CAPE_SUMMARY

Summary of NOAA WP-3D CaPE Research Flights

Six P-3 research flights were flown in support of the Convection and Precipitation/Electrification (CaPE) Experiment during the period 5-12 August 1991. A total of 30.1 flight hours were used from a possible 33.9 flight hours (25 h from HRD and 8.9 h from NSSL/MRD). Participating in the CaPE flights were three HRD scientists (Marks, Willis, and R. Black), two CRPE scientists (Testud, and Kabeche), John Hallett (DRI), Clive Saunders (UMIST), Bob Houze (UW), and Dave Jorgensen (NSSL). The CaPE flights addressed three specific scientific objectives: (1) test and evaluate the CRPE dual beam radar antenna for dual-Doppler wind estimation and stereo-radar measurement of attenuation; (2) measure the precipitation characteristics of the CaPE convective systems; and (3) study the microphysics and electrification processes active in the CaPE clouds.

The first objective was addressed through coordinated flights within the CaPE ground-based dual-Doppler network on four flights (5, 9, 11 and 12 August). On three of these days we had excellent intercomparisons of ground-based and airborne dual-Doppler radar data in squall lines moving through the CaPE network. These data sets will be instrumental in evaluating the dual-Doppler wind estimates.

The second objective was addressed through coordinated flights in the vicinity of the NCAR CP-2 radar (with polarization-diversity measurement capability) and the NASA rain gage network on Cape Canaveral on three flights (9, 11, and 12 August). The flight on 9 August was ideal, with measurements of precipitation made in convective systems over the NASA rain gage network and in view of the CP-2 radar. This data set will provide some excellent comparisons of the different rain estimation techniques. The flight of 12 August was significant because we were coordinating our measurements with the NASA ER-2 and the CP-2 radar.

The third objective was addressed through cloud penetrations at different altitudes in developing convective clouds on five days (7, 9, 10, 11, and 12 August). Excellent microphysics and electrification measurements were made on all five days (see the attached summary from Bob Black). On four of the five days we penetrated vigorous convection with updrafts as high as 20 m/s, significant liquid water contents and large electric fields. On 9 August we made a high level traverse of a squall line anvil cloud that produced some interesting results, and on 11 August we penetrated some mamatus clouds at the base of another large anvil cloud.

Overall, the CaPE flights were quite successful. All research objectives were met, with at least three data sets collected under each objective. The only negative in the whole program was the discovery that the CRPE antenna is not as sensitive as our current antennas, which is a major design issue for ELDORA. Hopefully, this problem will be addressed in future designs.

CaPE PROJECT MICROPHYSICS SUMMARY

There were six P-3 flights in support of the CaPE project. Days 1 and 4 (5 and 10 August) were marginal days with weak cumulus development. No FORMVAR data were obtained on Day 1, and only three PMS tapes were obtained during these two flights. The other days (7, 9, 11, and 12 August) were considerably more active. We obtained 5 to 7 PMS tapes on each of these days. The most vigorous and electrically active clouds were penetrated on 9 August. Those clouds contained much supercooled water and graupel. Good particle charge data were obtained for the first time, the 2-D probes worked

especially well, and good quality FORMVAR data were obtained. The DRI field mills were trouble free. The DRI aircraft charging system registered a discharge current during cloud passes even when the power supply was switched off. We are currently investigating the reasons for this current. An intercomparison of the DRI field mills with those on the South Dakota T-28 was obtained on 11 August. These data will be useful for calibrating the field mills on the P-3.

CaPE Mission 1 Flight Date: 5 August 1991

Take Off: 1809 UTC
Landing: 2220 UTC 4.3 h

mission objective: experiment 18: P3 dual beam antennae test

Scientific Crew and Visitors

Mission Scientists: F. Marks, P. Willis
Cloud Physics: Clive Saunders
Radar: Jacques Testud, Ahmed Kabeche
Visitors: John Hallett

AOC Crew

Flight Director: Parrish
Pilots: McKim, Player
Navigator: Strong, Nokutis
Engineer: Wade
El. Tech: Roles, Lynch
Data Tech.: Williams

Mission Modules:

Time (UTC)	Latitude	Longitude	Flight level
Radar Evaluation: CP-4/CP-3 baseline (squall line in N lobe, Fig. 1)			
1850	28°12"N	80°36"W	13000 ft TK 290
1902	28°24"N	81°03"W	13000 ft TK 120
1911	28°09"N	80°31"W	13000 ft TK 290 sector scan
1922	28°27"N	81°10"W	13000 ft TK 119
1933	28°06"N	80°29"W	13000 ft TK 290
1945	28°27"N	81°10"W	13000 ft TK 120
1957	28°05"N	80°29"W	13000 ft TK 290 no radar
2010	28°22"N	81°10"W	13000 ft TK 120
Radar Evaluation: Box around cells in S lobe			
2040	28°03"N	80°28"W	13000 ft TK 360
2042	28°14"N	80°30"W	13000 ft TK 270
2049	28°17"N	81°00"W	13000 ft TK 180
2054	27°48"N	81°00"W	13000 ft TK 090
2101	27°48"N	80°30"W	13000 ft TK 360
2107	28°14"N	80°30"W	13000 ft TK 270
2113	28°17"N	81°00"W	13000 ft TK 180
2119	27°48"N	81°00"W	13000 ft TK 090
2126	27°48"N	80°30"W	13000 ft TAS calib.

Synopsis of Flight:
Flew CP-3/CP-4 baseline with nice squall line in N dual-Doppler lobe (see Fig. 1). Squall line decayed to stratiform area ~1945 UTC. One leg (of eight) has no Doppler data because the radar system was being worked on. Problem with data on west bound legs because the aft beam had no data on the right side of track. After running baseline circled to check radar problem. Then boxed a developing line of clouds along boundary intersection in S lobe. Small isolate Cb developed - no major activity. Did true airspeed (TAS) calibration over Patrick AFB and returned to Miami.

Instrumentation Problems:
Cloud Probe not installed. PMS probes not working properly - power supply in

2D-C bad, 2D-P slight problem with one data buffer (recoverable). Slip-ring problem with new antenna - aft beam no data for sweep angles 50-130° (right side of track). INE#1 not too good. Used INE#1 on radar tapes (must use Standard Tape to get INE#2 navigation for post processing).

