



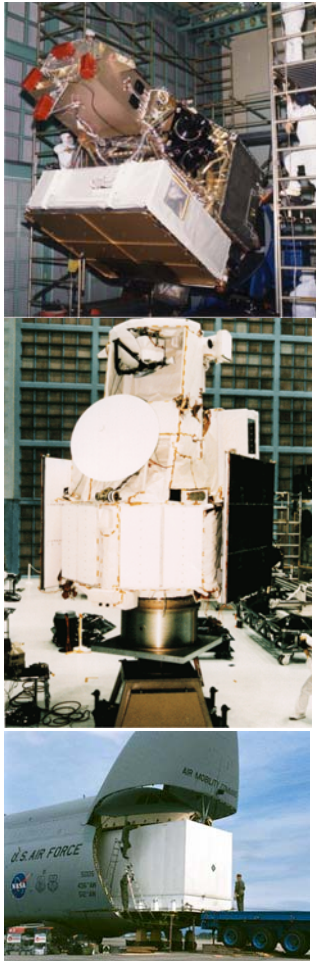
In Celebration of TRMM's 10th Anniversary

How to succeed beyond your dreams!

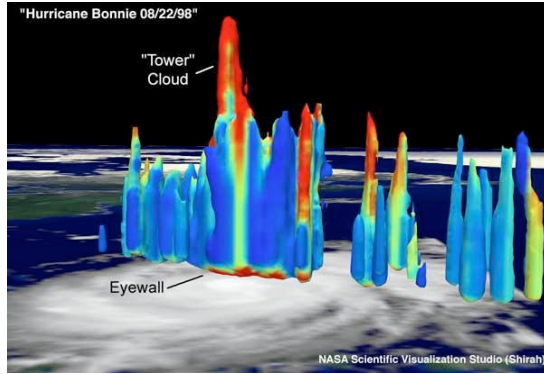
8 Tips from TRMM to GPM

Arthur Hou

The 3rd TRMM International Science Conference, 4-8 February 2008, Las Vegas, Nevada

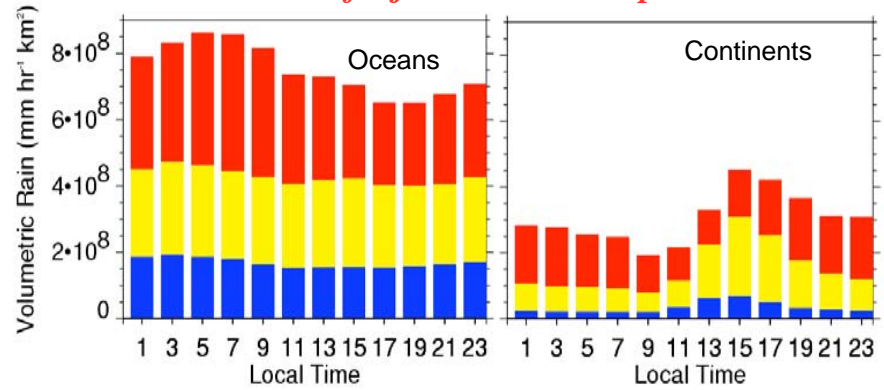


Engineering Feat

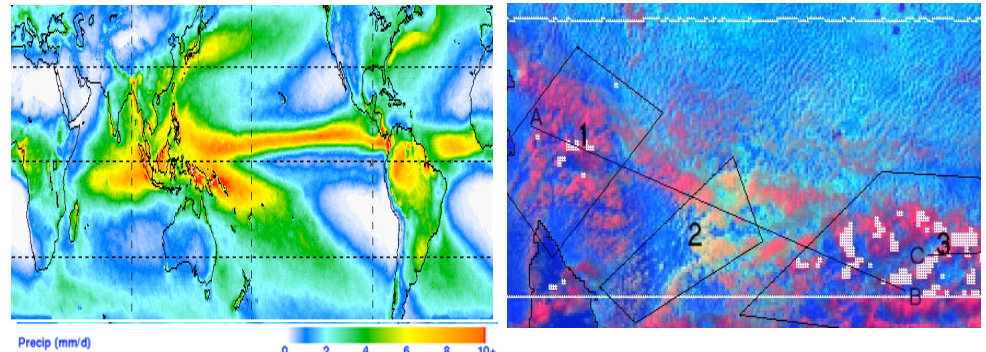
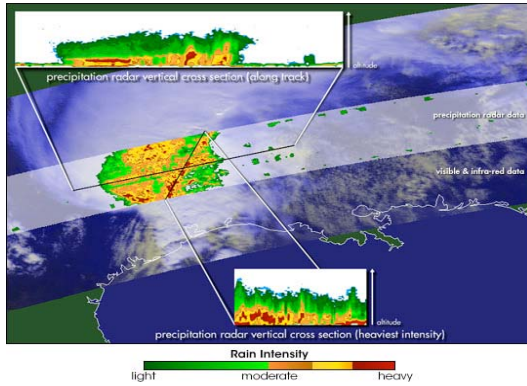


