NOAA Satellite Research to Operations
Transition Survey for
Global Precipitation Measurement (GPM) Mission

Background:
GPM is an international satellite mission that plans to provide an understanding of the earth system and its response to natural and human-induced changes. The GPM mission is designed to:

1. Improve predictions of floods, droughts, fresh water reserves, crop conditions, and other water-related applications
2. Produce accurate representation of the water cycle and its key components like precipitation to enable more realistic diagnosis and prediction of Earth's water budget and related changes
3. Establish a numerical relationship between global water cycle variability and global temperature change plus test the hypothesis that global warming accelerates the rate of water moving through Earth's system
4. Improve short to medium range weather forecasting and long-term climate simulations through improved integration of satellite precipitation data in computer model forecast systems

GPM will enable measurements of 3-D precipitation structures and microphysical properties that will provide an accurate estimation of rainfall rate and improved retrieval algorithms for passive microwave radiometers. This information will also be crucial for the advancement of National Weather Prediction (NWP) model parameterizations and data assimilation, which is only now beginning to assimilate such data from ground radars over the U.S.

GPM builds off the success of the ongoing Tropical Rainfall Measuring Mission (TRMM), includes the measurement of snow and light rain, and provides far more global coverage. GPM is a continuity mission for TRMM, and will enhance NOAA’s precipitation monitoring through advances developed by NASA’s Precipitation Processing System (PPS) – more accurate and timelier precipitation estimates. The PPS is the component of GPM that is ripe for transition from NASA to NOAA.

GPM is envisioned to comprise 5 or more satellites at any given time, enabling near global coverage of precipitation every 3 hours or less. The constellation will include NOAA POES (and JPSS), DMSP, NPP, MetOP, Megha-Tropiques and GCOM. GPM is currently a partnership between NASA and the Japan Aerospace Exploration Agency (JAXA), plus several external partnerships, both nationally and internationally. It also serves as the Precipitation Constellation in CEOS, the satellite component of GEOSS.

NOAA Benefits:
GPM will enable NOAA to sustain and improve flood forecasting and warnings, advance numerical weather prediction model accuracy, and to enhance seasonal to decadal climate variability monitoring and prediction. The specific benefits of the GPM Mission to NOAA are summarized below.

- GPM will advance precipitation measurement capability from space through combined use of active and passive remote-sensing techniques on the core satellite. These measurements will be used to calibrate dedicated and operational passive microwave sensors (e.g., the GPM Constellation) with the goal of achieving 3-hourly or less global sampling.
- GPM will advance numerical weather prediction (NWP) skills through more accurate and frequent measurements of instantaneous precipitation rates (including snowfall rates) with
better error characterizations and improved assimilation methods. It will also lead to the development of better NWP cloud parameterizations.

- GPM will improve flood-hazard and fresh-water-resource prediction capabilities through better temporal sampling and spatial coverage of high-resolution precipitation measurements by combining high resolution data from GOES-R with more accurate precipitation data from GPM and innovative designs in hydro-meteorological modeling.

- GPM will advance knowledge about the global water/energy cycle and fresh water availability. Improved measurements of the space-time variability of global precipitation will close the water/energy budget and elucidate the interactions between precipitation and other climate parameters.

- GPM will improve climate prediction through better understanding of surface water fluxes, soil moisture storage, cloud/precipitation microphysics and latent heat release in the Earth’s atmosphere.

- GPM will continue to expand the thirty year precipitation climatology being improved through NOAA’s Climate Data Record program by providing an intercalibrated set of precipitation products. Such data will be invaluable to NOAA’s National Climate Service.

**GPM Core Satellite Mission and Instruments**

NASA and JAXA’s contribution to GPM include the launch of the GPM core satellite (July 2013) and the development of two core sensors: The GPM Microwave Imager (GMI) and Dual-frequency Precipitation Radar (DPR). Additionally, a GMI will fly on a low inclination orbiting satellite with a launch vehicle to be supplied by a TBD international partner. The GPM core satellite is scheduled for a nominal 5-year mission design life just like the TRMM mission, which is now in its 12th year of operation.

GMI is a multi-channel, conical-scanning, microwave radiometer serving an essential role in the near-global-coverage and frequent-revisit-time requirements of GPM. It will span the frequency range between 10 and 190 GHz, with footprint sizes ranging from 5 to 50 km. The DPR consists of a Ku-band precipitation radar (KuPR) and a Ka-band precipitation radar (KaPR). The KuPR (13.6 GHz) is an updated version of the highly successful unit flown on the TRMM mission. The KuPR and the KaPR will be co-aligned on the GPM spacecraft bus such that the 5 km footprint location on the earth will be the same. Data collected from the KuPR and KaPR units will provide the 3-dimensional observation of rain (250 m vertical resolution) and will also provide an accurate estimation of rainfall rate to the scientific community. The DPR is expected to be more sensitive than its TRMM predecessor especially in the measurement of light rainfall and snowfall in the high latitude regions. Rain/snow determination is expected to be accomplished by using the differential attenuation between the Ku-band and the Ka-band frequencies.

**GPM Limitations:**

The core satellite will fly in a 65 degree inclination and therefore will not get full global coverage of DPR and GMI data needed for all types of precipitation systems.

The DPR is more sensitive than the precipitation radar on TRMM, but will not be sensitive enough to detect the lightest snowfall rates that can occur from shallow precipitation systems.

The restructuring of the NPOESS program could impact the number of conical scanners that will be available in the GPM nominal mission of 5-years (through 2018).