

Verification of Thunderstorm Occurrence Using the National Lightning Detection Network

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Introduction and Motivation

The background of the slide is a dramatic photograph of a thunderstorm at night. Several bright, jagged lightning bolts are visible, striking down from a dark, cloudy sky. The lower portion of the image shows a dark silhouette of a treeline or city skyline against a faint orange glow on the horizon, suggesting a sunset or sunrise during the storm.

- **Since 1983, a daily thunderstorm (TS) probability forecast contest has been organized by the University at Albany**
- **The contest involves predicting the probability that a TS will be reported at ten locations across the U.S.**
- **The forecasts are verified by standard METAR reports and scored against consensus and a 15 year TS climatology (1995-2009)**

TRW Forecast Game

As CORBOSIERO [Logout]

Calendar

Deadline: 1:45. Current Time: 08:11

#	Mon	Tue	Wed	Thu	Fri	Links	City	Prob. Thunder
1	Jun-04	Jun-05	Jun-06	Jun-07	Jun-08	Scores and F.O.W.	Albany, NY	0: 0%
2	Jun-11	Jun-12	Jun-13	Jun-14	Jun-15	Scores and F.O.W.	Greensboro, NC	0: 0%
3	Jun-18	Jun-19	Jun-20	Jun-21	Jun-22	Scores and F.O.W.	Nashville, TN	0: 0%
4	Jun-25	Jun-26	Jun-27	Jun-28	Jun-29	Scores and F.O.W.	Tampa, FL	0: 0%
5	Jul-02	Jul-03	Jul-04	Jul-05	Jul-06	Scores and F.O.W.	Oklahoma City, OK	0: 0%
6	Jul-09	Jul-10	Jul-11	Jul-12	Jul-13	Scores and F.O.W.	Omaha, NE	0: 0%
7	Jul-16	Jul-17	Jul-18	Jul-19	Jul-20	Scores and F.O.W.	Springfield, IL	0: 0%
8	Jul-23	Jul-24	Jul-25	Jul-26	Jul-27	Scores and F.O.W.	Bismarck, ND	0: 0%
9	Jul-30	Jul-31	Aug-01	Aug-02	Aug-03	Scores and F.O.W.	Denver, CO	0: 0%
10	Aug-06	Aug-07	Aug-08	Aug-09	Aug-10	Scores and F.O.W.	Salt Lake City, UT	0: 0%
11	Aug-13	Aug-14	Aug-15	Aug-16	Aug-17	Scores and F.O.W.		
12	Aug-20	Aug-21				Scores and F.O.W.		

Official Scores through August 21, 2012 Versus Consensus

COMPOSITE RANKING OF FORECASTERS

#	Name	Entries	Score
1	ENCON	300	1.70
2	*CONSENSUS*	450	0.00
3	Ross Lazear	320	-0.11
4	Andrea Lang	310	-1.82
5	Ernesto Findlay	420	-5.86
6	Patrick Duran	300	-5.92
7	Kevin Tyle	260	-6.40
8	Bob Ballentine	400	-7.29
9	Kristen Corbosiero	290	-8.27
10	Arielle Ahrens	300	-12.38
11	Michael Eckert	250	-12.89
12	Tom Wasula	310	-13.13
13	Gabe Susca-Lopata	330	-14.69
14	Jason Keefer	400	-16.08
15	Tim Humphrey	280	-17.50
16	Aaron Treadway	360	-21.54
17	*NAM*	450	-31.55
18	*GFS*	450	-36.26
19	*CLIMATOLOGY*	450	-43.67

Submit/Edit My Entry

Current MOS/CLIMO Entry

MOS	*CLIMATOLOGY*
2	Albany, NY
3	Greensboro, NC
3	Nashville, TN
4	Tampa, FL
3	Oklahoma City, OK
3	Omaha, NE
2	Springfield, IL
3	Bismarck, ND
4	Denver, CO
2	Salt Lake City, UT

DAES Contest Consensus, Entry, and Verification Viewer

VERIFICATION TABLE - 6/6/2012

KALB	KGSO	KBNA	KTPA	KOKC	KOMA	KSPI	KBIS	KDEN	KSLC
T/10	N/0	N/0	T/10	T/10	N/0	N/0	N/0	T/10	N/0

M = Missing, N = No Thunder, L = Lgt Observed, no Thunder, T = Thunder, G = Gift 10 Thunder; N and D verify as "0", T verifies as "10" [Go Back to Contest Page](#)

