GPM Mission Concept

- Coordinated precipitation measurements by a constellation of microwave sensors to achieve global sampling and coverage through partnerships.

  The GPM Core is specifically designed to:
  - Set a new reference standard for precipitation measurements from space
  - Provide a transfer standard to unify and improve precipitation estimates from passive microwave radiometers
Baseline GPM Constellation of Satellites

GPM Core Observatory (NASA/JAXA, 2014)

NPP (NASA/NOAA)

MetOp B/C (EUMETSAT)

JPSS-1 (NASA/NOAA)

DMSP F19/F20 (DOD)

Megha-Tropiques (CNES/ISRO)

NOAA 19 (NOAA)

GCOM-W1 (JAXA, 2012)

Next-generation global precipitation products for research & applications

G. Skofronick Jackson, 2nd NOAA User Workshop on the GPM Mission, Nov 29, 2011, College Park, MD
Core Observatory Measurement Capabilities

Dual-Frequency (Ku-Ka band) Precipitation Radar (DPR):
- Increased sensitivity (~12 dBZ) for light rain and snow detection relative to TRMM
- Better measurement accuracy with differential attenuation correction
- Detailed microphysical information (DSD mean mass diameter & particle no. density) & identification of liquid, ice, and mixed-phase regions

Multi-Channel (10-183 GHz) GPM Microwave Imager (GMI):
- Higher spatial resolution (IFOV: 6-26 km)
- Improved light rain & snow detection
- Improved signals of solid precipitation over land (especially over snow-covered surfaces)
- 4-point calibration to serve as a radiometric reference for constellation radiometers

Combined Radar-Radiometer Retrieval
- DPR & GMI together provide greater constraints on possible solutions to improve retrieval accuracy
- Observation-based a-priori cloud database for constellation radiometer retrievals
GPM Next Generation Precipitation Products

1) Intercalibrate constellation *brightness temperature* data with sensor differences reconciled using the non-Sun-synchronous Core satellite as a transfer standard.

2) Unify *precipitation* retrievals using a common hydrometeor database constructed from combined DPR+GMI measurements

Radiometer precipitation retrievals use a Bayesian database

TRMM’s database from cloud models  
*Simulated Tₜ, Z, & RR*

GPM’s database from DPR+GMI obs.  
*Observed Tₜ, Z, & combined retrievals*

**TRMM:** Cloud resolving model simulations to database $T_b$ and Z via forward radiative transfer model calculations.

**GPM:** GPM Core observations provide database $T_b$ and RR, this transfer standard allows for unified precipitation retrievals.

G. Skofronick Jackson, 2nd NOAA User Workshop on the GPM Mission, Nov 29, 2011, College Park, MD
GPM Mission Status

- GPM is in (Phase C) implementation at NASA and JAXA
  - Two agencies have signed a Memorandum Of Understanding on GPM cooperation
  - Launch readiness date: Feb 2014
  - NASA Precipitation Processing System (PPS) completed Build 3 Review and is currently producing prototype intercalibrated L1C products for TMI, SSMI, AMSR-E, SSMIS, & WindSat and L3 NRT merged global precipitation products using TMI, SSMI, AMSR-E, AMSU, and MetOp data.

- NASA and CNES, and NASA and ISRO have bi-lateral Implementing Agreements to formalize the participation of Megha-Tropiques in GPM

- The NASA-NOAA Inter-agency Agreement on GPM cooperation is in review

- NASA and EUMETSAT are in discussion to develop a formal agreement on GPM

- NASA and AEB have signed a Cooperative Agreement on GPM Scientific Collaboration in Oct. 2011.

- NASA PMM Science Team is on track to deliver GPM L2 and L3 baseline algorithm codes to PPS and MOS at end of Nov. 2011.

