Summary of the Precipitation Measurement Mission Science Team Meeting

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Introduction

The Precipitation Measurement Mission's (PMM) Science Team meeting took place in Baltimore, MD, August 4-7, 2014. The PMM program supports scientific research, algorithm development, and ground-based validation activities for the Tropical Rainfall Measuring Mission (TRMM) and the Global Precipitation Measurement (GPM) Core Observatory that launched on February 27, 2014.

The PMM Science Team meeting opened with a special memorial session dedicated to **Arthur Hou**, the former GPM Project Scientist, who passed away November 20, 2013. Hou's friends and colleagues remembered him as an exceptional scientist and leader who was able to build and navigate the international relationships that got the GPM mission off the ground—see *A Tribute to the "Heart and Soul" of the GPM Mission* on page 32.

The TRMM and GPM missions are co-led by NASA and the Japan Aerospace Exploration Agency (JAXA), with numerous additional international partners. The international community was well represented at the meeting, with more than 190 attendees from 14 countries, in addition to representatives from NASA, JAXA, the National Oceanic and Atmospheric Administration (NOAA), universities, and other partner agencies. Among the topics discussed—in 13 sessions of presentations and 2 poster sessions—were status updates from the TRMM and GPM programs, international activities, algorithm development, and ground validation, as well as science reports from team members.

Programmatic Updates and TRMM and GPM Status Reports

Mike Freilich [NASA Headquarters (HQ)—*Director of the Earth Science Division*] and **Ramesh Kakar** [HQ—*GPM Program Manager*] discussed the current state of NASA Earth Science missions and the immediate budget outlook for the next year, which is steady. The current PMM Science Team is in its second year of activities; in the coming months a solicitation for the ninth science team will go out—with proposals due in June 2015.

Scott Braun [NASA's Goddard Space Flight Center (GSFC)—*TRMM Project Scientist*] provided an update on TRMM. The biggest news is that TRMM is out of station-keeping fuel. The last drag-reduction maneuver to maintain TRMM's altitude was on July 8, 2014, and the decision was made to let the instruments continue to collect data at a reduced capacity as the spacecraft slowly loses altitude over the next 18 to 20 months. Science data from the TRMM Microwave Imager (TMI) will be collected until the spacecraft is shut down, which is estimated to be in April of 2015. The Precipitation Radar (PR) can only collect good science data at two altitudes, its current 407 kilometers and its original altitude of 350 kilometers.

Nobuhiro Takahashi [National Institute of Information and Communications Technology, Japan] explained JAXA's plan to collect data as TRMM passes through these altitudes, but at other altitudes they will stop science data collection and conduct experimental observations. During TRMM's remaining time in orbit, it will be part of the GPM constellation.

Gail Skofronick-Jackson [GSFC—*GPM Project Scientist*] and **Art Azarbarzin** [GSFC—*GPM Project Manager*] discussed the current status of the GPM Core Observatory. The satellite has a mission lifetime of 3 years, but its fuel unexpectedly appears to be sufficient for 13 to 15 years—an estimate that includes enough for a controlled reentry. The satellite is returning excellent data, but Skofronick–Jackson did note a couple of issues. The GPM Microwave Imager (GMI) experiences radio frequency interference in two channels due to reflection of satellite–broadcast TV signals from frozen lakes, and from certain wireless motion detectors when installed in sufficiently large numbers. Also, there have been some unexpected magnetic effects on the GMI—which are thought to be due to Earth's magnetic field but do not impact the instrument's performance—that have been corrected with an algorithm update. Neither issue is expected to significantly impact science operations, but both will be monitored.

Erich Stocker [GSFC] discussed the status of the GPM data products. GPM Core and constellation data products are scheduled to be publicly released on September 2, 2014[1]. Products range from near-real-time data from individual sensors and orbits to the Integrated Multi-satellite Retrievals for GPM (IMERG) product that will combine data from GPM with partner satellite data, which will be released in December 2014. The Precipitation Processing System at Goddard is meeting its latency requirements for the datasets.

