Global Precipitation Measurement (GPM)

NASA GPM
Ground Validation
Implementation Planning

December 6, 2007
GPM GV Implementation Strategy

GPM Ground Validation will
– Support pre-launch GPM algorithm development
– Support post-launch product evaluation

The GPM science framework has 3 components

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<th>The GPM science framework has 3 components</th>
<th>GPM GV supports the science framework with</th>
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<td>Field Campaigns &amp; Instrumentation</td>
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<td>• Physical Process Studies</td>
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<td>• Direct product validation</td>
<td>A validation network</td>
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7th GPM International Planning Workshop
GPM GV Implementation Approach

Field campaigns

Goal: **physical validation** through precipitation and hydrological process studies

A series of pre- and post-launch studies in different climatic regimes

Focused, in-depth study of atmospheric and land-surface variables that contribute to precipitation estimation, forecasting, and hydrological applications

Validation Network

Goal: **statistical validation** of GPM/DPR raw and attenuation-corrected reflectivity

Leverages US national infrastructure of weather radars and rain gauges

Matches TRMM/PR GPM/DPR observations to ground radars

Scalable to international sites
Planned as a series of Extended & Intensive Observation Periods (EOPs and IOPs)

Focus on precipitation process studies and integrated science

Study site locations leverage off operational agency sites, for example:

- Environment Canada C3VP
- DOE CART/SGP
- NOAA’s Hydro-meteorological Testbed
- International Partner Sites

Walt Petersen
Field Campaign Implementation Approach

- **Deployable instrumentation**
  - No single, obvious “super site” location within the US that can meet all of the GV scientific and programmatic needs for all time
  - Adaptive decisions on where and when to deploy GV instruments based on validation network statistical comparison studies & other criteria

- **Radar observations**
  - NASA-procured Ka/Ku-band dual polarization radar
  - S-band and X-band dual polarization measurements from existing sources

- **A complement of additional instrumentation and infrastructure, including**
  - Dual frequency radar profiler, radiometer, disdrometers & gauges, soundings
  - Radiometric and microphysical aircraft measurements
Field Campaigns: Notional Schedule

• GPM GV field campaigns are held about every 2 years
• Campaigns are conducted in coordination with operational agencies
  – Extended Operational Periods (EOPs) include routine observations over long periods
  – Intensive Operational Periods (IOPs) focus additional measurements, perhaps including aircraft on shorter time periods
  – Instrumentation provided by NASA, partner agencies, and by funded investigators
Winter 2006-2007 C3VP Field Campaign

• Organized by Environment Canada, with major contributions from
  – NASA/GPM
  – NASA/JPL CloudSat Project
  – DoD Center for Geosciences/Atmospheric Research at Colorado State University (Cloud Layer Experiment-10, CLEX-10)
  – McGill and other universities

• Four Intensive Operations Periods (IOPs) with instrumented aircraft
  – IOP-1: October 31 - November 9
  – IOP-2: November 30 - December 11
  – IOP-3: January 17 - January 28
  – IOP-4: February 18 - March 1
C3VP Instrumentation

Ground Based

- Scanning radars: C-, X-, Ka-, Ku-, W-band
- Radar profilers: W-, X-band and UHF
- Microwave radiometers
- Disdrometers
- Meteorological observations
- Radiosondes

Aircraft

- Microphysics probes
- Lidar
- Microwave radiometer
- Vis / Near IR radiometer
- X- and Ka-band radars

... plus satellite (Cloudsat, AMSU) and model output data (WRF)
C3VP Data Q/A and Data Access

Quality Assurance
• Complete for nearly all ground-based instruments
• On-going for most aircraft data, complete for some key snowfall events

Data Access
• All C3VP data are archived by Environment Canada
• Immediate access to QA’d data for PMM Science Team members and C3VP participants
• Full public distribution within 3 years
• See GPM GV web site for access info
New Instrument Development: NASA Ka-/Ku-band Radar