COMPLETE CONSENSUS TABLE - 6/6/2012

KALB	KGSO	KBNA	KTPA	KOKC	KOMA	KSPI	KBIS	KDEN	KSLC
4	2	0	7	7	1	0	6	7	0

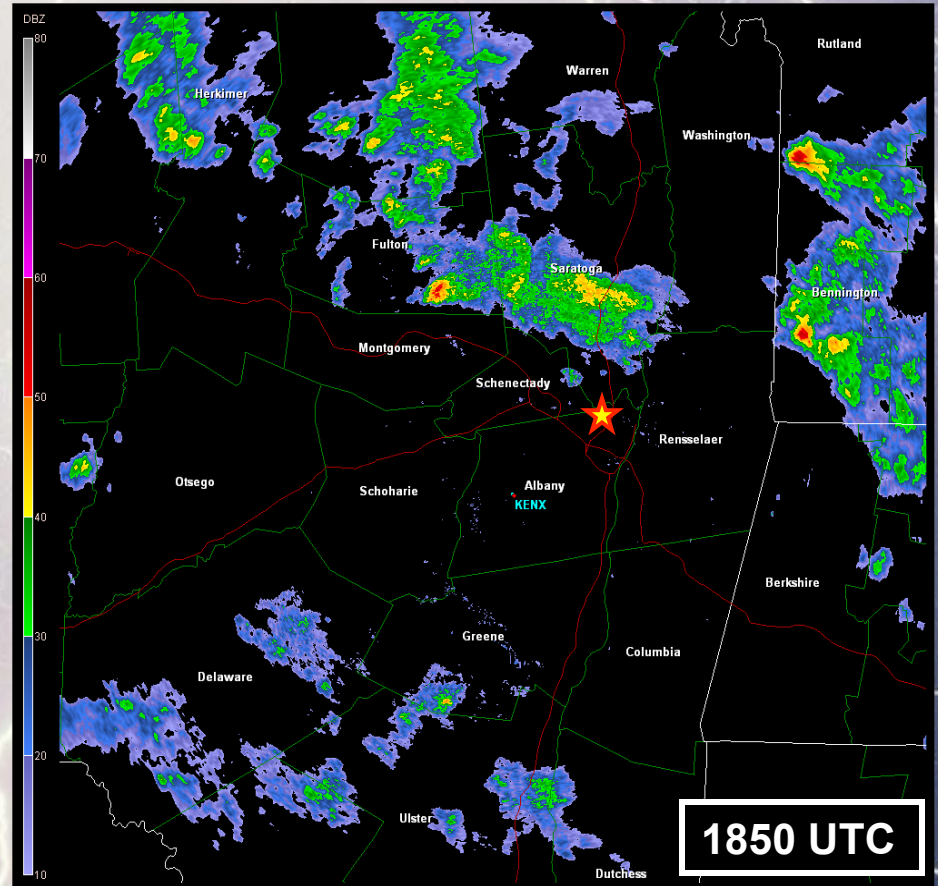
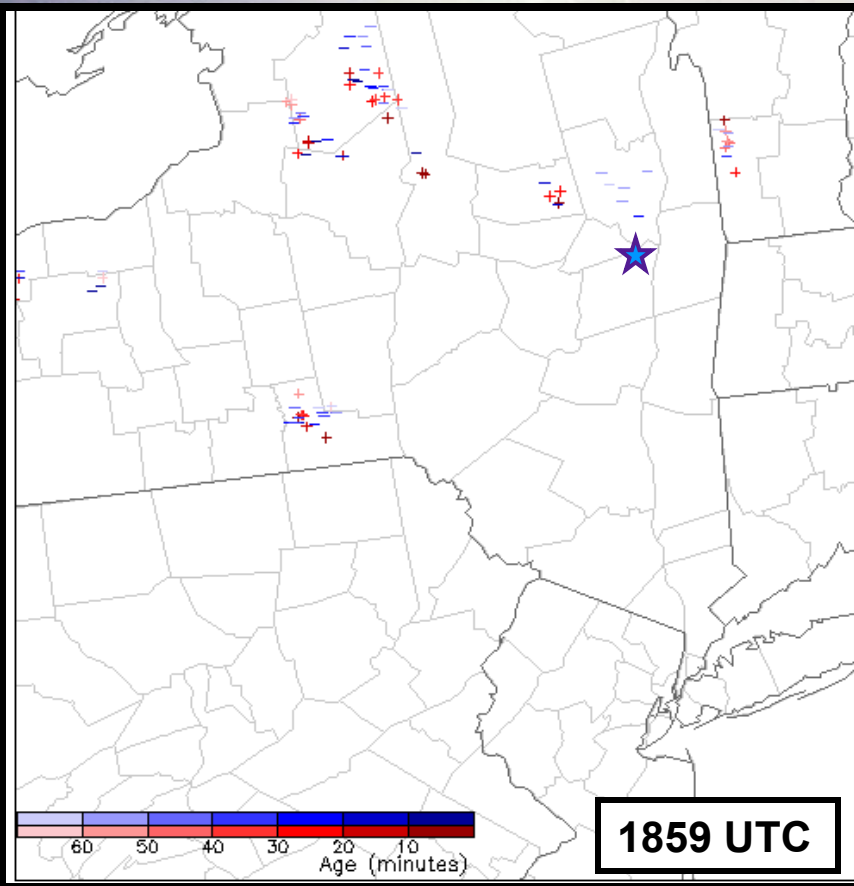
ENTRIES AND RANGES

FORECASTER	KALB	KGSO	KBNA	KTPA	KOKC	KOMA	KSPI	KBIS	KDEN	KSLC
CONSENSUS	4	2	0	7	7	1	0	6	7	0
(26)	1/10	0/6	0/1	4/10	4/10	0/3	0/2	2/10	2/10	0/0
CLIMATOLOGY†	2	3	3	5	3	3	3	3	4	2
GFS†	4	2	0	8	7	2	0	9	10	0
NAM†	2	2	0	8	6	3	0	5	10	0
Arielle Ahrens	7	2	0	7	10	0	0	5	10	0
Bob Ballentine	3	3	0	7	6	1	0	4	6	0
Kristen Corbosiero	3	1	0	6	7	0	0	6	7	0
Zach Davis	2	1	1	5	9	3	2	2	7	0
Patrick Duran	2	1	0	7	6	0	0	6	7	0
Michael Eckert	1	2	0	4	5	1	0	5	5	0
ENCON	4	2	0	7	8	0	0	6	7	0
Ernesto Findlay	3	1	0	8	5	0	0	7	8	0
Larry Gloeckler	5	0	0	7	5	0	0	9	6	0
Jason Keefer	1	2	1	7	4	3	0	5	9	0
Joe Kriss	5	6	1	9	7	0	0	8	7	0
Andrea Lang	1	1	0	6	8	0	0	5	6	0
Ross Lazear	5	1	0	7	6	0	0	7	7	0
Brent McGrady	10	1	0	9	10	0	0	7	9	0
Nick Metz	5	2	0	4	8	0	0	6	4	0
Adrian Mitchell	5	1	0	7	7	0	0	8	7	0
Philippe Papin	9	1	0	8	9	2	0	6	8	0
Scott Runyon	9	3	0	7	8	2	0	8	9	0
Nicholas Schiraldi	3	0	0	7	5	1	0	2	5	0
Brandon Smith	4	2	0	8	6	0	0	6	5	0
Stephanie Stevenson	1	1	0	6	9	0	0	3	2	0
Dan Thompson	5	1	0	7	10	1	0	5	7	0
Katie Towey	3	1	0	7	7	0	0	9	10	0
Aaron Treadway	2	2	0	4	7	0	0	6	6	0
Mike Ventrice	8	1	0	10	9	0	0	10	10	0
Michael Vuotto	2	2	0	7	9	0	0	8	6	0

† Not used in Consensus Calculation * denotes Corrected

* A Gift-10 Verification treats every entry for that city (except Climo) as an entry of 10.

