Improving Satellite Quantitative Precipitation Estimates By Using GOES Cloud Optical Depth

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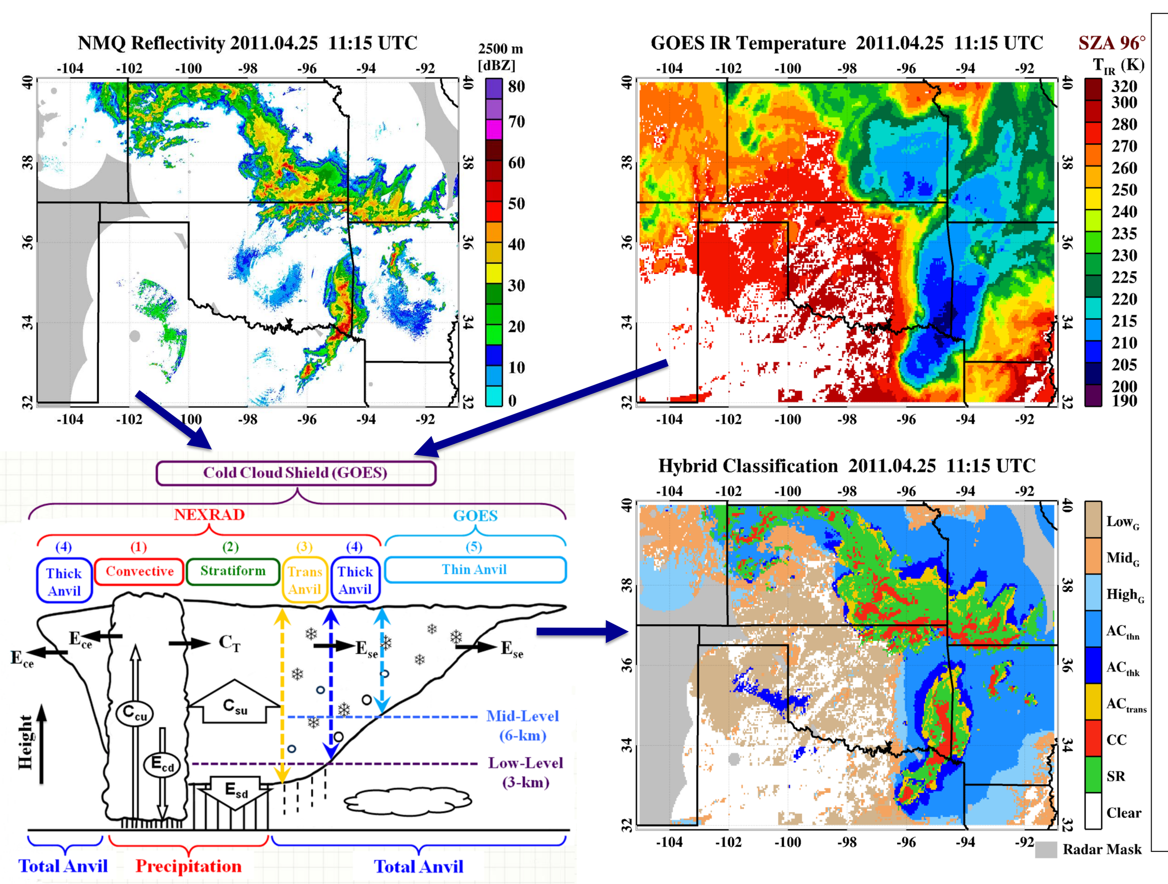
1) Objective

Evaluate the Performance of a Cloud Optical Depth based rain mask in NOAA SCaMPR estimates.