Radar Tape Log: A. Kabeche

Drive	Tape	Time on	Time off	Comments
1	1	1818	1918	
2	1	1918	2014	
1	2	2014	2154	off 2017-2036, working on radar

PMS Tape Log: Clive Saunders

Tape	Time on	Time off	Comments
1	185359	185804	8 EOFs
	191425	191510	
	192724	192747	
	193619	193658	
	193709	193748	
	195119	195153	
	200024	200112	
	205608	215613	

FORMVAR

Roll	Time on	Time off	Comments
(NO DATA)			

CaPE Mission 2 Flight Date: 7 August 1991

Take Off: 1837 UTC
Landing: 2139 UTC 3.3 h

mission objective: experiment 17 with emphasis on microphysics and electrification

Scientific Crew and Visitors	**AOC Crew**
Mission Scientists: F. Marks, P. Willis	Flight Director: Parrish
Cloud Physics: R. Black	Pilots: McKim, Player
Radar: J. Testud, A. Kabeche	Navigator: Strong, Nokutis
Visitors: John Hallett, Clive Saunders	Engineer: Wade
Bob Houze, Sandy Yuter,	El. Tech: Raines, Lynch
French Film Crew	Data Tech.: Hanchek

Mission Modules:

Time (UTC)	Latitude	Longitude	Flight level
Microphysics and Electrification - Cloud System 1, west of CP-3			
1922	28°16"N	81°19"W	18000 ft, TK 300, T=-11.1°C
1928	28°21"N	81°20"W	18000 ft, TK 130, T=-11.1°C
Microphysics and Electrification - Cloud System 2, in south lobe - Fig. 2			
1934	28°06"N	81°08"W	18000 ft, TK 167, T=-11.1°C, lightning discharge, 10 m s^{-1} up
1940			18000 ft, TK 320, 20 m s^{-1} up, lightning discharge
1947			18000 ft, TK 285, lightning to left of A/C
1954			18000 ft, TK 210, 13 m s^{-1} up
1958			18000 ft, TK 290, pass over new growth, in debris of old cell
2015			13000 ft, TK 165, anvil rain
2022			13000 ft, TK 340, anvil rain
2028			13000 ft, TK 230, anvil rain
2033			13000 ft, TK 030, anvil rain
Microphysics and Electrification - Cloud System 3 - northeast of MIA			
2112	26°18"N	80°00"W	10000 ft, TK 260, T=9.5°C
2118	26°01"N	79°48"W	10000 ft, TK 140, T=9.6°C
2122	26°09"N	79°49"W	10000 ft, TK 250, back to MIA

Synopsis of Flight:
Microphysics and Electrification mission in two cloud systems. The first cloud system was out of the dual Doppler lobes, west of CP-3. The second cloud system was in the southern dual-Doppler lobe. Two legs were flown through the first cloud system in a late stage in its lifecycle. The second cloud system (Fig. 2) was penetrated nine times at two altitudes, 18000′ and 13000′. Penetrated this cloud system during mature and decay phases. Mature phase penetrations were at 18000′, with good updrafts (as high as 20 m s^{-1}), large electric fields (3 discharges on aircraft), and microphysics data. Decay phase penetrations in

anvil debris were made at 13000' for precipitation microphysics data collection. Penetrated third cloud system (out of CaPE area) on return to MIA. Real good microphysics and electrification mission.

Instrumentation Problems:
Radar system down for 15 min early in flight with antenna control unit problems (no data lost). Swapped boards and it worked the rest of the flight. Minor problem with noise on charge probe signal from heater. Everything else worked real well.

Radar Tape Log: A. Kabeche

Drive	Tape	Time on	Time off	Comments
1	1	1848	2018	radar down 1857-1911
2	1	2018	2130	tape drive off line 212605-212750

PMS Tape Log: R. Black

Tape	Time on	Time off	Comments
1	192106	193253	
2	193416	195455	EOF at 193509
3	~195700	210405	
4	211119	212009	
5	212528	212819	

FORMVAR

Roll	Time on	Time off	Comments
1	192035	192437	Jammed during pass 1.
	201537	202105	Re-started count at 0.
	212008	212826	

CaPE Mission 3 Flight Date: 9 August 1991

Take Off: 1639 UTC
Landing: 2230 UTC 6.1 h

mission objectives: experiments 17 and 18, achieved all mission priorities with this flight

Scientific Crew and Visitors	**AOC Crew**
Mission Scientists: F. Marks, P. Willis	Flight Director: Parrish
Cloud Physics: R. Black	Pilots: McKim, Player
Radar: J. Testud, A. Kabeche	Navigator: Strong
Visitors: John Hallett, Clive Saunders, Bob Houze, French Film Crew	Engineer: Wade
	El. Tech: Roles
	Data Tech.: Raines

Mission Modules:

Time (UTC)	Latitude	Longitude	Flight level
Microphysics and Electrification - Cloud System 1, in north lobe			
1712	27°58"N	80°28"W	346°/26 from MLB, cloud A rosette pattern at 19000′
1721			cloud B
1746	28°21"N	80°35"W	cloud C, 20000′
1753			cloud D, 20000′ - wimpy
1758			cloud D, 20000′
1800	28°30"N	80°40"W	cloud E, 20000′ - good one
1805			cloud E, 20000′
1811			cloud E, 20000′ - real good pass
1815			cloud E, 20000′, TK 140
1820			cloud E, 20000′
1826			cloud E, 20000′, new+old cell
1828	28°28"N	80°35"N	cloud E, 20000′, TK 140, good
Precipitation Measurements - Cloud System 1			
1843			cloud E, 13000′, TK 310 at CP-2
1910			cloud E, 10000′, TK150 from CP-2
1918			cloud E, 10000′, TK 330 at CP-2
1924			cloud E, 10000′, TK145 from CP-2
T-28 Intercomparison			
1935			10000′, near Patrick AFB
Radar Evaluation - Dual-Doppler and Stereo-radar in squall line - north lobe (Fig. 3)			
2005	28°47"N	80°47"W	13000′, TK 200 from CP-2 - CP-3
2017	28°07"N	81°00"W	13000′, TK 020 to CP-2
2028	28°50"N	80°45"W	13000′, TK 200 into south lobe
2040	28°02"N	81°02"W	13000′, TK 025 east of line
2053	28°42"N	80°33"W	13000′, TK 185 in north lobe
2102	28°05"N	80°35"W	13000′, TK 290, CP-4/CP-3
2115	28°28"N	81°14"W	13000′, TK 030 west of line
2130	29°13"N	80°30"W	21000′, TK 195 west of line

2145	28°24"N	80°55"W	21000', TK 120 CP-3/CP-4
2151	28°08"N	80°35"W	depart for MIA

Synopsis of Flight:
Great Day! Achieved all experiment objectives with this flight. Started out with microphysics and electrification penetrations at 16000' and 18000', in conjunction with the two King Airs, CP-2, and the T-28, in a cloud system over KSC in the north dual Doppler lobe. Penetrated five distinct clouds in this cloud system between 1712 and 1827 UTC. Good electric field and microphysics data collected in the penetrations.

Following the high level penetrations descended to 13000' and 10000' to make precipitation measurements over the KSC rain gage network in same cloud system from 1838-1928 UTC. Good precipitation measurements collected in coordination with CP-2.

Next flew electric field intercomparison with T-28 in the vicinity of Patrick AFB from 1933-1948 UTC.

Finally, set up dual-Doppler and stereo-radar legs on N-S squall line entering CaPE network from the west from 2000-2140 UTC (Fig. 3). Initially, set up legs at 13000' along CP-2/CP-3 baseline, along eastern flank of squall line, extending legs into the southern dual-Doppler lobe to check on possible cloud system development. As the squall line moved eastward, the legs along the eastern flank were moved eastward into the north dual-Doppler lobe. Excellent dual-Doppler coverage, as well as, coverage from CP-2 for stereo-radar work. Finished squall line pattern by flying along western flank of the leading edge in the transition and stratiform region at 13000' and 21000'. These legs were centered in the north dual-Doppler lobe in the CP-2 sector. Excellent dual-Doppler and stereo-radar coverage, as well as, precipitation, microphysics, and electric field measurements in stratiform region.