Science Discovery

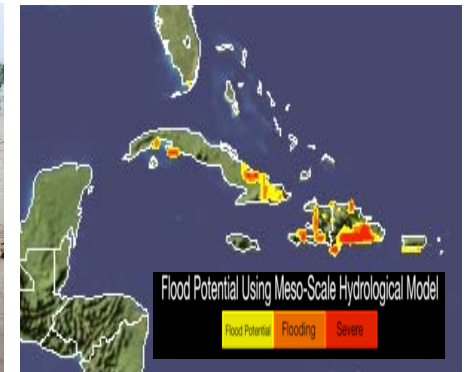
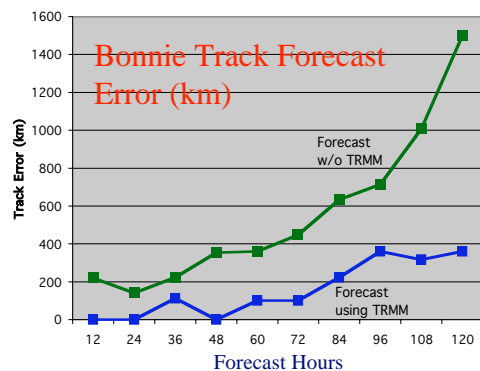
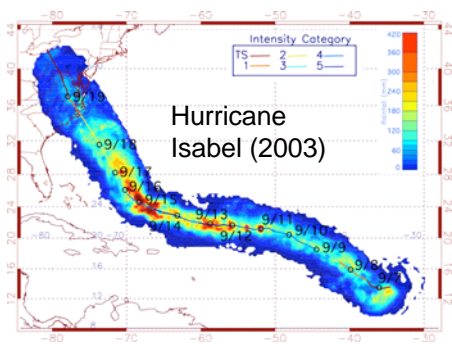
850 scientific journal articles published



Stunning Images



Societal Benefits

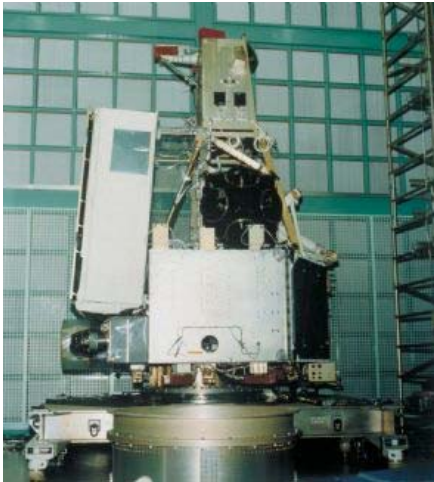


A remarkable achievement considering....

- *The PR was guaranteed to work for only 1 year.*
- *Designed for a minimum of 3 yrs with a goal of 5 yrs.*
 - *Intended as a “highly-focused, limited-objective research satellite aimed at measuring monthly and seasonal rainfall (over 5° x 5° areas)” (TRMM Science Plan)*
- *A single-satellite mission in the tropics - but it is producing 3-hr precipitation products over the globe.*
- *Began its life as a climate mission but data now in wide use by operational agencies.*



Pointer #1: Build strong partnerships



Assembling at GSFC



Arriving Kagoshima Airport



**Liftoff on 11-28 (27 in U.S.)
1997 from Tanegashima SC**



Transport at Kajiki Port



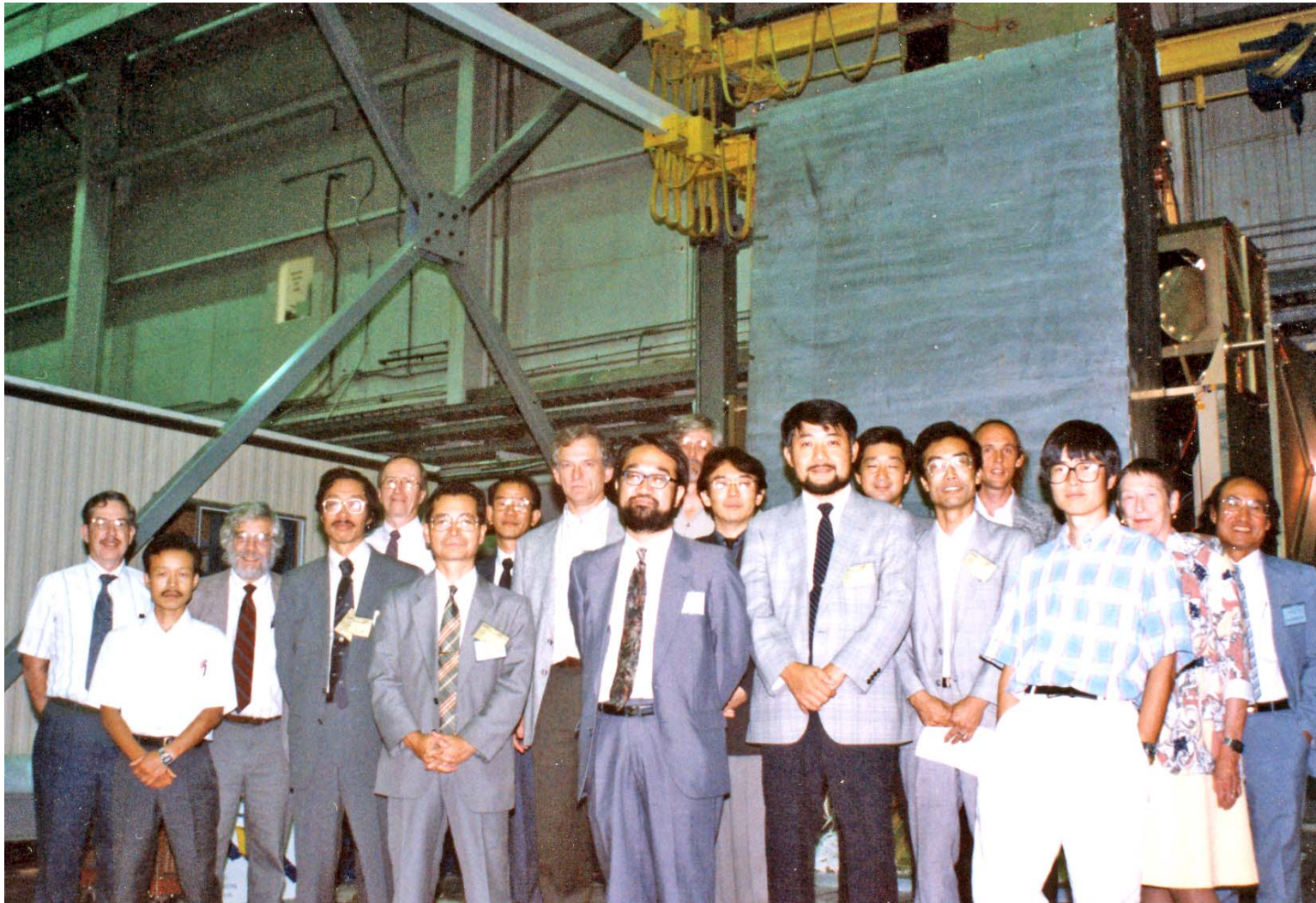
On board H-II 6F LV#6



Courtesy of R. Oki & JAXA Digital Archives



And it took a village...



