Operational Applications of Lightning Data Workshop
"The Diagnostic Potential of Lightning Data"

Using Total Lightning Information for Local Severe Storm Discernment

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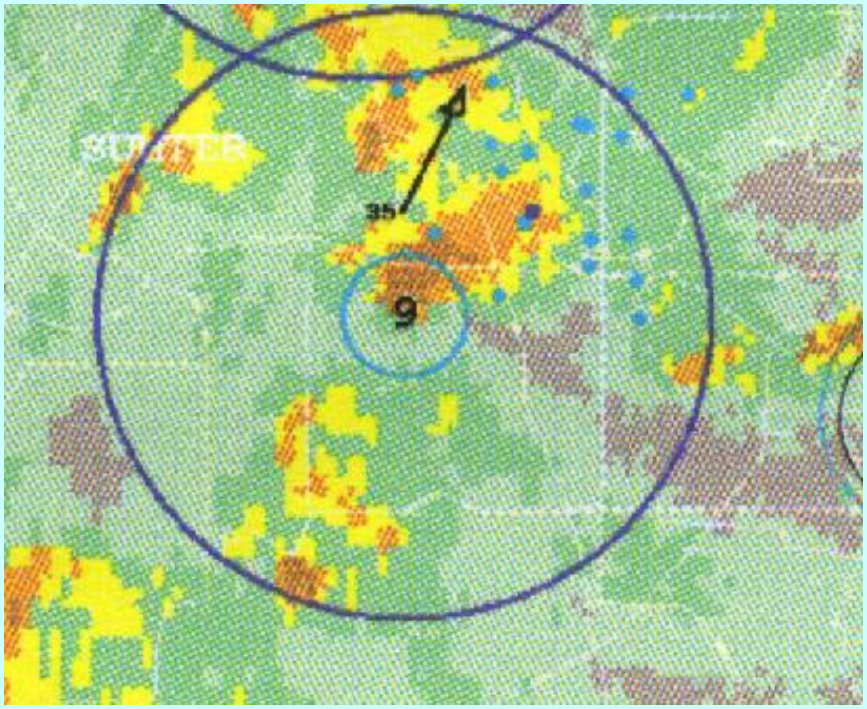


LISDAD operationally available at NWSO MLB thanks to: Earle Williams, Anne Matlin, and Mark Weber (MIT/LL) and Steve Goodman and Ravi Raghavan (MSFC)

Using TLI for SLS Discernment

- LDAR data set large and often difficult to interpret ("LDAR points" versus "flashes").
- LISDAD (Lightning Imaging Sensor Data Applications Display) workstation developed by MIT/LL. Initially for research purposes, later made operational.
- LISDAD algorithms interpret "lightning flashes" from LDAR "point source" data.
- The LDAR flash rate is determined by grouping LDAR sources (verified by two independent arrays of radio receivers) into flashes using the following definition: A new flash is declared if:

1. 300 msec elapse since the previous LDAR source, or if,

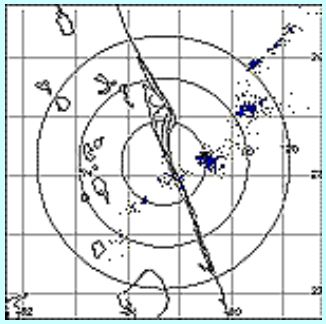
2. The new LDAR souce is greater than 5000 meters from the previous source.

- LISDAD (available at NWS MLB since summer 1995) incorporates:

1. NLDN (available at NWS MLB since 1990)
2. WSR-88D (available an NWS MLB since 1991) CR
3. LDAR (available at NWS MLB since 1994)
4. Trend tables (1997)

- Lightning "jump" versus severe weather table.

Severe storm assessment:



"Central Florida Tornado Outbreak"
Image from MSFC

"Dry Season" (November - April):

1. **high shear - high buoyancy (22-23 February 1998 tornado outbreak)**
2. **high shear - low buoyancy (low-topped supercell; see example #2 below)**

"Wet Season" (May - October):

1. **low shear - high buoyancy (July 1997 pulse severe thunderstorms)**
2. **high shear - low buoyancy (7 November 1996 tropical cyclone tornados)**

Results & Conclusions

- TLI "trends" associated with most cells (CG data often "noisy" and trends not apparent)

- TLI "jump" signal seen prior to most severe weather occurrences (especially "wet season" pulse storms)
- TLI "jump" proxy for rapid/strong updraft growth
- Core collapse subsequent to "jump" often results in hail or downburst winds
- TLI "jump" (as defined) resulted in warning lead-time (11 minutes over official warnings and 24 minutes over documented severe weather occurrences) in a sample of "wet season" cells
- Even when taking into account erroneous severe weather occurrence times, TLI lead time is apparent
- False alarms not documented (planned for 1998)
- May need to modify "jump" criteria to add maximum threshold TLI value (150-200 FPM)
- TLI appears to highlight TC rainband cells with tornadic potential
- TLI combined with radar data may allow increased lead time warnings in some situations

