

Precipitation Characteristics in Summer 2007 Oklahoma Extreme Events

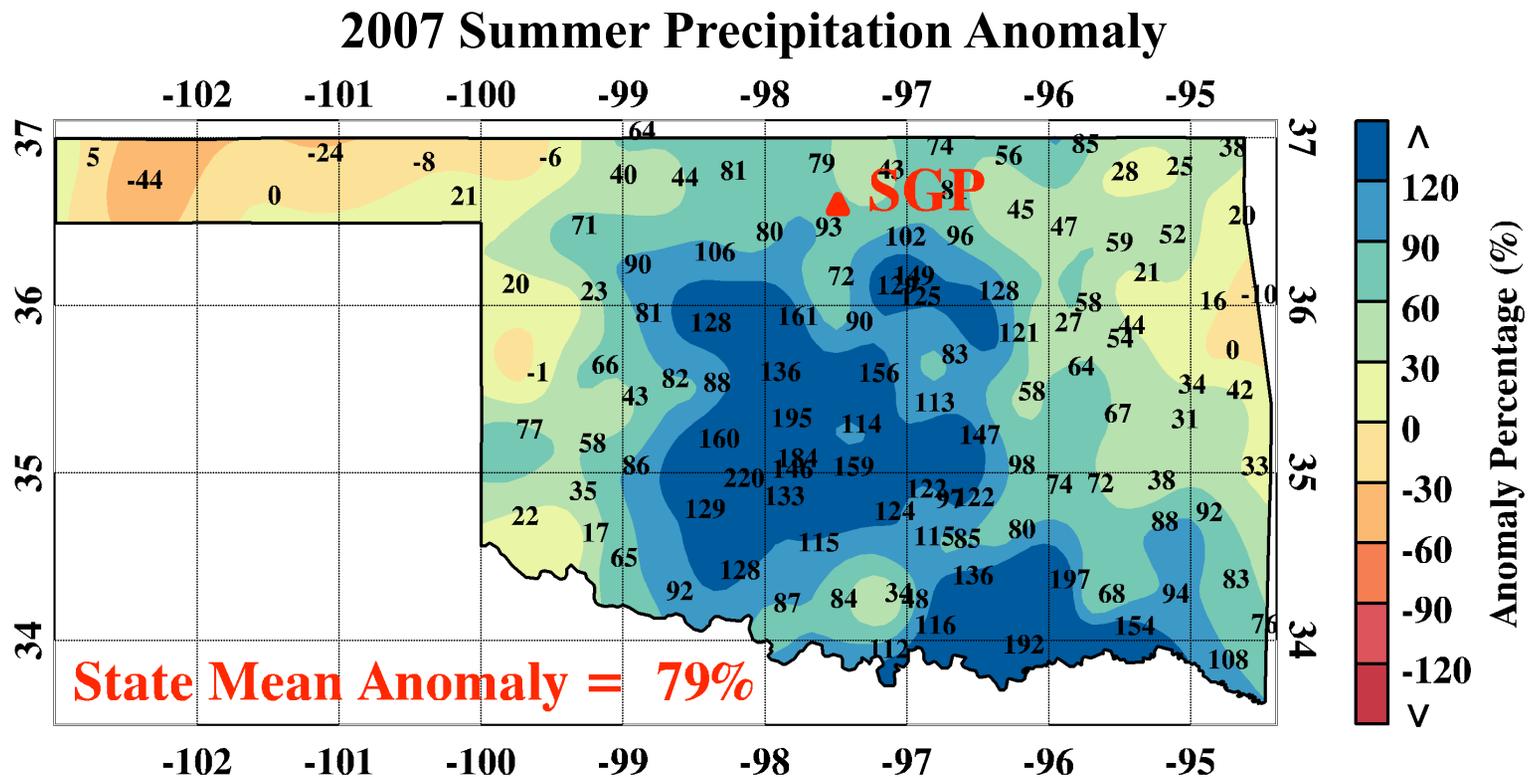
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University of North Dakota

Dec 2, 2009 NASA-NEWS



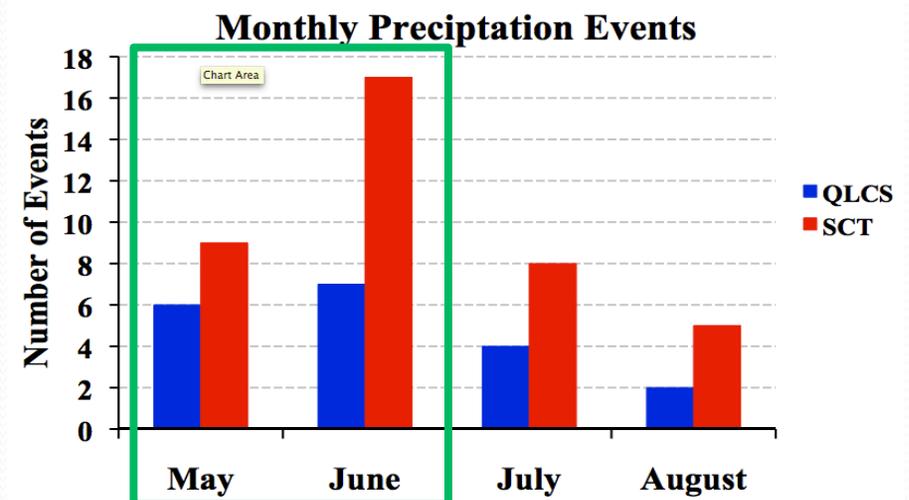
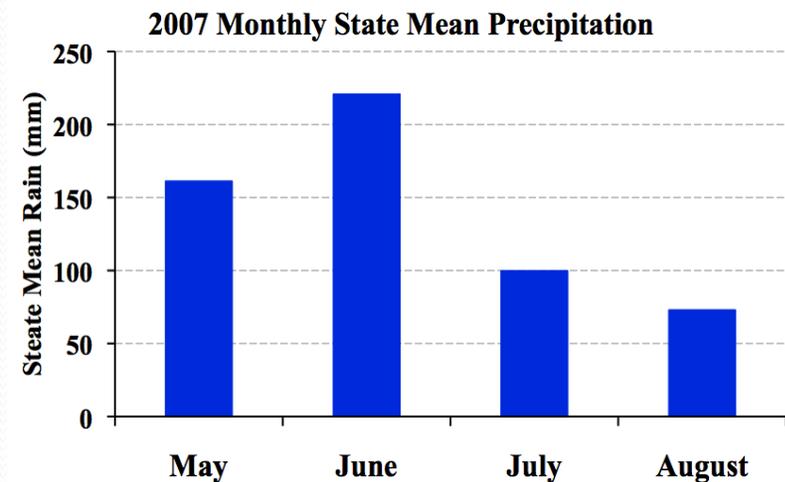
2007 Summer Season (May-Jul in this study)

- State Mean precipitation 79% above normal, 2nd wettest
- Central Oklahoma **+120% higher precipitation, the wettest**



