

**Verification of
thunderstorm
occurrence using
the National
Lightning Detection
Network (NLDN)**

**Kristen L. Corbosiero
University at Albany**

**Tom Galarneau NCAR
Sergio Abarca NPS
Ross Lazear SUNY Albany**

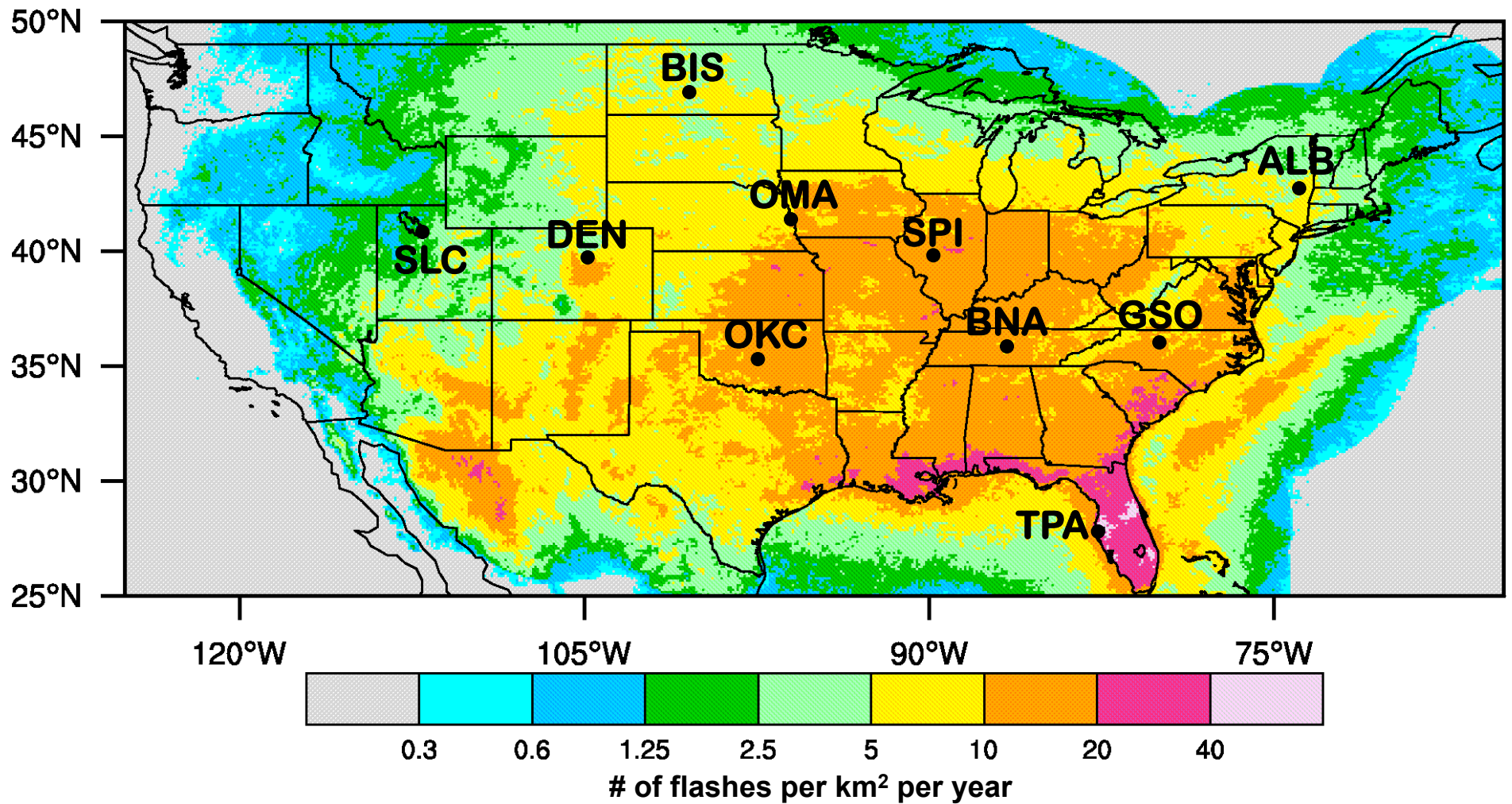
Introduction and Motivation

- **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)**

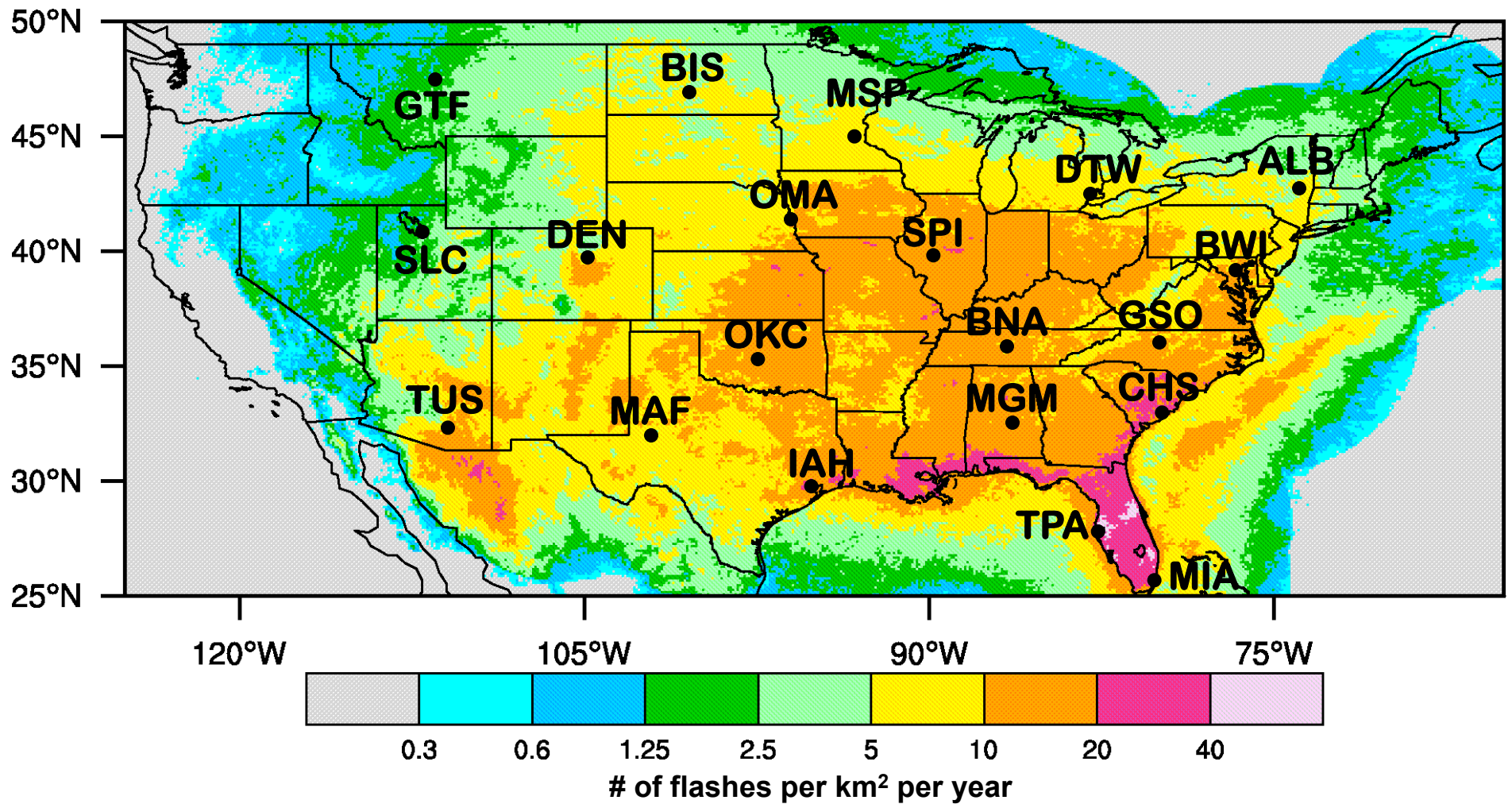
Introduction and Motivation

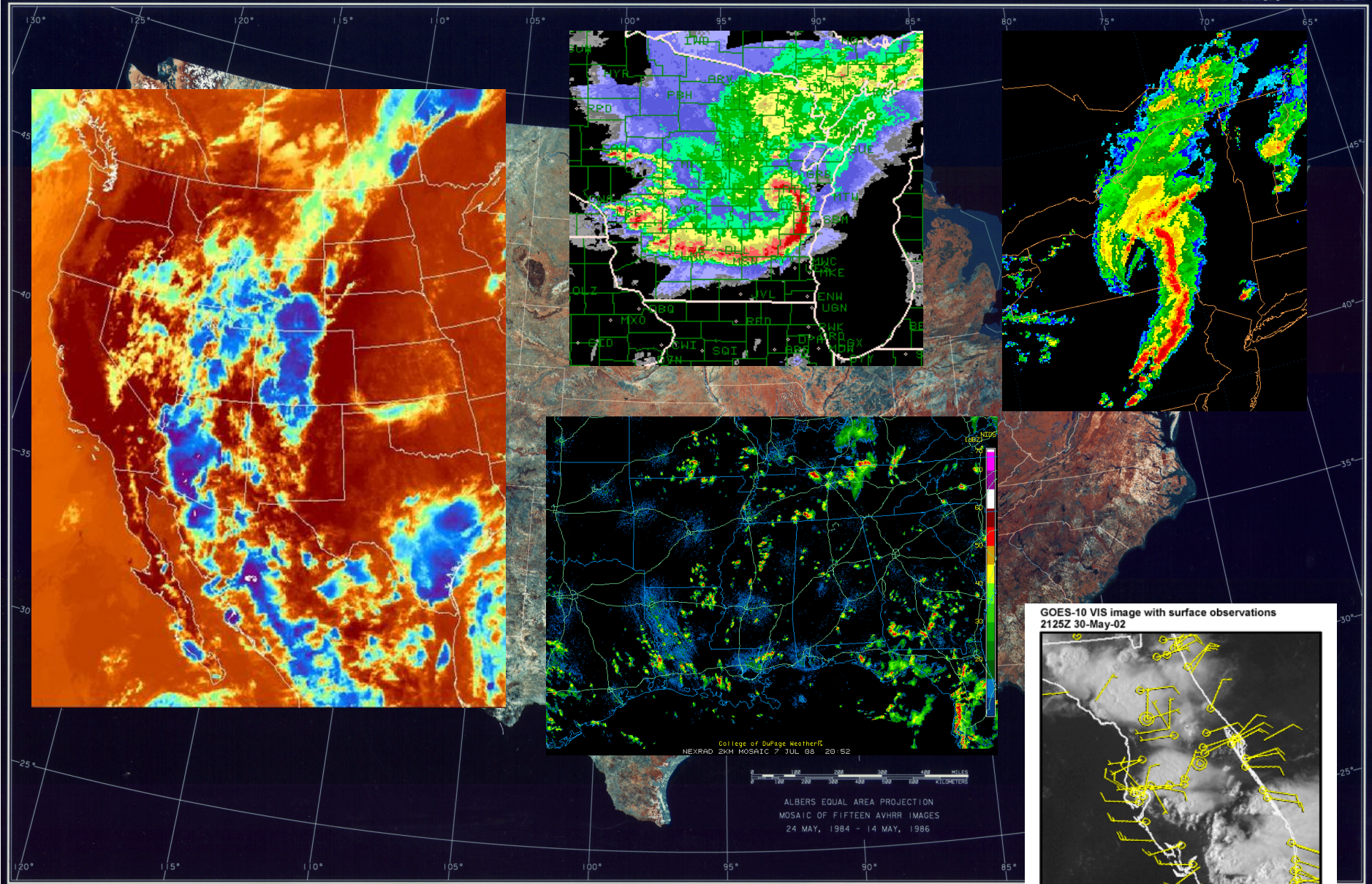
- **Each year there are several instances in which a TS fails to be reported despite its suspected occurrence**
- **During such instances, the forecast contest is verified by contacting the NWS office and examining WSR-88D and NLDN data**
- **Given its continuous space and time coverage, an average detection 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

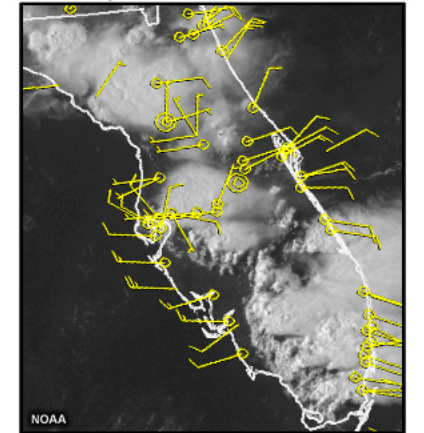


1995-2009 NLDN Flash Density Map with all 20 cities studied



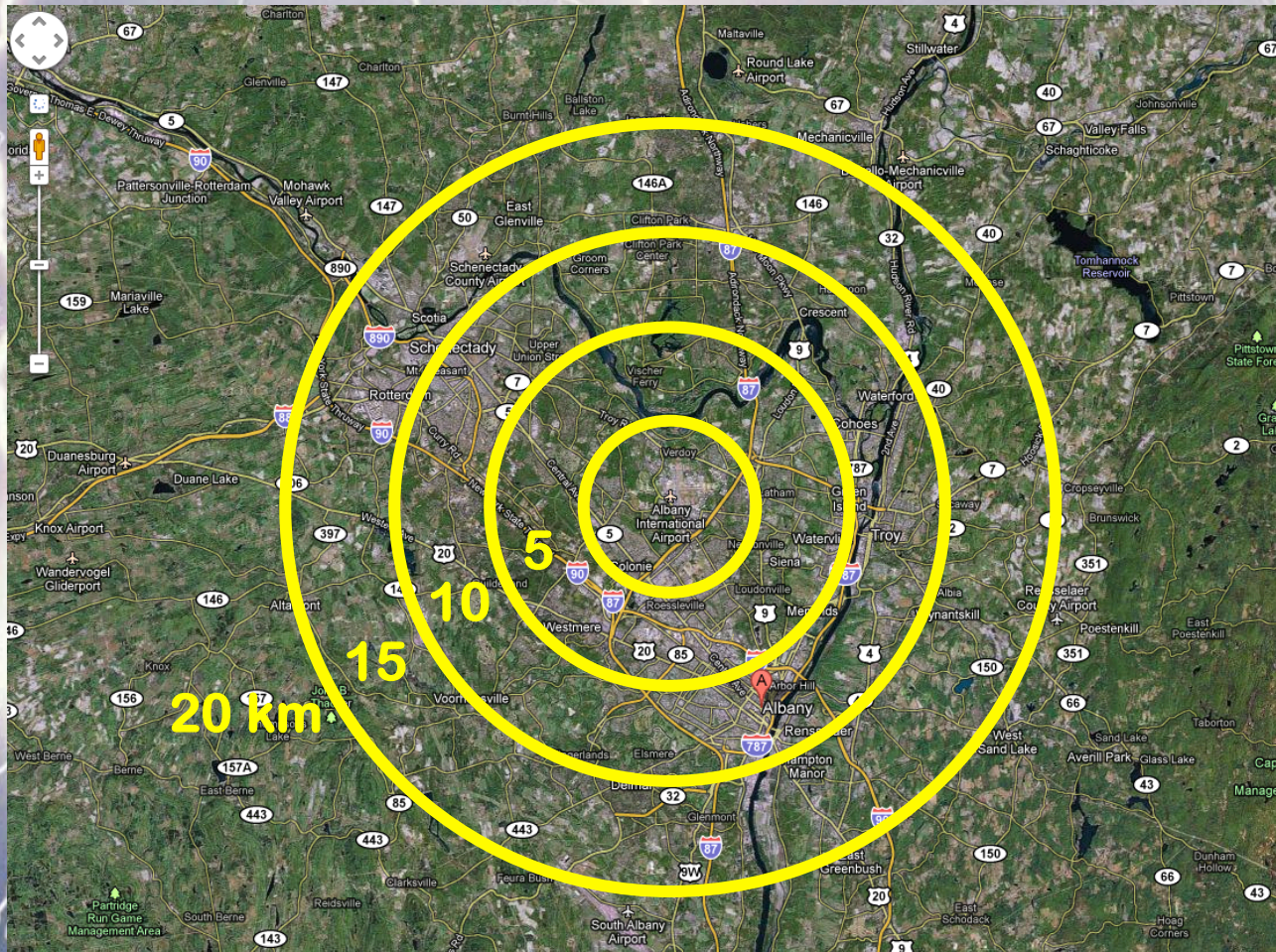


GOES-10 VIS image with surface observations
2125Z 30-May-02



NLDN Lightning Climatology Methodology

- To compare METAR TS reports with NLDN flashes, strikes were totaled within 20 km of each station (following Bosart and Landin (1994) and Holle (2009))



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

June 1995-2009					
METAR		5	10	15	20
.15	ALB	.12	.16	.20	.24
.23	BWI	.17	.24	.29	.33
.29	GSO	.20	.29	.32	.37
.35	CHS	.23	.34	.43	.49
.44	MIA	.40	.57	.65	.70
.43	TPA	.40	.51	.60	.65
.20	DTW	.14	.21	.24	.28
.25	MGM	.20	.28	.39	.40
.28	BNA	.22	.32	.37	.40
.23	SPI	.20	.25	.29	.33
.25	MSP	.17	.22	.27	.31
.32	IAH	.26	.34	.40	.44
.28	OMA	.17	.26	.31	.34
.30	OKC	.22	.29	.32	.35
.25	BIS	.13	.21	.27	.31
.23	MAF	.12	.20	.25	.31
.40	DEN	.18	.30	.38	.43
.07	TUS	.04	.07	.10	.13
.16	GTF	.11	.17	.21	.25
.18	SLC	.07	.15	.20	.25

July 1995-2009					
METAR		5	10	15	20
.14	ALB	.11	.17	.22	.25
.20	BWI	.16	.22	.30	.33
.33	GSO	.20	.30	.36	.41
.45	CHS	.32	.43	.50	.55
.42	MIA	.44	.58	.70	.74
.51	TPA	.50	.66	.75	.81
.21	DTW	.15	.22	.26	.30
.33	MGM	.27	.41	.49	.55
.25	BNA	.20	.29	.35	.39
.17	SPI	.14	.20	.23	.26
.20	MSP	.14	.18	.23	.26
.35	IAH	.28	.37	.45	.52
.26	OMA	.17	.23	.28	.30
.17	OKC	.13	.17	.22	.24
.29	BIS	.19	.26	.30	.33
.17	MAF	.12	.18	.20	.25
.43	DEN	.19	.32	.42	.48
.35	TUS	.26	.38	.49	.54
.17	GTF	.11	.18	.22	.27
.18	SLC	.09	.14	.19	.24

August 1995-2009					
METAR		5	10	15	20
.15	ALB	.12	.15	.22	.24
.16	BWI	.12	.17	.22	.25
.21	GSO	.14	.21	.26	.30
.35	CHS	.23	.34	.43	.50
.42	MIA	.52	.63	.71	.77
.47	TPA	.48	.63	.75	.80
.16	DTW	.10	.17	.21	.24
.25	MGM	.20	.32	.40	.46
.22	BNA	.17	.25	.31	.34
.19	SPI	.16	.22	.26	.28
.19	MSP	.14	.18	.21	.23
.32	IAH	.27	.37	.43	.49
.21	OMA	.15	.20	.24	.26
.20	OKC	.15	.20	.24	.27
.20	BIS	.13	.18	.22	.26
.18	MAF	.13	.19	.25	.29
.38	DEN	.22	.33	.42	.48
.44	TUS	.30	.43	.53	.62
.14	GTF	.06	.13	.17	.23
.20	SLC	.11	.19	.24	.28

- 10 km is the NLDN radial ring that **best correlates** with METAR TS occurrence
- Miami and Tampa have **more** days with **lightning** within 5 km of the stations **than METAR TS days**

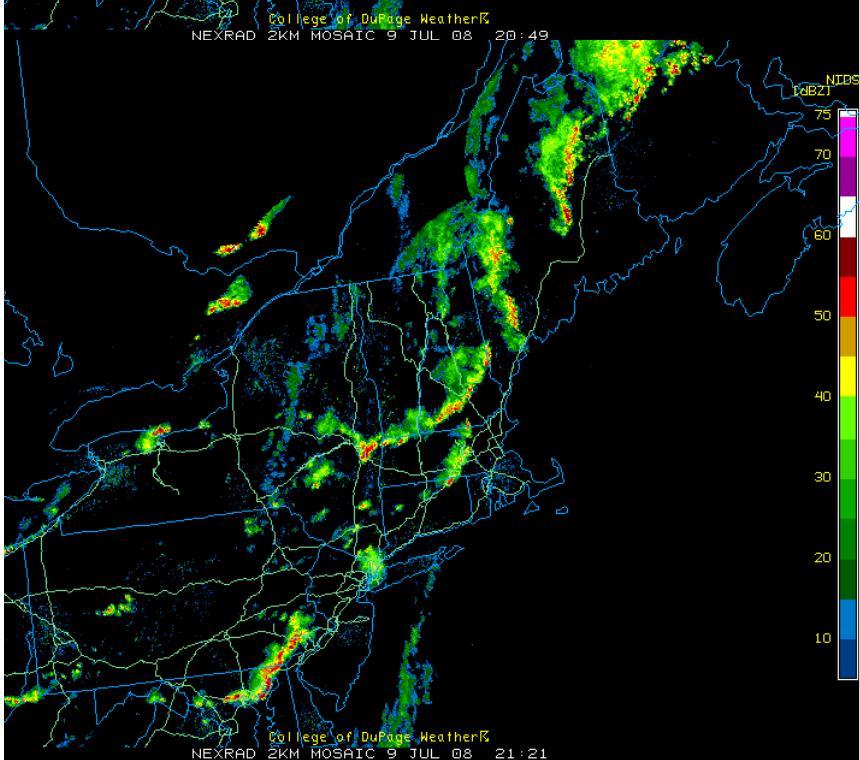
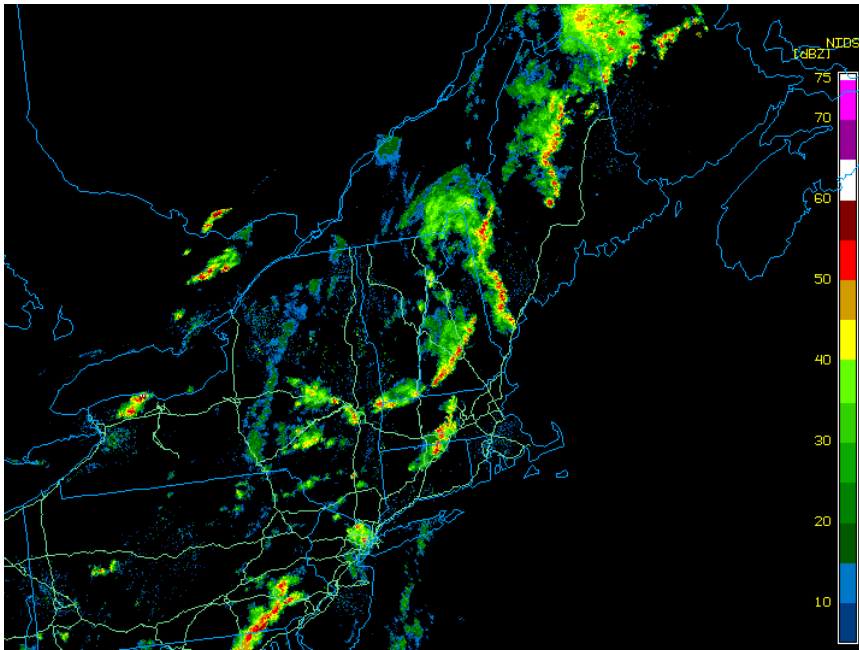
If the NLDN detects lightning within X km of a station, what percentage of the time does that station report a TS on that day?

