Global Precipitation Measurement

Evolution of Algorithms from TRMM to GPM



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- *Level 1C processing of GPM Microwave Imager (GMI) --intercalibration*
- *Radar-enhanced radiometer GPROF radiometer retrieval algorithm (radiometer-RE)*
- *Combined radar-radiometer algorithms*
- *Merged algorithm product*
- *Summary*

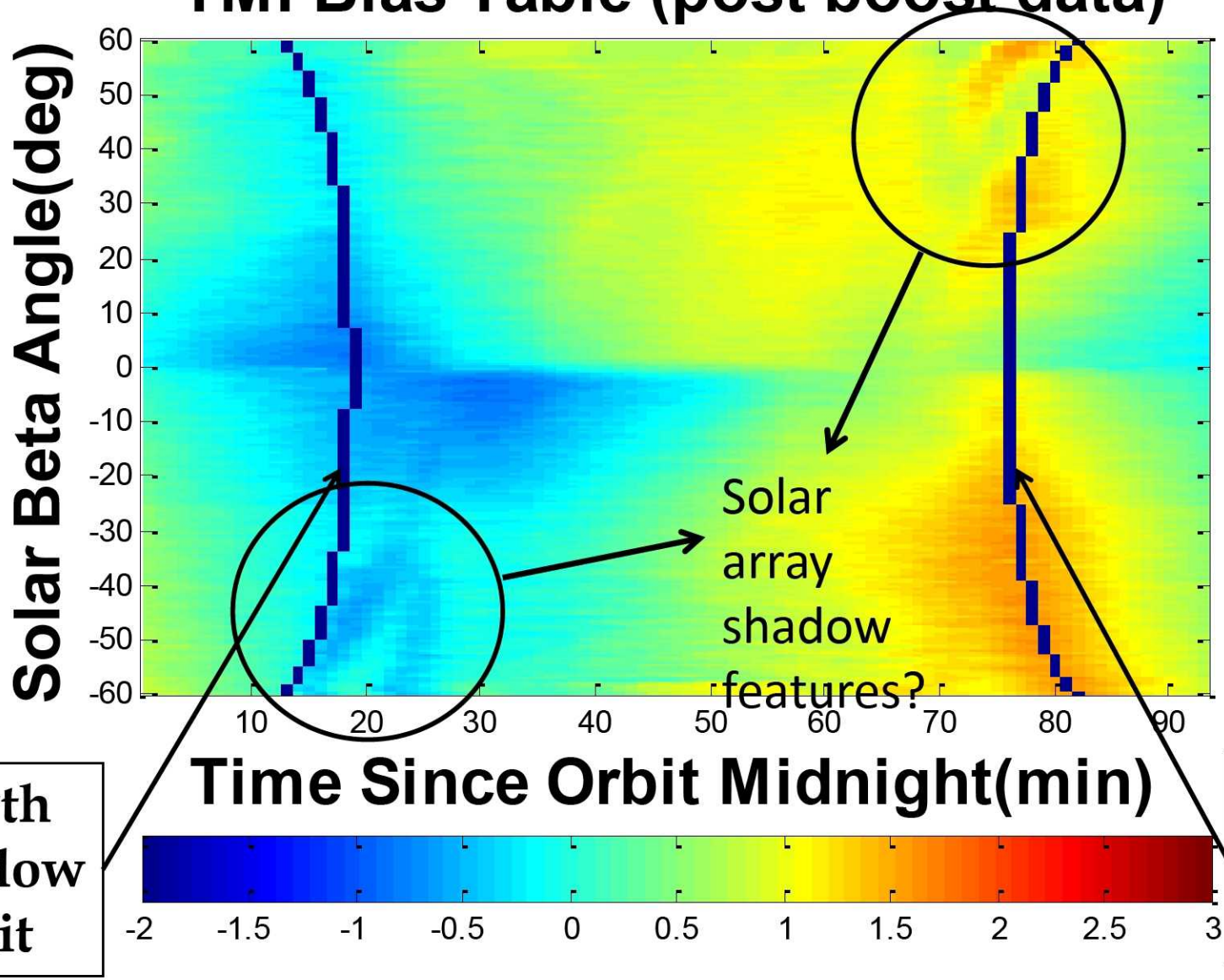
Purpose of 1C

- ***Develop a consistent, intercalibrated dataset of constellation T_b to be used in all precipitation retrievals and made available to community***
- ***Apply appropriate intercalibration to all partner constellation radiometer s brightness temperatures (including back porting to TMI as appropriate)***
- *Determine the type of data needed for carrying out intercalibration --Base file of T_a*
  - *Append but do not apply calibration (so X-cal team can apply their own)*
  - *Include all necessary incidence angles*
  - *Include all necessary housekeeping (e.g. noise diode, thermistor values, etc.)*
  - *Re-orbitize to a south to south orbit and verify geolocation*
- ***Work with partners to obtain an expert for their radiometer (i.e. instrument coordinator)***
- ***Characterize the partner radiometers***
- ***Used for all subsequent radiometer retrieval algorithms***

Level 1C Intercalibrated Radiometer Products

- ***Produce a consistent, intercalibrated T_b product (T_c) from all the GPM partner consellation radiometers (imagers and sounders)***
- ***Started as a prototype at PPS with researchers at Colorado State University***
  - *Prototype SSMI, AMSRE, WINDSAT, SSMIS/F16 using TMI when appropriate*
  - *Develop a common format which contains data needed by the next level of processing (avoid TOO much information)*
  - *Processed TMI/SSMI from 1998 to present, WINDSAT, AMSRE, SSMIS as they were available*
- ***GPM Precipitation Measurement Missions (PMM) science team established an Intercalibration Working Group***
  - *Develop a process for the use of the GPM radiometer/radar as the transfer reference standard for intercalibration*
  - *Develop the process by which new partner radiometers were to be accepted into data sets and intercalibration applied as necessary*
  - *Appoint with work with partner provided instrument coordinators*
  - *Study existing 1C prototype data and develop process for using TMI as reference standard as prototype for GPM*
  - *Detailed study of radiometers*

