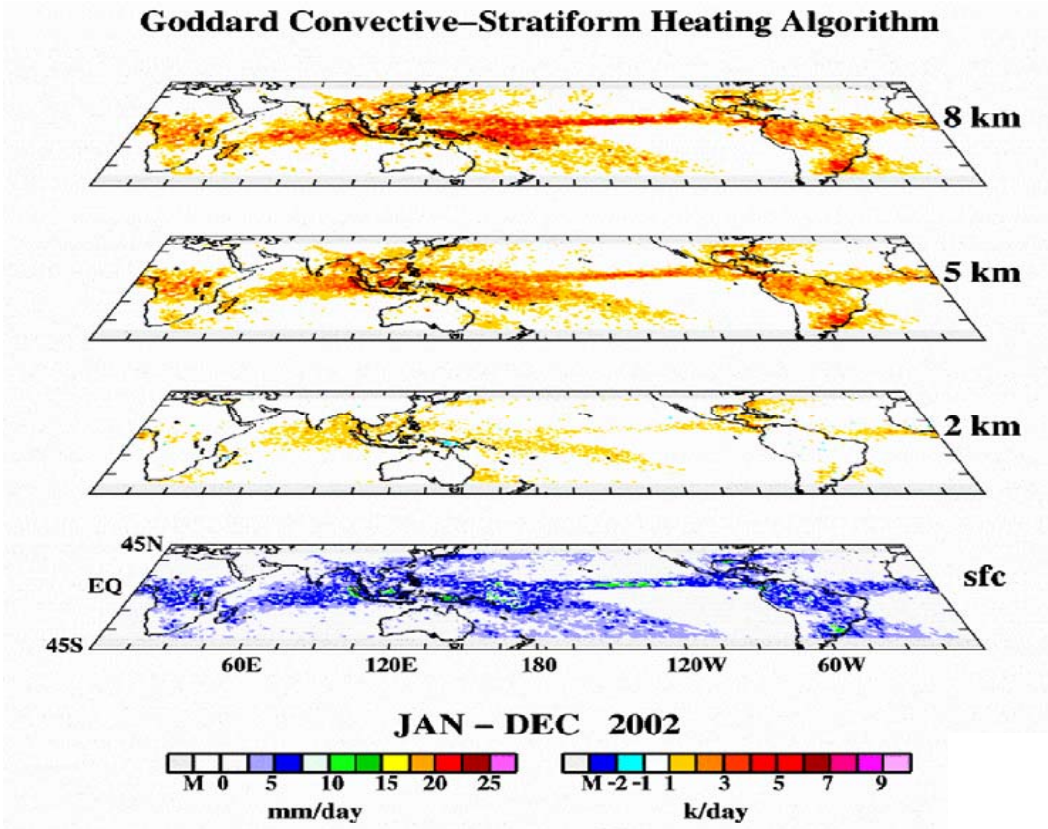
- *Has also allowed focus on regional and local scales*
- *Comparison with global climate models*



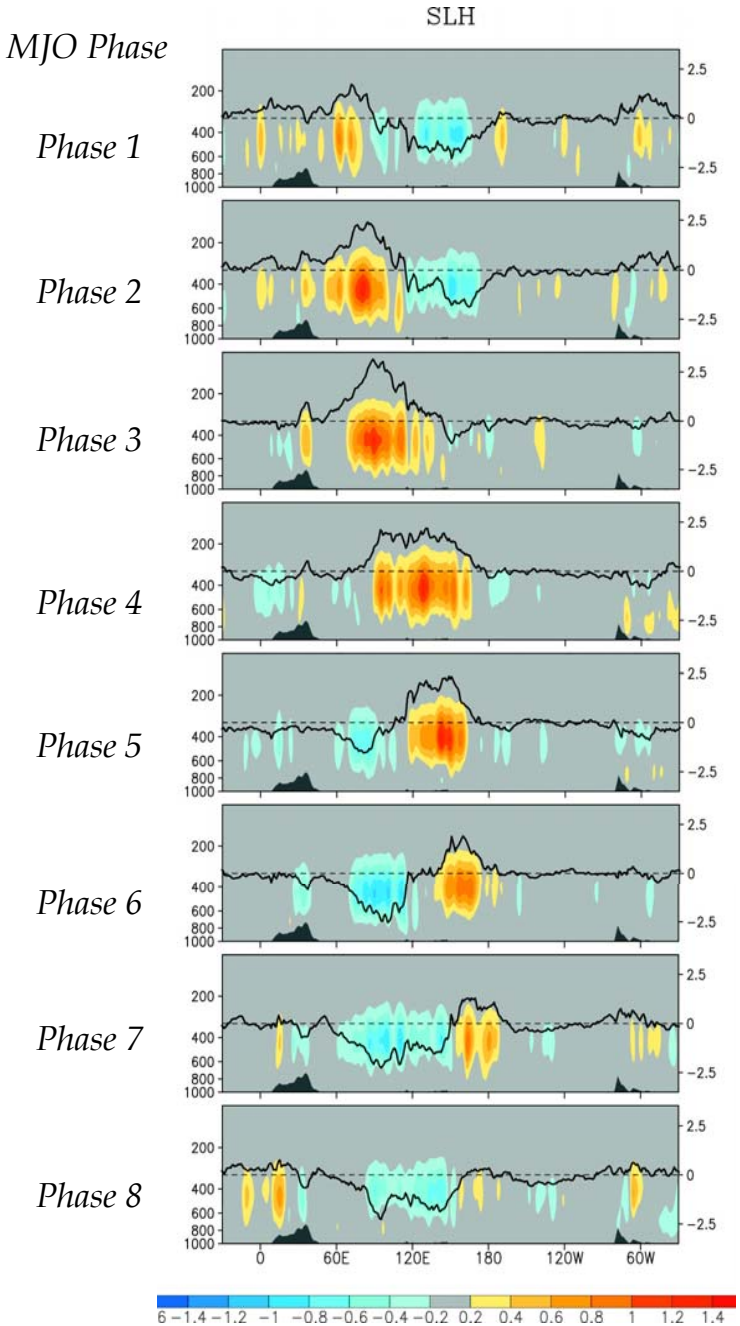
From Dai (2006)

