A comparison of precipitation occurrence from NCEP's StageIV and CloudSat's Cloud Profiling Radar

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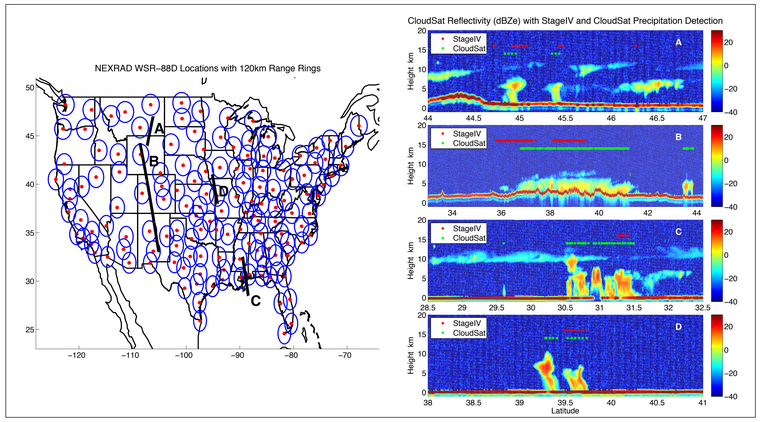
Motivation

- The NCEP StageIV (Lin and Mitchell, 2005) is an hourly precipitation accumulation product assembled from WSR-88D and surface gauge measurements across the CONUS. StageIV is a 4.7km gridded mosaic of the Multi-sensor Precipitation Estimator (MPE) produced at each of the twelve NWS River Forecast Centers (RFC).
- Due to its fine resolution, full-CONUS coverage, and manual quality control, it is often considered to be the best long term gridded precipitation observational dataset available.
- Radar beam blockage and elevation, gauge interpolation, and WSR-88D minimum detectable signal inhibit detection of light or frozen precipitation.
- Four years of highly sensitive CloudSat (Haynes et al, 2009) and StageIV observations are collocated for one-to-one comparisons of precipitation detection.

Besides signal sensitivity, detection differences can also result from…

- Interpolation far from the nearest radar (A)
- Beam blockage by terrain (B)
- Unknown or other reasons (C)
- Snow or light precipitation (D)



Some detection differences are expected to be due to unavoidable collocation offsets, alone, but these should be similar for CloudSat and StageIV (A?)

Accessing the Data

The CloudSat precipitation products used in this study are currently available through the CloudSat Data Processing Center at www.cloudsat.cira.colostate.edu.

Acknowledgements

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Data and Results

StageIV

- Hourly precipitation accumulations on a 4.7km grid
- Inputs: NWS Precipitation Processing System & surface gauges
- Manual quality control at each River Forecast Center
- "Gold Standard" of gridded precipitation observations
- Eta/EDAS & ECMWF precipitation assimilation

Weaknesses

- Interpolation of radar & gauge observations in the west
- Minimum detectable signal & lack of coverage at low levels

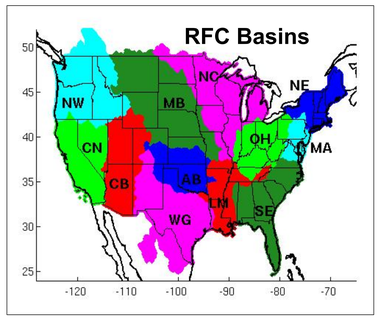
CloudSat Cloud Profiling Radar

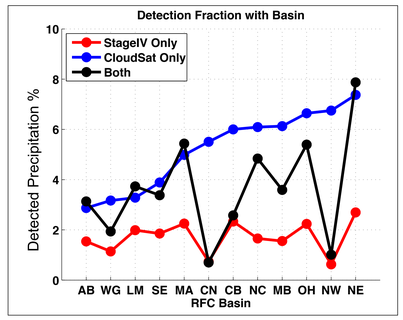
- 94GHz single track polar orbiting radar
- Sensitive to -30dBz reflectivities
- Detection based on attenuation threshold
- 1.7x1.4km footprint, 500m vertical resolution