Station	5	10	15	20
ALB	86	75	65	57
BWI	93	84	72	64
GSO	95	86	80	74
CHS	95	89	81	75
MIA	81	69	63	59
TPA	85	74	68	62
DTW	88	80	73	66
MGM	86	76	66	58
BNA	86	78	70	64
SPI	85	78	73	67
MSP	95	89	83	77
IAH	91	84	76	71
OMA	95	90	86	80
OKC	95	89	80	76
BIS	91	87	83	78
MAF	91	83	75	65
DEN	96	94	89	83
TUS	84	78	71	66
GTF	83	73	65	56
SLC	94	85	81	69
Average	90	82	75	68

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

Station	5	10	15	20
ALB	67	84	93	95
BWI	70	86	96	98
GSO	62	82	90	96
CHS	65	86	96	98
MIA	83	95	99	99
TPA	83	95	99	100
DTW	59	86	91	95
MGM	71	91	97	98
BNA	69	90	97	98
SPI	75	90	97	99
MSP	66	82	92	96
IAH	72	90	95	97
OMA	63	81	93	95
OKC	70	86	93	96
BIS	56	76	88	95
MAF	55	78	90	94
DEN	46	73	88	95
TUS	61	80	93	99
GTF	52	79	85	92
SLC	43	70	88	95
Average	64	84	93	96

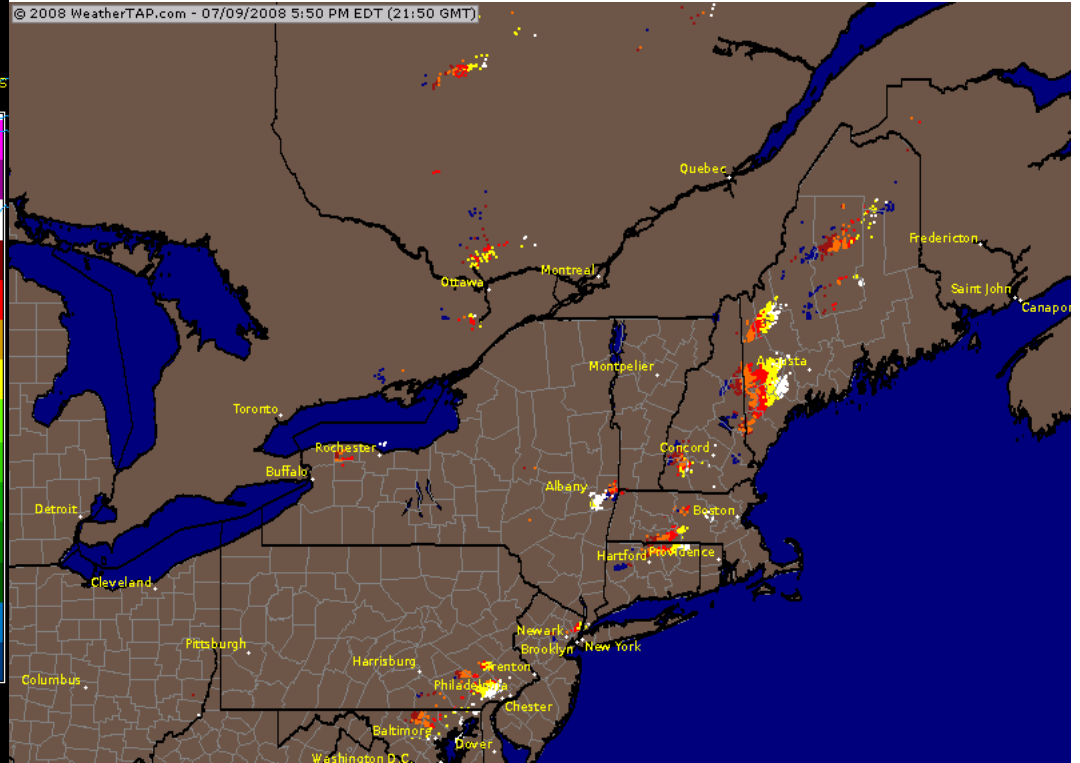
- ~ MSP, OKC, OMA and DEN are **excellent verifiers**; i.e., when there is lightning within 10 km, a TS is reported
- ~ MIA, TPA, TUS and GTF have **very poor verification**; there is a high percentage of days with lightning within 5 km when no TS is reported
- ~ Stations in the **western U.S.** (DEN,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



UALB THUNDERSTORM FORECASTING CONTEST CONSENSUS FOR: 7/9/08

FORECASTER	ALB	GSO	BNA	TPA	OKC	OMA	SPI	BIS	DEN	SLC
CONSENSUS	7	6	7	4	5	3	0	2	1	0
GAZA	7	3	8	3	6	4	0	3	1	0
CANNON	6	7	6	5	5	2	1	2	1	0
LAZEAR	5	7	6	3	5	3	1	2	1	0
T. WASULA	6	7	7	4	5	3	0	3	2	1
GALARNEAU	6	5	6	4	5	3	1	4	3	0
CORBOSIERO	8	7	6	5	5	3	0	3	2	0
SCALORA	6	6	8	5	5	3	0	3	2	0
WILSON	7	7	8	7	6	4	0	2	1	0
J. JONES	7	8	7	6	6	5	0	2	1	0
McGRADY	7	5	5	5	6	3	0	2	0	0
CASTELLANO	7	4	8	2	6	1	1	3	1	0
GRIFFIN	6	8	7	3	5	3	0	2	1	0
POLLAK	9	6	8	5	6	3	0	1	0	0
TRYPALUK	6	6	7	3	4	3	1	1	3	0
AVN MOS	6	5	6	4	3	2	1	3	3	0
ETA MOS	5	6	7	5	5	3	1	5	5	0
NGM MOS	9	7	9	6	6	3	2	4	6	0
OLD CLIMO	2	4	3	7	2	3	2	4	4	2
NEW CLIMO	2	4	3	6	2	3	2	3	4	2

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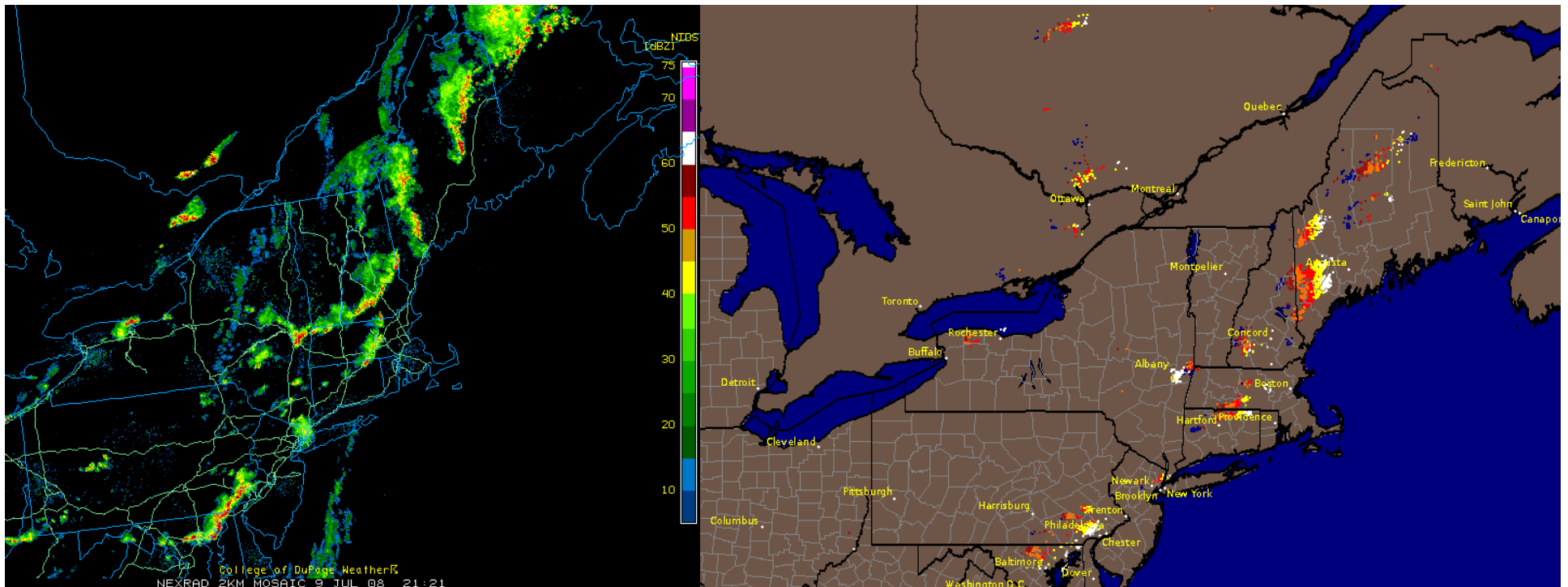
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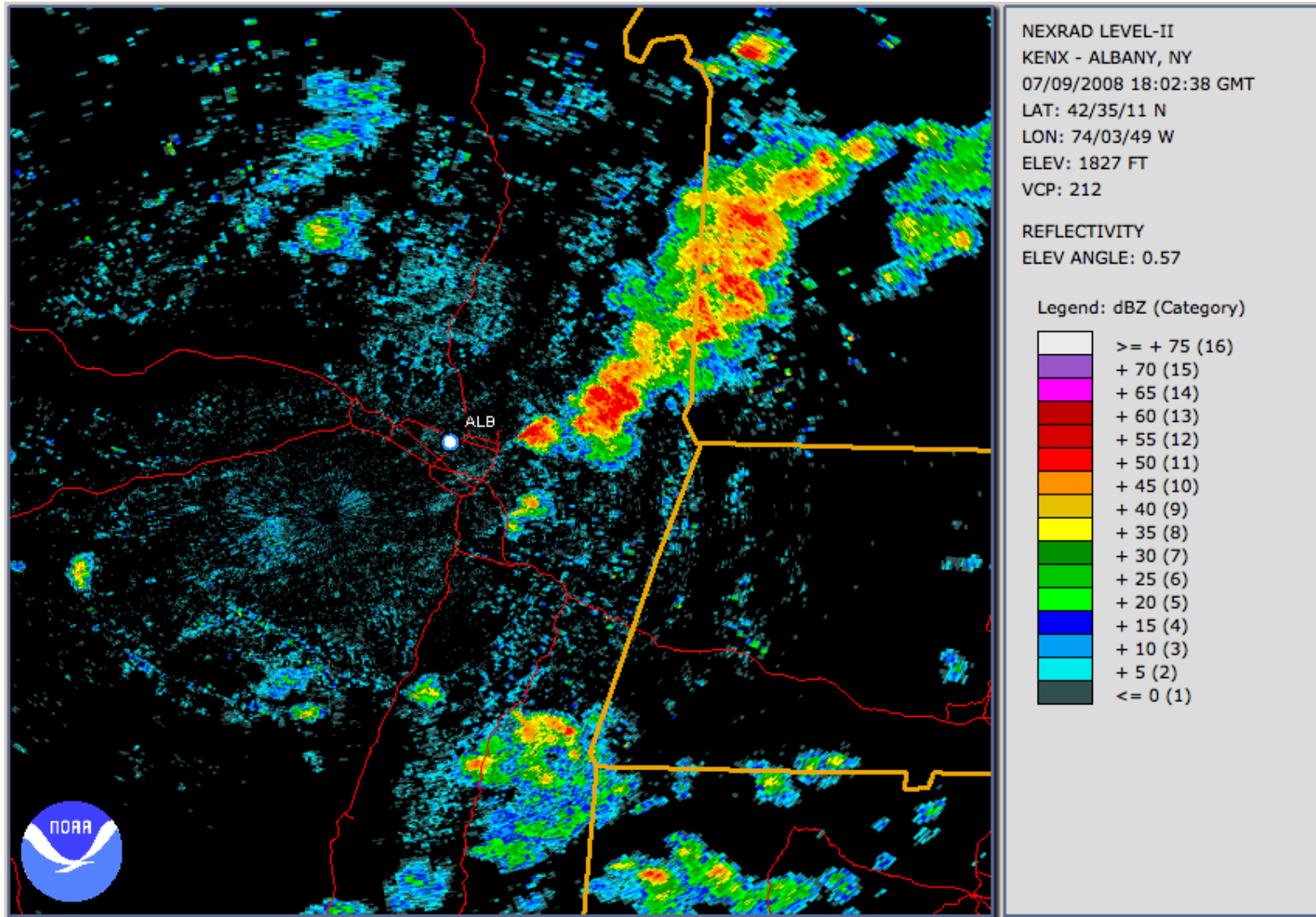
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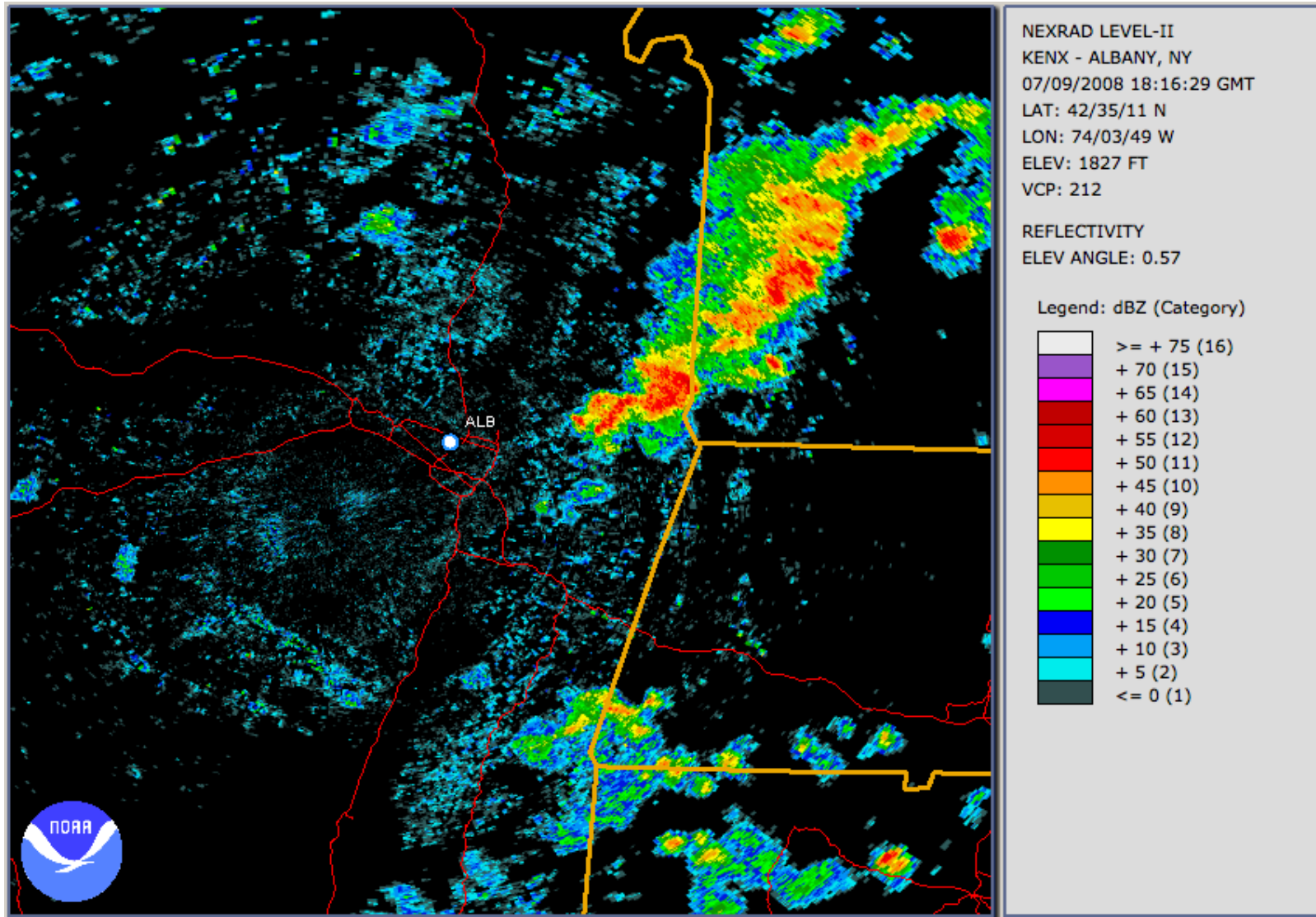
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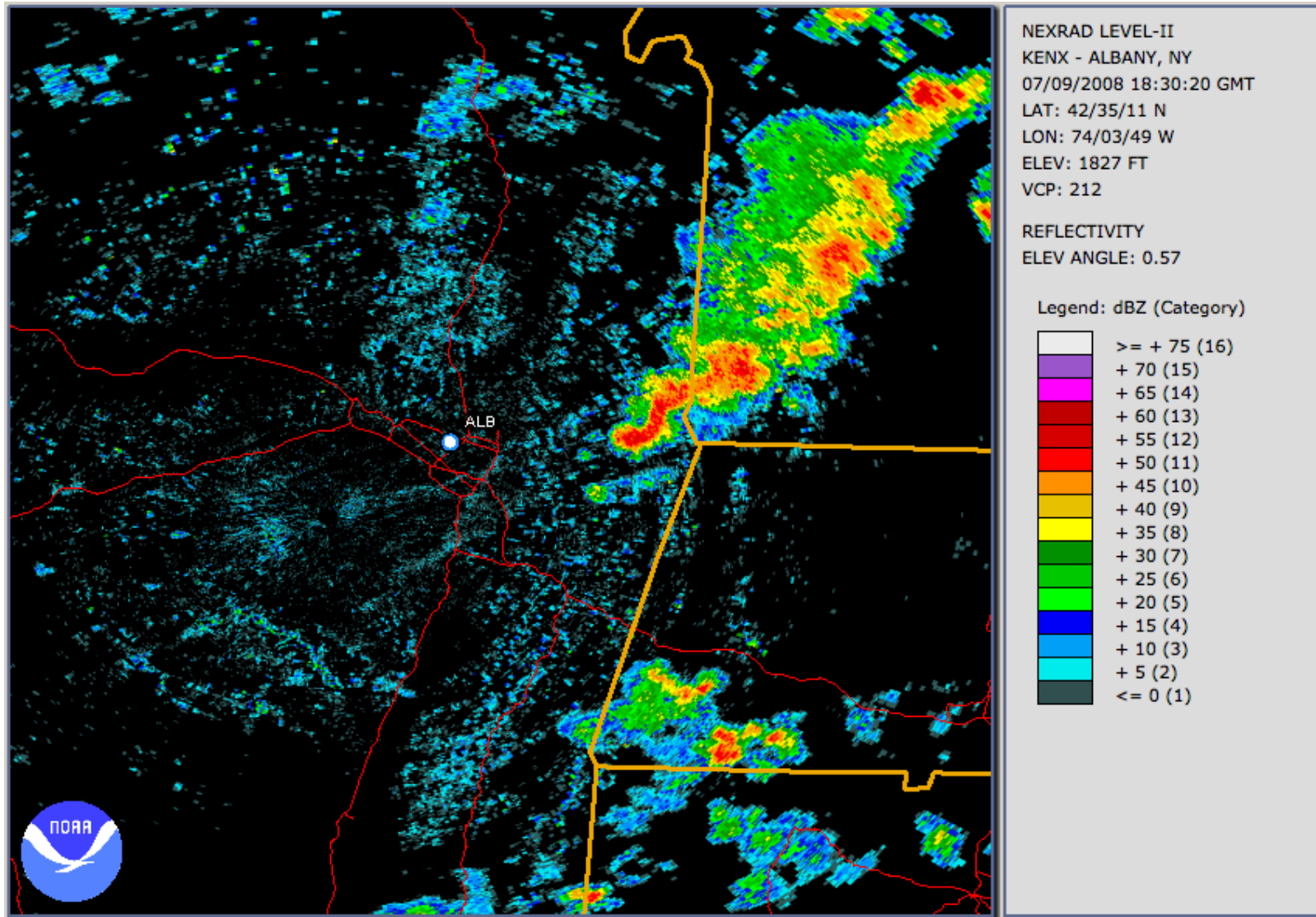
KENX radar: KALB missing METAR case 1803 UTC 09 July 2008