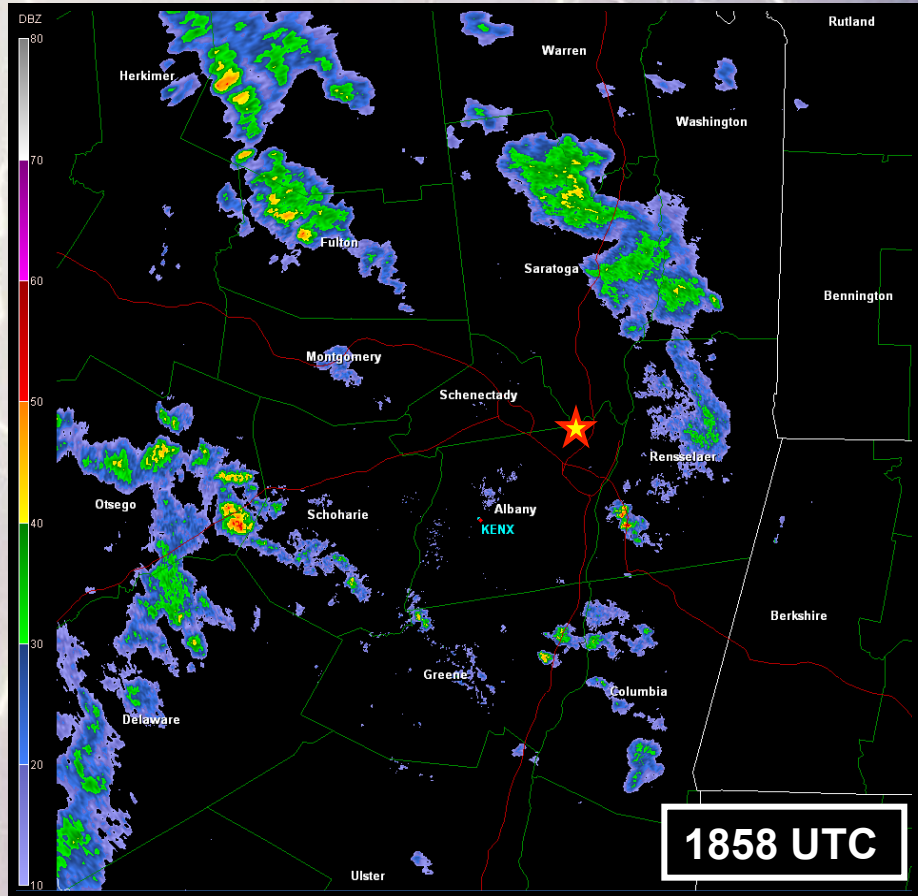
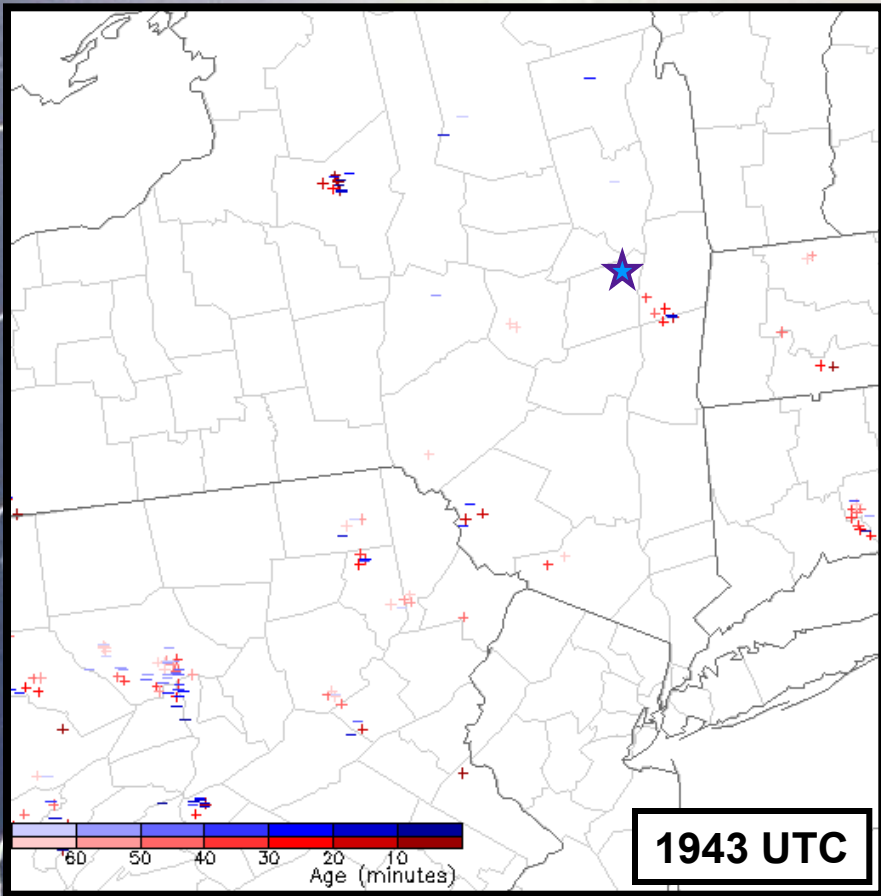
[Go Back to Contest Page](#)