TRMM Rainfall: Latent Heating Profiles

- ***Comprehensive estimates of how rainfall is directly related to latent heat release (LHR)***
- ***Quantification of LHR related to ENSO, MJO***
- ***Comparisons to global models***



Courtesy of W.-K. Tao

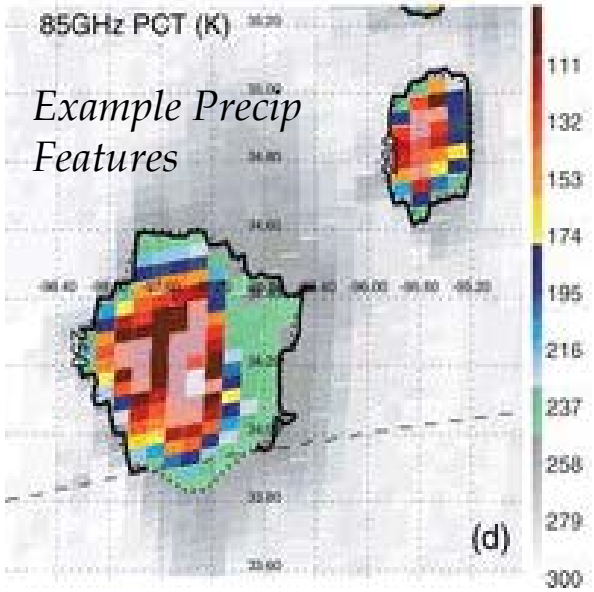


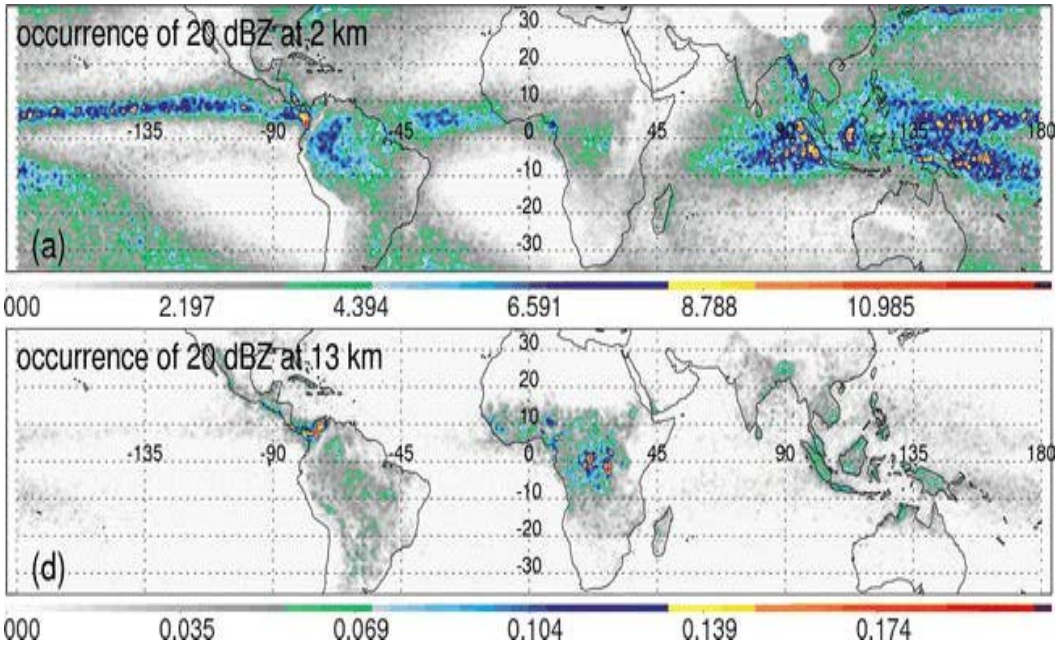
From Jiang et al. (2011)

