Improving understanding of supercell thunderstorms in Atlantic offshore zones

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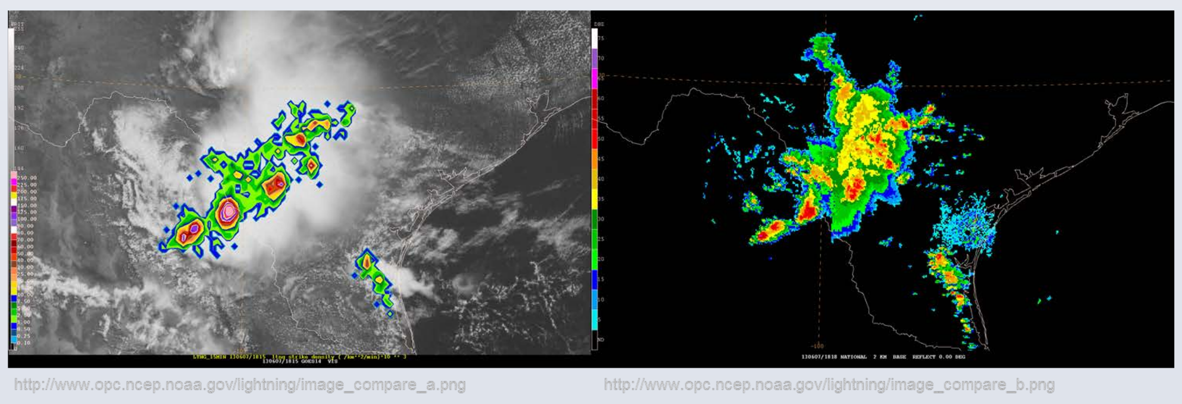
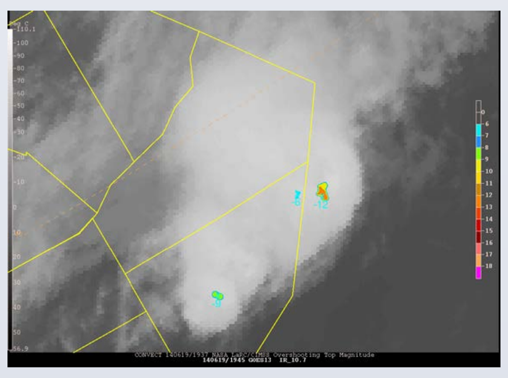
Introduction

Due to limitations in ground based severe weather detection systems, such as radar and certain lightning detections networks, identifying and forecasting convection over the ocean is more difficult than over land. The Ocean Prediction Center (OPC) is responsible for issuing forecasts and warnings for northern areas of the Atlantic and Pacific Oceans, where these limitations for severe weather detection are in effect. This project used available products to investigate supercell thunderstorms that passed through the OPC Atlantic Offshore Zones in order to have improved understanding of this type of convection and to possibly begin to develop a climatology for this area. Supercell thunderstorms are of particular interest to OPC due to the strong winds around them that can be a hazard to any mariners in the surrounding area.

This work also uses products from the GOES-R Proving Ground. The Proving Ground works to make sure that when the GOES-R satellite is launched and is operational, forecasters and scientists are prepared for the new data and can put it to good use. Here lightning density and overshooting top detection products similar to what will be produced by the Geostationary Lightning Mapper (GLM) and Advanced Baseline Imager (ABI) are used to demonstrate some of their capabilities and prepare forecasters for GOES-R's launch.

Data Products





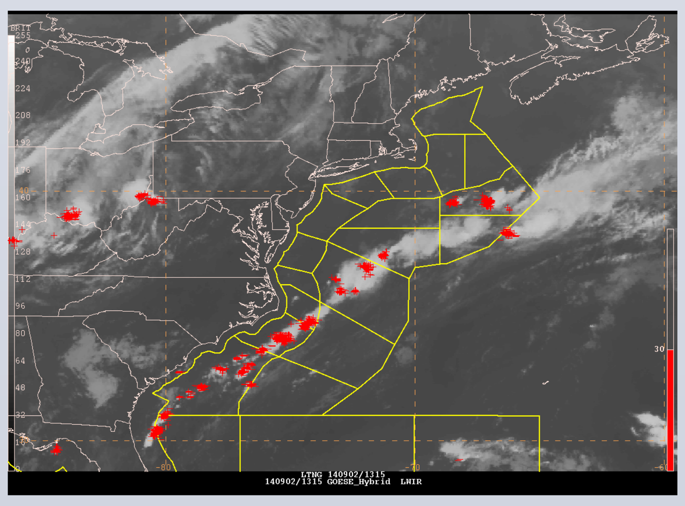
GOES-E IR Imagery: 4 km, 30 minute imagery at 10.7 µm wavelength (longwave IR)