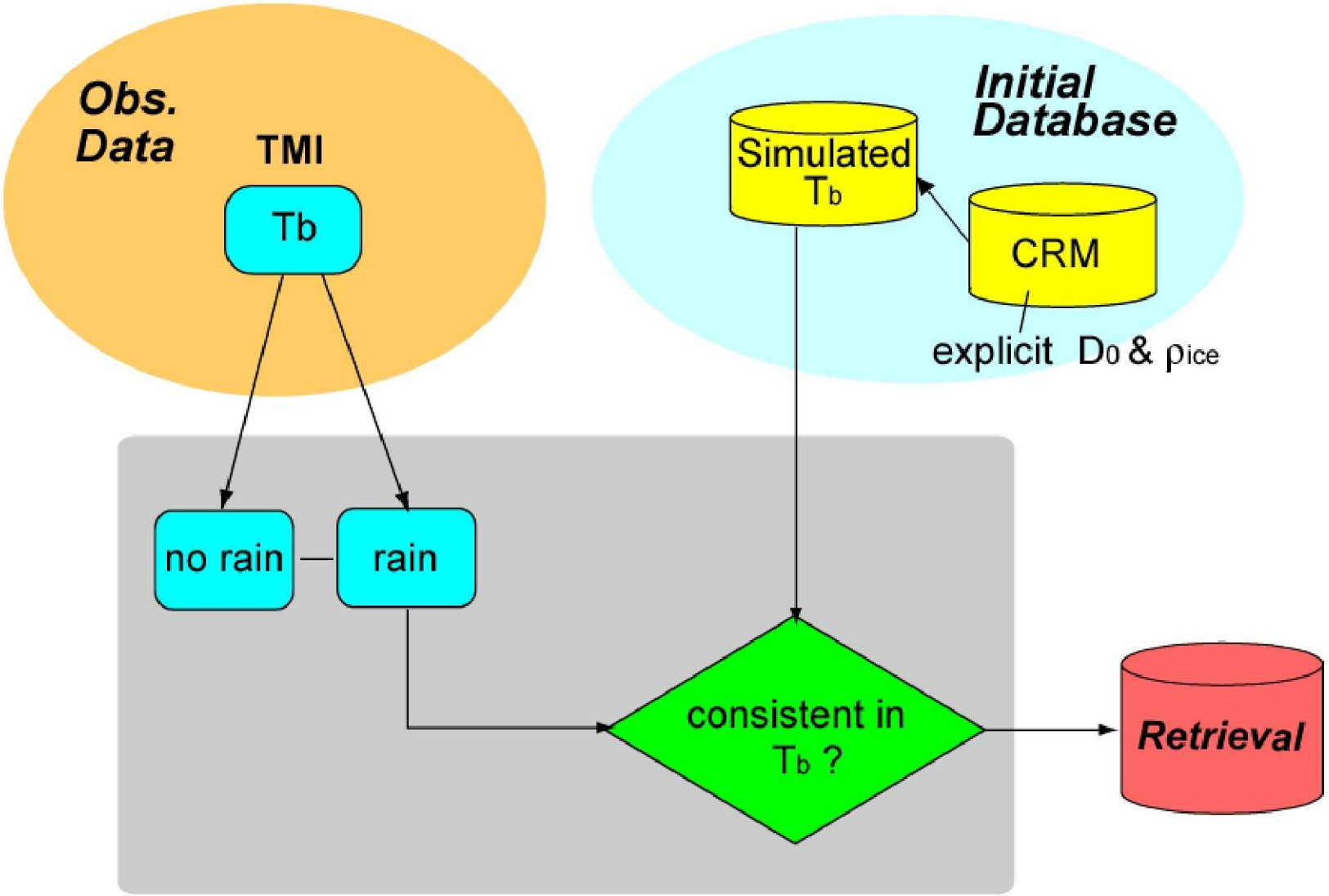
TMI Bias Table (post boost data)