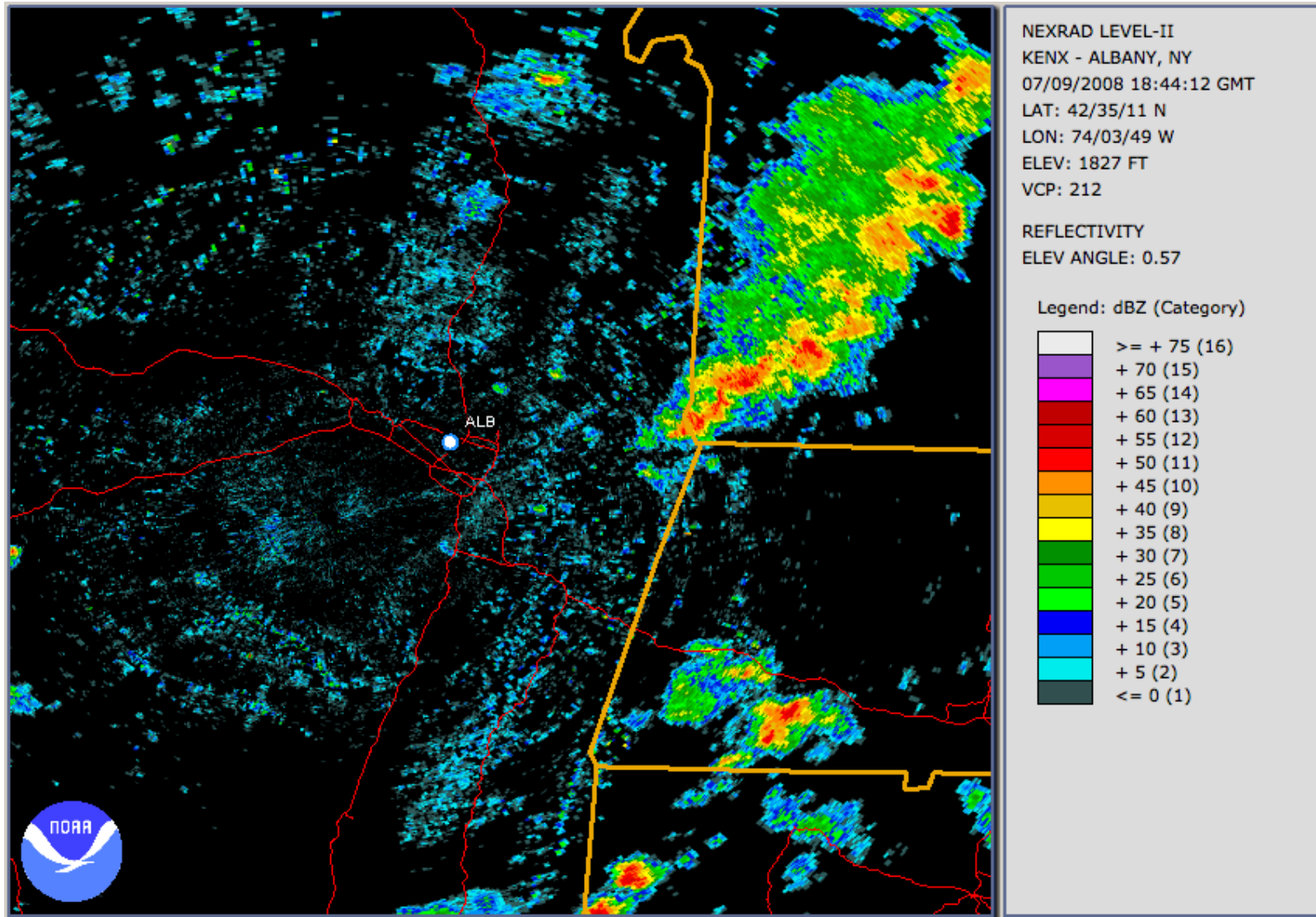
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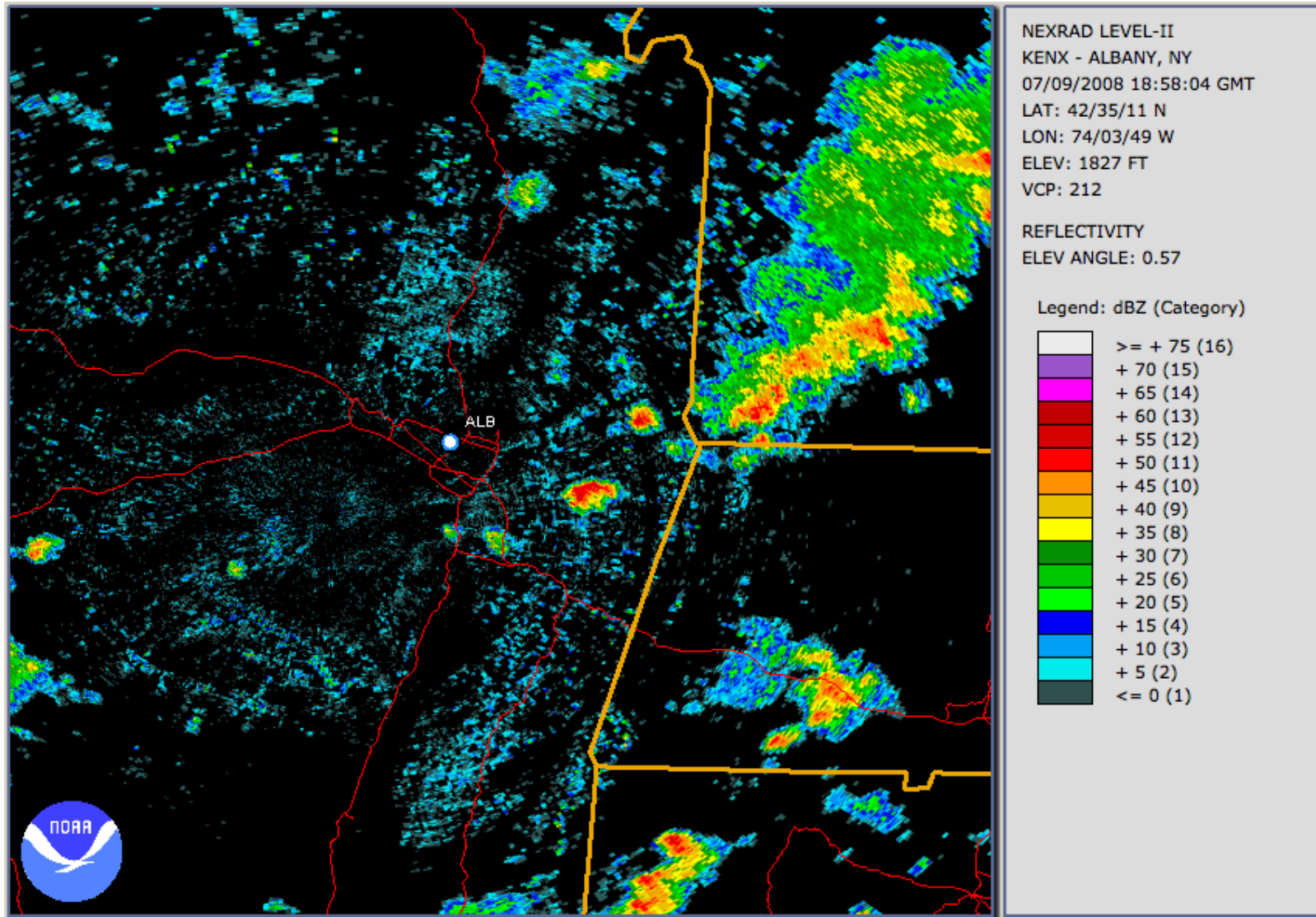
KENX radar: KALB missing METAR case 1830 UTC 09 July 2008



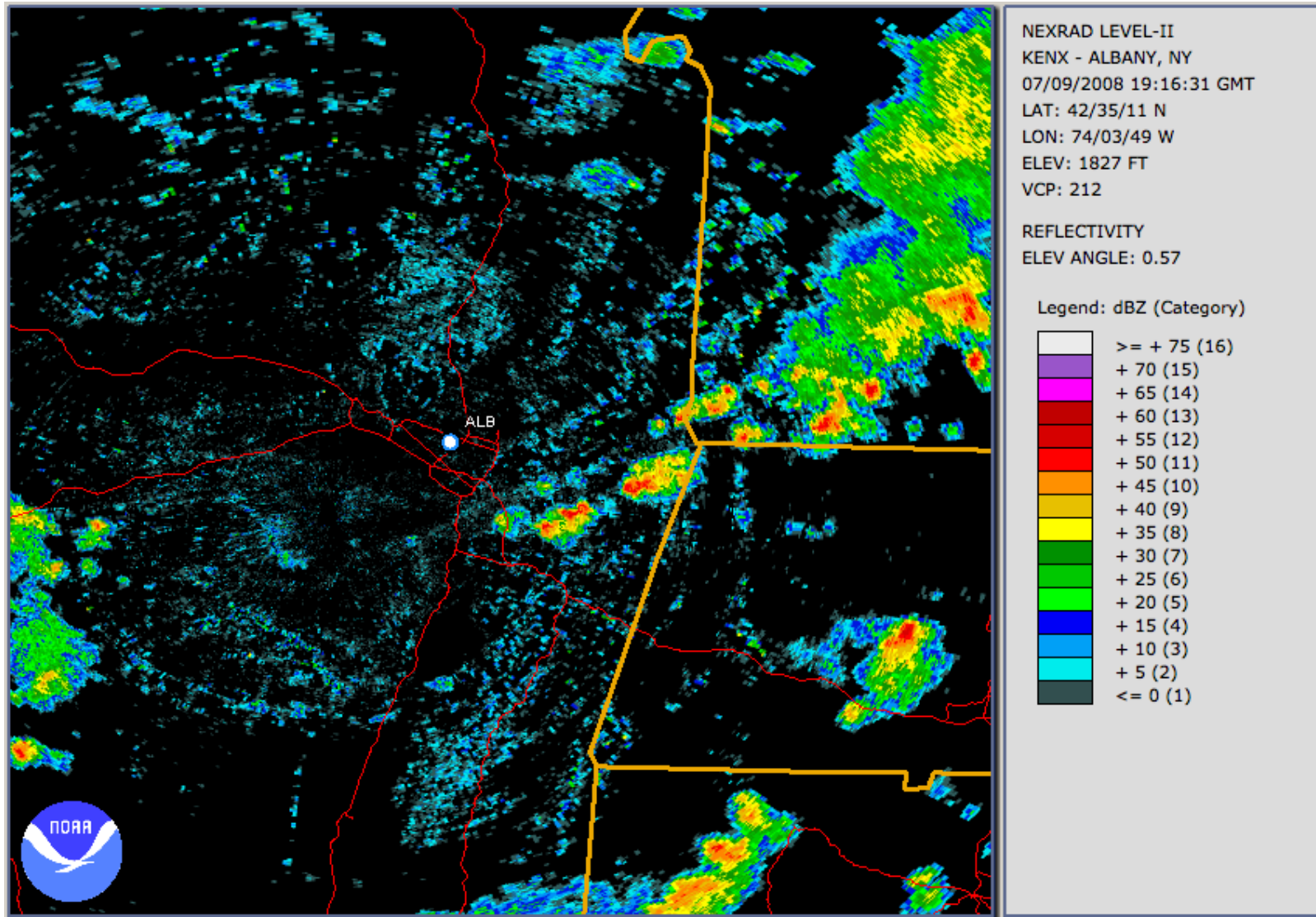
KENX radar: KALB missing METAR case 1844 UTC 09 July 2008



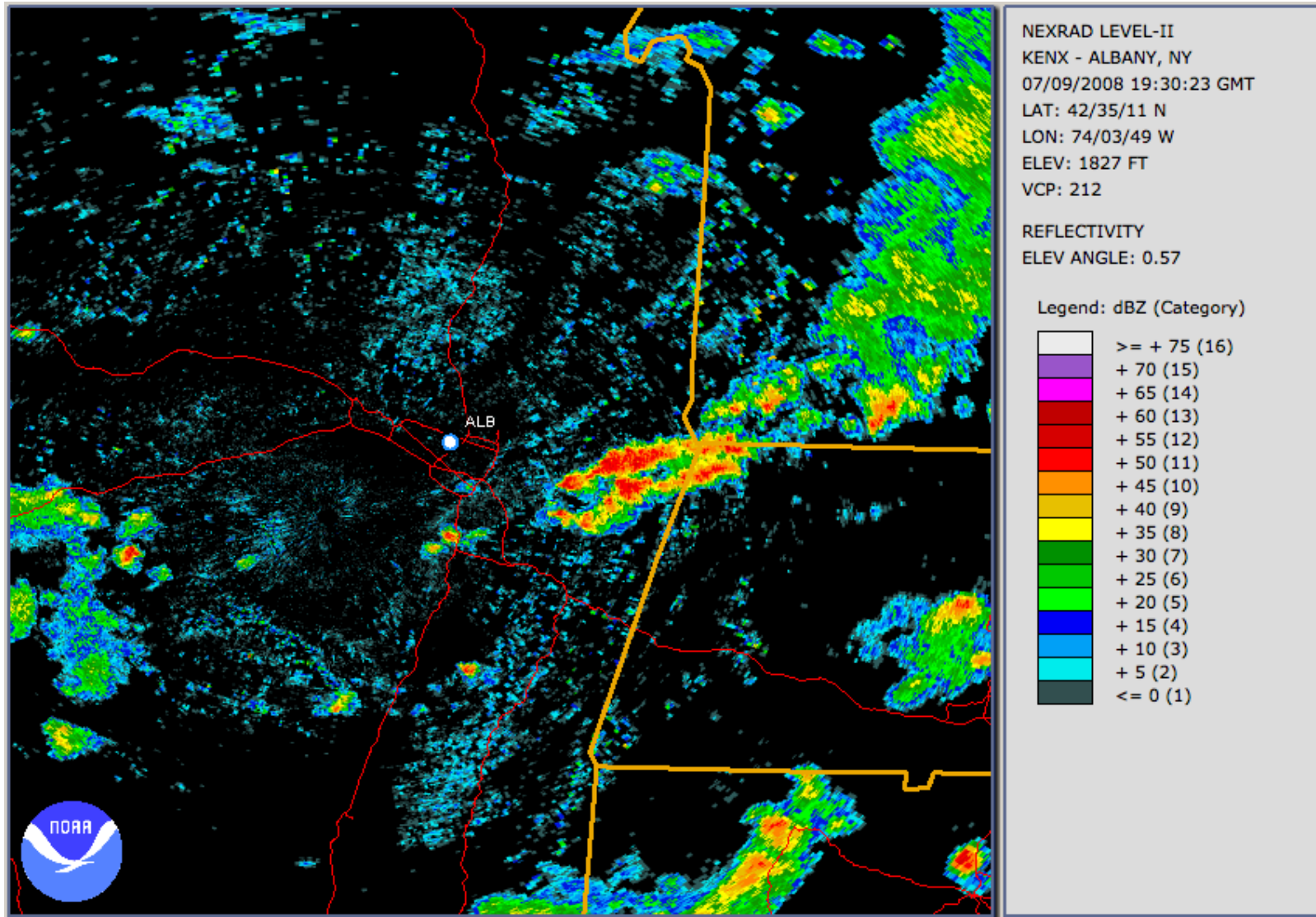
KENX radar: KALB missing METAR case 1858 UTC 09 July 2008



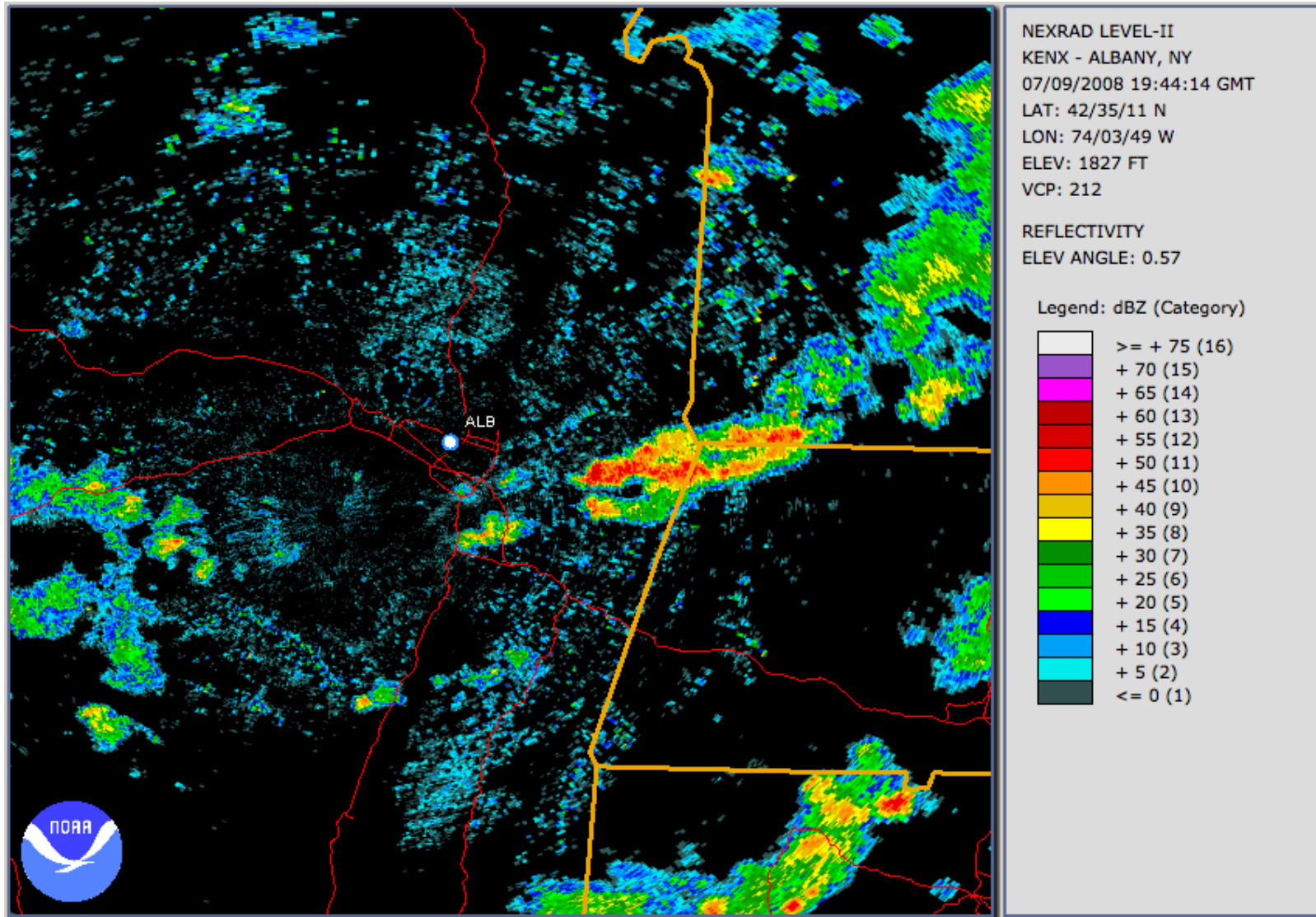
KENX radar: KALB missing METAR case 1917 UTC 09 July 2008