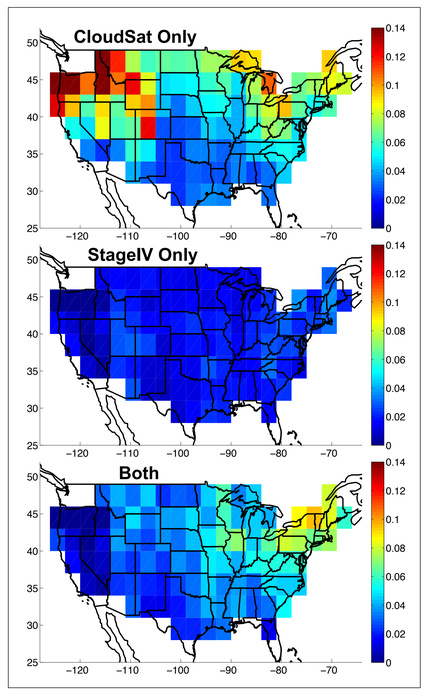
Data

- CloudSat 2C-Precip-Column *Precip_flag*
- NCEP StageIV precipitation accumulations
- 48 months 2007-2010
- 3,147,175 total comparisons

Detection comparisons for where StageIV does but CloudSat does not (StageIV Only), CloudSat does but StageIV does not (CloudSat Only), and both retrievals do observe precipitation (Both).





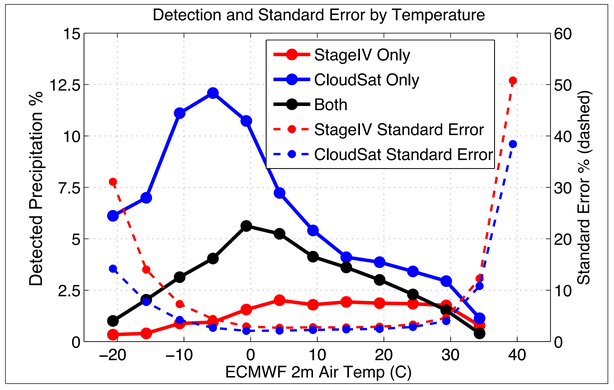


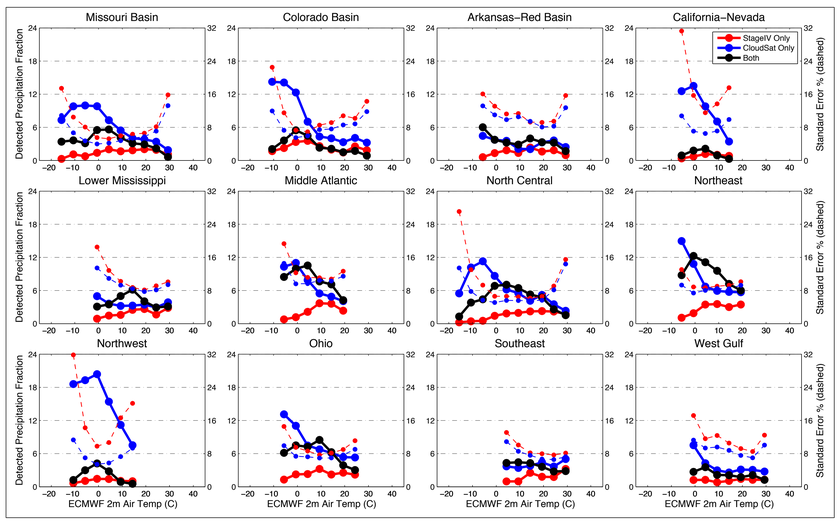
CloudSat observes far more precipitation in the northwest and much more in the northeastern CONUS.

The amount of StageIV Only is a result of random collocation offsets and the true precipitation in the area (contributing evenly to CloudSat Only and StageIV Only).

Large values of Both are likely due to heavy or large scale precipitation events where the reflectivities are more pronounced and there are fewer collocation offset differences.

Effect of Near-Surface Air Temperature





Conclusions

- ✧ This one-to-one comparison study shows that CloudSat observes much more precipitation than StageIV across the northern and especially the northwestern United States.
- ✧ Light and frozen precipitation continue to evade detection by even the best multi-sensor quality controlled precipitation observations from the surface.
- ✧ Terrain blockage and lack of radar coverage in the west, beam overshoot, and WSR-88D sensitivity contribute to differences in retrieved precipitation fractions across the United States.

References

Haynes, J. M., L'Ecuyer, T. S., Stephens, G. L., Miller, S. D., Mitrescu, C., Wood, N. B., & Tanelli, S. (2009). Rainfall retrieval over the ocean with spaceborne W-band radar. *Journal of Geophysical Research*, *114*, 1–18.

Lin, Y., & Mitchell, K. E. (2005). The NCEP Stage II/IV Hourly Precipitation Analyses: Development and Applications. *19th Conf. on Hydrology*. San Diego, CA: American Meteorological Society.