National Radar: Base Reflectivity 2.00 (used in 1 case, when storms were close to shore)

GLD360 Lightning Strike and Density Datasets: Lightning products from Vaisala worldwide Very High Frequency (VHF) sensor systems. Lightning strike locations product used to identify times with convection, and GOES-R proving ground lightning density product used as proxy radar, demonstrated by **Left Figure** which shows lightning density products (left) vs national radar (right).

Overshooting Top Magnitudes: LaRC/CIMSS storm overshooting top magnitude product, shows locations of overshooting tops using geostationary IR brightness temperatures. (**Right Figure**)

Methods



Part 1: Using GOES-E IR imagery, with GLD360 lightning strike data, identify dates and times with convection throughout 2014. **Right Figure**: Example image of time with convection, with clouds visible in IR imagery and lightning strikes marks by red + and – signs.

Part 2: Using IR imagery, lightning strike density, cloud overshooting top magnitude, and national radar, identify and characterize supercells that passed through OPC Atlantic Offshore Zones during the first 6 months of 2014. Nine supercell case studies were also selected for a more complete analysis that could be presented to OPC forecasters to better inform marine convective forecasts.

Results

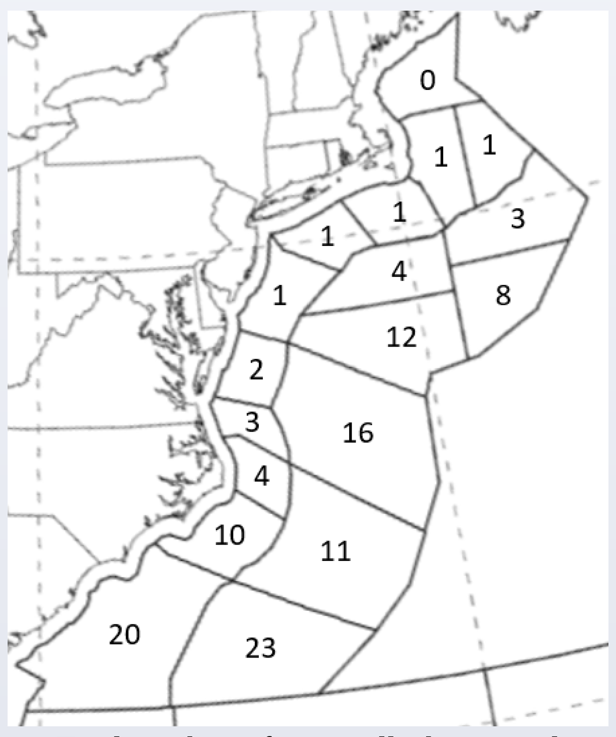
Month	January	February	March	April	May	June
# of Supercells	14	16	14	18	11	17

For each supercell identified that passed through OPC Atlantic Offshore Zones, a variety of information was collected. This included:

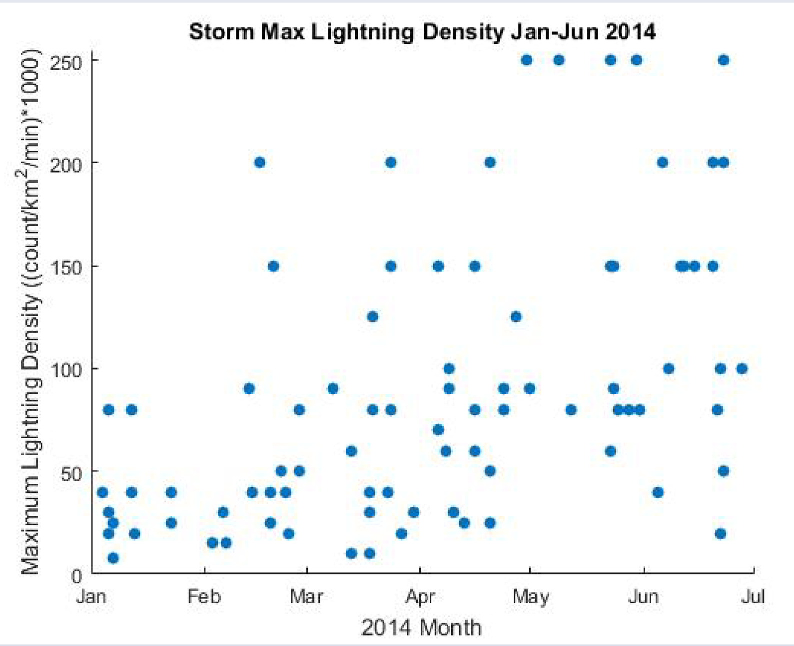
- General description of convection event
- Supercell starting time, latitude, and longitude
- Which OPC zones the supercell passed though
- Patterns in lightning density, IR Cloud Top Temperature, and overshooting top detection throughout life cycle, including max lightning density and largest overshooting top magnitude.

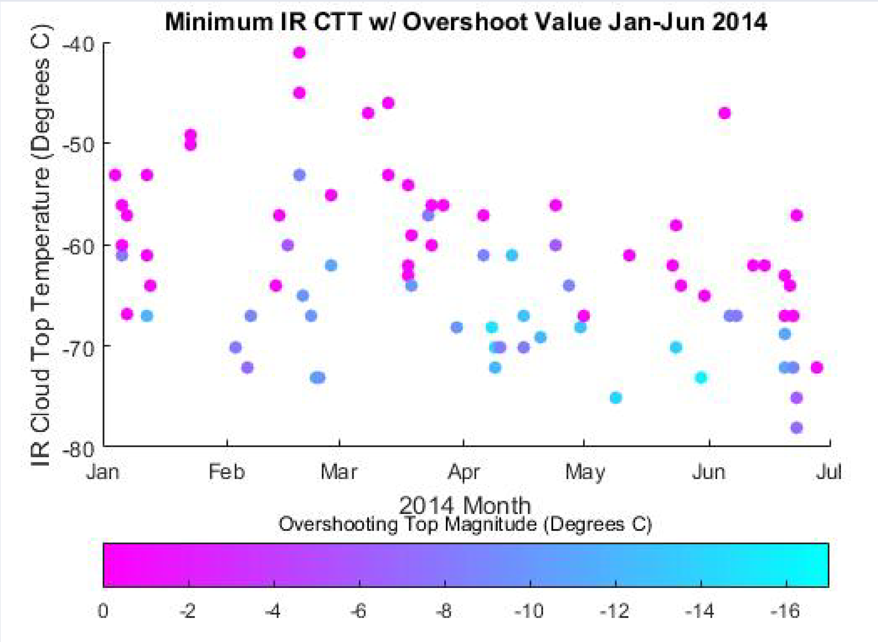
Some of these statistics are presented here.

Cases of interest were also selected for further evaluation and presentation to forecasters, such as the three examples below.



Total number of supercells that passed though each OPC zone.

