GID, the federated network of disdrometers in Italy at the service of satellite validation plans: an application to GPM DPR products

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MOTIVATIONS

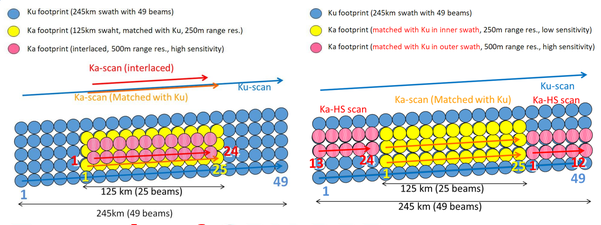
- Radar-based satellite data are subject to a variety of potential errors and need a continuous validation of satellite products to ensure data quality over time and to provide feedback for improving retrieval algorithms.
- EarthCARE will provide radar-based estimates rainfall rate and microphysical parameters.
- The federated disdrometer network GID have been used for the validation of the precipitation products of the Dual-frequency Precipitation Radar (DPR) on bord on the Global Precipitation Measurement (GPM) core satellite and has potential to contribute to EarthCARE validation effort.

OBJECTIVES

Showcasing the role of GID in satellite precipitation products through:

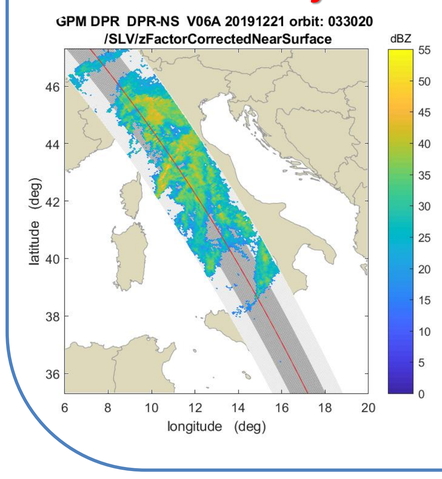
- Validation of GPM-DPR V06 precipitation products through eight laser disdrometers of the GID (Italian Group of Disdrometry) network in Italy.
- Preliminary analysis of the new version of the GPM-DPR algorithm (i.e. V07) released on December 2021.

SATELLITE DATA: GPM-DPR



Scan pattern of DPR before 21 May 2018 (left) and after 21 May 2018 (right).

Example of GPM DPR Reflectivity



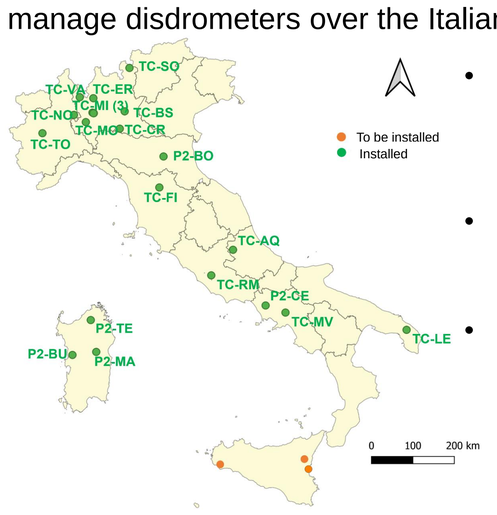
GPM DPR Products: precipitation Level 2 (L2) products (version 6A), either dual-frequency and single frequency.

Variables: *precipRateNearSurface (R), zFactorCorrectedNearSurface (Z), paramDSD (N_w e D_m)*. All the variables are referred at the first reliable (i.e. clutter free) bin near the ground that in our analysis ranges between 0.60 km and 1.48 km.

GROUND BASED DATA: GID network

GID network (https://www.gid-net.it/)

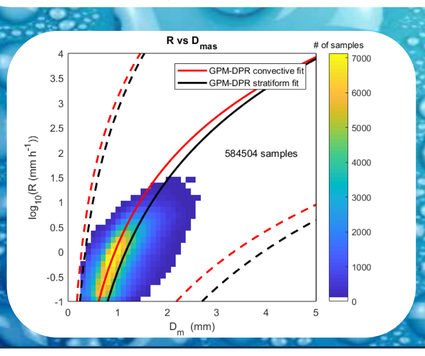
GID was set up in 2021 thanks to a spontaneous collaboration of different Italian institutions that manage disdrometers over the Italian peninsula.



- 18 laser disdrometers of Thies Clima and OTT.
- Common processing of the raw data.
- The longest disdrometer time series starts from 2012.

GID DSDs until December 2021 are available on Zenodo (10.5281/zenodo.7708563). An update will be provided soon.

- 8 devices of the GID network have been used for this analysis (in total more than 580.000 1-min. samples are available from Feb. 2014 to Sep. 2020).
- From 1-min DSDs obtained with the GID processing the precipitation and DSD parameters have been obtained.
- Only for two sites the disdrometer measurements are available from February 2014 (i.e. launch of the GPM core satellite).



2D scatterplot of disdrometer based R vs D_m.

GPM AND DISDROMETER COMPARISON STRATEGIES

1. Selection of the GPM pixels

Point

- Selection of the 5 × 5 km² DPR pixel at ground that contains the location of the disdrometer.
- The disdrometer measurement is taken as representative of the areal estimate.

Mean

- DPR pixels whose centers are within 5 km from the disdrometers are averaged.
- The possible mismatch between DPR pixel aloft and disdrometer at ground due to advection is limited.