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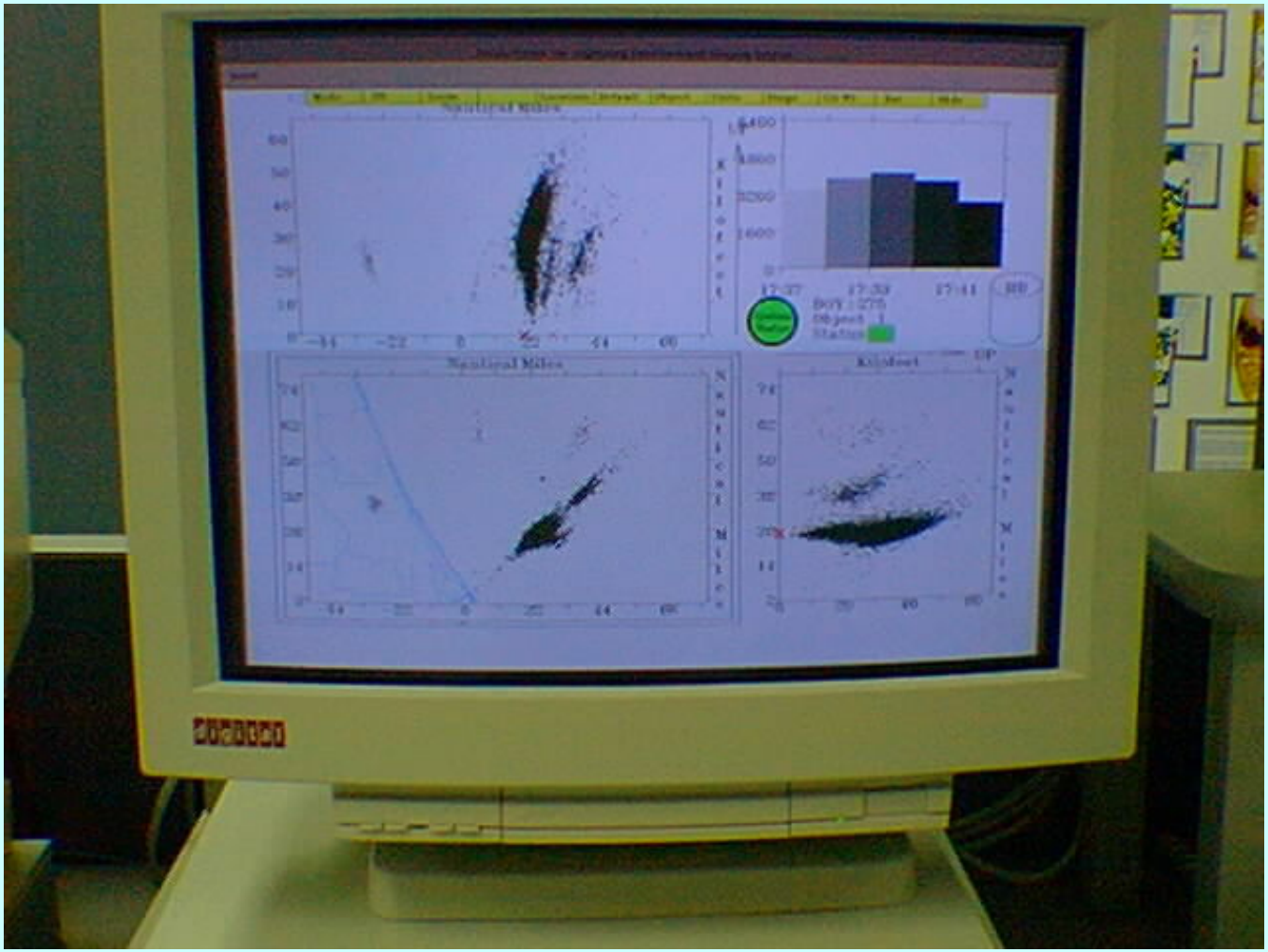