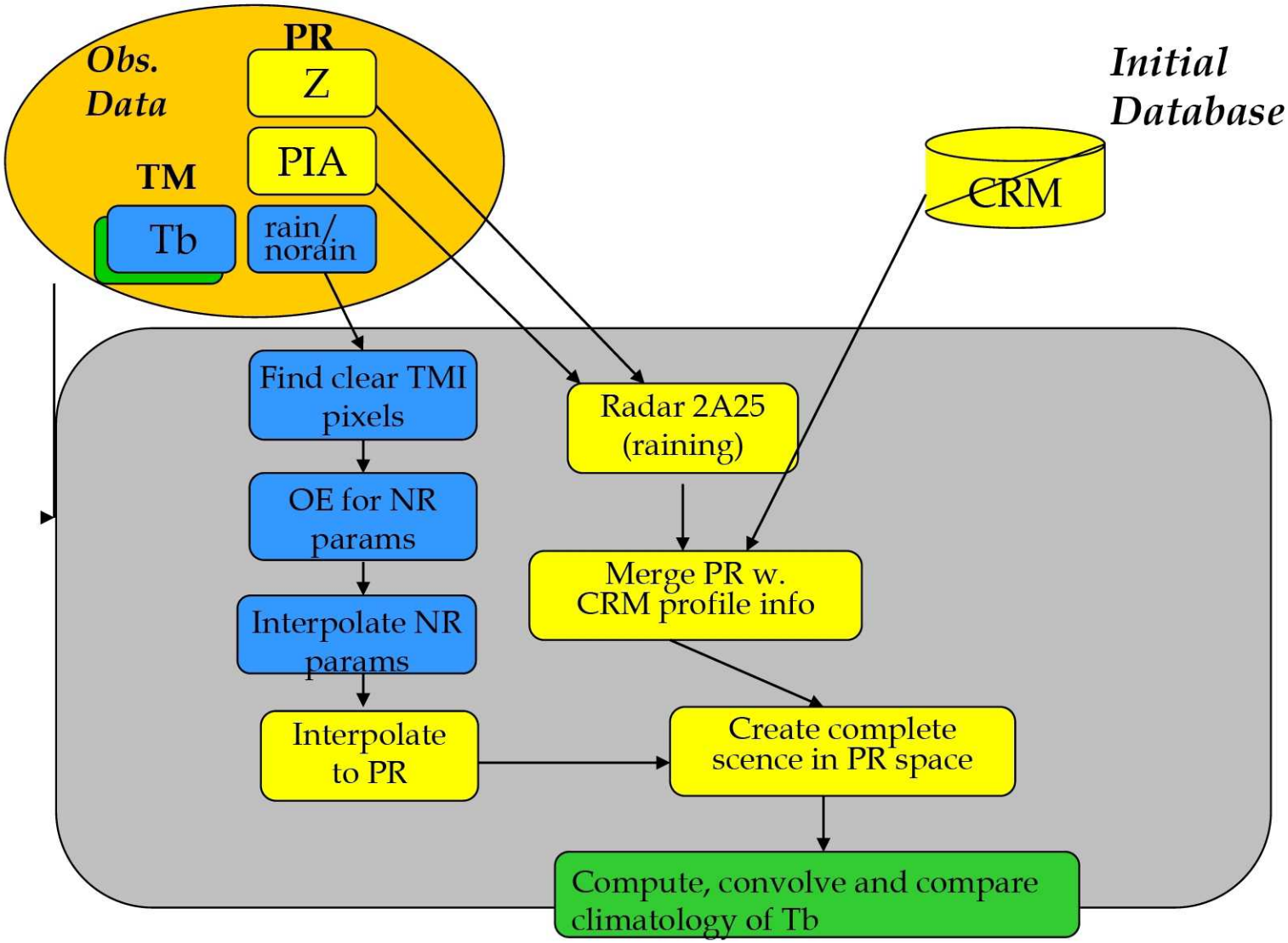
Radiometer-RE Algorithm Plans

- ***Based on TRMM v7 GPROF algorithm***
- ***Conversion to a physically based a priori database built from PR measurements***
  - *Current v7 database uses profiles from the pre-boast years (radar lost some sensitivity after the boast)*
  - *Extend the database to include extra-tropical areas*
  - *Extend the land portion of the retrieval to use a physically based database (e.g., land emissivity information)*
  - *Determine how best to incorporate the high-frequency channel Tb into the physical database*
- ***Include frozen falling precipitation retrievals into the code***
- ***Study the incorporation other methods for high frequency channels included (e.g. neural net approaches)***
- ***Apply algorithm to each partner radiometer 1C product to create consistent GPM precipitation retrievals.***
- ***When appropriate share common physics modules to both radiometer and radar retrieval algorithms***