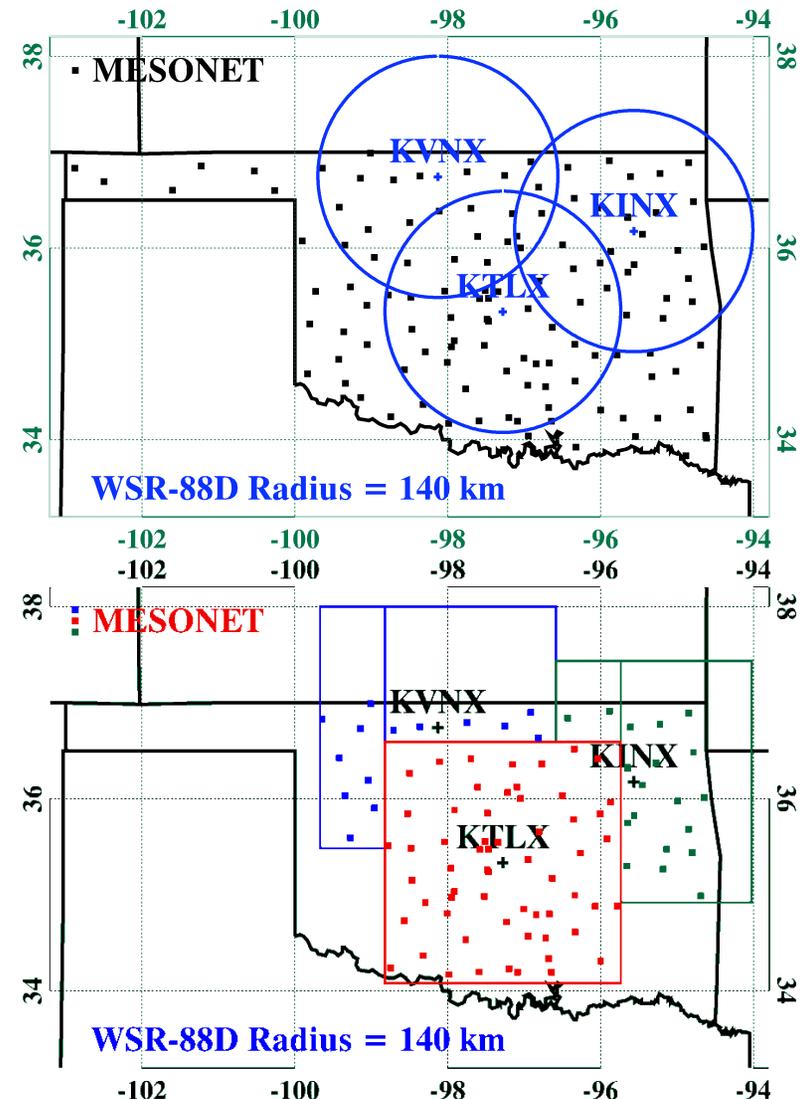
2007 Summer Season

- The total precipitation in the season > 400 mm
- Major precipitation events occurred during May-July
- Multiple organized convective events (QLCS) occurred in May and June



Observation Network

- Oklahoma Mesonet rain gauge network
- Mesonet stations divided into 3 regions covered by NEXRAD radars
- **Objective:** Use radar + surface observations to **characterize** each major **precipitation event**

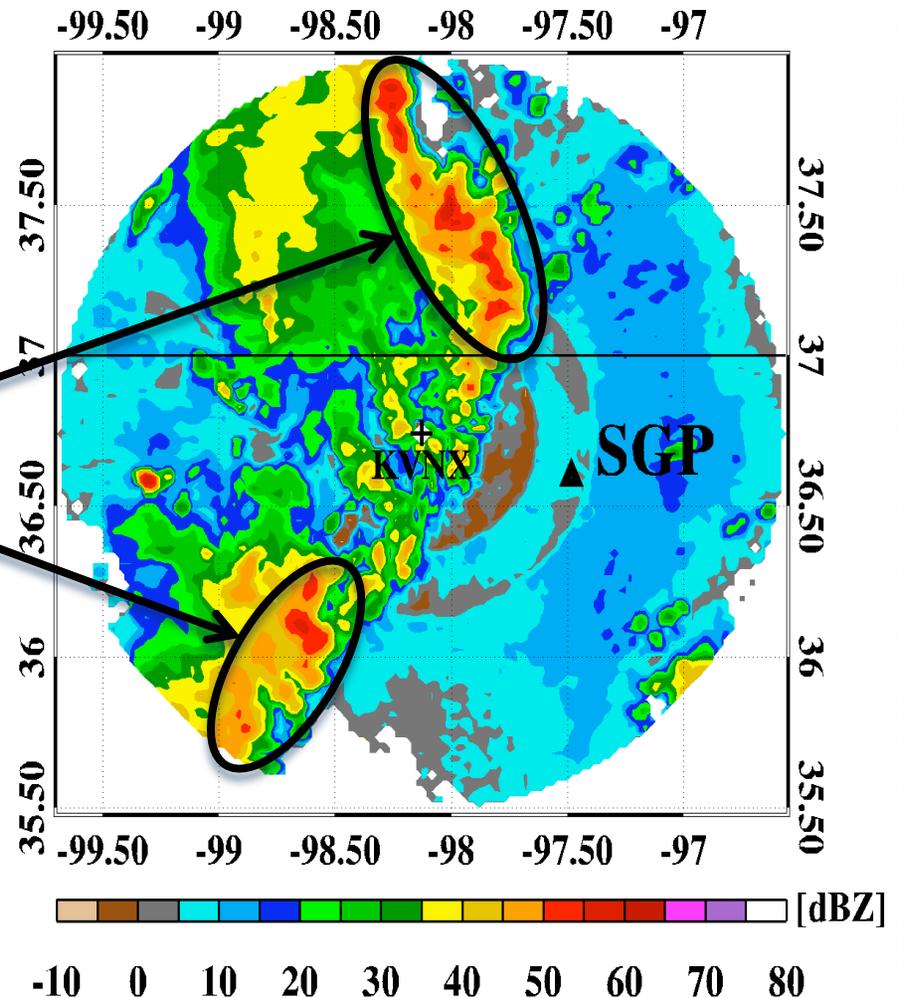


Radar Classification

- Each precipitation events have been classified into **convective** and **stratiform** regions using radar observations
- Developed by Steiner et al. (1995), provided by Courtney Schumacher (Texas A&M)
- Fully automatic, **parameters are retuned** to fit **mid-latitude** continental convection
- ARM Millimeter Cloud Radar involved in validating the classification

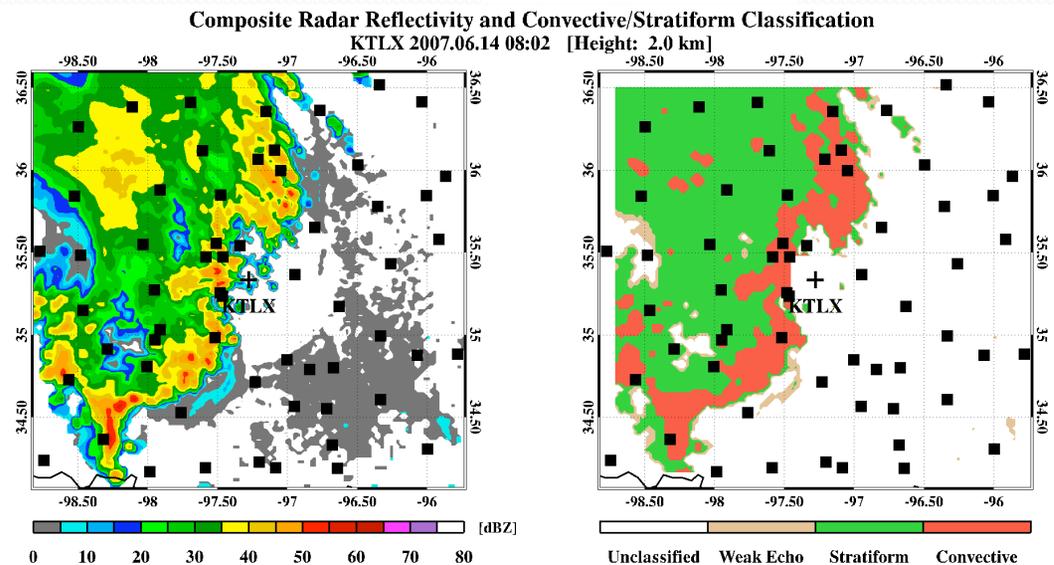
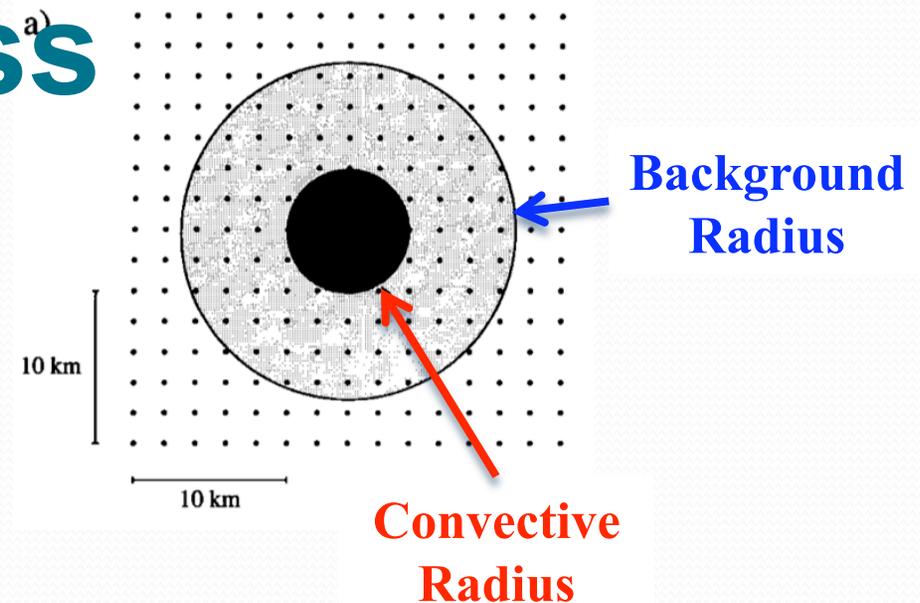
Classification Principle