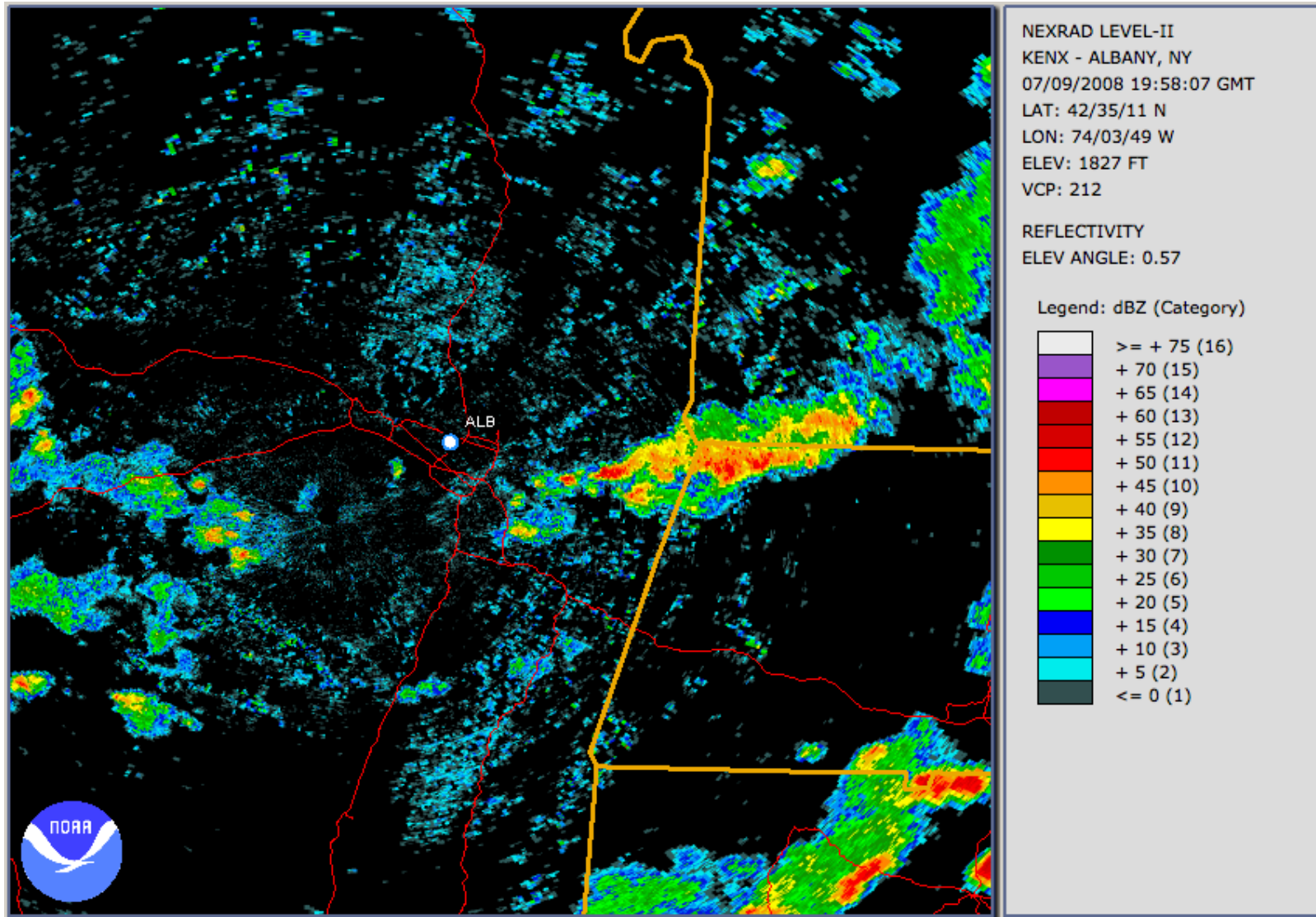
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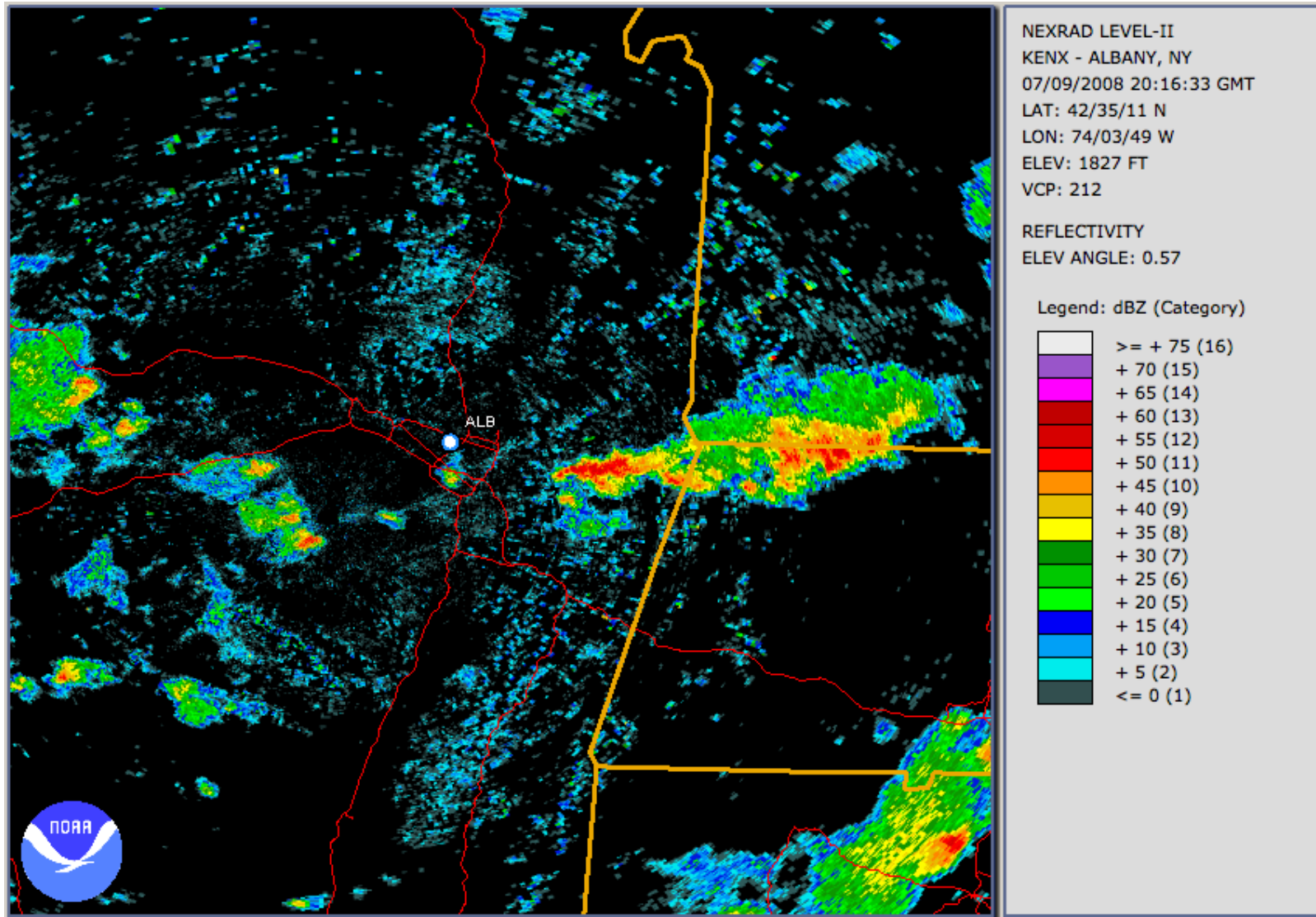
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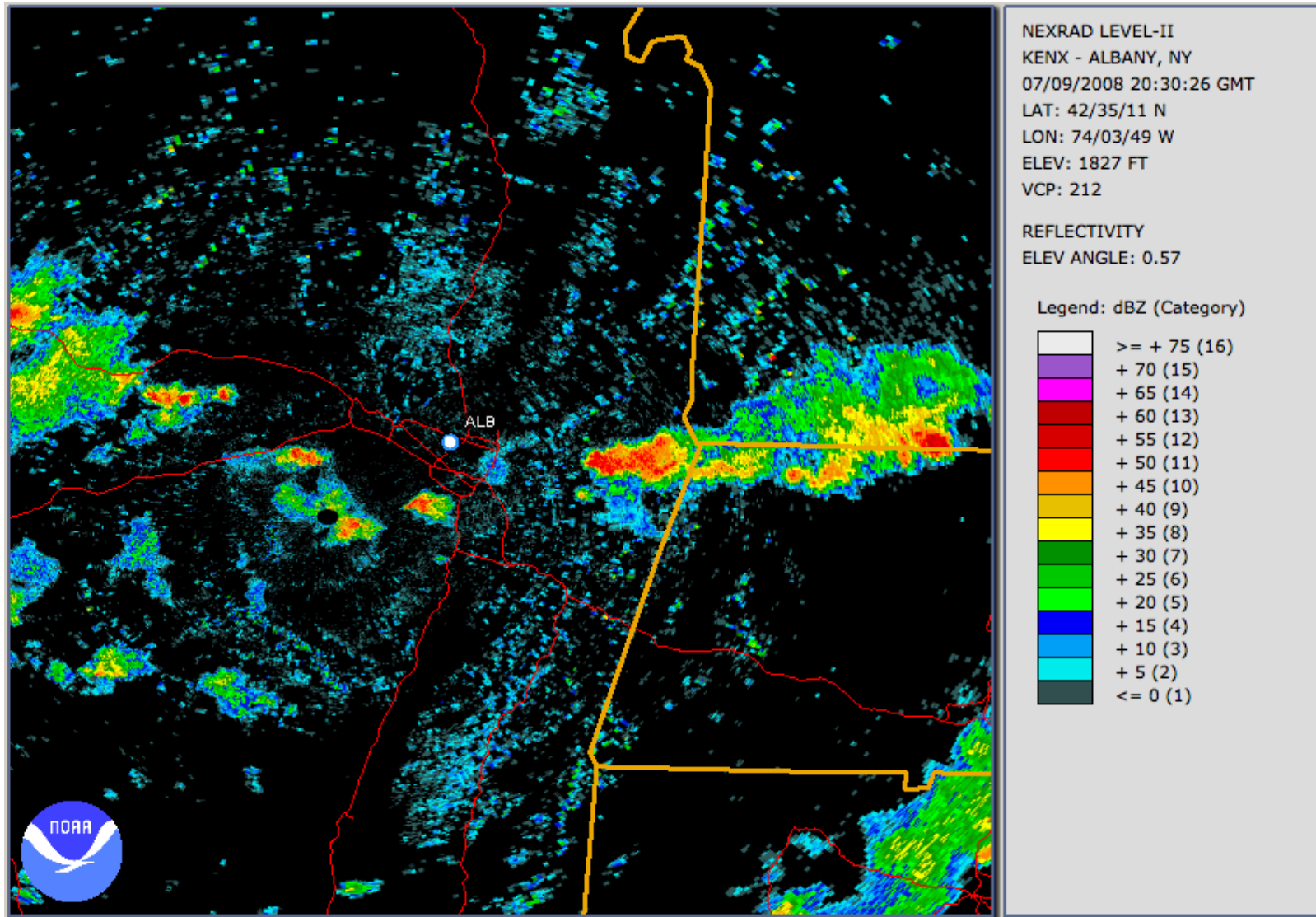
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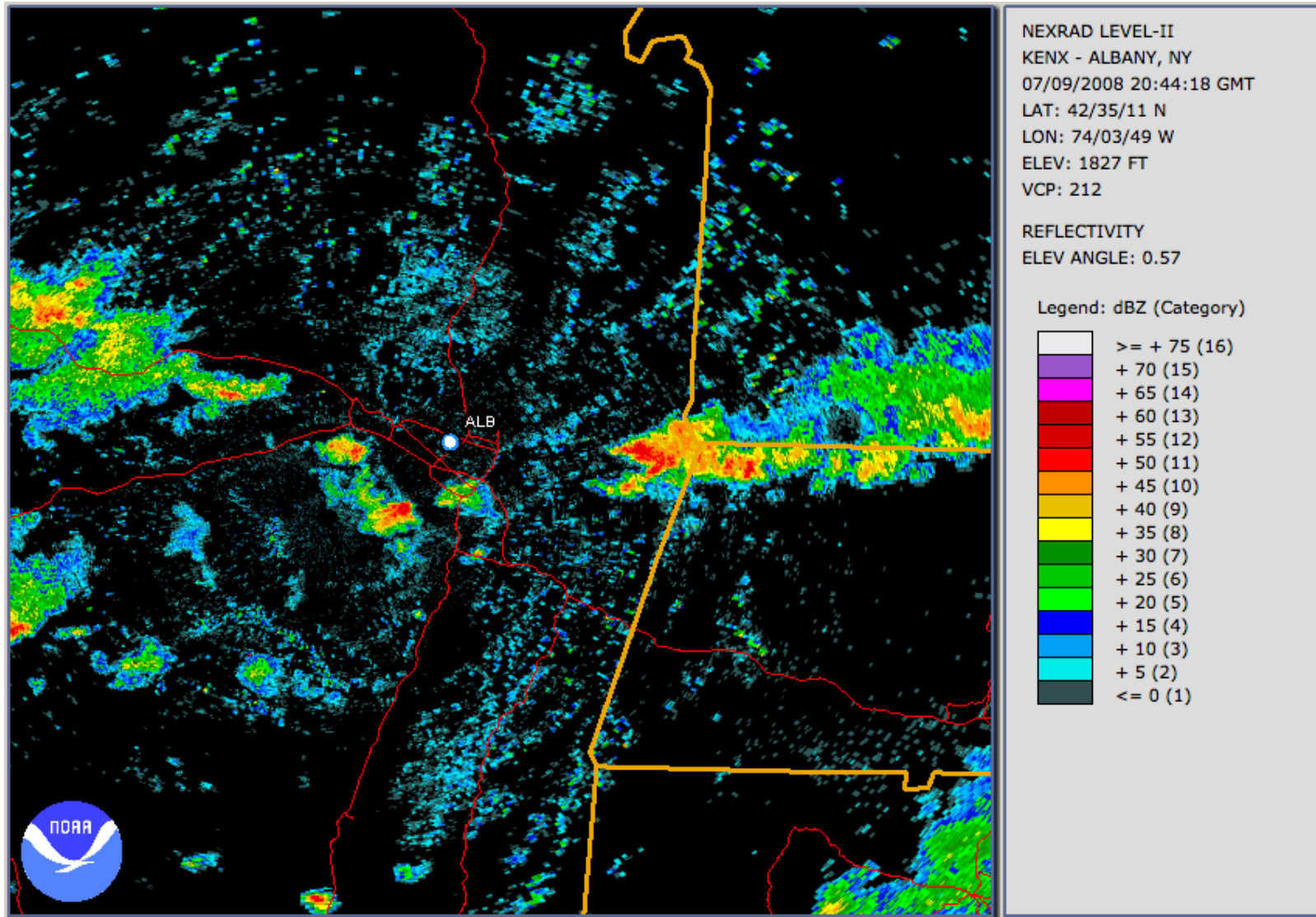
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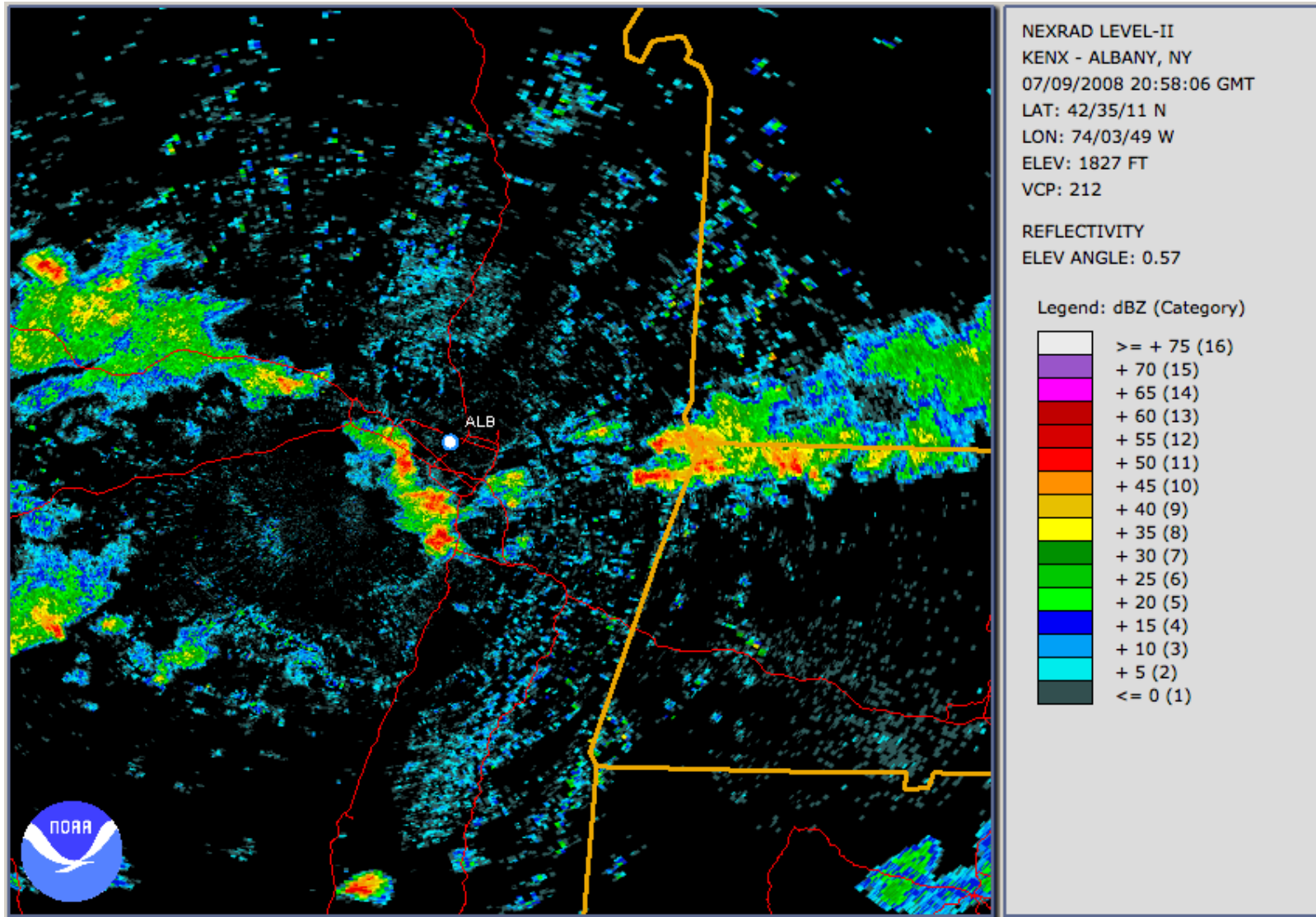
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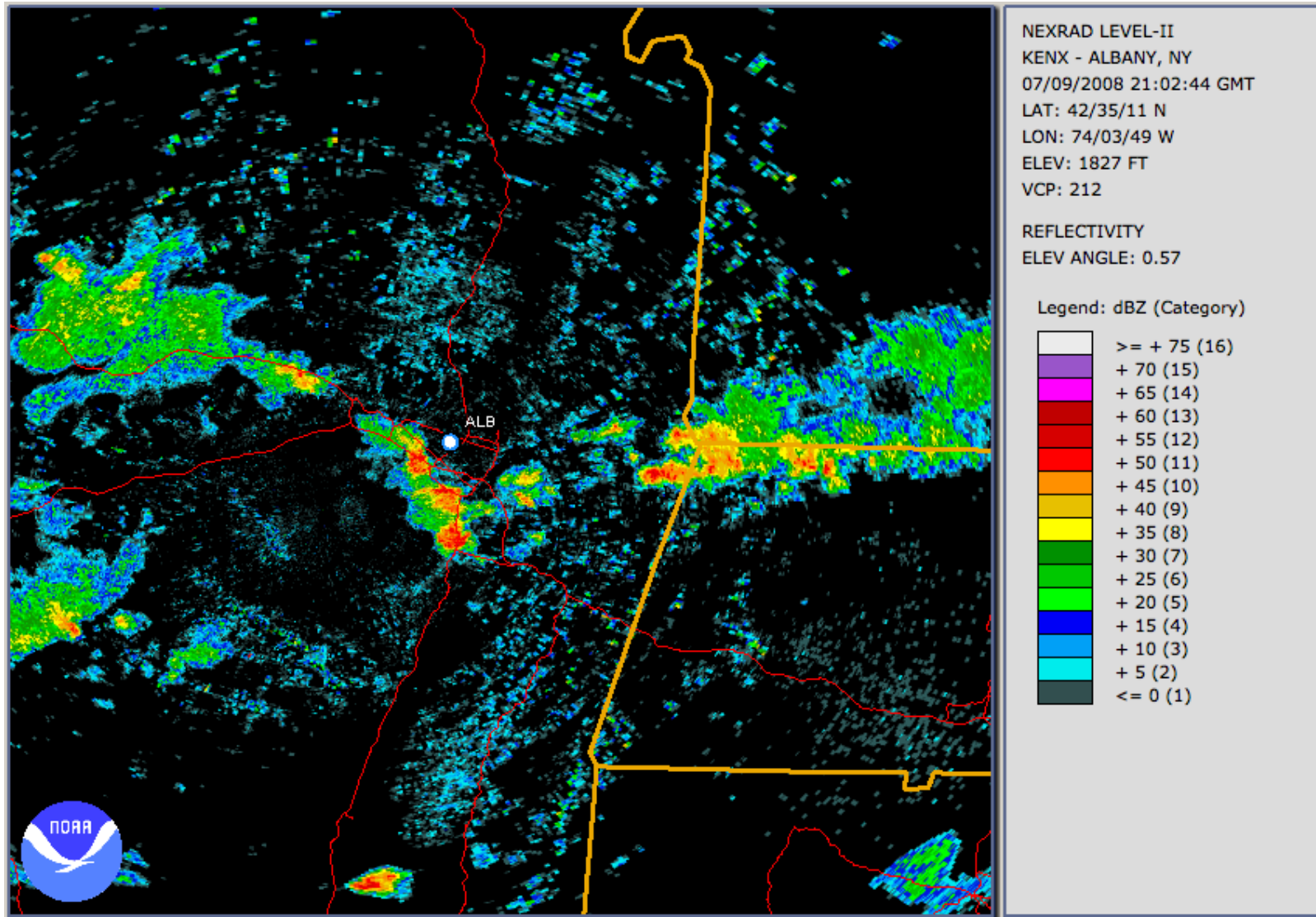
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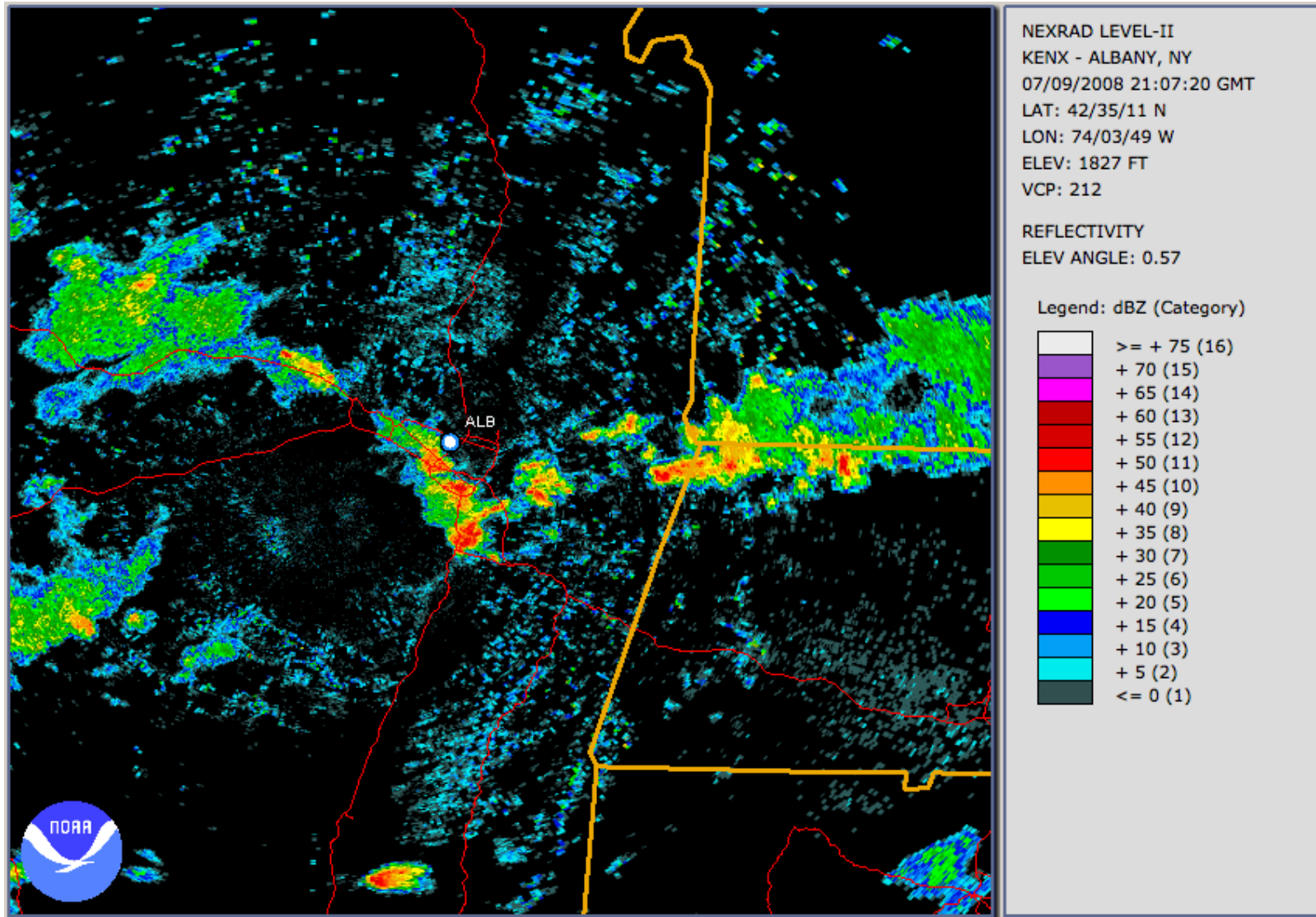
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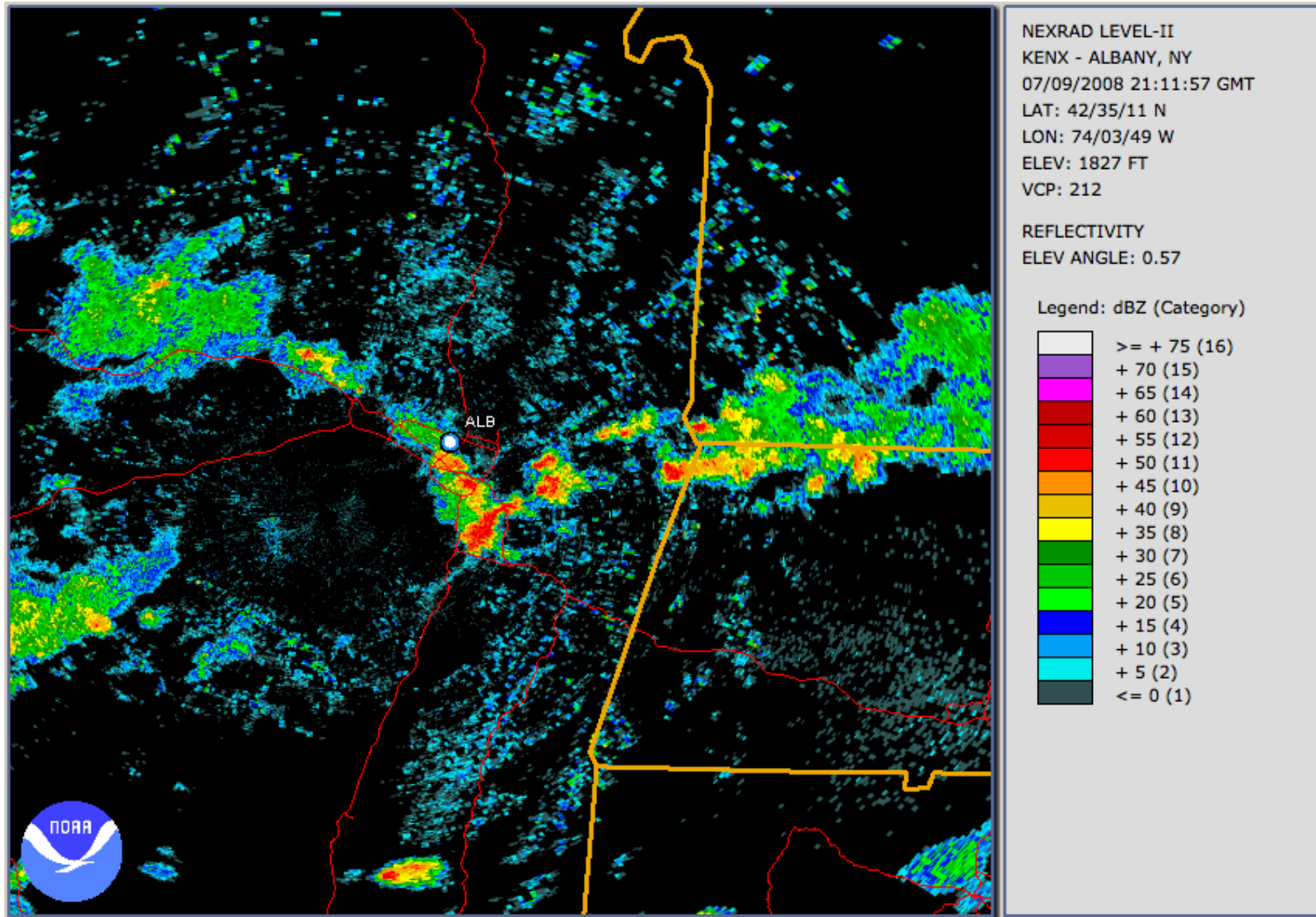
KENX radar: KALB missing METAR case 2103 UTC 09 July 2008