TRMM GPROF V6 Retrievals

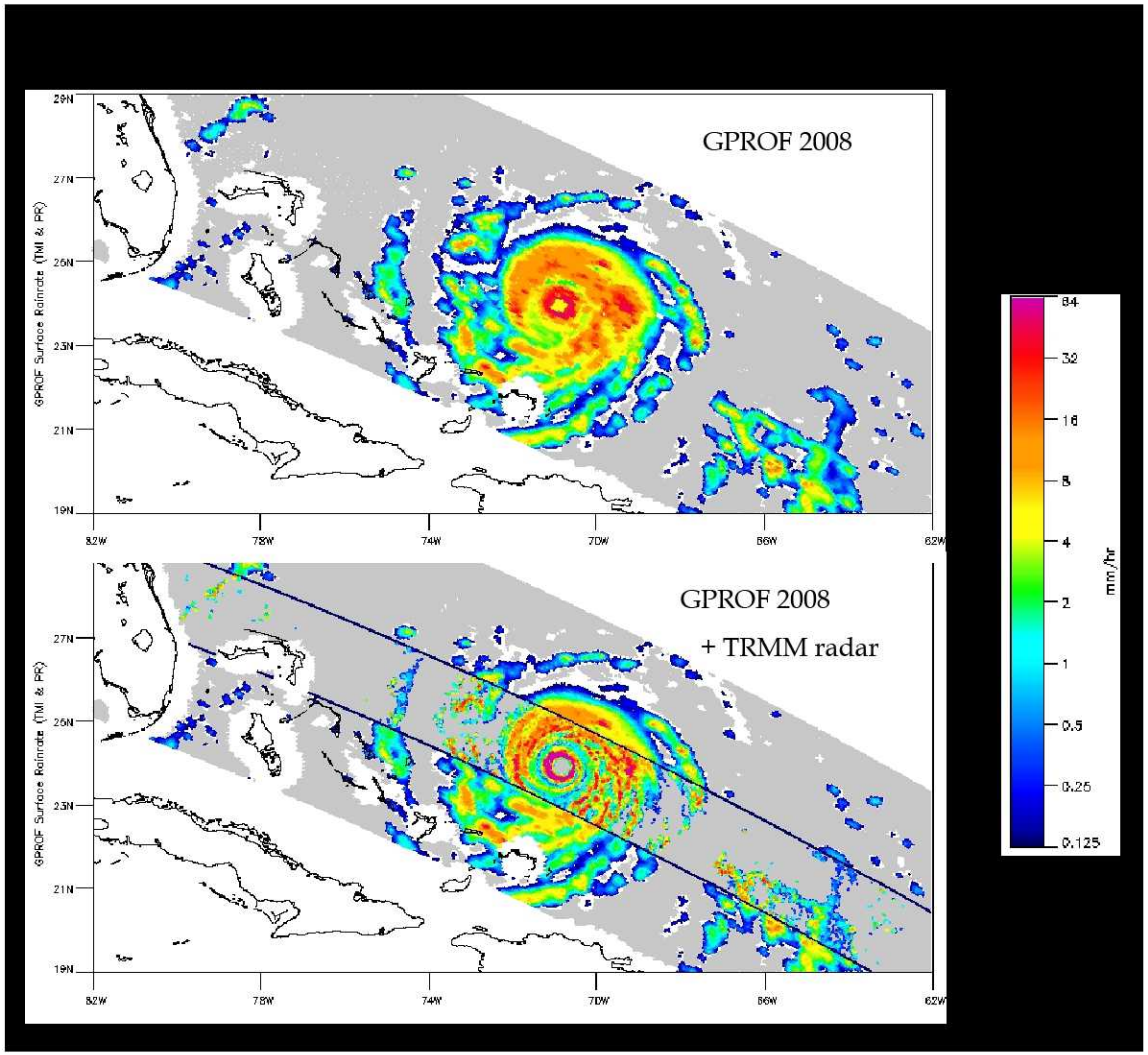


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GPROF with Empirical DB



- *Use TRMM PR as "truth"*
- *Database is built from PR rain and observed TMI Tb*
- *Bayesian scheme used to retrieve rainfall (TMI only). Database sorted by SST and TPW*

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Snow Retrievals for GPM GPROF

- ***One of the challenges for GPM will be to retrieve snow***
- ***The high frequency channel on GMI will provide the radiometer (RE) algorithm team a means for snowfall retrievals***
- ***Existing work at NASA and NOAA have been examining algorithms using high frequency channels on sounders (AMSU-B and MHS) to retrieve snowfall***
- ***Early work while not validated have shown promise in using these channels to retrieve snow***
- ***Next examples are snowfall using AMSU-B and MHS provided by Ralph Ferraro and Huan Meng at NOAA***
  - *These are experimental products*
  - *They have not yet been validated*
  - *Use a statistical, empirical approach that does well*
  - *Major snowstorm in the Washington D.C. Metro area.*