Optimal

- Among the DPR pixels in a 3 × 3 box around the disdrometer, the one whose reflectivity value is closest to that estimated by the disdrometer is selected.
- This should provide the best match.

2. Selection of the matched minutes

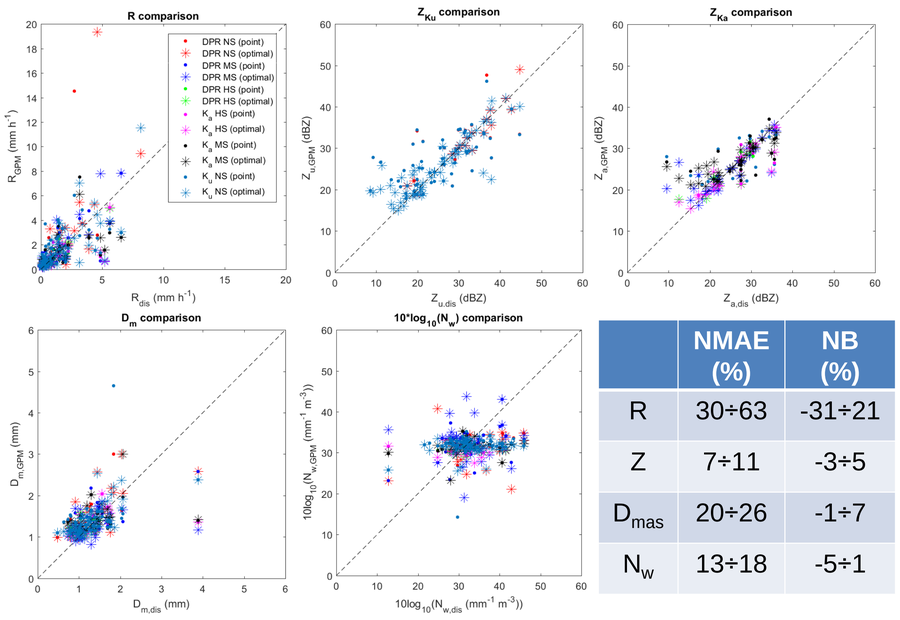
Disdrometer data

For each GPM overpass in rainy conditions (at least one pixel with R > 0.1 mm h^{-1}), the disdrometer data within $\pm\Delta t$ minutes with respect to the GPM overpass time were selected and averaged. Δt was set equal to 5 minutes.

GPM Product	# minutes (point)	# minutes (mean)	# minutes (optimal)
DPR NS	54	61	68
DPR MS	29	31	36
DPR HS	11	17	19
Ka HS	11	17	20
Ka MS	22	28	33
Ku NS	53	61	68

RESULTS FOR V06

Scatterplot of R, Z_{ka}, Z_{ku}, D_{mas} e N_w from disdrometer data (x-axis) and GPM products (y-axis)

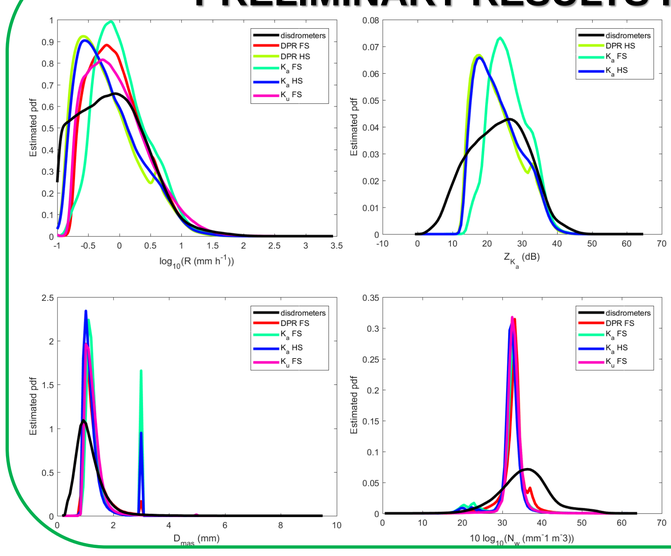


	NMAE (%)	NB (%)
R	30÷63	-31÷21
Z	7÷11	-3÷5
D_{mas}	20÷26	-1÷7
N_w	13÷18	-5÷1

- The agreement depends on the considered precipitation variable.
  - GPM R, Z and D_{mas} values are good
  - satellite estimates of N_w need to be improved
- The optimal comparison mode provides, in most of the cases, better results with respect to the point and mean comparison mode.
- The comparison shows limited differences in the performances of the different GPM products, although in most cases, the dual-frequency algorithms present the better performances.

Mostly light-to-moderate precipitation intensities were available for the comparison, however, with higher rain rates, the performance of Ka products would be affected by attenuation effects. Therefore, further analysis are needed.

PRELIMINARY RESULTS FOR V07



The agreement for all the variables is good. Main issues are:

- An upper limit at 3 mm is present for D_{mas}
- N_w still needs some improvements.

FUTURE WORK

We planned to perform a validation of the GPM-DPR V07 precipitation products over Italy considering all the disdrometers of the GID network including a higher number of ground-based devices over a long period, therefore it also increase the opportunities to sample intense precipitation. Opportunities to validate EarthCARE precipitation products will be explored as well.

Reference

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Adirosi, E., et al.: Database of the Italian disdrometer network, Earth Syst. Sci. Data, 2023, 15, 2417–2429, DOI: https://doi.org/10.5194/essd-15-2417-2023

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