Instrumentation Problems:
Minor tail radar system problems at the beginning of the flight during the first few cloud penetrations (missed radar data on 2nd pass). Otherwise, all other instruments worked well.

Radar Tape Log: A. Kabeche

Drive	Tape	Time on	Time off	Comments
1	1	1659	1714	Radar system flakey at 171349 take tape off
2	1	1742	1906	
1	2	1906	2024	
2	2	2024	2119	
1	3	2119	2155	tape off when radar system stopped

PMS Tape Log: R. Black

Tape	Time on	Time off	Comments
1	181528	190617	
2	190830	192449	
3	192642	194612	
4	201155	211037	
5	211259	212300	
6	212600	214139	
7	214712	215739	

FORMVAR

Roll	Time on	Time off	Comments
1	171812	172429	
	174542	174939	
	175131	175512	
	175752	181400	
	181404	181754	
	182036	182316	
	182639	183054	
	184239	184740	graupel
	191236	191459	
2	213437	214504	
	214746	215149	

CaPE Mission 4 Flight Date: 10 August 1991

Take Off: 1554 UTC
Landing: 1946 UTC 4.3 h

mission objective: experiment 17 with emphasis on cloud physics and electrification

Scientific Crew and Visitors	**AOC Crew**
Mission Scientists: F. Marks, P. Willis	Flight Director: Parrish
Cloud Physics: R. Black	Pilots: McKim, Player
Radar: J. Testud, A. Kabeche	Navigator: Strong, Gerrish
Visitors: John Hallett, Clive Saunders, Bob Houze	Engineer: Wade
	El. Tech: Roles
	Data Tech.: Raines, Ozzie

Mission Modules:

Time (UTC)	Latitude	Longitude	Flight level
Microphysics and Electrification - along sea breeze line, north lobe			
1710	28°16"N	80°40"W	13000′, cloud A - over cloud top
1714			13000′, cloud A - shrimpy
1720			13000′, cloud A
1825	28°27"N	80°44"W	18000′, cloud B
1828			18000′, cloud B - over top
1832	28°30"N	80°29"W	18000′, cloud C
1838	28°39"N	80°28"W	18000′, cloud D - (Fig. 4)
1840			18000′, cloud D
1843			18000′, cloud D
1846			18000′, cloud D
1852	28°30"N	80°39"W	18000′, cloud E - over top
1912			depart for MIA

Synopsis of Flight:
Microphysics and electrification mission in weak convection along the sea breeze line in the north dual Doppler lobe (Fig. 4). Made eleven passes in five different clouds at altitudes from 13000′ to 18000′. Most of the penetrations were in a stack coordinated with the two King Airs. Very suppressed day, not much deep convection. Not much electrical activity or intense radar echoes.

Tried to set up sea state overflight with the NCAR King Air (Peter Hildebrand mission). King Air was not available. Interesting contrast to previous day. Could be some useful data in comparison with the King Air missions. Met few of our objectives.

Instrumentation Problems:
Radar problems again in the early phase of the mission. Antenna control unit on tail antenna failed from 1721-1757 UTC (much of the time was spent diagnosing this persistent problem). Fortunately, not much data lost as the convection was pretty skimpy. All other systems worked fine.

Radar Tape Log: A. Kabeche

Drive	Tape	Time on	Time off	Comments
1	1	1603	1718	
2	1	1718	1721	tape off when system down for ACU problem
1	2	1757	1912	tape off on return to MIA

PMS Tape Log: R. Black

Tape	Time on	Time off	Comments
1	170959	184130	
2	184316	191430	

FORMVAR

Roll	Time on	Time off	Comments
1	170954	171309	
	171330	171556	
	171801	172105	
	182415	182635	
	182800	183052	
	183200	183358	
	183631	183948	
	184009	184215	
	184314	184446	
	184531	184757	

CaPE Mission 5 Flight Date: 11 August 1991

Take Off: 1833 UTC
Landing: 2335 UTC 5.3 h

mission priorities: experiment 17 and 18

Scientific Crew and Visitors

Mission Scientists: F. Marks, P. Willis
Cloud Physics: R. Black
Radar: J. Testud, A. Kabeche
Visitors: John Hallett, Clive Saunders, Bob Houze, Hank Tracy (FAA)

AOC Crew

Flight Director: Parrish
Pilots: McKim, Player
Navigator: Strong
Engineer: Wade
El. Tech: Roles, Raines
Data Tech.: Hanchek

Mission Modules:

Time (UTC)	Latitude	Longitude	Flight level
Microphysics and Electrification - Cloud System 1 - just W of MLB (Fig. 5)			
1909	28°09"N	80°42"W	17000′, TK 315, 20 m s^{-1} up
Radar Evaluation - dual Doppler and stereo-radar, box Cloud System 1 S of CP-4			
1912	28°16"N	80°54"W	17000′, TK 180
1915	28°03"N	80°54"W	17000′, TK 090
1919	28°04"N	80°33"W	17000′, TK 360
1922	28°21"N	80°33"W	17000′, TK 270
1926	28°21"N	80°54"W	17000′, TK 180
Microphysics and Electrification - Cloud System 1 - just W of MLB			
1930	28°07"N	80°54"W	17000′, TK 090, 22 m s^{-1} up
1936			17000′, TK 260, 23 m s^{-1} up
1946			17000′, cloud A+new cell (B)
1949			17000′, cloud B
1954			17000′, cloud B, new cell SE (C)
2002	28°07"N	80°33"W	21000′, just over clouds B and C
2010			21000′, in tops of clouds B&C
2012			21000′, cloud C, T=-13.1°C
2015			21000′, cloud C, no updraft
2017	28°08"N	80°45"W	21000′, TK 360 through mamatus
2022	28°31"N	80°45"W	21000′, TK 180 through mamatus
2029	28°06"N	80°45"W	21000′, TK 360 through mamatus
2036	28°35"N	80°51"W	21000′, cloud D, graze top
2040			21000′, cloud D, 7 m s^{-1} up
2044			21000′, cloud D, TK 295
2050			21000′, cloud D
2054			21000′, cloud D
2100			21000′, cloud D, iced out
Balloon Search - 2110-2133			
2127	29°07"N	80°09"W	balloon in water
Radar Evaluation - coordinated with CP-2 (cells near Sanford)			
2137	28°47"N	80°45"W	13000′, TK 200 from CP-2
2148	28°14"N	81°03"W	13000′, TK 020 to CP-2

2157	28°47"N	80°47"W	13000', TK 270 N of convection
2205	28°47"N	81°25"W	13000', TK 090, good radar data
2211	28°43"N	81°00"W	13000', TK 234 radial from CP-2
2218	28°26"N	81°19"W	13000', TK 058 to CP-2
2236	28°46"N	80°45"W	18000', TK 240/225 from CP-2
2246	28°27"N	81°17"W	18000', TK 045 to CP-2
2249			return to MIA

Synopsis of Flight:
Another great microphysics and electrification data set! Slight screw up on first penetration foiled sailplane experiment. Penetrated and boxed large cloud system in dual Doppler lobes in coordinated patterns with T-28 and CP-2 (Fig. 5). Made thirteen penetrations at altitudes from 17000' to 20000' in four clouds along the south flank of a rapidly growing convective system between 1909 and 2059 UTC. Excellent microphysics and electric field measurements along with good radar coverage (peak reflectivity=60 dBZ). As system dissipated made penetrations into mamatus at base of the anvil around 2055 UTC (should be some interesting microphysics and wind data).

