Evaluation of Germany's network radar composite rain producs with GPM near surface precipitation estimations

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Abstract

The Global Precipitation Measurement core satellite (GPM) has been collecting high quality precipitation data since 2014 over the globe with its Dual-frequency Precipitation Radar (DPR; Ku-band and Ka-band). Specificly over Germany, GPM provides data with typically two daily overpasses. Thus providing a unique opportunity to have a satellite based standard for estimation of precipitation in order to compare and evaluate ground-based radar network counterpart products. The German national weather service (DWD, Deutscher Wetterdienst) provides precipitation observations from its operational radar network RADOLAN as a composite products derived from 17 dual-pol C-band radars. The RADOLAN (RY) regular products are Germany-wide composites of precipitation estimates based on a set of precipitation type dependent Z-R relationships derived for liquid hydrometeors applied to radar reflectivity after clutter- and beam blockage-corrections. In this contribution we focus to compare three years of GPM DPR and RADOLAN precipitation products. This allows us to evaluate at which extend these two Near Surface products are consistent when observed from different geometries and obtained by independent instruements and retrieval methods. We quantify the uncertainties when directly comparing the DPR near surface product with RY. It is shown that a direct comparisons might not take into account a set of uncertainties originated from the scans geometry from DPR and RADOLAN, precipitation types, and sampling volumes. Therefore we suggest an adjusted DPR product, which is extracted from the DPR vertical profiles and adapted to fit the specific RY measurement configuration e.g. scans height and beam width. This allows a much more detailed classification of the hydrometoer phases per measuring volume, which we define as non-uniform phase beam filling (NPBF). The NPBF gives information about the ratio of liquid, solid or mixed hydrometeors in a given volume. Orographic, synoptic, microphysical influences as well as NPBF effects are examined and their uncertainties introduced on a direct comparison of satellite with ground-based producs are put into consideration. The adaptation of the DPR precipitation products to the specific scan geometry of the individual ground radars improves the correlation and reduce the RMSE.

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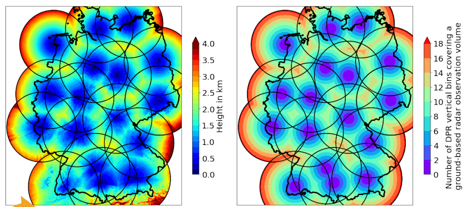
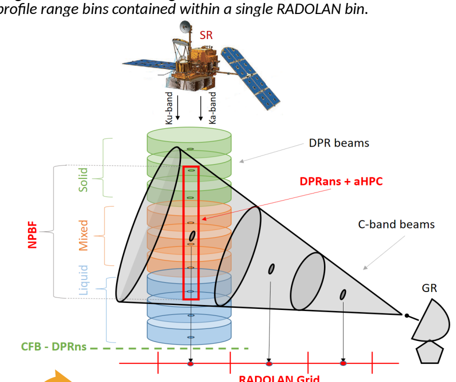
1. Introduction and motivation

*We compare the latest version (V05) of the DPR precipitation estimates with three years of surface precipitation product RADOLAN from the German national weather service (DWD, Deutscher Wetterdienst). Directly comparison of DPR near surface (**DPRns**) with RADOLAN composite product **RY** leads to inaccuracies due to the unmatched sampling volumes by both sensors. Thus the DPRns and RY suffer of miss-classification of hydrometeor phases and distinct rain rates. In order to mitigate those uncertainties we propose an alternative DPR product adjusted to RADOLAN scan pattern (**DPRans**). This is extracted from the DPR vertical profiles and fitted to the scans height and sampled volume of the ground radar. This method allows a precise classification of the hydrometeor phases within the **RY** measured volume taking into account the uneven distribution of liquid, solid or mixed phase within a sampled volume.*

2. Local ground observation network

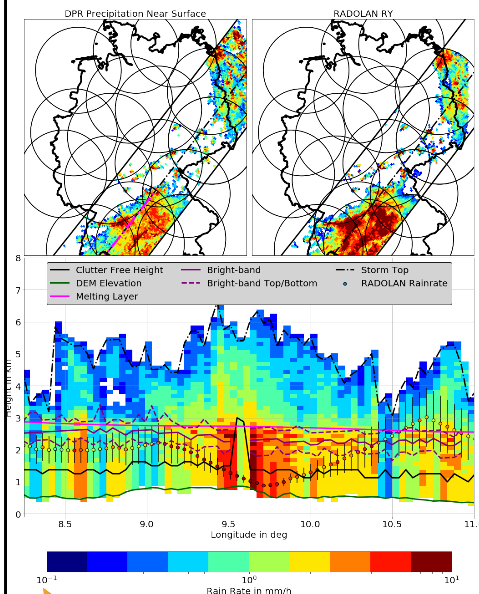


Radar network of DWD. Black circles are the maximum radar ranges. The heights of radar bin above ground in km (left). The number of GPM-DPR profile range bins contained within a single RADOLAN bin.