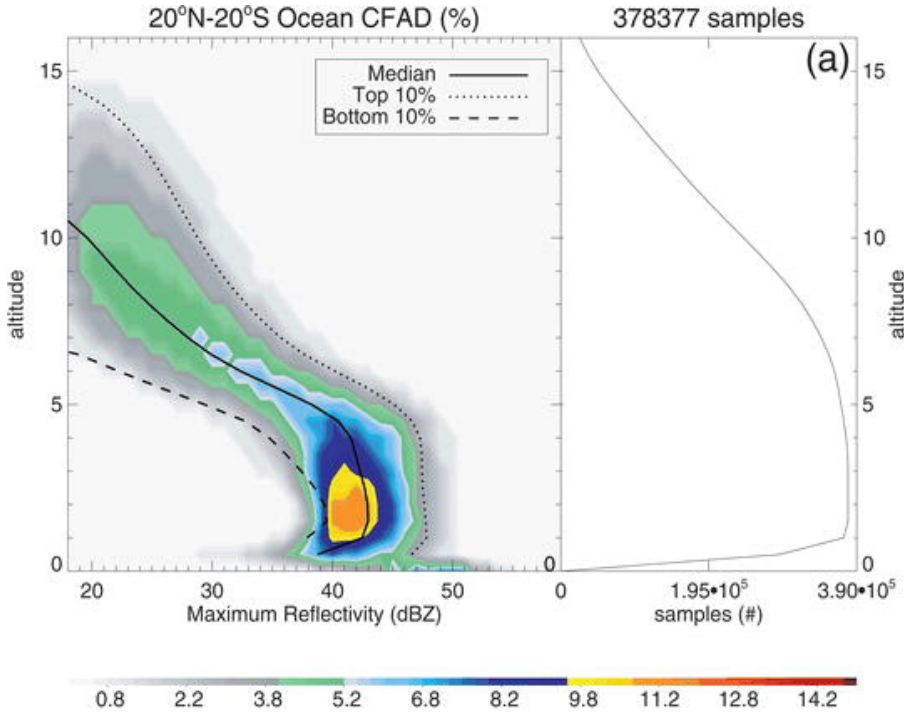
The TRMM Precipitation Feature Database

University of Utah: E. Zipser, C. Liu, S. Nesbitt, D. Cecil, H. Jiang

- ***TRMM PFD has yielded new insights into***
  - ***diurnal cycle of convective systems***
  - ***global distribution of convective extremes***
  - ***properties of electrified storms***
  - ***seasonal are regional distributions of warm rain***
  - ***tropical cyclone rainfall properties***



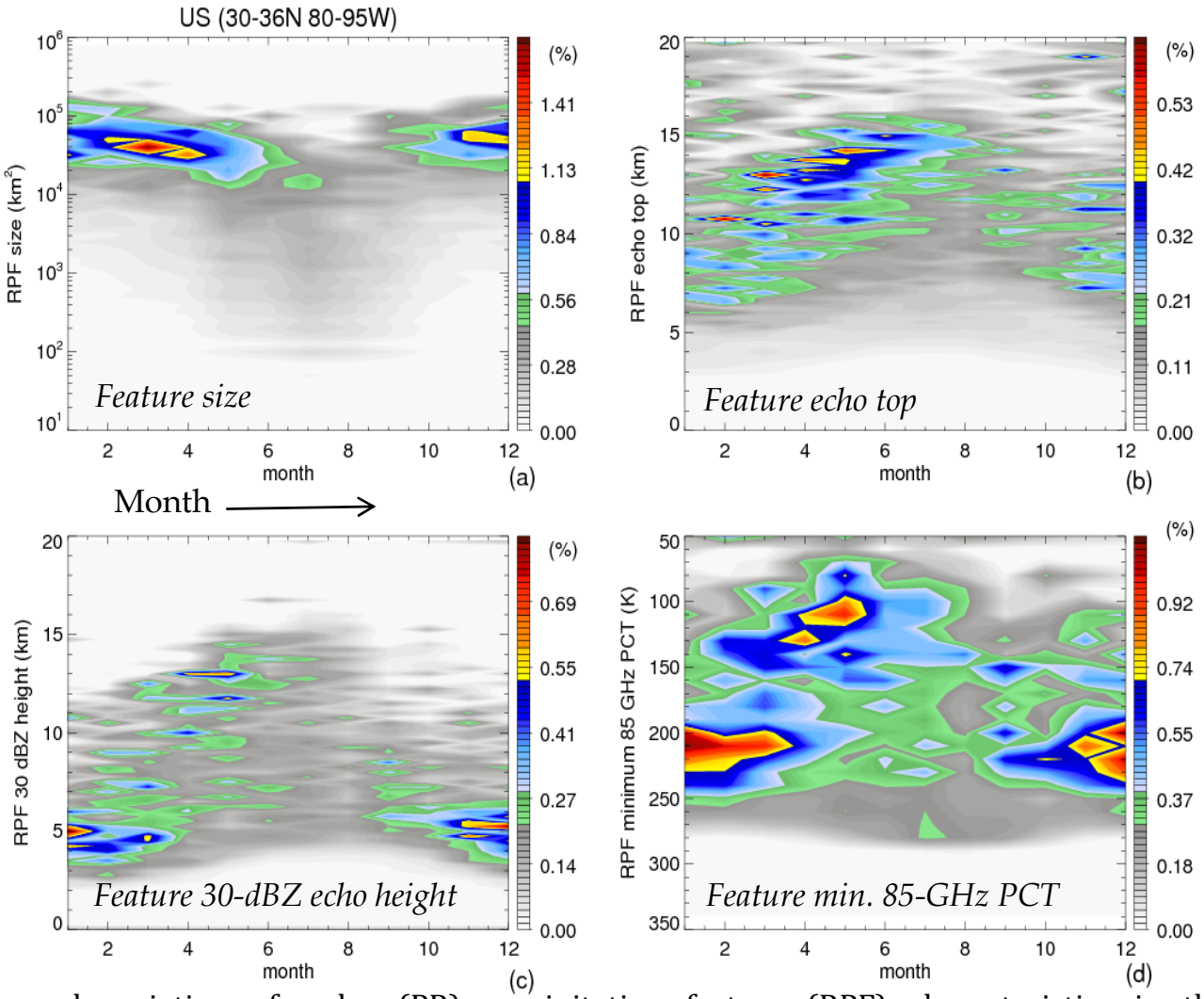




The TRMM Precipitation Feature Database

- ***The value of the TRMM dataset for climate research increases with every year of additional data***
- ***With 14+ yrs of data, analyses of regional seasonal variability are now becoming possible***

Seasonal variability of precipitation features in the S.E. United States

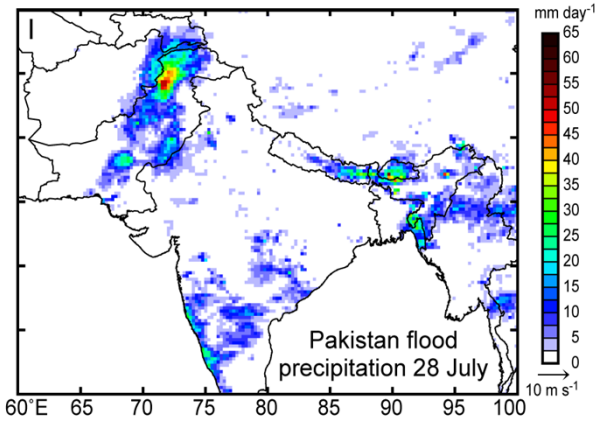


Seasonal variation of radar (PR) precipitation feature (RPF) characteristics in the Southeastern U. S. including (a) precipitation feature size, (b) echo top, (c) 30-dBZ echo height, and (d) minimum 85-GHz polarization corrected temperature (PCT).