Diverted from pattern to find NASA balloon from 2110-2130 UTC (no loss - waiting for convection to move into CaPE area from the west).

Returned to set up dual Doppler and stereo radar legs coordinated with CP-2 of convective system west of CaPE area from 2132-2230 UTC. Flew radials from CP-2 at 13000' and 18000', alot of air traffic problems. Some useful stereo-radar data possible, although line dissipated before moving into optimum range from CP-2.

Instrumentation Problems:
Radar system had minor glitch from 2136-2146 UTC (antenna control again, bad board). Dew point system failed half way through flight (no backup). All other systems worked fine.

Radar Tape Log: A. Kabeche

Drive	Tape	Time on	Time off	Comments
1	1	1844	1947	use REF thresholding, record spectral width
2	1	1947	2057	
1	2	2057	2224	system down from 2136 to 2146
2	2	2224	2256	off on return to MIA

PMS Tape Log: R. Black

Tape	Time on	Time off	Comments
1	190745	193711	
2	194055	201937	
3	202235	204612	premature rewind
4	204812	205549	"
5	205904	225459	

FORMVAR

Roll	Time on	Time off	Comments
1	190833	192900	
	192959	193305	
	193550	193814	
	194530	194856	

194904	195212
195300	200803
200921	201644
201704	202149
202330	202726
203524	203723
203851	204201
204411	204653
204925	205154
205400	205559

CaPE Mission 6 Flight Date: 12 August 1991

Take Off: 1836 UTC
Landing: 0103 UTC (13 August) 6.8 h

mission objectives: experiments 17 and 18

Scientific Crew and Visitors	**AOC Crew**
Mission Scientists: F. Marks, P. Willis	Flight Director: Parrish
Cloud Physics: R. Black	Pilots: McKim, Player
Radar: A. Kabeche, D. Jorgensen	Navigator: Strong, Nokutis
Visitors: John Hallett, Bob Houze (only the diehards)	Engineer: Wade
	El. Tech: Roles
	Data Tech.: Lynch

Mission Modules:

Time (UTC)	**Latitude**	**Longitude**	**Flight level**
Microphysics and Electrification - Cloud System 1 - S of MLB (rosettes)			
1916	28°35"N	80°37"W	14000′, TK 270, cloud A
1920			15000′, cloud A
1922			15000′, cloud A - over top
1934	28°05"N	80°41"W	14000′, cloud B, not much
1937			14000′, cloud B TK 090 new cells
1941			14000′, cloud B, no updrafts
1945			14000′, cloud B, 4 m s^{-1} up
1949			14000′, cloud B, new growth
1952	28°00"N	80°44"W	14000′, cloud C
1956			15000′, cloud C
1959			15000′, cloud C
2001			15000′, cloud C, looking good
2006			16000′, cloud C
2010			16000′, cloud C, 8 m s^{-1} up
2013			16000′, cloud C
2017			17000′, cloud C, 2 bubbles
2021			17000′, cloud C
2024			18000′, cloud C, new bubble
2041	27°54"N	80°47"	16000′, cloud D, TK 190
2046			14000′, cloud D, new bubble
2049			15000′, cloud D, 5 m s^{-1} up
2054			18000′, cloud D, top at alt.
2057			18000′, cloud D, 10 m s^{-1} up
2100			18000′, cloud D, old cell
2101	27°49"N	80°50"W	18000′, cloud E, 10 m s^{-1} up
2108	27°51"N	80°52"W	20000′, cloud F
2112			20000′, cloud F
Radar Evaluation - dual Doppler mapping in south lobe coordinated with CP-4 sector scan SE of track			
2126	28°11"N	80°47"W	14000′, TK 215/205 from CP-4 convection to SE of TK

2134	27°47"N	81°01"W	14000', TK 034 toward CP-4
			big anvil system to SE of TK
2144	28°15"N	80°42"W	14000', TK 215/225 from CP-4
2154	27°48"N	81°09"W	14000', TK 040 toward CP-4
2204	28°15"N	80°42"W	14000', TK 235 from CP-4
2215	27°53"N	81°13"W	14000', TK 055 toward CP-4
2225	28°14"N	80°42"W	14000', TK 235 from CP-4
			ER-2 in cloud system SE of TK
2235	27°53"N	81°13"W	14000', TK 050 toward CP-4
2244	28°14"N	80°45"W	14000', TK 230 from CP-4
2253	27°56"N	81°10"W	14000', TK 055 toward CP-4
2300	28°14"N	80°43"W	14000', head to CP-2 squall line
Radar Evaluation - dual Doppler in squall line near CP-2 (Fig. 6)			
2307	28°31"N	80°38"W	14000', TK 350 E of line
2318	28°56"N	80°39"W	14000', TK 200 E of line
			pass over CP-2, lots of CG ltg
2328	28°31"N	80°51"W	14000', TK 020 E of line
			pass over CP-2, what a show!!
2336	28°58"N	80°39"W	14000', TK 195 E of line
			pass just E of CP-2
2346	28°29"N	80°48"W	14000', TK 020 E of line
			pass E CP-2, gust front at CP-2
2355	28°58"N	80°36"W	14000', TK 200 E of line
			pass E of CP-2
0002	28°34"N	80°49"W	14000', TK 290 across line
0004	28°38"N	80°55"W	14000', TK 340/020 W of line
			very little strat. precip.
			leg cut short for ATC
0009	28°56"N	80°56"W	14000', TK 210 W of line
0012	28°45"N	81°03"W	14000', TK 165 across line
0016	28°30"N	80°56"W	head for MIA

Synopsis of Flight:
The mother of all P-3 CaPE missions (I still don't know how we stayed up that long). Excellent microphysics and electrification data collected in 25 penetrations of six clouds from 1916-2115 UTC in a rapidly intensifying cloud system south of MLB (outside of the dual Doppler lobes). Early penetrations in the first two clouds were marginal - not much subsequent development (almost went home). However, starting at 1952 UTC things got interesting. Started following building clouds up from 15000' to 20000' on north and west flank of rapidly developing cloud system. Excellent microphysics and electric field measurements. Good coordination with CP-2 (although pretty far away).

As the convective system expanded westard into south dual Doppler lobe, switched to dual Doppler and stereo radar patterns flying radials from CP-4 at 14000' from 2126-2259 UTC. Legs flown on NW flank of developing system, while ER-2 and Lear Jet penetrating system. Good dual Doppler data.

For a finale we flew a dual Doppler and stereo-radar pattern at 14000' along the flanks of a rapidly moving N-S squall line just west of CP-2 from 2307-0016 UTC (13 August) (Fig. 6). Flew six legs along eastern flank of the squall line (three directly over CP-2) as it progressed rapidly eastward from 2307-0000 UTC. Flew partial leg behind leading edge of squall line in meager stratiform region from 0001-0010 UTC. Leg was cut short because of air traffic considerations. Excellent dual Doppler and stereo-radar data set.

