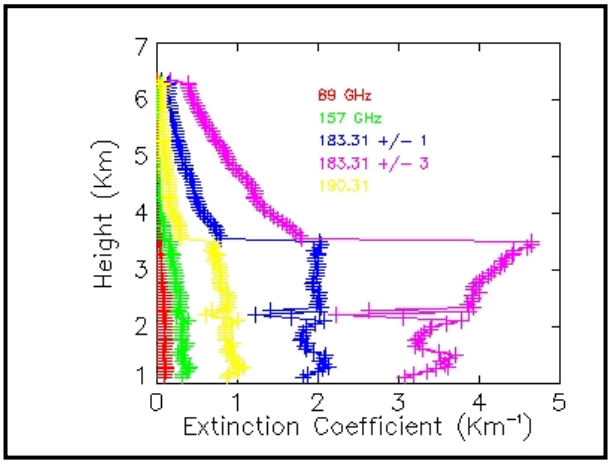
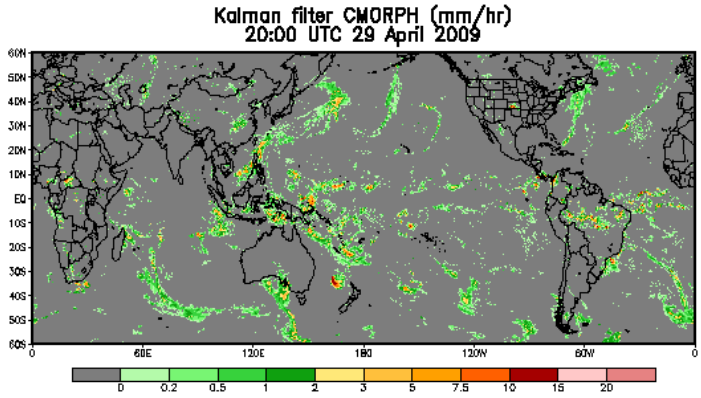
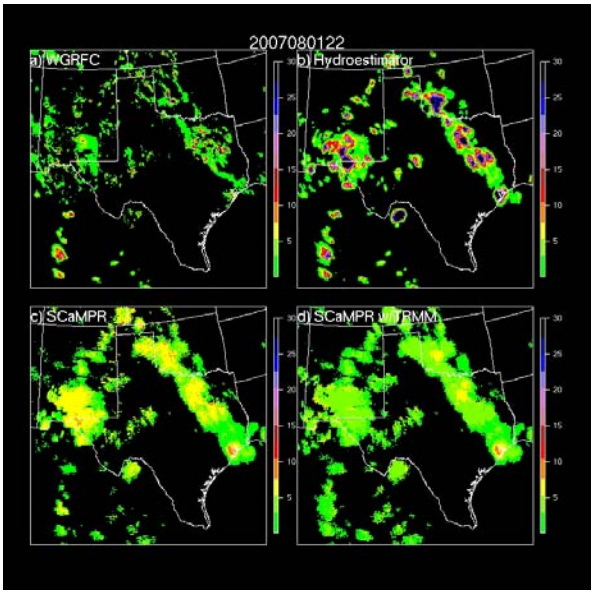


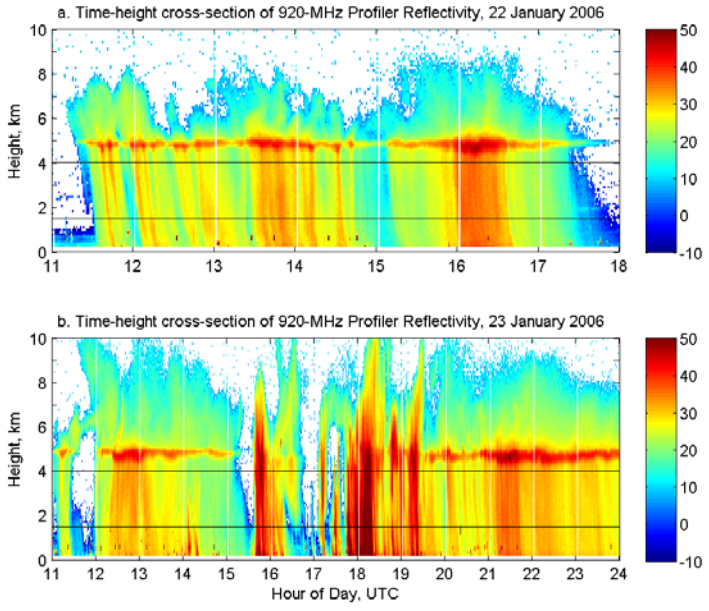


Annual Progress Report:

NOAA's Steering Group on Precipitation Measurement from Space

August 1, 2008 – July 31, 2009





Annual Progress Report:
NOAA's Steering Group on Precipitation Measurement from Space
August 1, 2008 – July 31, 2009

1. Introduction

NOAA's Steering Group on Precipitation Measurement from Space (SGPMS), established through a memo from Assistant Administrator for Satellite and Information Services, Mary Kicza, on July 15, 2008, is pleased to submit an annual progress report for the period August 1, 2008 through July 31, 2009.

The SGPMS was formed based on a recommendation presented in the 2007 National Research Council (NRC) report *NOAA's Role in Space-based Global Precipitation Estimation and Application."* As indicated in the NRC report, the future success of NOAA's utilization of advanced precipitation sensors such as NASA's Global Precipitation Measurement (GPM) Mission will come from an across Line-Office coordination of requirements, research and development, and transition into operations.

2. SG Membership

The current membership is in the table below. It is proposed that this membership remain intact for another year, then, new membership will be rotated on beginning in July 2010.

Name	Organization
Ralph Ferraro (Chair)	NESDIS
Chandra Kondragunta	NESDIS
Jim Silva	NESDIS
James Yoe	NESDIS
Pingping Xie	NWS
Dave Kitzmiller (Co-Chair)	NWS
Fuzhong Weng	JCSDA (NESDIS)
Allen White	OAR
Marty Ralph	OAR
Tim Schneider	OAR
Tilden Meyers	OAR
Christopher Miller	OAR

3. Meetings

The SGPMS met four times during the past year – July 31, 2008; October 29, 2008; January 28, 2009; May 07, 2009. These were conducted through telecon, however, some meetings were conducted at locations where several of the members were able to meet face to face. Meeting minutes were recorded, action items assigned and tracked.

4. Major Accomplishments

- **Interactions with NASA**

The SGPMS is the main communicating body between NASA and NOAA on GPM science, validation and data matters. Members meet periodically with NASA on various topical issues and when meetings of opportunity present themselves and communicate through email and phone on a regular basis. During the reporting period, the following meetings were held:

Meeting	Purpose	Outcome
August 2008 Ft. Collins, CO	NOAA's involvement in NASA's PMM Science Team	Same arrangement between NASA and NOAA agreed upon for forthcoming science team (2010-12). Several NOAA PI-led proposals submitted to the NASA PMM Solicitation in August 2009.
January 2009 College Park, MD	PMM Science Team Working Groups	Several scientific plans for 2009 were outlined for advancing the state of GPM-era retrieval algorithms.
April 2009 College Park, MD	Strategy for enhancing NASA/NOAA synergy for GPM	Develop a list of benefits for each agency for eventual joint agency white paper (see July meeting below).
May 2009 Ann Arbor, MI	PMM "X-Cal" Working Group Meeting	NESDIS agrees to lead microwave sounder sensor inter-calibration activity for GPM (as part of its WMO/GSICS activity)
June 2009 Chapel Hill, NC	Develop potential joint GPM validation effort through NOAA's HMT program	Mature planning is taking place for the HMT-SE program, subject to NOAA funding availability.
July 2009 Greenbelt, MD	Development of joint NASA-NOAA White Paper on GPM	Areas of mutual benefit to NOAA and NASA identified; NASA to lead the development of formal MOU on GPM between NASA and NOAA

- **Funding and Review of NOAA PI's on PMM Science Team**

  NOAA and NASA pooled together $1,605K (20% NASA and 80% NOAA) during FY07 – FY09 to fund four NOAA-led Precipitation Measurement Missions (PMM) projects (see Appendix A). These projects are in their third year of funding. The SGPMS held its annual review of the projects in College Park, MD (June 2009). The progress during the first two years has been excellent which has led to several publications, as well as improved algorithms resulting in new data sets of instantaneous and hourly rainfall, and high quality validation data sets of precipitation microphysics. The research outcome is critical to GPM's success and demonstrates NOAA's preparation for utilizing advanced precipitation data from the mission. Also, NOAA's participation on the PMM science team is a crucial building block for eventual transition of certain components of the GPM processing system from NASA to NOAA.

