Deriving a NMQ Snow Quality Index: Attempts to establish consistent and robust snowfall references for benchmarking spaceborne snowfall products

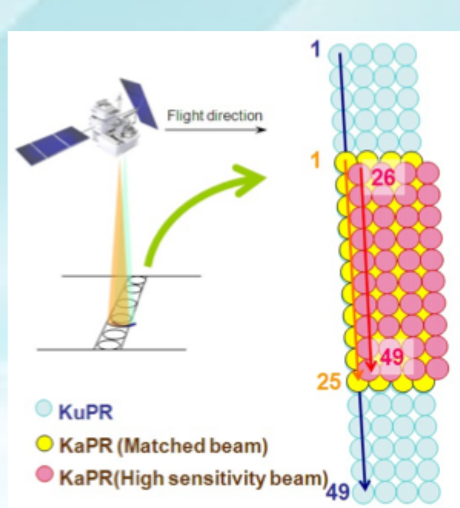
Berry Y. Wen[1,2,3], Y. Hong[1,2,*], P.E. Kirstetter[2,3,4], J.J. Gourley[4], J. Zhang[4], and G. Zhang[1,2,3]

(1) School of Meteorology, University of Oklahoma, Norman, OK, USA
(2) HyDro-meteor-climatology and RemOte Sensing (HyDROS) Laboratory (http://hydro.ou.edu), University of Oklahoma, Norman, OK, USA
(3)Advanced Radar Research Center (http://arrc.ou.edu), University of Oklahoma, Norman, OK, USA
(4) NOAA/National Severe Storms Laboratory (http://www.nssl.noaa.gov), Norman, OK, USA

* Contact: YangHong@ou.edu

1. INTRODUCTION

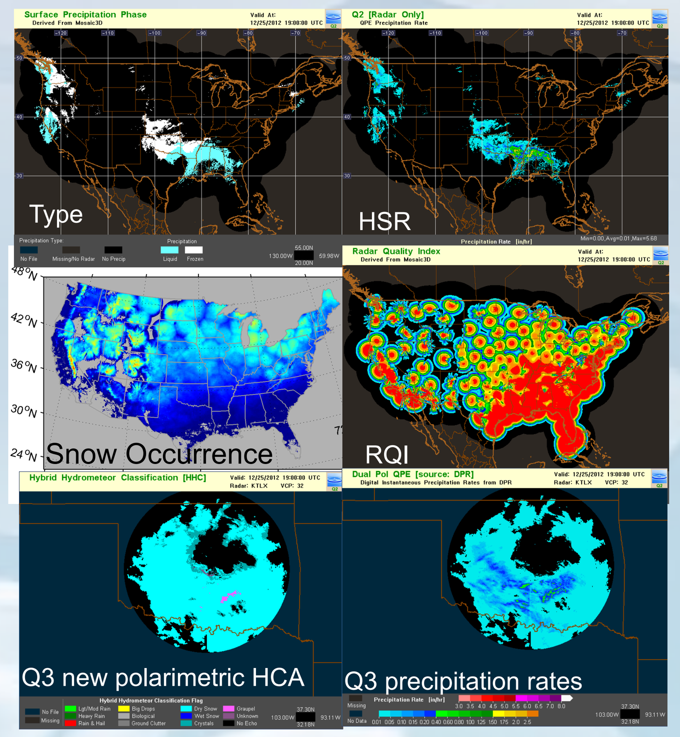
- Snow, as a primary contribution to regional or even global water budgets is of critical importance to our society. Snow can also cause potentially hazardous weather, and rapidly-melting snowpack may cause flooding (Skofronick-Jackson et al, 2012). For large-scale weather monitoring and global climate studies, satellite-based snowfall observations have become highly desirable. Accordingly, the Global Precipitation Measurement Mission (GPM) with its core satellite scheduled for launch in 2014 will carry active and passive microwave instrumentation anticipated detecting and estimating snowfall or snowpack. However, verification and refinement of these retrievals requires ground-validation datasets. Routine observations of snowfall have so far mostly been restricted to limited ground-based stations, with spotty spatial distribution and inconsistent duration of data record (Walsh, 1996; Liu and Seo, 2012). Currently the NOAA/NSSL and University of Oklahoma (OU) National Mosaic and Multi-sensor QPE (Zhang et al. 2011) is already an independent reference for GPM **rainfall** products (e.g. Kirstetter et al. 2012; Munchak and Skofronick-Jackson, 2013). Since July 2013 the NMQ system has been upgraded to the Multi-Radar/Multi-Sensor system (MRMS), which accommodates the recent dual-polarization upgrade of NEXRAD radars. By extending the value of NMQ products to the snow community, an opportunity exists to evaluate GPM **snowfall** retrievals over various land surface and meteorological conditions.
- The overarching goal of this general exam project is to derive a NMQ Snowfall Quality Index, which represent the quality of NMQ snowfall products. Thus, a consistent and quality controlled reference snowfall database over North America can be used to evaluate GPM core and constellations' global snowfall products in the future.



