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Global Observation of Forest and Land Cover Dynamics

Land-Cover / Land-Use Change Program

"Rainfall Measurements from Space-based Platforms"

Mediterranean Regional Information Network (MedRIN), 20th March 2019

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NASA's Precipitation Remote Sensing Missions

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My presentation is about an aspect of NASA's space missions which are not given enough attention and usage. These missions are exclusive to measuring precipitation from space and in my opinion are very relevant to the MedRIN initiative.

The need for accurate rainfall distribution determination

The 21st century is rightfully called "the century of water." Water is an essential element of the Earth's environment and is indispensable for our life and economic activities. Many places in the world now face water problems, such as water shortages and floods, which can cause food shortages, epidemic diseases, and so on.

In addition to these problems, global warming and climate change affect the global water cycle and result in abnormal weather, such as frequent heavy rains and droughts. In order to solve these problems, we urgently need to accurately determine the rainfall distribution, which is the input to water resources, and to improve the techniques of predicting and preparing for abnormal weather.

Traditional Rainfall Measurements

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Traditionally, Rainfall is measured *in situ* (at the ground) with rainfall simple measuring instruments: the raingauges.

Raingauges are available in different shapes, materials and exposures.

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Rainfall as height of water collected at the Earth's surface

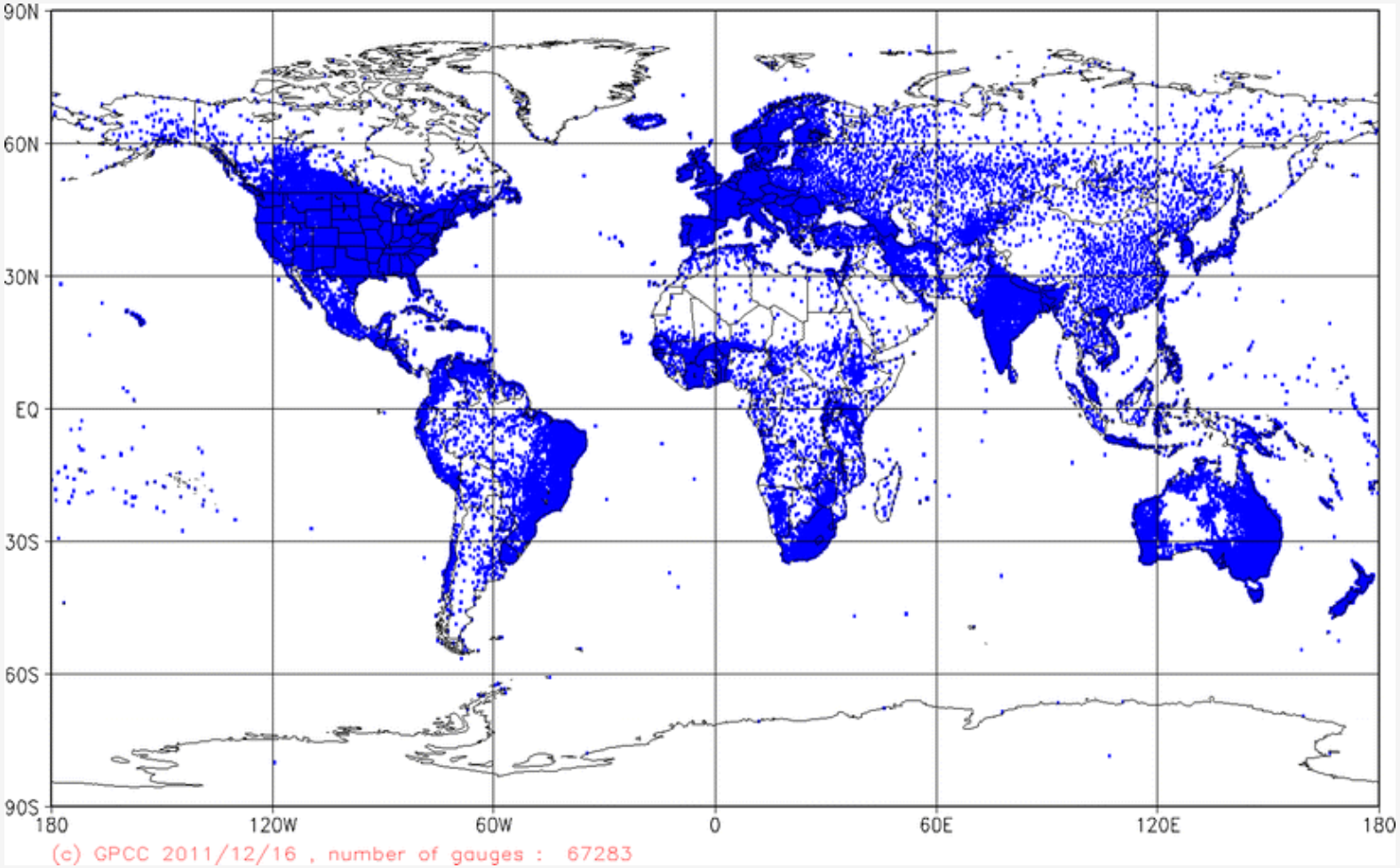
However, they all make use of the same principle: all raingauges collect rainfall falling on the surface of the Earth and measure the height of water collected (usually in mm).