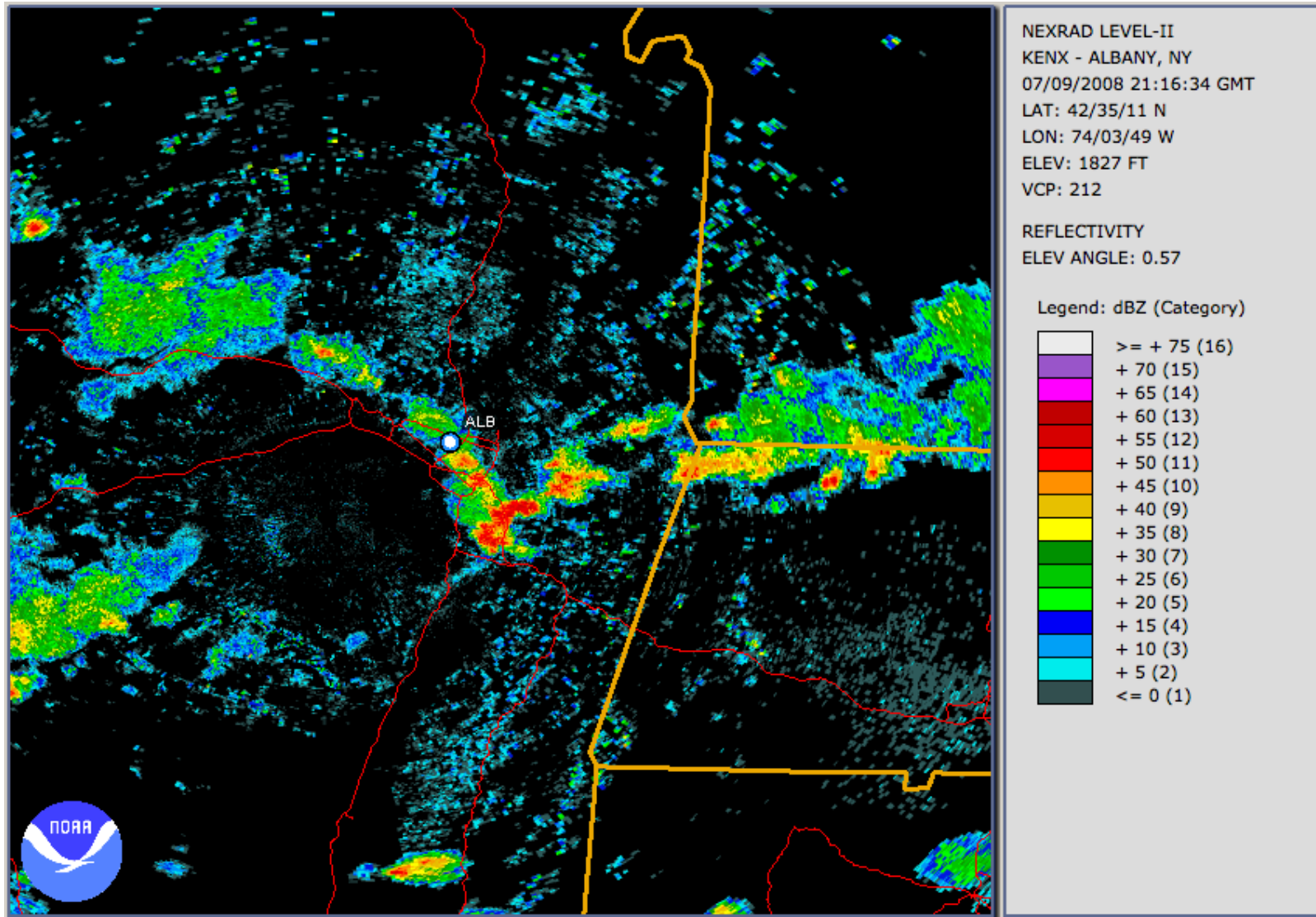
KENX radar: KALB missing METAR case 2107 UTC 09 July 2008



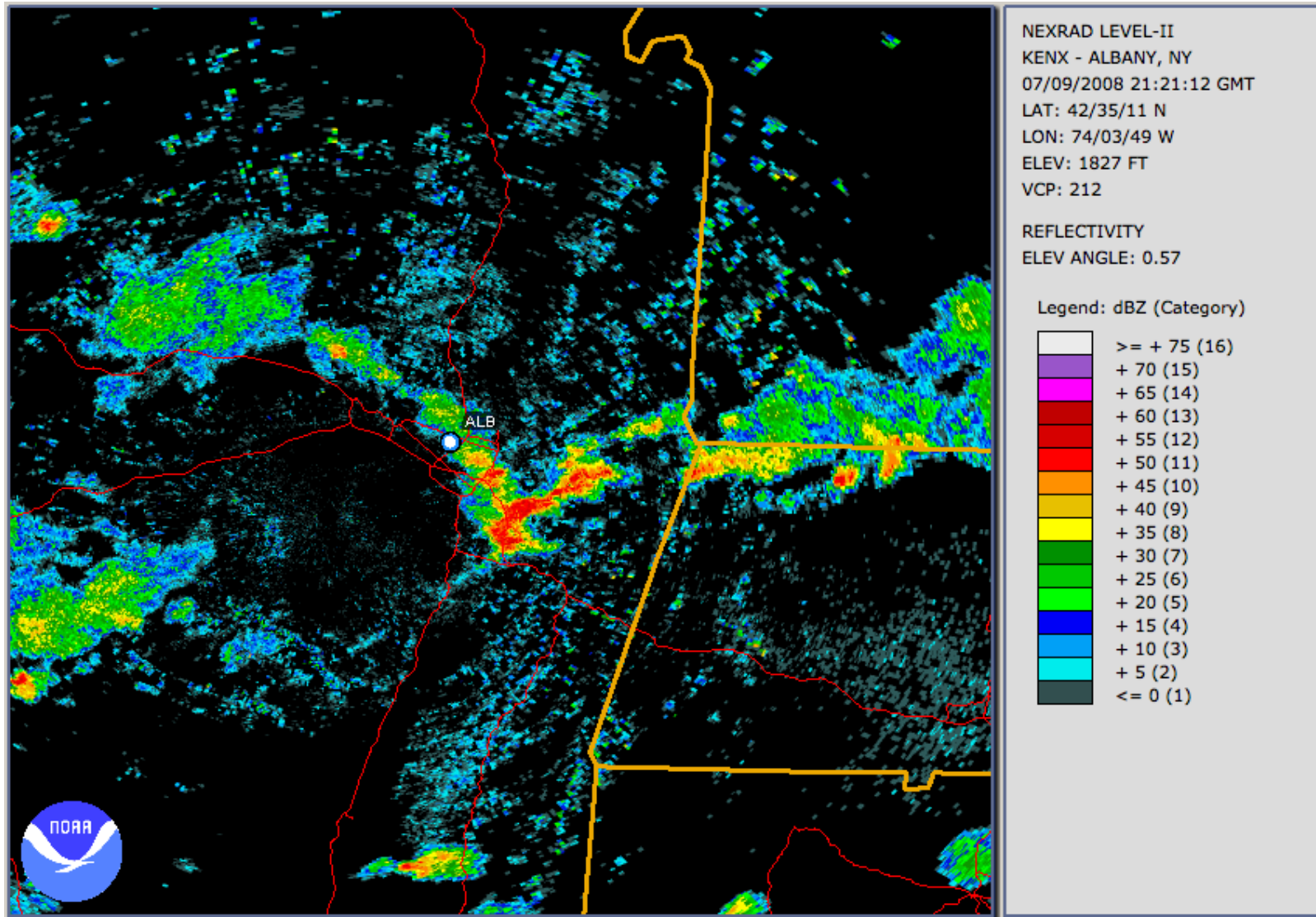
KENX radar: KALB missing METAR case 2112 UTC 09 July 2008



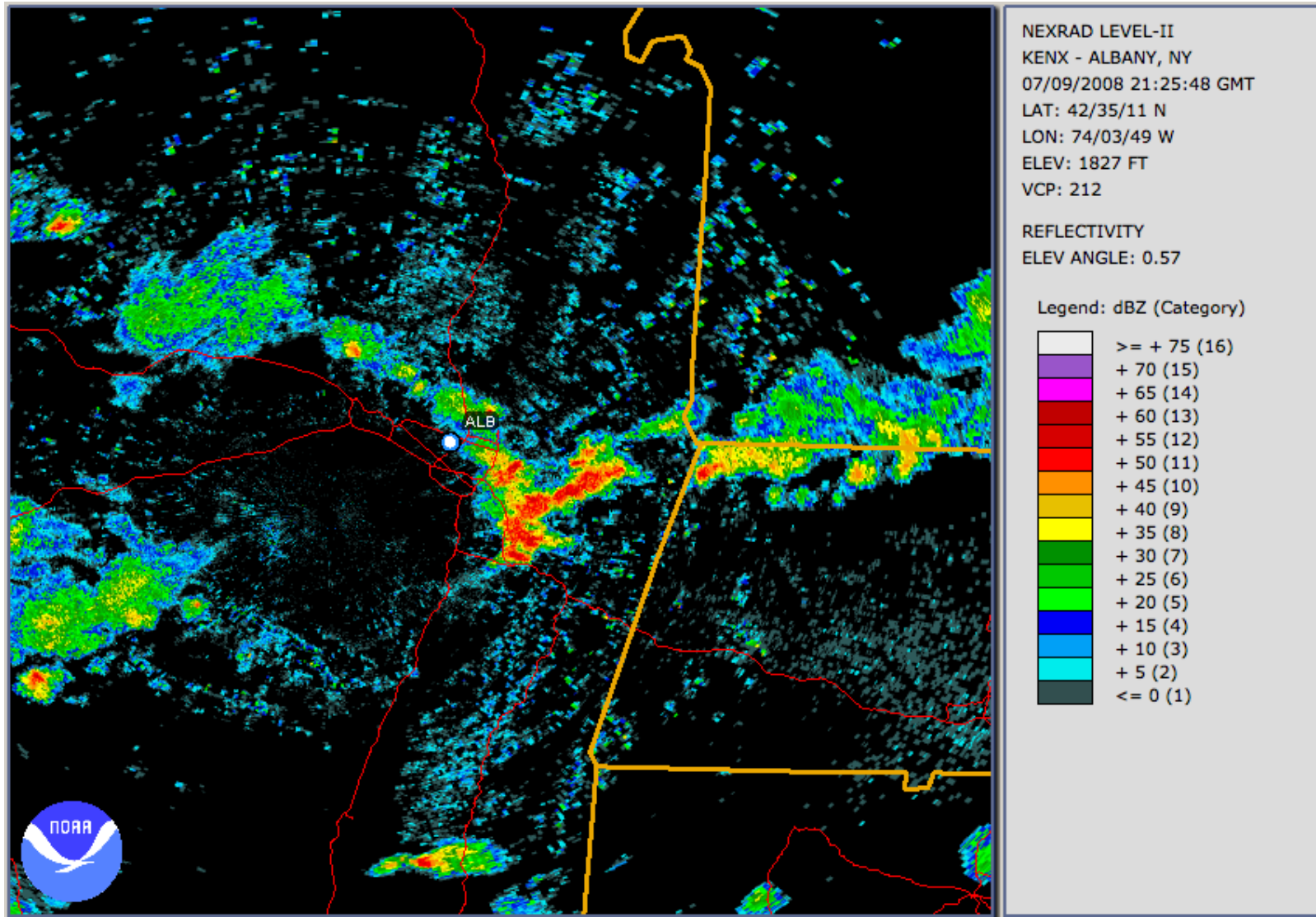
KENX radar: KALB missing METAR case 2117 UTC 09 July 2008