- Look at radar **reflectivity gradients** at a PPI
- Convective cores have a **strong gradient** compared to the surrounding
- Gradient can be used to separate convective cores and stratiform regions



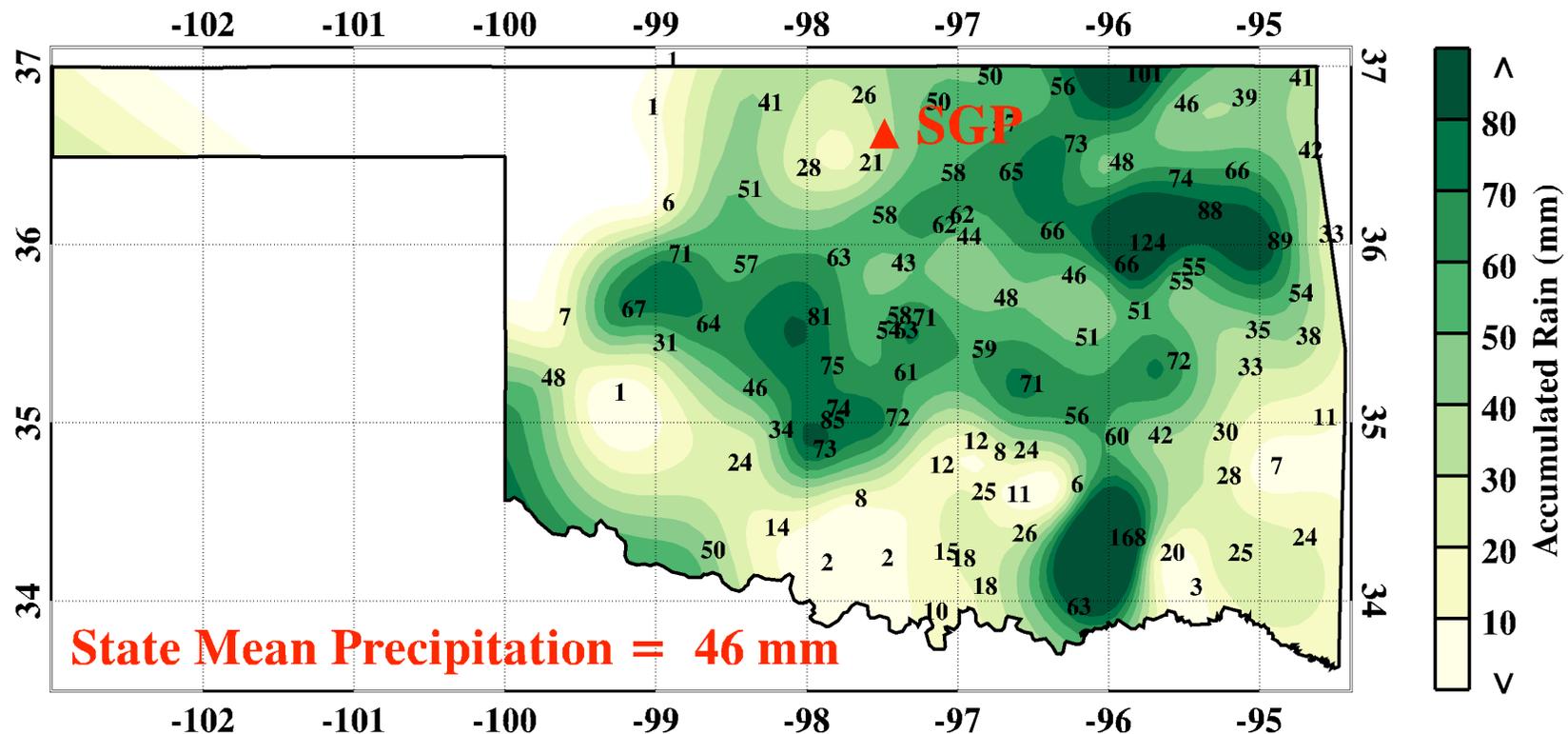
3 Step Process^{a)}

- Intensity: $Z_e > 43$ dBZ always convective
- Peakedness: convective if pixel's Z_e above certain threshold to its background
- Surrounding area: surrounding pixels within a background intensity-dependent **convective radius** also included as convective



Heavy Precipitation from QLCS

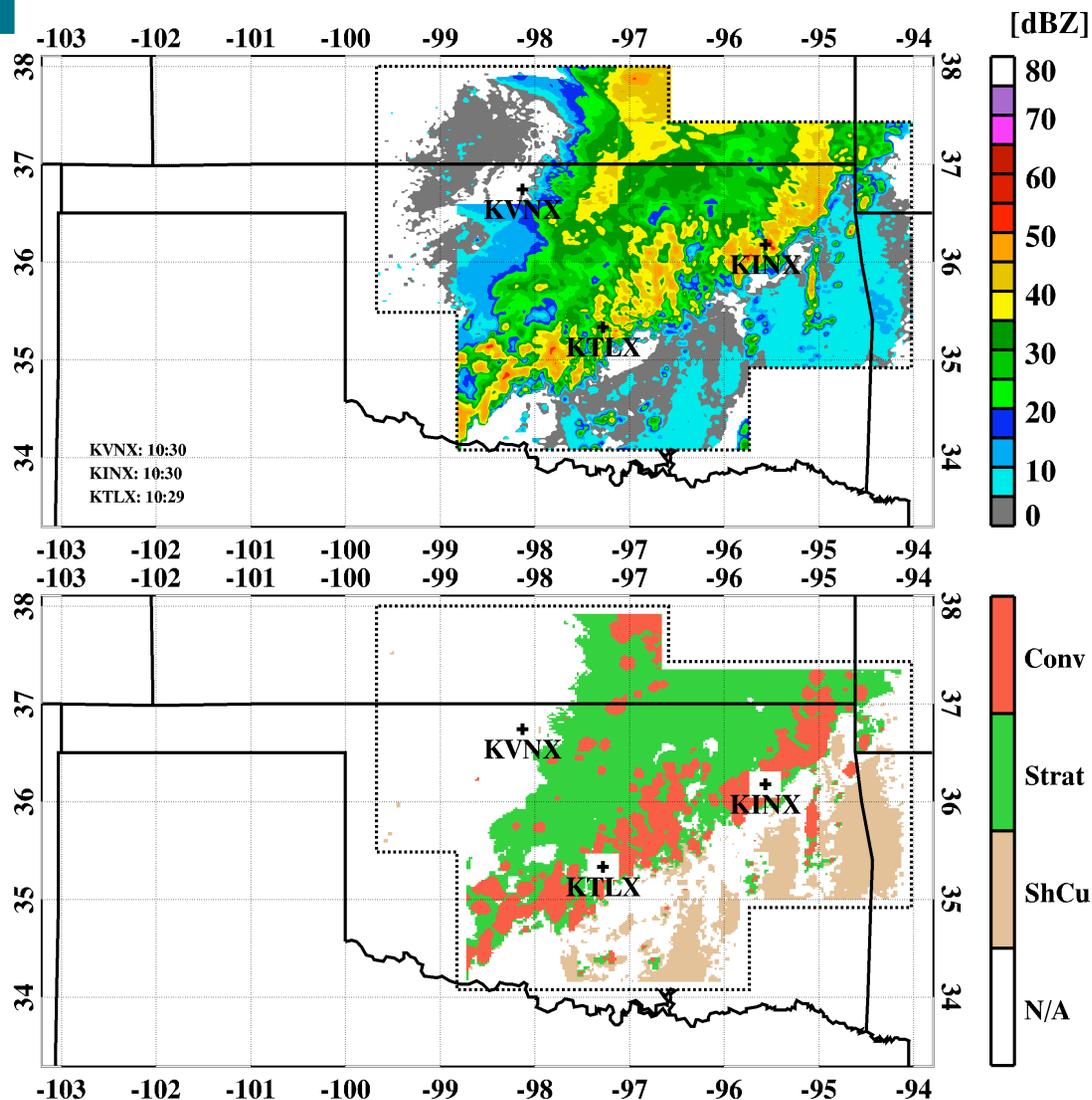
Oklahoma Mesonet 2007.05.07 Accumulated Rainfall