KALB 061751Z 31006KT 10SM SCT040 BKN130 20/11 A2995 RMK AO2
SLP141 **CB DSNT N** 60000 T02000106 10200 20111 58016

KALB 061851Z 00000KT 10SM **TS** BKN044**CB** BKN075 BKN250 21/11 A2994
RMK AO2 TSB48 SLP140 **OCNL LTGCG VC NW-N TS VC NW-N MOV S VCSH**
NW-NE T02060106

KALB 061935Z 36011G16KT 10SM FEW048 SCT065 BKN100 19/10 A2995
RMK AO2 TSE34 **CB DSNT NW VCSH NW**



**KALB 071751Z VRB04KT 10SM SCT045 SCT100 BKN160 BKN250 22/09
A2993**

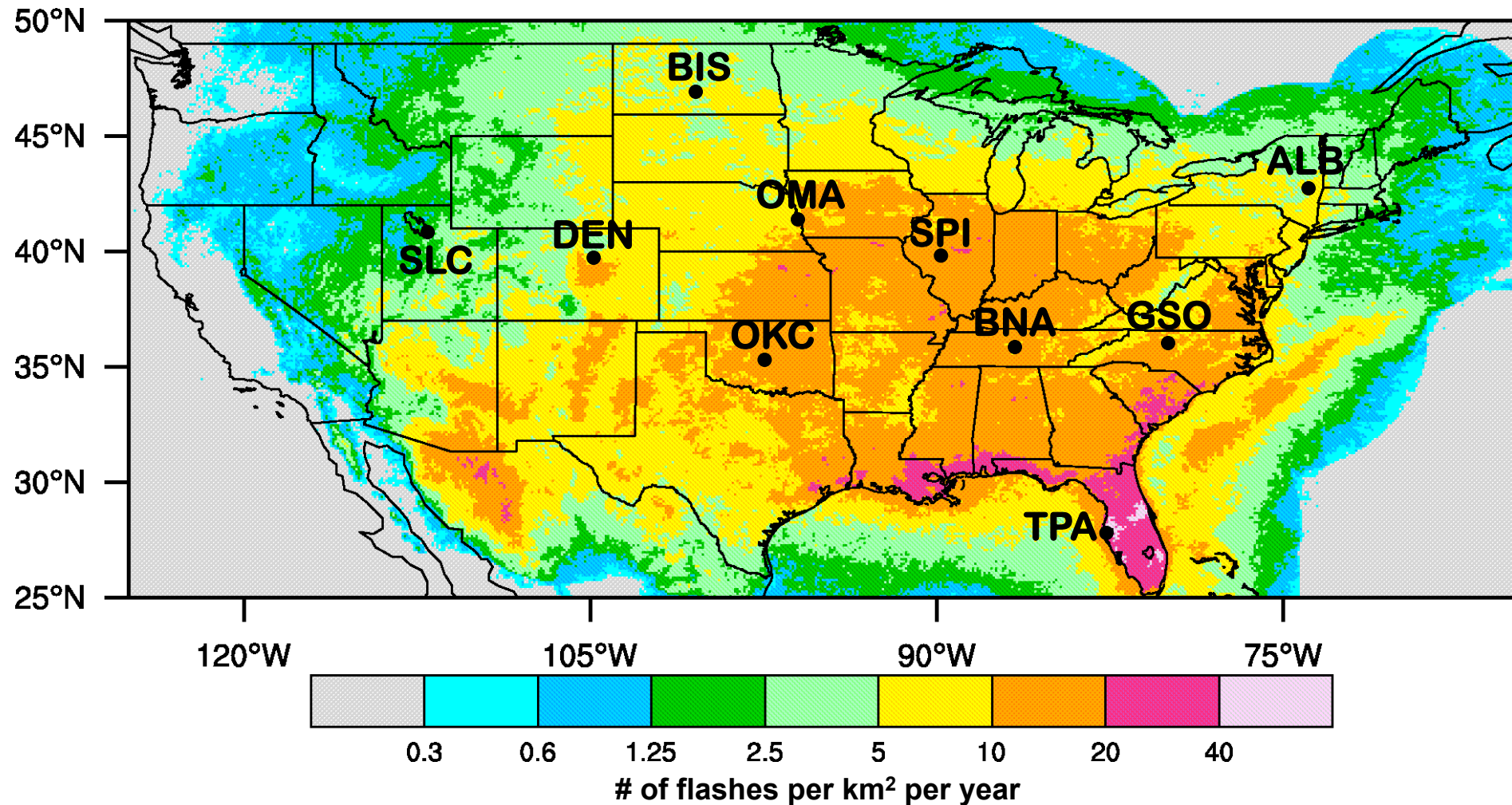
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22/11 A2994**

**KALB 071951Z 05011KT 10SM SCT045 SCT095 BKN130 BKN220 21/11
A2994**

Introduction and Motivation

- **Each year there are several instances in which a TS fails to be reported despite its suspected occurrence**
- **During such instances, the forecast contest is verified by contacting the NWS office and examining WSR-88D and NLDN data**
- **Given its continuous space and time coverage, an average detection efficiency of $>95\%$ and mean location errors of <500 m, we explore using the NLDN to verify TS occurrence**

1995-2009 NLDN Flash Density Map with the 10 Albany TS game cities



Percentage of days per month with a METAR TS or NLDN flash within X km

June 2001-2011

METAR		5	10	15	20
.19	ALB	.13	.18	.22	.25
.24	BWI	.18	.26	.31	.35
.28	GSO	.18	.27	.31	.36
.35	CHS	.25	.35	.44	.51
.44	MIA	.39	.56	.61	.68
.45	TPA	.39	.53	.62	.67
.20	DTW	.15	.20	.23	.27
.28	MGM	.20	.29	.36	.42
.28	BNA	.22	.34	.37	.42
.26	SPI	.22	.27	.30	.33
.27	MSP	.17	.24	.28	.32
.30	IAH	.26	.35	.40	.43
.30	OMA	.19	.28	.33	.36
.29	OKC	.23	.27	.32	.35
.25	BIS	.15	.21	.26	.31
.20	MAF	.13	.19	.25	.29
.38	DEN	.18	.29	.36	.40
.05	TUS	.04	.06	.07	.09
.14	GTF	.10	.15	.18	.20
.18	SLC	.06	.13	.18	.22

