Finding Differentiating Characteristics between Tornado Producing and Non-Tornado Producing Mesoscale Convective Systems with Synergistic Usage of GOES Imagery and NMQ Data

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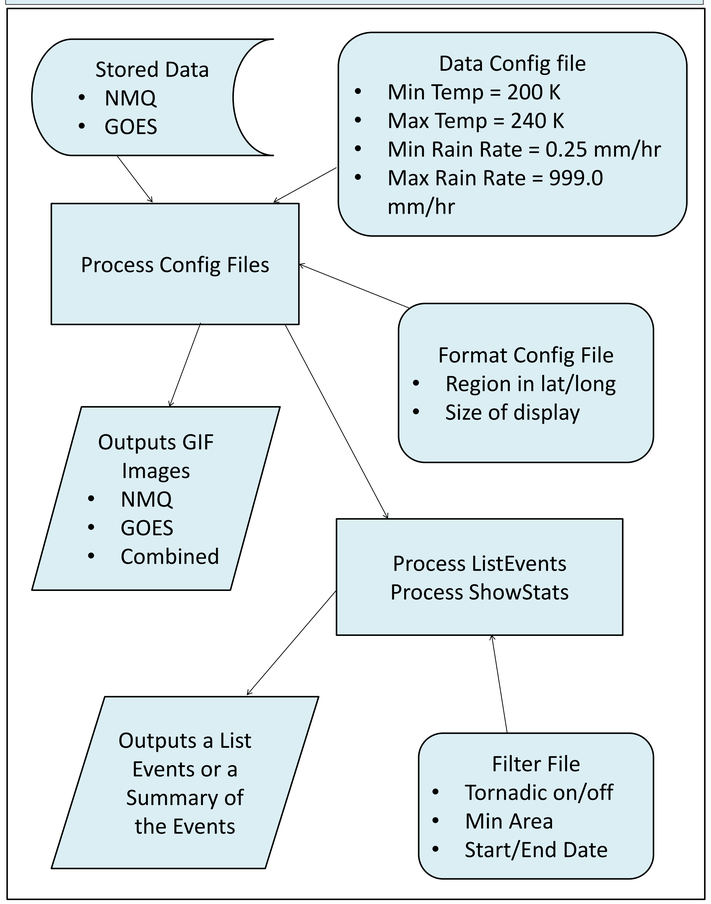
Abstract

Mesoscale convective systems (MCSs) can produce severe weather such as flooding, hail, lightning, wind gusts, and particularly tornados. The severe weather associated with MCSs is difficult to predict. Thus, our study, assisted with an automated software tool (Event Tracker), focuses on MCSs in the continental US with the hope to find distinguishing characteristics between tornadic (i.e. tornado producing, TP) and non-tornadic (NTP) MCSs. To compare TP and NTP MCSs we process 1-km, 5-minute NMQ 2D precipitation intensity data and 4-km, ~1/2 hourly GOES Rapid Scan Operations (RSO) satellite data associated with the MCSs during the dates of April 22 – 25 2010. The archived National Weather Service (NWS) Watches/Warnings database is used to determine whether a (potential) MCS area coincides with reported occurrence of tornado(s). The database compiled by the Tornado History Project is used as a supplementary source of information for the same purpose. In the course of these 4 days there was an explosion of ~88 tornados, with the most severe activity occurring in Mississippi. The statistics produced by Event Tracker show that TP MCSs are larger in area, last for longer periods of time, have higher rain rates and colder cloud top temperatures. However, more analysis covering a longer period of time is necessary to determine specific distinguishing characteristics of TP MCSs. The next step in our investigation will be to identify and track MCSs in the continental US over 5.5 years with the intent to determine discriminating features in TP MCSs, especially early in MCS lifecycle, that can help improve our nowcasting capabilities.

Methods



Results

Tornado Producing Events	
Number of Events	7
Area	**square km**
Min	1000
Max	1451387.92
Mean	517135.39
SDev	510334.20
Duration	**minutes**
Min	160
Max	1435
Mean	995.71
SDev	481.62
Rain Rate	**mm/hr**
Min	0.25
Max	100
Mean	2.71
SDev	6.18
Temperature	**K**
Min	194.60
Max	322.31
Mean	245.76
SDev	14.17

Non-Tornado Producing Events	
Number of Events	593
Area	**square km**
Min	1000
Max	98813.85
Mean	5298.87
SDev	10200.51
Duration	**Minutes**
Min	60
Max	1435
Mean	225.23
SDev	193.07
Rain Rate	**mm/hr**
Min	0.25
Max	99.83
Mean	1.02
SDev	2.01
Temperature	**K**
Min	213.18
Max	319.30
Mean	260.71
SDev	7.35

Table 1: Data produced by Event Tracker ShowStats Process using NMQ, GOES, and NWS archived Tornado Watches/Warnings for April 23-25 2010.