TRMM Scientists Visiting Goddard, 1994

GPM partnership building...

- *NASA & JAXA have signed a Formulation MOU and are working on an Implementation MOU for GPM.*
- *Discussion underway with ISRO (India) & CNES (France) to formalize Megha-Tropiques' participation in GPM.*
- *AEB (Brazil) is planning to contribute a low-inclination constellation satellite.*
- *Cooperation with NOAA and other space agencies under development.*
- *GPM identified as a cornerstone of the CEOS Precipitation Constellation to meet the objectives of CEOS, GEO, IGOS, and GCOS.*

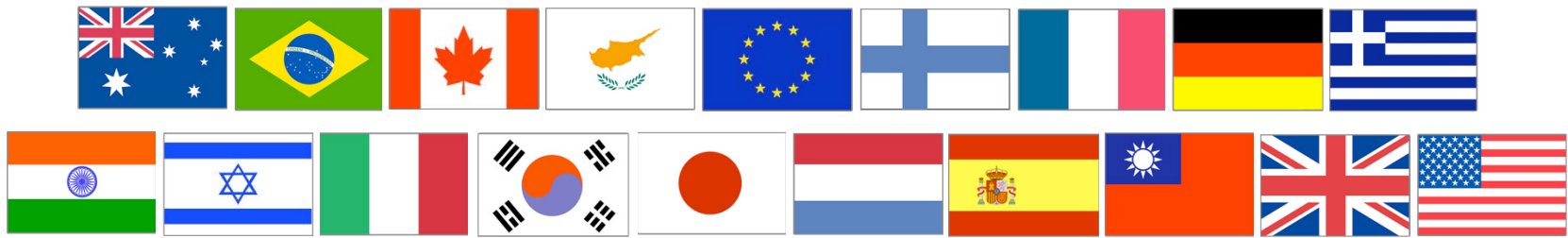


Canadian Space Agency
Agence spatiale canadienne



GPM/PMM GV Partnership

- *Joint field campaigns (for pre-launch algorithm development):*
 - *NASA participation in Canadian CloudSat-CALIPSO Validation Program (C3VP) IOP's in 2006-07 winter.*
 - *Joint NASA-DOE and NASA-NOAA field campaigns under discussion.*
- *International research collaborations:*
 - *Active: France, Finland, Japan*
 - *In preparation: Canada, Brazil, Germany, Australia*
 - *Under consideration: U.K., Italy, India, Greece, Cyprus, Taiwan, Spain, Korea, and more.*

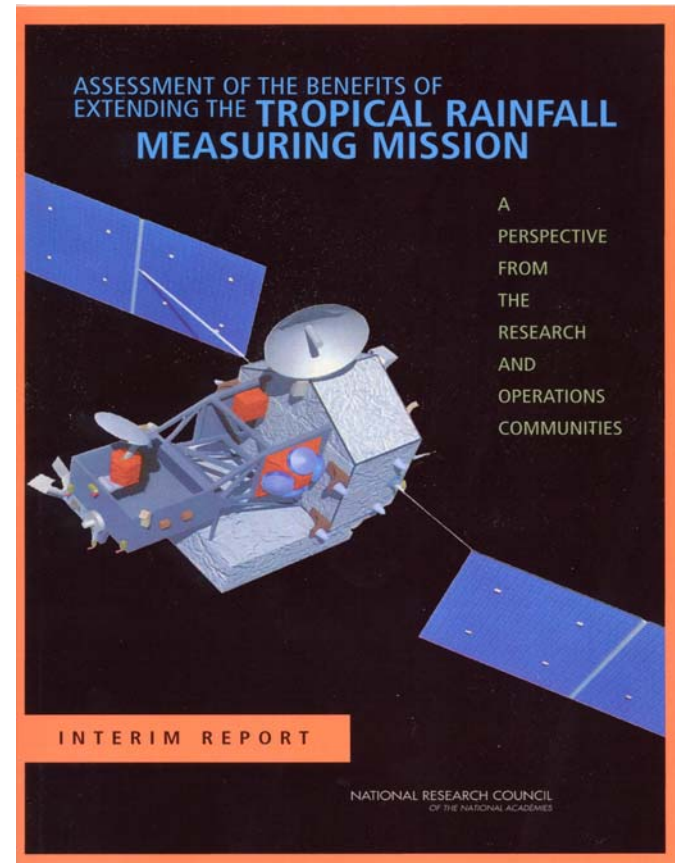


*The 3rd International GPM Ground Validation Workshop
in Buzios, Brazil, 4-6 March 2008*

Pointer #2: NAS endorsement + Congressional mandate

- *10/5/1987: TRMM reviewed and strongly supported by the Earth Science Subcommittee of the NAS Board on Space Sciences.*
- *10/6/1988: TRMM Phase A Study reviewed and strongly supported by Climate Research Committee of the NAS Board on Atmospheric Sciences (BAS).*
- *3/28/1989: Strong support letter from NAS BAS Chair (Anthes) to NASA AA (Fisk).*
- *4/6/89: TRMM Briefing to Federal Coordinating Council on Science, Engineering, and Technology under OSTP, followed by strong written endorsement from Chairmen Bierly to NASA.*
- *10/90: Congress funds TRMM as a 1991 New Start.*