Dalia Kirschbaum [GSFC—*GPM Applications Scientist*] discussed GPM applications and outreach activities, showing the new, user-friendly web interface for downloading data (*pmm.nasa.gov/data-access/downloads/gpm*).

[1] **Editors Note**: This release took place as scheduled on September 2. See the announcement in the September–October 2014 issue of *The Earth Observer* [**Volume 26, Issue 5**, p. 19].

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Riko Oki [JAXA—*GPM Project Scientist*] and **Kinji Furukawa** [JAXA—*GPM Project Team Leader*] gave an overview of JAXA's activities and the checkout of the Dual-Frequency Precipitation Radar (DPR), whose initial results—when compared to the TRMM PR—are good. Of note, the DPR does have more *side-lobe clutter* (which causes noise on either side of the swath) than the TRMM PR, but software fixes have been applied. **Yukari Takayabu** [University of Tokyo] described the preliminary results of the increased sensitivity of the DPR's two bands as very good and promising for the study of cloud microphysics. **Toshio Iguchi** [JAXA] gave an update on JAXA's DPR algorithms and the major differences from those for the TRMM PR.

Algorithm Status

Chris Kummerow [Colorado State University], **Bob Meneghini** [GSFC], **Bill Olsen** [University of Maryland, Baltimore County], **George Huffman** [GSFC], and **Tom Wilheit** [Texas A&M University] each gave presentations on algorithm status for GMI, DPR, combined GMI and DPR, IMERG combined global data product, and constellation partner datasets, respectively. A few minor glitches notwithstanding, development of all the algorithms is progressing well, and all are on schedule for the September 2 data release (now released), with the exception of IMERG, which is planned for a December 2014 release.

Ground Validation

Walt Petersen [NASA's Wallops Flight Facility] summarized GPM's ground validation efforts, including the two campaigns that took place since the last PMM Meeting: The Iowa Flood Studies (IFloodS), which took place in northeastern Iowa in 2013[2], and the Integrated Precipitation and Hydrology Experiment (IPHEx), which took place in North Carolina in the summer of 2014.

Withold Krajewski [University of Iowa—*IFloodS Principal Investigator*] described IFloodS in more detail. GPM partnered with the Soil Moisture Active Passive (SMAP) mission for this campaign, which examined conditions that lead to flooding; they have done preliminary analysis of the hydrology.

Ana Barros [Duke University—*IPHEx Principal Investigator*] described the IPHEx field campaign, which looked at precipitation over the Appalachian mountain region, and has just wrapped up its intensive observing period.

Lynn McMurdie [University of Washington] described plans for the next GPM ground validation campaign, the Olympic Mountain Experiment (OLYMPEX), which will take place on the Olympic Peninsula in Washington in the fall and winter of 2015-16.

Giullia Panegrossi [CNR–ISAC[3], Italy] reported on ground validation of GMI algorithms in European experiments that serve as an independent validation for rainfall, snowfall, and related hydrology estimates. Similarly, **Pierre Kirstetter** [National Severe Storms Laboratory (NSSL), University of Oklahoma] showed results of comparing data from NOAA's NEXRAD multiradar and multisensor networks to GPM and TRMM rainfall estimates. This work better characterizes differences between sensors in order to achieve more consistent datasets from multiple sensors that can be used to complement the ground validation campaigns. Kirstetter also discussed other ground validation experiments conducted by GPM's international partners.

Science and Applications

Three themes emerged among the science reports: evaluation and improved approaches to GPM algorithm retrievals of rain and snow, studies of the precipitation processes that improve parameterization for GPM algorithms, and longer-term global studies of convection and rain rates using TRMM's 16-year record. The **Table** on page 31 gives a list of speakers and presentations.

One of the new capabilities provided by GPM is its ability to detect and estimate snowfall. The processes governing the formation of snow are somewhat more complicated than those for rain, since there are many possible ways for snow to form, grow, and/or melt inside clouds. A number of presentations discussed approaches using measurements from dual-frequency radar on the ground and comparing them to those obtained from DPR to help distinguish between different snow processes. In particular, data from past snow ground validation field campaigns are being used to study these processes: **David Hudak** [Environment Canada] is evaluating differences in synoptic *versus* lake effect snow; **Dmitri Moisseev** [University of Helsinki] is working with data from multiple sites in Finland; and **Brian Colle** [Stony Brook University] is looking at microphysical processes of snow formation to improve the parameters used in models to represent snowfall.