Radar Mosaic & Classification

- Classification performed for every radar scan
- 3 NEXRAD radar mosaic shows evolution of convective system
- Active convection, scatter storm merged into organized QLCS

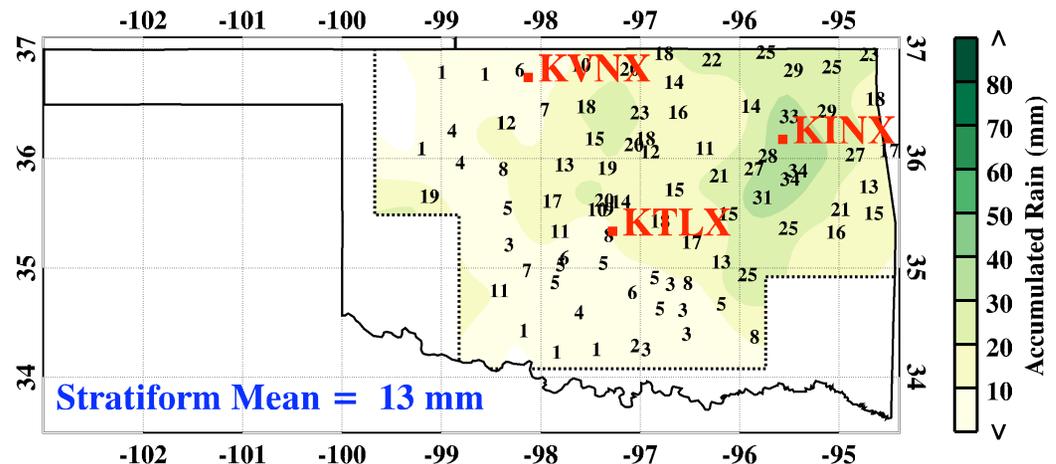
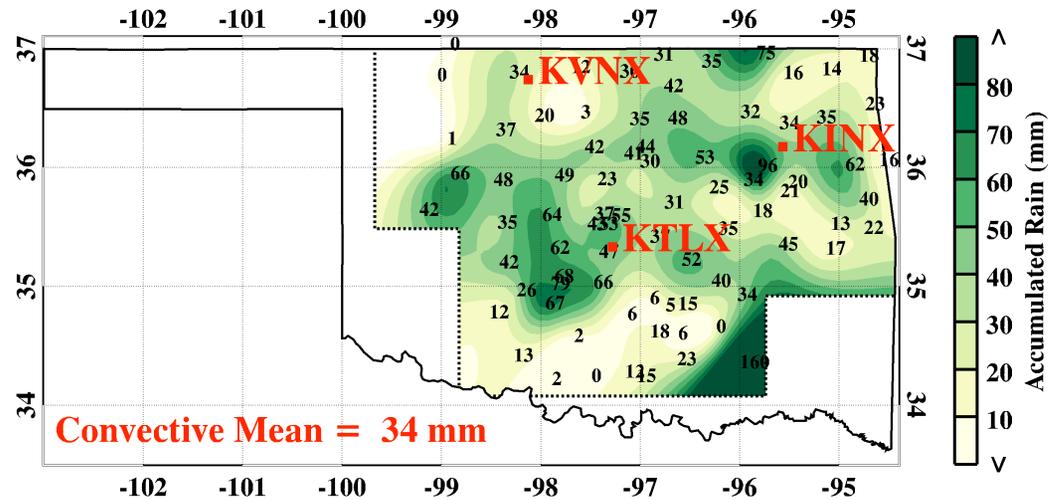
2007.05.07 10:30 Oklahoma Radar Classification



QLSC

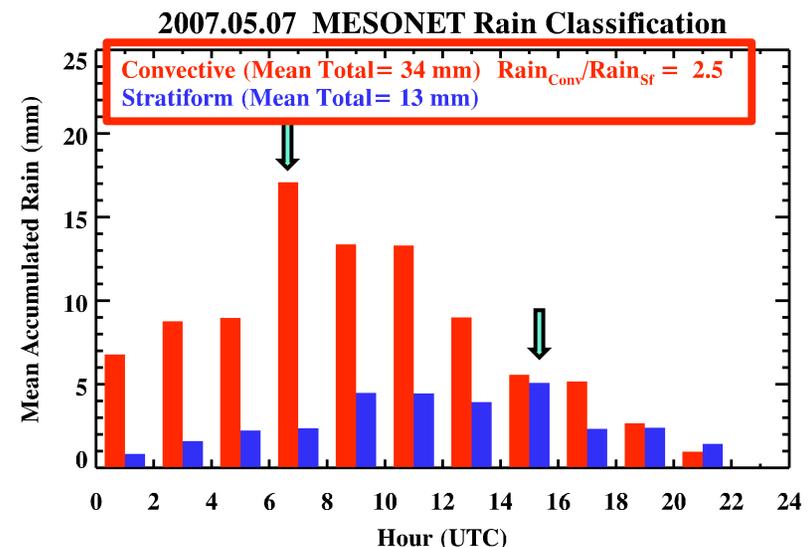
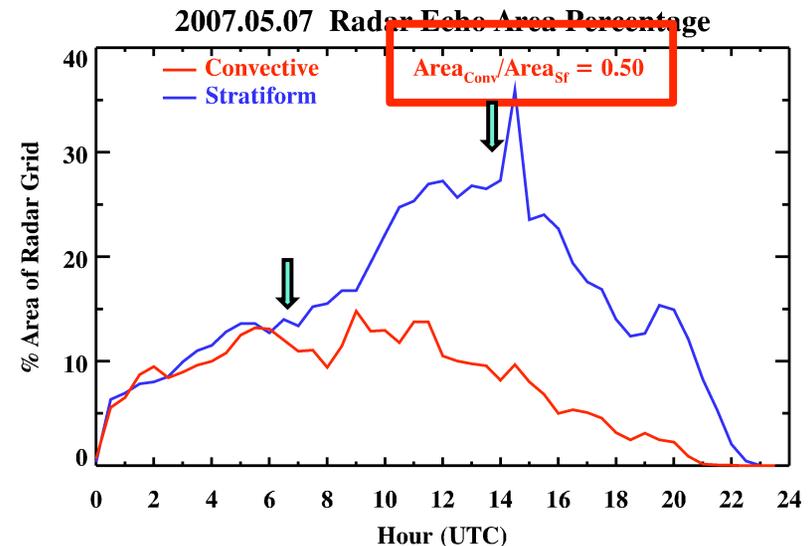
- Each Mesonet station is classified for each radar scan
- 5-min resolution from both dataset provide detailed evolution of precipitation system
- Accumulated rain are separated into **convective/stratiform**

