19991015I1_LPS

On-Board Lead Project Scientist Check List

Date 15 October 1999 Aircraft NOAA 43 RF Flight ID 99101511

A. Participants: ~~WXWXA~~ IRENE

HRD		AOC	
Function	Participant	Function	Participant
Lead Project Scientist	P. Dodge	Flight Director	J Parrish
Cloud Physics	X	Pilots	P. Kenul, B. Taggert
Radar	J Cione	Navigator	C. Newman
Workstation	M Black	Systems Engineer	S. MacMillan
Photographer	X	Data Technician	G. Bast S. Wade
Omegasonde	M Black	Electronics Technician	Dewey Floyd
AXBT/AXCP	J Cione	Other SRA	E. WALSH

P. Hall

rolling 1922 Visitor: Adm E. Fields Jorge Delgado

Take-Off: 193426 Location: MacDill Landing: 031137 Location: Gulfport Mississippi

5 Penetrations

B. Past and Forecast Storm Locations:

Date/Time	Latitude	Longitude	MSLP	Maximum Wind

C. Mission Briefing: Briefed for landfall / Florida bay pattern.

Engineers: Sean McMillan, Jorge Delgado, Phil Hall
Flt Engineers Greg Bast, Steve Wade,

E.2 Lead Project Scientist (On-Board)

E.2.1 Preflight

_____ 1. Participate in general mission briefing.

_____ 2. Determine specific mission and flight requirements for assigned aircraft.

_____ 3. Determine from CARCAH or field program director whether aircraft has operational fix responsibility and discuss with AOC flight director/meteorologist and CARCAH unless briefed otherwise by field program director.

_____ 4. Contact HRD members of crew to:

a. Assure availability for mission.
b. Arrange ground transportation schedule when deployed.
c. Determine equipment status.

_____ 5. Meet with AOC flight crew at least 90 minutes before takeoff, provide copies of flight requirements, and provide a formal briefing for the flight director, navigator, and pilots.

_____ 6. Report status of aircraft, systems, necessary on-board supplies and crews to appropriate HRD operations center (MGOC in Miami or FGOC at remote recovery location).

E.2.2 In-Flight

_____ 1. Confirm from AOC flight director that satellite data link is operative (information).

_____ 2. Confirm camera mode of operation.

_____ 3. Confirm data recording rate.

_____ 4. Complete Form E-2.

E.2.3 Postflight

_____ 1. Debrief scientific crew.

_____ 2. Report landing time, aircraft, crew, and mission status along with supplies (tapes, etc.) remaining aboard the aircraft to the appropriate HRD operations center (MGOC or FGOC).

_____ 3. Gather completed forms for mission and turn in at the appropriate operations center. [Note: all data removed from the aircraft by HRD personnel should be cleared with the AOC flight director.]

_____ 4. Obtain a copy of the 10-s flight listing from the AOC flight director. Turn in with completed forms.

_____ 5. Determine next mission status, if any, and brief crews as necessary.

_____ 6. Notify the appropriate operations center (FGOC or MGOC) as to where you can be contacted and arrange for any further coordination required.

_____ 7. Prepare written mission summary.

D. Equipment Status

Equipment	Pre-Flight	In-Flight	Post-Flight
Aircraft	✓	✓	✓
Radar/LF	✓	✓	✓
Radar/TA (Doppler)	✓		
Cloud Physics	X	✓	
Data System	✓	✓	
~~Omegasondes~~ GPS	✓	✓	
AXBT/AXCP	✓		
Workstation	✓	✓	
Photography			video

REMARKS: Data sys & radar sys had minor glitches. Sean M. tweaked LF to improve return. TAIL dBZ seems too low, but Doppler looked OK. Had several sonde failures in high winds (W eyewall). Jorge thinks a bad batch. We mapped the windfield very well, with soundes at most C-MAN stations, in wind maxima and over the Everglades