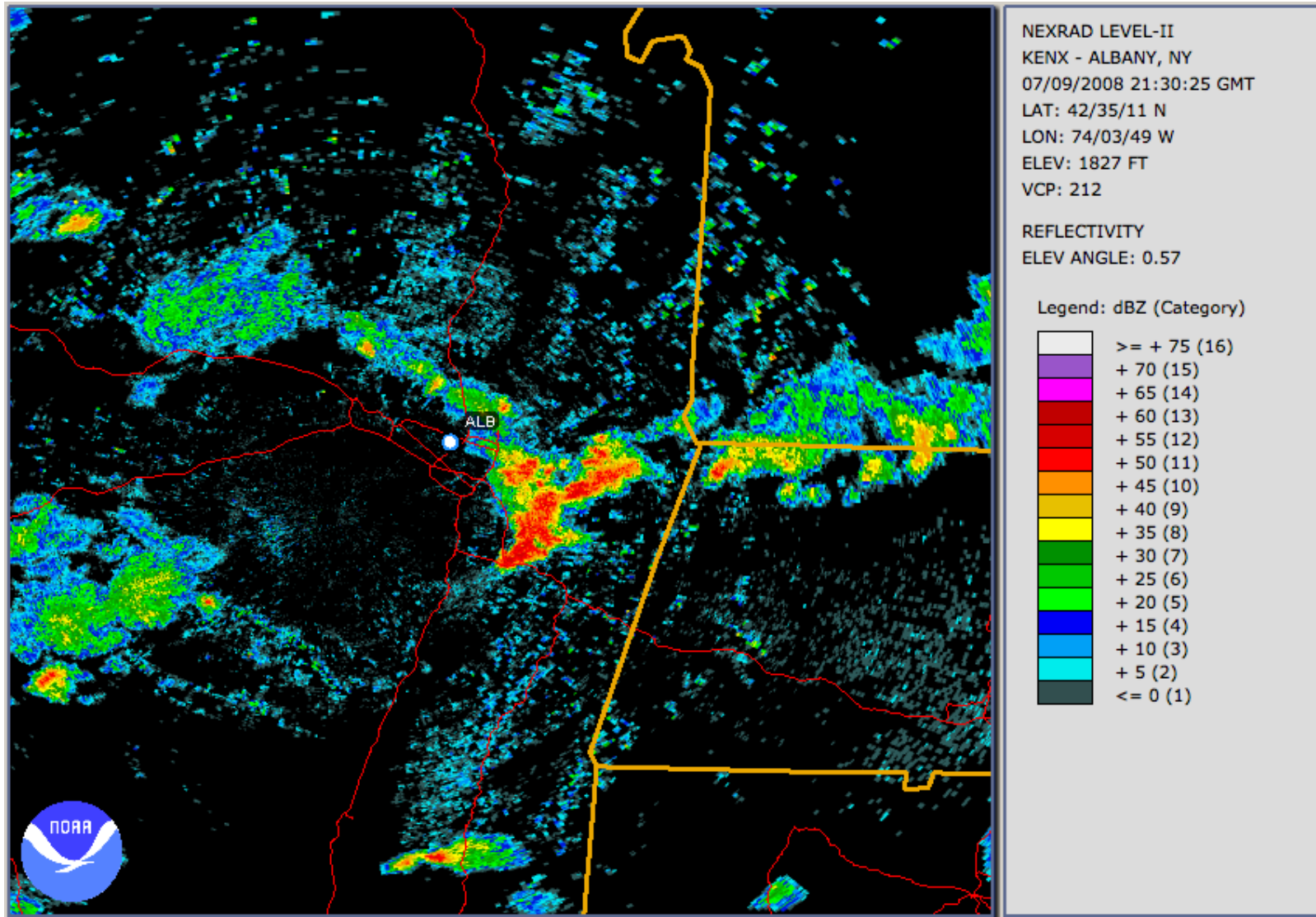
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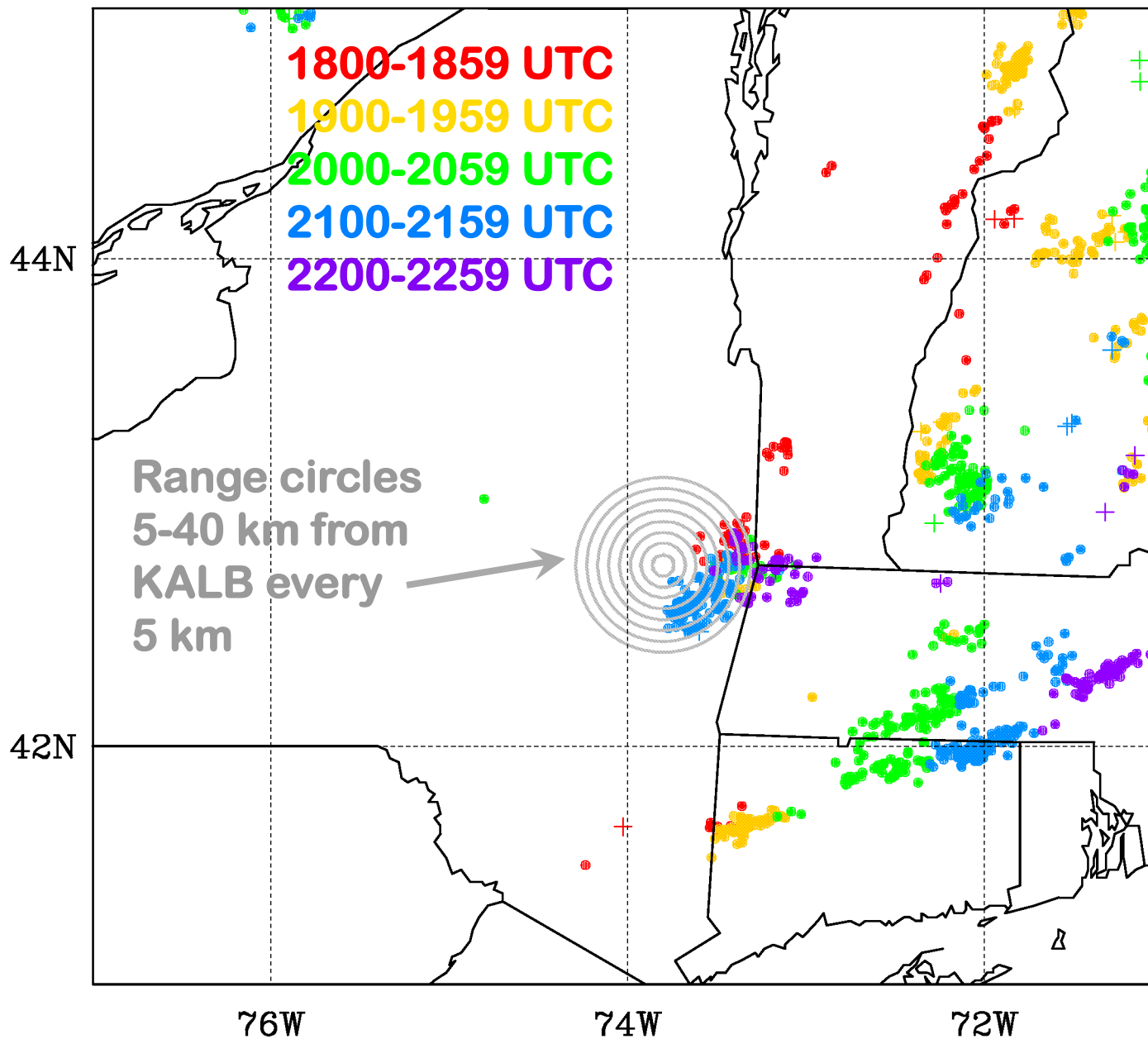
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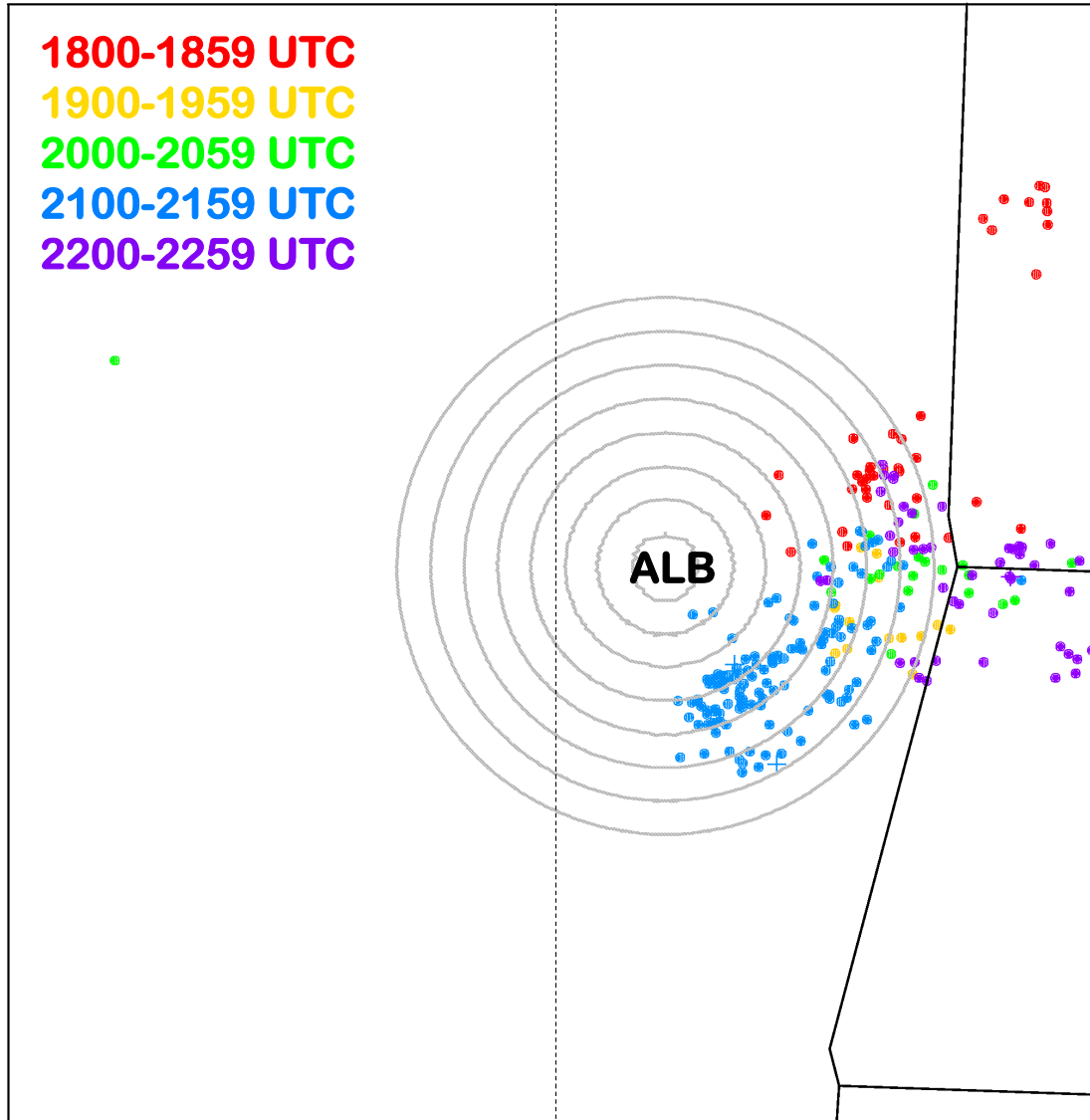
KENX radar: KALB missing METAR case 2130 UTC 09 July 2008



NLDN Flashes 1800–2259 UTC 9 July 2008



NLDN Flashes 1800–2259 UTC 9 July 2008

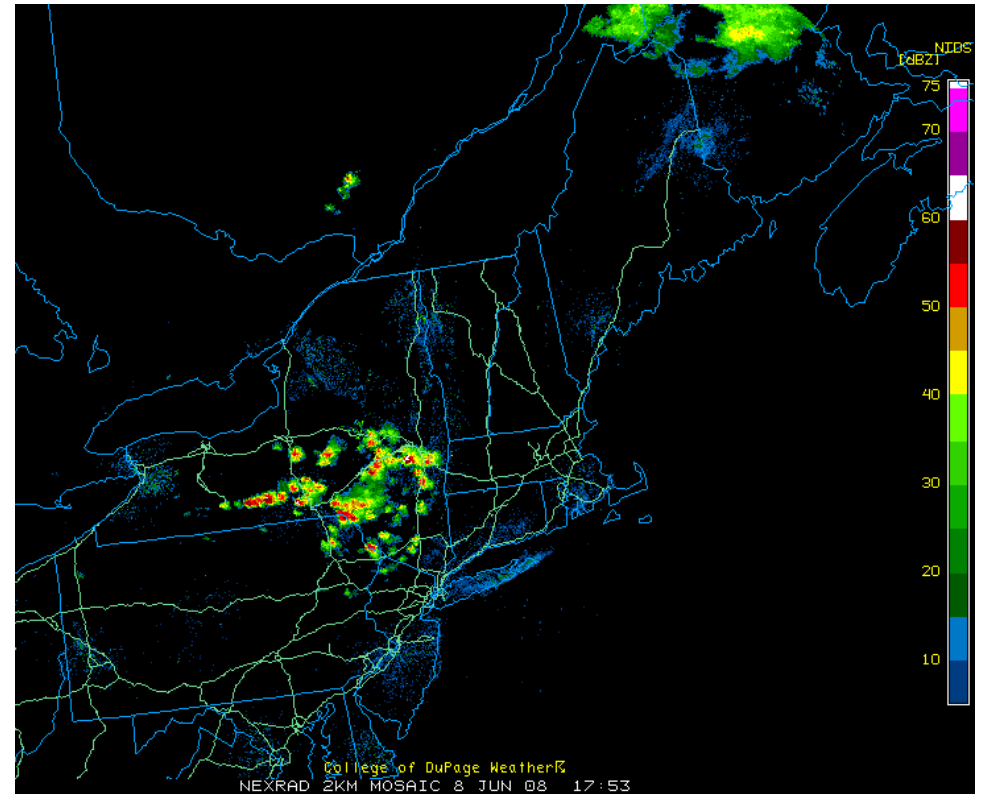
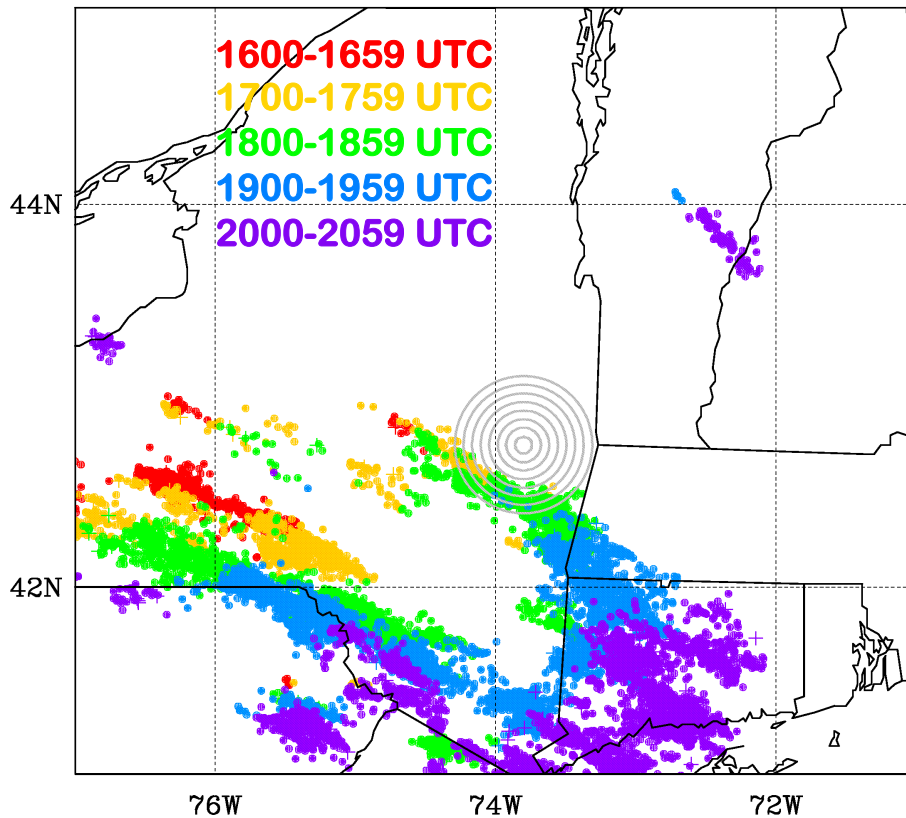


74W

⚡ The NLDN detected 2 flashes within 20 km of **KALB @ ~1805 UTC** and another 19 flashes between 2100 and 2159 UTC

⚡ A total of 106 flashes were detected within 30 km during the 4 hours of missing METARs

NLDN Flashes 1600–2059 UTC 8 June 2008



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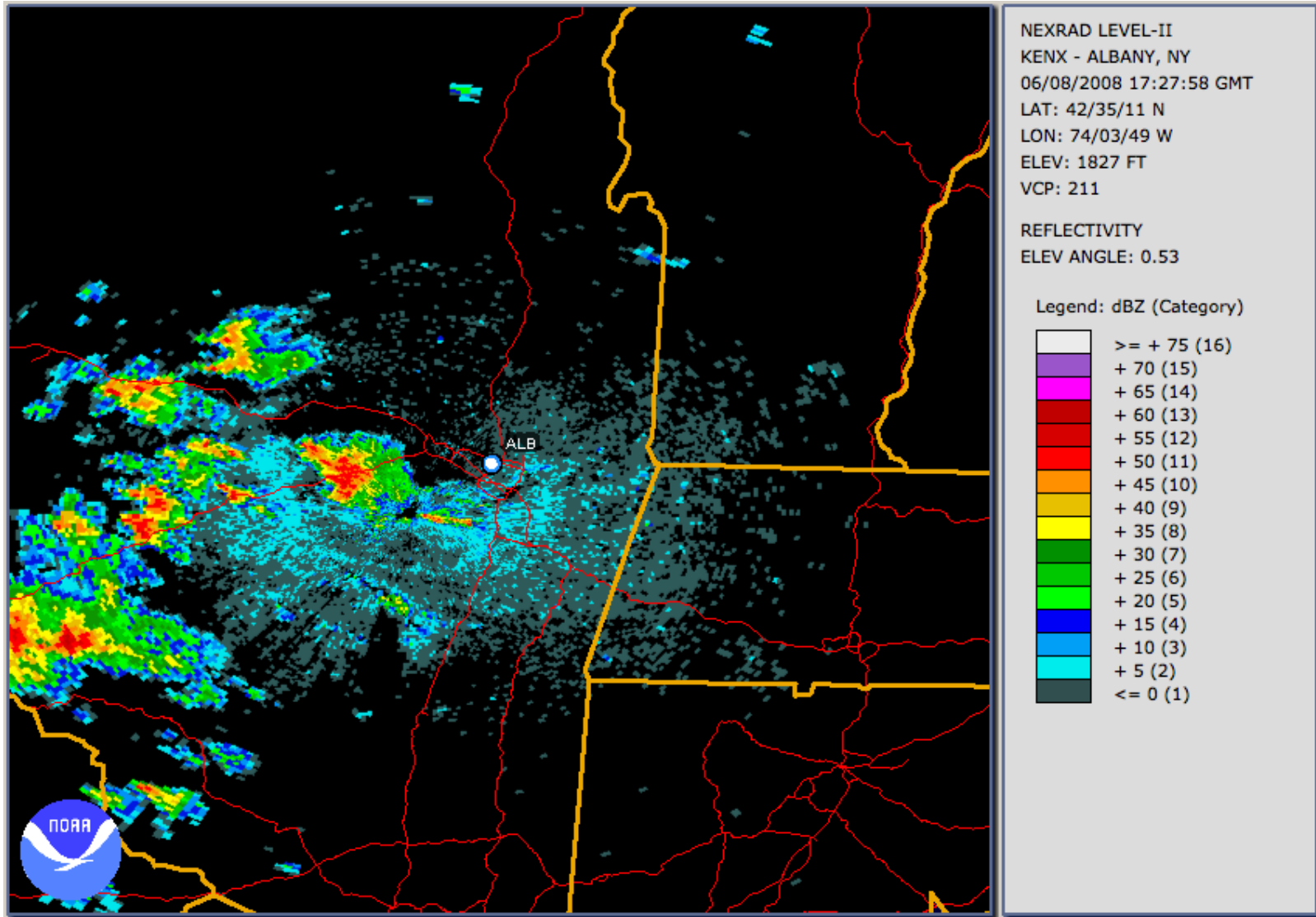
**KALB 081751Z 35010KT 5SM TS HZ CLR 30/21 A2983 RMK AO2 TSB51 SLP097 TS
SW MOV SE T03000211 10328 20244 56013**

