Global Precipitation Measurement - Report 2
Benefits of Partnering with GPM Mission

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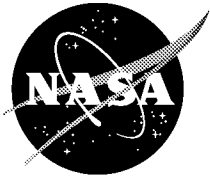
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Executive Summary

An important goal of the Global Precipitation Measurement (GPM) mission is to maximize participation by non-NASA partners both domestic and international. A consequence of this objective is the provision for NASA to provide sufficient incentives to achieve partner buy-in and commitment to the program. NASA has identified seven specific areas in which substantive incentives will be offered: (1) partners will be offered participation in governance of GPM mission science affairs including definition of data products; (2) partners will be offered use of NASA's TDRSS capability for uplink and downlink of commands and data in regards to partner provided spacecraft; (3) partners will be offered launch support for placing partner provided spacecraft in orbit conditional upon mutually agreeable co-manifest arrangements; (4) partners will be offered direct data access at the NASA-GPM server level rather than through standard data distribution channels; (5) partners will be offered the opportunity to serve as regional data archive and distribution centers for standard GPM data products; and (6) partners will be offered the option to insert their own specialized filtering and extraction software into the GPM data processing stream or to obtain specialized subsets and products over specific areas of interest (7) partners will be offered GPM developed software tools that can be run on their platforms. Each of these incentives, either individually or in combination, represents a significant advantage to partners who may wish to participate in the GPM mission.

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1.0 Introduction

An objective for the Global Precipitation Measurement (GPM) project is the production of 3-hour global precipitation products. To achieve this temporal coverage on a global basis will require a constellation of satellites with the appropriate instruments. It is clear that partners, both national and international, will be required to assist in configuring the appropriate constellation. It is equally clear that partners will need some incentive for contributing their assets toward the GPM constellation needs. This study looks at incentives that NASA could provide for potential partners.

The current GPM approach calls for NASA to build a core satellite that will carry at the very least a NASA provided radiometer and a National Space Development Agency of Japan (NASDA) provided dual-frequency precipitation radar. NASDA will provide the launch capability. NASA will provide the ground system for the core satellite and its instruments. The ground system will provide both the mission operations component for spacecraft and instrument monitoring and data download. Current GPM concepts plan for the ground system to download data via (Tracking and Data Relay Satellite System) TDRSS continuous mode. This provides immediate access to collected data. The NASA provided ground system also includes a science data processing system that will produce all GPM approved data products from the core satellite.

It is anticipated that at least eight satellites will be needed in a constellation to provide the desired 3-hour global precipitation product. To achieve this constellation, NASA will provide and launch at least one constellation satellite containing an appropriate radiometer. Current GPM concepts assume that national and international partners contribute the remaining constellation satellites into the constellation.

The NASA-provided ground system for the core satellite is, however, planned to operate not only the core satellite but the NASA-provided constellation satellite also. This NASA constellation satellite will also probably download its data via the TDRSS continuous mode. This ensures that the radiometer data will also be available immediately. The NASA GPM science data processing component of the ground system will produce appropriate precipitation products from the constellation satellite as well as merging products from this satellite and from the core. Indeed, the data processing component will have the capability of merging products from multiple constellation satellites into combined 3-hour global precipitation products.

NASA's capability of providing access to launch opportunities, TDRSS, the mission operations command upload and data download capabilities, and the GPM science data processing system offer many opportunities for partner incentives. In addition to access to these assets, NASA can include GPM partners in the governance process for science and data production.

2.0 Participation in Science Governance

One of the major advantages for partners is the opportunity to participate in the determination of direction of the science investigation for GPM and the determination of the GPM standard approved data products. A combined GPM science team will be established that will participate not only in decisions during the implementation phase of GPM but will also have a determining influence during the operational phase of GPM.

Using TRMM's Joint TRMM Science Team (JTST) as the model, GPM will organize an analogous Combined GPM Science Team (CGST). The CGST will have appropriate representation from the key contributors to the mission. During the development phase, the scientists on the CGST will help hone and finalize the science research objectives to ensure the most effective implementation of the

science requirements. They will provide guidance in the establishment of GPM standard products. The CGST will also establish review and evaluation procedures by which new algorithms will replace initial algorithms for producing standard products or for adding new standard products. They will be given the opportunity for review of the GPM science implementation plan, data processing plan, data formats, and data delivery. The CGST will also guide GPM partners as to the roles they play in each of these areas. This guidance participation will give CGST members a unique ability to help establish the overall science and data product framework for GPM.

During the operations phase of GPM, the CGST plays a major role in the determination of algorithm improvements. Members will carry out the review and evaluation procedures for determining when improved or new standard product algorithms should be implemented by the data systems partici-pating in GPM. The CGST will also establish the priorities and timeframe for the reprocessing of GPM standard products once the team has accepted new or improved algorithms. Working with the appropriate GPM Project Scientists the team will also help in establishing special processing activi-ties for the participating GPM data systems. Such activities might include (but are not limited to, special or experimental products) regular subset production (such as the TRMM coincident subsetted intermediate products), and ongoing special parameter extractions. As a result, this incentive offers partners a unique opportunity to ensure that their algorithm and product objectives are considered within the overall GPM mission framework.

