The Effectiveness of Using Total Lightning for Severe Weather Prediction: A Performance Analysis of Earth Networks Dangerous Thunderstorm Alerts for 2016

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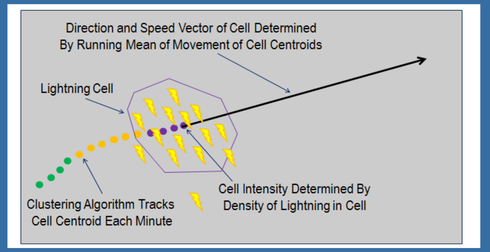
INTRODUCTION

Since 2009, the Earth Networks Total Lightning Network (ENTLN) has been utilized to track the properties of storms cells, such as lightning flash rate and cell movement, as a basis for issuing alerts for thunderstorms that have potential for severe weather. From this storm cell data, Earth Networks produces the Earth Networks Dangerous Thunderstorm Alert (ENDTA), which is an auto-generated short-fused polygon prepared by the total lightning cell tracking system.

The fully automated system tracks lightning cells within convective systems using clustering algorithms to locate the storm cells on a minute to minute basis. Flash rates are then calculated, and when exceedance of critical thresholds is achieved, a Dangerous Thunderstorm Alert (DTA) is issued. The DTA is re-issued every 15 minutes as long as the flash rate remains above threshold. The alert system uses unique Valid Time Event Codes to insure clients and consumers only receive one alert – despite possibly being inside a re-issued DTA.

The purpose of this analysis is to develop a standard for comparison – comparing the completely automated, flash rate driven ENDTAs to the NWS – whose alerting process, efficiency and accuracy is considered the best in the world.

THE EARTH NETWORKS DANGEROUS THUNDERSTORM ALERT SYSTEM



Lightning Cells/Cell Tracks

- Given Cell ID when flash rate > 2/min
- Cell location, size, speed and direction updated each minute
- Clustering handles merging and

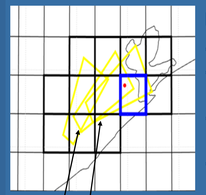
Lightning Flash Rates

- Tracks CG, IC and combined rates
- Tracks flash rate change, or jump

Lightning Cell Polygons

- Level 1 – flash rate > 2/min
- Level 2 – flash rate > 12/min
- DTA – flash rate > 25 (winter and west of 104 degrees west) or flash rate > 45/min (Summer and east of 104 degrees west)

LEADTIME CALCULATION METHOD



LSR timestamp: Jan. 8 20:10:00

- DTA's based off Cell ID's
- Consists of single or multiple polygons
- For each LSR, corresponding DTAs were found
- Each start time is subtracted from LSR timestamp

Cell polygon issue times (15 minute updates)
19:39 Difference: 31 minutes (Accepted lead time)
19:44 Difference: 26 minutes (Lead time discarded)

POD AND FAR METHODS

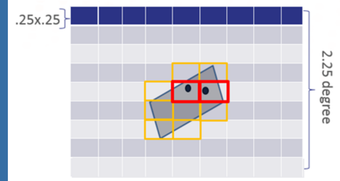
Probability of Detection (POD), **False Alarm Ratio** (FAR) and **Lead Time** calculations were evaluated using the 2016 Local Storm Reports (LSRs) as the ground truth for verifying an "event" had occurred. The continental U.S. was divided into 15 zones to track if there were any geographical differences in the statistics.

Probability of Detection is simply the probability that an LSR was captured by a warning polygon. It is computed as the ratio of LSR's alerted by NWS and ENDTA warning polygons divided by the number of total LSRs.

The **False Alarm Ratio** was calculated using two methods. The first method is referred to as the Area Method while the second is referred to as the Binary Method.

	Observed -YES	Observed - NO
Alerted - Yes	N1	N2
Alerted - No	N3	N4

Area Method: N1 = 2; N2 = 8; N3 = 0; N4 = 71
FAR = N2/(N1+N2) = 8/8+2 = 0.8



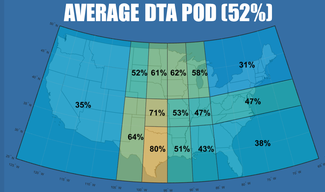
Binary Method: If LSR observed inside warning polygon, FAR = 0. Else, FAR = 1
FAR = 0

POD AND FAR RESULTS

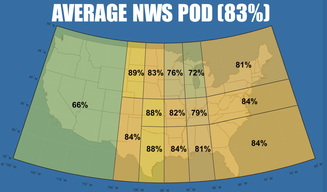
LX SENSOR LOCATIONS

ZONE MAP

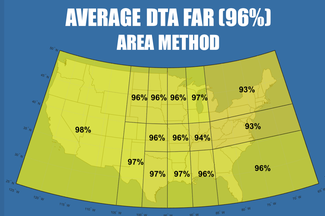
AVERAGE DTA POD (52%)



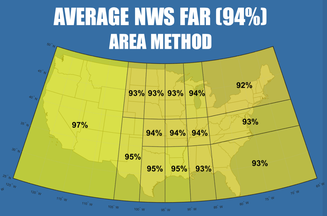
AVERAGE NWS POD (83%)



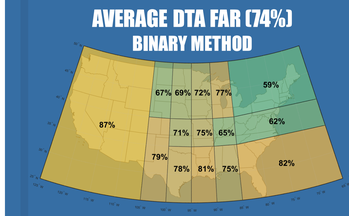
AVERAGE DTA FAR (96%) AREA METHOD



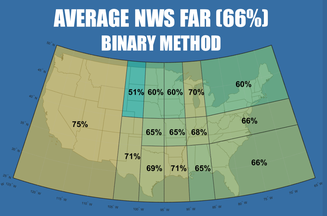
AVERAGE NWS FAR (94%) AREA METHOD



AVERAGE DTA FAR (74%) BINARY METHOD



AVERAGE NWS FAR (66%) BINARY METHOD



LEADTIME RESULTS

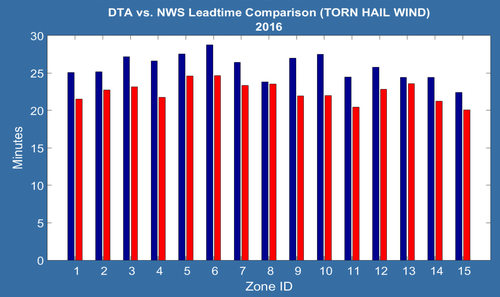
2016 Lead Times: All Severe Events w/ Lightning

Total LSR Reports – 23,657

Alerted by NWS: 19,517 (83%)
NWS Mean Lead Time: 22 Minutes

Alerted by DTAs: 12,408 (52%)
DTA Mean Lead Time – 26 Minutes

Alerted by both EN DTA and NWS: 11,294
NWS Matched Mean Lead Time – 24 min
DTA Matched Mean Lead Time – 26 min



Separate/Unique	Tornado	Hail	Wind
DTA Lead Time (min)	28	27	25
NWS Lead Time (min)	24	21	23

CONCLUSIONS

For storms with sufficient lightning rates, it is shown that the Earth Networks automated alerting system presents a significant contribution to lead time as compared to NWS alerts. Automating an alert (ENDTA) for a significant storm based on high lightning rates can add crucial minutes of situational awareness to the consumer. The verification process for ENDTAs is much different from that of the NWS, where storm reports are actively sought out to verify issued NWS alerts. This is probably the most significant reason for the variance in the validations for POD and FAR.