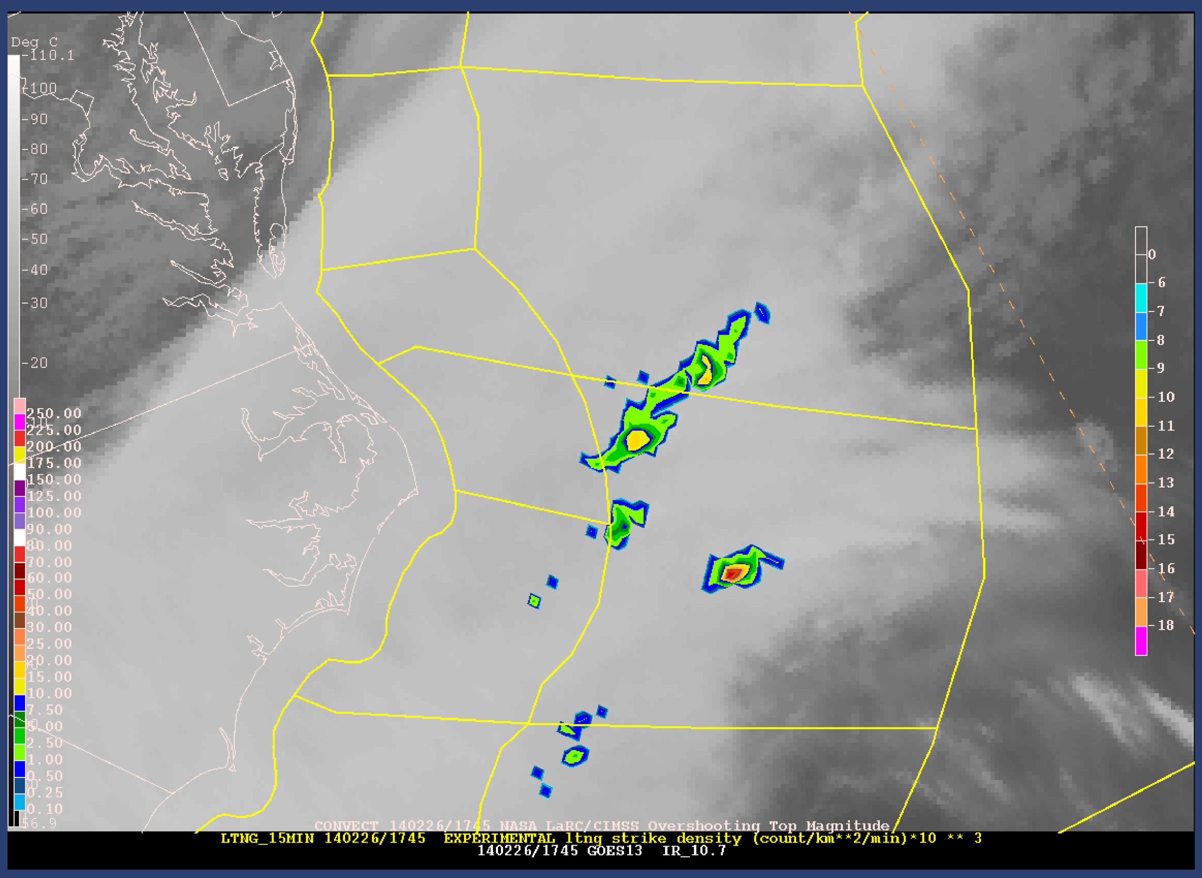




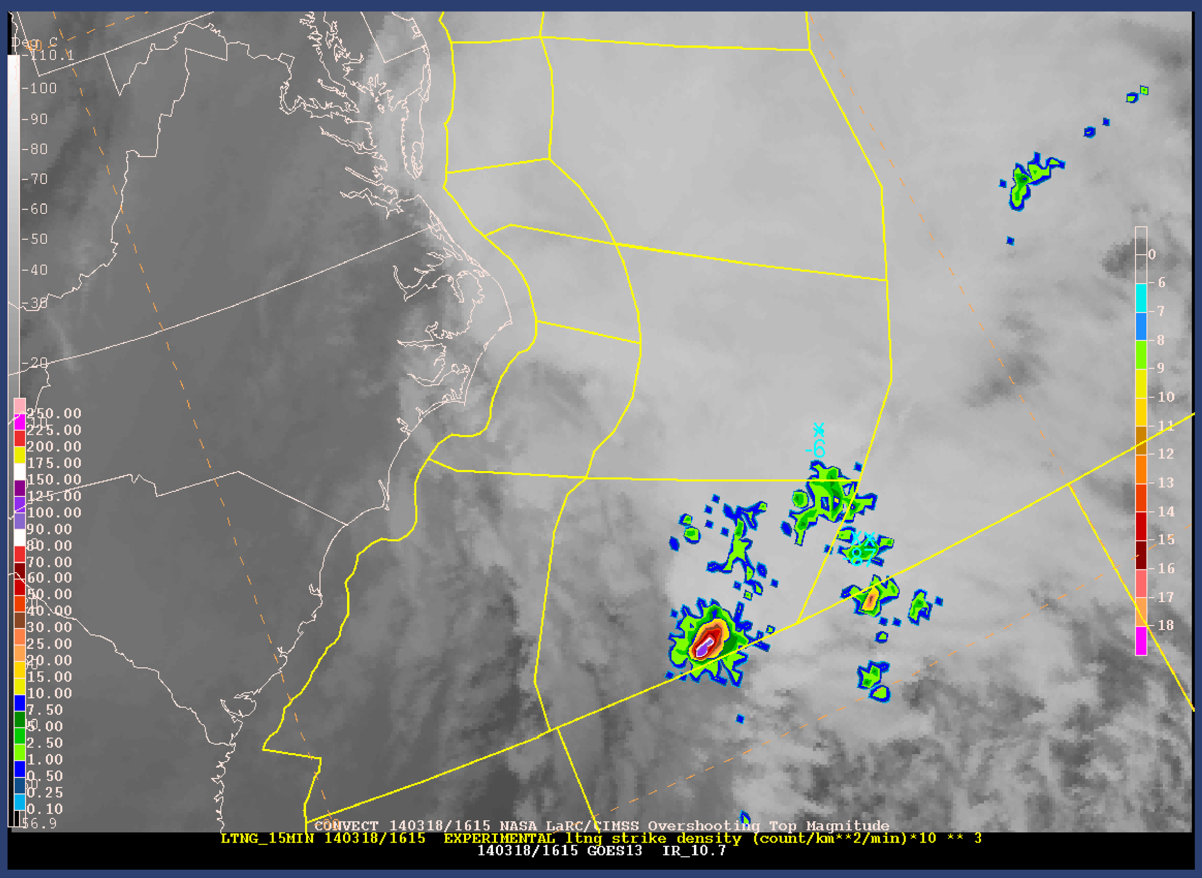
Discussion

Some clear patterns are present through the supercell statistics collected, including increasing lightning densities and decreasing cloud top IR temperatures as the year progresses, and spatial patterns with supercells far more common in southern OPC Atlantic Offshore Zones. Continuing research into other years and using better products could confirm these patterns and make it possible to better identify supercells as they are happening and allow forecasters to produce better marine convection forecasts. Due to the fact that supercells were identified by eye looking through a great deal of imagery, it is possible that some supercells, particularly weak or short lived supercells, were missed by this survey, or that some storms identified as supercells do not meet criteria for supercells detected over land. The upcoming Geostationary Lightning Mapper on GOES-R will bring products with improved detection of lightning in the Atlantic Offshore Zones, and imagery with higher spatial and temporal resolution, and may allow better identification of offshore supercells beyond the capabilities of the products used during this research. Improved understanding of offshore supercell thunderstorms through this research and further studies combined with more advanced imaging and lightning detection systems will hopefully contribute a great deal to advancing marine convective forecasts.

