GPM

Global Precipitation Measurement

Evolution of Algorithms from TRMM to GPM

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GLOBAL PRECIPITATION MEASUREMENT

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NASA

- *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*

- *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*

- ***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*
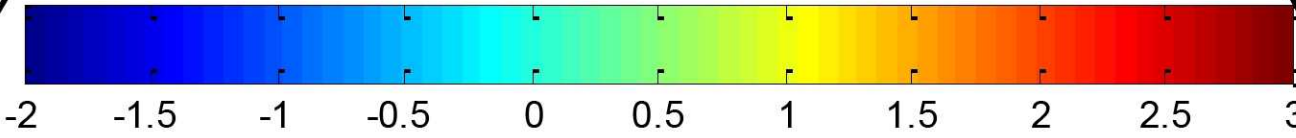
GPM

TMI Bias Table (post boost data)

Solar Beta Angle(deg)
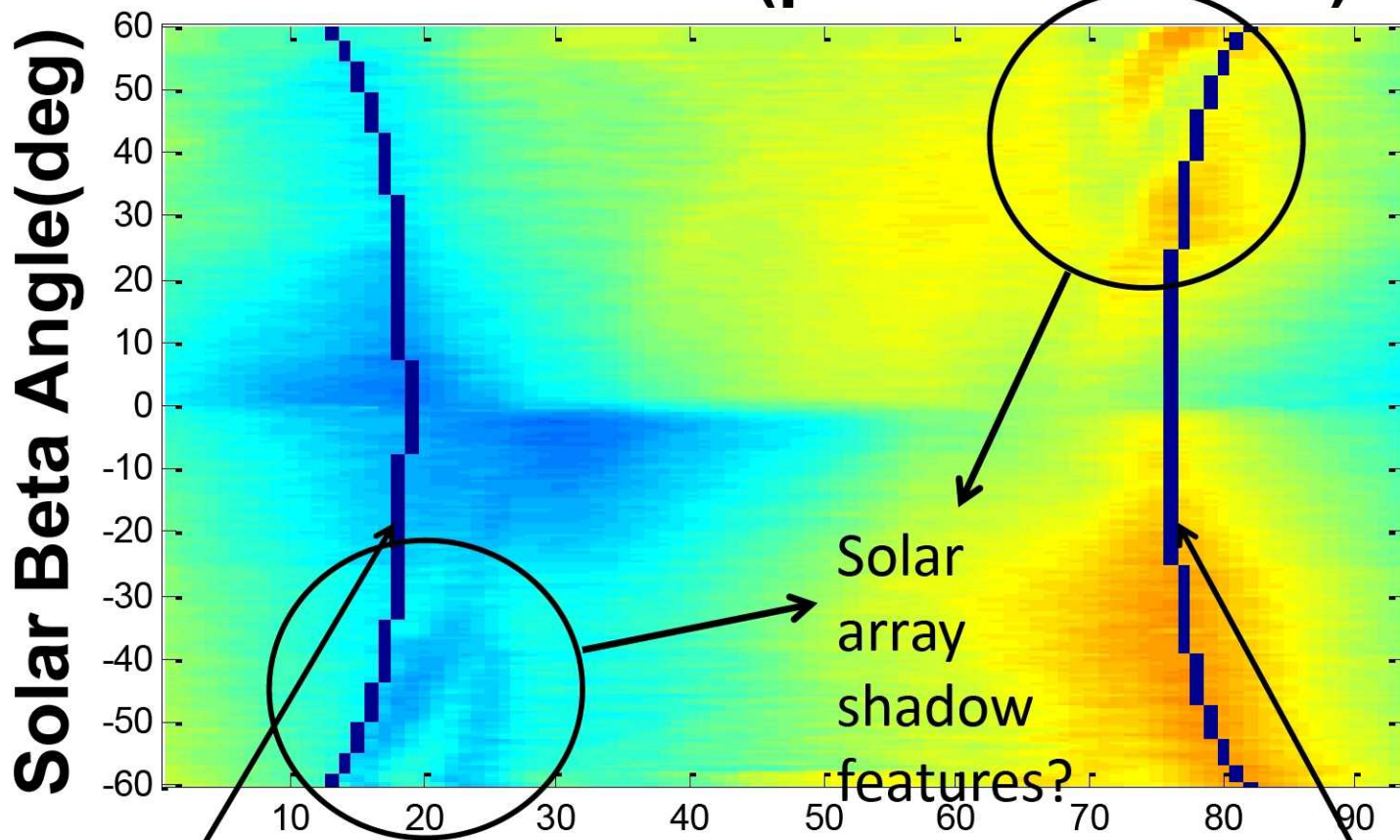
Solar array shadow features?

