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Enhancing TRMM with a Near-realtime System and Special Products

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Special Dedication for the 15th Anniversary

Dr. Joanne Simpson

Dr. Tsuyoshi Nitta

Stocker's Special Thanks for TRMM Excellence

- **Dr. John Theon NASA/Hq TRMM Program Scientist**
- **Dr. Ramesh Kakar NASA/Hq Current TRMM Program Scientist**
- **Dr. Nobuyashi Fugono – CRL**
- **Mr. Thomas LaVigna NASA GSFC TRMM Project Manager**
- **Mr. Thomas Keating NASA GSFC TRMM System Engineer (*special thanks for the nice large fuel tank*) – who died very recently**
- **Dr. Otto Thiele- NASA/GSFC**
- **Dr. Ken'ichi Okamoto CRL - for leading a well oiled international PR science team and fantastic original CRL PR design team**

Of course many others, both in U.S. and Japan, should be mentioned but time does not allow

Realtime Background

- **Beginning several years before launch many attempts were made by the TRMM project to incorporate a "near-realtime" component into the TRMM requirements**
- **Management forbade altogether that any mention of "realtime" be used in conjunction with TRMM**
- **Cost estimates for implementing "realtime" requirements at the project/satellite-instrument level were very high**
- **So, prior to launch no permission was given to implement "realtime" requirements for the mission instead these were expressly prohibited.**
- **However, TRMM did have the capability of providing 3 quicklook downloads each day and at times up to 4 per day.**
- **Even after launch requests continued from operational agencies to get TRMM "realtime" data (particularly from JMA and NRL)**

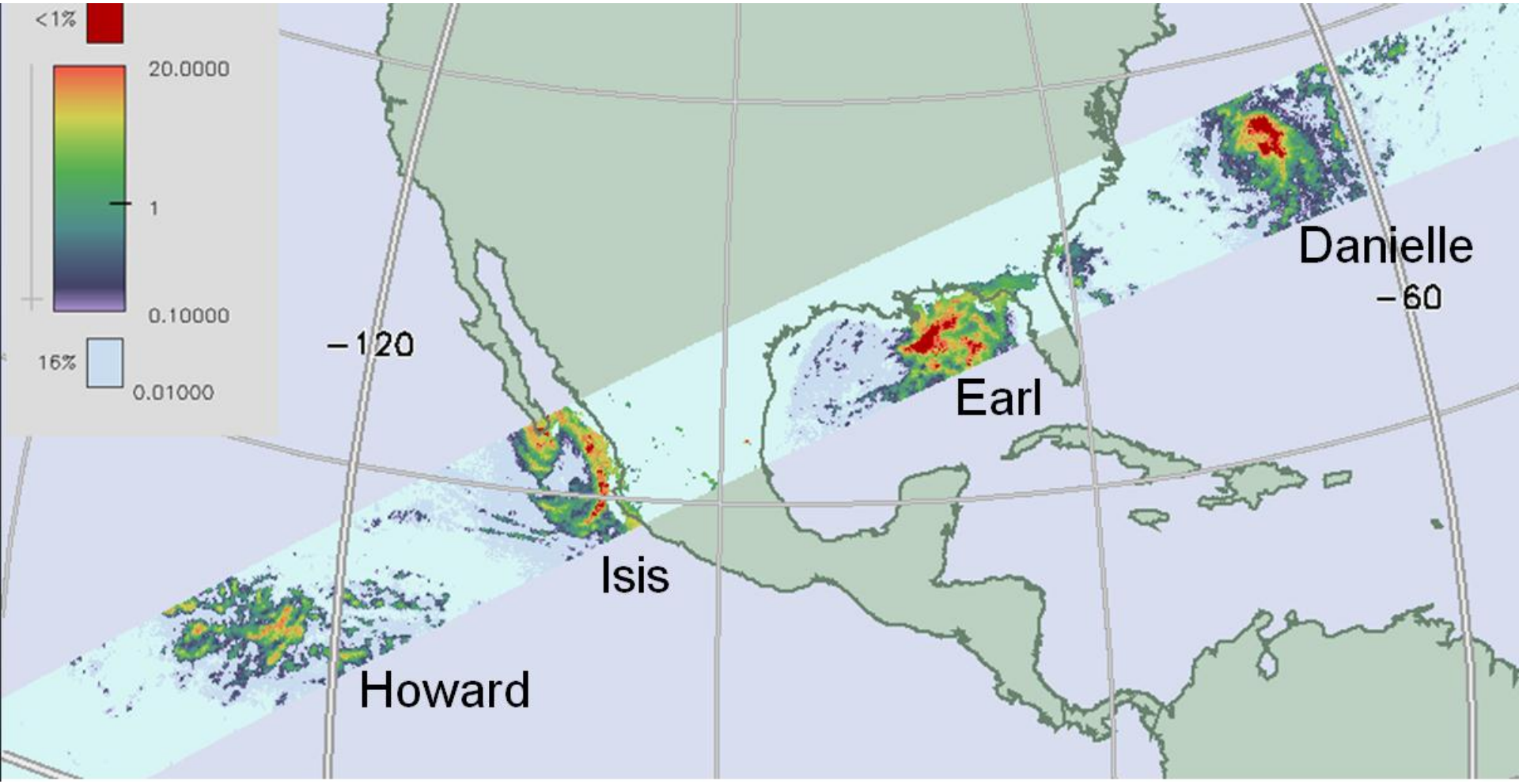
NASA TRMM Project Scientist Waved his Magic Wand

