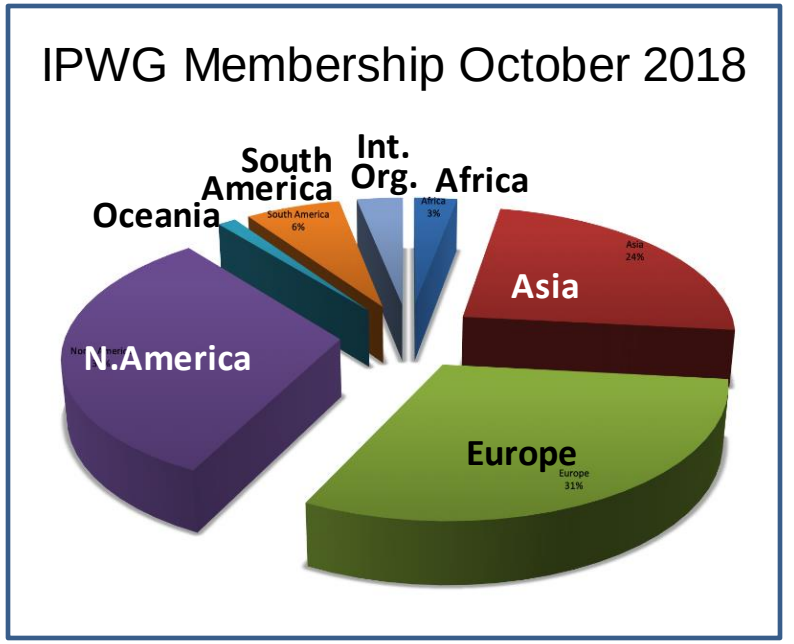
Report from the International Precipitation Working Group

New co-chairs : Chris Kummerow (CSU) and **Takuji Kubota** (JAXA)
New rapporteur to CGMS : Joe Turk (NASA JPL)

Former co-chairs : Philippe Chambon (Météo France) and **Viviana Maggioni** (GMU)
Former rapporteur to CGMS : Ralph Ferraro (NOAA STAR)

What is IPWG?

- IPWG was established as a permanent Working Group of the Coordination Group for Meteorological Satellites (CGMS) in 2001.
- The IPWG is co-sponsored by CGMS and the World Meteorological Organization (WMO).
- Focused on operational and research satellite based quantitative precipitation measurement issues and challenges.
- Provides a forum for operational and research users of satellite precipitation measurements to exchange information.
- IPWG fosters:
  - Development of better measurements, and improvement of their utilization;
  - Improvement of scientific understanding;
  - Development of international partnerships.



IPWG Meetings

- Under the lead of the two Co-Chairs, the IPWG organizes Workshops, co-sponsored by CGMS and WMO, approximately every two years.
- The Workshops promote the exchange of scientific and operational information between the producers of precipitation measurements, the research community, and the user community.

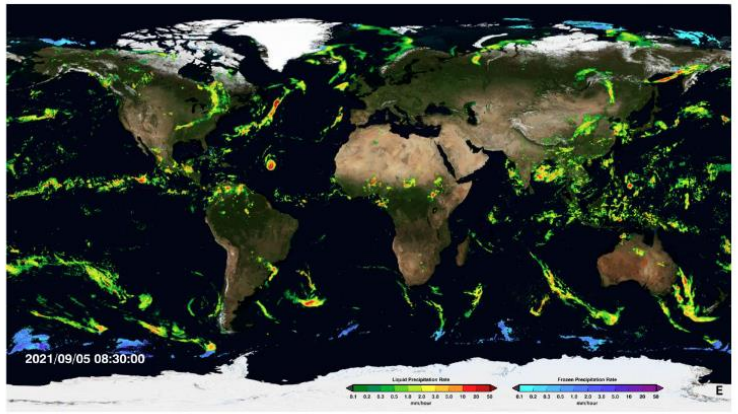
IPWG-1: Madrid (2002)
IPWG-2: Monterey (2004)
IPWG-3: Melbourne (2006)
IPWG-4: Beijing (2008)
IPWG-5: Hamburg (2010)
IPWG-6: São José dos Campos (2012)
IPWG-7: Tsukuba (2014)
IPWG-8: Bologna (2016)
IPWG-9: Seoul (2018)
IPWG-10 : Fort Collins (2022) + Hybrid

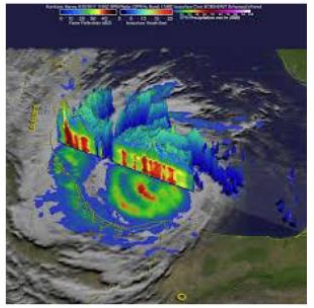
Post-conference website : https://www.cira.colostate.edu/conferences/ipwg-post-conference/
Using the password: IPWGpost