Rainfall

Raingauge

Measuring height of water collected

World network of raingauges



Each of these *in situ* rainfall measurements are taken individual locations, with about 70000 such collecting and measuring points around the World.

Note that vast areas (oceans, deserts) are not covered at all.

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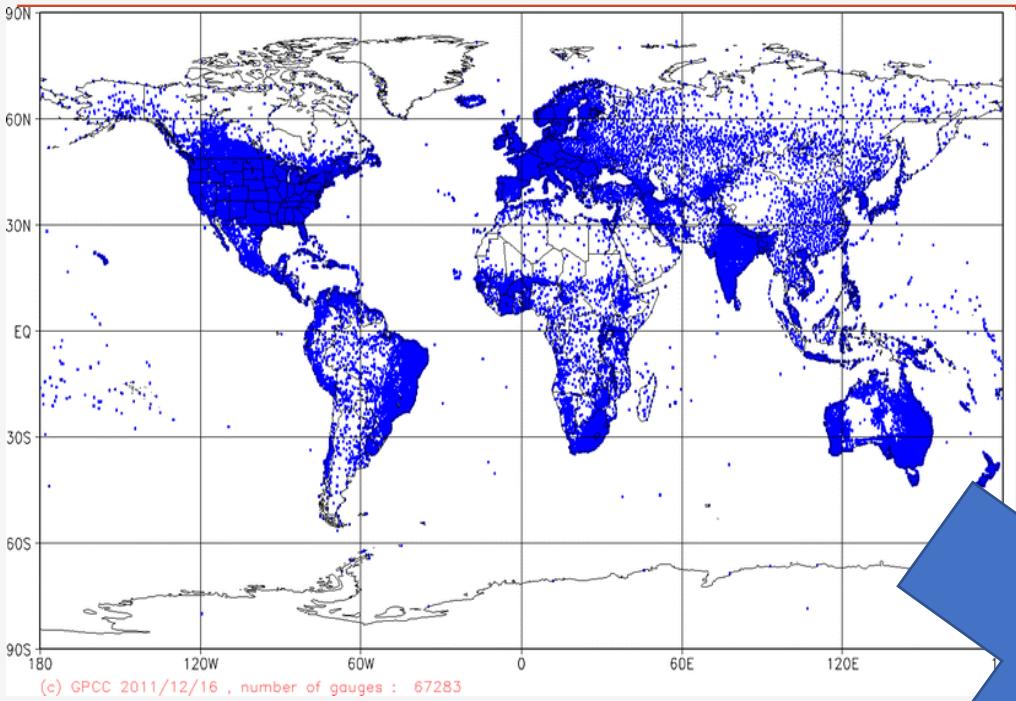
Emphasis on low coverage of the World's with raingauges



If you gather all of the World's currently in use rain gauges in one place, they would cover an area of only about the size of two basketball courts !!!

This is an unacceptably low coverage for the entire Earth's surface, if you wish to have a wide view of what is happening to all the water falling from the sky !!!

Satellite platforms for measuring precipitation

Since it is not possible to have a raingauge or sensor everywhere rain can fall, trying to collect global precipitation data from the ground is an impossible task.

We need to set the rainfall measuring platform much higher, ideally in space.