2. DATA DESCRIPTION

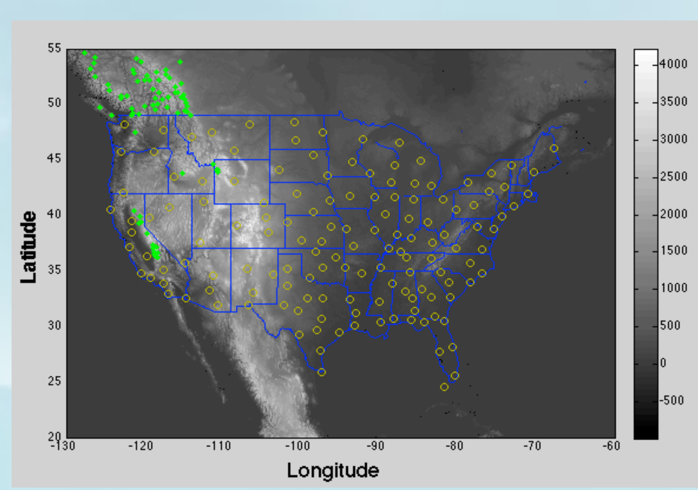
A. NMQ Snowfall Products:

NMQ (National Mosaic & Multi-sensor QPE) system (Multi-Radar/Multi-Sensor system since July, 2013)



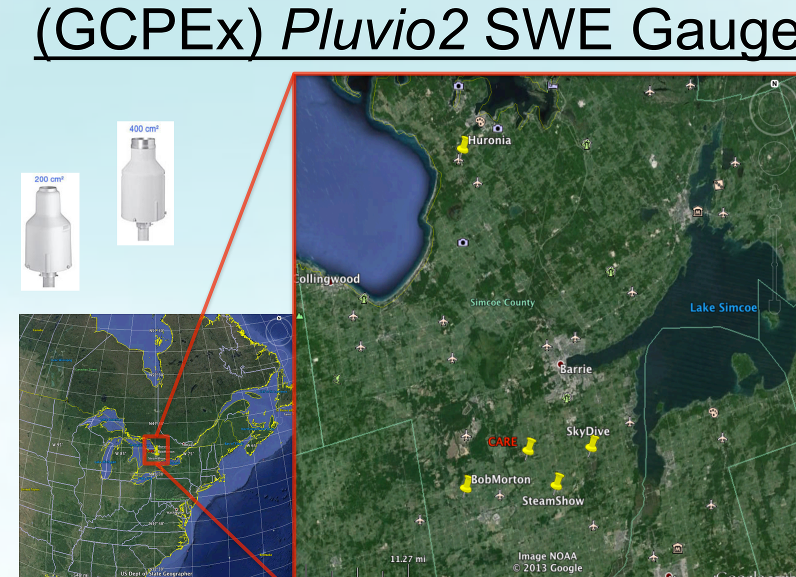
- Operational system by NOAA/NSSL
- 3D radar mosaic
- Precipitation classification (Snow defined as surface temperature < 2 °C, wet bulb temperature < 0 °C).
- 3D radar reflectivity mosaic
- High resolution (1x1 km, 5min)
- $Z=75R^2$
- Minimum reflectivity threshold is set as 5 dBZ.