IPWG Scientific Outreach and Training

Joint GPM-IPWG Applications Training

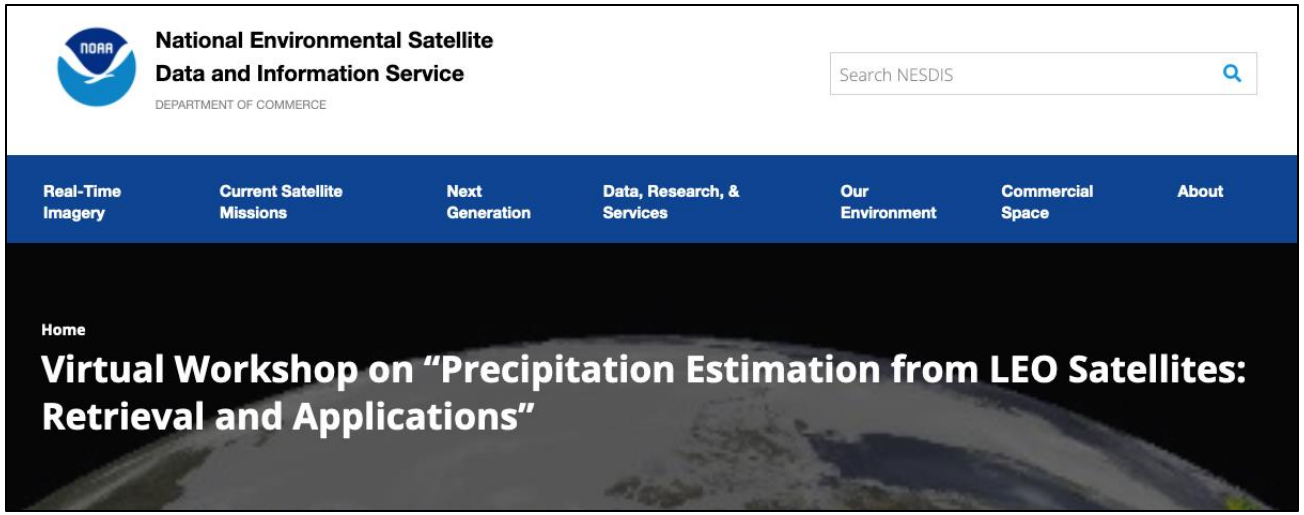
Part 2: GPM Precipitation Data Applications





- 15-16 September 2021
- Organized with the GPM applications team (Andrea Portier, Amita Mehta)
- Over 140 participants

Satellite Constellation Requirements: NOAA Workshop



https://www.nesdis.noaa.gov/events/virtual-workshop-precipitation-estimation-leo-satellites-retrieval-and-applications

- Online workshop, 1-2 March 2023
- Organized between UC-Irvine and the JPSS Project Office (Satya Kalluri)
- 100 participants, including international agencies (JAXA, EUMETSAT)
- Similar to the NOAA MW Sounder Workshop in July 2021
- Workshop report forthcoming

IPWG-10: Emerging Topics and Trends

- Growing usage of AI/ML techniques in algorithms
- Advancements to passive MW techniques specifically for estimating frozen (snow) precipitation from operational satellites, eg MetOp
- Continued effort to improve established global precipitation products, to address shortcomings inherent to high latitude/cold season and orographic precipitation
- Limited availability of science-quality ground radar network data, Needed to evaluate these same products in various regimes worldwide
- Growth in the number of limited lifetime, high quality small satellite observations with precipitation-sensing capabilities is expected to continue
- First participation of colleagues from the private sector (tomorrow.io)

IPWG-10: Science highlights (1/2)

Small Satellites for Precipitation

COWVR+TEMPEST (12/2021-)

- US Air Force sponsored mission on the ISS to demonstrate low-cost passive microwave sensor technologies for weather
- Support from NASA for data integration
- 18-183 GHz channels
- 3-year operations from the ISS

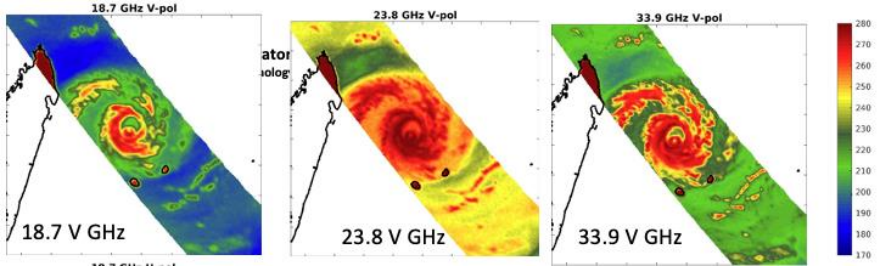
TROPICS-Pathfinder (6/2021-)