- **In 1999, the then Project Scientist, Dr. Christian Kummerow (now of CSU fame) came to PPS (then TSDIS) to explore possibilities of implementing a low-cost "near-realtime" (NRT) system**
  - There were to be no REQUIREMENTS for the products
  - The goal was to have the swath precipitation retrievals available to the users within 120 minutes 90% of the time.
- **NRT objectives suggested by Dr. Kummerow:**
  - Minimum to no additional cost and NO impact on the standard TRMM operation
  - Because of network bandwidths at the time, keep the NRT products around 7MB to facilitate retrievals
  - Avoid having to prepare separate algorithms for NRT but tie the NRT algorithms to the JTST controlled TRMM standard products
  - Implement as quickly as possible
  - Provide swath based NRT products from both TMI and PR
  - Make the NRT products as simple as possible for easy use

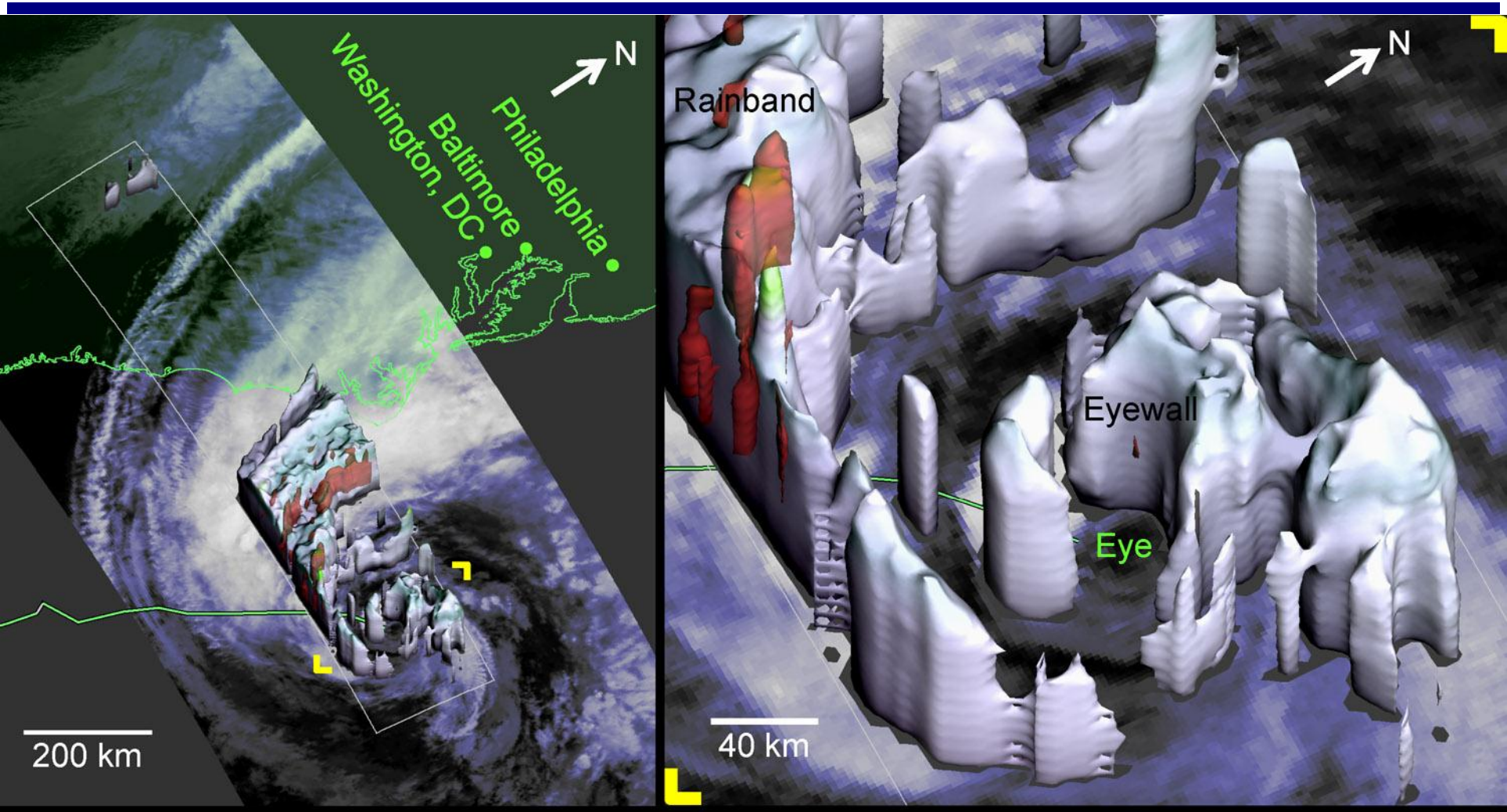
NRT Swath Products

- **Implementation**
  - Generate the full products (so only JTST approved algorithm code used)
  - Parameter subset the full products to the target size
  - Distribute the parameter subsetted products
- **Products**
  - VIRS L1B radiances
  - TMI L1B Brightness Temperature
  - TMI L2 GPROF rain retrievals
  - PR L2 Rain classification
  - PR L2 Estimated surface rain/near surface reflectivity
  - PR L2 20-level Vertical profile of rain/reflectivy

Four Storms Line Up for TMI in Sep 1998



PR Captures Hurricane Sandy (2012)

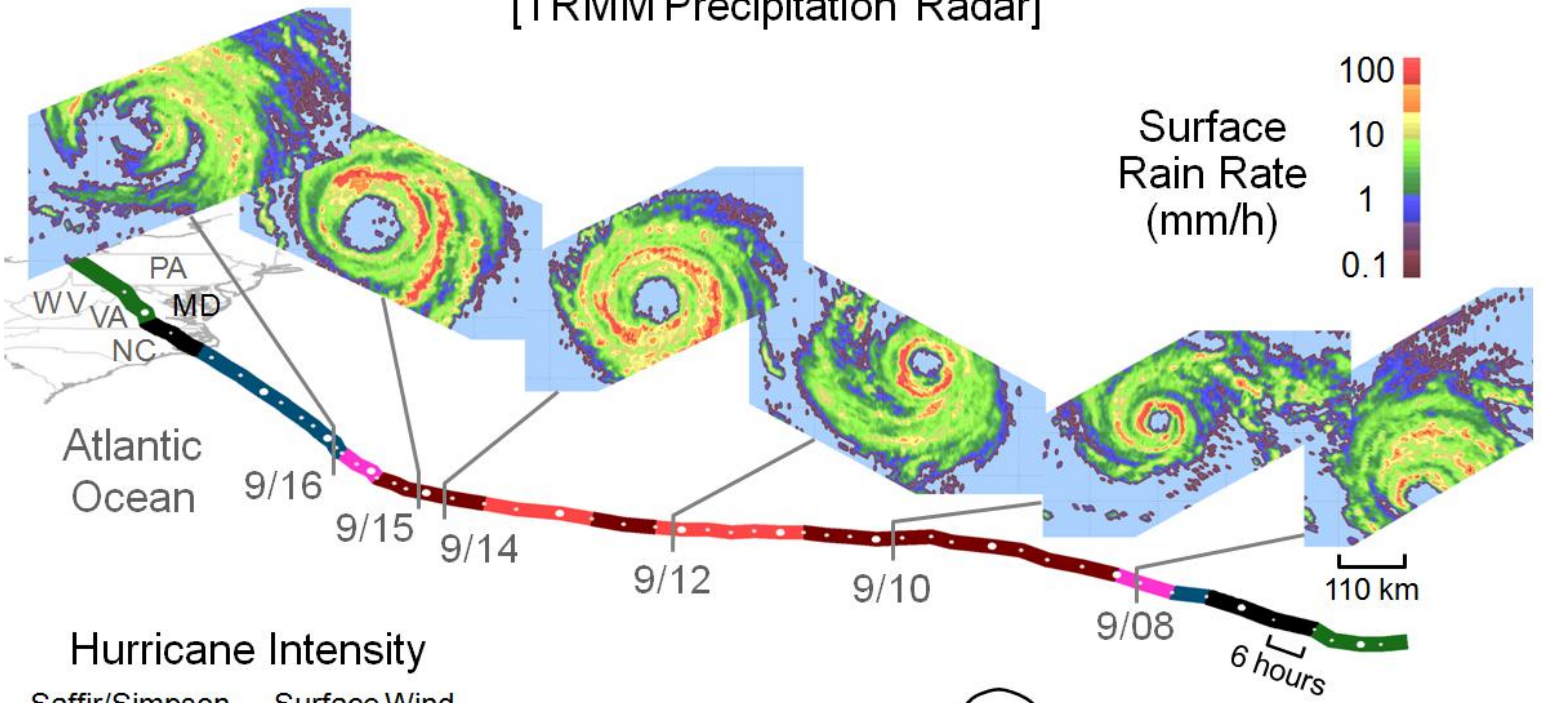


Hurricane Sandy observed by the TRMM Precipitation Radar at 2:20 EDT on 28 October 2012

Tracking Isabel via PR-Sep 2003

Horizontal View of Hurricane Isabel in September, 2003

[TRMM Precipitation Radar]