B. Hydrometeorological Automated Data System (HADS) Hourly Precipitation Data



Locations of HADS gauges that transmit SWE information (green points), with terrain elevation (m) as background. The yellow circles indicate NEXRAD radar locations. 31 Canadian C-band radars are not included in this figure, but mosaicked by NMQ system.

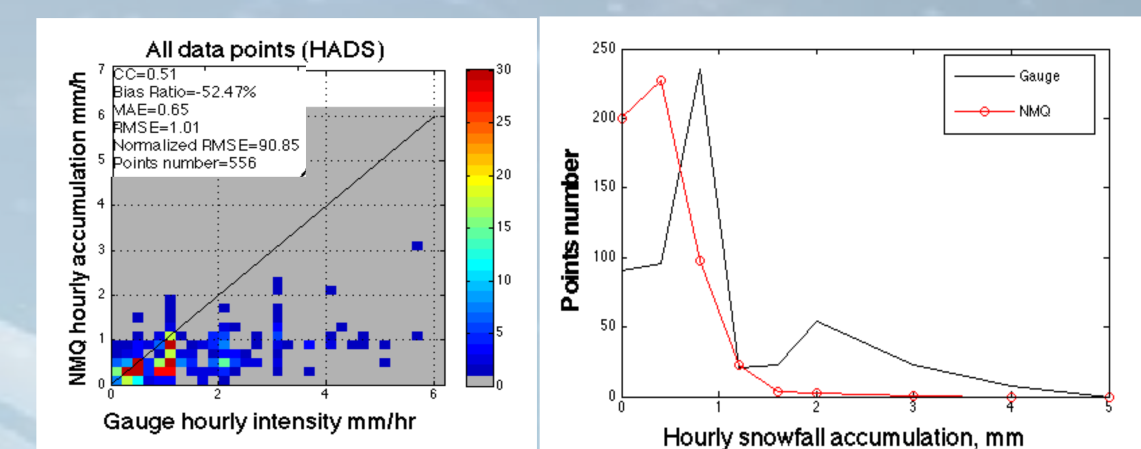
C. GPM Cold-season Pricipitation Experiment (GCPEx) *Pluvio2* SWE Gauge Data



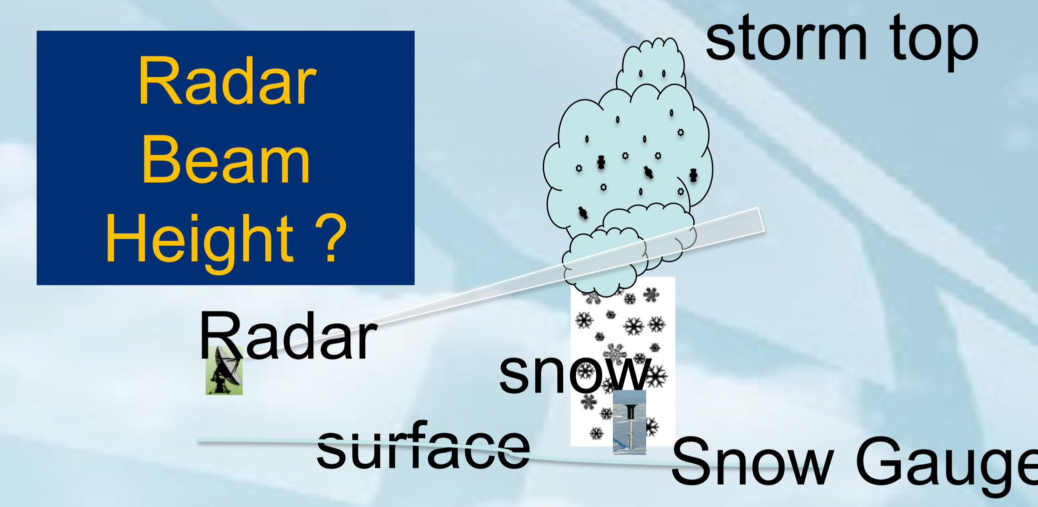
The location of ground sites. The main ground site was the EC Centre for Atmospheric research Experiments (CARE)