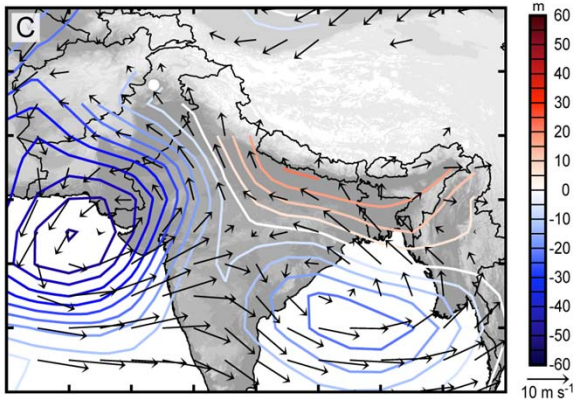
Courtesy of Chuntao Liu and Ed Zipser.

Tropical Rainfall Measuring Mission

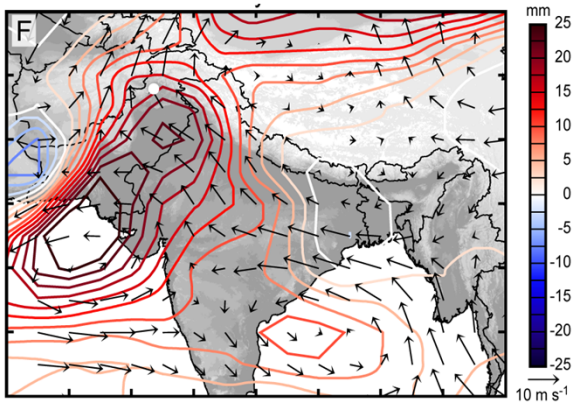
TRMM 3B42 Avg. Rainrate



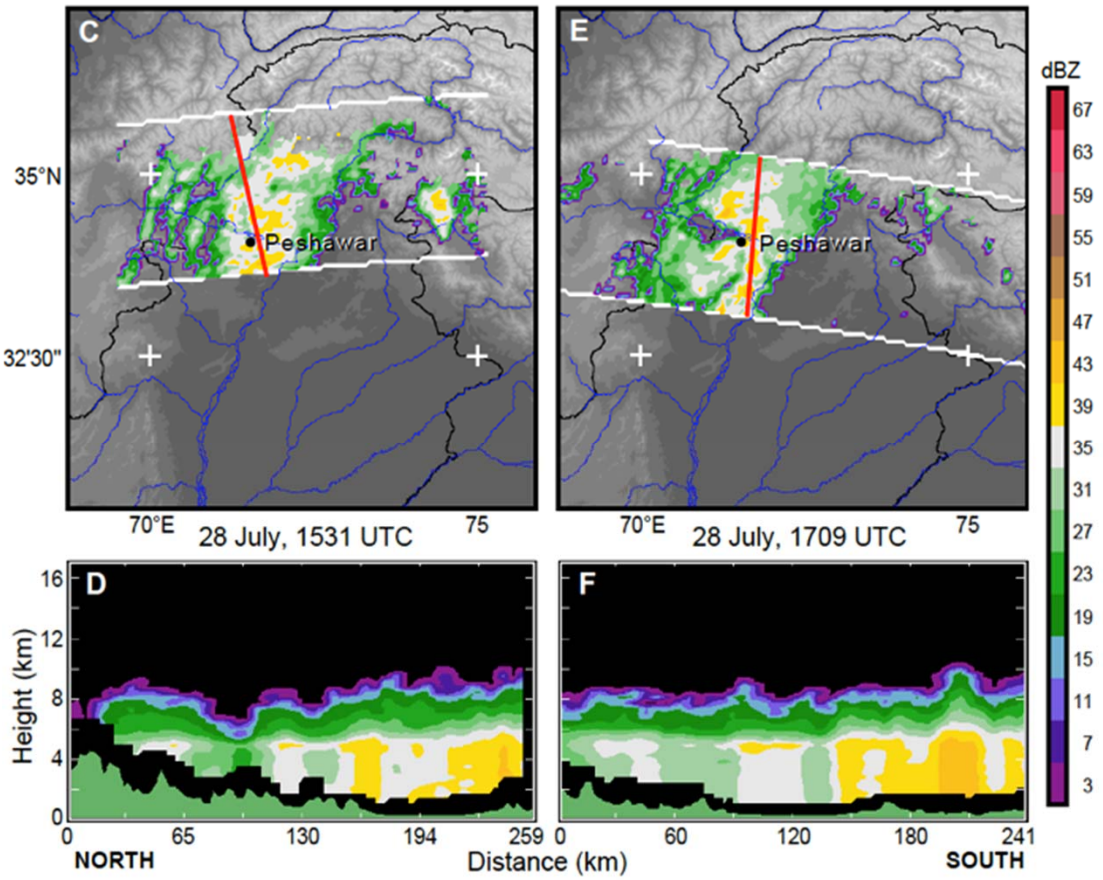
700 hPa Height anomalies and winds



TPW anomalies and 500 hPa winds



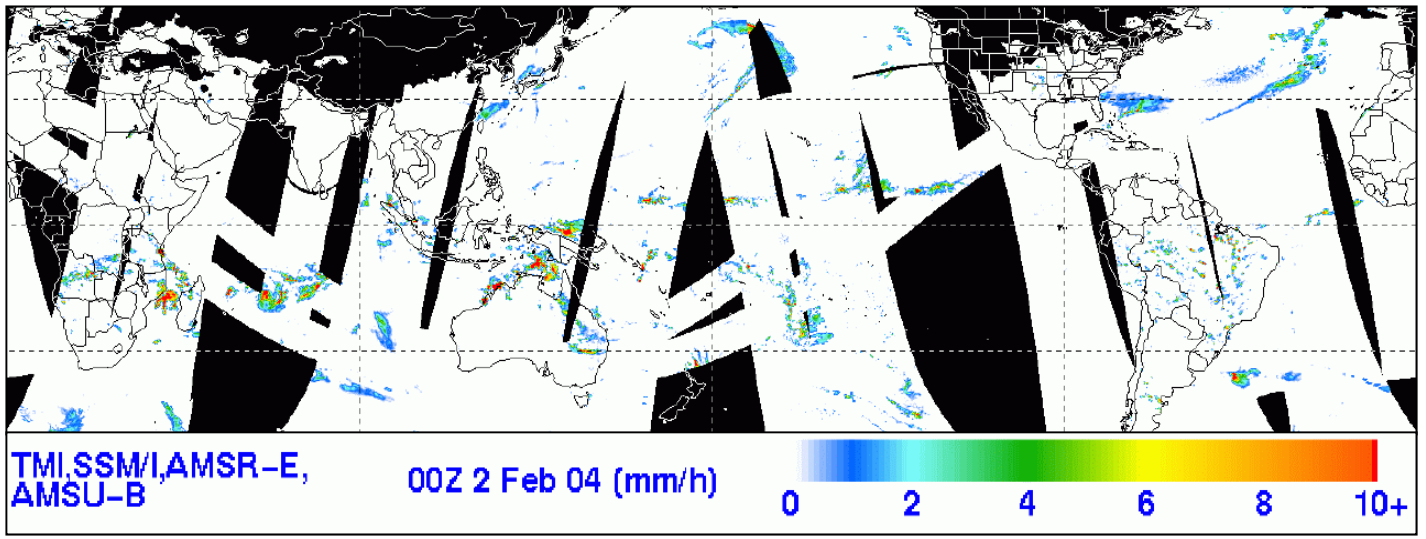
Understanding Extreme Events Such as the 2010 Pakistan Floods (From Houze et al. 2011)