Oklahoma Mesonet 2007.05.07 Rainfall Classification



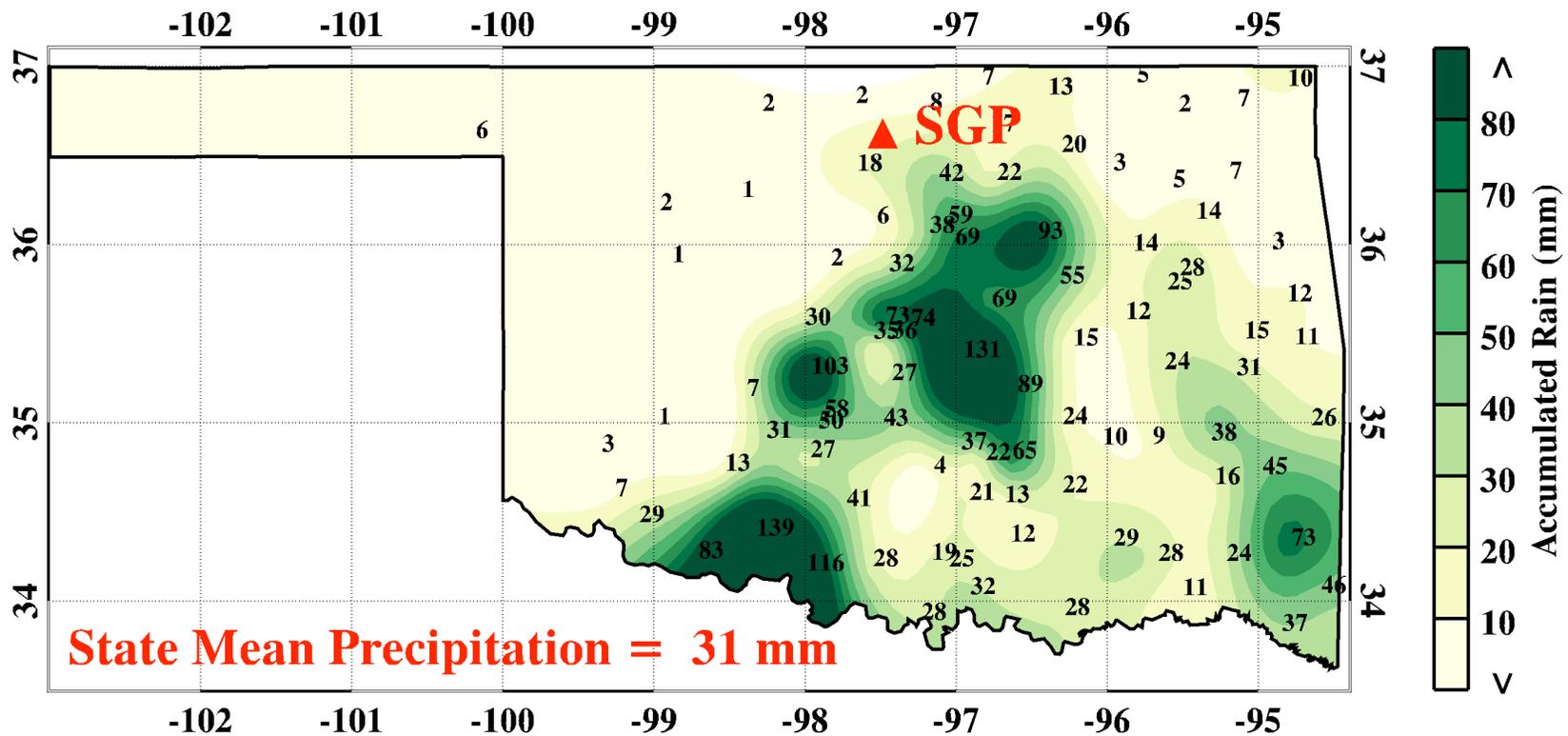
Convective/Stratiform Area vs. Precip

- Convective area coverage vs. stratiform area
- Separation shows similar peak time for area coverage and precipitation
- Integrated **Convective core area** coverage is 1/2 of **Stratiform area**
- **Convective rainfall intensity** is 2.5 times of **Stratiform rainfall**



Heavy Precipitation from Local Storms

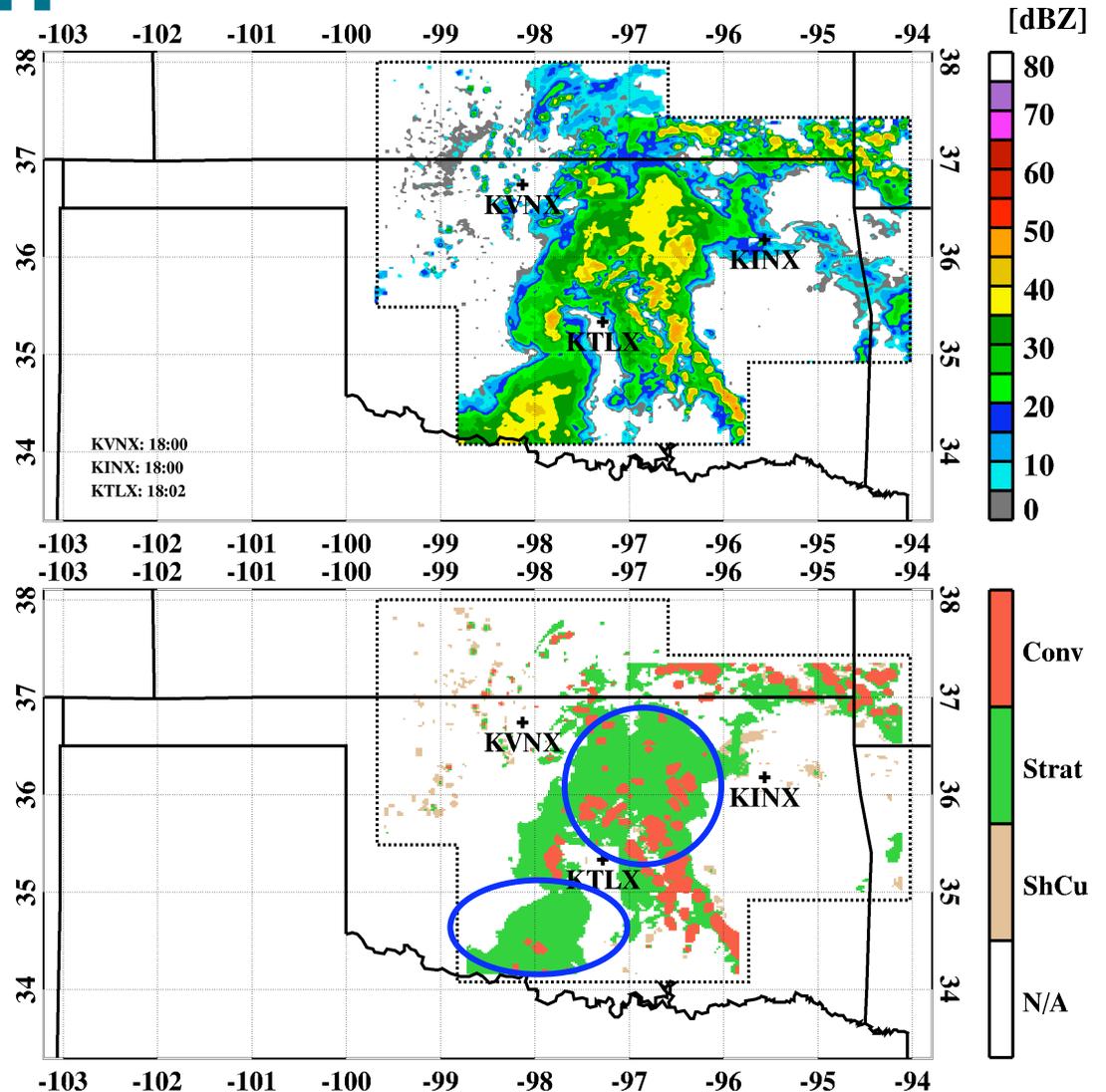
Oklahoma Mesonet 2007.06.26 Accumulated Rainfall



Radar Mosaic & Classification

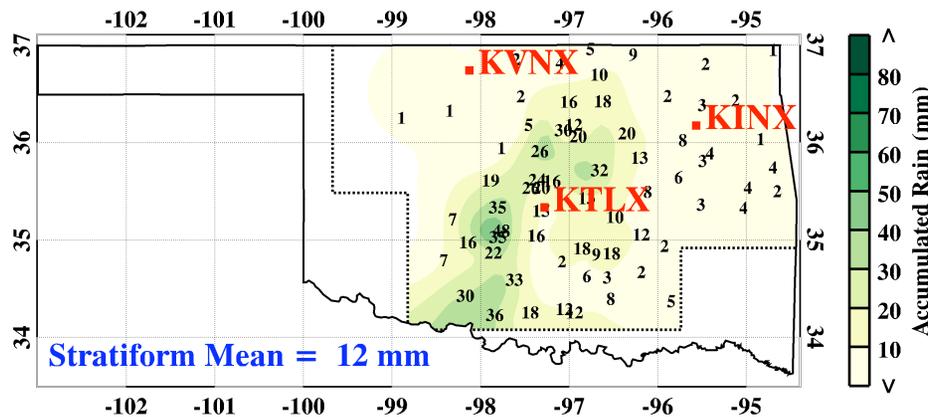
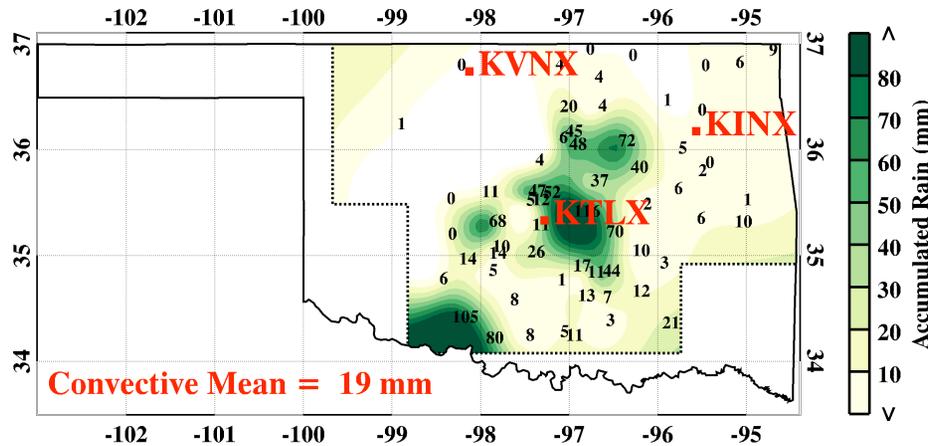
2007.06.26 18:00 Oklahoma Radar Classification