Ralph Ferraro [NOAA—*Chief for the Satellite Climate Studies Branch*] discussed NOAA's efforts to assimilate GPM data into operational models. NOAA is using GPM data for hurricane, flood, and hydrology applications. **Peter Lean** [European Centre for Medium-Range Weather Forecasting (ECMWF)] discussed incorporating GPM data into weather forecasts in European models. Initializing models with data from GMI has improved model data for both groups, such that they better fit with observations.

[2] To learn more, read "A Flood—of Information—Is Needed" the January–February 2014 issue of *The Earth Observer* [**Volume 26**, **Issue 1,** pp. 12-18].

[3] CNR-ISAC stands for the Institute of Atmospheric Sciences and Climate of the Italian National Research Council, *Istituto di Scienze dell'Atmosfera e del Clima*.

Table. Science and Applications Presentations Given During the PMM Science Team Meeting.

Presenter	Affiliation	Title*
Christopher Ruf	University of Michigan	Time and space sampling coordination between PMM and CYGNSS ocean surface winds
Jonathan Gourley	NOAA	Use of NSSL ground radar datasets to support IPHEx and GPM
Marshall Shepherd	University of Georgia	Urban-snow relationships: Process studies and a new framework for optimizing and managing global urban water systems in the GPM era
Efi Foufoula-Georgiou	University of Minnesota	A new algorithm for GPM passive microwave rainfall retrieval: Extremes, discontinuities, and spatial structure
Milija Zupanski	Colorado State University	Improvements of the WRF-EDAS for assimilation and downscaling of the GPM satellite precipitation information
Luca Baldini	CNR-ISAC	Scanning strategies For Tier 1 GPM ground validation radars
Jinho Shin	Korea Meteorological Administration	GPM ground validation system optimization and operation over the Korean Peninsula
Stephen Durden	NASA/JPL	Global surface characteristics using GPM
Mircea Grecu	GESTAR NASA	Expectation maximation analysis of the consistency of GPM combined retrievals
Wesley Berg	Colorado State University	How calibration and sensor differences impact precipitation estimates from the GPM radiometer constellation
Robert Adler	University of Maryland	TRMM/GPM climatology and variations during the TRMM era and earlier
Daniel Cecil	MSFC	Extremely low brightness temperatures with deep convection—discriminating signal from noise
Edward Zipser	University of Utah	Latent heating profiles and their relationship to the structure and intensity of convective systems
Christa Peters-Lidard	GSFC	Dynamic emissivity estimation with calibrated and simplified forward models
Anthony Del Genio	GISS	Sensitivity of MJO hindcasts to cumulus parameterization assumptions
Robert Houze	University of Washington	Extreme convection in the Equatorial Zone as seen by 16 years of TRMM Precipitation Radar observations
Anthony Illingworth	University of Reading	Chilbolton radar
Alexis Berne	EPFL-LTE	Radar and disdrometer measurements: Processing and evaluation using HyMeX data
Mekonnen Gebremichael	University of Connecticut	Validation of satellite rainfall products across the Blue Nile basin
Daniel Vila	CPTEC/INPE	GoAMAZON - CHUVA - The last field campaign
Cliff Mass	University of Washington	High-resolution modeling support of Olympex
Carl Schreck	NCSU/CICS-NC	A global survey of Kelvin waves and tropical cyclogenesis
Anita Rapp	Texas A&M University	Relationships between properties of subtropical cumulus convection and lower tropospheric water vapor
Eugenia Kalnay	University of Maryland	Effective assimilation of TMPA observations
Liang Liao	Morgan State University	Uncertainties of GPM/DPR rain estimates caused by DSD parameterizations

* **List of acronyms used in Table *not* found in text**: CYGNSS = Cyclone Global Navigation Satellite System; WRF-EDAS = Weather Resarch and Forecasting–Environmental Data Assimilation System; MJO = Madden–Julian Oscillation; HyMeX = Hydrological Cycle in the Mediterranean Experiment; CHUVA = *Cloud processes of the main precipitation systems in Brazil* (English translation of Brazilian acronym); TMPA = TRMM Multisatellite Precipitation Analysis; DSD= Drop Size Distribution.