Instrumentation Problems:
Dew point system not working (no backup). No major radar system failures (no loss of data). All other systems worked fine.

Radar Tape Log: A. Kabeche

Drive	Tape	Time on	Time off	Comments
1	1	1854	2000	
2	1	2000	2055	
1	2	2055	2148	
2	2	2148	2237	
1	3	2237	2345	
2	3	2345	2347	off when problem with tape drive (PE)
1	4	2347	0024	off on return to MIA

PMS Tape Log: R. Black

Tape	Time on	Time off	Comments
1	191349	194329	
2	194459	201739	
3	201944	205821	
4	210007	214118	
5	230736	242449	

FORMVAR

Roll	Time on	Time off	Comments
1	191511	191737	
	191900	192047	
	193348	193534	
	193705	193842	
	194031	194201	
	194448	194653	
	194904	195045	
	195200	195408	
	195520	195709	
	195815	200023	
	200051	200307	
	200531	200731	
	200925	201203	
	201300	201458	
	201600	201841	
	202010	202254	
	204015	204304	
	204550	204747	
	204930	205119	
	205316	205621	
	205700	205927	
	205958	200200	

Figure Legends

Fig. 1. Single sweep of the lower fuselage radar for 185354 UTC, 5 August 1991 (CaPE Flight #1). The domain of the analysis is 120 km on a side, with tics separated by 12 km. The Florida coastline, major lakes, islands and rivers are depicted as solid lines. The aircraft flight track from 1849-1910 UTC, with wind barbs at 1-min intervals, is depicted as a thin solid line. The locations of CP-2, CP-3, and CP-4 are denoted by circles. The intensity of radar reflectivity is depicted by shades of gray. Wind barbs denote 2.5 m s^{-1} for every half barb, and 5 m s^{-1} for every full barb.

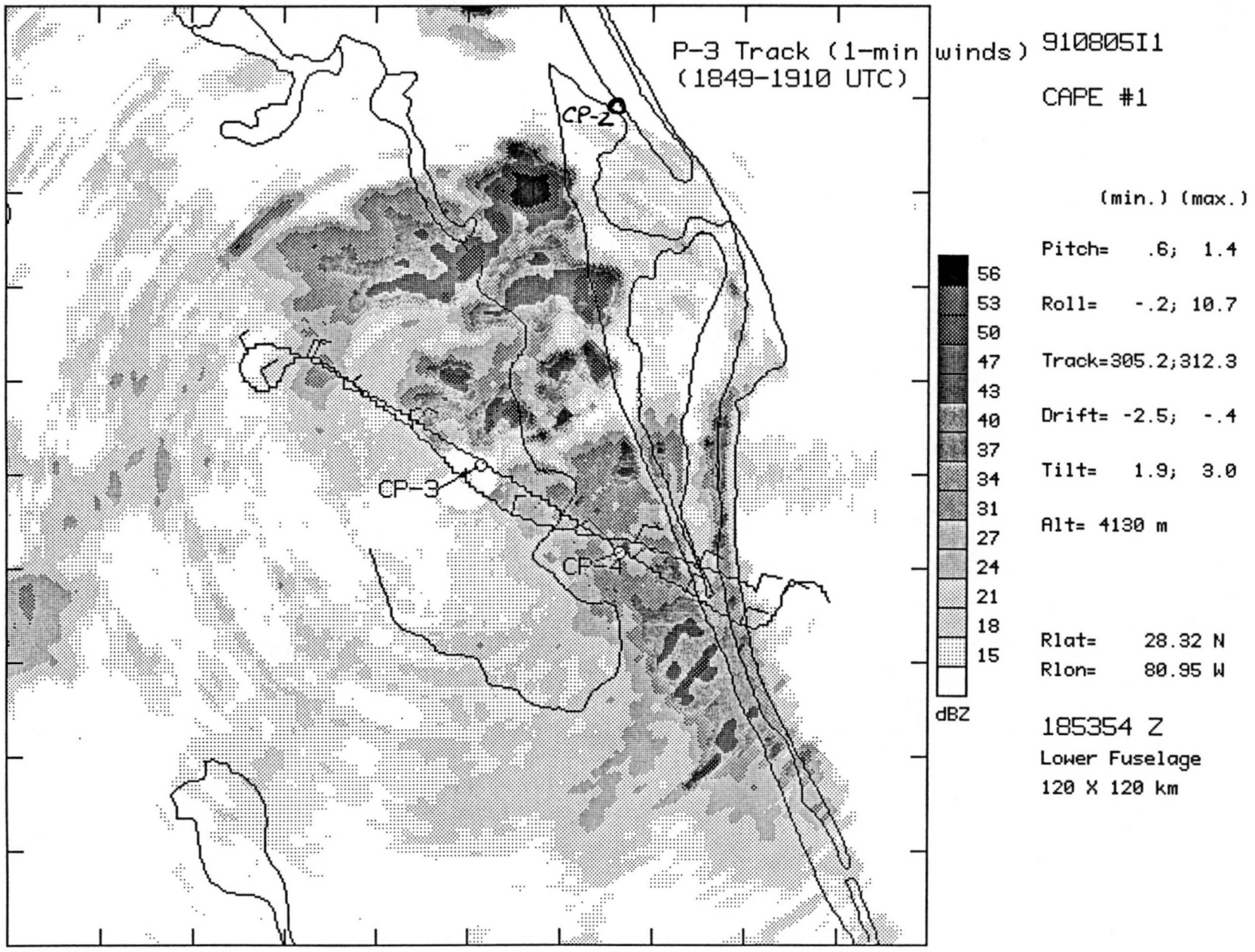
Fig. 2. Same as in Fig. 1 but for 193909 UTC, 7 August 1991 (CaPE Flight #2). The aircraft flight track from 1930-2018 UTC, with wind barbs at 1-min intervals, is depicted as a thin solid line.