Combining TRMM rainfall and vertical structure information with environmental information from global meteorological analyses allows better characterization of environmental regimes and the role of topography in extreme orographic events

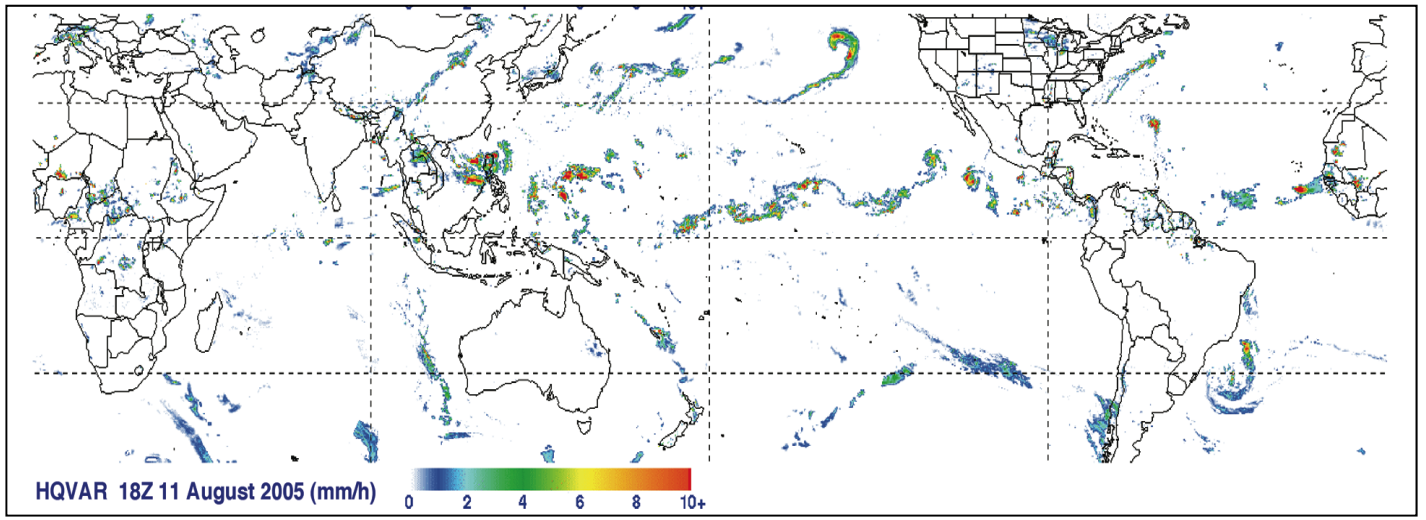
TRMM Multi-Satellite Precipitation Analysis

3-hr window with passive microwave (gaps filled with Geo-IR) calibrated by TRMM



(0.25° grid)

Research product uses TRMM radar information and monthly gauges--real-time product avail. ~6 hrs. after obs. time