- **PPBES Activities**

  The SGPMS developed a white paper (Appendix B) to describe the end-to-end use and benefits of GPM-era data at NOAA. It was distributed to all NOAA goal team leads and program leads in April to further integrate NOAA program interest in GPM. As a result, new (or enhanced) alternatives were proposed to CL-COM; WW-IWWS; and MS-STP. The SGPMS will continue to engage with the goal teams over the upcoming year.

- **Establishment of Web Site**

  A web page has been established to serve as a source for SG documents and to provide links to other PMM web resources:

http://www.nws.noaa.gov/oh/hrl/hsmb/GPMSG/index.html

The site presently contains the group charter, most recent membership roster, and annual reports from NOAA's PMM scientists on their projects. We plan to maintain an updated list of relevant science conferences and meetings.

- **GPM Transition Planning**

NESDIS has identified GPM transition leads as R. Ferraro (Transition Scientist) and C. Kondragunta (Transition Manager). A draft transition plan has been developed that focuses on the transition of NASA's Precipitation Processing System (PPS) from NASA to NESDIS. Because GPM comprises of a constellation of satellites, the PPS includes all U.S. and international satellites as input to the system. Thus, if accepted, the GPM transition will allow for data access for NOAA to the entire set of satellites that GPM is comprised of. A final version of the plan is anticipated by the end of 2009.

- **Representation at Relevant Meetings and Workshops**

Meeting	Purpose	Outcome
PMM Science Team Meeting Fort Collins, CO - August 2008	Science	NOAA PI's engage NASA on GPM and TRMM science, future plans, etc.
1st Conference on Global Change and Environment in Asia and Pacific Hong Kong, China - September 2008	Science	Present results of NOAA-funded precipitation research utilizing CMORP global rainfall product.
4th Workshop of the International Precipitation Working Group, Beijing, China - October 2008	Science Programmatic	NOAA researchers engage international precipitation community to discuss topics of mutual interest
JAXA GSMaP International Symposium Tokyo, Japan – February 2009	Science	Present results of NOAA-funded precipitation research and product applications.
Soil Moisture and Soil Temperature Observations and Applications: A Joint USCRN – NIDIS Workshop Oak Ridge, TN - March 2009	Science	Gain a better understanding of the needs of the remote sensing community in terms of in-situ soil moisture measurements
NOAA Testbed USWRP Workshop Boulder, CO - April 2009	Science Programmatic	Develop potential linkages between USWRP and GPM
Meetings of the GPM X-Cal Working Group – Ft. Collins, CO - August 2008; Ann Arbor, MI - May 2009	Science	NESDIS agrees to lead microwave sounder sensor inter-calibration activity for GPM (as part of its WMO/GSICS activity)
2nd Workshop on Modeling and Retrieval of Surface Properties from Satellites Toulouse, France, June 2009	Science	Engage with surface science community to develop collaborations to advance the state-of-the-art in precipitation over land retrievals
3rd GPM Data Working Group Meeting Paris, France - June 2009	Programmatic	Engage with GPM data providers to establish plans for common data processing, archival and distribution
8th International GPM Planning Workshop Paris, France - June 2009	Programmatic	Gather recent information on GPM and it's international partners; present NOAA's plans for GPM

5. Goals for Upcoming Year

In addition to sustaining the activities just described, SGPMS major goals for the upcoming year include:

- Hold a NOAA-wide workshop on GPM/Precipitation Requirements
- Secure funding for the NOAA PI's on NASA's incoming PMM Science Team
- Review final year of current PMM projects at NOAA
- Complete GPM Transition planning; secure funding for transition activities
- Continue joint Ground Validation (GV) activities with NASA, including HMT-SE
- Continue to inform NOAA leadership of SGPMS activities, including potential briefings to Goal Teams, NRC and NOSC
- Investigate potential post-GPM plans within U.S. and with international partners
- Continue to lead surface emissivity efforts in preparation of GPM
- Continue to facilitate the expansion of the JCSDA CRTM to accommodate GPM-era sensors
- Help facilitate the development of an MOA between NASA and NOAA on GPM.
- Develop linkages with NCDC's Climate Data Record (CDR) Program
- Improve coordination between users of satellite and in-situ observations using testbeds of opportunity.

Appendix A – Summary of NOAA PI-led Projects on NASA's Precipitation Measurement Missions (PMM) Science Team (2007-2009)

1. Utilizing TRMM Precipitation Products in Operational Hydrology through Multi-Satellite and Multi-Sensor Quantitative Precipitation Estimation (QPE)

- Principle Investigator: Bob Kuligowski (NESDIS), Co-Investigator, Yu Zhang (NWS)
- Funding levels: FY07 – 94 K, FY08 – 93 K, FY09 – 124 K (Three year total – 311 K)
- Project Objective: Assess and demonstrate the value of TRMM/GPM precipitation products for quantitative hydrologic forecasting in NOAA/NWS by infusing these data into an integrated framework of multi-satellite and multi-sensor precipitation estimation and hydrologic validation.

2. Improved Microwave Precipitation Retrieval over Land from TRMM through GPM era

- Principle Investigator: Ralph Ferraro (NESDIS)
- Funding levels: FY07 – 145 K, FY08 – 152 K, FY09 – 157 K (Three year total – 454 K)
- Project Objective: To develop advanced precipitation retrievals over land with an emphasis on cold season precipitation (snow and light rain) using GPM radiometer and other constellation radiometers such as NOAA AMSU/MHS and DMSP SSMIS.

3. Improvement and Validation of a Mult-Satellite, Multi-Sensor Precipitation Algorithms: A Prototype 'Day 1' GPM Product

- Principle Investigator: Pingping Xie (NWS)
- Funding levels: FY07 – 117 K, FY08 – 121 K, FY09 – 124 K (Three year total – 362 K)
- Project Objective: To create an analysis system of high-resolution precipitation over the globe using all estimates available from GPM and other satellites as well as other sources of information.

4. Vertical Structure of Precipitation Retrieved from Multi-Frequency Profiling Radars for Validating Satellite-Based Precipitation Products

- Principle Investigator: Christopher Williams (CIRES/OAR)
- Funding levels: FY07 – 154 K, FY08 – 159 K, FY09 – 165 K (Three year total – 478 K)
- Project Objective: Analyze vertically-pointing profiler and polarimetric scanning radar observations to quantify the vertical and spatial structure of raindrop size distributions (DSDs).

Appendix B

NOAA's Preparation for NASA's Global Precipitation Measurement (GPM) Mission

NOAA's Steering Group on Space-based Precipitation Measurements
R. Ferraro (NESDIS) and D. Kitzmiller (NWS), co-chairs
May 2009

Introduction

The distribution of water and its change over time are two of the most critical environmental issues facing the world's population. The single most destructive storm-related hazard is flooding, which can result from heavy precipitation from either relatively short-lived "weather" phenomena (e.g., severe storms, tropical cyclones) to relatively long-lived "climate" events (e.g., El Niño). Drought and inadequate planning for drought events also represent major economic burdens. Because these events occur throughout the world where U.S. interests may be affected, a system to monitor potential flooding hazards is important. NOAA is the sole federal agency with the responsibility for issuing weather and hydrologic warnings and near-term climate forecasts for the country. To support this function, NOAA develops and validates algorithms for the retrieval of precipitation rates from remotely-sensed and in-situ data and uses this information as a basis for flash flood forecasts, rainfall potential estimates, input into NWP models and climate monitoring. Additionally, NOAA serves the interests of other government agencies here and abroad (e.g., the Departments of Defense and State) by providing assessments of impending hazards.