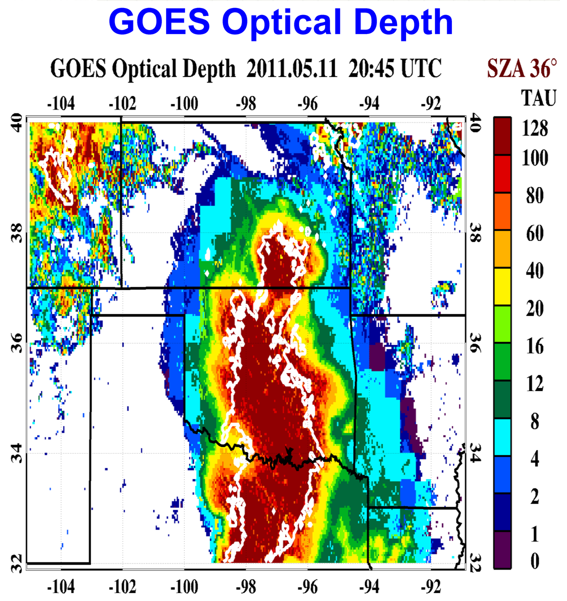
SCaMPR, the Self-Calibrating Multivariate Precipitation Retrieval, attempts to combine the strengths of microwave based and infrared based satellite QPEs (Kuligowski 2002).

2) Methodology

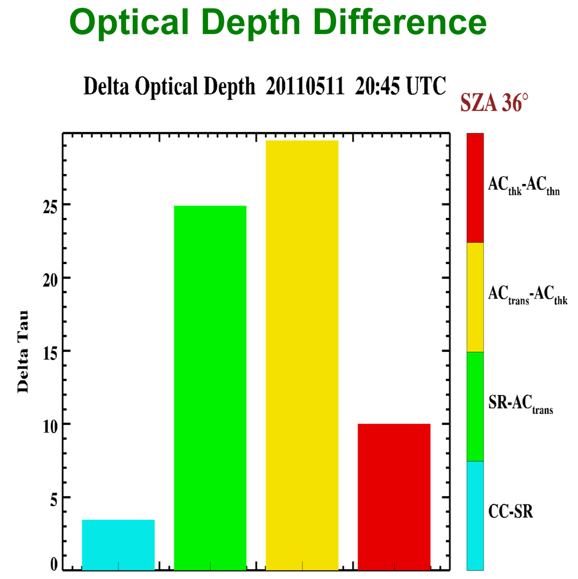
(a) Cloud Optical Depth can be used to filter out Non-Precipitating Anvil Regions



- Using the Hybrid Classification to Identify the Regions of a DCS
- Classifying a DCS into precipitating clouds (Convective/ Stratiform) and non-precipitating anvil clouds
- For details, See Feng et al. (2011) JGR



GOES Optical Depth

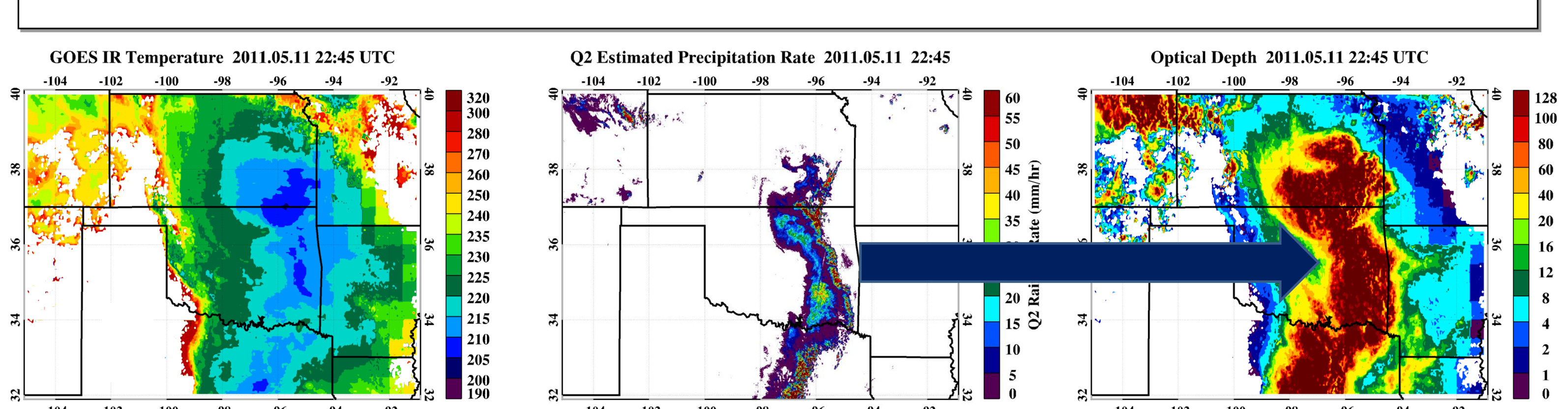


Optical Depth Difference

The difference in optical depth between convective and stratiform regions is very small, but the difference is large between stratiform and Anvil regions → filter out Anvil regions