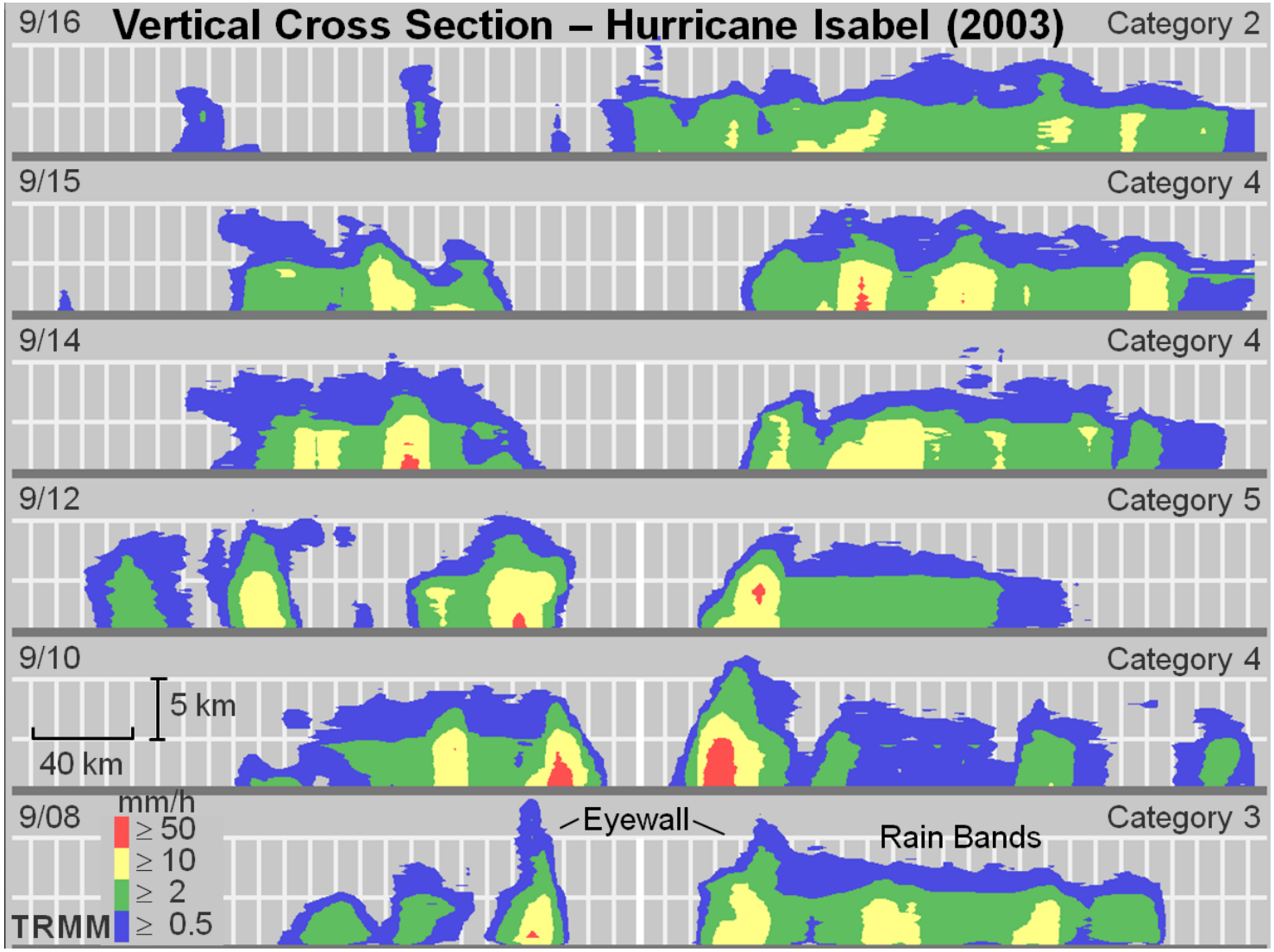
Hurricane Intensity

Saffir/Simpson Category	Surface Wind (km/h)	(mph)
5	≥ 248	≥ 156
4	209	130
3	180	112
2	151	94
1	118	74
Tropical Storm	61	38