- NASA is conducting a series of GPM ground validation campaigns in cooperation with domestic and international partners.
Ground Validation: MC3E (April 22 – June 6, 2011)

- 70 ER-2 and 45 Citation flight hours including 8 ER-2/Citation coordinated missions
- 3 ER-2 emissivity missions
- Continuous sampling by 5-7 ground radars
- Citation microphysics and cloud missions
- Launch of ~1200 radiosondes
## MC3E Algorithm-GV Traceability Matrix

Improving physical parameters in retrieval algorithms using MC3E campaign measurements

### Campaign Data

+ **Microphysics/EM Modelers**

+ **Algorithm Developers**

=> Algorithm Refinements

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G. Skofronick Jackson, 2nd NOAA User Workshop on the GPM Mission, Nov 29, 2011, College Park, MD
Ground Validation

• LPVEx (Sept 15 – Dec 21, 2010):
  - Data review workshop in Helsinki, Oct 13-14, 2011.

• GCPEX (Jan 17 – Feb 28, 2012):
  - Ground instrumentation installation underway at and around the EC CARE sites.

• Partnership with NOAA National Mosaic QPE (NMQ) project:
  - GPM radiometer retrieval database development using 3D radar/rain data.
  - NMQ data also being used to characterize uncertainties in satellite precip. products.

• Future campaigns under consideration:
  - Large-scale Flood Testbed in Iowa: Target date - 2013.
  - Orographically-enhance Convection Testbed in the SE U.S.: Target date - 2014
  - Semi-Arid Monsoon Testbed in the SW U.S. (possibly jointly with SMAP)
  - Snow/Rain Testbed on Olympic Peninsula: OLYMPEX campaign (post-launch)
Objective

Characterize uncertainties in satellite products using radar and/or gauge data

\[ \text{Var}(R_r - R) = \text{Var}(R_r - R_g) - \text{Var}(R_g - R) \]

Location: NASA/GSFC Wallops Flight Facility

25 km range rings

• Approach: Dense long-term gauge/disdrometer network under radar coverage

• **Stage 1:** Dense gauge network and multi-parameter/frequency radars
  • 25 gauge pairs, 5 x 5 km² area. Total inventory 70+ TB rain gauges
  • 4 existing locations with gauge pairs along the Eastern Shore (range studies)
  • NPOL (S-band), SPANDAR (S-band), WSR-88D (S-band), TOGA (C-band), D3R (Ka-Ku band) – quantify radar reference accuracy as f(scale, measurement type);

• **Stage 2:** 20+ disdrometers, 5 2DVDs, 20+ Parsivel, ~4 Joss; DSD variability studies +6 MRR’s

• **Addressing precipitation regime diversity via partnerships and collaboration:**
  • Coastal land/oceanic and seasonal regime gradients; long term observations between IOPs
  • Leverage partnering activities to expand regimes; e.g., Iowa Flood Center, HyMeX, S. Korea
GPM Near Real-time Data Products

- GMI L1 and L2 swath products within 20 min. of data collection
- Selected DPR L2 (e.g., reflectivity and precipitation rate) swath products within 120 min. of data collection
- Combined GMI and DPR L2 swath products within 120 min. of data collection
- L1C intercalibrated brightness temperature swath products and L2 GPROF precipitation products for partner radiometers within 10 min. of receiving L1B data from data providers
- L3 merged MW+IR, 0.1° x 0.1° gridded, half-hourly global precipitation products:
  - Low-latency, quick-look products (with relatively high IR data content) near data collection time
  - Late-look products with all available MW data within the collection window
Summary

GPM is an international satellite mission that will unify and advance precipitation measurements from a constellation of microwave sensors for research and application.

- **Advanced active/passive sensor capabilities**
  - Higher sensitivity to light rain and solid precipitation than TRMM instruments
  - Insights into precipitation physics with quantitative estimates of PSD parameters
- **Next-generation uniform global precipitation data products**
  - Inter-calibrated radiometric data from a constellation of MW sensors
  - Unified precipitation retrieval using a common hydrometeor database consistent with combined active/passive sensor measurements
- **Near real-time data for operational use and societal applications**
- **Ground validation is key to refining algorithm assumptions & parameters and characterization of uncertainties in precipitation estimates for improving GPM data products and data utilization:**
  - Conducting a series of focused GV field campaigns in collaboration with domestic and international partners to improve GPM satellite algorithms
  - Establishing GV research facilities to characterize uncertainties in satellite and ground-based precipitation estimates to improve understanding error propagation from inputs to forecasts of hydrological models.

**URL:** pmm.nasa.gov or gpm.nasa.gov