(b) Optical Depth Based Rain Mask

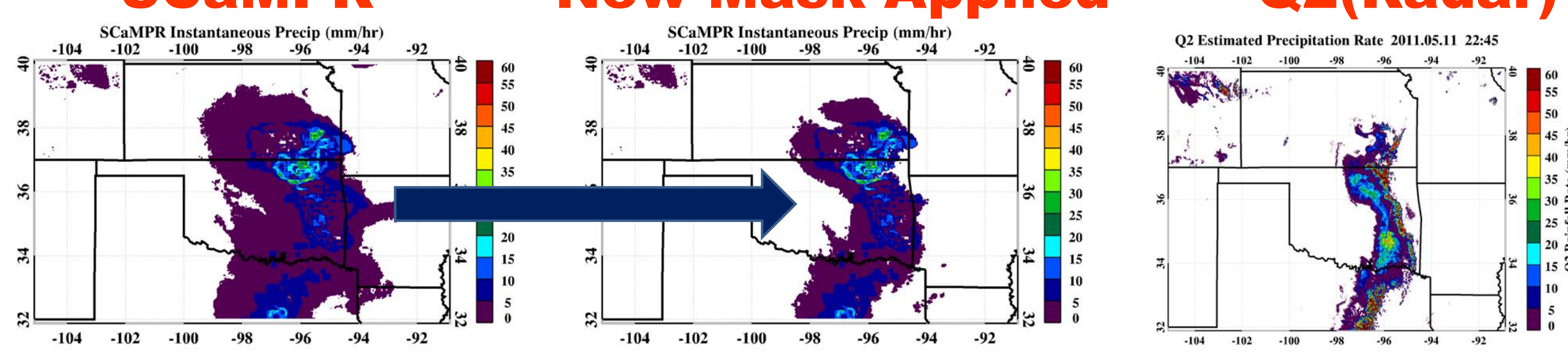
- Identify all pixels where the optical depth exceeds a threshold value
- All pixels exceeding the threshold value and their bordering pixels may be identified as precipitating
- All other pixels are identified as non-precipitating
- SCaMPR estimates for non-precipitating pixels are set to 0



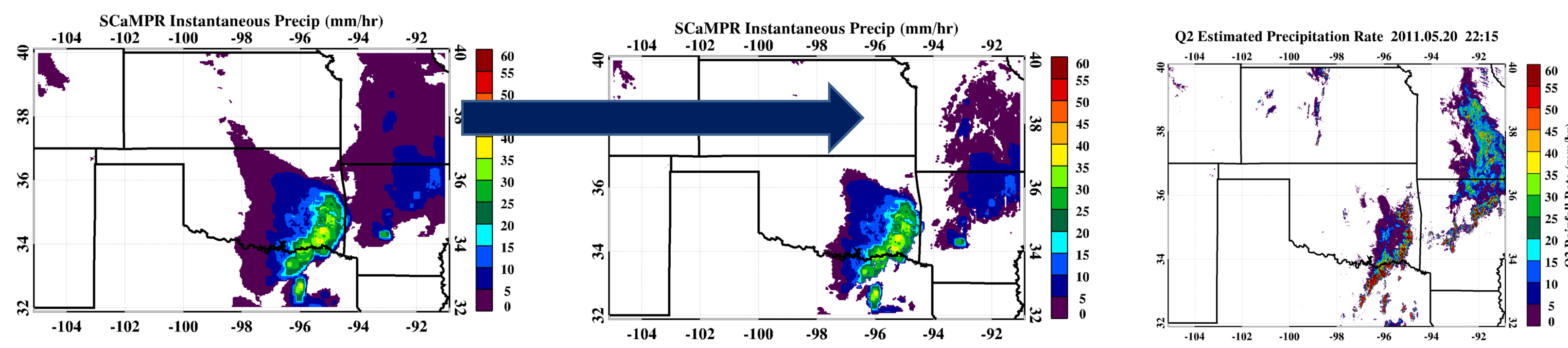
Utilize Strong Relationship between Optical Depth and Precipitating Area