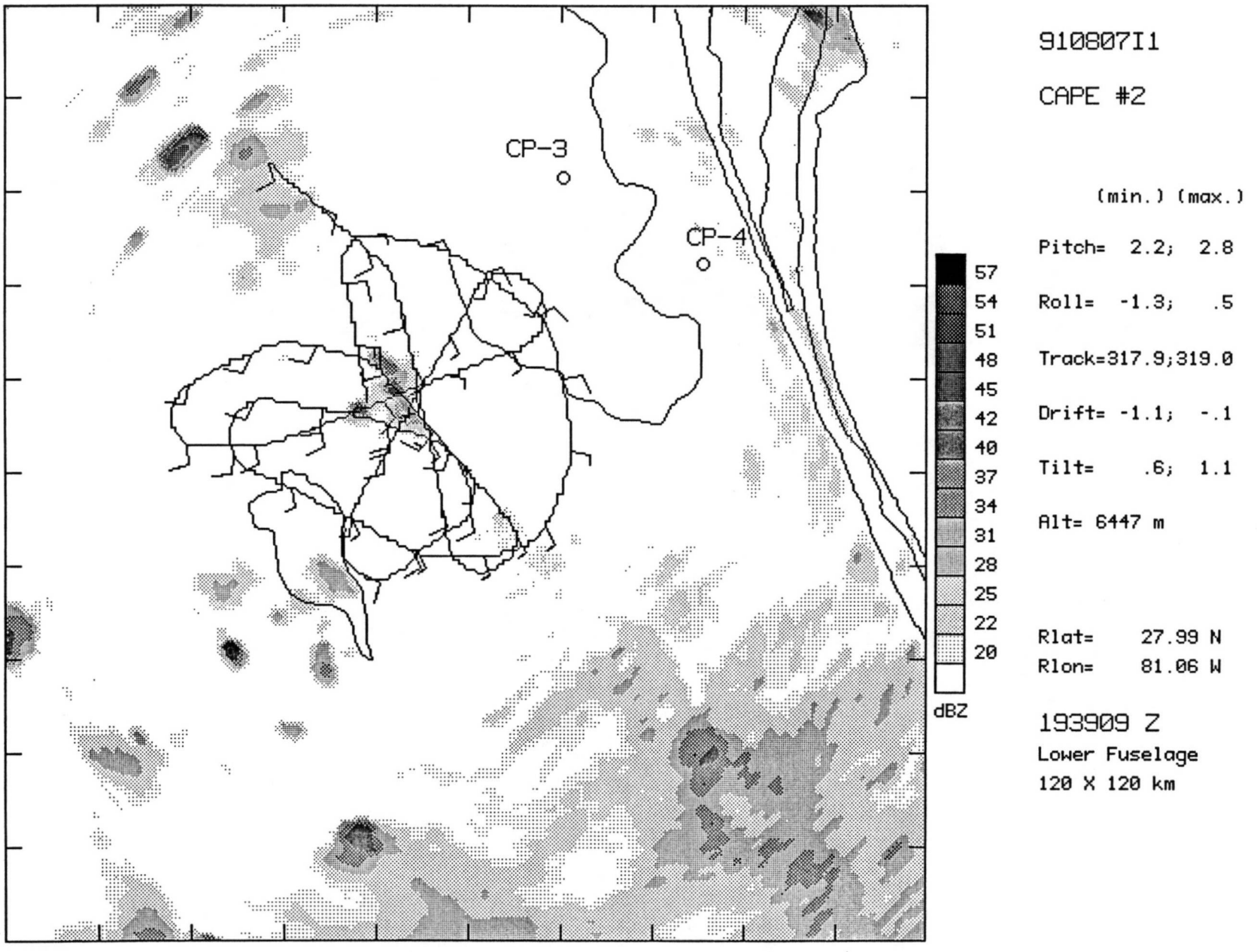
Fig. 3. Same as in Fig. 1 but for 203009 UTC, 9 August 1991 (CaPE Flight #3). The aircraft flight track from 2028-2053 UTC, with wind barbs at 1-min intervals, is depicted as a thin solid line.

Fig. 4. Same as in Fig. 1 but for 183638 UTC, 10 August 1991 (CaPE Flight #4). The aircraft flight track from 1830-1850 UTC, with wind barbs at 1-min intervals, is depicted as a thin solid line.

Fig. 5. Same as in Fig. 1 but for 192430 UTC, 11 August 1991 (CaPE Flight #5). The aircraft flight track from 1900-1947 UTC, with wind barbs at 1-min intervals, is depicted as a thin solid line.

Fig. 4. Same as in Fig. 1 but for 235757 UTC, 12 August 1991 (CaPE Flight #6). The aircraft flight track from 2346 UTC (12 August)-0016 UTC (13 August), with wind barbs at 1-min intervals, is depicted as a thin solid line.


P-3 Track (1-min winds)
(1849-1910 UTC)
CP-2
CP-3
CP-4
56
53
50
47
43
40
37
34
31
27
24
21
18
15
dBZ
910805I1
CAPE #1
(min.) (max.)
Pitch= .6; 1.4
Roll= -.2; 10.7
Track=305.2;312.3
Drift= -2.5; -.4
Tilt= 1.9; 3.0
Alt= 4130 m
Rlat= 28.32 N
Rlon= 80.95 W
185354 Z
Lower Fuselage
120 X 120 km



910807I1

CAPE #2

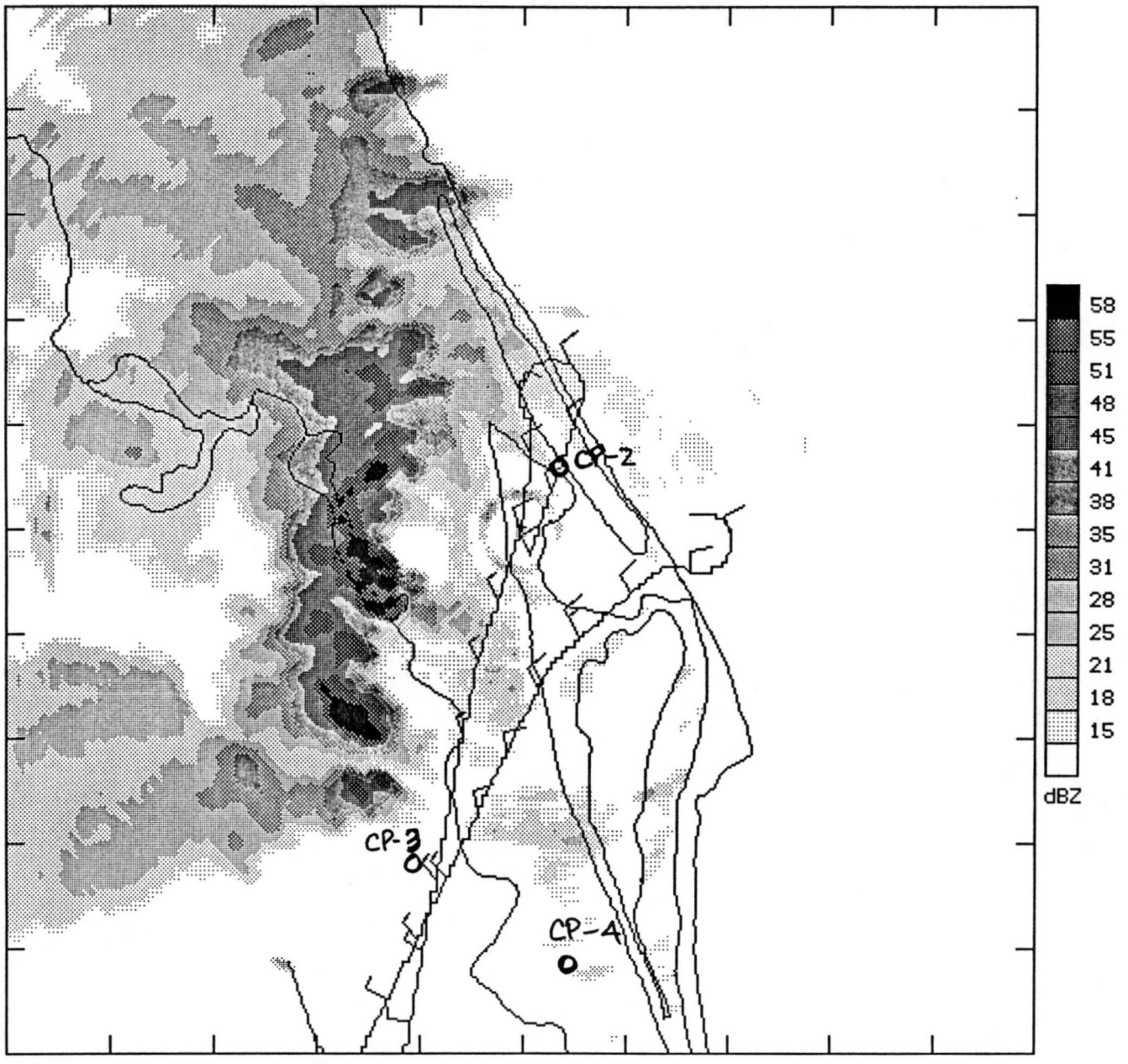
	(min.)	(max.)
Pitch=	2.2;	2.8
Roll=	-1.3;	.5
Track=	317.9;	319.0
Drift=	-1.1;	-.1
Tilt=	.6;	1.1