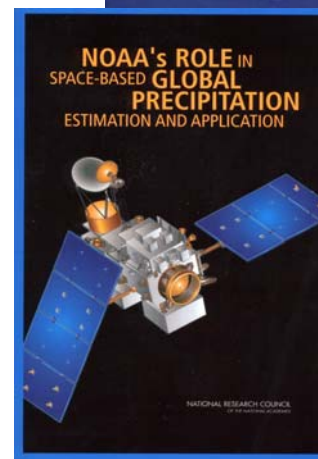
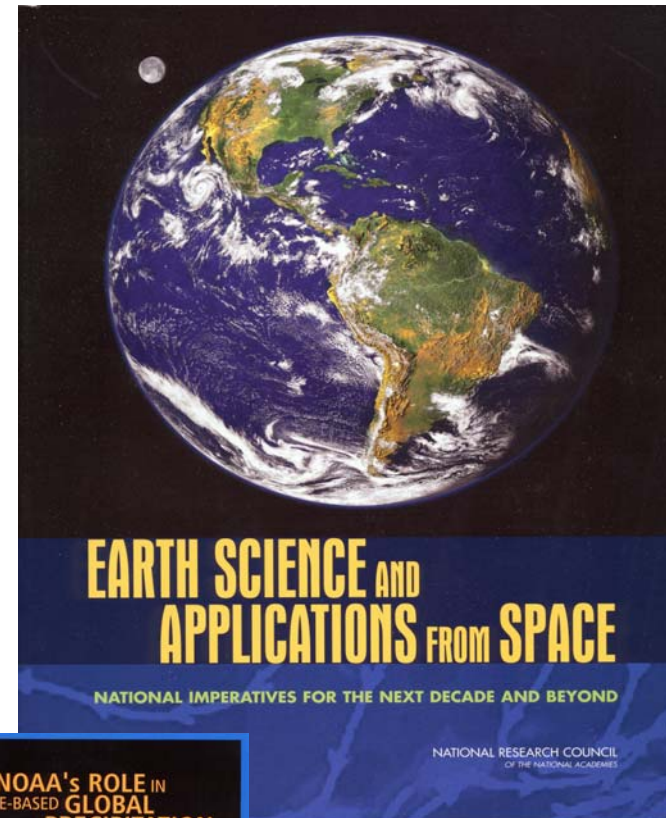
(From J. Simpson's notes on TRMM history)



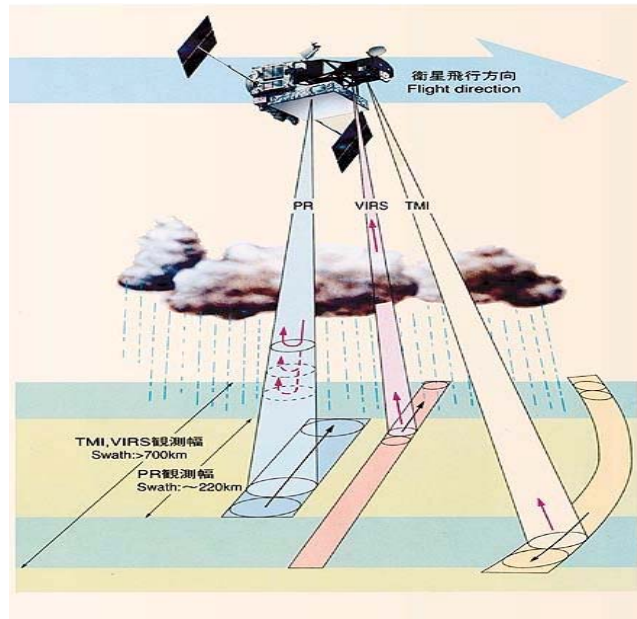
- *11/8/04: Briefing to NAS/BASC Committee on the Future of TRMM on the benefits of extending TRMM.*

GPM designated high priority in NAS Earth Science Decadal Survey

- *1/07: Strong endorsement of GPM in the NAS Decadal Survey in Earth Sciences*
 - *“The committee believes that it is vital to maintain global precipitation measurements as offered by GPM.”*
 - *Recommendation: NASA should ensure continuity of precipitation measurement by launching GPM mission in or before 2012*
- *10/18/05: GPM briefing to NAS/BASC Committee on the Future of Rainfall Measuring Missions, leading to*
 - *Publication of “NOAA’s Role in Space-Based Global Precipitation Estimation and Application” (April 2007) with specific recommendations for NOAA preparations for the operational use of GPM data.*