- Precipitation mainly produced in two circled area
- Non organized convective event
- Scatter convective cores evolved into large stratiform area

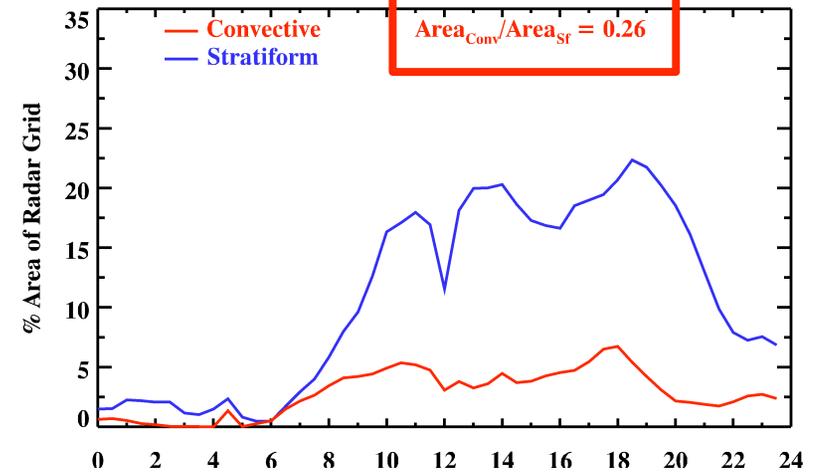


Scatter Storm Case

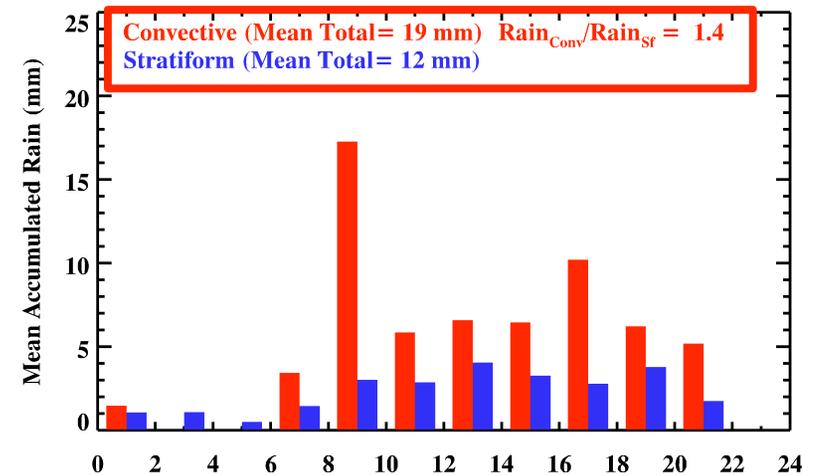
Oklahoma Mesonet 2007.06.26 Rainfall Classification



2007.06.26 Radar Echo Area Percentage



2007.06.26 MESONET Rain Classification



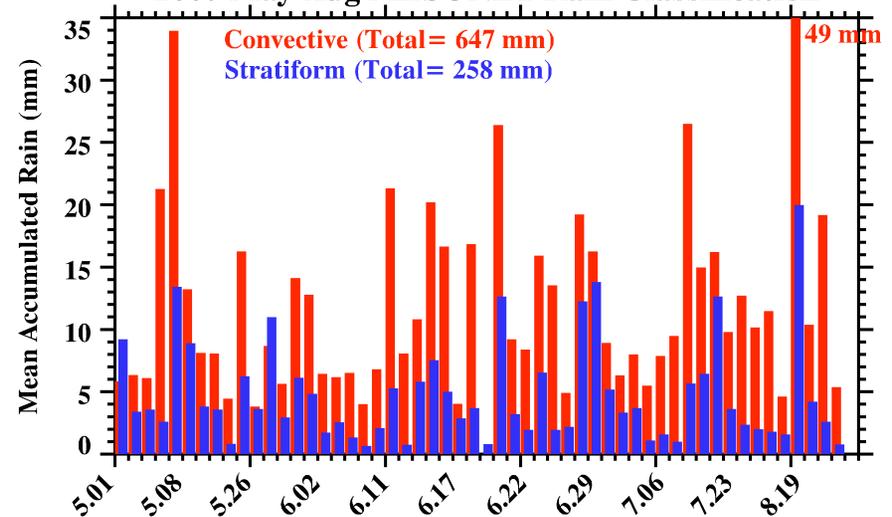
Most intense precipitation produced by small convective cores

Large stratiform area also contribute to significant amount of rainfall

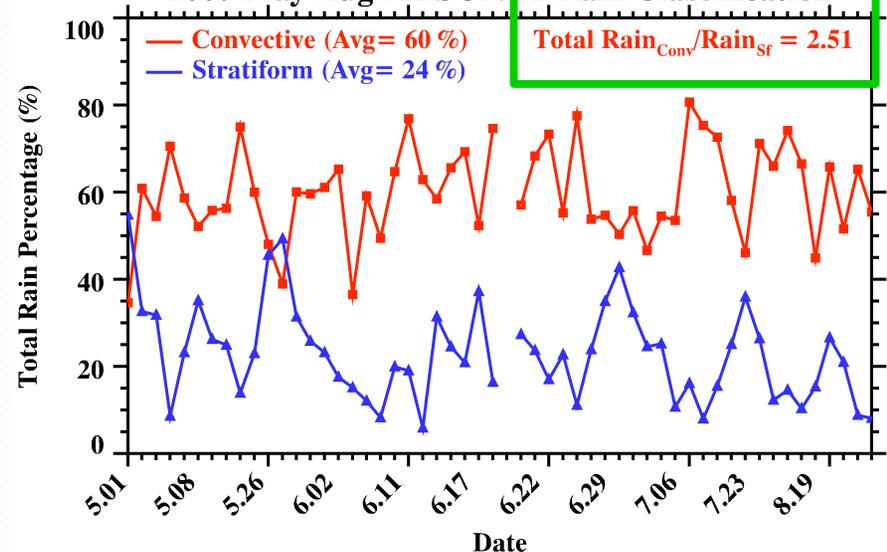
2007 Season Statistics

- **Convective rain** dominates the total precipitation in most events
- **Percentage of total rain:**
 - **60% convective**
 - **24% stratiform**
- **Convective to stratiform rain ratio: 2.5**