E. (I) Proposed Flight Pattern (sketch or designate by number)

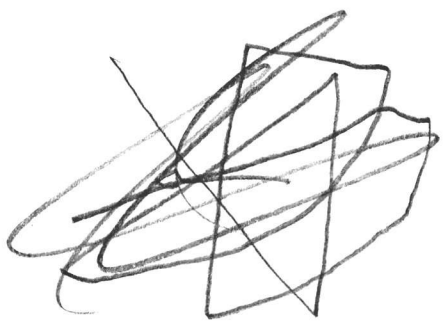
see attached

Flight pattern at 8,000

E. (II) Actual Flight Pattern

flew planned + many mods

see attached



99101 ⑤I1 | ⑤ IRENE

193426 Take off from MacDill

1937 radars up 1913 25°17' 81°03'

1958 we're at 8000' radar TEAL (37) FIX

2004 C Newman doing penetration check list
2007 SFMR 19 m/s FLT LEV 35 KTS
2008 waves on shallows
200853 turn 25
200923 25°41 81°39' Sonde (1) BT, 60 KTS at 200'
2012 Bouncy, but tail only shows ~30 dBZ

2014 65 KTS flt level

201519 D_2 25°31' 81°15' "wind max" drop
60 kts 1000'
50 KTS sfc

JP ⑤ hunting

FIX 201930 25°30' 80°58' ~983 mb est

2028 25°01' 80°40' D_3 FLAMINGO

2042 JP saw ship to Port side

204402 ½∆ ↓ (TA & LF) 204851 ↑ (TA & LF)

205506 25°05' 80°08' D_4 FLT 190° 52 KTS

210125 25°37' 80°02.8' D_5, BT at FWY FI

2105 cutting RB, we have 80 KTS FLT LEVEL (MB same SFMR

210953 turn at 26°20' 79°56', to head back thru wind max

211534 D_6 26°06' 79°53' - just off Hollywood

2118 BOUNCING TA dBZ looks low. 80 KTS

2120 we're right over MIA, Opa Locka

2126 inside "eyewall"

FIX
213128 25°~~30~~' 80°53' D_7 fix
025° 10KTS

2138 GOOD CLEAR AIR BUMPS

2139 D_8 25°10' 81°10' 65 KTS

2140 Vert wind messed up right now (15 m/s) after big clear-air JOLT

~~2141~~

2155 E Walsh isn't getting ANY return signal, so the KEYS run may not help him

2158 EW ↑ again - his foot hit wave guide switch!

220024 turn to head up Keys

220112 D_9 24°29' 81°46' SANF1

2210 maneuvering to be 1 mi S of SMKF1

221226 24°34.8' 81°02.6' D_{10} / BAD sonde & BT SMKF1

2219 D_{11} LONF1 24°48' 80°48'

2224 can see waves breaking on reef

222508 D_{12}, B_T MLRF1

2227 ½ FIX 330° 50 nmi from 25°09' 80°14'
→ 25°50' 80°42'

2289 BOUNCING around ~~BTF~~ more

223254 25°33' 80°04' D_{13}

2240 D_{14} 26°13' 80°02' WIND MAX

224047 D_{15} 26°35' 80°03.8' near LWF1

2308 29°02 80°33 turn to head S ~~over~~ to S again

2308 Just over Belle Glade

2314 23 picking our way through stuff, between decent cells.

2316 Neyewall only 48 KTS

2317 JPG hunting

2318 nice deep sunset colors

2320
25°53' 80°38' JACKS FIX 982 mb
035°/09 KTS movement

2325
BOUNCING in CLEAR AIR 25°30' 80°39'

2328 Drop #16 25°23' 80°40 in region where we see a lot of mammatus above us on TAIL - hence the bouncing?
DROP had no winds

2336 - we are headed back to SW side of storm to get a BT we didn't get...

2344 45 BT 24°53' 81°21'

2352 passed by FLAMINGO tower

2358 HOMESTEAD off to LEFT, plenty of lights

0002 more bouncing as we head NW offshore
25°24' 80°

001039 25°39 79°25 Drop 17 near Bimini
JP FIX 26°14' 80°31'
0011

0015 in BAND, maneuvering between cells
ST ELMO'S (I DID NOT SEE)