3. METHODOLOGY

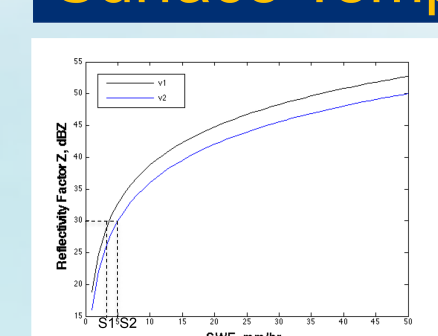
A. Comparing NMQ snowfall accumulation with HADS SWE measurements



Left: The color-density scatterplot of SWE hourly accumulation of HADS SWE gauges and NMQ. The correlation coefficient, bias ratio, MAE, RMSE, Normalized RMSE (in %), and sample size are shown in the embedded text. Right: Histograms of HADS and NMQ hourly SWE for data shown in Fig. 3a.



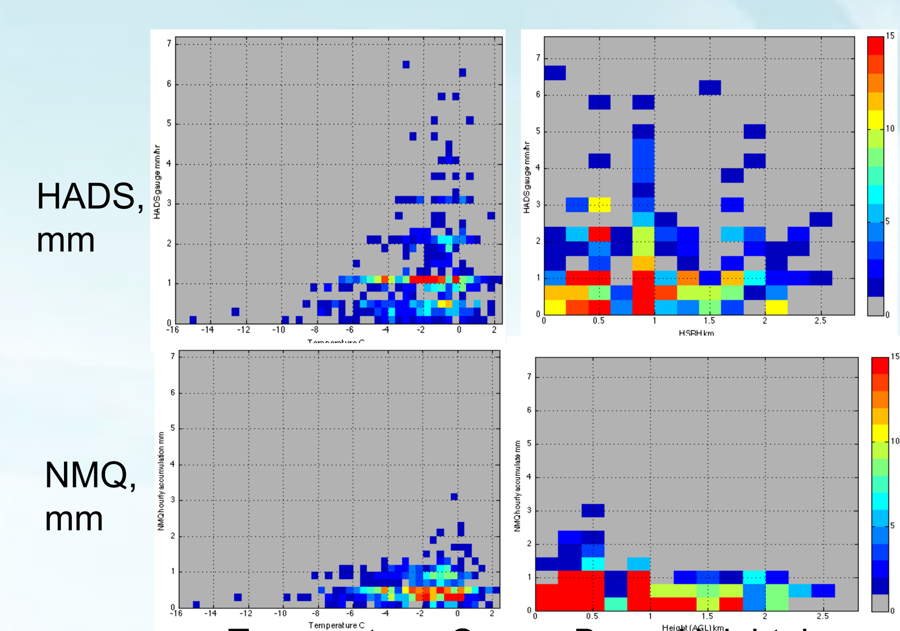
Surface Temperature?