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A Tribute to the "Heart and Soul" of the GPM Mission

On August 4, 2014, a memorial symposium took place to honor the life and work of **Arthur Hou**, former Project Scientist of the GPM Mission, who passed away on November 20, 2013, three months shy of GPM's launch. The memorial event took place at the Embassy Suites–Grand Historic Venue in Baltimore, MD, in conjunction with the PMM Science Team Meeting.

Ramesh Kakar gave the opening remarks; he remembered Arthur as the "heart and soul of the GPM mission," and gave him credit for getting the mission back on track at a time when it was foundering. **Michael Freilich** also gave some remarks on Arthur's central role to the mission, saying that, "Without Arthur's effort with GPM, we would be worse off as a nation and worse off as a species." **Piers Sellers** [GSFC—*Deputy Director of Science and Exploration Directorate*] described Arthur as "master conductor" who will be remembered with great affection.

Many speakers at the symposium shared anecdotes from Arthur's distinguished professional career—see full agenda for more. For example, **Isaac Held** [NOAA] knew Arthur as a graduate student at Harvard, where he began work on theories of large-scale systems in the atmosphere, in particular what controls the size, strength, and transport of air masses in the Hadley Cell. **Bob Adler** [UMD] knew Arthur as a colleague; the two worked together when Arthur came to NASA in 1990 and worked on the TRMM mission; he said that Arthur's research influenced how data were assimilated into models. He recalls that Arthur didn't like how Adler's multisatellite flood monitoring approach was done, and wanted to build them better tools to bridge observations and models.

A recurring theme during the symposium was Arthur's ability to bring people together. **Ed Zipser** [University of Utah] spoke of Arthur as a champion of the GPM mission, who really understood how to deal with people. That charisma was most helpful in bringing together the international community to support his vision of combining international satellites to produce a robust worldwide precipitation dataset. **Vincenzon Levizzani** [ISAC] remembers Arthur as emphatically inclusive in his interactions with international partners. Arthur spent hours of negotiating in meetings and on telephone calls across both the Pacific and the Atlantic Oceans, working through armies of lawyers and bulky governmental offices to help make the GPM concept a reality.

> I really hope that Arthur is remembered every time a piece of data from GPM helps to further our understanding of precipitation, helps to predict the direction of the next hurricane, flood prediction, or landslide. Every time we save a life, I hope that some scientist out there remembers Arthur and that his legacy for this mission lives on.
>
> —**Gail Skofronick-Jackson** [GSFC—*GPM Project Scientist*].

There were also glimpses into Arthur's personal life shared during the symposium. Levizanni also remembered Arthur as a "man of culture and science, a citizen of the world." Their friendship was cemented over a shared love of the opera. **James Carton** [UMD] knew Arthur when he was a post-doc, and says they got to know each other better on a sailing trip. Arthur was an enthusiastic sailor throughout his life. It was on one such trip that he met his wife **Sandra**. Both Sandra and their daughter **Sara** both spoke at the symposium, remembering their husband, father, and best friend.

Though Arthur died a few months short of seeing his satellite finally reach space, his legacy lives on through the pioneering research enabled by GPM. With an improved global picture of rain and falling snow, scientists and others can gain a better understanding of Earth's climate, regional effects of severe storms, and impacts on water resources for society.

Closing

Ramesh Kakar, **Gail Skofronick-Jackson**, and **Scott Braun** closed the meeting, extending congratulations and thanks to the science team for all their hard work making sure all the algorithms were in place for day one of observations, and their continued work evaluating and improving the new—and in some cases, unprecedented—data as the team enters the GPM era. ■