Objective: Validate GPM estimates of Snow Water Equivalent Rate (SWER).

Approach(es):


2. Marquette (MQT) Reference Pluvio Network (RPN) and NWS measurement site. Ten GPM-GV Pluvio weighting gauges (single Alter) in 120 km footprint within 20 km of WSR-88D (KMQT) radar. Remote Rain Radar (2MR) and Precipitation Imaging Package (PIP) installed at the NWS Forecast Office MQT. The RPN provides SWER reference, and PIP provides physics, KMQT provides "regional scale" distributed pixel measurements of SWER for comparison to GPM swath data.

3. Probabilistic POPE (POPE) approach (Kirstetter et al., 2015, Water Resources Research). Capture range of Z-S behavior that minimizes bias while providing an estimate of error. Compare POPE range of Z-S (e.g., 25th, Expected Value, 50th, 75th, percentiles) against those diagnosed in other regimes.

   - Left: POPE Z vs. SWER relationships (inset) for the Expected (S-v), red, bold), 25th, and 75th percentile (bold black) plotted against CARE, Hyttiala, and WFO-MQT local KMQT Z-S relationships.
   - Note all Z-S fit broadly within POPE envelope.
   - KMQT WFO relationship most similar to POPE 25th% behavior.
   - When used with KMQT radar and verified against the MQT RPNI how well do the Z-S relationships perform?


Results:

1. Example GPM SWER Comparisons over Hyttiala Finland

   (GMI-GPROF (VS) SWER (y-axis) vs. IKA Radar SWER (x-axis) Winter 2014/15, 17/18.

   - As in figure for GMI-GPROF but DPR MS product (left) and DPR NS product (right) - DPR Ku similar

2. Marquette

   - RPN against manual SWE measurement at NWS Marquette site

   - Swer "reference" at NWS Site, single Alter shield, compares reasonably well with observer SWE (manual core)

   - KMQT radar comparisons against RPN very noisy.

   - Best bias is for local Z-S (SMQT) and POPE 25th% Z-S

3. VN and GPM

   - The POPE 25th% and KMQT Z-S relationships are the "best" for the MQT network (from a purely bias perspective).

   - How well do DPR-estimated SWERs compare to these estimates in the KMQT radar domain and subsequently over the Continental U.S. (CONUS) when using WSR-88 radars in the VN architecture?

   - DPR matched swath (MS) product: only slightly lower than "best" relationships (POPE 25% and KMQT Z-S) in the KMQT radar domain. [Combined algorithm, similar, not shown].

   - DPR Markedly lower for POPE SEV and dual-pol KMQT (as expected based on RPNI comparisons).

Summary:

- We have developed an ensemble of tools/approaches designed to provide physically-tuned/consistent and/or statistically optimal radar-based SWER estimates to validate instantaneous GPM estimates of SWER from the pixel to swath scale.

- Comparison of the GPM products to reference radar-based SWER estimates over Finland and the U.S. suggest that GPM GMI-GPROF and DPR SWER estimates may be biased low.

- Ongoing and future analysis work will include expansion of the case database in Finland and Canada, continued evaluation of snow physical properties defining regime Z-S behavior, examination of footprint to sub-footprint scale SWER variability.

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Translating the Physics of Snowfall to Radar-Based Validation of GPM
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