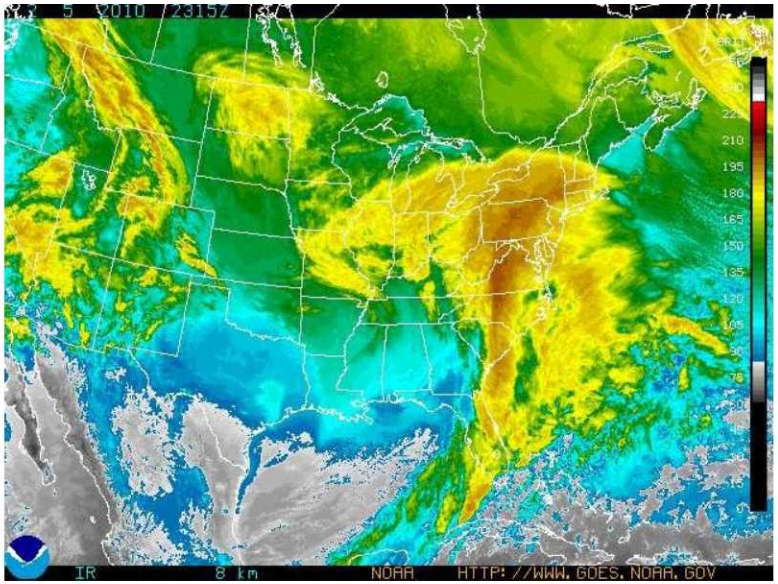
Validation – U.S. Mid-Atlantic Snowstorm

Feb 5-6, 2010

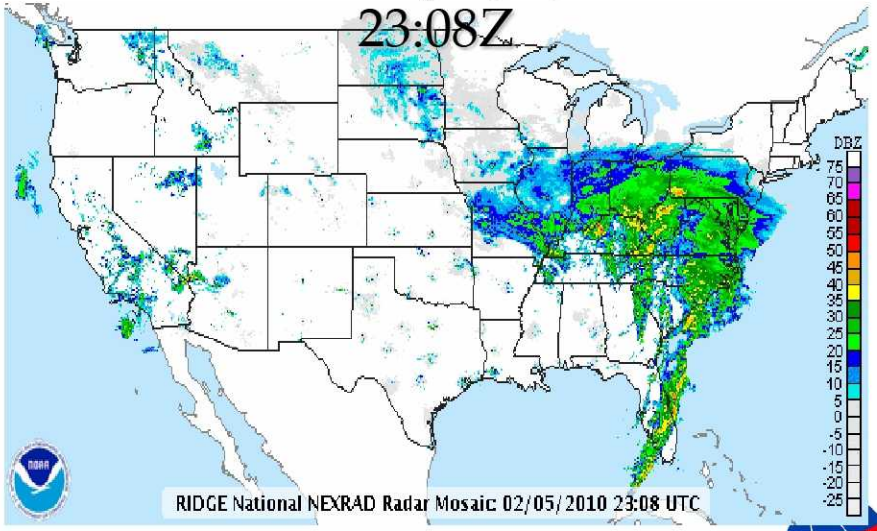
- ***A record breaking snow storm hit the mid-Atlantic region (Washington DC, Maryland, Virginia, Pennsylvania, and Delaware) on Feb 5-6, 2010.***