Earth Shadow Exit

Earth Shadow Entry

Time Since Orbit Midnight(min)

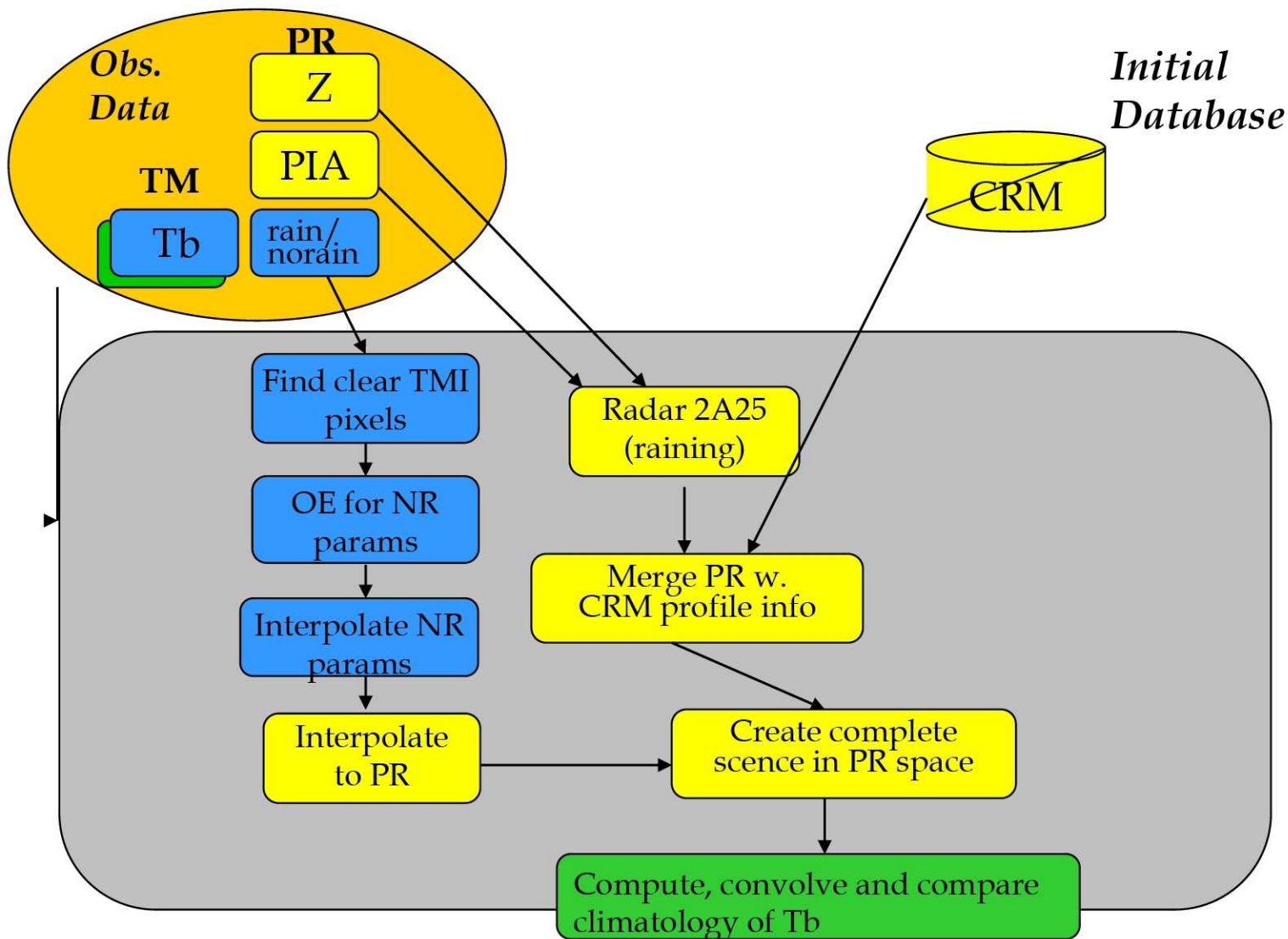-2   -1.5   -1   -0.5   0   0.5   1   1.5   2   2.5   3