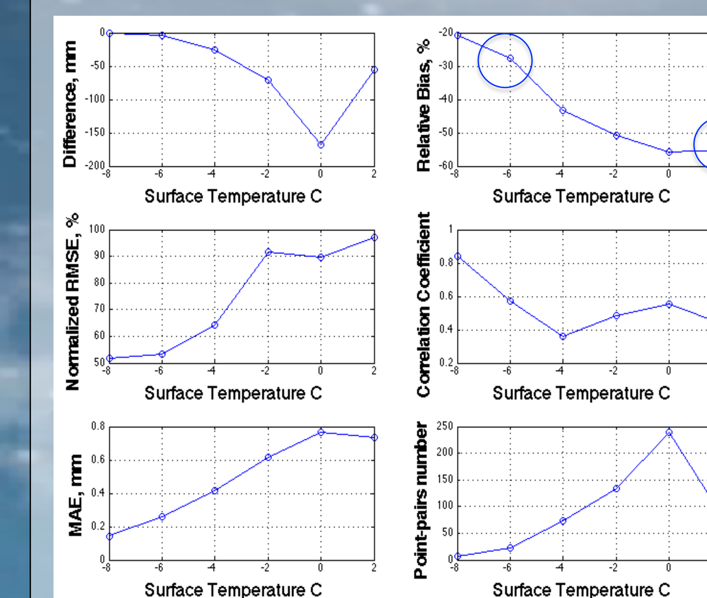


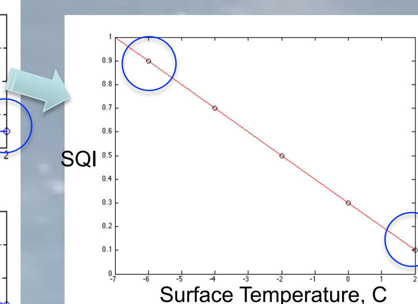
$Z = a S^b$

$\rho_s \uparrow \longrightarrow V(D) \uparrow \longrightarrow a \downarrow$

Increasing (decreasing) v values by 30%, does not significantly change the coefficient b, but it would cause about a 40% decrease (increase) of the coefficient a. (Matrosov et al. (2009))



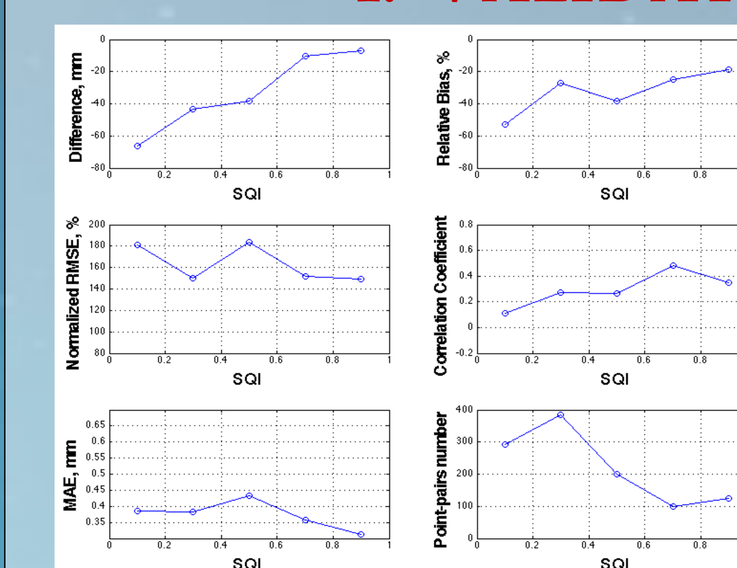




Deriving SQI :
$SQI = -0.1\,T + 0.3$

Validation indices change vs. surface temperature.

4. VALIDATION



Validation indices change vs SQI value. GCPEx gauges are used.

5. CONCLUSIONS AND FUTURE WORK

- In this study, an early stage NMQ Snow Quality Index, or SQI was developed as a function of surface temperature.
- SQI value ranges from 0.1 to 0.9, with higher values representing relative higher qualities of the NMQ snow data.
- A national SQI map can be also derived using the SQI algorithm.
- By choosing SQI greater than a higher value, a quality-controlled robust snowfall dataset can be established, which will act as a bridge for error characterization for satellite snowfall observations.
- In the GPM era, such a consistent and robust ground snowfall database over North America at high spatial and temporal resolution is invaluable for evaluation of GPM core and constellations' snowfall products.
- The wind effects and radar beam blockage issues on snowfall measurements are going to be investigated in the future.

5. REFERENCES

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