The influence that the CGST has both during the implementation and the operational phase should make this a strong incentive for potential GPM partners.

3.0 Access to TDRSS

For partners who could contribute spacecraft with appropriate instruments, NASA could make avail-able the opportunity to use TDRSS continuous access mode for the downloading of data from the partner spacecraft. This would allow partners to receive their data in real-time. While partners would be expected to provide the necessary trans-mitter and antenna hardware for access to TDRSS, the costs of use during operations could be elimi-nated or be at a very low level.

TDRSS continuous access mode has the advantage over traditional ground system downloads because data from the spacecraft can be continuously available through the system. In traditional ground station modes, science data would be downloaded at most once per orbit using a single ground station. While additional ground stations could be added, both the cost and the locations make this approach less competitive than the TDRSS continuous access mode. In addition, costs for network transfer from the ground stations, particularly polar stations, to the partner's desired processing location could substantially increase costs for partners.

Partners could just be sent the raw data as it comes from White Sands. However, the GPM Mission Operations Component (MOC) could make Level 0 processing available to potential partners at no or very nominal cost. The automated protocols antici-pated for this type of processing make possible very flexible conversion of raw data to Level 0 data. In addition, general-purpose processors rather than specially designed hardware can now generate these products. Partner data could, therefore, be processed with only incremental hardware costs required. These hardware costs would be extremely low given the anticipated use of "off-the-shelf" hardware.

If the partner desired, NASA could offer the GPM MOC facilities to upload partner commands and do some monitoring of partner instrument and spacecraft. Most partners would probably wish to do this aspect of operations themselves. In this event, the MOC could just pass through partner provided upload commands to TDRSS. They would also pass through any special housekeeping data downloads to the partners.

The extent to which NASA could provide such capabilities will be dependent upon partner downlink bandwidth needs. Extremely high download or upload bandwidth would not be able to be supported through any NASA provided TDRSS continuous access mode. Also, network bandwidth between the partner facility and the GPM MOC facility where GPM data is received will also need to be considered. However, it is anticipated that any partner able to contribute spacecraft and instruments would have or could have the necessary network bandwidth required.

4.0 NASA Launch Support

NASA has knowledge of a number of launch opportunities both as part of the GPM mission and other Earth Science missions. In addition, NASA's extensive national and international partnering gives it a unique knowledge of many other launch opportunities. NASA might be able to offer potential partners information about and access to co-manifest opportunities.

This incentive might involve arranging a co-manifest on another appropriate NASA mission. NASA could equally offer to serve as coordinator or "broker" for partners in arranging for agreements on non-NASA missions. Obviously, some costs for such arrangements would need to be borne by the partner. But, the arrangement could substantially reduce costs for the partner. This might make the difference as to whether the partner could contribute or not.

5.0 Server Level Data Access

NASA will offer major contributing partners the ability to access all GPM data (whether from NASA provided satellites or partner provided satellites) directly from the GPM Science Data Processing System servers. Partners will also be offered the opportunity to retrieve data directly as they are being processed.

While this offer does not impinge on NASA's policy to make data from its missions available to all users, it does provide partners with the ability to retrieve data quickly and directly from the GPM processing stream. All GPM standard products will be universally available from a designated NASA archive and distribution facility. This incentive offers a partner the opportunity to be considered as part of the mission science team. This allows them to be served directly by the production system rather than the distribution system. Partners would access GPM standard products directly from the processing system server similar to the approved GPM distribution and archive system. This means that availability of data is not restricted by the latency necessary for the archive and distribution facility to ingest the data from the processing system server, incorporate it into its tracking system, and make it available through its search and order system.

The partner would be able to transfer the data electronically and automatically from the processing system servers. No query or search of an archive would be necessary. This direct access from the processing system server will afford the partner access to the data faster than via retrieval from the archive and distribution facility. This would allow the partner to do extra or special processing that they desire without delaying their production.

Server level access also provides partners with access to intermediate data generated by the GPM processing system for debugging and product

quality control. These data are not standard products and are not intended for either archive or distribution. These data are the temporary products produced so that algorithm actions can be trended, geolocation quality controlled, data product quality assessed, temporary results accumulated, etc. The result of generating these intermediate data is a high quality standard product. However, for a partner access to such intermediate data provides them with data that could be used for their own processing needs without having to generate such intermediate products themselves. This would offer savings in both processing costs and the development of the processing software.

A major advantage of server level access is the ability to retrieve all partner data from a single server location rather than having to negotiate access to all partner servers. One of the major responsibilities of the GPM Science Data Processing System is the creation of global products for instantaneous rain maps, 3-hour rain products and for the research quality climate products. A consequence of this responsibility is the need for the processing system to have data from all GPM satellites available on its servers. The opportunity to access all this data, just as the distribution and archive facility accesses it, from a single location would certainly materially contribute to reduced costs for partners.