This is what the two precipitation measurement missions from space have in their focus.

These two satellite measuring missions are:

- **TRMM = Tropical Rainfall Measuring Mission**
- **GPM = Global Precipitation Measurement Mission**

TRMM (Tropical Rainfall Measuring Mission)

NASA worked together with JAXA with to measure tropical and subtropical rainfall through the Tropical Rainfall Measuring Mission (TRMM). GPM is designed to make more accurate and frequent observation of tropical rainfall by expanding its observing areas to higher latitudes.

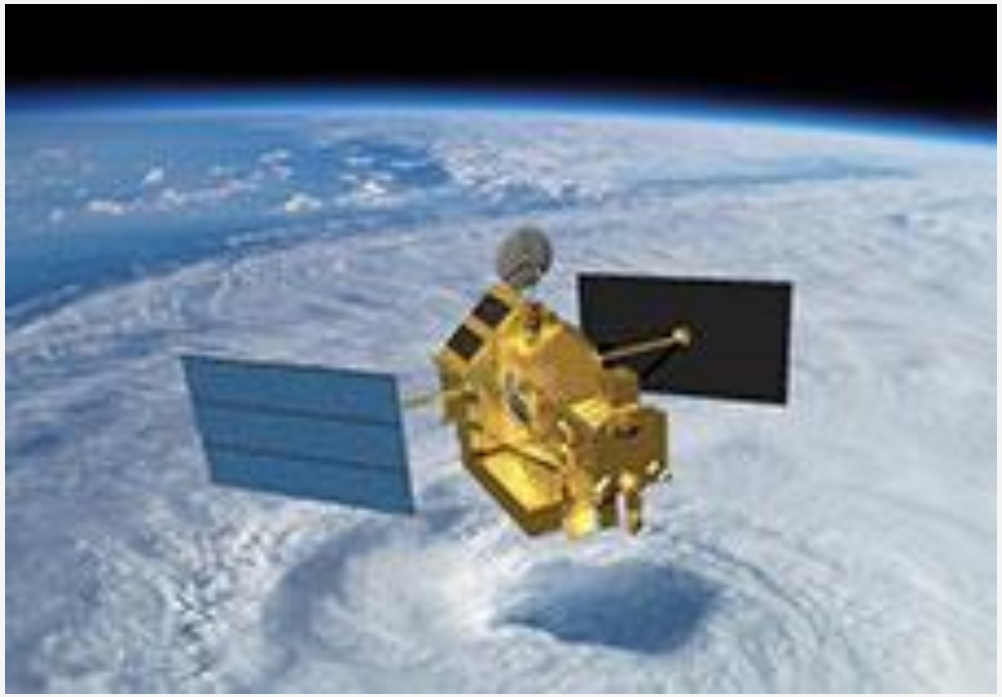
GPM (Global Precipitation Measurement Mission)

Heading 2

GPM is a unique and complex program. GPM is composed of one core satellite and approximately eight constellation satellites. The core satellite carries a dual-frequency precipitation radar (DPR) and a microwave radiometer, and the constellation satellites carry microwave radiometers. Led by JAXA and NASA, the GPM program will be conducted in cooperation with NOAA, CNES, ISRO, China, etc. JAXA is responsible for launch (TBD) and development of a key instrument, DPR, in cooperation with the National Institute of Information and Communications Technology (NICT). NASA will develop the core satellite bus and its microwave radiometer. Other partner countries and organization are responsible for the development of the constellation satellites. Multiple number of constellation satellites will enable global measurement of precipitation about every three hours.

TRMM = Tropical Rainfall Measuring Mission

A successful NASA – JAXA joint mission for measuring precipitation with the first space-borne precipitation radar, collected tropical and subtropical precipitation data from 1997 until 2015.



GPM = Global Precipitation Measurement Mission

GPM is a unique and complex program led by NASA and JAXA and operating since 2014. GPM is composed of one core satellite and approximately eight constellation satellites. The core satellite carries a dual-frequency precipitation radar (DPR) and a microwave radiometer, and the constellation satellites carry microwave radiometers

http://global.jaxa.jp/projects/sat/gpm/

GPM = Global Precipitation Measurement Mission

The GPM's core observatory was built and maintained by NASA and JAXA which initiated the project as a continuation of TRMM. In addition, the project embraces a consortium of international space agencies, including the Centre National d' Études Spatiales (CNES), the Indian Space Research Organization (ISRO), the National Oceanic and Atmospheric Administration (NOAA), the European Organization for the Exploitation of Meteorological Satellites (EUMETSAT) and others.