- NASA will build a mobile Ka/Ku-band, dual polarization scanning radar for GPM GV field studies
- A risk-reduction prototype will be funded for delivery later this year
- Some characteristics:
  - Solid-state Ka and Ku power amplifiers
  - Pulse compression
  - Multi-chirp waveform
  - Usual list of dual-pol products: $Z_{VV}$, $Z_{HH}$, $Z_{VH}$, $Z_{HV}$, $Z_{DR}$, $\rho_{hv}$, $K_{DP}$, $\phi_{DP}$, LDR
  - Plus radial Doppler and scene microwave brightness temperature $T_H$, $T_V$
Ground Validation Network

- **Motivation:** Characterize GPM satellite errors
- **Use available national resources including radars and rain gauge networks**
- **Identify systematic discrepancies in GPM products, using TRMM as a pre-launch proxy**
- **Start small but make it scalable**
Ground Validation Network

• Supports pre-launch GPM algorithm development
• Lessons learned contribute to GPM GV system development
  – Long term goal: validate GPM DPR retrievals
  – Near term goal: use TRMM PR as a proxy for DPR
  – Prototype started August 2006
  – Reflectivity and rain rate comparisons (PR vs. WSR-88D) in current prototype

• TRMM Level 1 and 2 PR products
  – Normal and Attenuation-Corrected Reflectivity
  – PR and Combined rain rates
  – Well-calibrated PR is assumed

• TRMM Level 2 GV Products (WSR-88D)
  – Manually Quality-Controlled reflectivity and rain rate
  – Unadjusted WSR-88D products
Prototype started with 21 WSR-88D sites in southeast U.S.
A 300x300 km Cartesian analysis grid defined for each site
Validation Network Methods

- TRMM PR products 1C-21, 2A-23, 2A-25, 2B-31 (reflectivity and rain rate) plus WSR-88D data are collected when the ground track of the PR passes within 200 km of a VN ground radar site
  - WSR-88D manually QC’ed and processed into TRMM GV 2A-53,-54,-55
  - 10,305 valid coincident overpass events occurred between August 8, 2006 and March 2007
- Gridded netCDF files are generated when PR swath overlaps ≥25% of analysis area, with confirmed precipitation over ≥25% of overlap area
  - 532 individual matchups met the 25/25 criteria from August 2006 through March 2007, more added each month
  - About 1.5 matchups per month per site meet the criteria
- Processing methods based on research results and code from Liang Liao and V. Chandrasekar
PR and WSR-88D Resampling

Grid characteristics
- Local Cartesian grid, centered on WSR-88D site
- 4 km horizontal spacing
- 13 vertical layers, 1.5-19.5 km; 1.5 km vertical spacing

PR and WSR-88D data are resampled to common grid
- Gridded PR and WSR-88D stored in separate netCDF files

3-D grids
- PR: raw and attenuation-corrected reflectivity; rain rate
- WSR-88D: reflectivity (from TRMM 2A-55 via SPRINT)

2-D grids
- PR: land/ocean flag, bright band height, rain flag
- PR, WSR-88D: near-surface rain; rain type (stratiform, convective, other)
Example Results

- 300 x 300 km (PR on left — NEXRAD on right)
- 4 km horizontal resolution, 75 grid elements in x- & y-direction
- 1.5 km vertical resolution
- 13 vertical slices (4 shown here) up to 19.5 km
Scalability

• The VN was designed to be scalable
• PostGRESQL database tracks all raw and analyzed data files and precip event metadata
• Perl and bash scripts run the data acquisition and cataloging
• All raw and processed data permanently retained
• Minimal human intervention in normal operations
  – Except for manual QC of WSR-88D by TRMM GV in the 2A-55 data processing stream

• Additional sites and grid layers can be added easily
  – HGX site was added in December 2006
  – TRMM PR-TMI rain rates (2B31) grid processing added
  – Discussions held with Dr. Calheiros about adding stations from Brazil
• GPM GV web site provides access to VN data
  – Data that meet the 25%/25% criteria are available by ftp
  – ftp access information is on the GPM GV web site
  – A VN user’s guide provides details on the netCDF file formats
  – No restrictions on access or distribution of the VN

• GV web site is also a portal to C3VP data…

• And to GV sites from other partners

http://gpm.gsfc.nasa.gov/groundvalidation.html