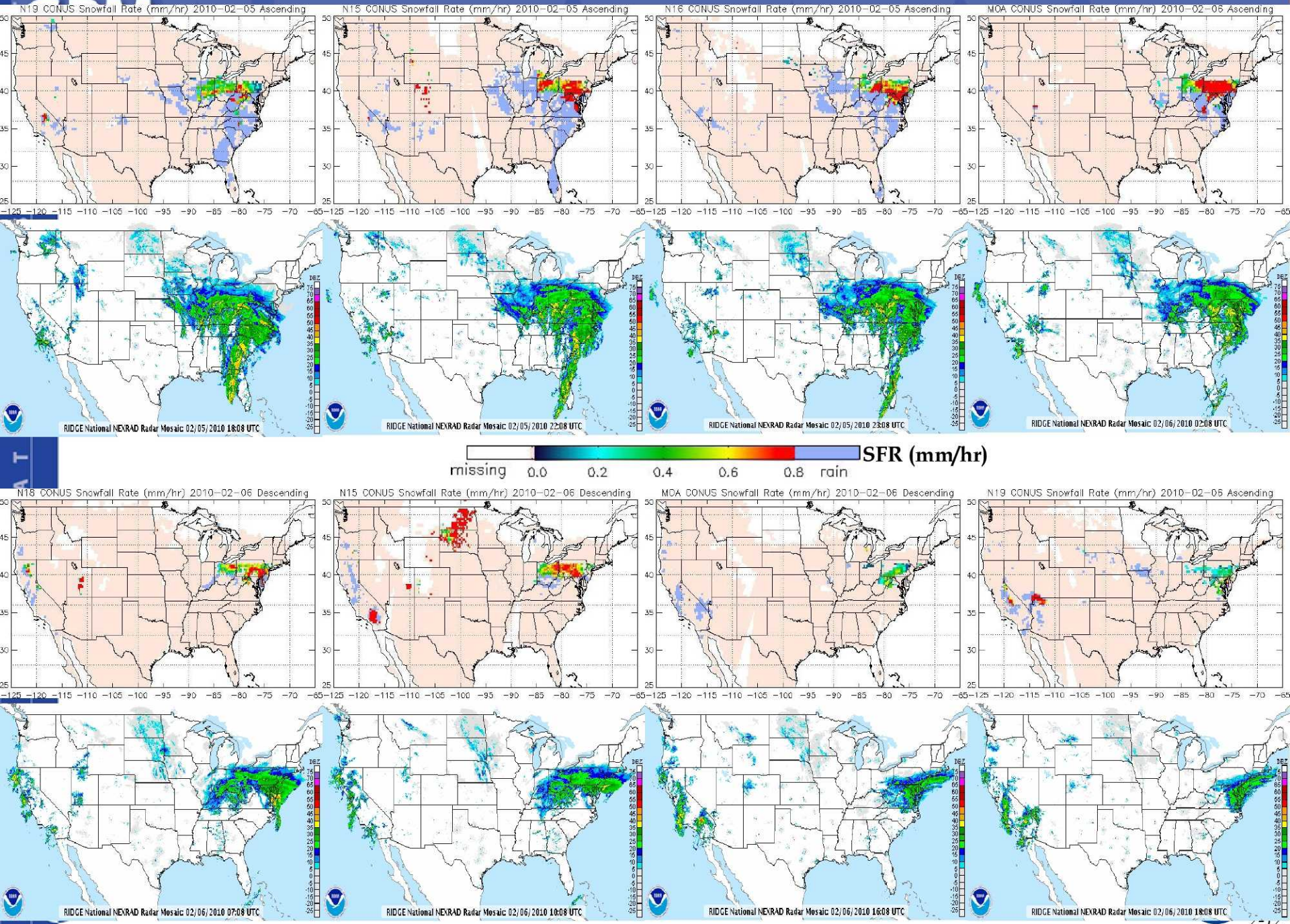


GOES IR 2/5/2010 23:15Z



NEXRAD Base Reflectivity 2/5/2010 23:08Z




N19 CONUS Snowfall Rate (mm/hr) 2010-02-05 Ascending
N15 CONUS Snowfall Rate (mm/hr) 2010-02-05 Ascending
N16 CONUS Snowfall Rate (mm/hr) 2010-02-05 Ascending
MOA CONUS Snowfall Rate (mm/hr) 2010-02-05 Ascending
RIDGE National NEXRAD Radar Mosaic 02/05/2010 18:08 UTC
RIDGE National NEXRAD Radar Mosaic 02/05/2010 22:08 UTC
RIDGE National NEXRAD Radar Mosaic 02/05/2010 23:08 UTC
RIDGE National NEXRAD Radar Mosaic 02/06/2010 02:08 UTC
missing 0.0 0.2 0.4 0.6 0.8 rain
SFR (mm/hr)
N18 CONUS Snowfall Rate (mm/hr) 2010-02-06 Descending
N15 CONUS Snowfall Rate (mm/hr) 2010-02-06 Descending
MOA CONUS Snowfall Rate (mm/hr) 2010-02-06 Descending
N19 CONUS Snowfall Rate (mm/hr) 2010-02-05 Ascending
RIDGE National NEXRAD Radar Mosaic 02/06/2010 07:08 UTC
RIDGE National NEXRAD Radar Mosaic 02/06/2010 10:08 UTC
RIDGE National NEXRAD Radar Mosaic 02/06/2010 16:08 UTC
RIDGE National NEXRAD Radar Mosaic 02/06/2010 18:08 UTC

Dual Frequency Precipitation Radar Retrievals

- ***DPR-Ku product for GPM is based upon the Ku algorithm used for TRMM***
- ***One objective is to allow appropriate improvements made in Ku retrievals to be applied to TRMM data.***
- ***Major additions to GPM DPR***
  - *Determination of drop size (to facilitate the application of Z-R relationship)*
  - *Differential Frequency techniques for improving mixed phase detection*
  - *Light precipitation (and to some extent snowfall)*
  - *Greater sensitivity in the narrow inner swath (125km) which will help with the radiometer-RE as well as light precipitation retrieval from DPR*
- ***Deal with extra-tropics retrieval challenges***
- ***Investigate how to extend the appropriate inner swath (dual frequency information) to the larger outer Ku only swath.***

Radiometer-Radar Combined Retrievals

- *Convert to a physically based retrieval (current is a Bayesian statistical combination approach)*
- *Run both radiometer and radar retrievals and feedback information from one into the other to help constrain the retrieval problem*
- *At launch combined retrieval only within the Ku swath*