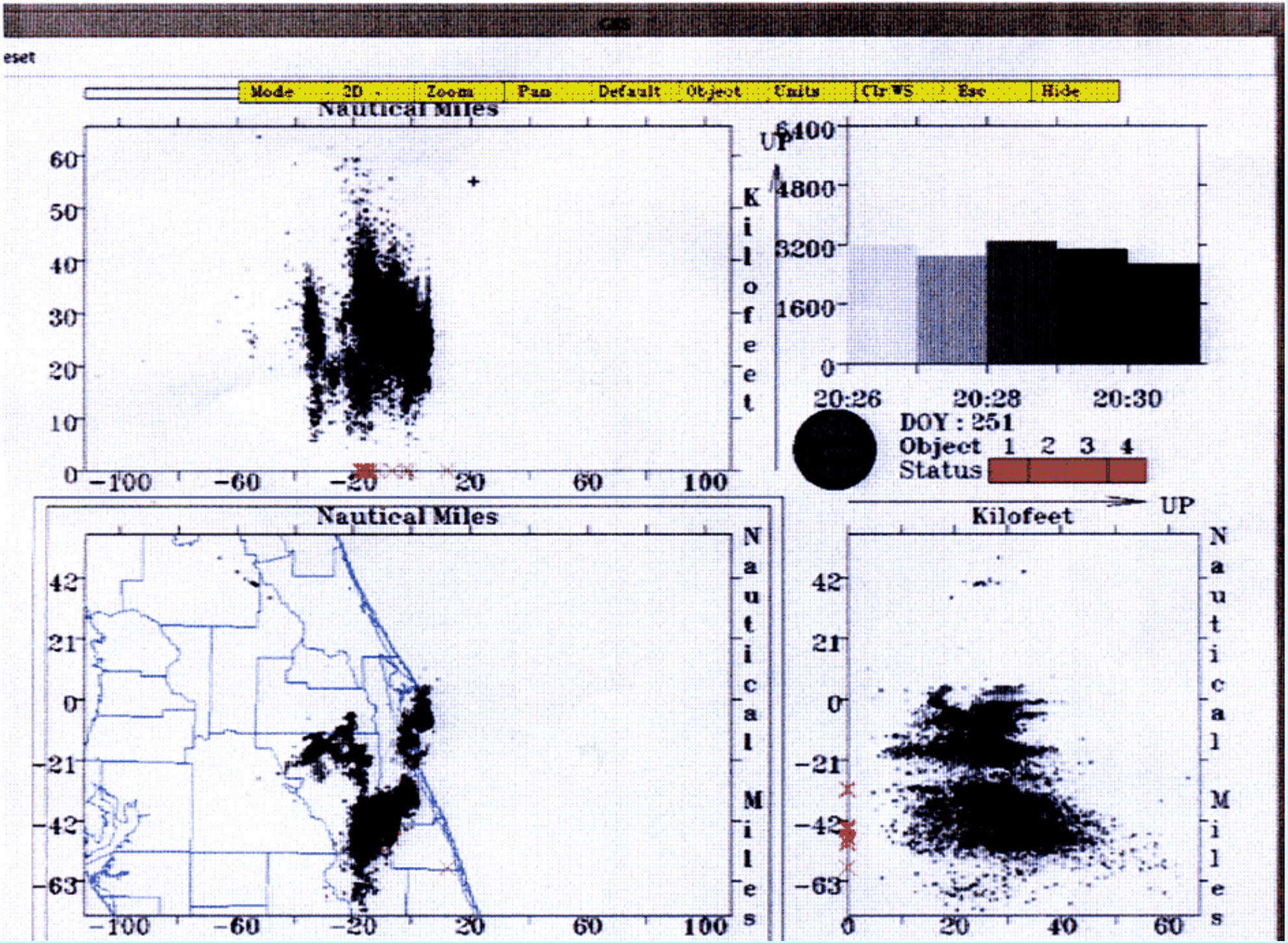
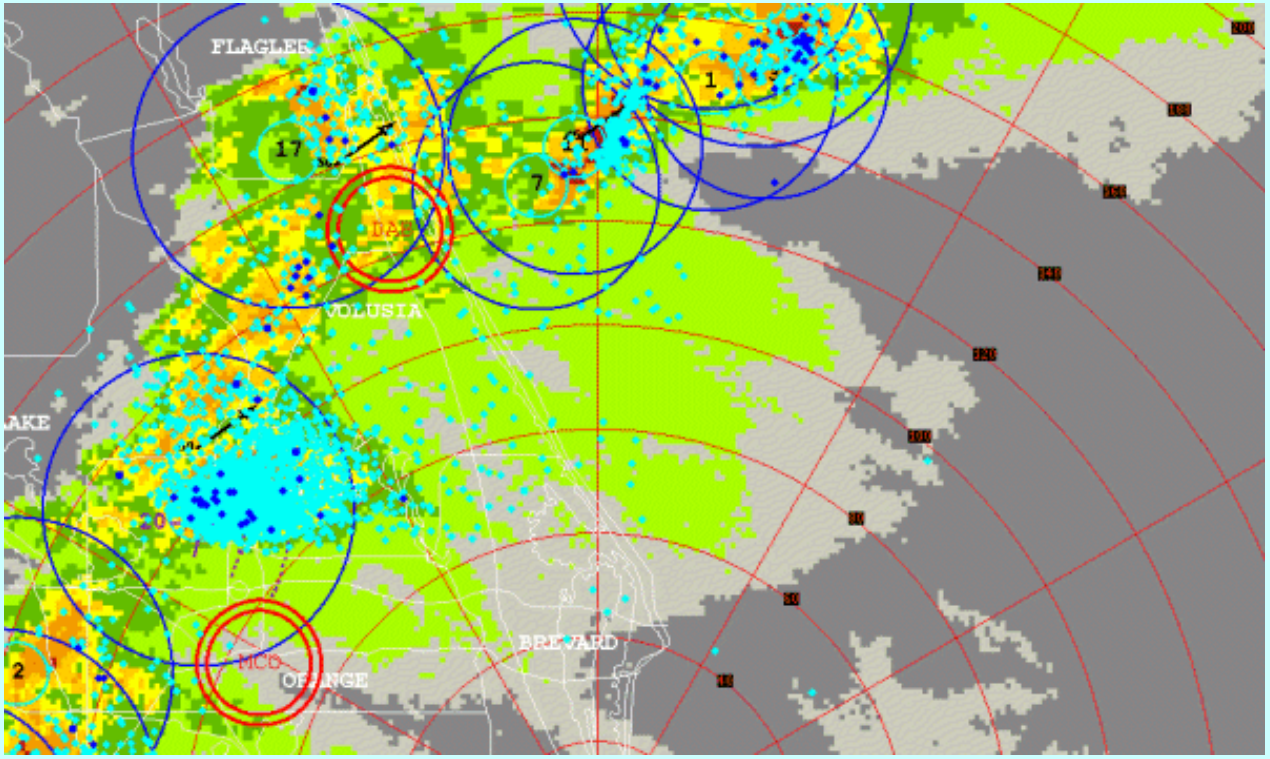
NWSO MLB OPERATIONS AREA