- ***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***
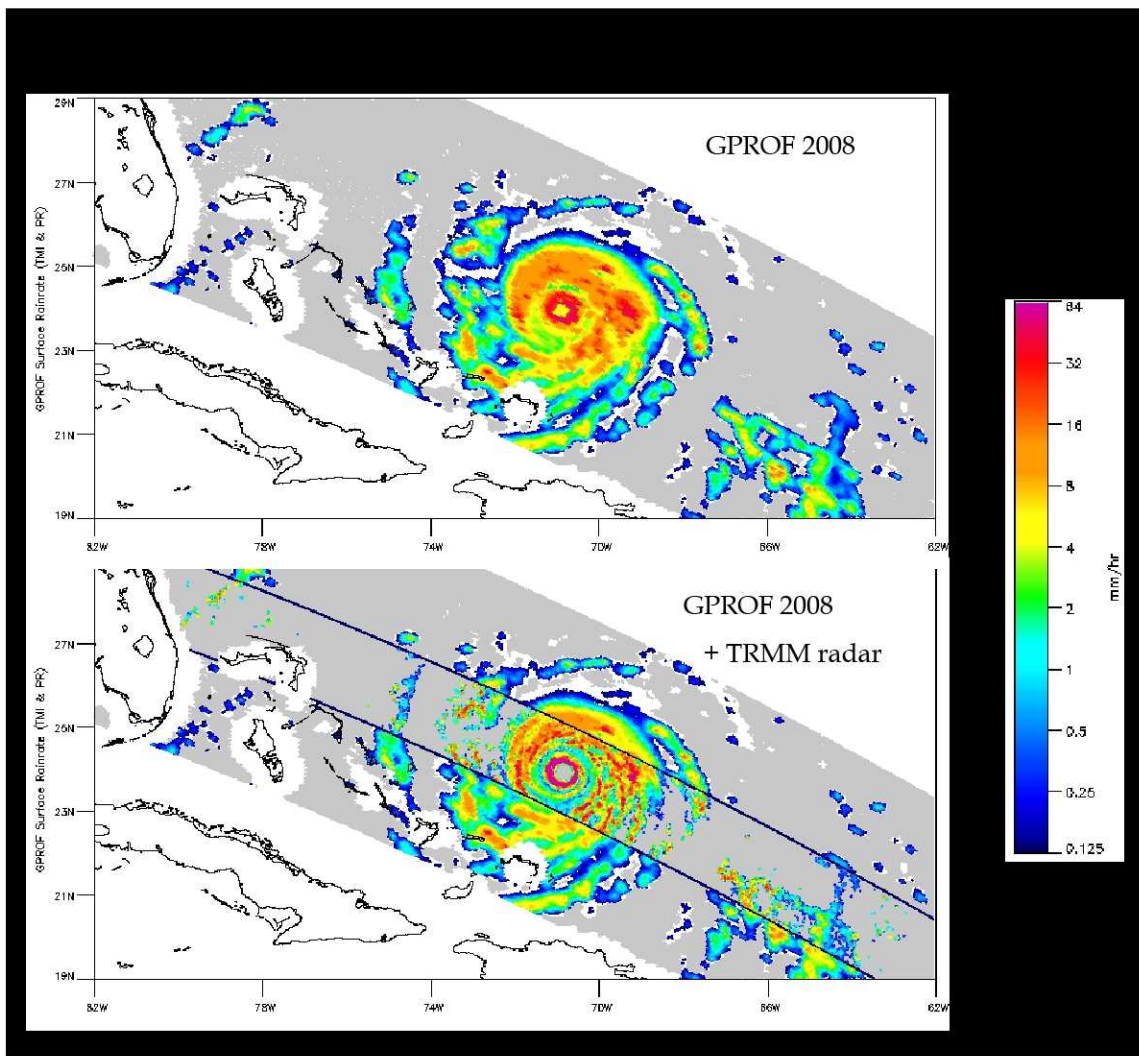
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Obs. Data