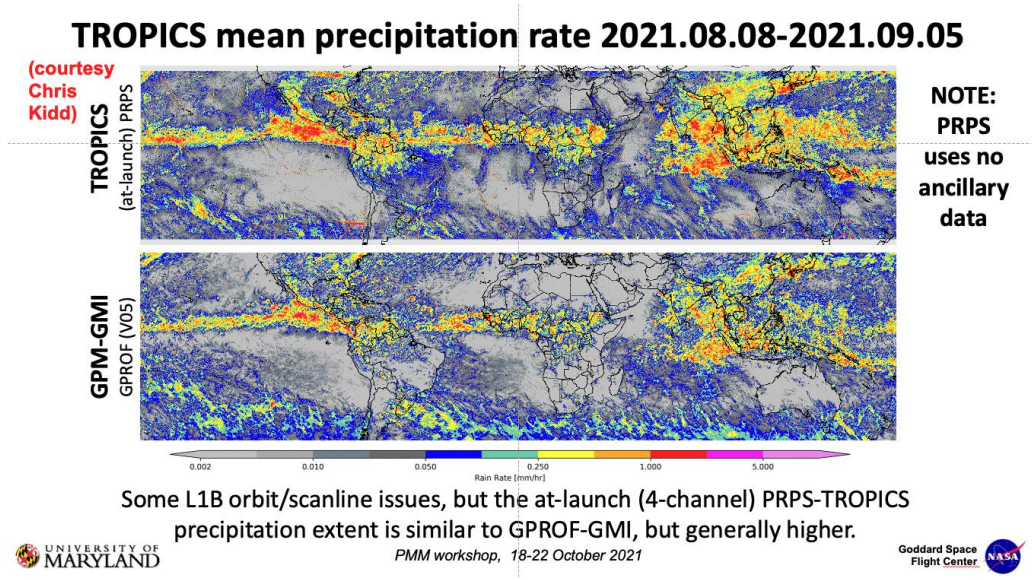
- 89-205 GHz channels

TROPICS (4 satellites, 2023)

- 89-205 GHz channels

Figures courtesy of Shannon Brown, JPL/Caltech



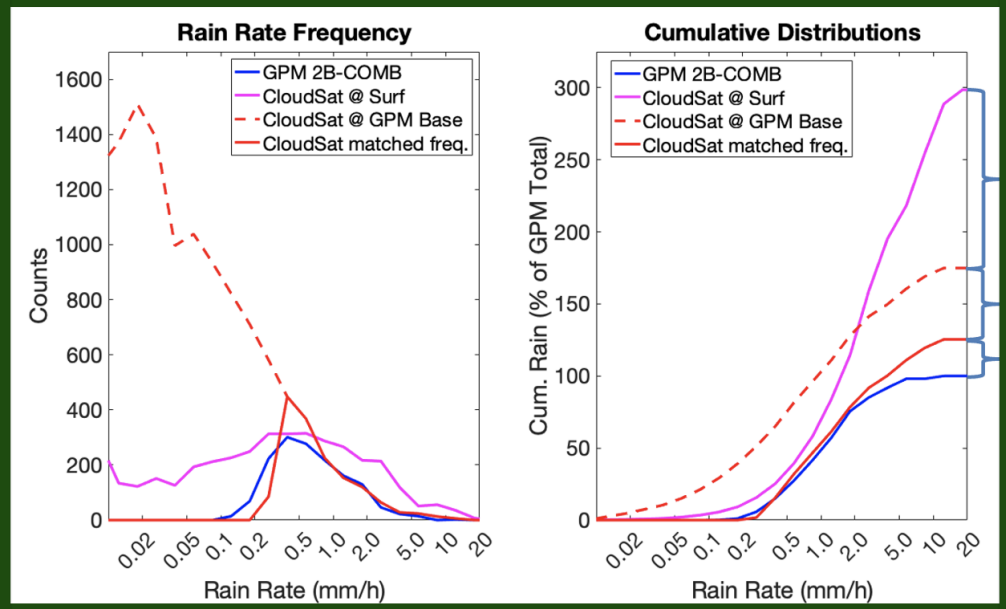


Figures courtesy of Chris Kidd NAA GSFC/UMD

IPWG-10: Science highlights (2/2)