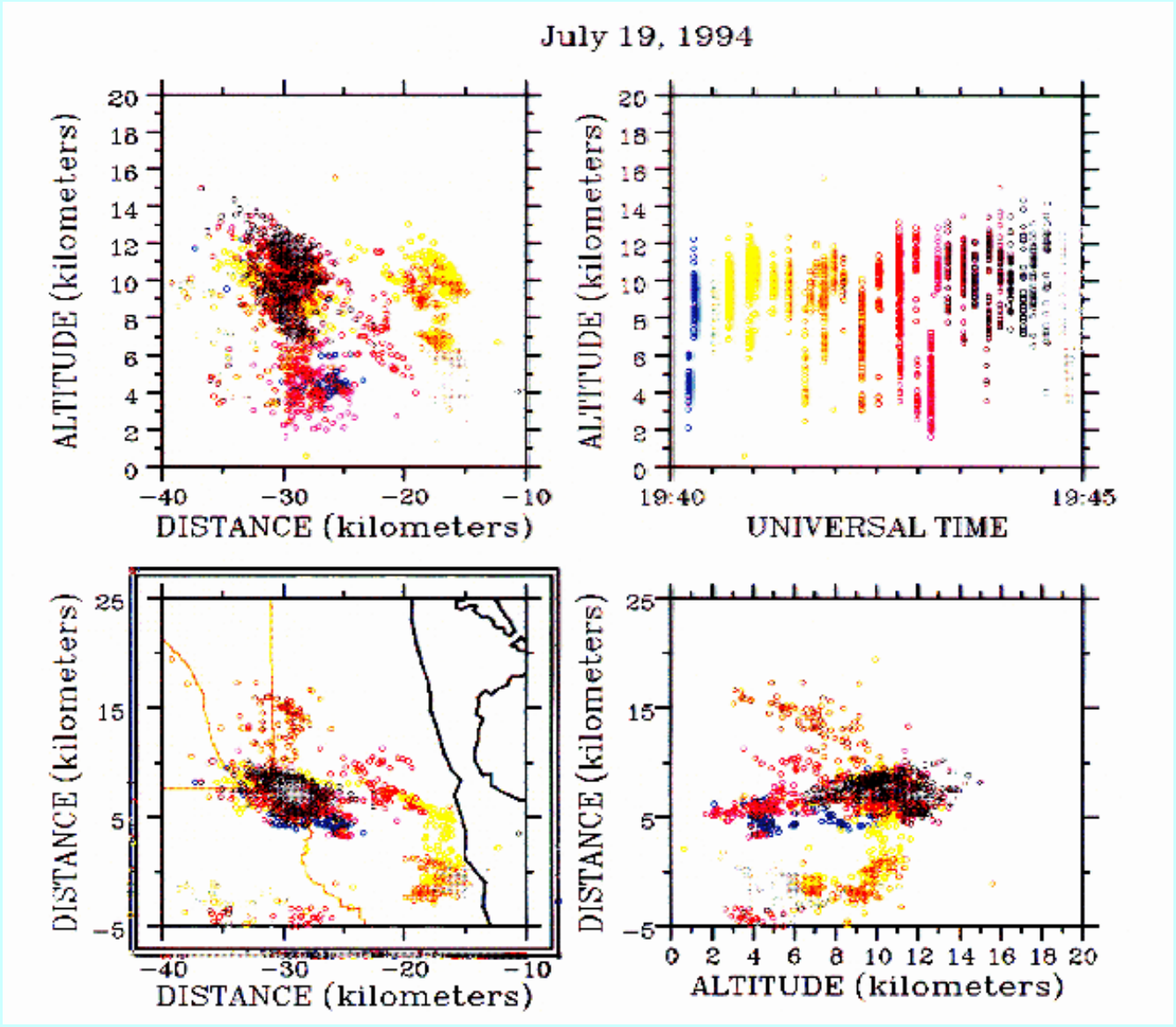


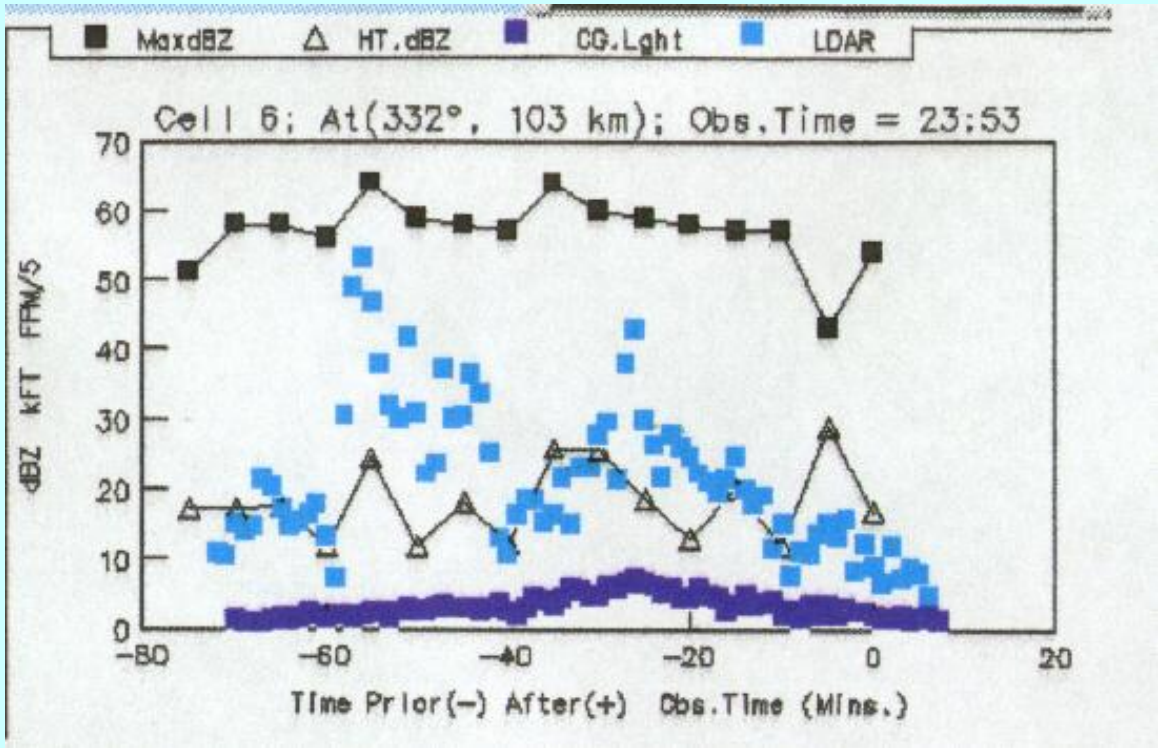
LDAR WORKSTATION

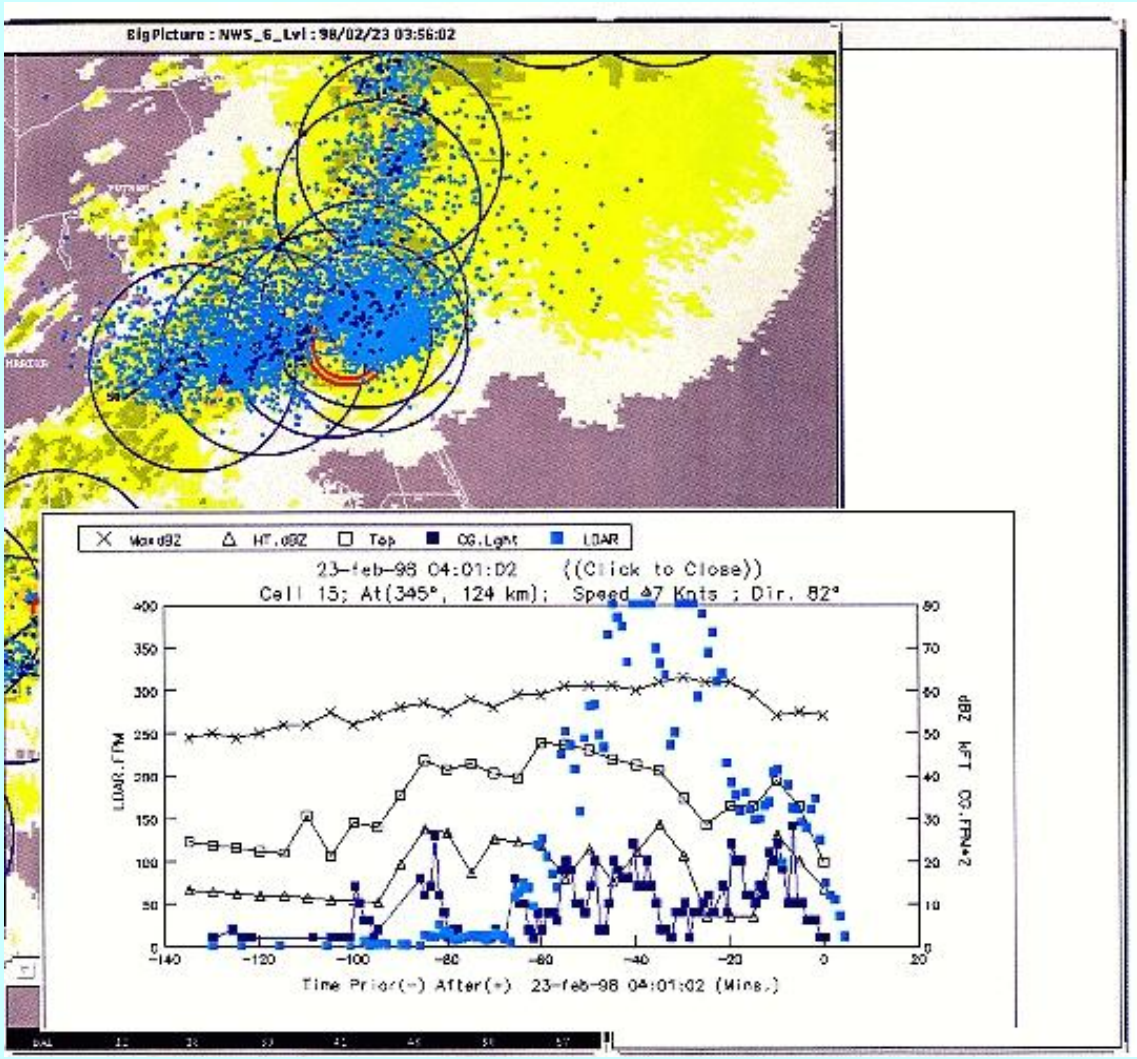


CLOSE-UP OF LDAR DISPLAY


FLAGLER
VOLUSIA
DAY
MCO
ORANGE
BREVARD
17
7
1
20
2

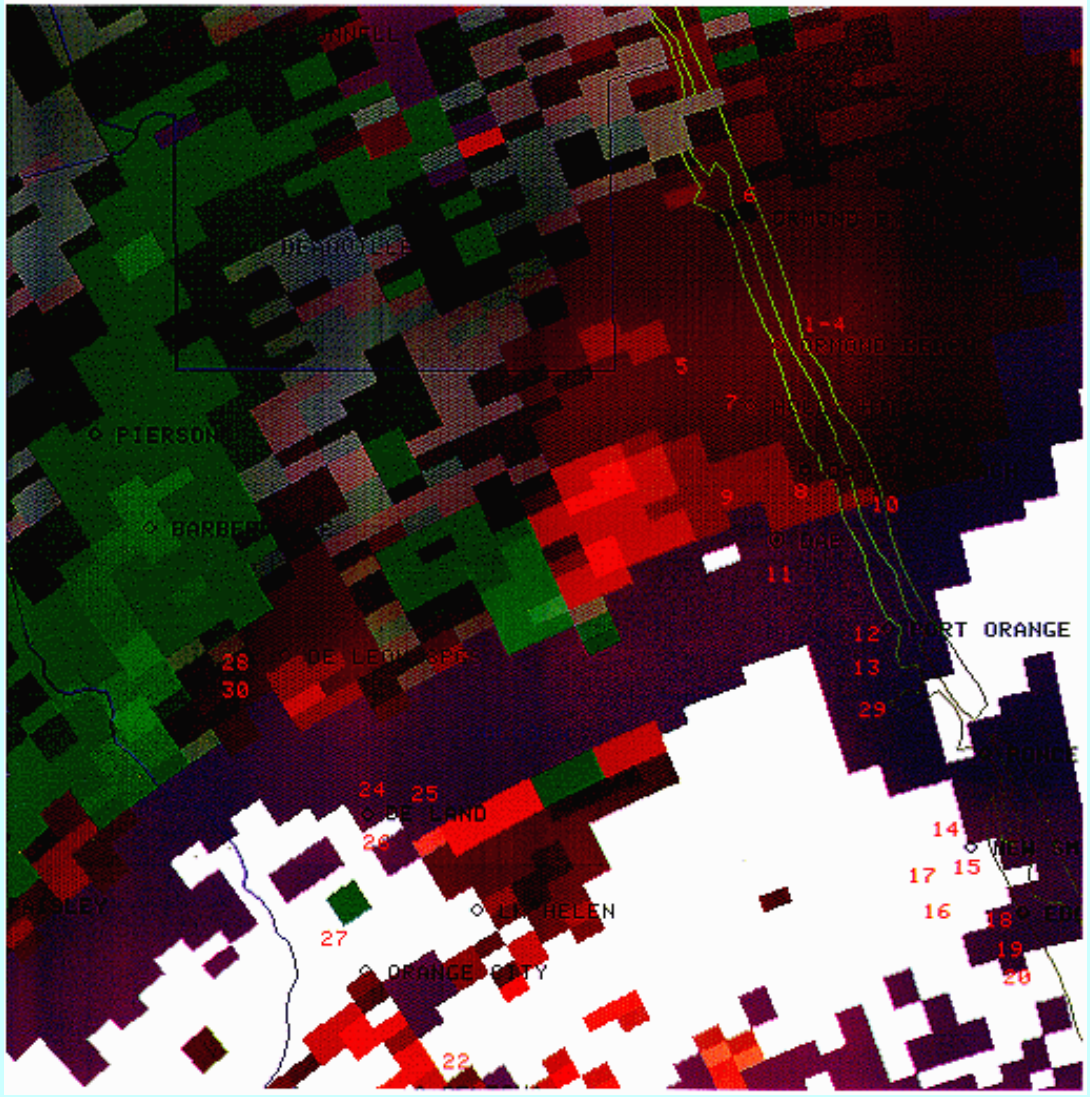

July 19, 1994
ALTITUDE (kilometers)
DISTANCE (kilometers)
ALTITUDE (kilometers)
UNIVERSAL TIME
19:40
19:45
DISTANCE (kilometers)
DISTANCE (kilometers)
DISTANCE (kilometers)
ALTITUDE (kilometers)


MaxdBZ
HT.dBZ
CG.Lght
LDAR
Cell 6; At(332°, 103 km); Obs.Time = 23:53
dBZ kFT FRM/5
70
60
50
40
30
20
10
0
-80
-60
-40
-20
0
20
Time Prior(-) After(+) Obs.Time (Mins.)



0401 UTC 23 February 1998 TLI (LISDAD time = 0)
F2 tornado touchdown at 0355 UTC (LISDAD time = -6)

TLI increase from ~50 FPM to >400 FPM in ~12 minutes
End of TLI increase preceeded tornado by ~40 minutes
CG signal "noisy" during same period
TLI, ET, Ht Max dBZ all decrease prior to tornado (BWER collapse?)