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GPM = Global Precipitation Measurement Mission

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The GPM constellation of satellites enables Global measurement of precipitation at a spatial and temporal resolution never achieved before.

For the past 5 years, GPM data has provided critical information to end-users to further our understanding of Earth's water cycle and to facilitate decision-making at local and global scales. Building on the legacy of TRMM, the use of high-quality precipitation data provided by GPM, with global coverage, has initiated new scientific research and data applications to benefit society across a diverse range of applications including:

- **water resource management,**
- **ecological management,**
- **operational numerical weather prediction,**
- **disease prediction,**
- **disaster modeling and response.**

GPM = Global Precipitation Measurement Mission

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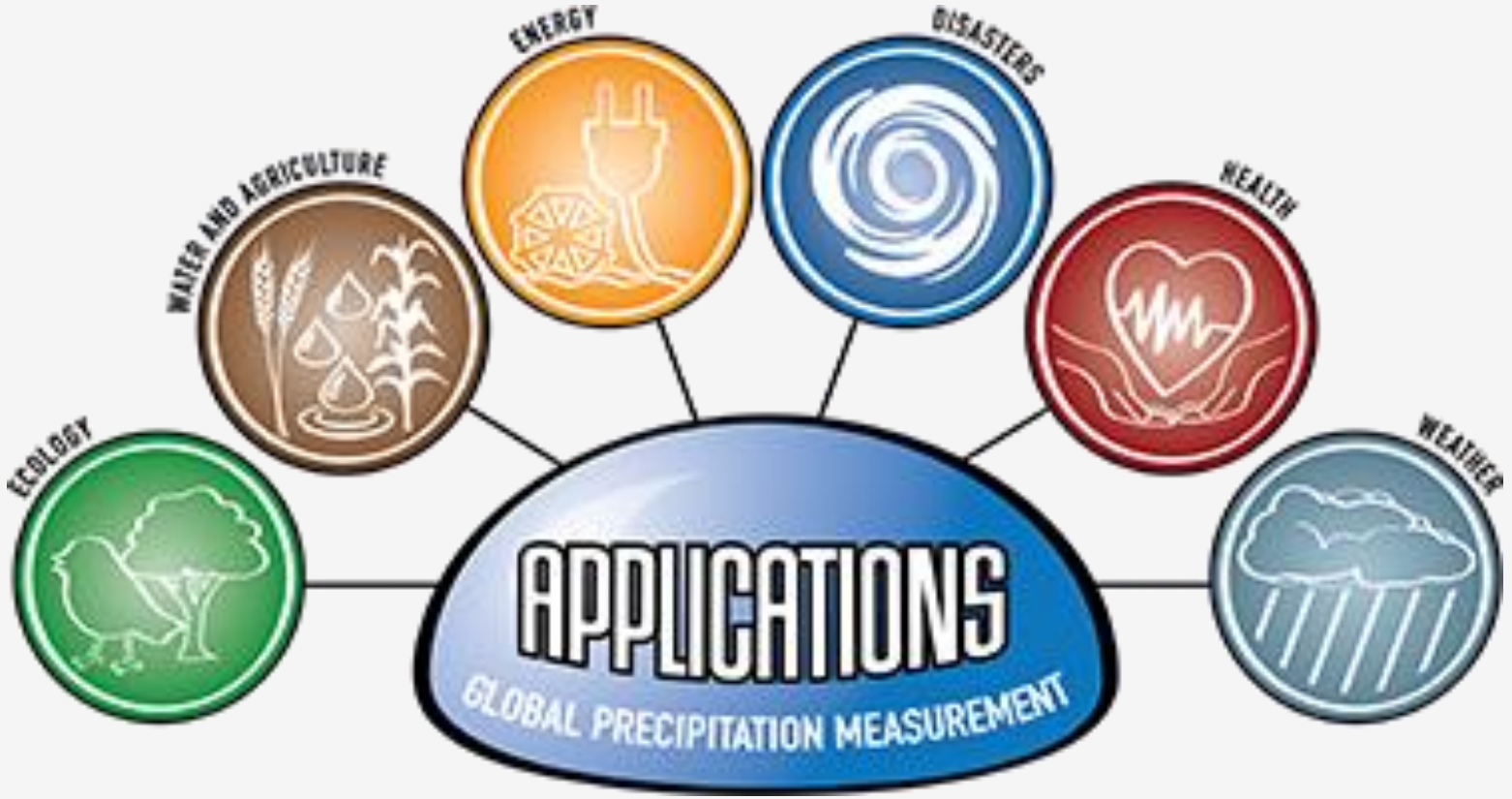
The main application areas of GPM are shown in the following diagram:



Many of these applications fit very well the priority topics, the objectives and scope of the MedRIN initiative.

Intercalibration of TRMM and GPM data

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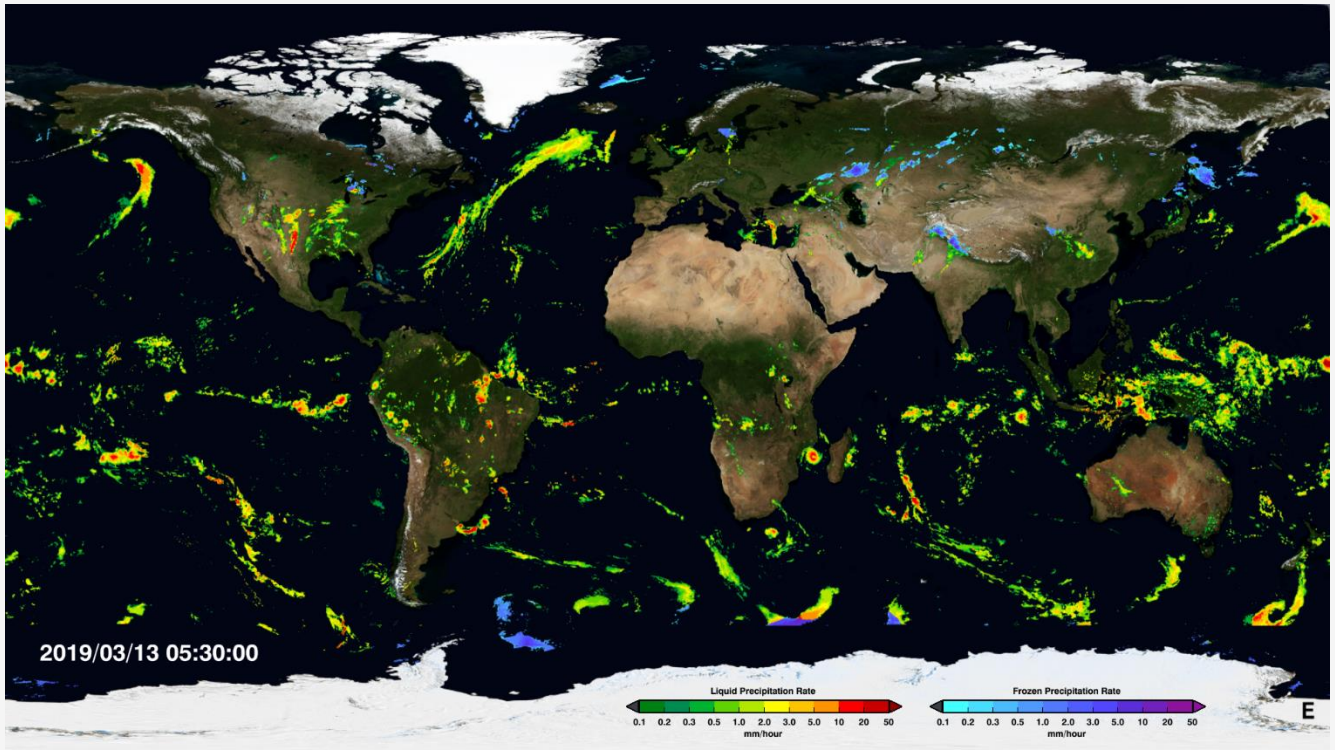
TRMM and GPM data are currently inter-calibrated to provide a combined long-term precipitation record into a single compatible data base. This is a continuous process with updated versions as more GPM data become available.