Pointer #3: Setting new measurement standards

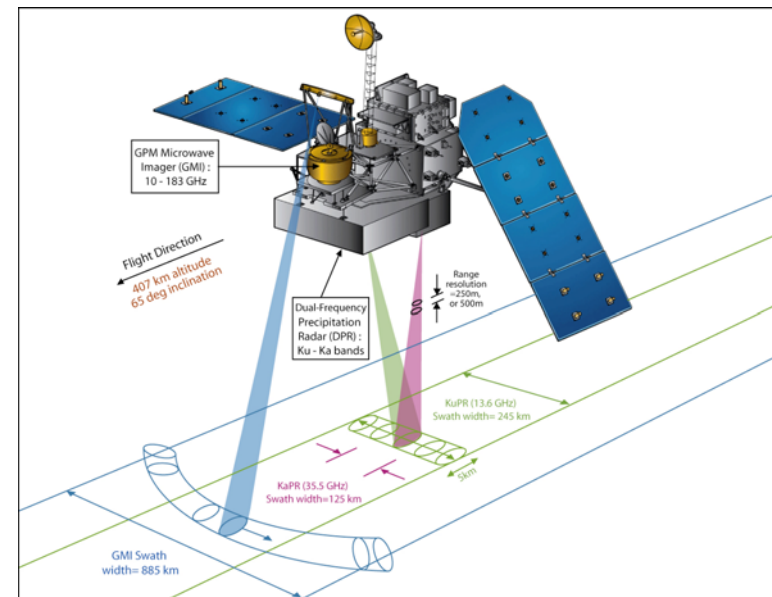


TRMM

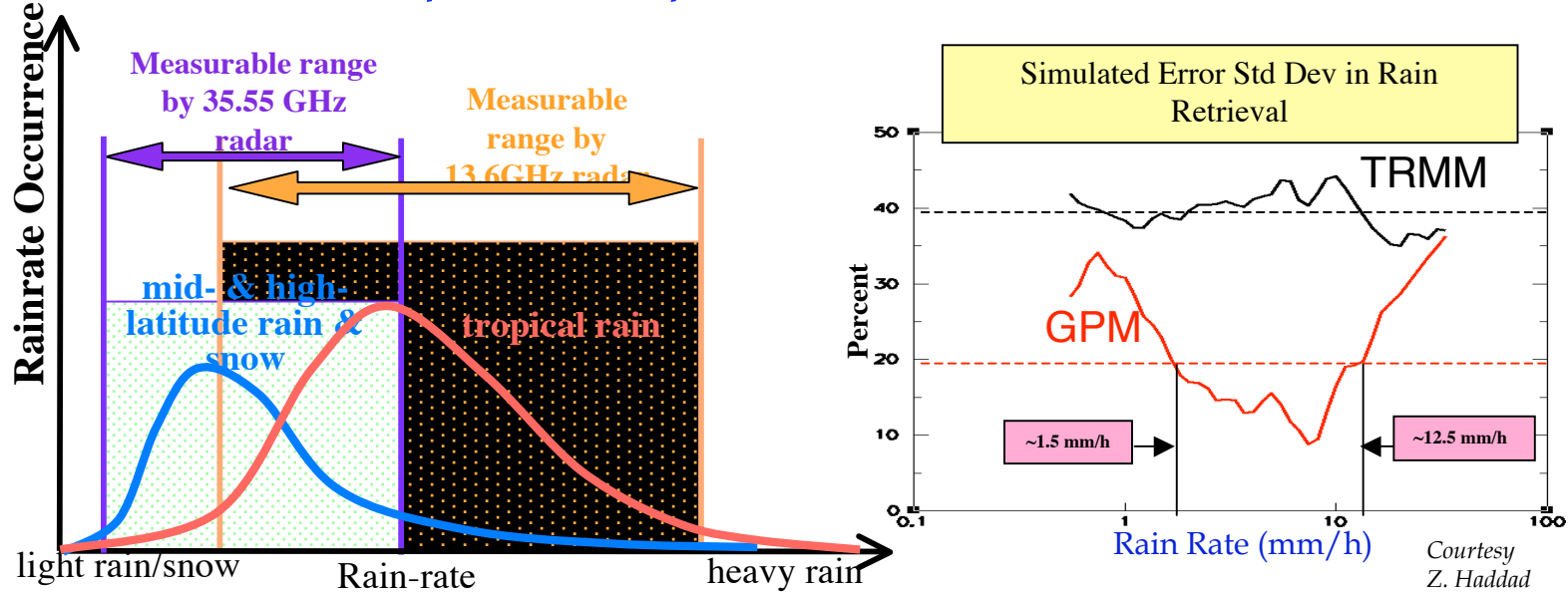
- First precipitation radar in space to provide observations of 3-D rain structure for understanding storm dynamics.
- First to make combined use of active and passive MW sensors to improve accuracy of space-based rainfall measurements.

GPM

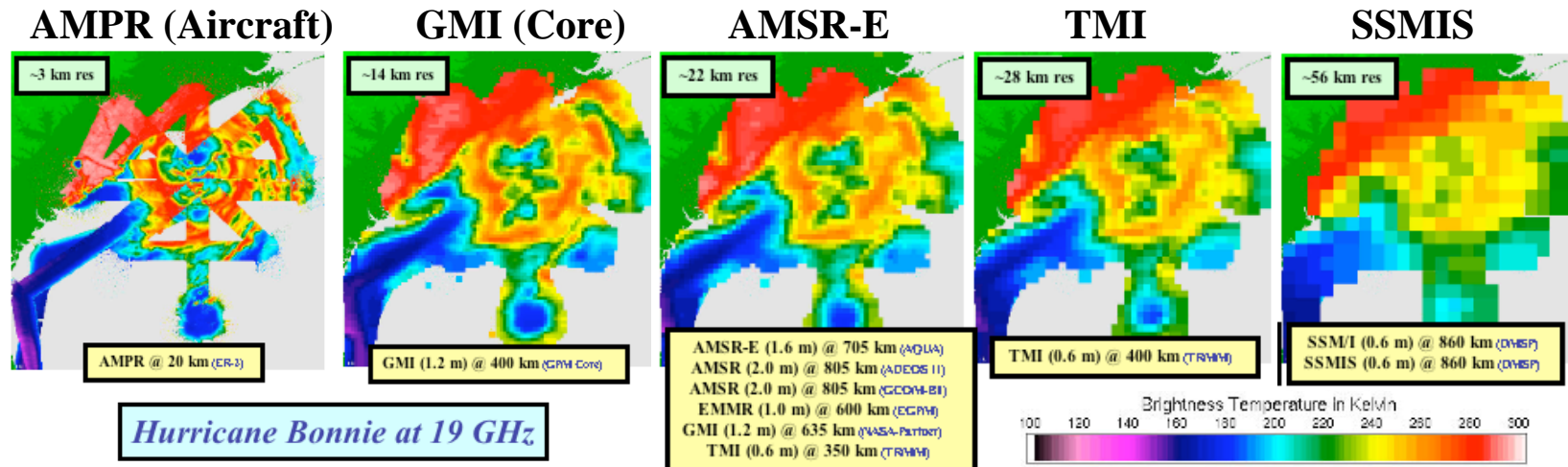
- First dual-frequency radar to provide a wider spectra of rain measurements (for detecting changes in rainfall characteristics) and information on microphysics.
- GMI with HF capabilities
- Improved calibration procedures.