0351 UTC 23 February 1998 SRM (LISDAD time = -10)
F2 tornado touchdown at 0355 UTC (LISDAD time = -6)

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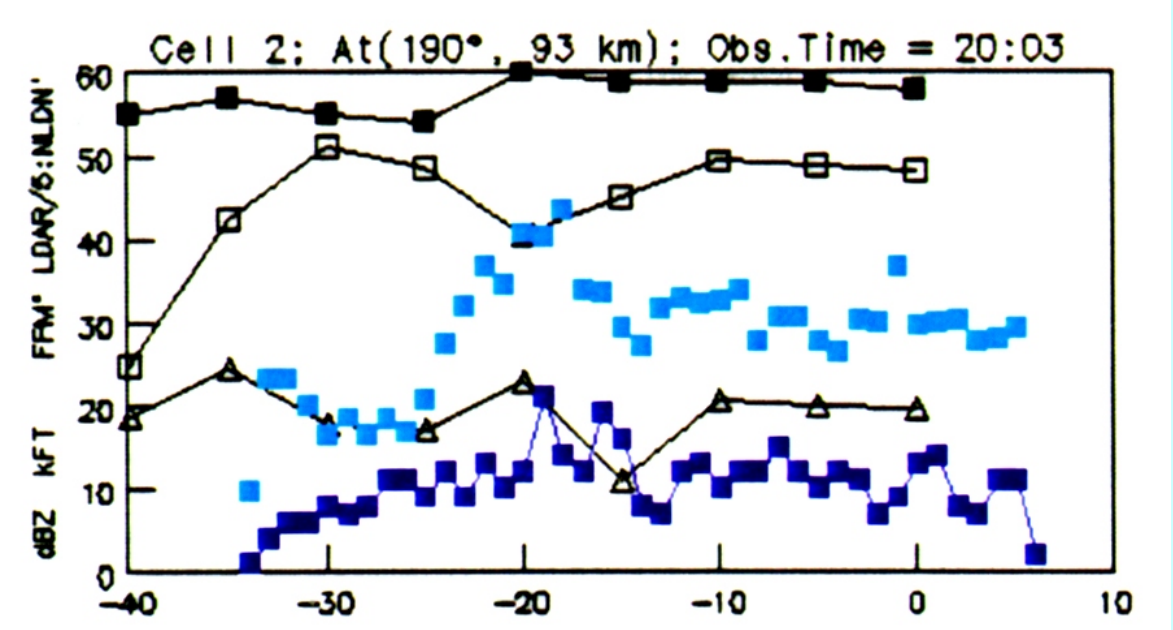
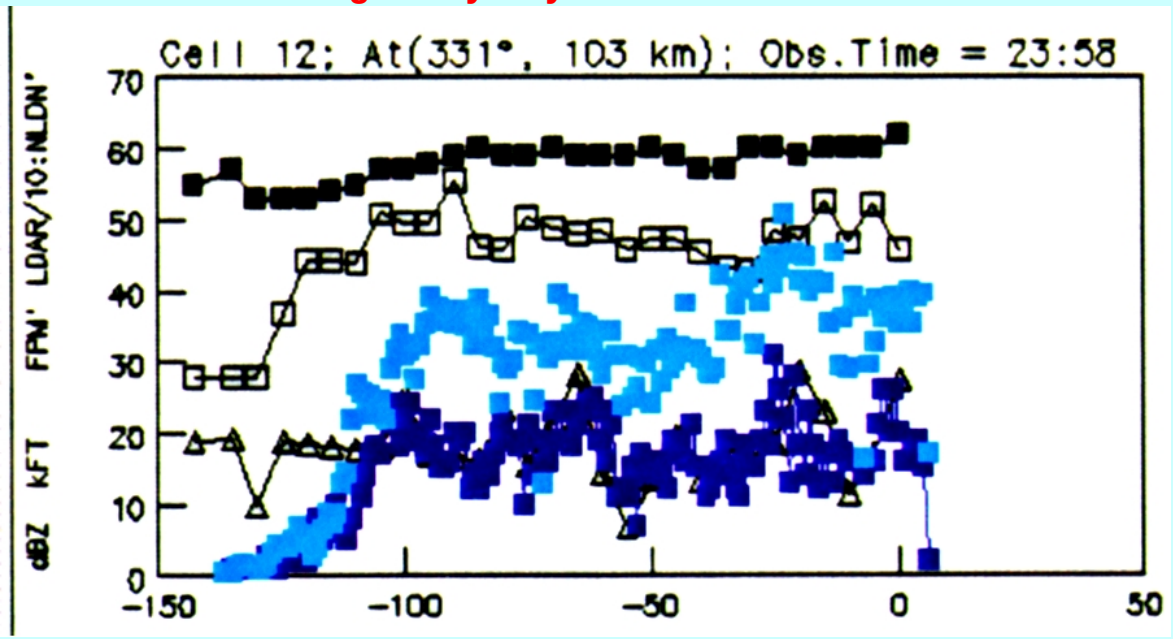
low shear - high bouyancy = PULSE SEVERE

- **Numerous cases examined**
- **Lightning "jump" noted prior to many severe events**
- **Lightning "jump" defined as "a steady TLI increase of at least 50 flashes during the entire period. The "jump" ends when 2 consecutive one minute flash rates are less than, or equal to, the prior 1-minute flash rate." For example:**



LISDAD "pop-up box" for July 6, 1997 at 2003 UTC.
TLI "jump" begins at 1937 UTC (LISDAD time = -26)
TLI "jump" ends at 1945 UTC (LISDAD time = -18)
NOTE: scale on left must be multiplied by 5 to determine TLI.