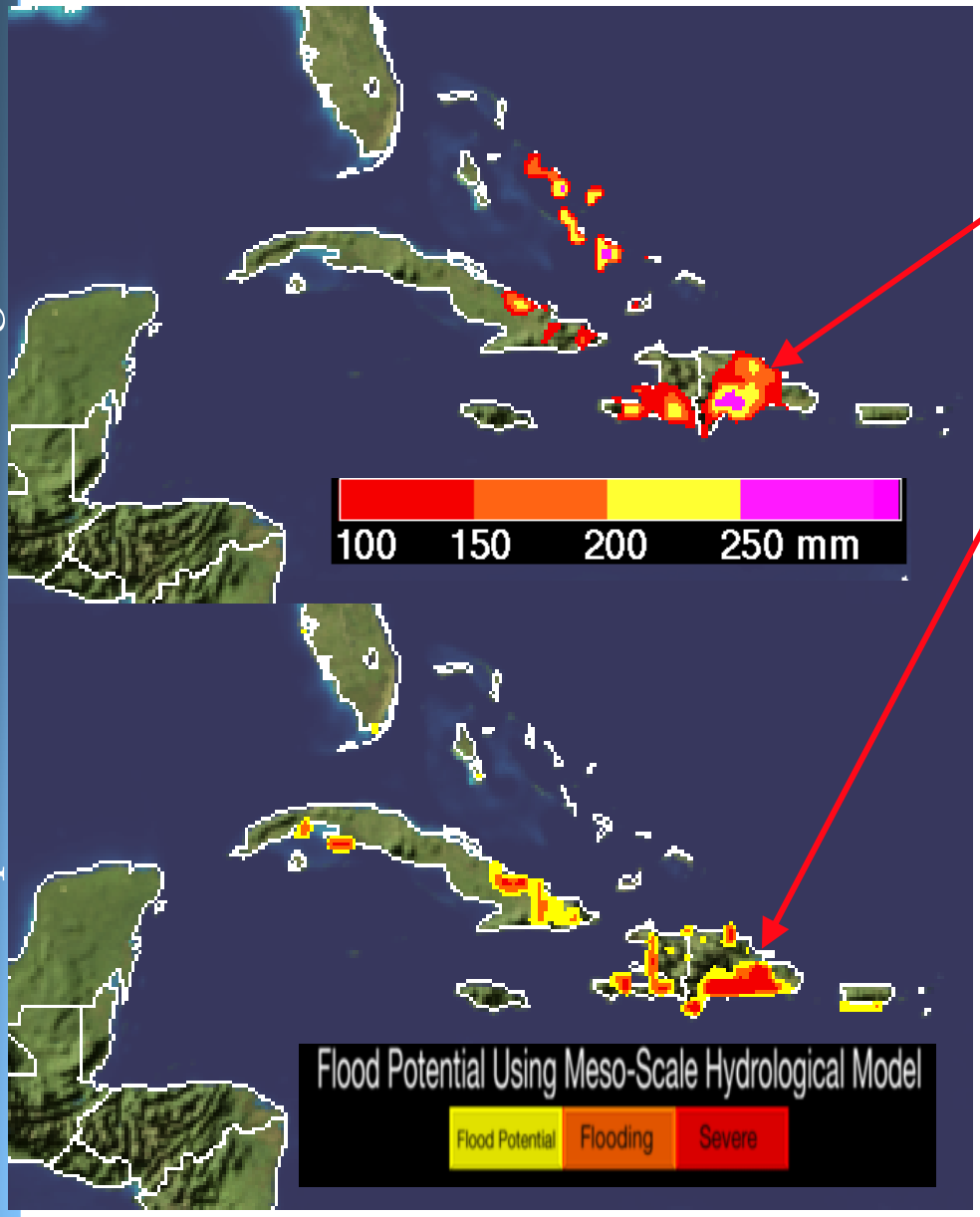


9 years+ ('98- '07)of 3-hr analysis available--produced at TRMM data system. Available from Goddard DISC (most downloaded TRMM product)

Flood Events: Applications

Multi-satellite rainfall estimates converted into probabilities of flood and landslide occurrence

3-day heavy rains over 250 mm over Dominican Republic related to Hurricane Noel produces flooding (deduced by hydrologic model running globally in real-time) and landslides (estimated from real-time landslide potential algorithm)



Rainfall information is from TRMM Multi-satellite Precipitation Analysis (TMPA)

Tropical Cyclones: Applications

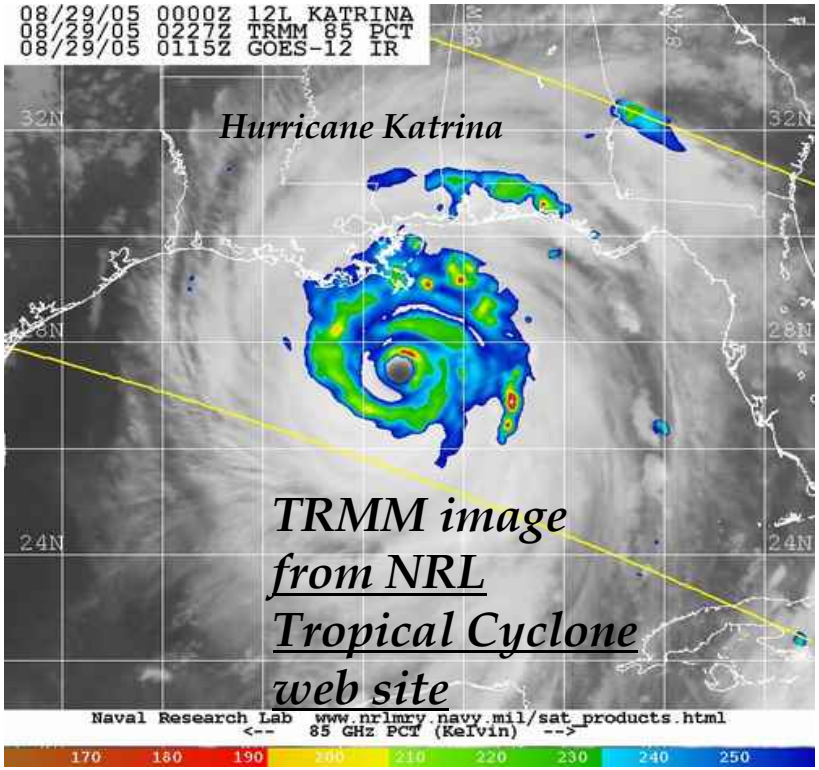
TRMM data used by NOAA and DoD (and int'l agencies) for tropical cyclone detection, location and intensity estimation