Expected improvements with DPR



Comparison of GMI resolution with other radiometers



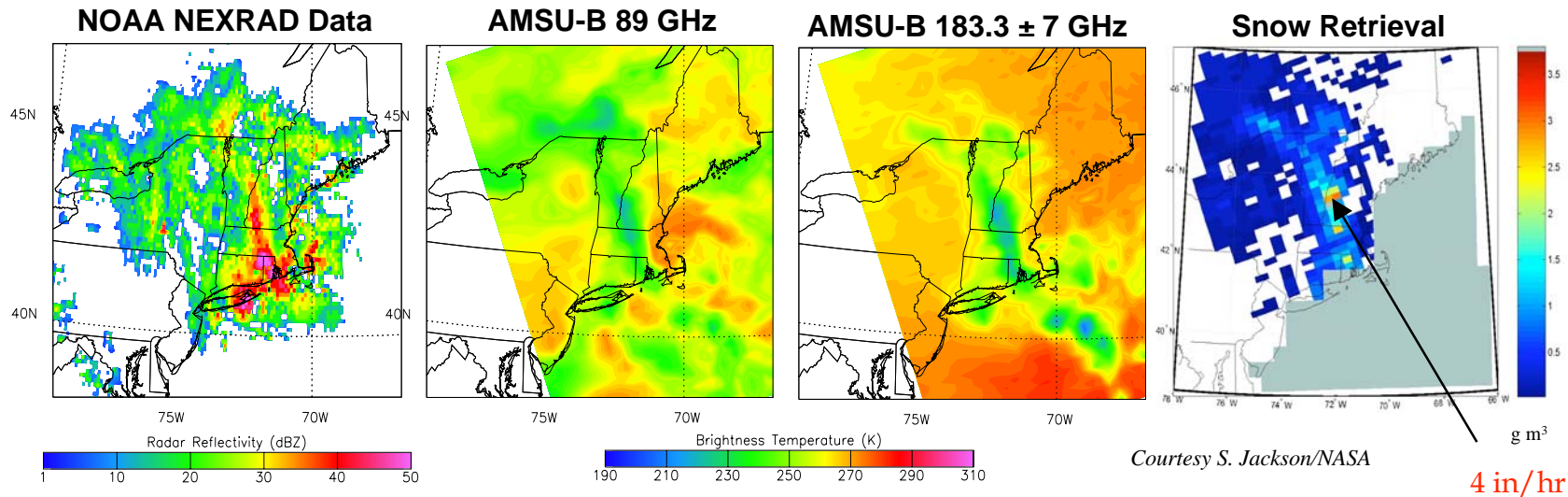
Synthesized Brightness Temperatures (R. Hood NASA/MSFC)

Improved intercalibration of constellation radiometers to a common reference standard

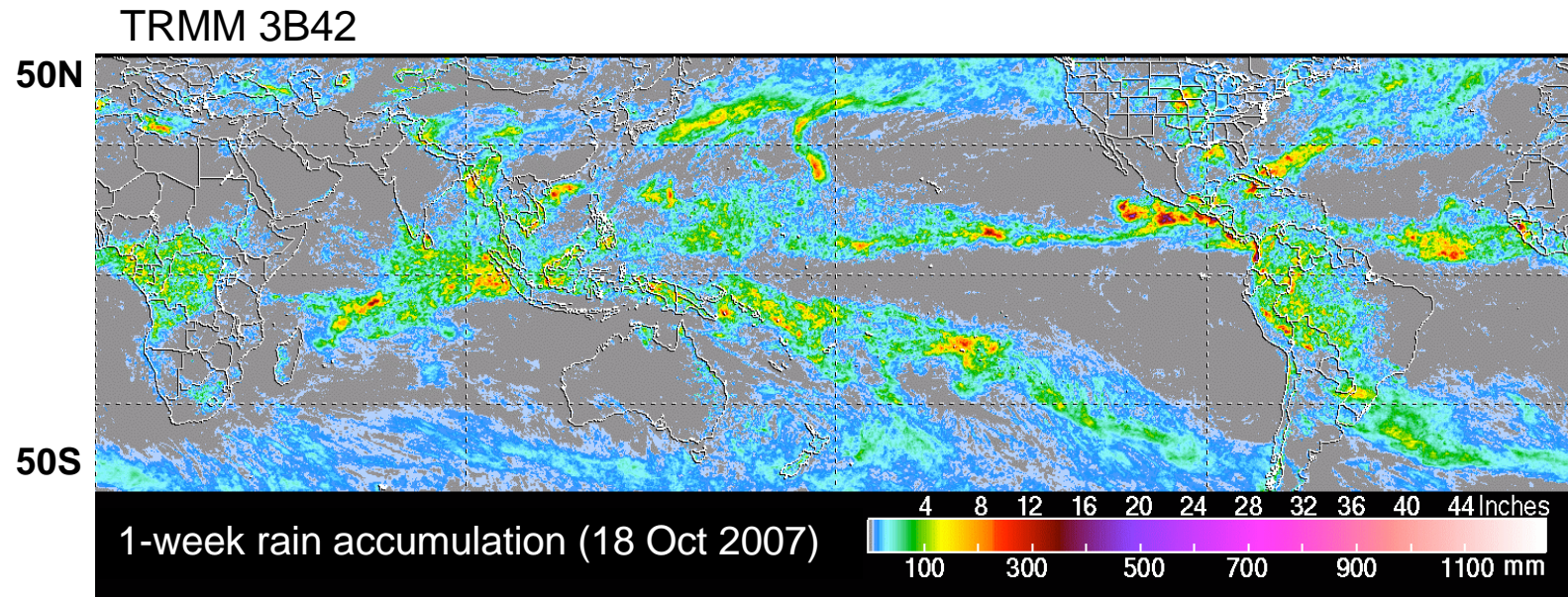
- *Calibration of Level 1 brightness temperature data using GMI as a reference*
- *Calibration of Level 2 precipitation data using a common DPR/GMI-derived cloud database*