Circular Motion

Forward Motion

PR Vertical Cross Section for Isabel-2003



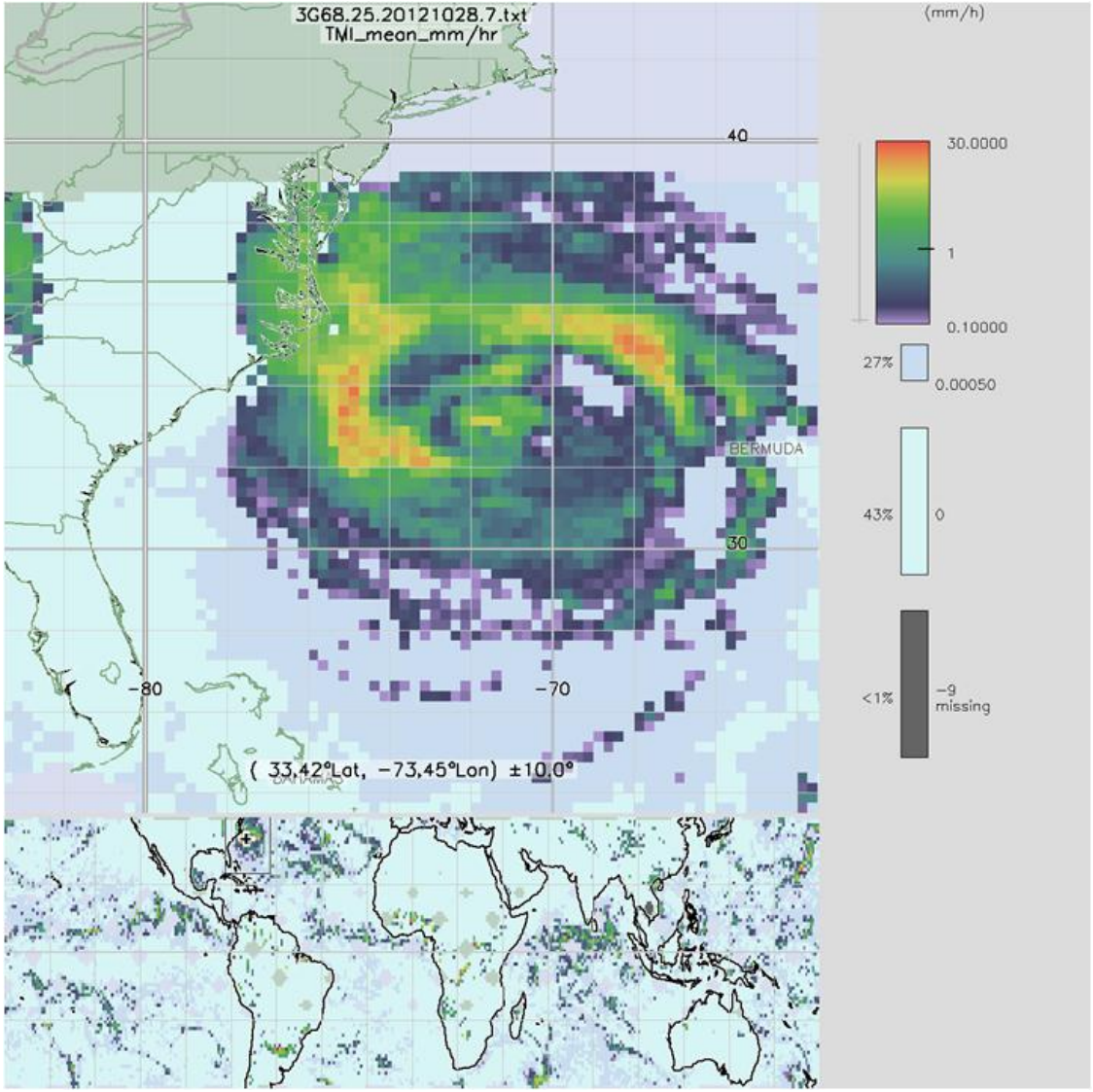
More Kummerow Magic-Special Products

- **In 1999, Dr. Kummerow developed the concept of files that contained retrieval information**
  - for the three key “instruments” (TMI, PR, combined)
  - were to be in text, line driven and easily accessible even via spreadsheets.
- **From this objective were developed the 3G family of products (these not realtime)**
  - 3G01 Hourly gridded .5 deg x .5 deg VIRS Tb packaged into daily files (one for channel 4 and a separate one for channel 5)
  - 3G68 Hourly gridded .5 deg x .5 deg TMI, PR, Combined retrievals packaged into daily files: (total pixels, rainy pixels, unconditioned mean, percent convective)
  - 3G68 quarter degree hourly gridded .25 deg x .25 deg TMI, PR, Combined retrievals packaged into daily files: (total pixels, rainy pixels, unconditioned mean, percent convective)
  - 3G68Land Hourly gridded .1 deg x .1 deg TMI, PR, Combined retrievals packaged into daily files: (total pixels, rainy pixels, unconditioned mean, percent convective)
    - Africa
    - South America
    - Australia (at request of a Japanese investigator)