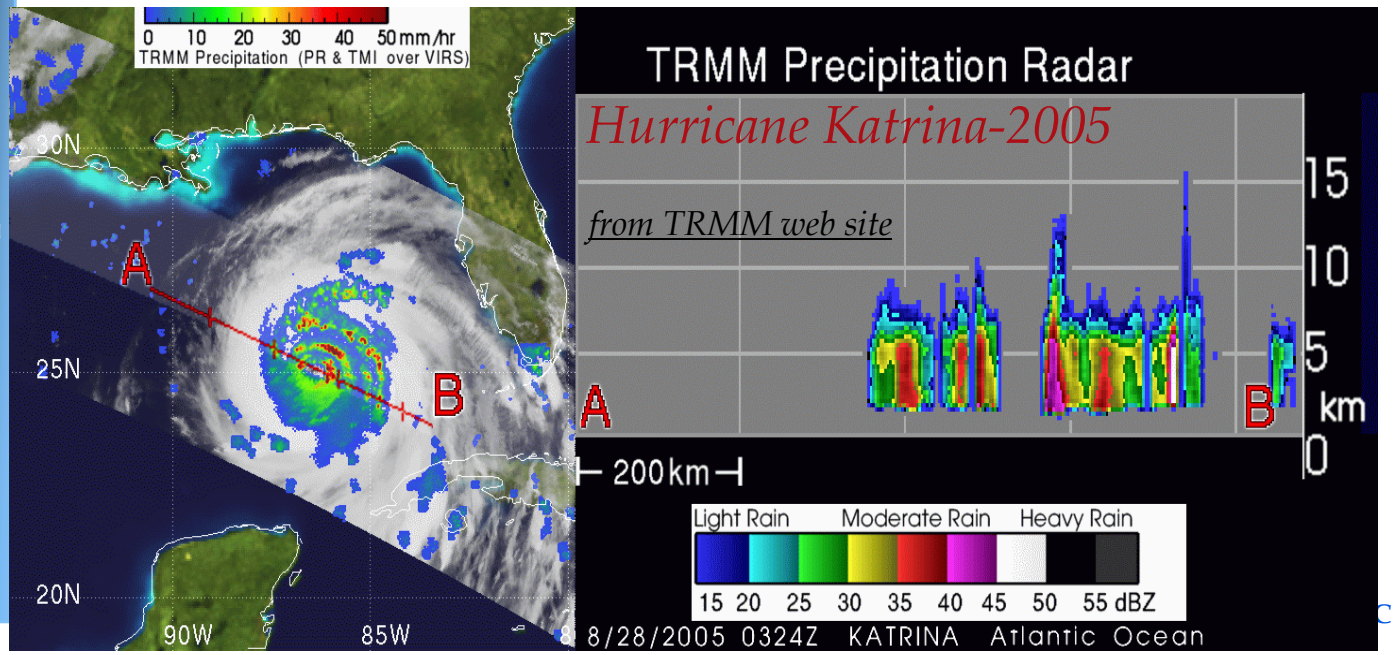
~600 TRMM tropical cyclone "fixes" per year

TRMM orbit always in tropics, sampling best in 10-35° latitude storm band

High horizontal resolution

Precessing orbit provides off-time observations relative to sun-synchronous satellites