KALB 081821Z 32007KT 6SM HZ FEW044 29/22 A2982 RMK AO2 TSE15

KALB 081851Z 24011KT 7SM CLR 29/22 A2983 RMK AO2 TSE15 SLP099 T02890217

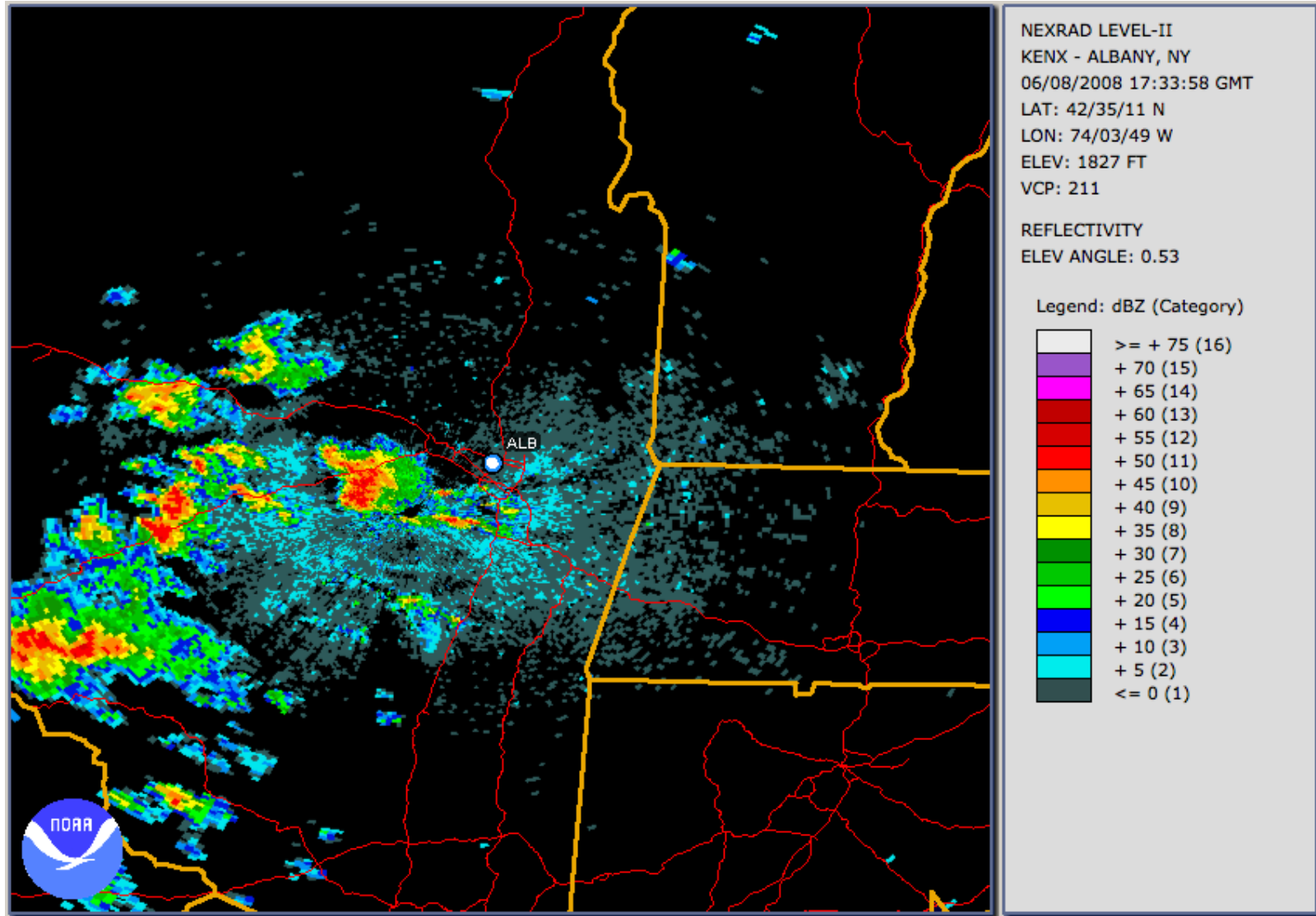
KENX Radar

1728 UTC 08 June 2008



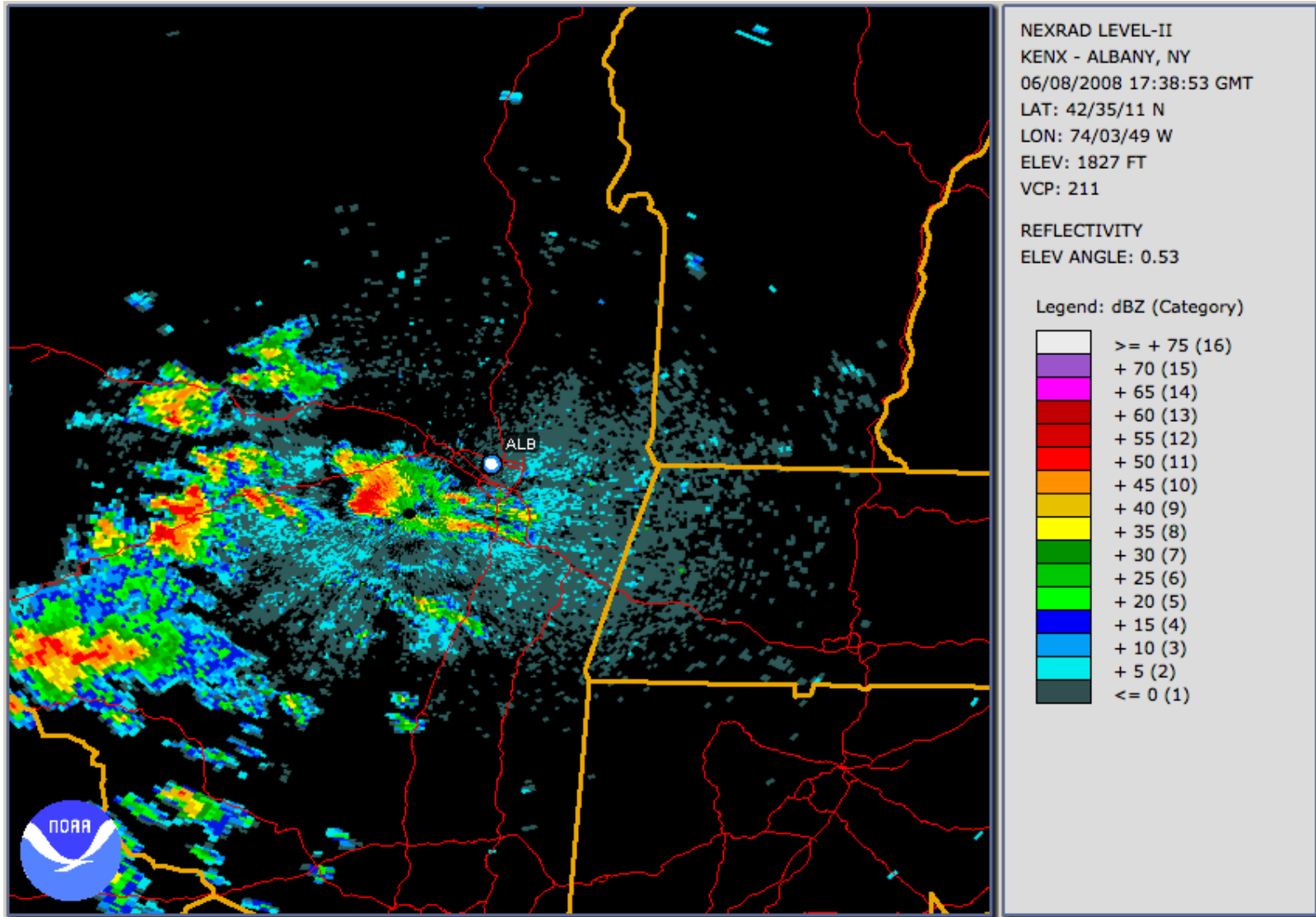
KENX Radar

1734 UTC 08 June 2008



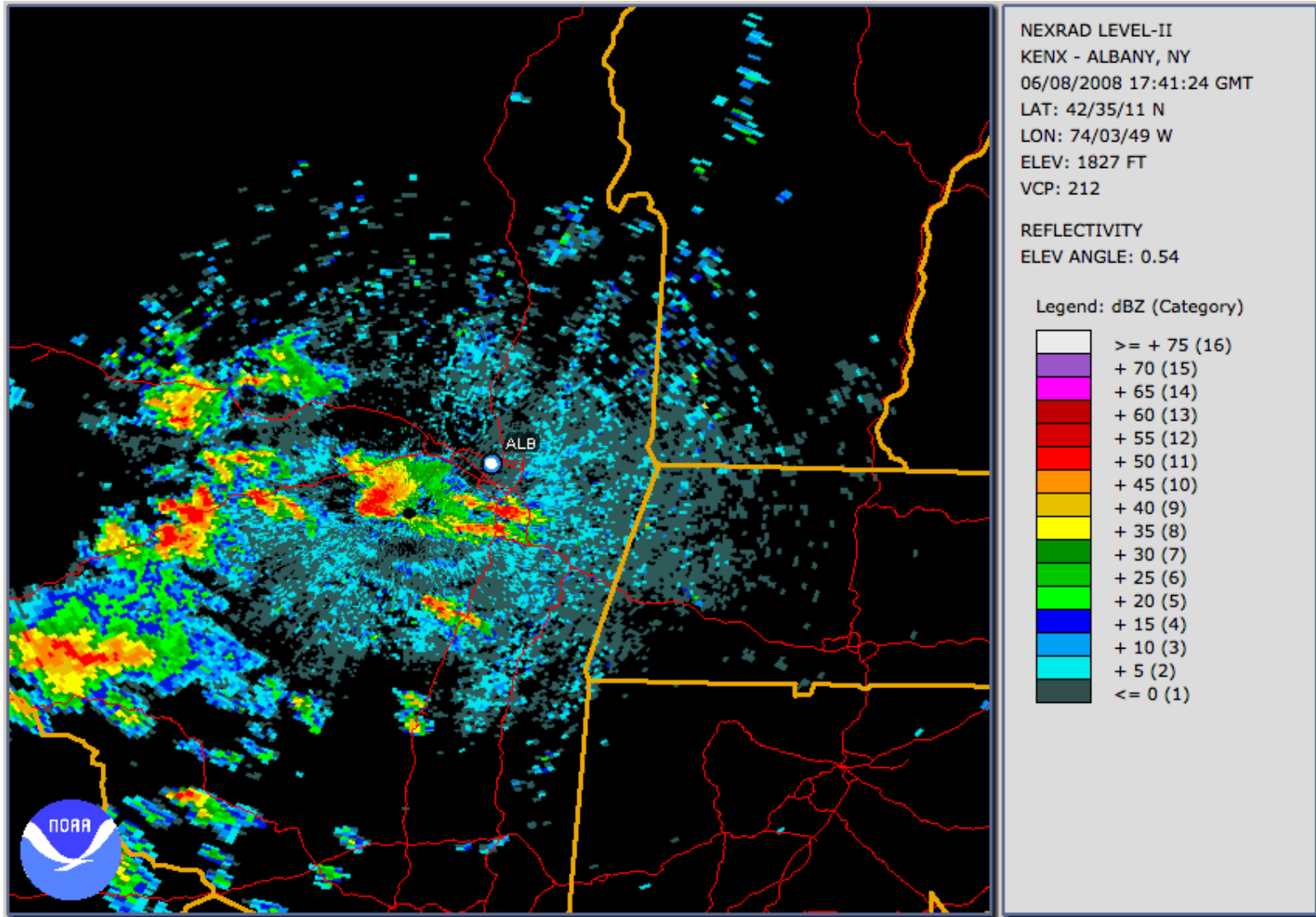
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1739 UTC 08 June 2008