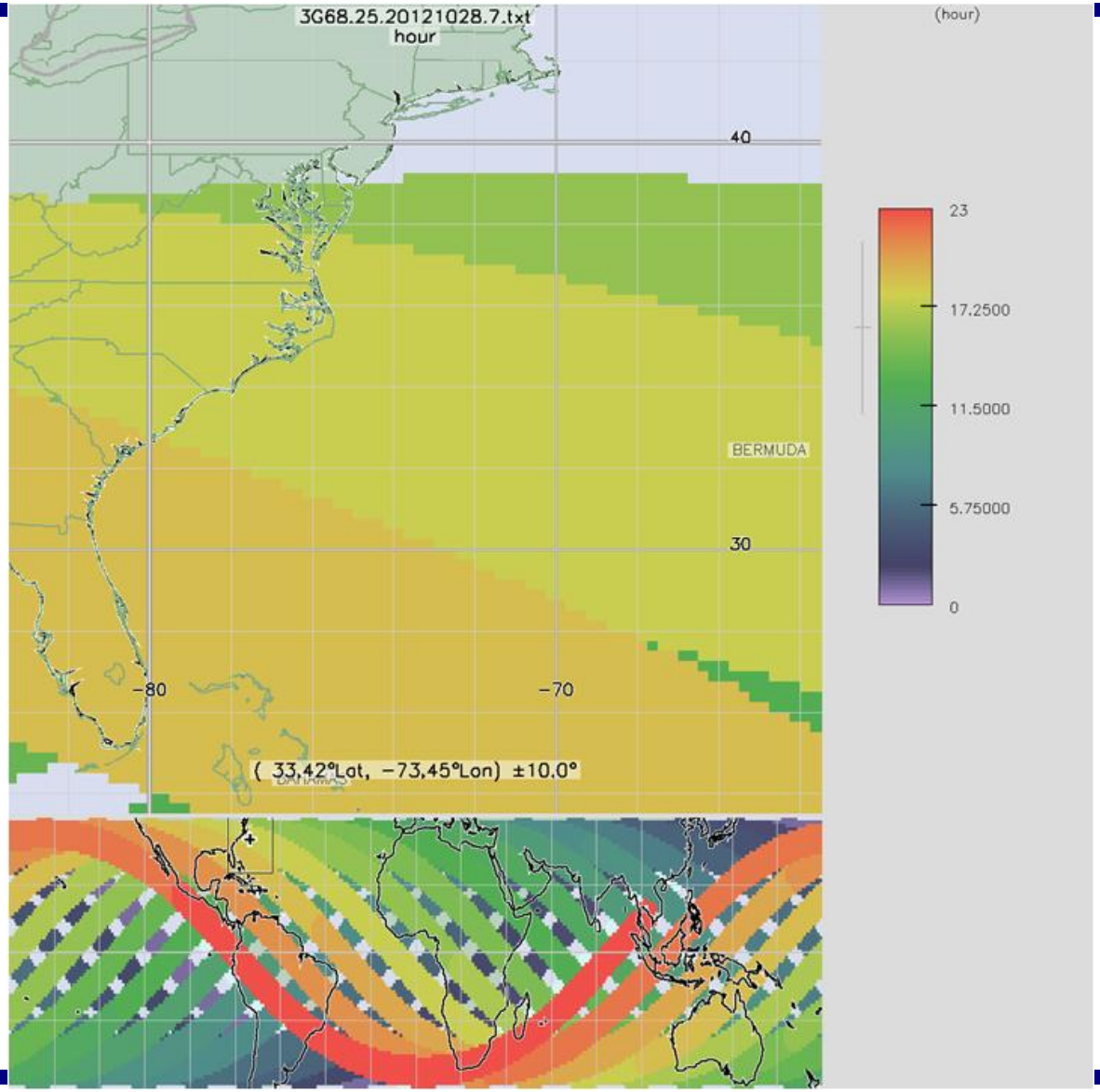
Sample of 3G68 file

4G68Quarter 2.1 NONE NONE NASA/JAXA/NICT 2012-11-01T15:24UTC
720 1440 -90 -180 0.25 20121028
-40 40 -180 180
Grid_First_Row=0 Grid_Center_Latitude=-89.875 Grid_First_Column=0
Grid_Center_Longitude=-179.875 Grid_Cell_Resolution=0.25
Duration=Day
hour minute row column TMI_total_pixels TMI_rain_pixels TMI_mean_mm/hr
TMI_%convective PR_total_pixels PR_rain_pixels PR_mean_mm/hr
PR_%convective TCI_total_pixels TCI_rain_pixels TCI_mean_mm/hr
TCI_%convective
0 24 203 692 3 0 0.0000 0 0
0 24 203 693 3 0 0.0000 0 0
18 13 499 447 11 11 19.7037 55 0
18 13 499 448 12 12 20.3272 43 0
18 13 499 449 12 12 19.7004 63 0
18 13 499 450 14 14 15.2794 53 0
18 9 502 387 10 4 0.5315 0 27 9 0.5863 35 27 9 0.4929 23
18 9 502 388 8 5 1.0687 0 23 12 0.7991 23 23 12 0.7089 14
18 9 502 389 11 0 0.0000 0 22 8 0.3653 0 22 8 0.3812 0