July 2001-2011

METAR		5	10	15	20
.17	ALB	.13	.18	.23	.26
.24	BWI	.19	.27	.33	.36
.35	GSO	.21	.30	.35	.41
.42	CHS	.32	.41	.47	.52
.41	MIA	.41	.55	.65	.70
.55	TPA	.48	.66	.76	.81
.23	DTW	.16	.23	.29	.32
.37	MGM	.28	.42	.50	.54
.25	BNA	.20	.28	.34	.38
.18	SPI	.16	.21	.25	.26
.21	MSP	.15	.20	.23	.26
.38	IAH	.32	.43	.51	.58
.25	OMA	.16	.21	.25	.28
.17	OKC	.13	.17	.21	.24
.28	BIS	.19	.26	.28	.33
.17	MAF	.10	.15	.17	.22
.43	DEN	.22	.33	.41	.48
.35	TUS	.26	.39	.51	.56
.14	GTF	.10	.17	.22	.28
.19	SLC	.07	.14	.19	.23

August 2001-2011

METAR		5	10	15	20
.16	ALB	.12	.14	.21	.23
.20	BWI	.15	.21	.26	.29
.24	GSO	.14	.20	.26	.32
.37	CHS	.26	.35	.43	.53
.41	MIA	.50	.61	.68	.76
.54	TPA	.46	.62	.74	.80
.15	DTW	.09	.16	.21	.24
.29	MGM	.19	.31	.40	.47
.22	BNA	.18	.26	.32	.35
.18	SPI	.16	.22	.26	.28
.20	MSP	.15	.19	.21	.23
.30	IAH	.28	.33	.39	.44
.23	OMA	.18	.22	.25	.28
.24	OKC	.18	.23	.27	.30
.19	BIS	.13	.17	.21	.24
.21	MAF	.15	.21	.26	.30
.38	DEN	.20	.31	.40	.45
.39	TUS	.24	.35	.43	.54
.12	GTF	.06	.14	.17	.23
.22	SLC	.11	.19	.23	.28

- Although there is significant variability, the **10 km** NLDN radial ring **best matches** METAR TS occurrence
- Miami has **more** days with **lightning** within 5 km of the station **than METAR TS** days

If the NLDN detects lightning within X km of a station, what percentage of the time does that station report a TS?