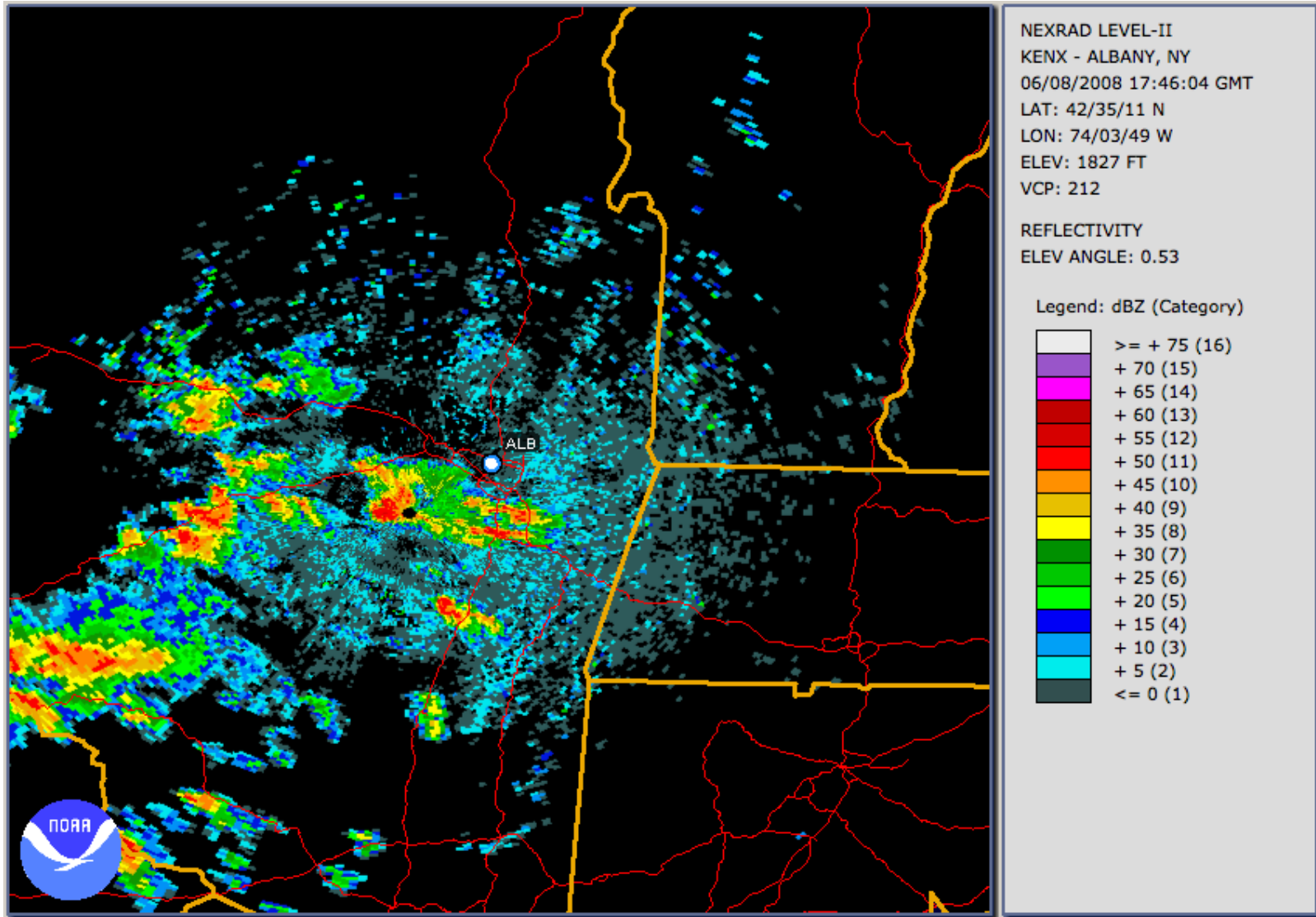
KENX Radar

1741 UTC 08 June 2008



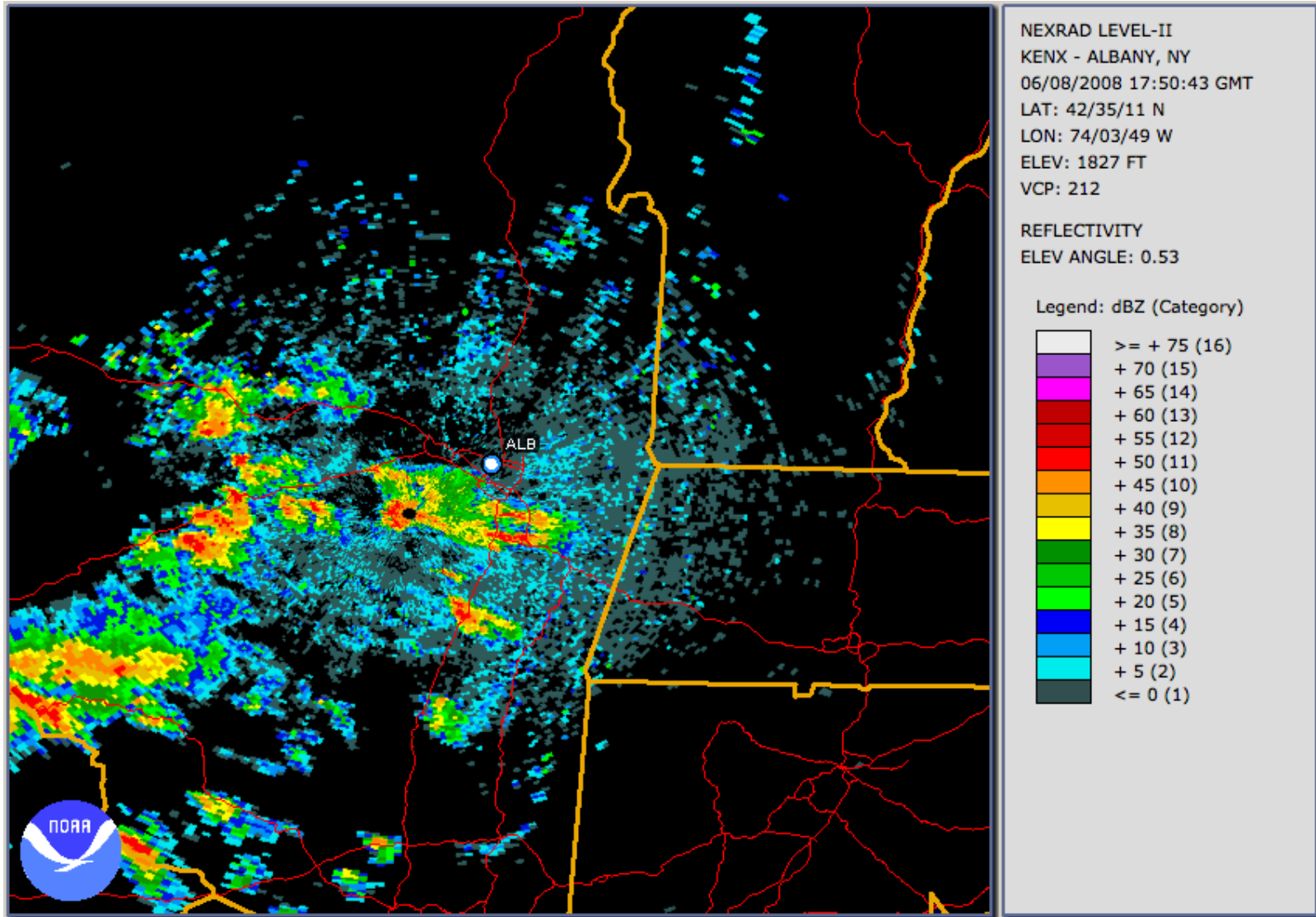
KENX Radar

1746 UTC 08 June 2008



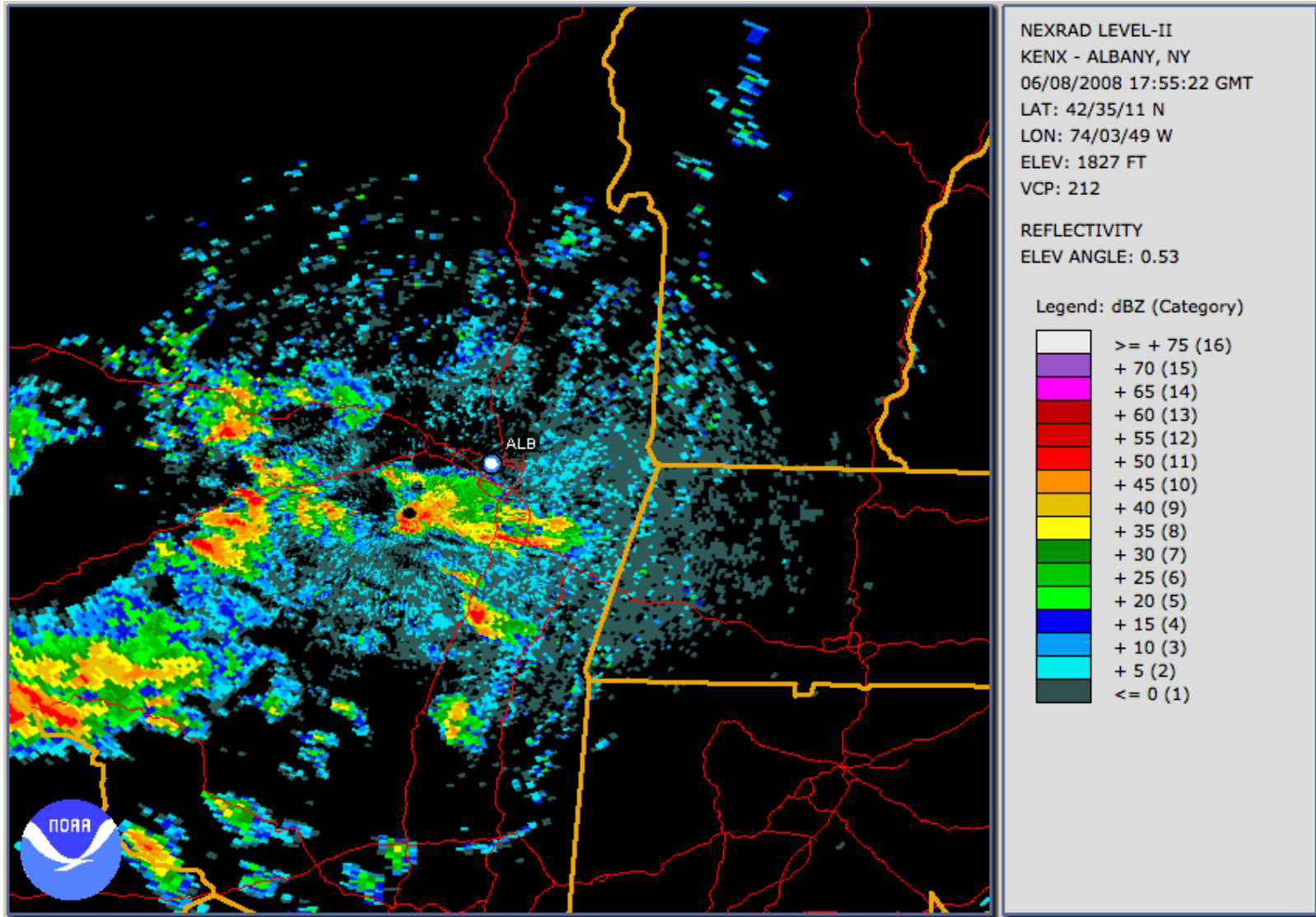
KENX Radar

1751 UTC 08 June 2008



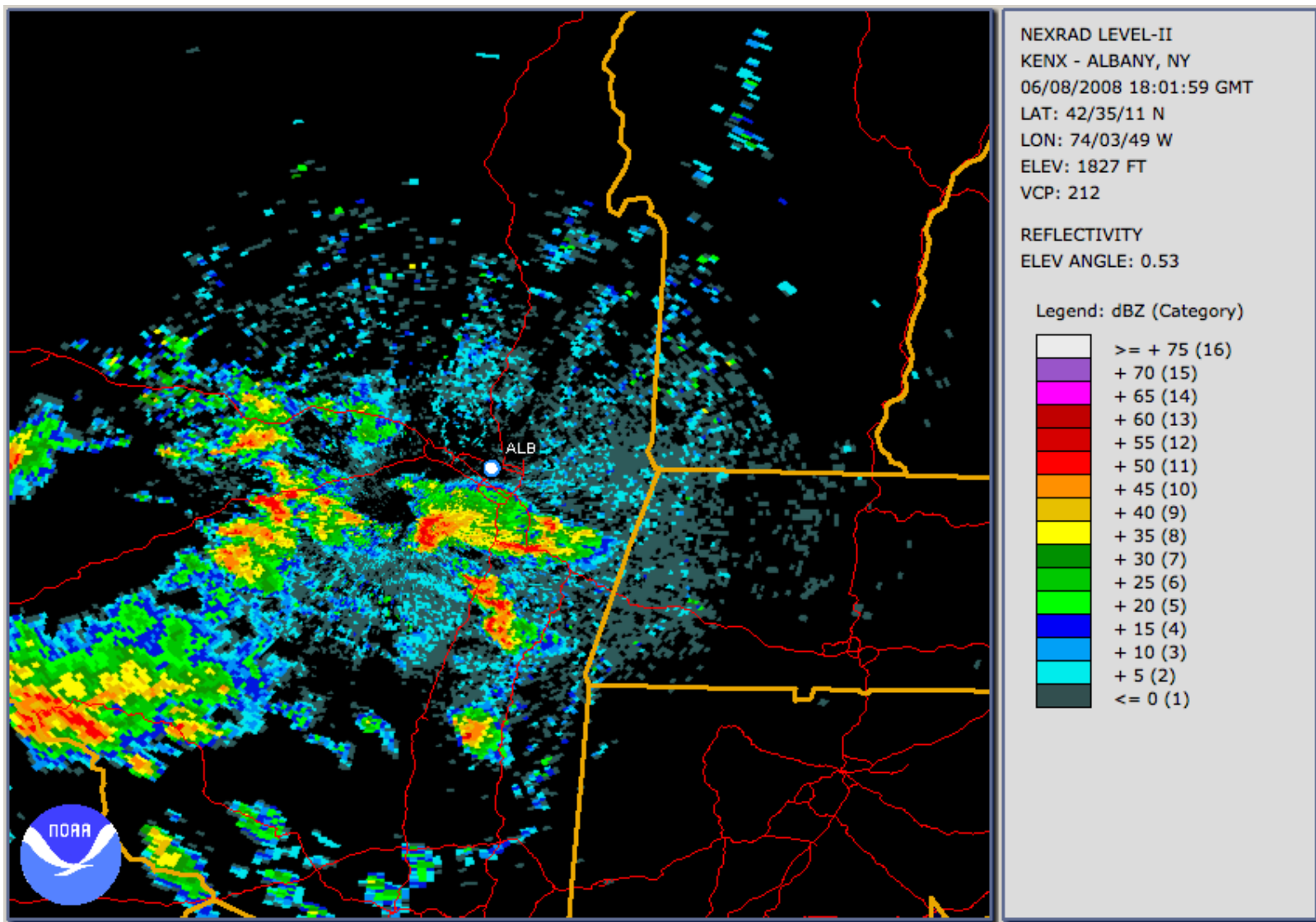
KENX Radar

1755 UTC 08 June 2008



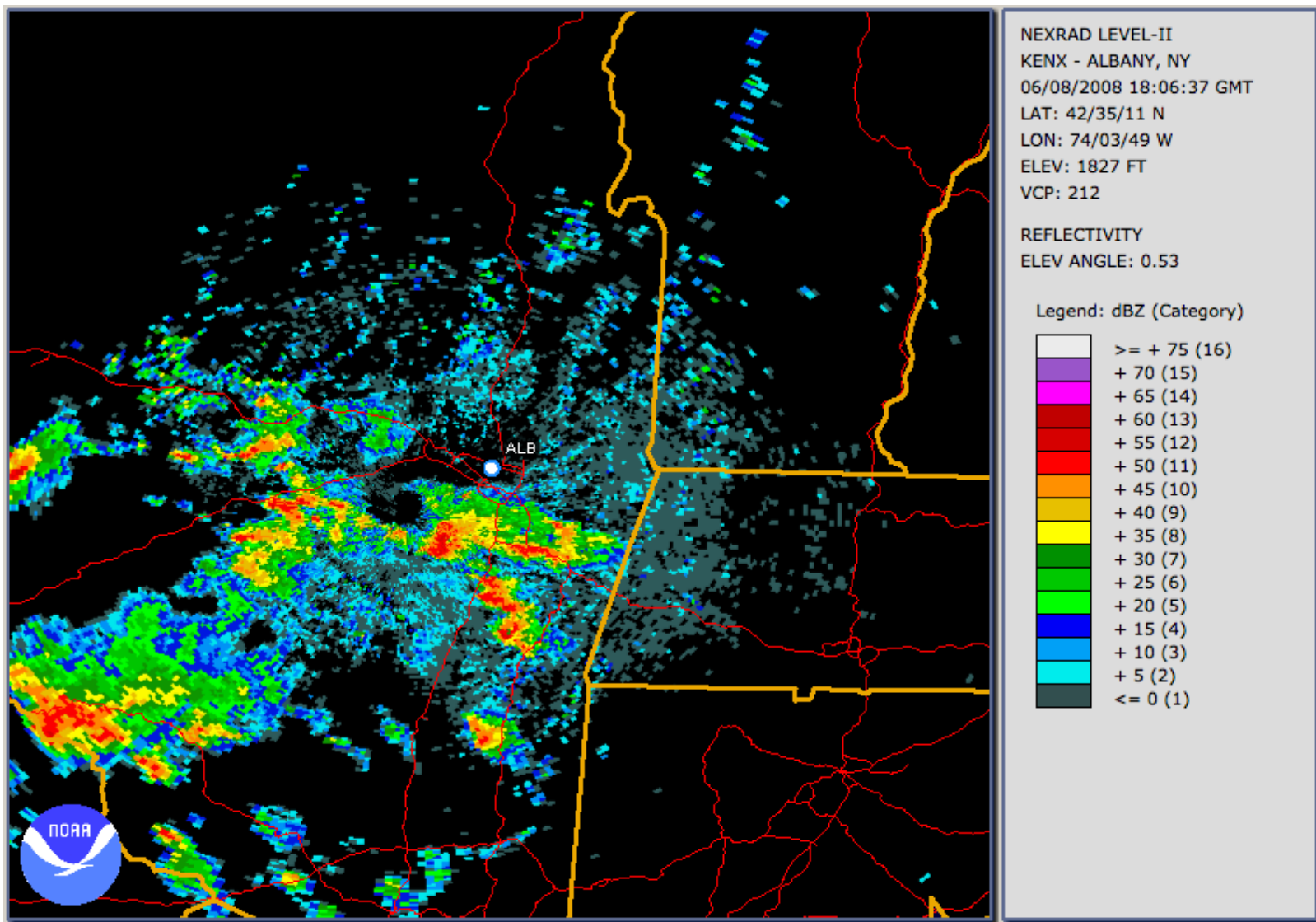
KENX Radar

1802 UTC 08 June 2008



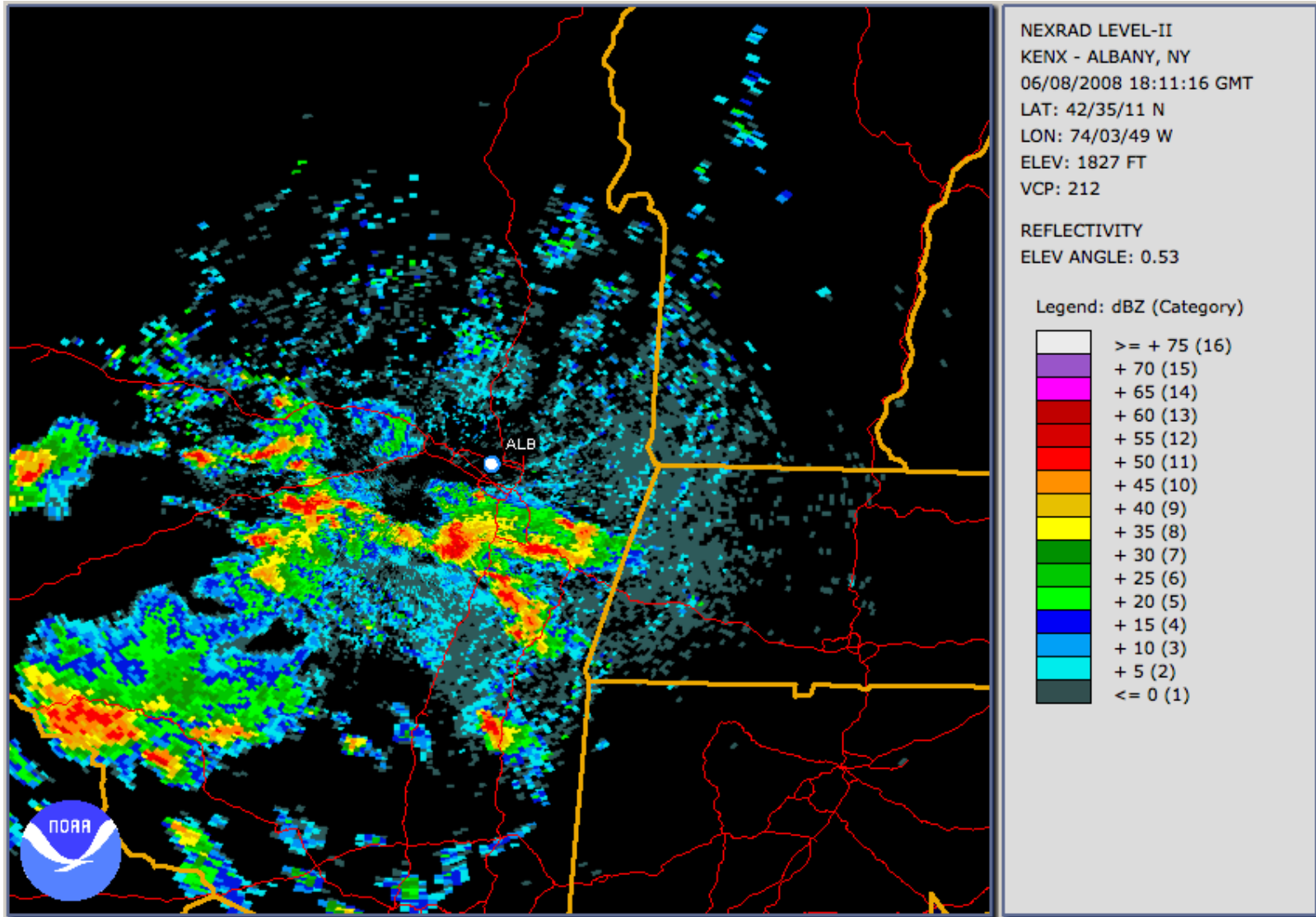
KENX Radar

1807 UTC 08 June 2008



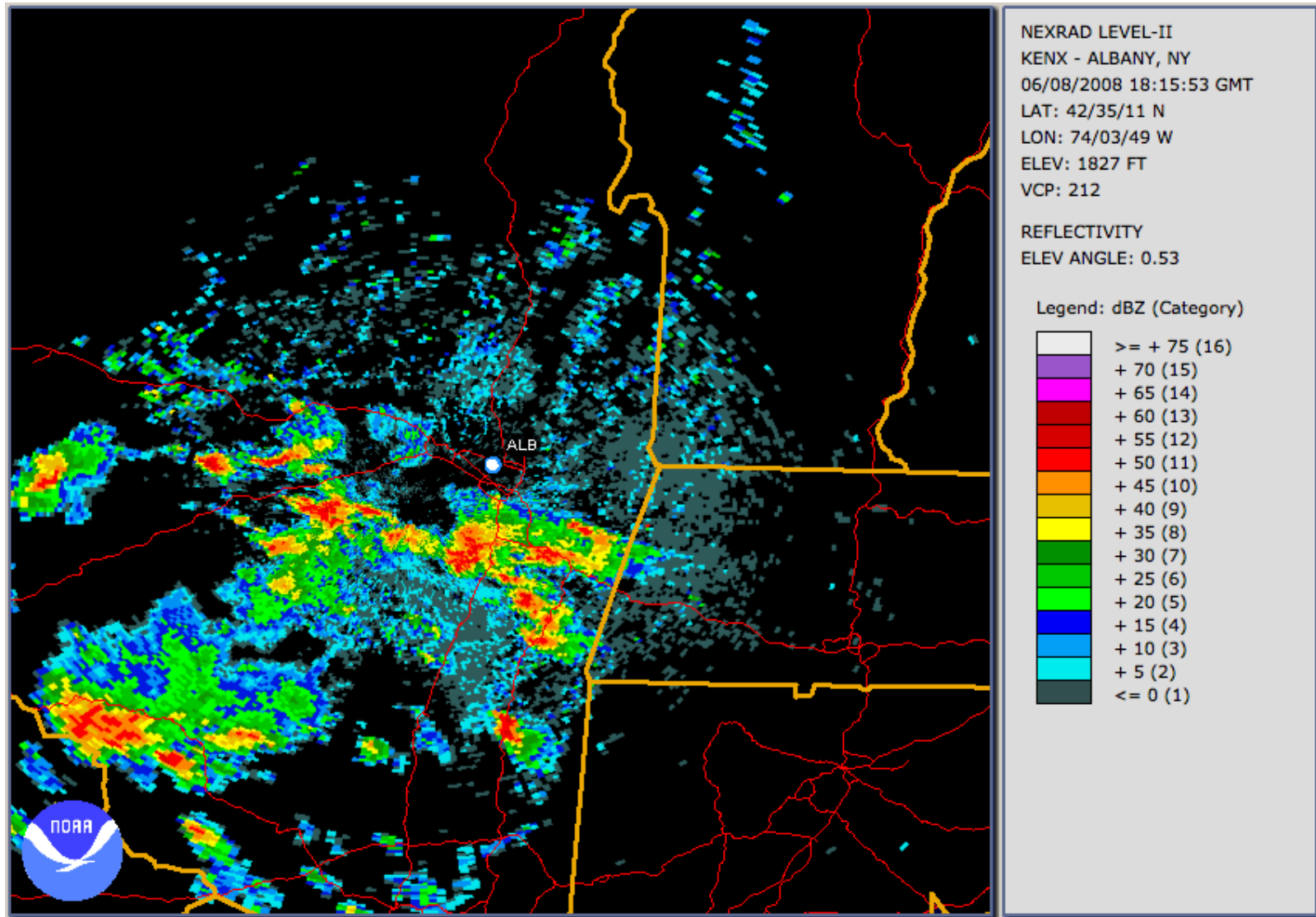
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1811 UTC 08 June 2008



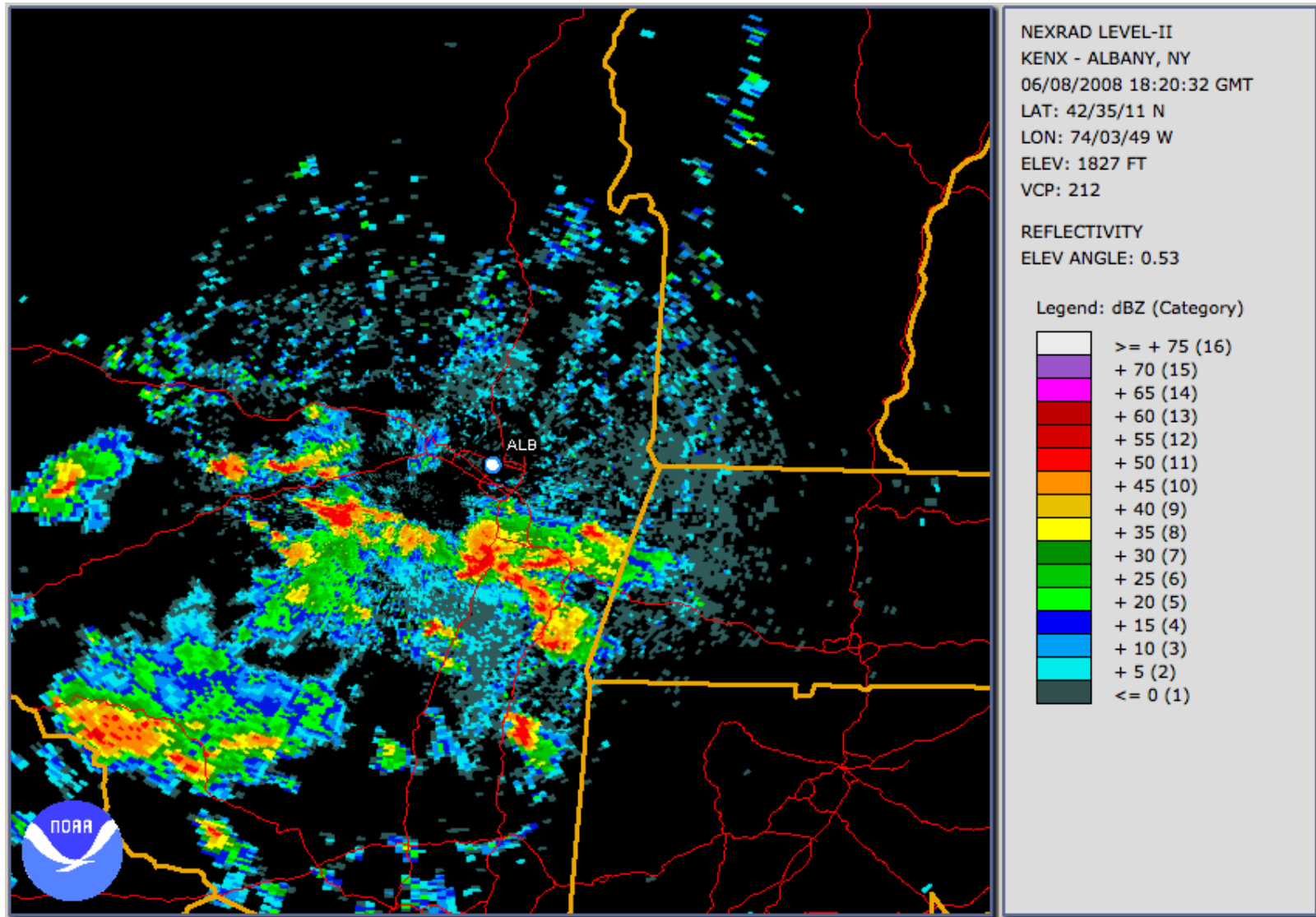
KENX Radar

1816 UTC 08 June 2008

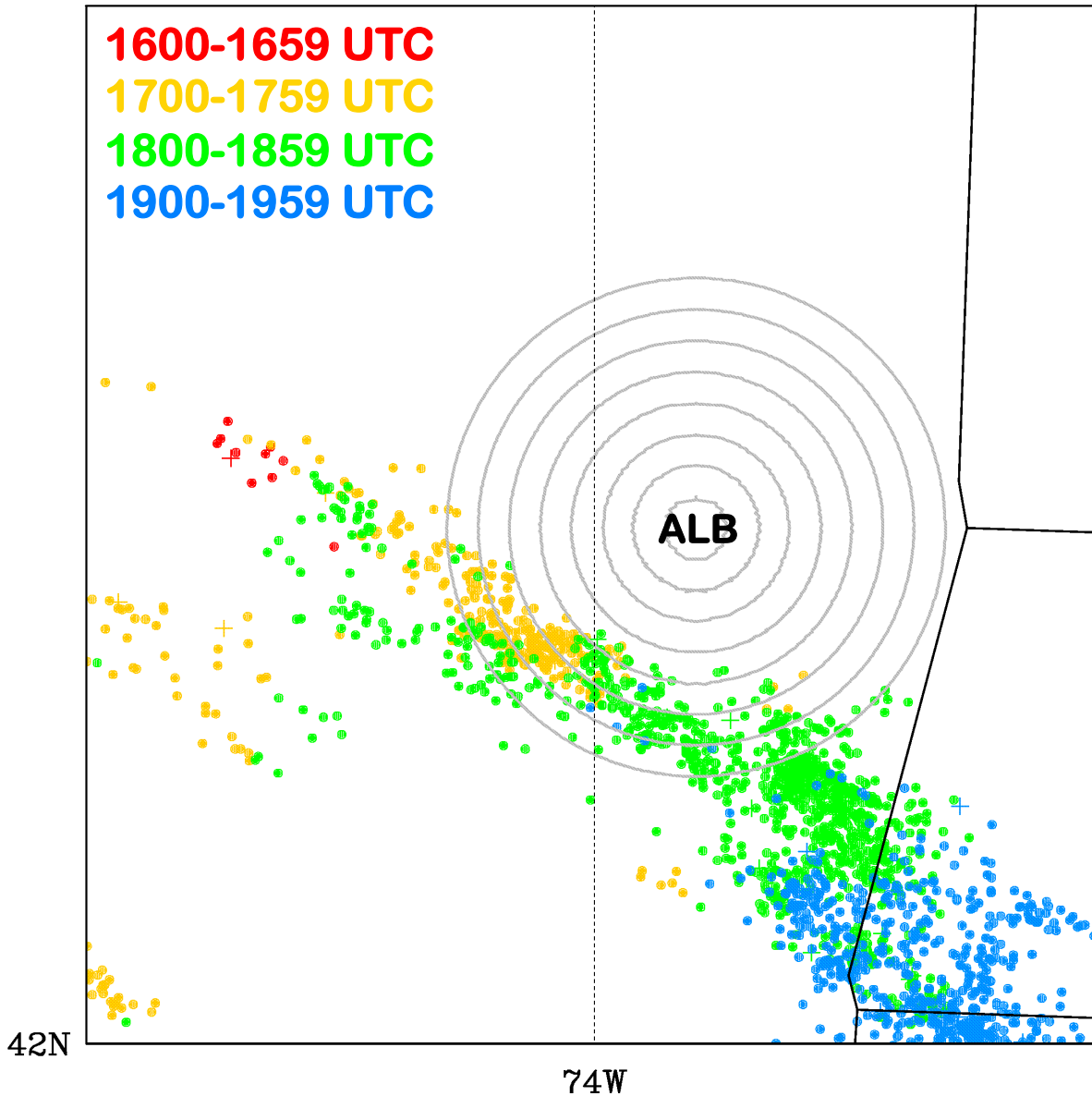


KENX Radar

1821 UTC 08 June 2008



NLDN Flashes 1600–2059 UTC 8 June 2008



⚡ The NLDN detected NO flashes within 20 km of KALB

⚡ Only 6 (25) flashes were detected within 25 (30) km and ±5 min of the TSB report @ 1751 UTC

Summary and Future Work

- A 15 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, an updated evaluation of forecaster skill and picking on other cities besides Albany