Alt= 6447 m

Rlat= 27.99 N
Rlon= 81.06 W

193909 Z
Lower Fuselage
120 X 120 km

N



910809I1

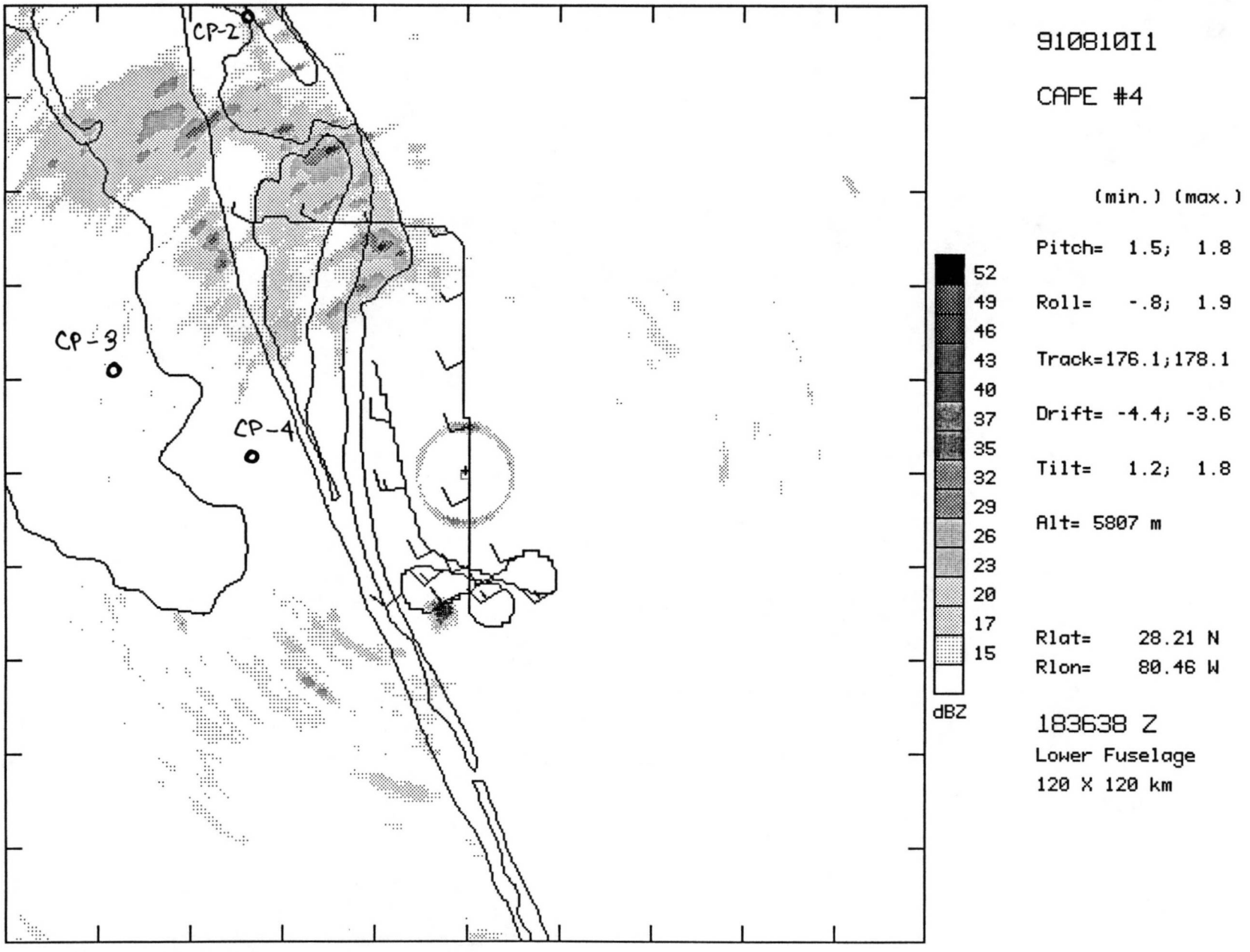
CAPE #3

	(min.)	(max.)
Pitch=	.7;	1.3
Roll=	2.7;	6.4
Track=	184.7;	195.4
Drift=	-1.1;	-.4
Tilt=	2.4;	3.3