GPM has formed - in coordination with CGMS/GSICS - an international WG to develop a community consensus on intercalibration of MW radiometers

Improved light rain and solid precipitation retrievals using GMI high-frequency channels

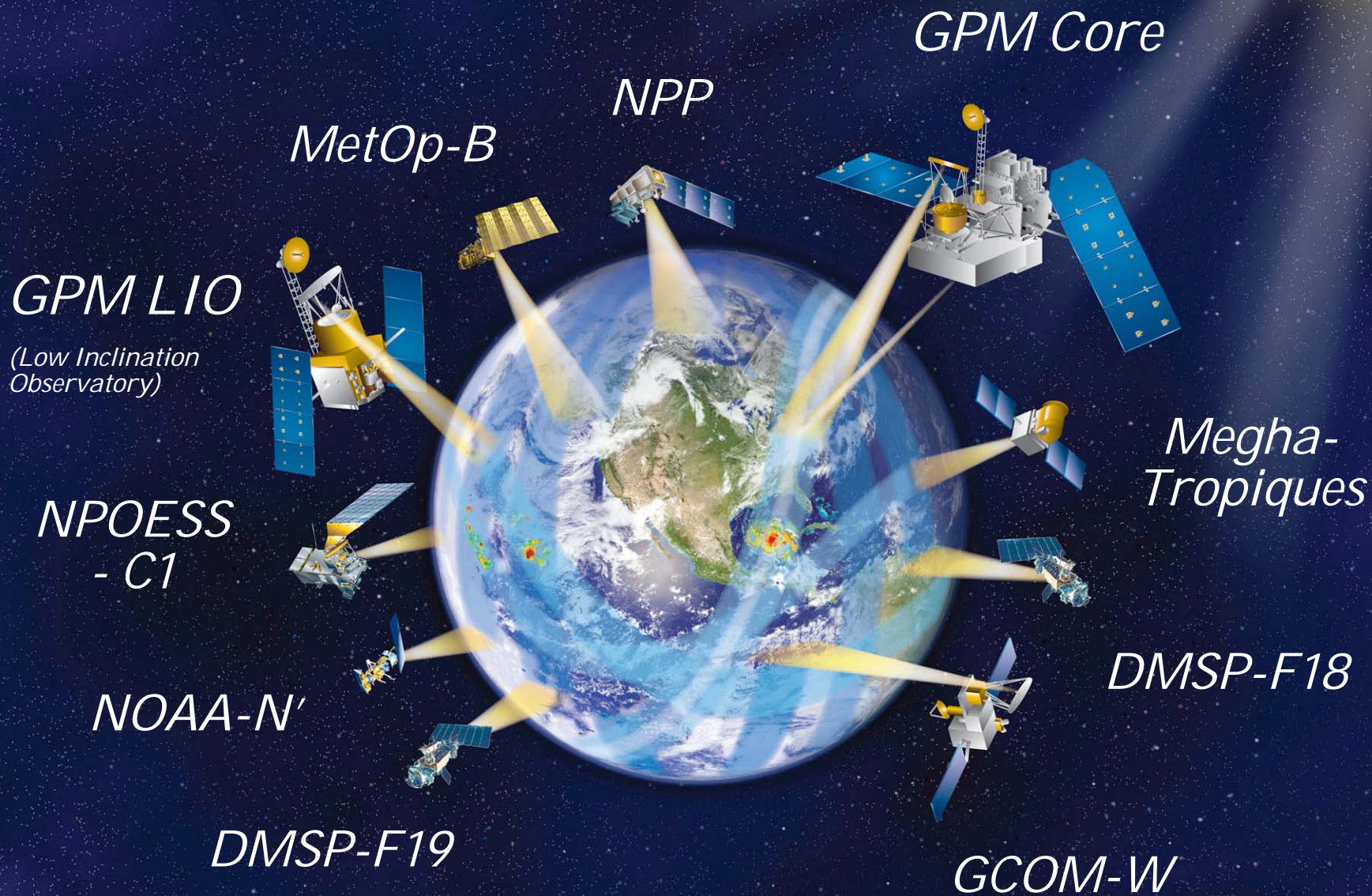


Pointer #4: Leveraged global coverage



- TRMM has brought us a number of merged multi-satellite (MWR or MWR+IR) rainfall products.
- These “first-generation” products are based on observations from *uncoordinated* satellite missions using different merging techniques.
- GPM is *by design* a constellation mission to unify and advance global precipitation measurements from research and operational satellites.

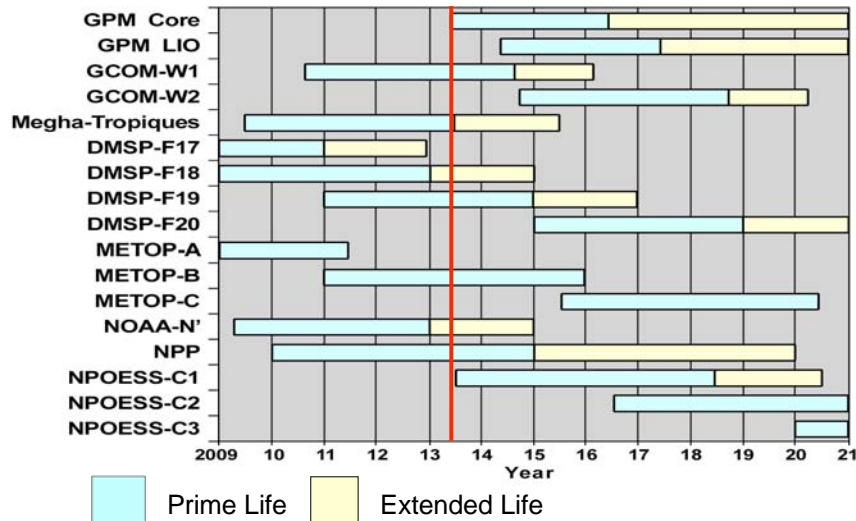
GPM Baseline Constellation



Additional partners possible: Brazil, Russia, China..