Another potentially useful advantage of server level data access is direct access to the immediate data used to generate the global rain maps for immediate "web" access. This data will be replaced by higher quality 3-hour data and finally by the highest quality research level climate data. As a result, no need exists for archiving this "first look" data. Its main purpose is the generation of the immediate rain maps that will be globally accessible by any user. However, partners may wish to generate their own immediate products from this early data. They might wish to use this immediate data to generate other products for special monitoring uses in their area or region.

Server level data access provides a partner with faster, more automated, less human intensive access to all GPM data as it is produced. The reduction of required human intervention for data retrieval and the reduction in the latency of data arrival offer opportunities for substantial partner cost savings. This is potentially one of the greatest incentives that NASA could offer. From a NASA perspective, this incentive is especially appealing, as it entails no substantial costs. This server level data access also does not impinge upon NASA data distribution policies while still offering substantial advantages to partners.

6.0 Operation of Regional Data Archive and Distribution Centers

A consequence of server level data access is the ability for a partner to become an approved regional archive and distribution center for all GPM data. Approval could be part of the partner agreement. This incentive is "costless" as it just requires NASA not to actively promote or distribute GPM data to users in the partner's area or region.

This would allow the partner to be viewed as the "GPM expert" in the designated area or region. It is the usefulness of the mission data that makes a mission ultimately successful. When a partner facility is recognized as the center of such "successful" products, it might become easier for a partner to obtain funding from their sources for other missions of interest in the region or area. Partners would also become recognized as the area or region experts in precipitation research. This also has the potential of offering positive future benefits for the partner.

This incentive should be particularly beneficial for NASA. When a partner distributes in a designated area or region, the demands on the NASA provided archive and distribution facility might reduce. This alleviates network bandwidth costs. It also allows the archive and distribution facility to target its support more effectively.

7.0 Specialized Software Execution in the NASA-GPM Data System

NASA will offer partners the opportunity to execute special software as part of the normal data processing in the GPM Science Data Processing System. Such support will provided in two ways: executing partner provided software or running GPM developed subsetting or filtering software using partner provided parameters. TRMM provided such services to designated TRMM "partners." The service was very effective in establishing the recipients as strong advocates of TRMM. The same would also be true for GPM.

Partner provided software would be run on a non-interference basis with production. It would also be a "best effort" rather than a specified requirement. Partner software could be parameter-extracting software, special filtering software that both extracts and creates special small output products in partner designed formats. Partner software could also create special or merged output products that are not intended for GPM distribution and are not GPM approved standard products but are of particular use in the partner's area or region. The real advantage to the partner in this approach is immediate access to all GPM data as it is produced as well as the reduction in data streams that partners might have to retrieve to achieve the same product at their own site. The reduction in bandwidth requirements could provide cost savings for partners. It could also allow them to provide value added services to their users without substantial expenditure of additional funds.

NASA will also offer partners the opportunity to receive subsetted or filtered products using GPM data system filtering and subsetting tools. While such software would naturally not be as specific as partner provided software, it also would not require them to implement it. Its great advantage for the partner is the potential for a greatly reduced output volume of data that they might have to retrieve. If they had a special project in a particular area or region, they might wish to retrieve only data in that area with only the parameters that they believe are appropriate to the study. Their users would gain results more quickly at greatly reduced overall costs.

From NASA's perspective such an incentive would not be a cost driver on the data system. For example, reprocessing capacity or overhead capacity in the system could be used to deliver the functionality. This means almost no additional costs for the processing system. On the other hand, even having a number of such requests would not greatly increase costs as this is a scalability issue rather than a personnel or development issue. Commodity-based microcomputer hardware could allow scaling up with very little additional cost for the system.

8.0 Software Tools

NASA will also offer partners access to all generic software tools developed as part of the GPM project. Such tools would greatly enhance the ability of partners to serve their users without having to develop such tools on their own. This increased service capability, at little or no cost, offers a substantial benefit to partners. This software is intended to be portable across any UNIX based system and will include — but not be limited to —

- Tools to display and help in the analysis of GPM data products.
- Toolkits for easily reading and writing GPM data product file formats.
- Generic geographical subsetting software that can be run in the partner's production or research systems.
- Generic filtering software that filters GPM data products for values (able to be set in parameter files) in key parameters and creates much smaller files.
- Product generating algorithm code.

NASA will also make available to partners GPM software that performs automated ingest, distribution, automated scheduling of jobs, and data management. The availability of such software would greatly reduce partner costs if they wish to build their own processing system. A substantial part of a production system's tasks could be built using this GPM provided software. Partners would then not have to allocate funds for these activities. They would be able to focus their development costs on unique components of their processing system but still in the end have a complete end-to-end system.

9.0 Summary

NASA has at least seven different ways in which it can offer incentives to potential partners in GPM. All of them offer the partner major advantages. In addition, most of them do not contribute to NASA's cost or risk in any substantial manner. None of the incentives described would impinge on NASA responsibilities or current policies in any way.

The ability to offer governance participation, server level data access, and partner software insertion provide the most effective and least expensive incentives that NASA could offer. Each of these functionalities could contribute greatly to any partners research and commitment to the user community they serve.

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