low shear - high bouyancy = PULSE SEVERE EXAMPLES

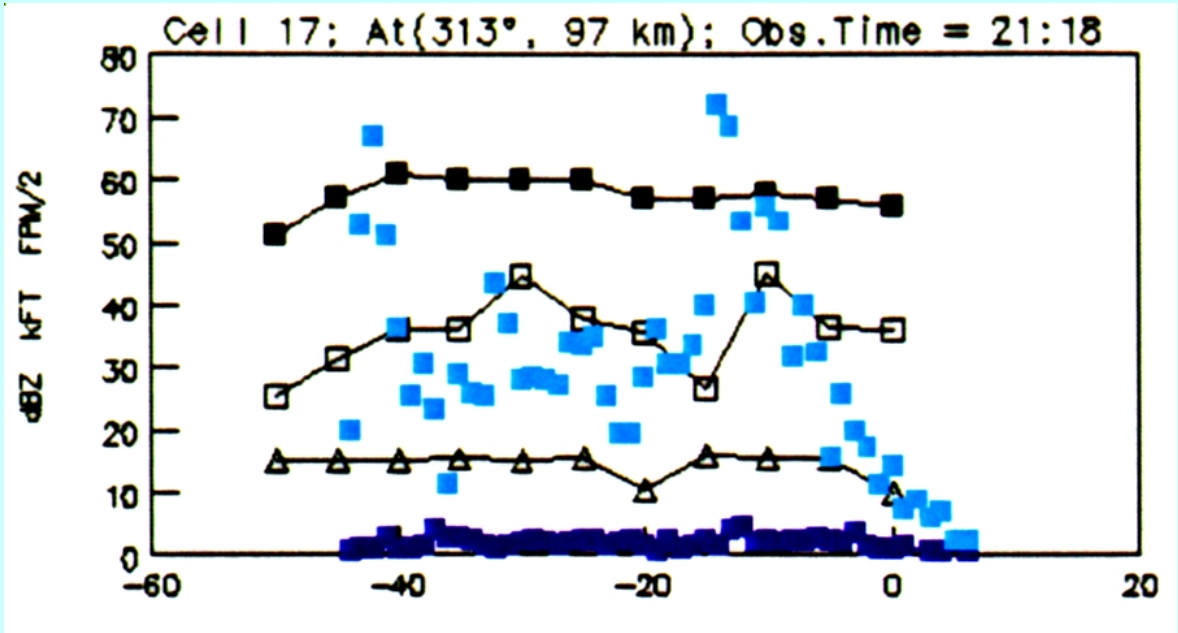


Date: July 7 1997
LISDAD Image: 2358 UTC
Severe Weather: Wind and Hail damage across Volusia county.
2335 UTC: Stadium power poles down.
2350 UTC: golfball hail report.
0020 UTC: Trees and power poles down.
Warning Issued: 2253 UTC (-65 minutes on plot above)
(re-issued at 2355 UTC)
LDAR FPM Scale: ..... FPM x **10**
NLDN FPM Scale: ..... FPM x 1

Cell developed on sea breeze boundary and moved SSW through county.
Cell acquired supercell characterisitics ("moderate mesocyclone").
Hook echo was clearly seen in the base reflectivity data.
Cell remained relatively isolated through most of its life.
Cell produced TLI of 300+ FPM for >1.5 h and 450+ FPM for ~10 min!
CG strikes averaged ~20 FPM for over 100 min!

Summary of lightning increase:

Rapid increase began:	2203 UTC
Rapid increase ended:	2210 UTC (**+85 minute lead time**)
Warning Issued:	2253 UTC (**+42 minute lead time**)
First severe weather report:	2335 UTC



Date: July 15 1997
LISDAD Image: 2118 UTC
Severe Weather: ~2058 UTC Large hail report
~2058 UTC Golfball hail report
LDAR FPM Scale: FPM x **2**
NLDN FPM Scale: FPM x 2

Cell did not appear severe based on WSR-88D data
Hail to "golfball" size over-estimated?
Lightning "jump" seen...but occurred **after** severe weather
As with most severe weather reports, time generally **+**/- 10 min

Summary of lightning increase:

Steady increase began: 2101 UTC
Steady increase ended: 2104 UTC **(-6 minute lead time)**
Warning Issued: No Warning Issued
First severe weather report: 2058 UTC

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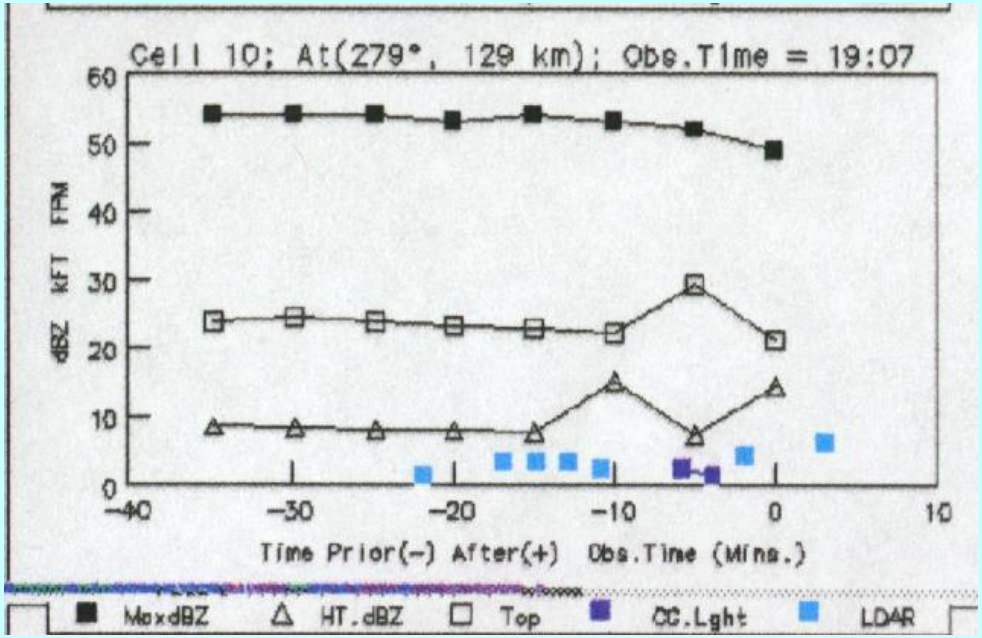
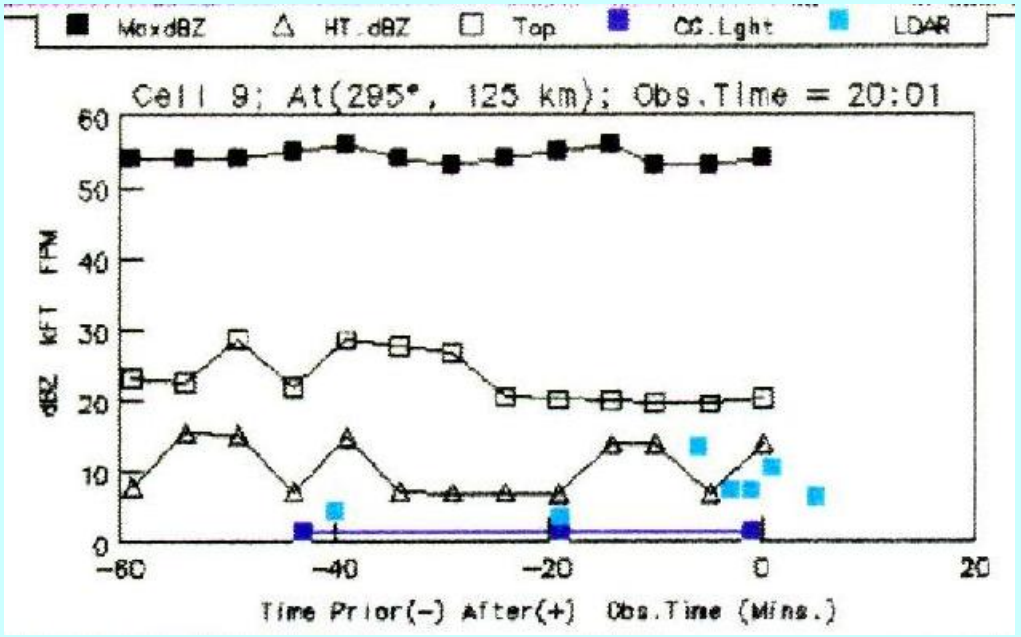
high shear - low bouyancy = TROPICAL CYCLONE TORNADO