Furthermore, accurate precipitation measurements support all of NOAA's overarching Strategic Goals. NOAA supports the Global Precipitation Measurement (GPM) Mission because it is a system that can assist NOAA in meeting its user and mission requirements and fulfilling its strategic goals. The GPM will be a resource that can greatly improve NOAA's primary mission, the protection of life and property and the enhancement of the national economy, by providing timely and accurate information on precipitation events worldwide. This service is critical for accurate meteorological and hydrologic modeling and assessment. GPM will also serve as a prototype to help NOAA improve its current satellite capabilities and to define better future operational space-based precipitation measuring systems, including a follow-on operational space-borne radar. In addition, NOAA should develop techniques for integrating GPM data into its operational precipitation analysis systems and for assimilating these analyses into weather, water, ecological and climate forecast models.

In June 2005, NESDIS commissioned the National Academy of Sciences (NAS) to perform a study whose primary objective was to develop strategies for NOAA's involvement and utilization of GPM data. The final report (published in April 2007), "NOAA's Role in Space-based Global Precipitation Estimation and Application" highlighted several key areas for NOAA to pursue, including the formation of a NOAA Steering Group on Space-based Precipitation Measurements (SGSPM). The SGSPM, comprised of members of NESDIS, NWS and OAR, was formally established in July 2008 through a memo from M. Kicza, AA of NESDIS, with endorsement by NWS, OAR and all of the goal teams. The SGSPM meets quarterly and is the focal point within NOAA for developing and enhancing our partnership with NASA on GPM, and making linkages within NOAA programs for this satellite mission.

This white paper describes the SGSPM's vision for GPM's role at NOAA and discusses the linkages between NOAA requirements, GPM and NOAA programs.

NOAA Precipitation Requirements and Linkages to Existing NOAA Programs

Real-time operational use of satellite-based precipitation includes rainfall and runoff estimation over areas poorly served by the present rain gauge and radar networks. For example, current operational NEXRAD effective radar coverage is less than half of the area in the western United States – due to beam blockage and inability to capture low level rainfall - in the winter season. There is little radar coverage and a sparse rain gauge network within the Rio Grande basin south if its main channel. Radar coverage over Alaska is limited to a small fraction of the state.

The GPM offers the opportunity to improve current geostationary and polar-orbiting observational capabilities for precipitation estimation, and to provide satellite-based estimates over high latitudes, where geostationary observations are lacking. These precipitation estimates are important for not only river discharge and flood forecasts, but drought monitoring as well. Additionally, these data will be valuable for cutting edge NWP data assimilation experiments through the Joint Center for Satellite Data Assimilation (JCSDA). As documented in NOAA Consolidated Observation Requirement List (CORL), 7 out of 20 NOAA Programs have precipitation amount/rate/type as Priority-1 – Mission Critical – requirement. In addition, the Environmental Modeling Program has microwave radiances as Priority-1 requirement.

The initial linkage of GPM to NOAA's program came through the WW-STI Program. Over the last few years, this linkage has been fortified, and most recently expanded to include the Hydrometeorological Testbed (HMT) and NPOESS Data Exploitation (NDE), both capacities under the WW-STI. Additionally, a new program has been developed under the Satellite sub-goal (MS-STP and MS-SSV) to explicitly plan for the transition of NASA's of the GPM core satellite (2013 launch) to NOAA operations and to explore the development of a follow-on mission to be flown circa 2018. However, the majority of these programs are unfunded gaps in the NOAA budget.

Across mission goals and NOAA LO's support and coordination for GPM has been growing (e.g., October 2008 NESDIS-OAR Summit), in part, due to the activities of the SGSPM, however, a much greater effort is urgently needed, to capture the necessary funding for NOAA to exploit GPM data and then plan for a follow-on operational precipitation radar and/or precipitation constellation. Such a NOAA-based mission would additionally, satisfy some of the long term goals for CEOS and GEO, for example. Finally, NESDIS is developing formal "transition plans" to extend the precipitation capabilities from the current pre-GPM era constellation (i.e., SSM/I, SSMIS, AMSR-E, TRMM, Megha-Tropiques and AMSU) into the NASA GPM-era (e.g., 2013-2018), and then post-GPM era, where a continuity mission will be developed by either NASA or NOAA. If funded, transition teams will be formed that will work directly with NASA counterparts.

