Solutions Network Formulation Report

The Potential Contribution of the International GPM Program to the NOAA Estuarine Reserves Division's System-wide Monitoring Program

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1. Candidate Solution Constituents

a. Title: The Potential Contribution of the International GPM Program to the NOAA Estuarine Reserves Division's System-wide Monitoring Program

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c. Identified Partners: NOAA's (National Oceanic and Atmospheric Administration's) Estuarine Reserves Division

d. Specific DST/DSS: SWMP (System-wide Monitoring Program)

e. Alignment with National Application: Coastal Management

f. NASA Research Results – Table 1:

Missions	Sensors/Models	Data Product
GPM[1]	DPR[2] and GMI[3]	Precipitation measurements
NOAA's Estuarine Reserves Division	SWMP	In situ precipitation measurements

[1]GPM – Global Precipitation Measurement; [2]DPR – Dual-frequency Precipitation Radar; [3]GMI – GPM Microwave Imager

g. Benefit to Society: Estuary preservation

2. Abstract

Data collected via the International GPM Program could be used to provide a solution for the NOAA Estuarine Reserves Division's System-wide Monitoring Program by augmenting in situ rainfall measurements with data acquired via future satellite-acquired precipitation data. This Candidate Solution is in alignment with the Coastal Management National Application and will benefit society by assisting in estuary preservation.

3. Detailed Description of Candidate Solution

a. Purpose/Scope

Estuarine water bodies and the land that surrounds them provide a land-to-sea transition zone. Protected from the full force of waves, winds, and storms by topographic features (e.g., reefs and barrier islands), estuaries provide habitats for countless numbers of plant and animal species. An estuary's wetlands, including salt marshes, naturally improve water quality and offer flood control. Estuaries also provide nesting areas for commercial fish species and shellfish populations while offering human recreational opportunities. Thus, preservation of estuaries has societal benefits. Nevertheless, anthropogenic and natural disturbances have both impaired water quality and resulted in fragile underwater vegetation loss. The U.S. Government, in realizing both the benefits and threats to estuaries, passed the Coastal Zone

Management Act of 1972, creating the NERRS (National Estuarine Research Reserve System). This protected areas program consists of a network of 26 estuarine reserves covering over one million acres of protected estuarine waters, adjoining wetlands, and uplands across the continental United States, Alaska, and Puerto Rico (Hilbert, 2006; Owen and White, 2005).

Nevertheless, concern continues over the present status of estuaries in the United States and over their future viability. Between 1980 and 2003, the population of coastal counties increased by 33 million people, increasing anthropogenic impacts on coastal waters. In fact, the EPA (2007) rated the Nation's coastal habitats as poor overall. Hence, continued efforts are needed to protect and preserve the Nation's estuaries.

b. Identified Partner

NOAA's NERRS maintains the System-wide Monitoring Program. SWMP is a DSS that both provides standardized data on environmental trends and allows the flexibility of assessing coastal management issues at regional or local scales. The system currently measures physical and chemical water quality indicators, nutrients, and the impacts of weather on estuaries (Owen and White, 2005). Coastal managers use this monitoring data to make informed decisions on local and regional issues, such as "no-discharge" zones for boats, and to measure the success of restoration projects. SWMP's mission is to quantitatively measure both the short-term variability and the long-term change that occurs within each NERR (NERRS, 2006). SWMP is a three-phased program. Phase 1 involves monitoring abiotic parameters while Phase 2 entails biological monitoring. Phase 3 demands watershed and land use classifications (Owen and White, 2005). This Candidate Solution focuses on supplying precipitation data for Phase 1 of SWMP in partnership with NOAA.

Acquiring accurate precipitation measurements within estuaries is important for a number of reasons. Precipitation dilutes salinity concentrations via freshwater runoff. Salinity concentration influences both the number and type of species found in an estuary. Precipitation-related runoff also delivers both sediment and particulate organic matter. Organic matter provides nutrients and promotes phytoplankton growth while sediment influx assists in either maintaining or increasing estuary size. However, runoff produced from precipitation may negatively impact water quality depending on the surrounding land-use characteristics. For example, eutrophication may occur within estuarine areas in close proximity to nitrogen-fertilized agricultural land. A better understanding of how precipitation affects finely calibrated estuarine ecologies will enable NERRS managers to make decisions on how to modify actions, to mitigate impacts, or to influence local and regional policy.