Alt= 4152 m

Rlat= 28.68 N
Rlon= 80.80 W

203009 Z
Lower Fuselage
120 X 120 km



910810I1

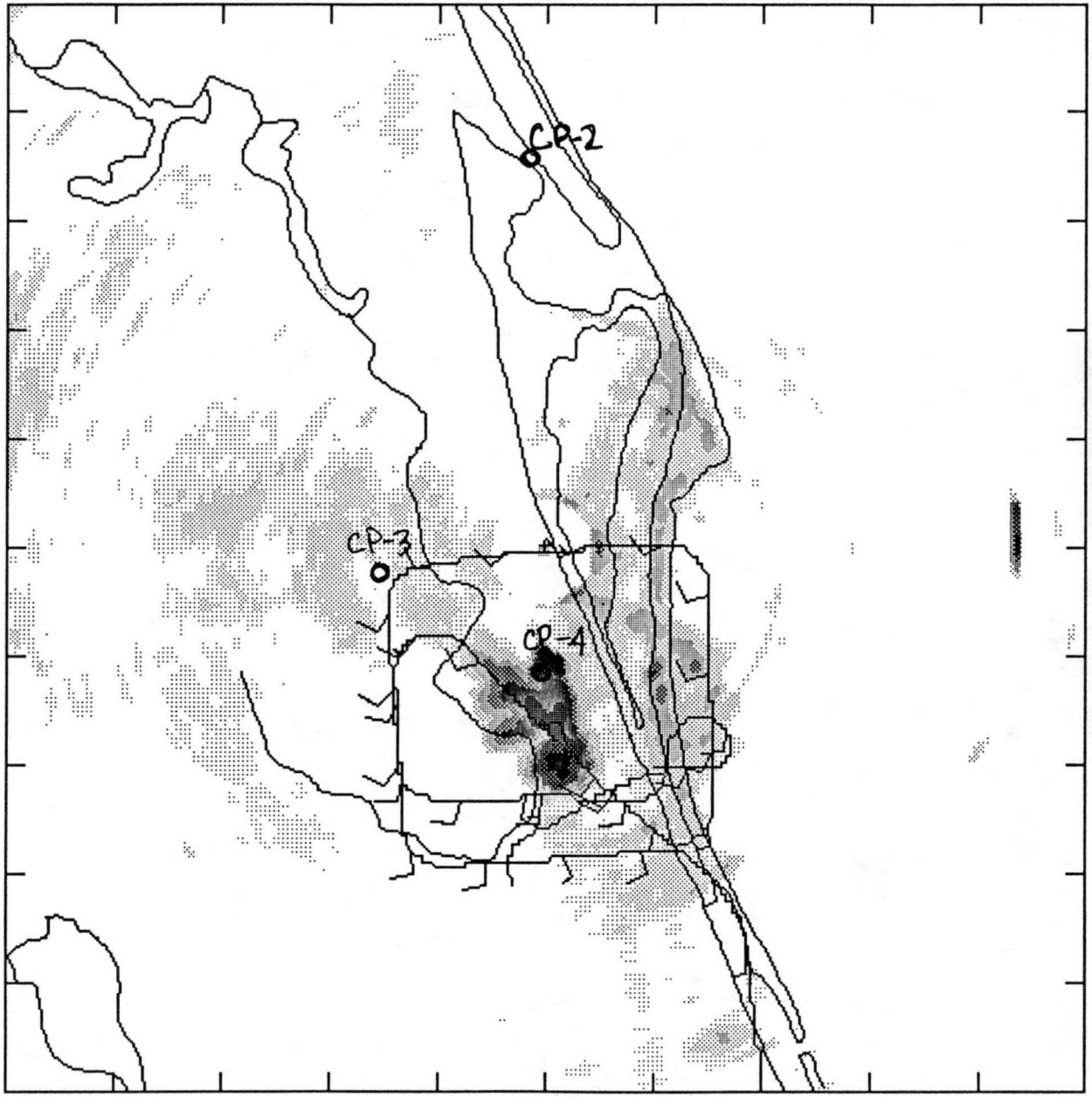
CAPE #4

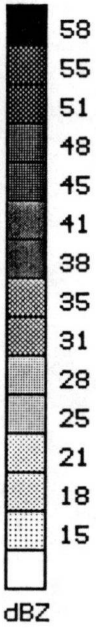
	(min.)	(max.)
Pitch=	1.5;	1.8
Roll=	-.8;	1.9
Track=	176.1;	178.1
Drift=	-4.4;	-3.6
Tilt=	1.2;	1.8

Alt= 5807 m

Rlat= 28.21 N
Rlon= 80.46 W

183638 Z
Lower Fuselage
120 X 120 km





910811I1

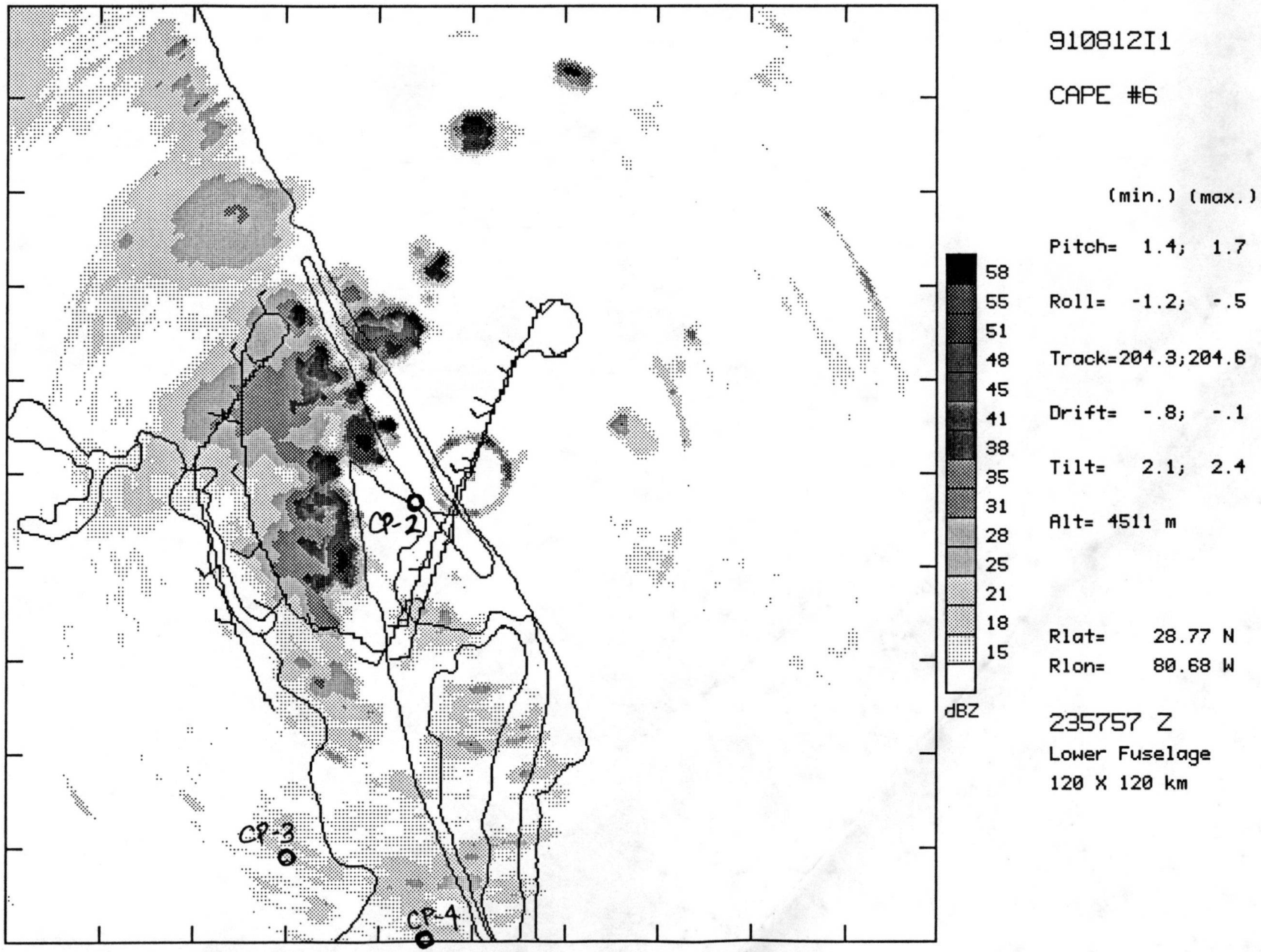
CAPE #5

	(min.)	(max.)
Pitch=	1.7;	2.0
Roll=	-1.0;	-.6
Track=	265.9;	266.4
Drift=	-.5;	.0
Tilt=	1.4;	1.8

Alt= 5790 m

Rlat= 28.36 N
Rlon= 80.74 W

192430 Z
Lower Fuselage
120 X 120 km



910812I1

CAPE #6

	(min.)	(max.)
Pitch=	1.4;	1.7
Roll=	-1.2;	-.5
Track=	204.3;	204.6
Drift=	-.8;	-.1
Tilt=	2.1;	2.4

Alt= 4511 m

Rlat= 28.77 N
Rlon= 80.68 W

235757 Z
Lower Fuselage
120 X 120 km

6