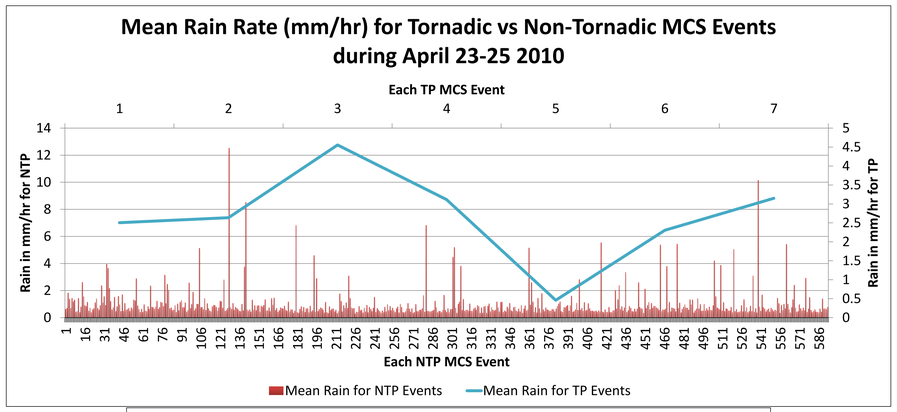


Figure 1: Mean rain rate for each NTP MCS (in red) and each TP MCS (in blue) during April 23-25 2010.

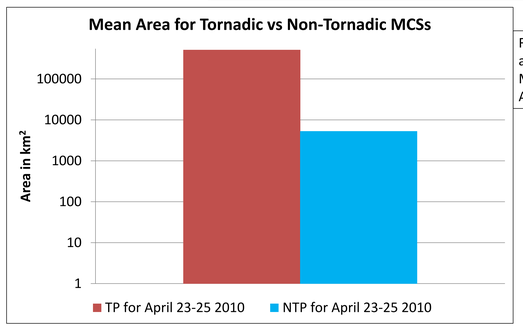


Figure 3: Mean area of TP vs NTP MCSs during April 23-25 2010.

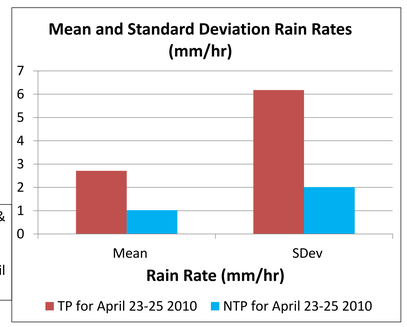


Figure 4: Mean & standard deviation of rain rates during April 23-25 2010.

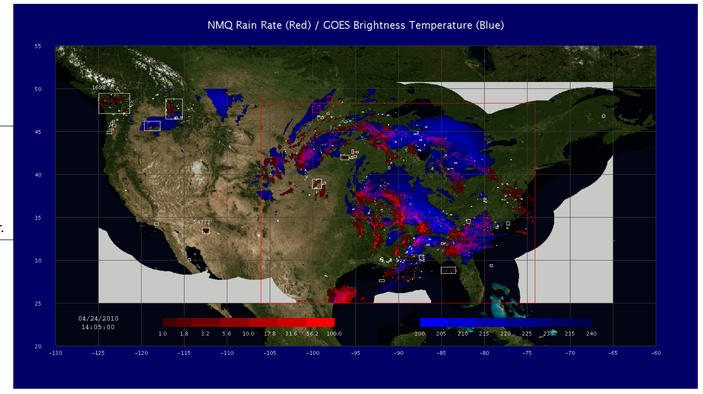


Figure 4: NMQ Rain Rate (mm/hr) combined with GOES Brightness Temperature (K) for April 24, 2010, 1405 Z. Image produced by Event Tracker.

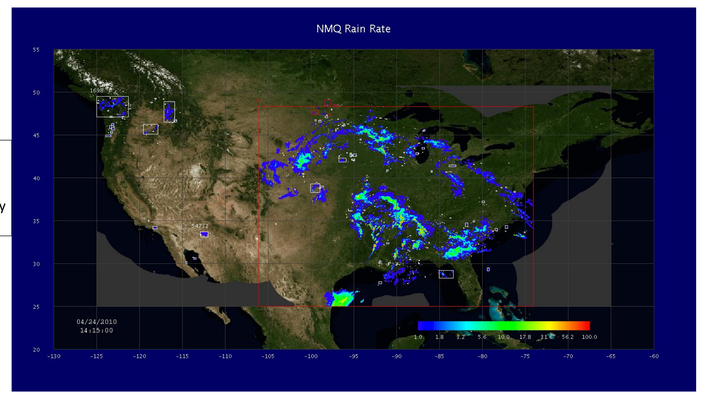


Figure 5: NMQ Rain Rate in mm/hr on April 24, 2010, 1415 Z. Image produced by Event Tracker

Conclusions

Based on statistics produced by Event Tracker TP MCSs compared to NTP MCSs during April 23-25 2010 have:

- Larger areas
- Longer durations
- Larger rain rates
- Colder cloud top temperatures

These conclusions are drawn from a short period of time of intense tornadic activity, however further investigation is needed covering a much longer period of time. In the next phase of our research, we plan to process 5.5 years of data. By comparing the statistics of TP vs. NTP MCSs we hope to identify discriminating features in structure/morphology and precipitation characteristics in their life cycles that can help improve our nowcasting capability for the occurrence of tornados

References & Acknowledgments

Houze, R. A. 2004: Mesoscale Convective Systems. *Reviews of Geophysics*, **42,** 1-43.

Jirak, I. L., W. R. Cotton, and R. L. McAnelly, 2003: Satellite and Radar Survey of Mesoscale Convective System Development. *Monthly Weather Review,* **131**, 2428–2449.

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