PR
Z
PIA

TM
Tb
rain/norain

Initial Database

CRM

Find clear TMI pixels

Radar 2A25 (raining)

OE for NR params

Merge PR w. CRM profile info

Interpolate NR params

Interpolate to PR

Create complete scence in PR space

Compute, convolve and compare climatology of Tb

26

CSU-C. Kummerow

- 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

CSU-C. Kummerow

European Geosciences Union –Vienna Austria (May 3 – 7, 2010)

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- *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*
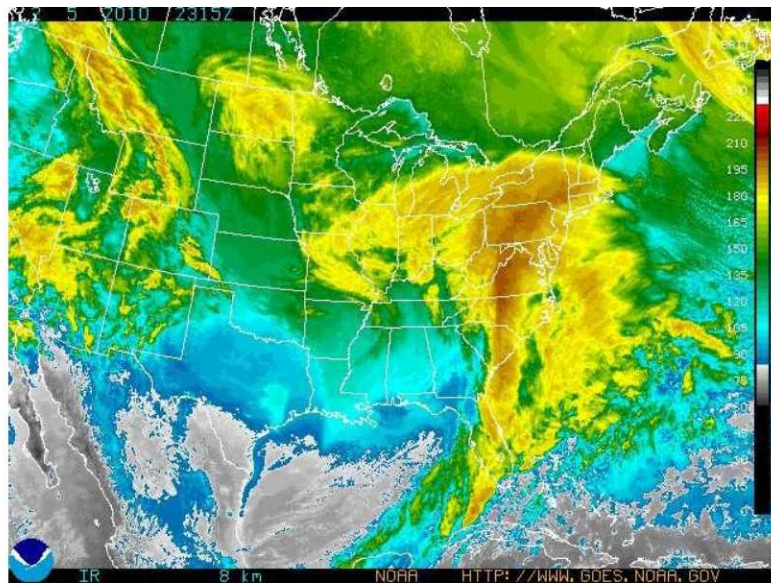 - *Major snowstorm in the Washington D.C. Metro area.*
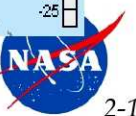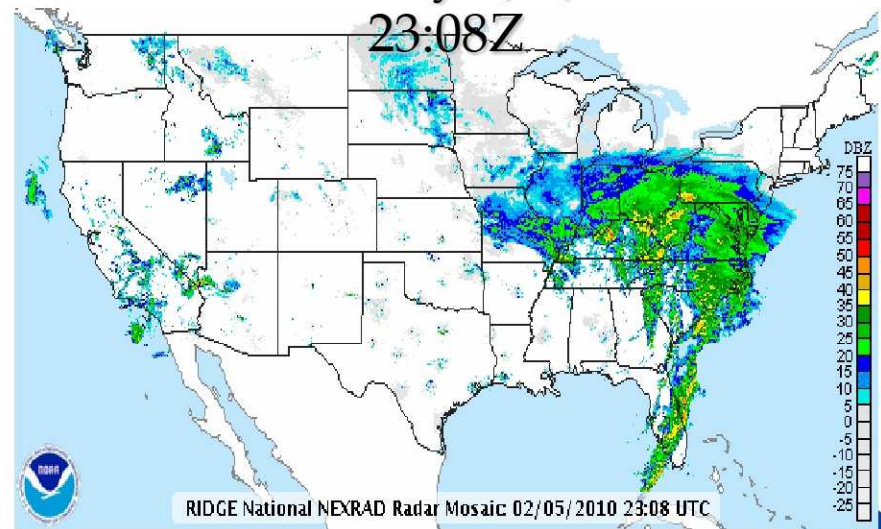
GLOBAL PRECIPITATION MEASUREMENT