Currently, abiotic data are collected via both water quality and weather stations. Each NERR contains four long-term water quality data loggers and one weather station. Each water quality data logger monitors conductivity, salinity, temperature, pH, dissolved oxygen, turbidity, and water level every 30 minutes. One data logger is located at a control site while the others are placed along known or suspected gradients in abiotic parameters. The spatial scales of such gradients vary as the spatial extents of NERR sites differ. Each NERR weather station monitors temperature, wind speed and direction, relative humidity, barometric pressure, rainfall, and photosynthetic active radiation (Owen and White, 2005).

The Research Coordinator for the National Estuarine Reserves Division within NOAA, Susan White, is the point of contact regarding SWMP.

c. NASA Earth-science Research Results

Internationally, a wide range of basic and applied research requires high-quality, globally distributed, and continuous precipitation measurements. Research areas include local- and regional-scale water budget, water cycling modeling, climate reanalysis and climate simulations, numerical weather prediction, and regional and global rainfall climatology development, to name a few. Developing a next-generation / space-based precipitation measurement system is the International GPM Program's purpose (Smith et al., 2007).

The International GPM Program calls for the following: a Core spacecraft with the GMI and the DPR; a constellation of multiple spacecraft to provide frequent, global precipitation measurements; a GV (Ground Validation system, a PPS (Precipitation Processing System) to provide ground data processing, and the involvement of people (i.e., individual scientists, engineers, and program officials) that make up the science teams and the oversight committee/working group infrastructure responsible for managing and coordinating the mission's international aspects. People are the most important component of this program (Smith et al., 2007).

The GPM Program will include the Core spacecraft and an international constellation of new and previously existing satellites, referred to as satellites of opportunity. The Core satellite, to be constructed by NASA and planned for a launch in 2013, will include a JAXA-provided DPR (ka and ku band) and two NASA-provided GMIs. The DPR sensor, having both 250 m and 500 m spatial resolutions, will offer increased sensitivity for light rain and snow detection, improved measurement accuracy, and more detailed microphysical information (Nakamura et al., 2005). The GMI will provide significantly improved spatial resolution compared to the TMI (TRMM (Tropical Rainfall Measurement Mission) Microwave Imager). The Core spacecraft's instrumentation will provide standards for both precipitation and radiometry for other spacecraft within the proposed GPM constellation (Bidwell et al., 2005; Flaming, 2005, 2004). Additionally, the Core spacecraft's non-sun synchronous orbit will both resolve the diurnal precipitation cycle and cross the orbital paths of the constellation's satellites, allowing for sensor calibration (Nakamura et al., 2005; Smith et al., 2007).

Smith et al. (2007) discussed the satellites of opportunity and potential back-up satellites in great detail. An international constellation of satellites will make a 3-hour revisit time possible approximately 90 percent of the time.

A GV System will assist in characterizing errors and in quantifying uncertainty. The system should provide a physically based measurement standard, allowing for performance assessment and science retrieval algorithm improvement. Planning is currently underway to develop a world-wide GV network, a necessity because of both the variability in the types of rainfall and the effects of geographical location and geomorphologic features in affecting precipitation events and the associated event frequencies (Flaming, 2005, 2004; Smith et al., 2007).

The current GPM Program plan calls for a PPS, similar to the TRMM Science and Data Information System, to collect and process rainfall data from not only the Core spacecraft but also from the GPM constellation. In addition, the plans call for the PPS to receive inputs from the GV Systems, making it possible to offer error-corrected and calibrated GPM data products to data users (Flaming, 2005, 2004).

d. Proposed Configuration's Measurements and Models

This Candidate Solution focuses on determining the potential contribution of the future International GPM Program in augmenting precipitation data currently acquired by the weather stations located at each NERR. Use of satellite-derived rainfall data may augment the abiotic monitoring capabilities of SWMP, which may improve both management and decision-making capabilities.

4. Programmatic and Societal Benefits

This Candidate Solution aligns with the Coastal Management National Applications Element of the Applied Sciences Program because it advocates the formation of a partnership between NOAA's Estuarine Reserves Division and NASA. It also aligns well with the stated focus of Earth Science Applications Program, as presented in the *Earth Science 2004 Applications Plan* (NASA, 2004). This Candidate Solution promotes the integration of NASA Earth science observations into a partner's decision-making process. Furthermore, it may assist in preserving and enhancing the condition of estuaries located in the United States, a societal benefit given the important roles of estuaries in fin fish and shellfish habitat protection, flood control, water filtration, and recreational opportunities.

5. References

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