When completed, this satellite precipitation database unification from 1997 till to-day, will comprise a unique Global dataset with the highest spatial and temporal resolution, covering the needs of several applications which are under the focus of MedRIN.

This long-term precipitation records from both TRMM and GPM missions will comprise and an indispensable contribution to MedRIN.

In addition to this long-term data records, almost near-real time data from the GPM are also available to the community, fulfilling supplementing data needs for MedRIN activities.

Global distribution of rainfall every *half hour*



This image was generated from the Integrated Multi-satellitE Retrievals for GPM (IMERG) data.

This is the near-realtime "early run" product generated by NASA every *half hour* with a 6 hour latency. The time shown is the data acquisition end-time, rounded to the nearest minute.

Picture taken from: https://pmm.nasa.gov/gpm/imerg-global-image

Ground Validation of satellite measurements

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The other aspect of Satellite-based precipitation measurements that I will touch upon very briefly is the Ground Validation of the current GPM records.

Validation of the GPM data is an important aspect of the incorporation of such data into operationally useful applications, such as hydrology, Numerical Weather Prediction, water management etc.

Validation can be pursued with in-situ measurements, like raingauges but also with weather radars.

Ground Validation

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In support of GPM GV efforts, NASA has developed the GPM Ground Validation System GVS) Validation Network (VN). In the GPM era the VN will perform a direct match-up of GPM's space-based Dual-frequency Precipitation Radar (DPR) data with ground radar data from the U.S. network of NOAA Weather Surveillance Radar-1988 Doppler (WSR-88D, or NEXRAD.

Ground radar networks from international partners will also be part of the VN. The VN match-up will help evaluate the reflectance attenuation correction algorithms of the DPR and will identify biases between ground observations and satellite retrievals as they occur in different meteorological regimes.

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Space-based measurements versus in situ data

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Validation of satellite derived precipitation fields is pursued with in situ measurements using raingauge data, disdrometers and weather radars.

Spaced-based precipitation measurements

validation

In situ precipitation measurements

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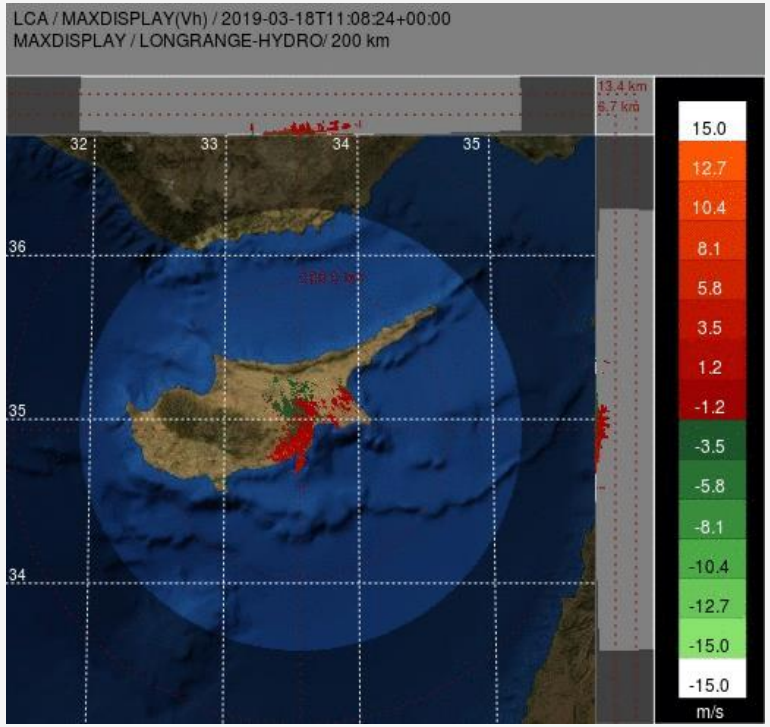

Cyprus has two X-band radars, a network of around 40 automatic raingauges, two Joss-Waldvogel disdrometers and one Parsivel disdrometer. Although these instruments are part of different institutions, we are currently trying to bring them under a single ground based validation site for Cyprus.

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Participation in Ground Validation efforts

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Conclusion

I trust that many countries in the Mediterranean area are in a similar or better position to contribute to the validation task of GPM derived precipitation fields.

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Thank you

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