001719 25°52 78°56 D_{18} RAINBAND
0019 25°57 78°45 D_{19} ← NO WINDS
GOOD DROP

0023 TURN 26°07 78°30' to head NW

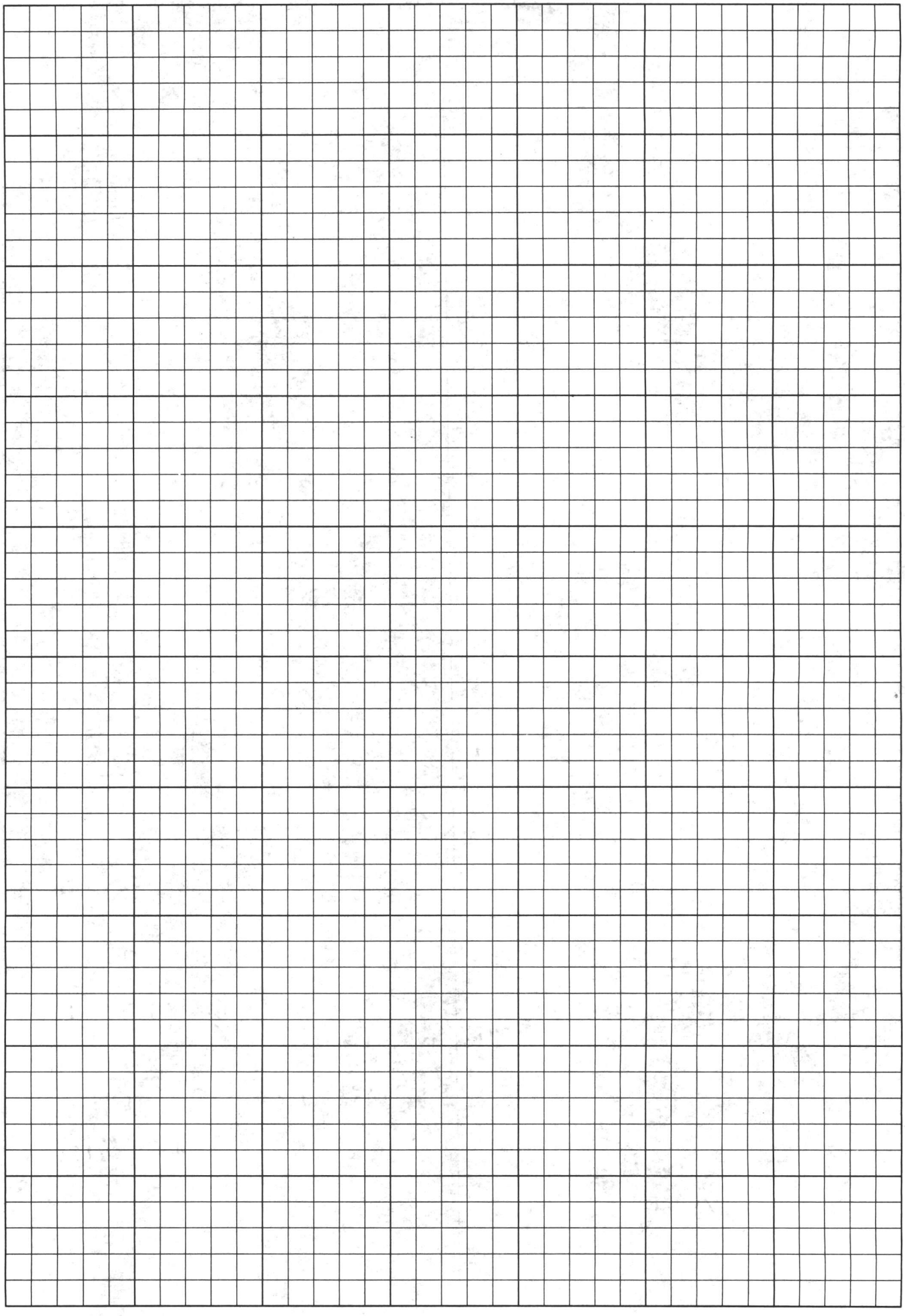
003248 26°35 79°03' SPGFI D_{20}
after turn

No winds!
0037 50 BT / 26°26' 79°25'
59 D_{21} 70 KTS FLT LEVEL

0039 Bouncing in cells 5.6 m/s ↑
0043 E eyewall on Miami Beach (MB)
004456 D_{22} 26°18' 79°56'
0047 TAIL ↑ after being down ~1 minute
Greg et al checking strange bump
~~0048~~ 0050 glow in the sky from city lights