Hurricane Sandy (2012) in 3G68-25



Example of 3G68 Daily File



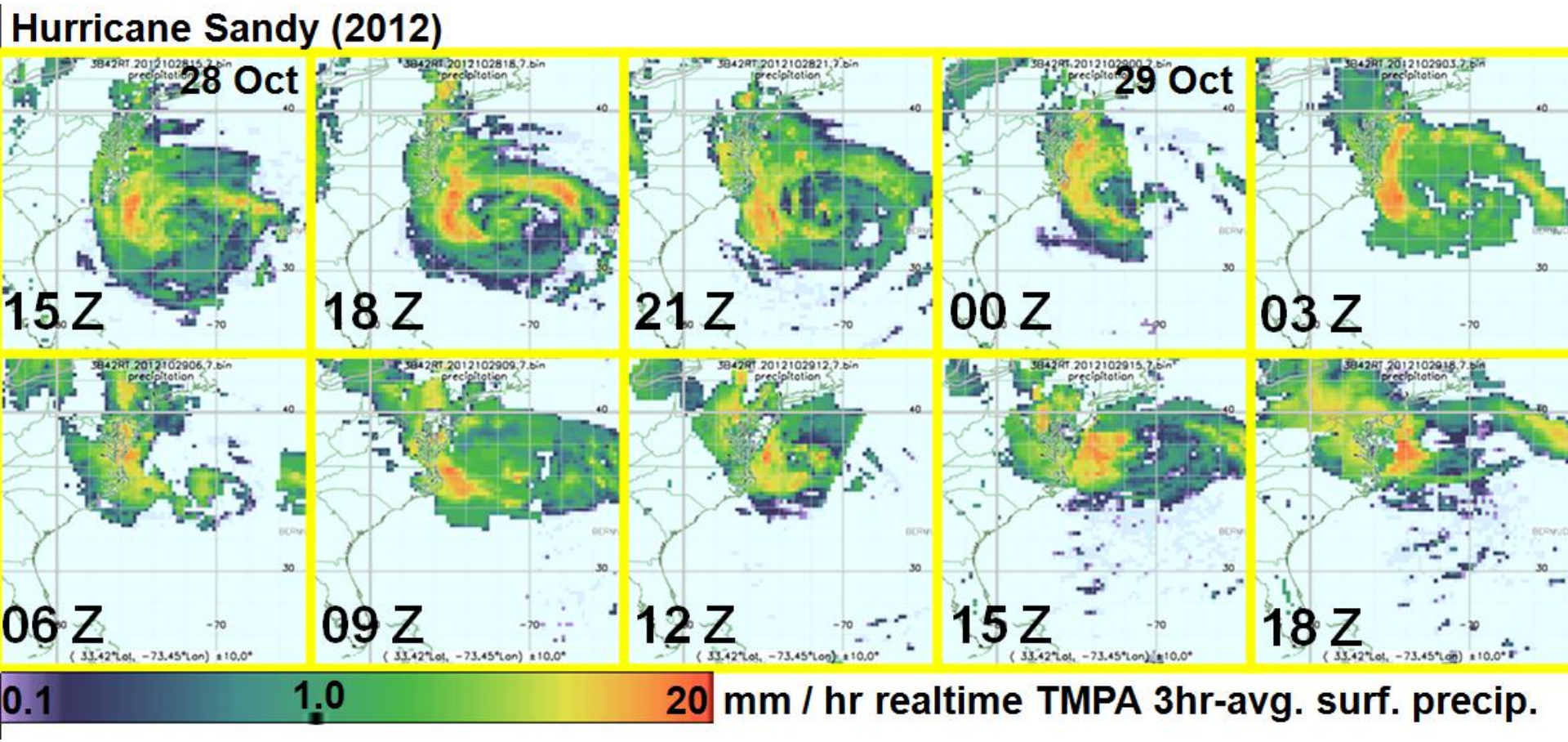
Why have we been up for 15 years

- **We have 15 years because of Dr. Robert Adler who became the TRMM Project Scientist in 2000 when Dr. Kummerow left for academia**
- **Dr. Adler advocated, coordinated and insured the carrying out the boost in August 2001**
  - Obtained TRMM science team buy-in to the boost
  - Coordinated with Japanese colleagues to get the buy-in by JAXA
  - Close coordination with Dr. Okamoto and the PR team who did the analysis and the work to ensure the PR continued to give useful precipitation data even at the new altitude
  - Coordinated with NASA Hq to get the approval to boost the orbit.
  - Coordinated and guided the Flight Operations Team (FOT) activities for the boost maneuver (FOT did a remarkable job)
- **2004 Dr. Adler puts his career on the line to keep TRMM in orbit**
  - In 2004 NASA/Hq Dr. Asrar decided that TRMM's usefulness to research had been carried out and the satellite should be brought down. JAXA agreed.
  - Dr. Adler worked tenaciously and often against the advice of his managers to ensure that TRMM stayed in orbit.
  - He prepared the documentation to obtain an exception to the controlled re-entry requirement from NASA Hq
  - TRMM science team members helped get congressional support

Another Adler gift

- **In 2001 while project scientist Dr. Adler asked that PPS set up a realtime version of the TRMM Multi-satellite Precipitation Analysis (TMPA)**
  - Merged radiometer data only 3B40rt
  - “calibrated “ IR 3B41rt
  - Merged IR and radiometer product 3B42rt
- **Products to be**
  - .25 x .25 degree “global”
  - 3 hour time resolution
  - Binary format
- **Latency objective: ~6 hours after data collection**
- **NRT TMPA uses when available**
  - TMI
  - CPC 1 hourly 4km IR
  - SSMI/SSMIS (F13, F14, F15, F16,F17, F18)
  - AMSUB and MHS
  - AMSRE