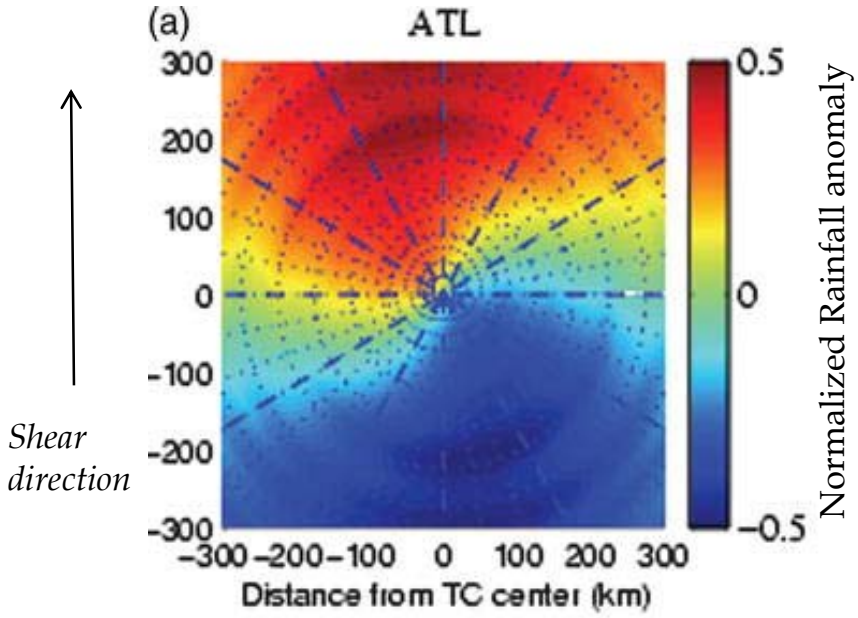




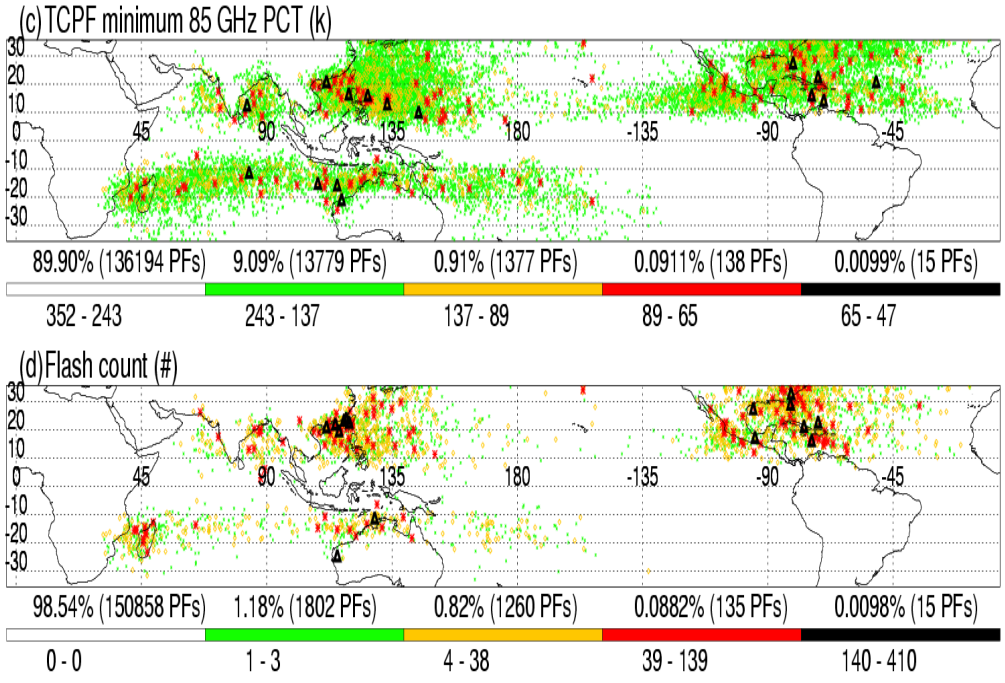
TRMM radar (PR) cross-sections of hurricanes available in real-time for operational analysis from TRMM web site

Tropical Cyclone Science

- *Rainfall climatologies in hurricanes*
  - *Radial distribution*
  - *Shear and motion induced asymmetries*
  - *Eyewall and rainband vertical structure and lightning*
  - *Contributions to global precipitation*
  - *Precipitation feature database characteristics*
- *Data assimilation*
- *Evaluation of storm structures in mesoscale models*
- *Case studies*
- *Improved SST estimates in storm wakes*



From Chen et al. (2006)

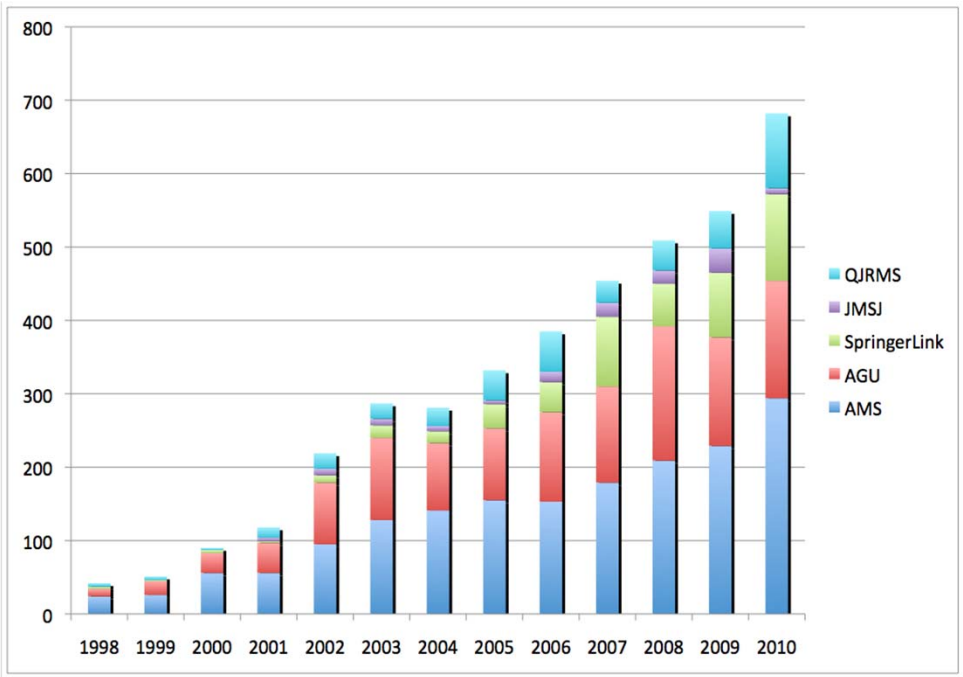


Courtesy of H. Jiang

Summary

- *Space standard for measuring precipitation*
- *Improved climatology of tropical rainfall and variations*
- *Vertical hydrometeor/heating structure and diurnal signal*
- *Improved climate and weather modeling*
- *Impact of humans on precipitation*
- *Hurricane/typhoon structure/evolution*
- *Multi-satellite (~3-hr) rainfall analyses using TRMM+other satellites*
- *Flood and agricultural applications*
- *Operational use of data by*

Estimated Publications by year



>3000 scientific journal articles published using TRMM data

Spacecraft and instrument status:

- *All spacecraft systems in excellent shape for continuation*
- *The Precipitation Radar, Microwave, Visible and IR Scanner, and Lightning Imaging Sensor (LIS) are all working well*
- *Fuel required for altitude maintenance is expected to last until ~January 2014*