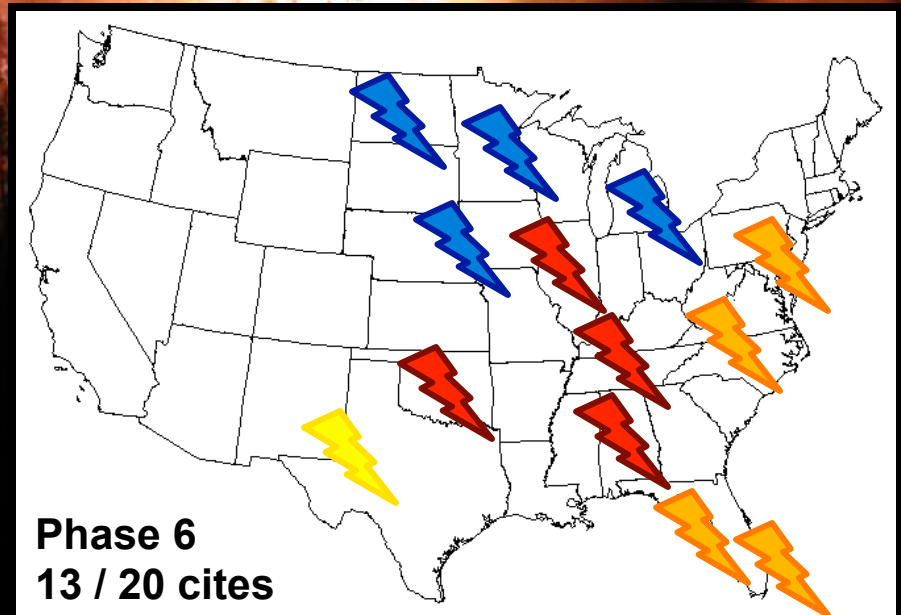
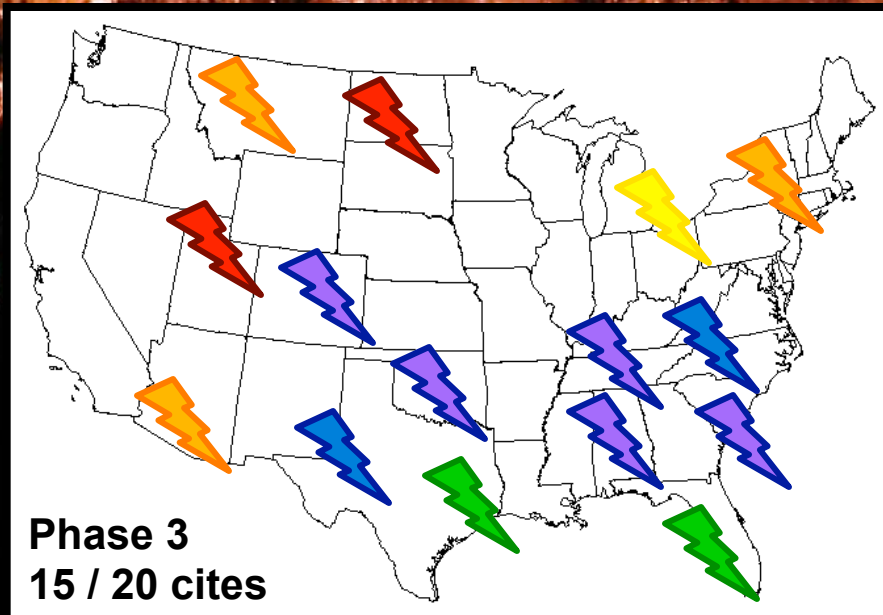
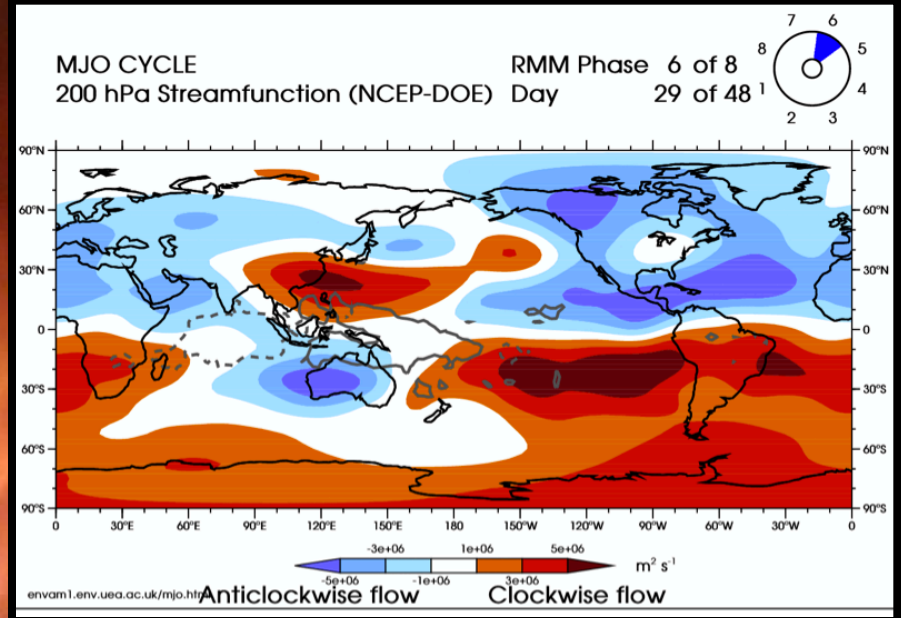
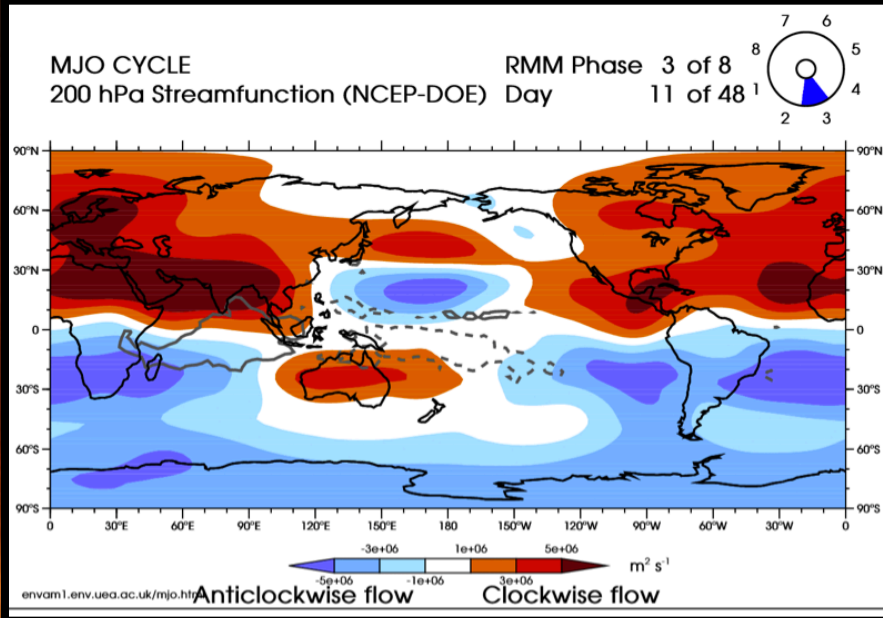
Station	5	10	15	20
ALB	90	82	71	65
BWI	94	83	74	67
GSO	96	88	84	74
CHS	96	90	81	75
MIA	82	71	65	59
TPA	91	80	72	67
DTW	90	80	73	65
MGM	89	80	71	65
BNA	86	79	70	64
SPI	86	79	76	71
MSP	99	92	88	82
IAH	90	82	72	66
OMA	96	93	89	82
OKC	97	91	83	77
BIS	93	88	85	80
MAF	91	85	78	70
DEN	98	96	92	87
TUS	81	71	72	68
GTF	78	71	60	53
SLC	97	91	86	77
Average	91	84	77	71

If a TS is reported by a station, what percentage of the time does the NLDN detect lightning within X km?