3Hr Sequence-3B42rt Sandy Images

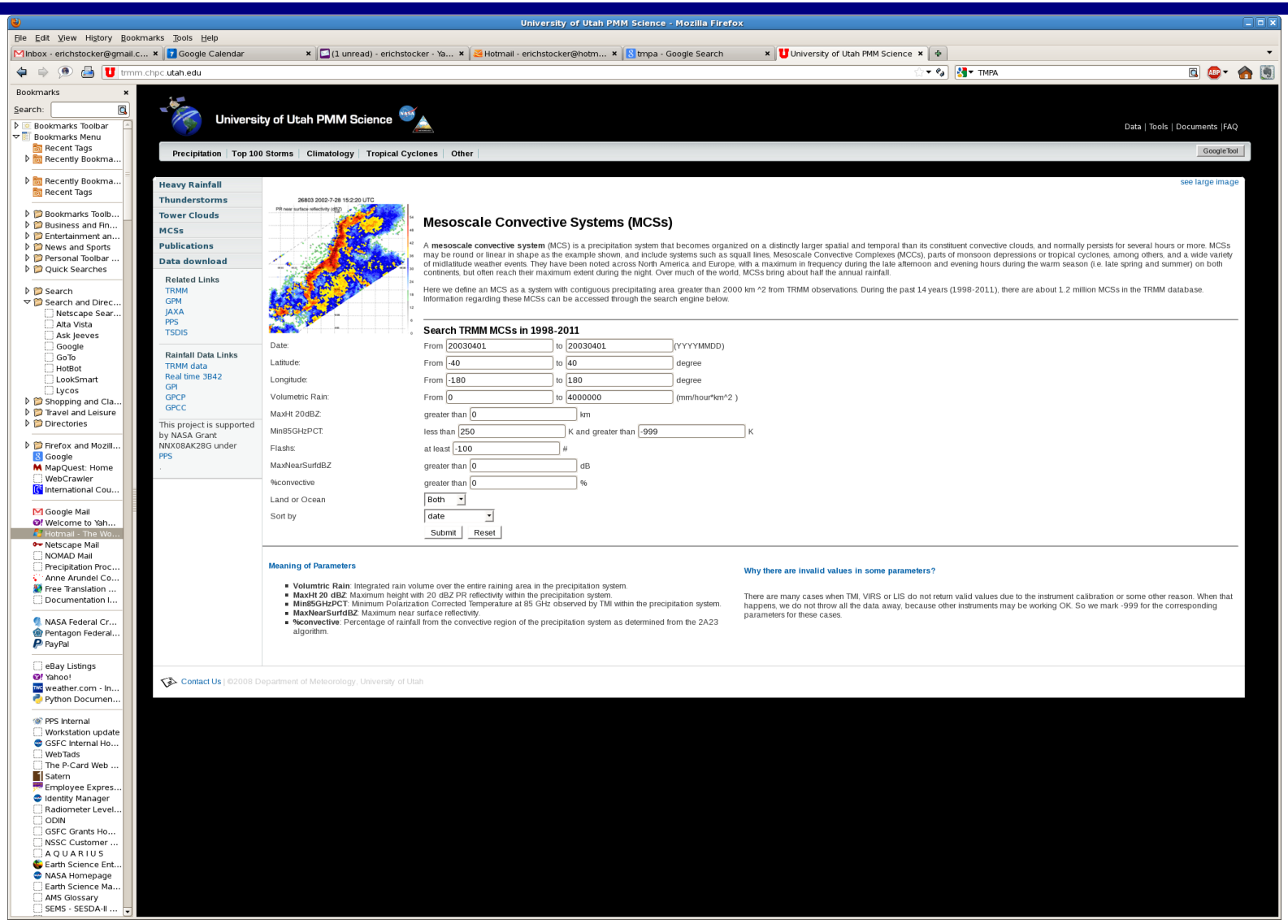


Another Special Product-Univ of Utah

- **PPS and University of Utah started working jointly to run the University of Utah Precipitation Features (PF) algorithm at PPS. Initial coordination initiated by Dr. Ed Zipser (TAMU and now University of Utah)**
  - Started working with Dr. Steve Nesbitt on the core L1 and L2 products
  - Worked with Dr. Daniel Cecil (now at GHRC) to add LIS information to PF
  - Currently working with Dr. Chuntao Liu to extend and include latent heating
- **Products produced at PPS NASA/GSFC but supported and distributed by University of Utah**
- **PPS helped with funding to set up a PF website at UU to facilitate widespread use of TRMM PF**

trmm.chpc.utah.edu

Sample of MCS Search-UU website



Acknowledgement

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