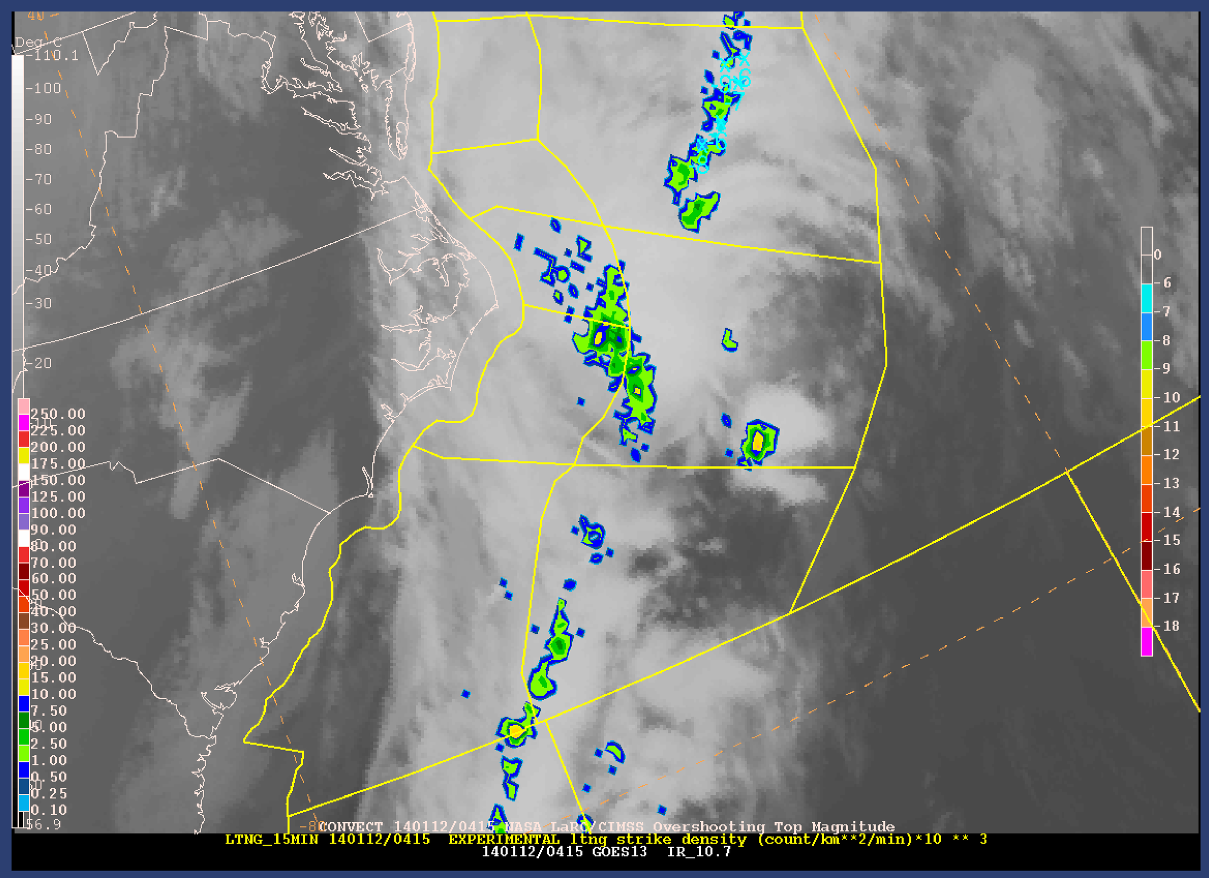
CASE STUDIES EXAMPLES



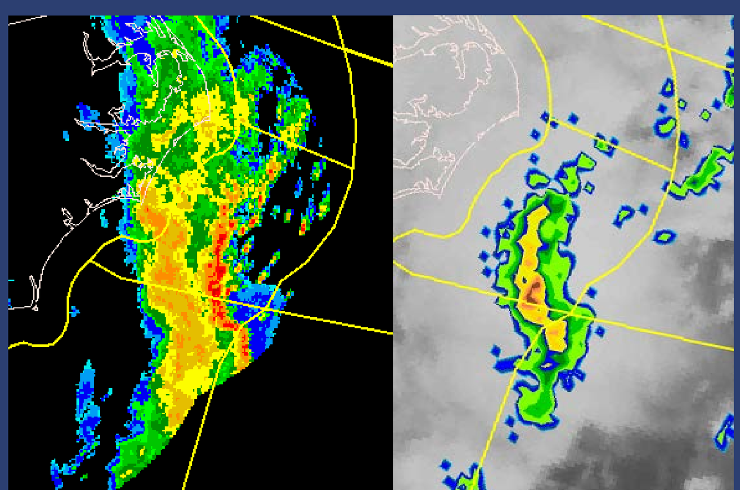
FEBRUARY 26: During this event, there is one particularly noticeable renegade supercell that lasts for approximately 6 hours ahead of other convection. Highest lightning density of 90 ((flash count/minute/kilometer^2)*10^3). No overshooting tops were detected during any of this time, and the IR cloud top temperature is -55.1 degrees Celsius. There are other questionable supercells present in OPC zones before and after this time, on the ends of short lines. These are not as long lasting, and have lower lightning densities in their cores. One of these questionable supercells does have an overshooting top detected.



MARCH 18: Multiple supercells are present in a warm season pattern that passes through southern OPC Atlantic Offshore Zones. Strongest supercell has a maximum lightning density of 125 ((flash count/minute/kilometer^2)*10^3) for a short period, a much higher density than other convection for the event. Overshooting tops were detected with a highest magnitude of -10 occurring just before the times with highest lightning density. This storm lasts for approximately 2 hours on the very southern edge of OPC Atlantic Offshore Zones.



JANUARY 12: Small possible supercells are visible ahead of the line on radar, but are not visible in the lightning density, with no overshooting tops (Figure: National Radar left, Lightning density right). Overshooting tops were detected further north, separate from the highest lightning densities. A larger supercell is also visible further east, out of range of radar, with no overshoot detections, but high lightning density.



Acknowledgements and References

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