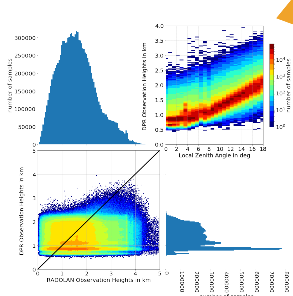


Schematic of a scan scenario by the ground radar and a DPR profile. Note the further the radar bin the more profiles DPR bins are covered by the ground radar.

3. Example of GPM DPR Overpass



GPM overpass on 2014.08.31 at 12:54 UTC. **DPRns** (top left) and **RY** (top right) rain rates. The magenta line indicates the position of the height-longitude cut through the GPM 3D precipitation field (bottom). In the longitudinal cut the clutter-free height (**DPRns** height) is shown as a black line. The circles are **RY** observations heights from corresponding scan. Circle's color indicates **RY** rain rate. The vertical bars represent the extend of **RY** beam widths at that point.

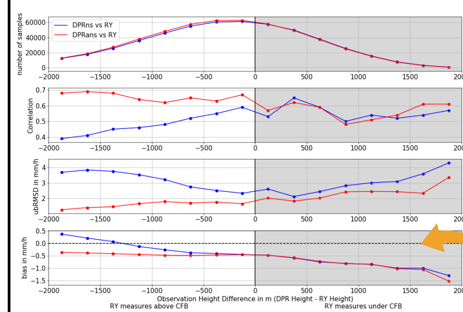


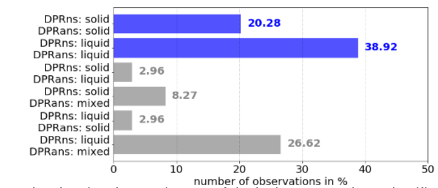
*Distribution of the heights of the **DPRns** versus the local zenith angle.*

*Distribution of 3 years **RY** versus **DPRns** observation heights.*

Here it is clear a direct comparison implies observation volume mismatch.

4. Improvement by adjusting DPR observations

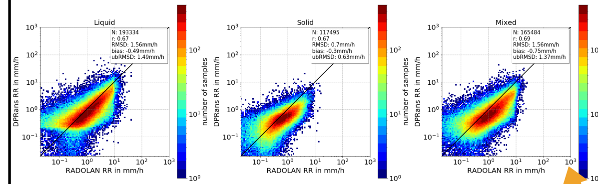




Bar plot showing the consistency of the hydrometeor phase classification for **DPRns** and **DPRans** (both phase classification match in blue and mismatch in grey).

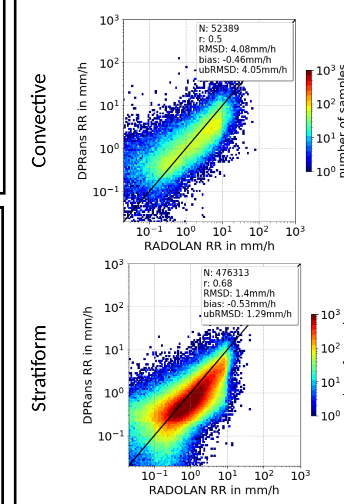
Number of samples (top), Correlation (second), unbiased RMSD (third) and bias (bottom) of **RY** versus **DPRns** (blue) and **DPRans** (red) as a function of the difference in observation height.

5. Impact of hydrometeor phase



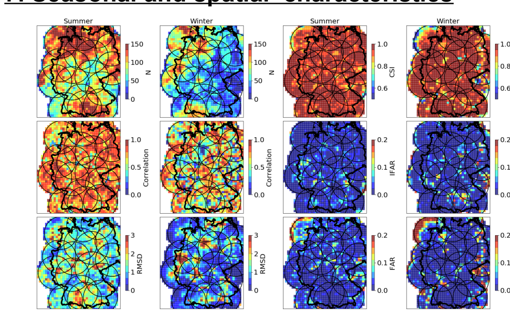
Rain rates RADOLAN **RY** versus **DPRans** by hydrometeor phase into liquid phase, solid phase, and mixed phase.

6. Impact of precipitation type



*Precipitation rates for the upscaled **RY** product and the **DPRans** products for convective (top) and stratiform cases (bottom).*
Rain/No-rain threshold: 0,02 mm/h.

7. Seasonal and spatial characteristics



Number of observations, correlation and RMSD of **DPRans** and **RY** for summer (first column) and for winter (second column). Seasonal CSI, FAR and IFAR of **DPRans** and **RY** for summer (third column) and winter (fourth columns). All observations are binned on a 20 km x 20 km grid. Rain/no-rain threshold=0.02mm/h

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