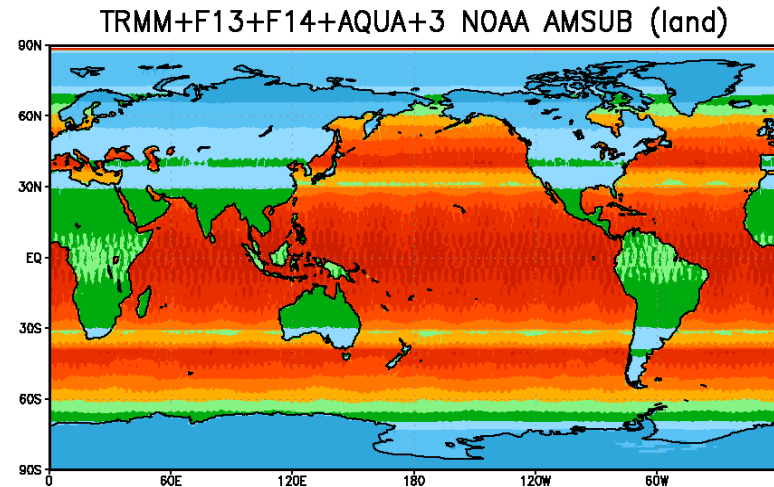
Expected GPM Constellation Performance

GPM Core Launch



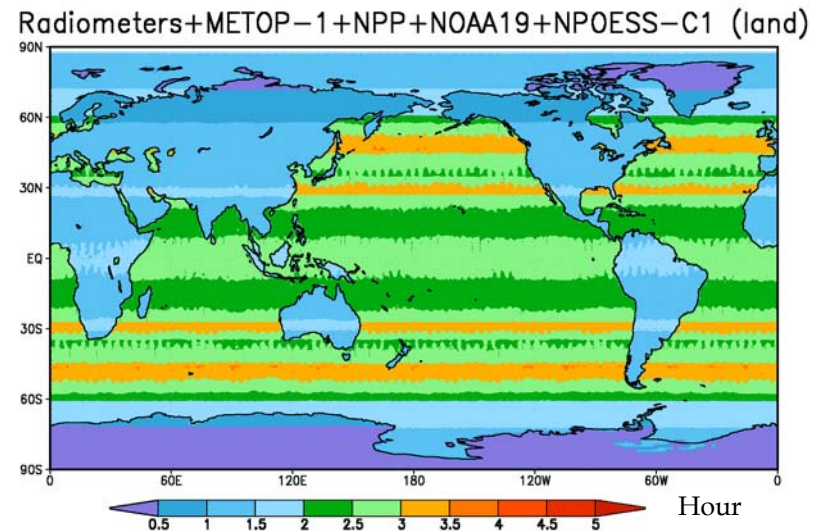
TRMM Era

(≤ 3 h over 45% of globe)



GPM (2014)

(≤ 3 h over 92% of globe)

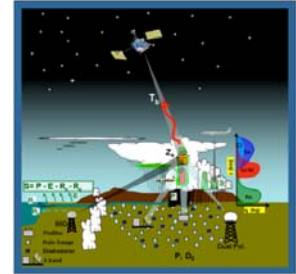


Year	Average Revisit Time (hr)				
	2013	2014	2015	2016	2017
Land					
Tropics	1.6	1.5	1.6	1.8	2.3
Extratropics	1.1	1.0	1.0	1.0	1.4
Globe	1.4	1.2	1.3	1.4	1.8
Ocean					
Tropics	3.1	2.5	3.2	3.9	4.9
Extratropics	3.2	2.6	2.1	2.6	3.3
Globe	3.1	2.5	2.7	3.3	4.2
Land and Ocean					
Tropics	2.6	2.2	2.7	3.1	4.0
Extratropics	2.3	1.9	1.6	1.9	2.5
Globe	2.4	2.0	2.1	2.5	3.3

1-2 hr re-visit time over land

Pointer #5: GV is more than comparison of rain rates between ground and satellite measurements

GV provides the means for improving satellite simulators, retrieval algorithms, & model applications



GPM Ground Validation Activities:

- *Direct statistical validation (at the surface):*
 - Leveraging off operational networks to identify and resolve significant discrepancies between satellite and ground-based precipitation estimates
- *Precipitation physics validation (in a vertical column):*
 - Cloud system and microphysical studies geared toward testing and refinement of satellite simulators and retrieval algorithms
- *Integrated science validation (4-dimensional):*
 - Integration of satellite precipitation products into weather, land surface, and hydrological prediction models to evaluate the strengths and limitations of satellite precipitation products

*Pointer #6a: Give data away for free
(so people will use it)*

*Pointer #6b: Provide data in near realtime on “best effort” basis not as an operational requirement
(so you don’t break the bank)*

TSDIS



PPS

*Precipitation Processing System
within a distributed environment
including partners and universities*

*Pointer #7: Extend mission life by raising the orbit
(and forget controlled re-entry)*



*GPM is designed for demise upon decommissioning.
(so all the fuel can be used for science)*

Pointer #8: It's people that make missions successful

For TRMM:



For GPM:



It's YOU

GPM

Carrying on TRMM's tradition of delivering cutting-edge precipitation measurements from space for research and applications for the benefits of all nations



Providing next-generation global precipitation products through

- advanced active & passive microwave sensor measurements*
 - a consistent framework for inter-satellite calibration*
- international collaboration in algorithm development and ground validation*



Oh, TRMM,
I can't help falling in
love with you ...

Thank you!

Courtesy of S. Braun