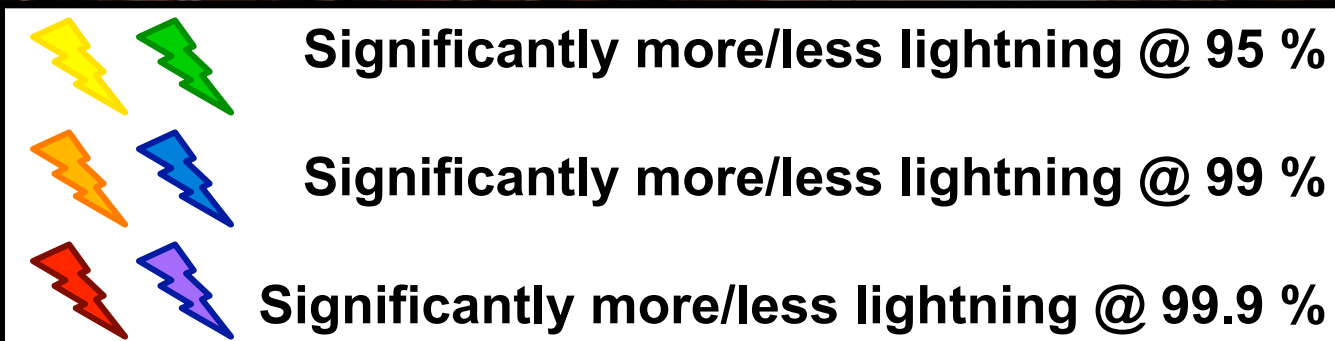
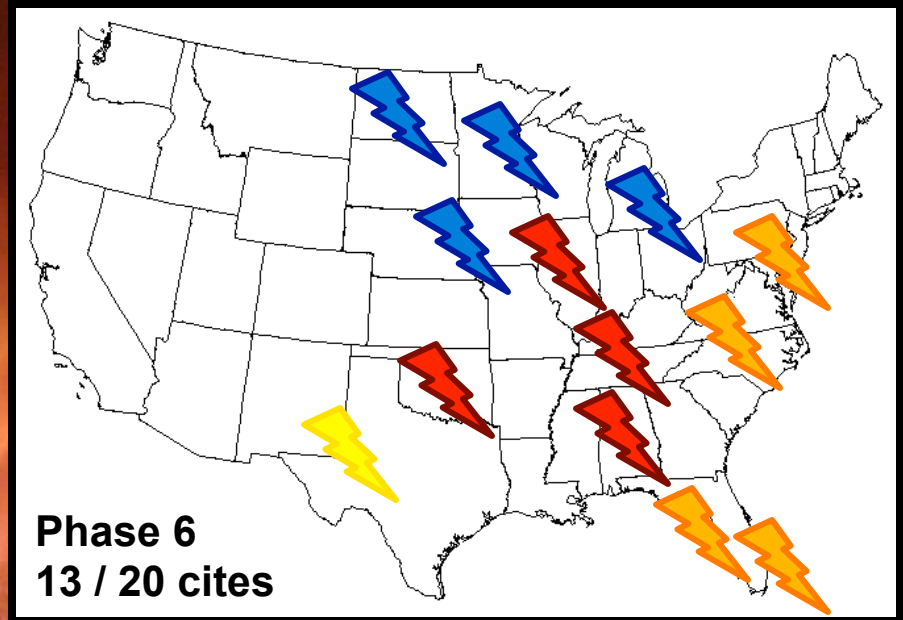
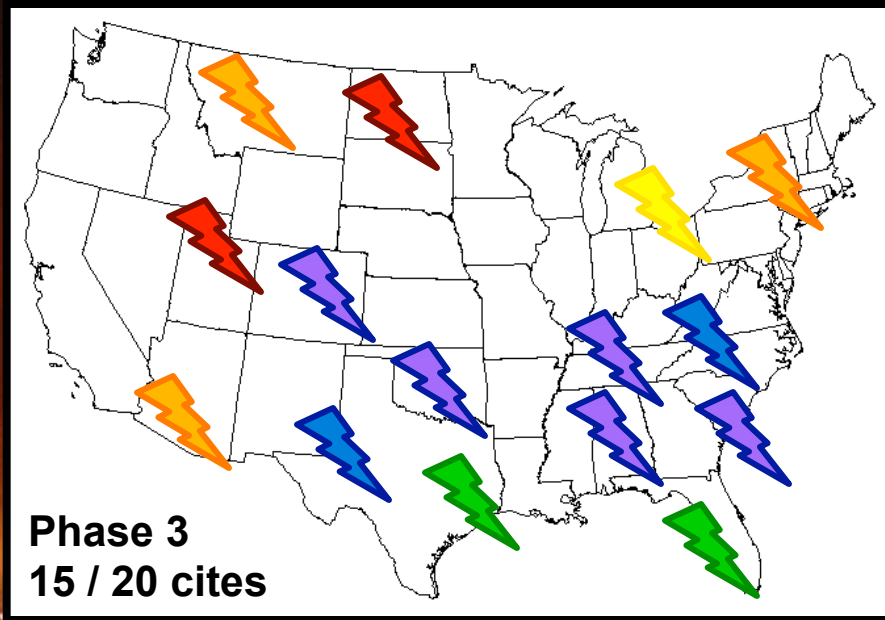
Station	5	10	15	20
ALB	66	78	89	92
BWI	71	87	95	97
GSO	57	76	87	94
CHS	69	87	96	98
MIA	81	96	99	99
TPA	79	95	100	100
DTW	62	83	89	93
MGM	65	87	96	98
BNA	71	92	97	98
SPI	74	89	96	100
MSP	68	85	95	98
IAH	81	95	97	99
OMA	66	84	94	96
OKC	74	87	94	97
BIS	59	78	88	97
MAF	58	78	95	95
DEN	50	75	91	97
TUS	58	80	92	100
GTF	55	85	90	94
SLC	40	70	96	96
Average	65	84	94	97

- ~ MSP, OKC, OMA and DEN are **excellent verifiers**; i.e., when there is lightning within 10 km, a TS is reported
- ~ MIA, TUS and GTF have **very poor verification**; there is a high percentage of days with lightning within 5 km when no TS is reported
- ~ Stations in the **western U.S.** (DEN, SLC, BIS, GTF) verify with lightning at much farther distances than stations in the **east**