005237 26°03 80°26 mark mile left side NO WINDS
FIX 0052 983 26°04' 80°26'

005731 drop 26°01.9 80°48' W eyewall D_{23}
sonde failed so we'll try again — reversed course
to hit W eyewall again — "a cheap penny" (JP)
↑ JP will get another fix
104 5 m/s ↓
10456 77 KTS FLT Level
10504 D_{24} 25°58' 80°42'
NO FUCKING WINDS



991015I	(5)	SIRENE

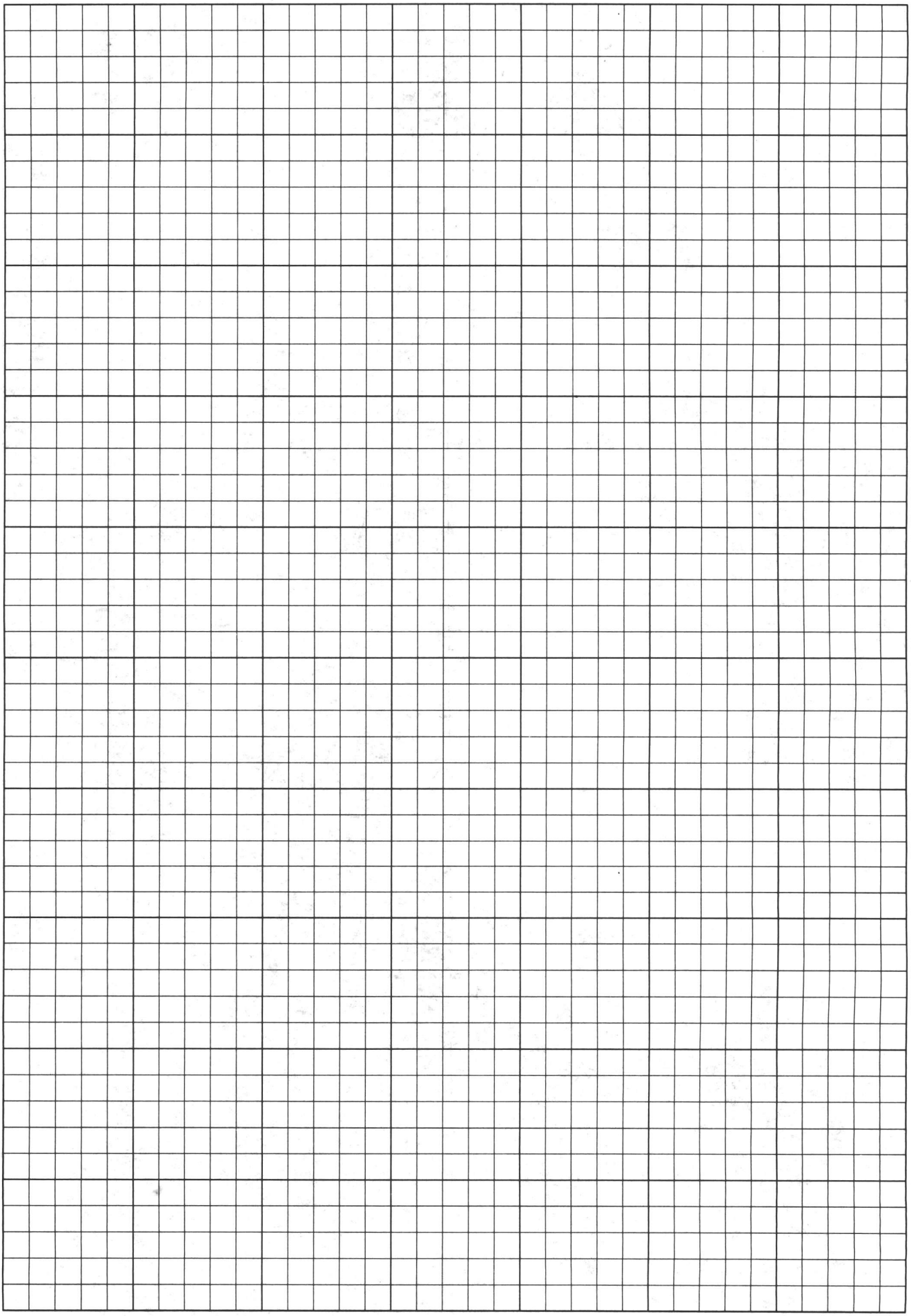
0109 55 26°06 80°23 JP FIX

0116 WEYEWALL again
+26 D_{25} 26°00.6 80°42' ✓
GOOD WINDS

0118 Climb to 3250 m for smoother ride so Jorge can get one more sonde as for a drop in this weird west side.