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

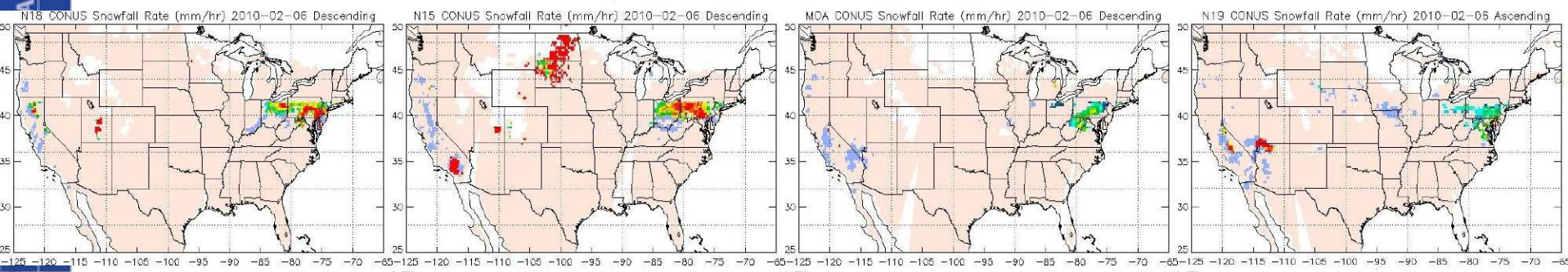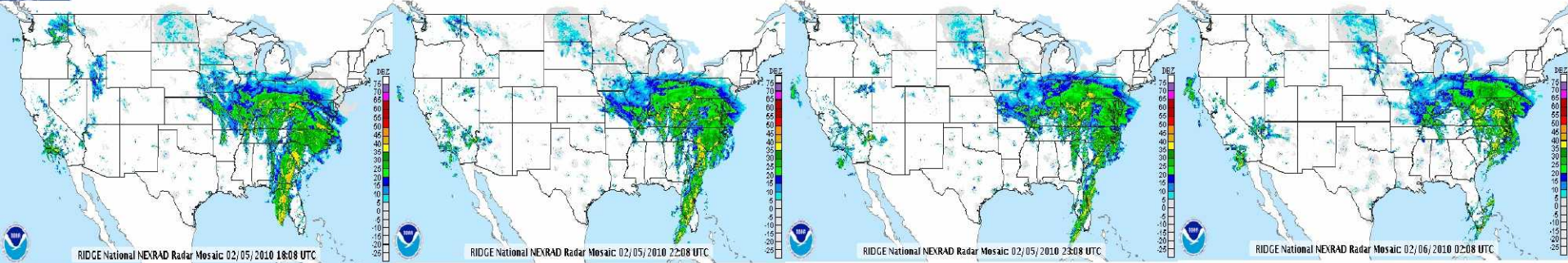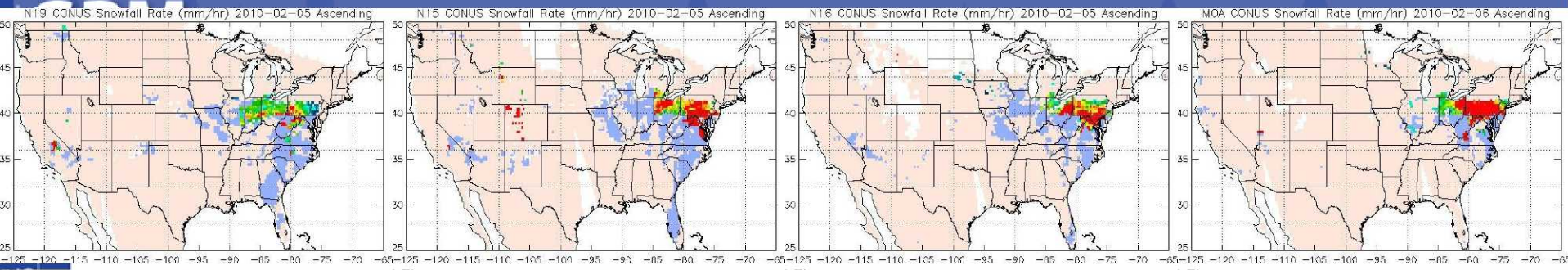Our Cars

GOES IR 2/5/2010 23:15Z

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

RIDGE National NEXRAD Radar Mosaic 02/05/2010 23:08 UTC

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

SFR (mm/hr)

missing 0.0 0.2 0.4 0.6 0.8 rain

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) 2010-02-06 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

- *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.*

- *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*

GPM

- *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*

- *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:*

erich.f.Stocker@nasa.gov