3) Results

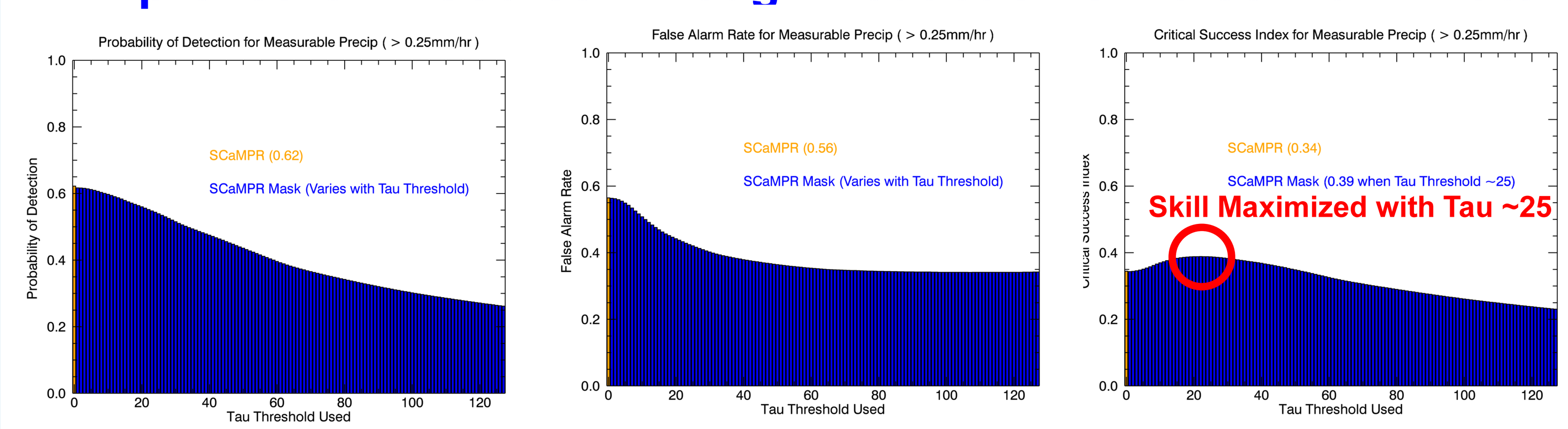
SCaMPR — New Mask Applied — Q2(Radar)



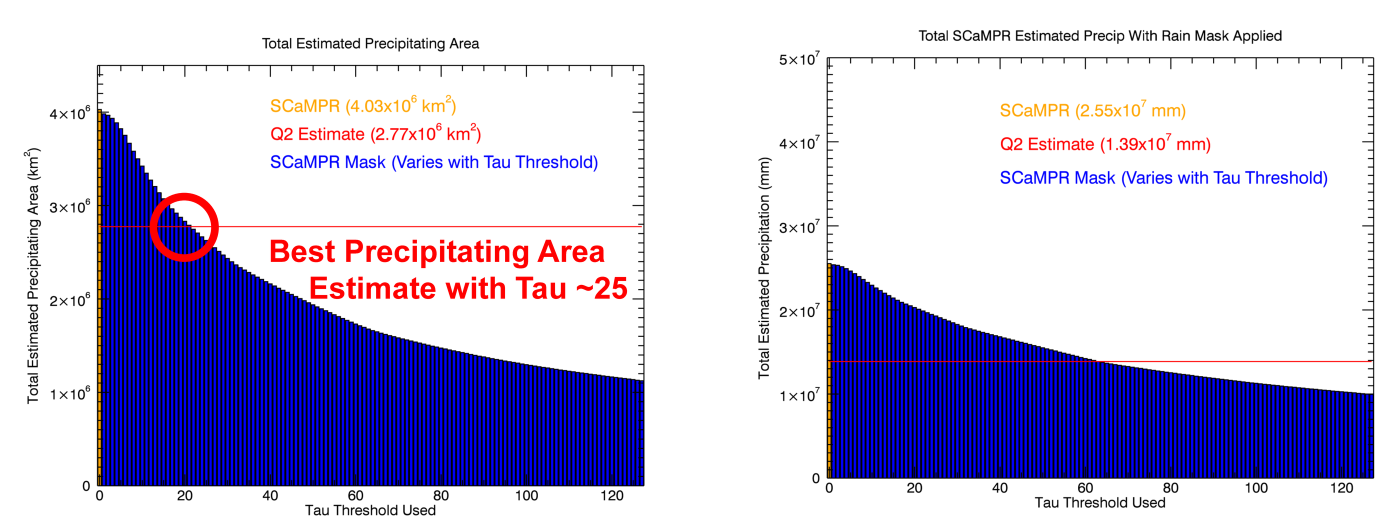
Significant Reductions in Overestimates of Precipitating Area