2007 May-Aug MESONET Rain Classification

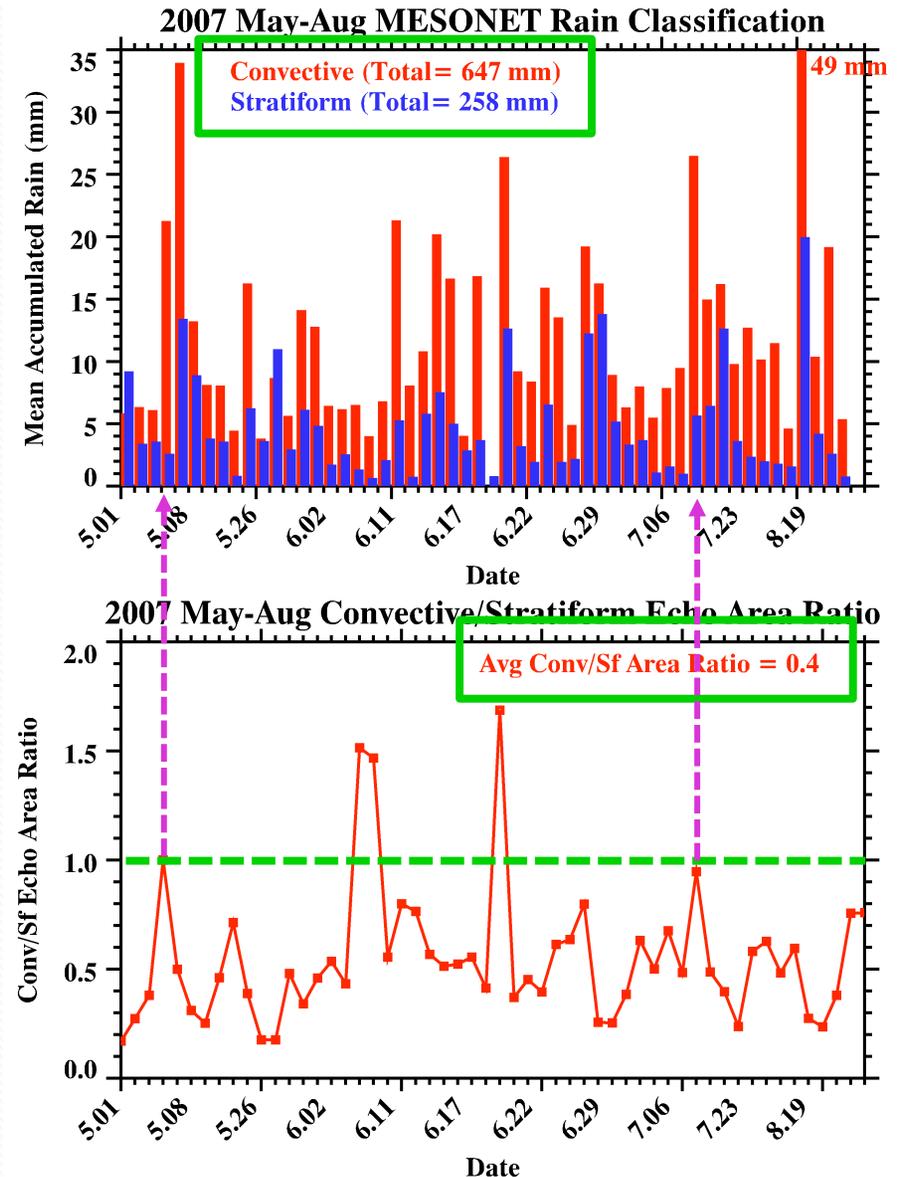


2007 May-Aug MESONET Rain Classification



2007 Season Statistics

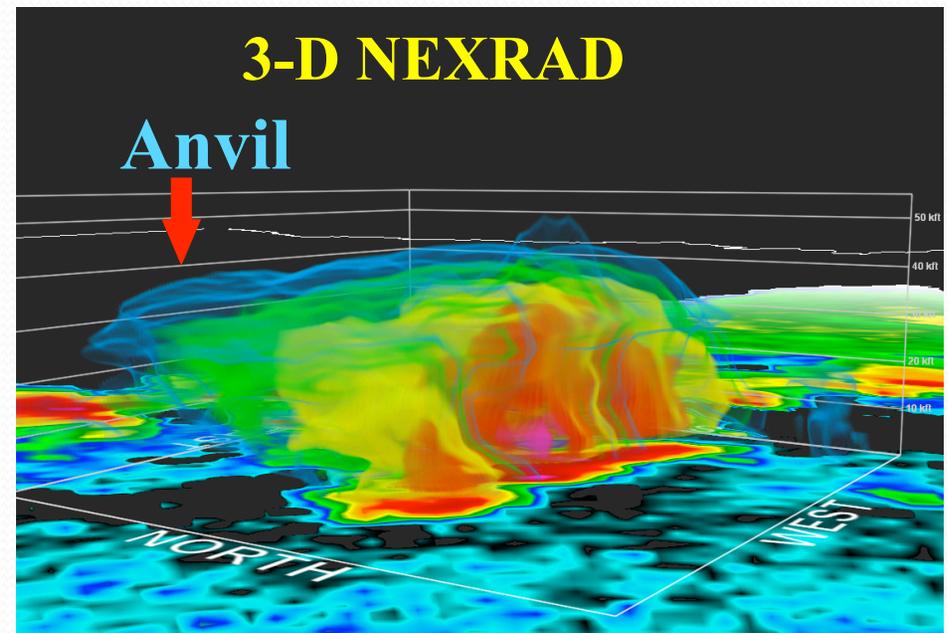
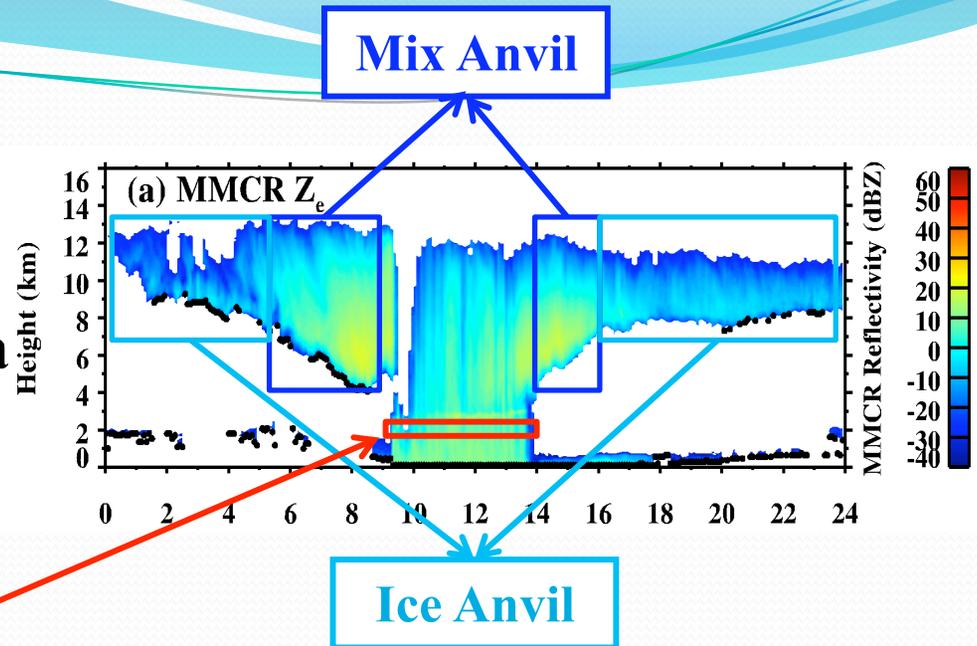
- Convective to stratiform precipitation ratio: 2.5
- Convective to stratiform area cover ratio: 0.4
- Convective area comparable or larger than stratiform: 5 events
- Only **2 events** have produced significant precipitation, and **convective rain is dominant**



Anvil

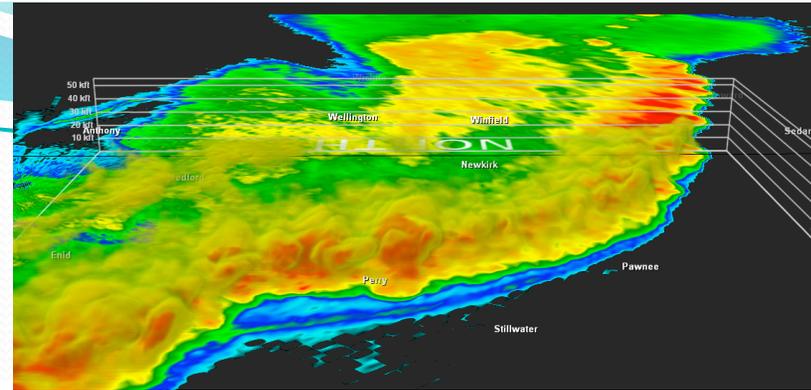
Classification

- Anvil cloud covers large area
- Important for moisture transport, radiation, etc.
- Steiner et al. (1995) classification only used lower level gradient
- Frederick and Courtney (2008) added anvil classification
- Use full 3-D radar volume scan to add **mix anvil**, **ice anvil**