- **Data examined for TC Josephine (1996) & others**

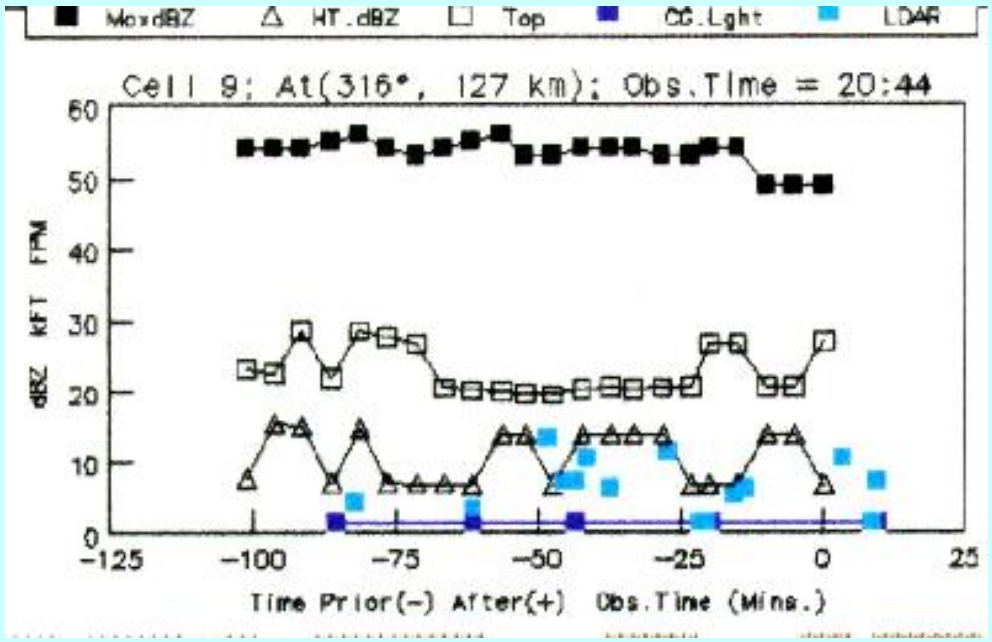
- **TLI minimal but often occured with cells which produced tornadoes**
- **TLI absent from cells which did NOT produce tornadoes**
- **TLI absent during life-cycle of two F2 TC tornadoes!**



Tornado: Hillsborough County from 2 S to 9 NNE of Plant City 1845-1900Z **(-22 to -7 LISDAD time)**



Tornado: Hillsborough County from 11 NNE Plant City to 14 NNW of Lakeland 1906-1920Z **(-55 to -41 LISDAD time)**



Tornadoes struck Mt Dora at 2034 UTC **(-10 LISDAD time)** and Eustice at 2039 UTC **(-5 LISDAD time)**.
Note TLI prior to, and after the tornadoes, but not at the time of the tornado occurrences.

Table comparing TLI "jump" signal versus official severe weather warning time and documented severe weather occurrence time.

Date	TLI jump began (T1 min)	TLI value at (T1 #)	TLI jump ended (T2 min)	TLI value at (T2 #)	Warning time (WT)	Svr wx time (ST)	Max TLI ST +/-10 min	ltg jump (T2-T1)	jump time (T2-T1)	WT-T2 minutes	ST-T2 minutes
5 July	1705	30	1713	160	1711	1730	160	130	8	-2	17
6 July	1938	110	1945	210	2001	2011	200	100	7	16	26
7 July	2203	75	2210	260	2253	2335	500	185	7	43	85
8 July	.	.	.	.	1937	1948	200	.	.	.	.
8 July	2005	40	2010	140	2025	2035	160	100	5	15	25
8 July	2120	0	2131	100	NO	2130	120	100	11	n/a	-1
9 July	2053	25	2059	135	2109	2143	325	110	6	10	44
11 July	1729	10	1731	100	1744	1758	160	90	2	13	27
11 July	1807	20	1815	130	1820	1925	450	110	8	5	70
12 July	2107	80	2113	180	2120	2130	200	100	6	7	17
15 July	2101	60	2104	140	NO	2058	140	120	3	n/a	-6
25 July	2255	80	2258	290	2303	2315	550	210	3	5	17
29 July	2110	125	2112	275	2114	2124	275	150	2	2	12
31 July	2015	75	2019	225	2026	2035	300	150	4	7	16
23 Aug	2016	60	2035	300	NO	2030	300	240	19	n/a	-5
AVG	.	**56**	.	**189**	.	.	**269**	**135**	**6.5**	**+11**	**+24.5**
.	.	TLI # at jump start	.	TLI # at jump end	.	.	Max TLI near svr wx time	ltg jump-# strikes difference	ltg jump-time period	warning-end of TLI jump	severe-end of TLI jump