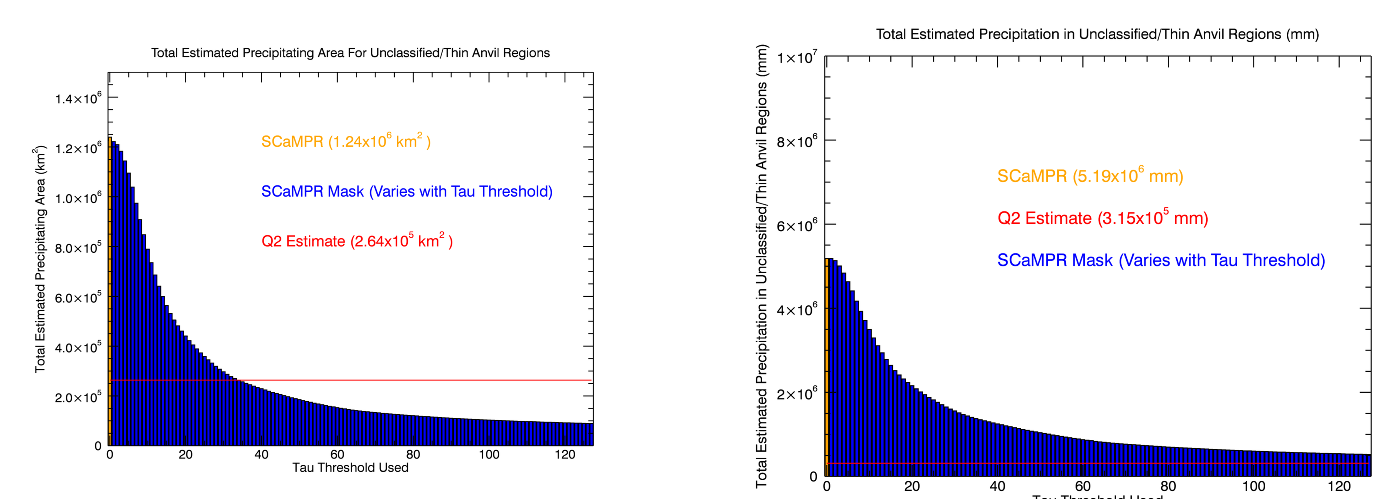
Improved Skill Scores Through Reduction of False Alarm Rate



Application of Rain Mask Improves Estimated Precipitation Coverage and Estimated Precipitation Amounts



Overestimates of Precipitation in Anvil Regions have been reduced significantly By Implementing the Rain Mask



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Precipitation Observation Data were provided by the Oklahoma MESONET.

SCaMPR data was provided by Dr. Bob Kuligowski at NOAA STAR.

NEXRAD Q2 data was provided by NSSL NMQ.