Relationship between U.S. lightning and the MJO



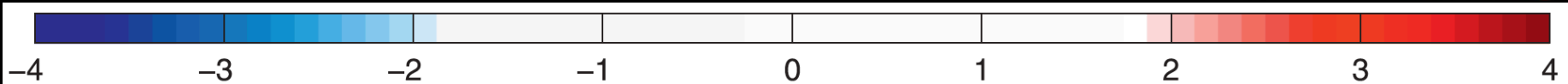
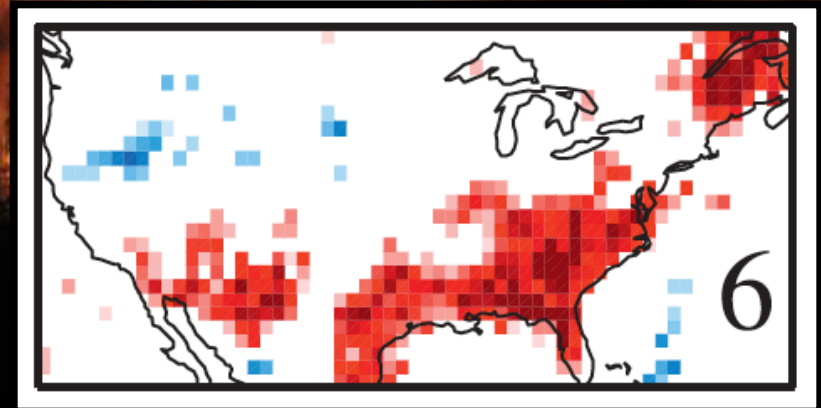
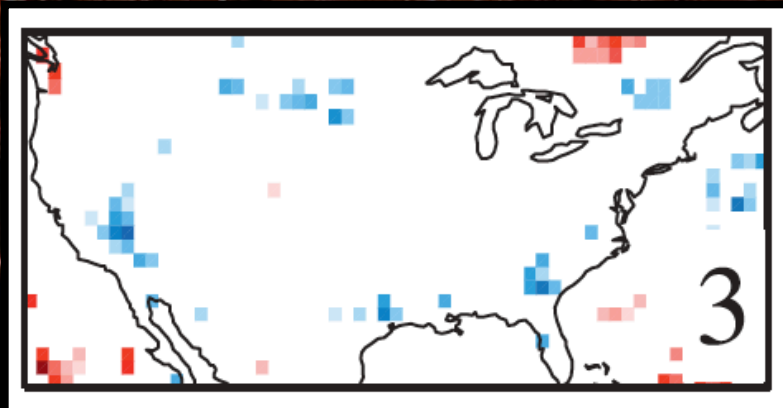
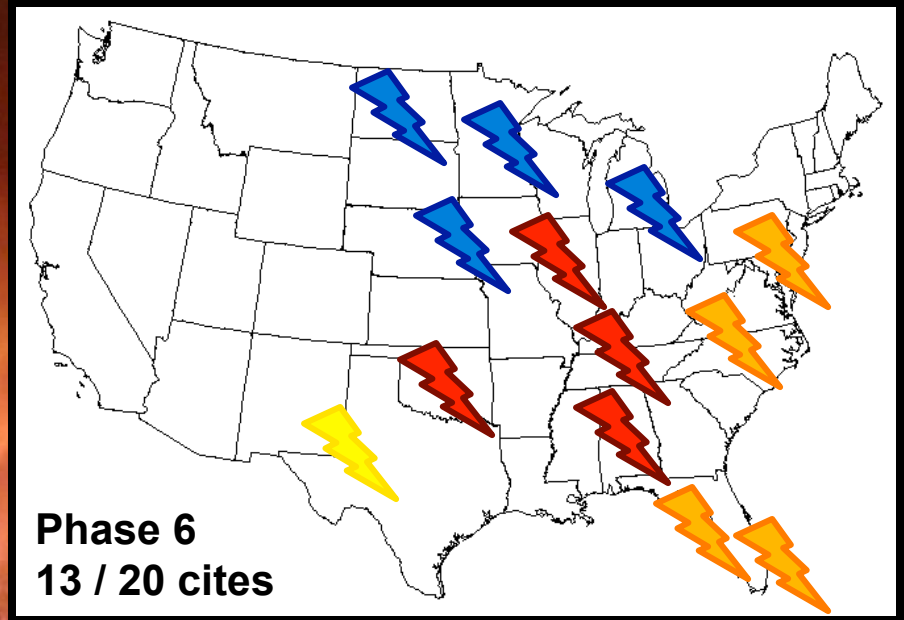
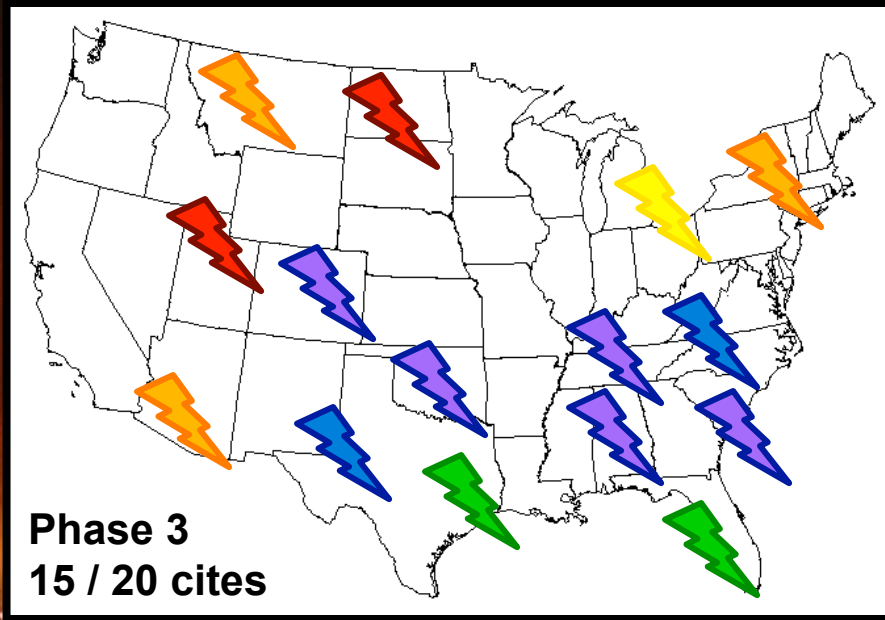
Relationship between U.S. lightning and the MJO



Summary and Future Work

- An 11 year METAR climatology of TS occurrence reveals TPA, MIA and DEN as the highest, and ALB and GTF as the lowest, TS reporters
- NLDN flash occurrences best correlate with the METAR climatology at radial ranges between 10 and 15 km of the station
- Future work includes examining year to year verification variability, and the physical processes responsible for the strong U.S. lightning frequency – MJO relationship

Relationship between U.S. lightning and the MJO



Abatzoglou and Brown (2009)