Reconciling the difference between CloudSat and GPM estimates of warm rain

Rick Schulte and Chris Kummerow, *Colorado State University*



- We looked at all observations of warm rain from the CloudSat-GPM Coincidence Dataset (Turk et al. 2021)
- The gap between CloudSat and GPM estimates can be mostly explained by three factors: surface clutter, radar detection thresholds, and drop size distribution (DSD) assumptions
- Changing the DSD shape assumed in our own GPM retrieval algorithm increased the accumulated rain by 28%, nearly matching the gap from operational products after accounting for surface clutter heights and detection thresholds

Recommendations from IPWG10 (1/3)

Constellation

- **Sustain continuity** in missions that provide core, high-quality passive microwave (MW) observations across a wide range of frequencies (e.g. AMSR-2/3).
- Organization of these sensors into **complementary sun-synchronous orbits** across the diurnal period and mitigate observation-poor time periods.
- At least **one space-based precipitation radar** (e.g. GPM DPR) to provide a calibration source for the passive MW radiometers, and a climate data record for extreme events and precipitation types that are inherently difficult for passive MW sensors to detect.
- **Maintain continuity** of observations from deprecated, but still functioning sensors: The IPWG recognizes the value of these continued observations to augment the prime constellation at different times of day as their orbits drift.

=> Since ITWG and IPWG share many of the same sensors, suggest that the Co-Chairs and Rapporteurs coordinate CGMS observing system requirements to the extent possible

Recommendations from IPWG10 (2/3)

Validation

- Foster and encourage the use alternative datasets, such as commercial microwave links and expanding citizen science (CoCoRaHS, mPING)
- Develop **a common calibration for ground radar**, to encourage the use of high-quality radar data for validation
- Provide error statistics of measurements and estimates for individual radar sites
- Utilize a common radar sampling protocol
- Getting validation data from PIs: IPWG set the standards and if can process the data according to the standards, IPWG can connect to the funding agencies

Recommendations from IPWG10 (3/3)

Instrument Characteristics

- Encourage collaboration between IPWG / ICWG / ITWG to share information related to sensors used by all groups
- **Support for microwave channels at low frequencies** (10 GHz - 89 GHz) should continue, loss of these channels would lose information related to liquid phase precipitation
- **Hyperspectral microwave should be encouraged** to improve robustness of sensors with respect to RFI, improve vertical resolution for sounding regions, provide an option to create "virtual" tunable channels by using supersets of the hyperspectral channels
- Encourage high revisit times for submillimeter sensors / platforms to better sample the diurnal cycle, and / or highly variable processes, such as convection.

Reorganization of IPWG Working Groups

IPWG workshops have traditionally been broken into working group areas, which collectively contribute to the overall recommendations that are reported to CGMS, typically broad areas such as:

- Research
- Applications
- Data Assimilation
- Validation

In order to be more responsive to the discussions and sentiments expressed at IPWG-10, we have formed **four new Working Groups that have deliverables in one-year increments**.

Additionally, there are now **Focus Groups**, whose primary aim is to act as a forum for individual research questions that are meant to facilitate the transition from research to operations.

Reorganization of IPWG Working Groups

New Working Groups

WG 1: Baseline Surface Precipitation Network

Goal: Produce a document that outlines the steps needed to produce a Quantitative Precipitation Estimation (QPE) product of uniform quality from radars/gauge networks for use in satellite data validation.

WG 2: Satellite Precipitation

Goal: Produce a document that outlines (a) User needs from global product producers (b) Needs from global product producers from research community.

WG 3: Machine Learning

Goal: Produce a standard training and independent test data set for individuals to test Machine Learning algorithm capabilities in a consistent fashion.

WG 4: CubeSat/SmallSat WG

Goal: Produce a document outlining relative capabilities of various channel combinations/spatial resolutions for helping constellation requirements. Likely will use geostationary IR as a baseline for comparison.

New Focus Groups

FG 1: Orographic Precipitation

Longstanding issue, addressed in several algorithm products.

FG 2: Snowfall

Deficiencies in detecting and quantifying cold season precipitation.

FG 3: Particle Scattering

Needed for simulating passive/active MW sensors and use in DA forward operators

FG 4: Data Assimilation

Assimilation of rain-affected radiances, use of products for model validation. Latent Heating is being used in high resolution models

FG 5: Land Surface

Initially useful to properly simulate active/passive radiances but has clear feedback to cloud properties.

Thank you for your attention !

CGMS

IPWG International Precipitation Working Group