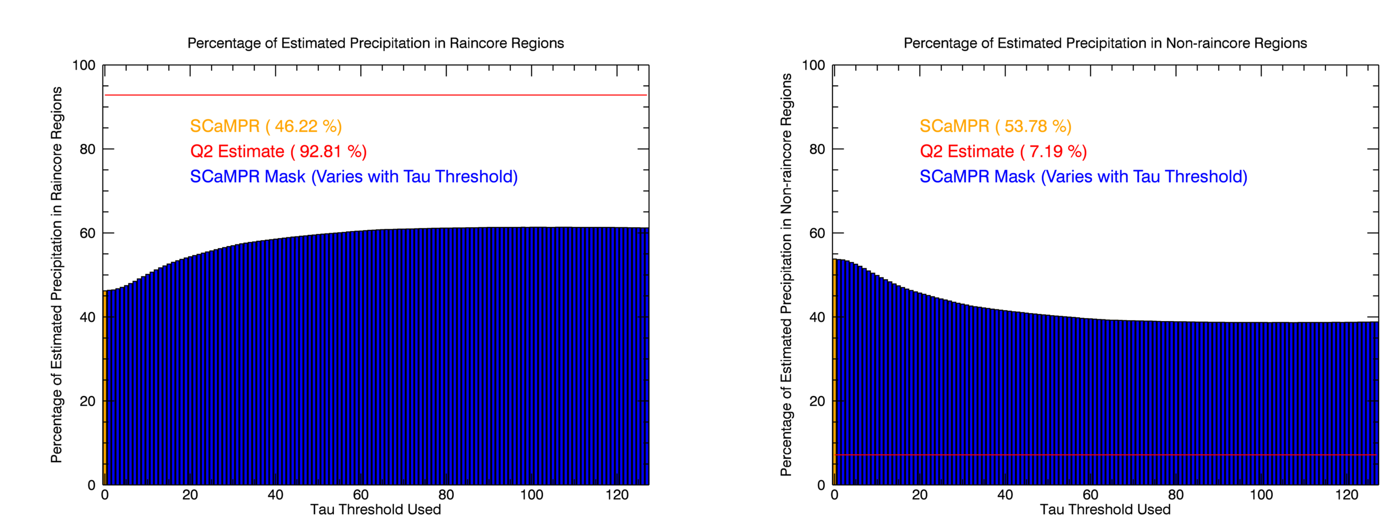
For more details see: Ronald Stenz, Xiquan Dong, Baike Xi, and Robert J. Kuligowski, 2014: Assessment of SCaMPR and NEXRAD Q2 Precipitation Estimates Using Oklahoma Mesonet Observations. J. Hydrometeor, 15, 2484–2500.

Improvements in the Estimated Precipitation Distribution Among Deep Convective System (DCS) Components

Percentage of Estimated Precipitation in Each DCS Region

DCS Region	SCaMPR	SCaMPR Mask (τ = 25)	SCaMPR Mask (τ = 50)	Q2 Estimate
Convective Core	13.83	16.52	18.39	65.66
Stratiform Region	32.39	39.20	41.22	27.15
Anvil Region	33.22	34.82	33.69	4.91
Thin Anvil Region	20.56	9.46	6.70	2.28

- Q2 Estimates can accurately represent the precipitation distribution among the components of a DCS (Stenz et al. 2014)
- SCaMPR Overestimates Precipitation in Anvil Regions and Underestimates Precipitation in Rain Cores (Convective Core / Stratiform Regions)
- Application of the Rain Mask Increased the Percentage of Estimated Precipitation in Rain Core Regions and Decreased the Percentage of Estimated Precipitation in Anvil Regions
- More Stringent Rain Masks (higher tau thresholds) produce more realistic SCaMPR estimated precipitation distributions



- Majority of estimated precipitation is now in rain core regions after applying rain mask to SCaMPR

4) Summary

- An Optical Depth Based Rain Mask Was Evaluated Over a Wide Range of Thresholds
- Significant Improvements Were Made To SCaMPR Precipitation Estimates
  - Improved areal coverage (now similar to Q2)
  - Improved areal totals (reduction of overestimates)
  - Improved distribution among DCS components
- The "optimal" threshold depends upon application

5) Future Work

- Adjusting precipitation rates with optical depth
- Using optical depth to identify undetected precipitation