Early successes of NOAA's involvement with GPM and NOAA goal linkages

Perhaps the most mature and immediate linkage between an established NOAA program and GPM is in NOAA's Water Resources Capability, namely, the Hydrometeorological Testbed (HMT) program. NOAA testbeds have proved to be successful at accelerating the transfer of research technologies into operational use by the National Weather Service (NWS). As part of the WW-STI program, the development and utilization of a regional and re-locatable HMT in which NOAA researchers join forces with NWS weather forecasters and River Forecast Center hydrologists has been instrumental in evaluating new precipitation observing techniques and modeling tools in an operational setting.

Currently, HMT-West has been invaluable in this capacity, developing and testing new tools to monitor and predict the evolution of "atmospheric rivers" that feed large streams of tropospheric moisture from the tropics to the west coast of the U.S to produce and sustain prolonged precipitation events. NOAA is currently planning for HMT-East (Tar River Basin, NC) which will begin in 2010, and many of its activities are being coordinated with NASA's GPM GV program, serving as a NOAA base for additional GPM ground validations and providing a direct link between the new GPM products and operational forecasting. Through this collaboration, both agencies can leverage validation assets and scientific expertise to advance our prediction and monitoring of the hydrological cycle over the U.S. It is envisioned that this partnership will closely follow the highly successful SPoRT (Short-term Prediction Research and Transition Center) program.

The NPOESS Data Exploitation (NDE) Project will be the cornerstone of data processing and distribution as NOAA transitions into the NPOESS era. Several new and innovative satellite data processing systems are currently being developed under the auspices of NDE, including the Microwave Integrated Retrieval System (MIRS), which produces surface parameters (emissivity, snow water equivalent, surface precipitation rate, etc.) and atmospheric parameters (temperature, moisture and hydrometeor profiles) from polar orbiting microwave sensors. MIRS helps to reduce the "stove pipe" product processing systems that have become burdensome to maintain at NESDIS. In preparation for NPOESS, the NPOESS Preparatory Project (NPP) will have on board a microwave instrument called ATMS which will supply the observations input to MIRS. Anticipated in 2011, NPP driven MIRS products will be reformatted to meet NOAA user's needs and made available in a timely manner to support HMT efforts. Additionally, the advanced precipitation products will serve as prototypes for NPOESS, which will be an integral component of the GPM constellation. Other advanced atmospheric and land-surface properties from NPP and NPOESS will provide background fields to complement precipitation observations when used in analyses and forecasts.

The roots of the SGSPM, dating back to 2002, developed a working relationship with NASA through informal, joint activities related to R&D, applications, etc.; both agencies have benefited greatly from these efforts. This lead to a "consortium" of NESDIS and OAR funding managers during FY07 which has provided for nearly 80% of support to four NOAA PI's which were competitively selected to become members of NASA's Precipitation Measurement Missions (PMM) science team for 2007-2009. This visionary group of managers at NOAA has been critical in establishing a true partnership between NASA and NOAA on TRMM and GPM and has funded cutting edge research at NOAA which benefits both agencies. This work would not normally have been performed and now is advancing NOAA's preparation and knowledge for advanced precipitation measurements.

Future Goals and Milestones (see table)

It is essential that in the next few years, NOAA's focus on GPM will be to establish a true funding line that will have the support of all the goal teams; our successful use of GPM and the development of a continuity mission can only occur with the proper resources. The SGSPM will work closely with the various goal teams within the PPBES process to gain funding support. Major milestones and budget line items are presented in the table below.

