Improving GOES-R Cloud and Precipitation Products Associated with Deep Convective Systems by using NEXRAD Radar Network over the Continental U.S.

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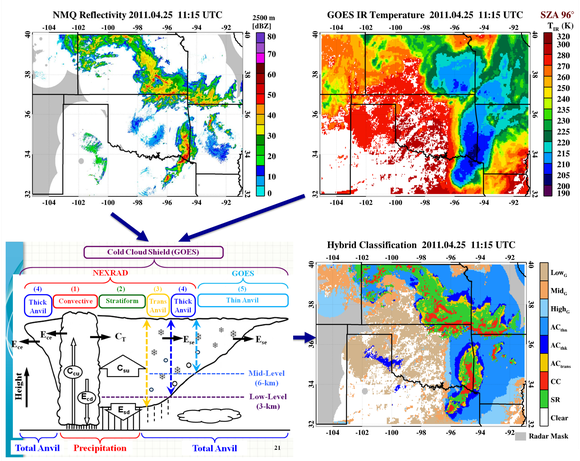
1) Goal of R3 project

Improve GOES-R precipitation estimates from Deep Convective Systems (DCS) over the continental U.S.

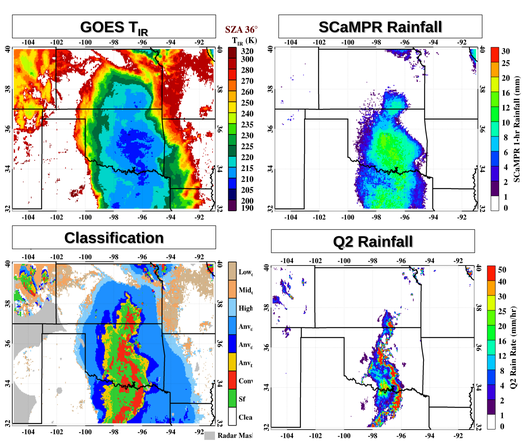
2) Accomplishments thus far

(a) Developed A New Hybrid Classification Algorithm



- Combined NEXRAD and GOES data
- Classified precipitating clouds (Convective/ Stratiform) and non-precipitating anvil clouds
- See Feng et al. (2011) JGR for details!

(b) Compared GOES-R SCaMPR with Q2/classified results

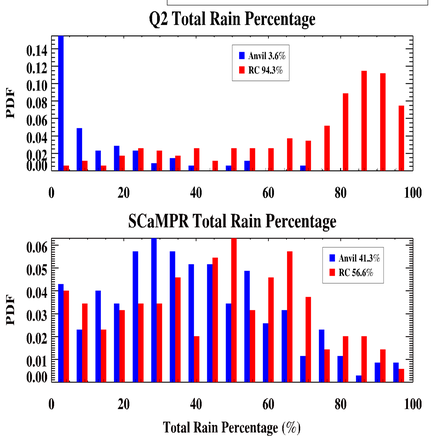


SCaMPR method

- SCaMPR rainfall estimates are mainly based on GOES IR temp (Kuligowski, 2002).
- Mainly for convective precipitation
- Issue: Exaggerated rain area, particularly for anvil region
- Study domain: Oklahoma area (14×8°)
- May 2011 (hourly rainfall)
- New version of SCaMPR rainfall estimate is available.

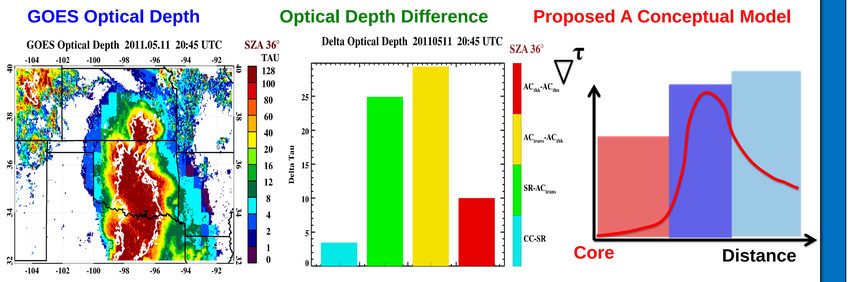
A summary of Comparison (May 2011, before improvement):

Rain Core (RC): precipitating clouds, including convective and stratiform regions
Anvil Clouds: non-precipitating clouds



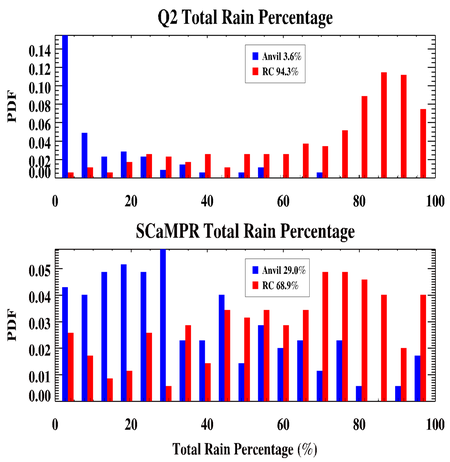
Comparing to radar Q2 results, SCaMPR overestimated Precip. in Anvil region (41.3% vs. 3.6%), and underestimated Precip. in Rain Core (56.6% vs. 94.3%) during May 2011 (Daytime)

(c) Improved SCaMPR rainfall in Anvil region using optical depth difference between Stratiform and Anvil regions



Through study, we found that the optical depth difference between convective and stratiform regions is very small, however, there is a large difference between Stratiform and Anvil regions as demonstrated in left and right columns. Therefore we proposed a Conceptual Model which uses the patch-based optical depth gradient to filter out the non-precipitating anvils in SCaMPR rainfall estimates.