- *Investigating how to extend information from the DPR into the wider GMI swath.*
- *Share common physics modules between the DPR portion of the code and the radiometer portion of the code*
- *Establish the best way for both instruments to be used together to improve snow and light precipitation retrieval.*
- *This product will be used to build the a priori database for the radiometer-RE retrievals*

Global Merged Product Algorithm

- ***Core based on the current TMPA (TRMM Merged Precipitation Analysis) product (TRMM 3B42)***
- ***Extend from 55 degree to 65 degree (GPM orbital limits)***
- ***Change to a .1 x .1 degree, hourly product using all radiometers and as appropriate IR data***
- ***Incorporate additional approaches for the merge***
  - *Current rain rate statistical "calibation"*
  - *Morphing as appropriate*
  - *Kalman filtering (to help smooth morphing techniques)*
  - *Investigate incorporating different techniques for using IR data*
- ***Speed the process for incorporating new radiometer data into the retrieval algorithm***
- ***Maintain consistent dataset back to at least the beginning of the TRMM era***

Summary

- ***We currently have only 3 years to develop, code, and test all algorithms***
- ***The algorithm team and team leaders have been selected and are meeting and working on the development***
- ***PMM has established working groups to help address key issues (land emissivity, X-cal, land-surface, etc.)***
- ***NASA/JAXA science team determined that appropriate algorithms at retrieval level will be jointly developed.***
  - *Current joint algorithm teams have been established*
  - *These teams have been meeting*
- ***Algorithm teams will be publicizing their approaches to ensure that they get early feedback from the community as a whole***
- ***First detailed Algorithm Theoretical Basis Documents (ATBD) will be delivered in November of 2010.***
  - *Will be available to the community for download as PDF documents from the Precipitation Processing System (PPS)*
  - *pps.gsfc.nasa.gov*
- ***Questions, comments or ideas about ATBD, algorithms, etc can be mailed to:***