NOAA's successful involvement on the PMM science team must continue during the next recompetition (September 2009 proposal submission, FY10 selection). A broader based participation from NOAA on cutting edge science and new applications is desired, as well as establishing a larger set of resources from within currently funded programs (e.g., WW-STI, MS-STP, etc.) is urgently needed. Additionally, NOAA and NASA's relationship will continue to thrive through partnerships on

NOAA's HMT-East program and the maturing NESDIS led GPM transition plans. Coordination through NPP and NPOESS are also vital as they will constellation members of GPM.
Planning for improved and consolidated precipitation product suites at NOAA during the GPM-era is a long term goal. The opportunity to develop multi-sensor (e.g., gauge, radar and satellite) products at various temporal and spatial scales, in various formats, will greatly aid both NOAA and non-NOAA users and be essential to new NOAA missions such as the Climate Information Service and the National Integrated Drought Information System.

As discussions between NASA and NOAA continue, NOAA should be prepared to build and operate a GPM-like precipitation radar to fly on one of its satellites as a 'standard' payload for continued tuning of more frequent radiometer measurements and also as a calibrator of the US ground based radar network. Resources are budgeted to investigate the feasibility of such a sensor.

In summary, if NOAA is to truly exploit NASA's GPM mission, it is essential to establish a fully funded program (across mission goals and LO's) that will prepare fully utilize data from GPM, develop cutting edge applications to fulfill mission goals and plan for the eventual transition of the mission to NOAA and the continuation of space-based radar measurements beyond the nominal 5-year GPM core satellite mission.

GPM Program Plan (01May09)		FY10	11	12	13	14	15	16	17	18	19	20
Above core	Planning, management	250	250	500	500	500	500	500	1000^	1000^	1000^	1000^
	PMM Science Team Support	500	500	500	1000	1000	1000	500	500	500		
	GV Support	250	250	250	250	250	250	250	250	250	250	250
	Applications development (operational and scientific)			250	500	1000	1000	1000	500	500	500	500
	IT acquisition, maintenance and refresh		500	100	100	500	100	100	500	100	100	500
	GPM Operational transition and production		100	300	500	500	500	500	500	500	500	500
	Follow on radar concept and trade studies	125	250	500	250							
	Follow on radar procurement				1000^	2000^	5000^	10000^	50000^	20000^		
	Follow on radar operation[+]									500^	500^	500^
	Subtotal "above core"	**1125**	**1850**	**2400**	**4100**	**5750**	**7850**	**12850**	**53250**	**23350**	**2850**	**2850**
Total cost	**Option A: Excluding GPM Follow-on Radar**	**1700**	**2700**	**3750**	**3100**	**3750**	**2850**	**2850**	**2750**	**2850**	**1850**	**1850**
Total cost	***Option B: Including NOAA GPM Follow-on Radar^***	***1125***	***1850***	***2400***	***4100***	***5750***	***7850***	***12850***	***53250***	***23350***	***2850***	***2850***
Major milestones	Renew NOAA Membership on PMM Science Team for continued cutting edge R&D for GPM-era algorithms and applications[*]	**X**			**X**			**X**				
	HMT-East execution and collaboration with NASA GPM Ground Validation (GV) program[*]	**X**	**X**	**X**	**X**							
	NPP Launch – Generation of ATMS-based precipitation products via NDE		**X**	**X**	**X**	**X**	**X**					
	Integration of GPM-era precipitation products into NOAA merged surface/satellite rainfall products			**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**
	GPM Core Satellite Launch/nominal 5-year mission				**X**	**X**	**X**	**X**	**X**			
	NASA GPM Constellation/nominal 5-year mission						**X**	**X**	**X**	**X**	**X**	
	NOAA utilizes GPM-based data to support operations*					**X**	**X**	**X**	**X**	**X**	**X**	**X**
	NOAA develops and produces specialized GPM-era products (e.g., Alaska, TRaP, etc.)				**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**
	NPOESS C1 Launch – Generation of ATMS-based precipitation products via NDE					**X**	**X**	**X**	**X**	**X**		
	NASA Transitions GPM operations to NOAA*							**X**	**X**	**X**	**X**	**X**
	NPOESS C2 Launch – Generation of MIS-based precipitation products							**X**	**X**	**X**	**X**	**X**
	GPM Follow on Mission (TBD)*										**X**	**X**

[+] Assumes that launch vehicle will be supplied by NASA or be on NPOESS or follow-on NOAA spacecraft

[*] "NOAA's Role in Space-based Global Precipitation Estimation and Application", National Research Council, April 2007