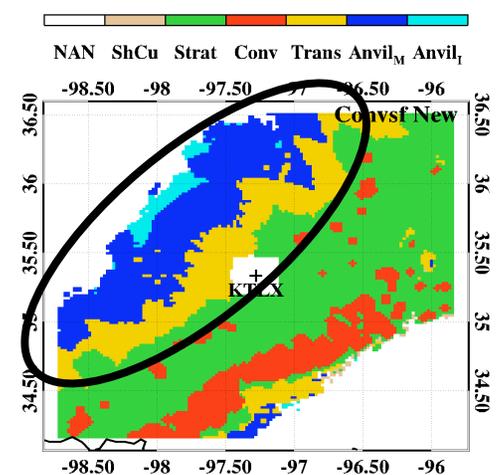
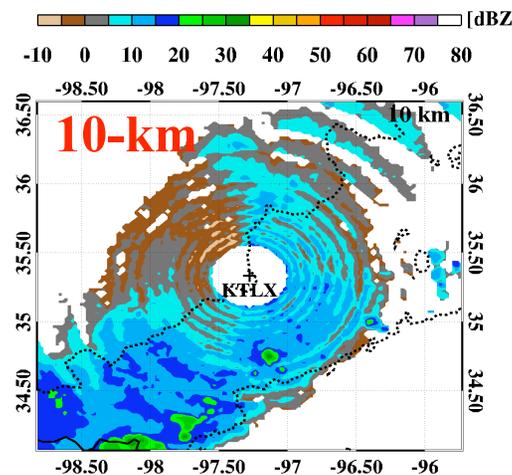
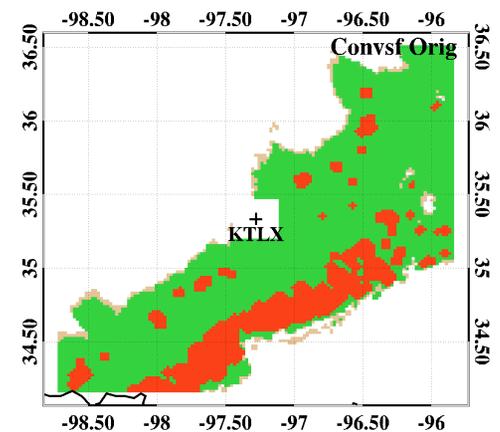
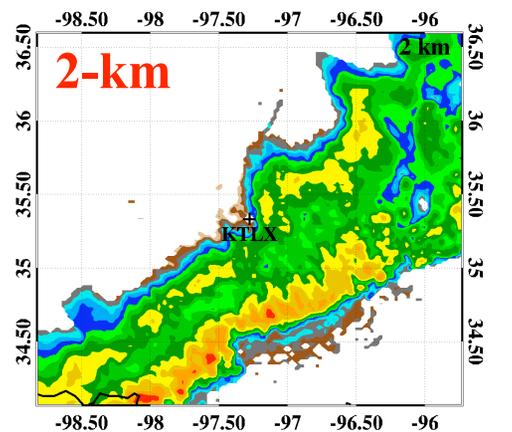
Anvil

- Our improved version include multi-level cloud base-top height estimation
- Added **transition**, **mix anvil**, **ice anvil**
- Provide complete 3-D evolution from precipitation to cloud



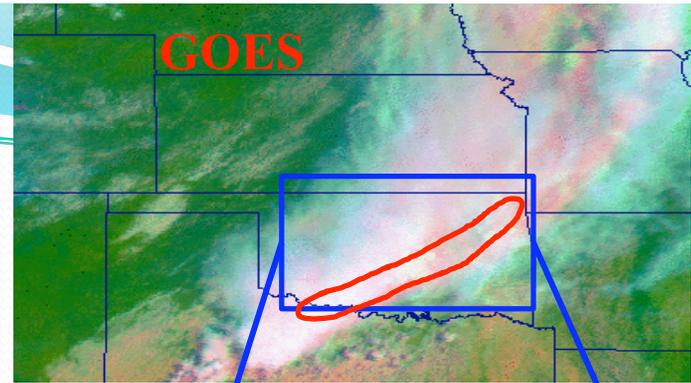
Composite Radar Reflectivity and Convective/Stratiform Classification

KTLX 2007.05.24 16:28 [Height: 2.0 km]

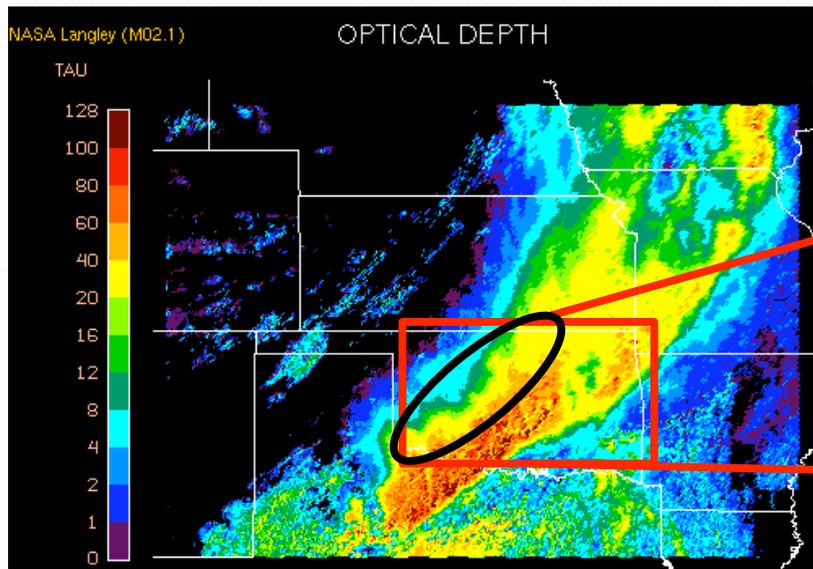
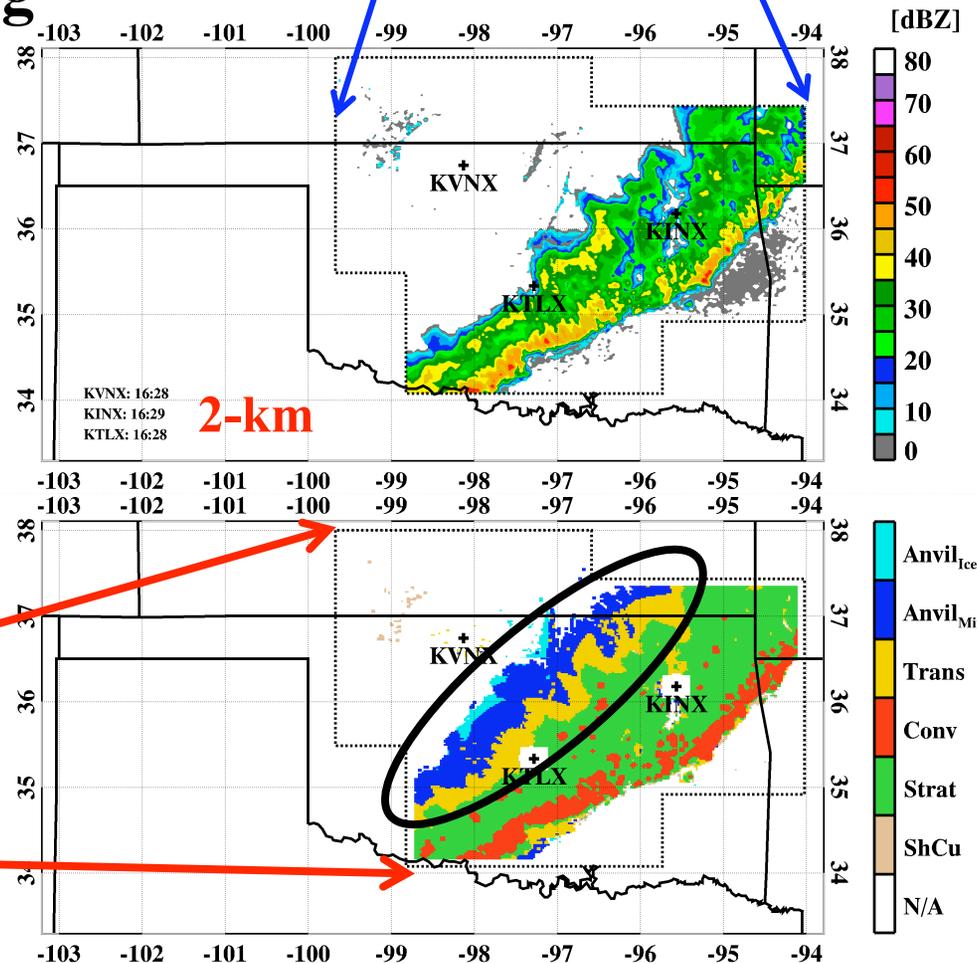


Radar vs. Satellite

- Visible GOES image confirms anvil cloud, but cannot separate from leading convective line
- Radar classification DOES!
- Optical depth (8~20): anvil, (20~40): transition



2007.05.24 16:30 Oklahoma Radar Classification



Summary

- **2007 Summer seasonal average:**
 - Convective to stratiform **rainfall ratio: 2.5**
 - Convective to stratiform **area coverage ratio: 0.4**
- All data available, we look forward to providing them for collaborating with modeling groups.
- Developing classification using **ARM Cloud Radar**, to **fine tuned the NEXRAD** precip-cloud classification.
- Classification technique **potentially useful for satellite cloud retrieval** applications.
- Widely applicable to **continental U.S.**, covered by **~140 NEXRAD**.