Applied this Conceptual Model to improve SCaMPR rainfall estimates



A summary of Comparison (May 2011, after improvement):

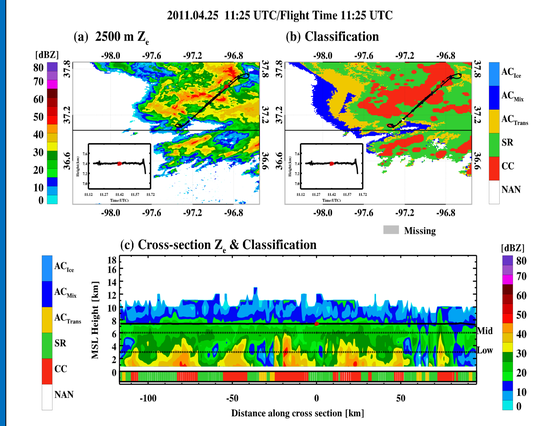
SCaMPR overestimated Precip. in Anvil region has been reduced from 41% to 29%, and underestimated Precip. in raincore has been increased from 57% to 69% during May 2011 (Daytime)

3) Accomplishments anticipated at end of Year two

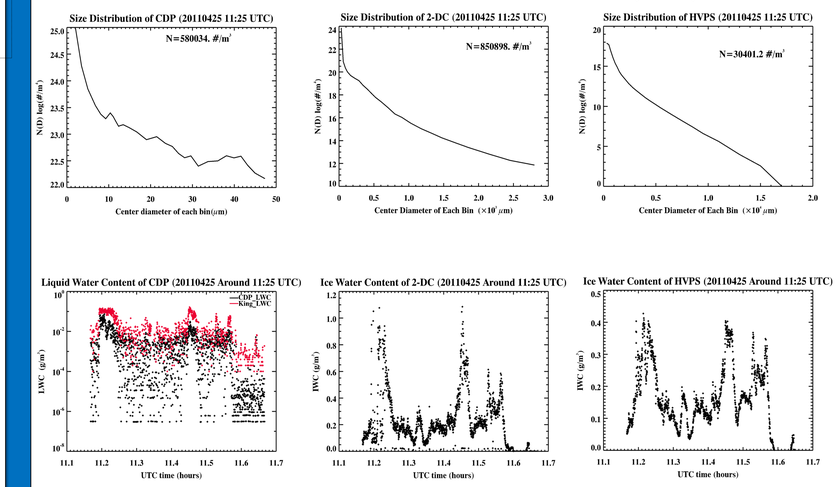
a) Applying the hybrid classification algorithm, radar Q2 results, and the Conceptual model for the entire continental USA to improve the SCaMPR rainfall estimates.
b) Develop a satellite-microphysics-based cloud classification method using the intensive surface radars, aircraft in-situ measurements, and satellite observations during MC3E.
c) These aircraft in-situ measurements and various radars observations and retrievals during MC3E will provide a "cloud-truth" dataset and are an invaluable data source for validating GOES/MODIS retrieved cloud microphysics. These validated satellite retrievals will help us to derive a microphysics-based satellite classification, which should be independent of radar.
d) Using CloudSat-Calipso to automatically identify DCS and anvils that can be compared/combined with NEXRAD/GOES to extend the study to global scale.

Acknowledgement: GOES microphysical properties were provided by Dr. Pat Minnis at NASA Langley.

MC3E radar observations and Aircraft in situ data



The UND citation aircraft in situ measurements on April 25, 2011 over the ARM SGP region, including cloud particle sizes and LWC/IWCs derived from Cloud Droplet Probe (30 channels from 0.951 to 48.718 μm), 2DC (24 channels from 15 to 3000 μm), and High Volume Precipitation Spectrometer (28 channels from 200 to 30,000 μm). Those sensors can detect different sizes of cloud water droplets and ice particles in convective clouds. During the time period 11:15 UTC the UND aircraft descended from cloud top (~ 8 km) to mid cloud (~ 5 km) .



4) Initial feedback from potential users

Dr. Kuligowski from NOAA NESDIS is our collaborator for this project. We have reported our findings, such as SCaMPR overestimated rainfall estimates in Anvil region and underestimated rainfall estimates in Raincore region to him. We will work together to modify the SCaMPR rainfall algorithm based on the results from this study, particularly reducing the overestimated precipitation in Anvil region during second year.

5) What could be accomplished with a 3rd year of funding

a) The outcome with a 3rd year of funding will be to provide the guidance for improving the SCaMPR precipitation product over the entire continental USA, and modify its retrieval algorithm with Dr. Kuligowski. For example, we will apply the satellite-microphysics-based cloud classification to improve the SCaMPR underestimated precipitation in Raincore region.
b) Based on the results from this study, we will submit three papers, such as the comparison of modified SCaMPR rainfall estimates with radar Q2 results; DCS cloud microphysical property comparison between satellite, surface radars, and aircraft in situ measurements; and DCS formation and dissipation processes, as well as their diurnal and life cycles.