013157 D_{26} 26°01.3' 81° 51.8'

013224 Turn & climb for BILOXI



468
·6
468

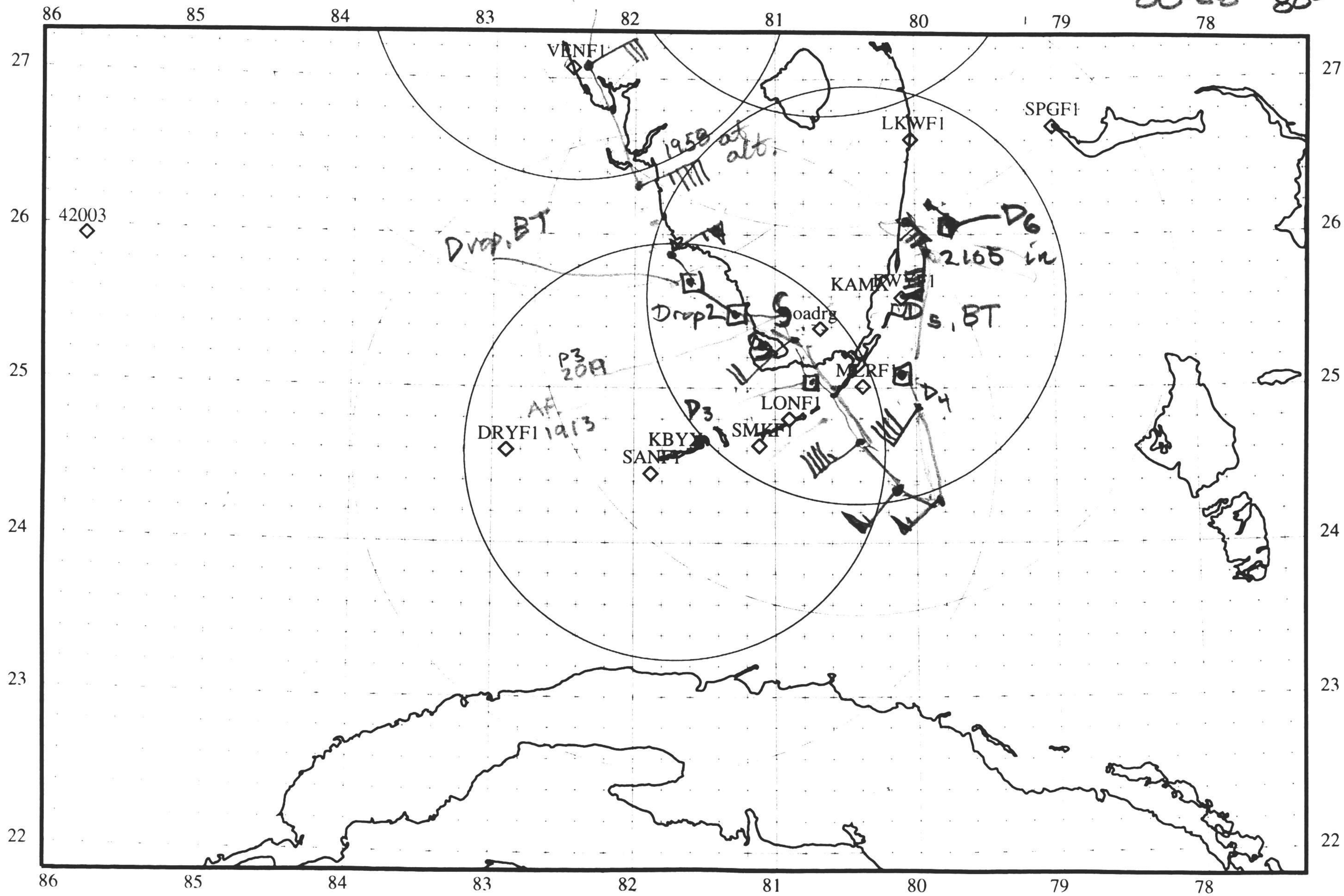
IRENE991015I1

TEAL 37 at 5000'
1913 25 17 81 08

1

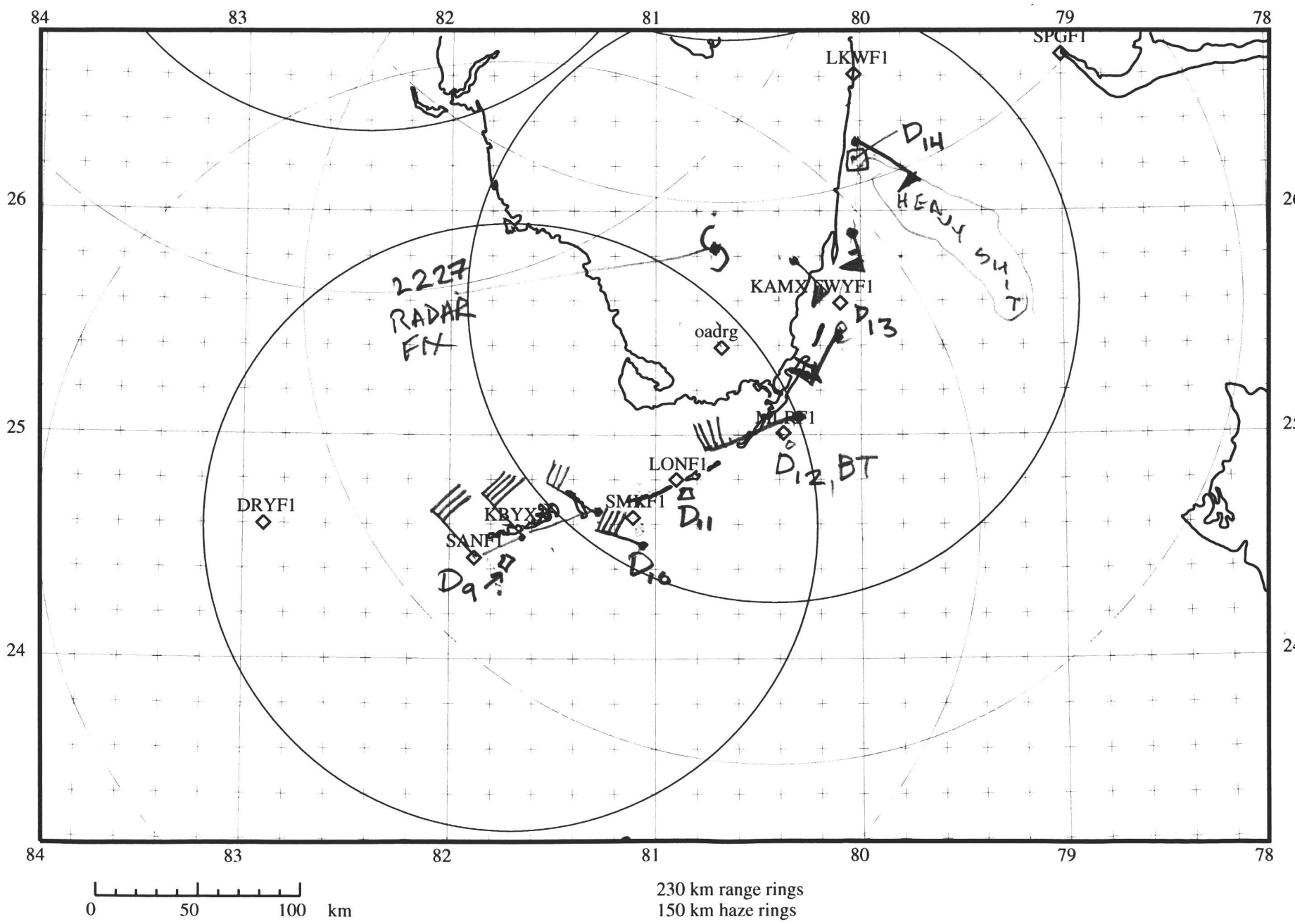
OADRG 25.39 = 25° 23'
80.68 80° 41'

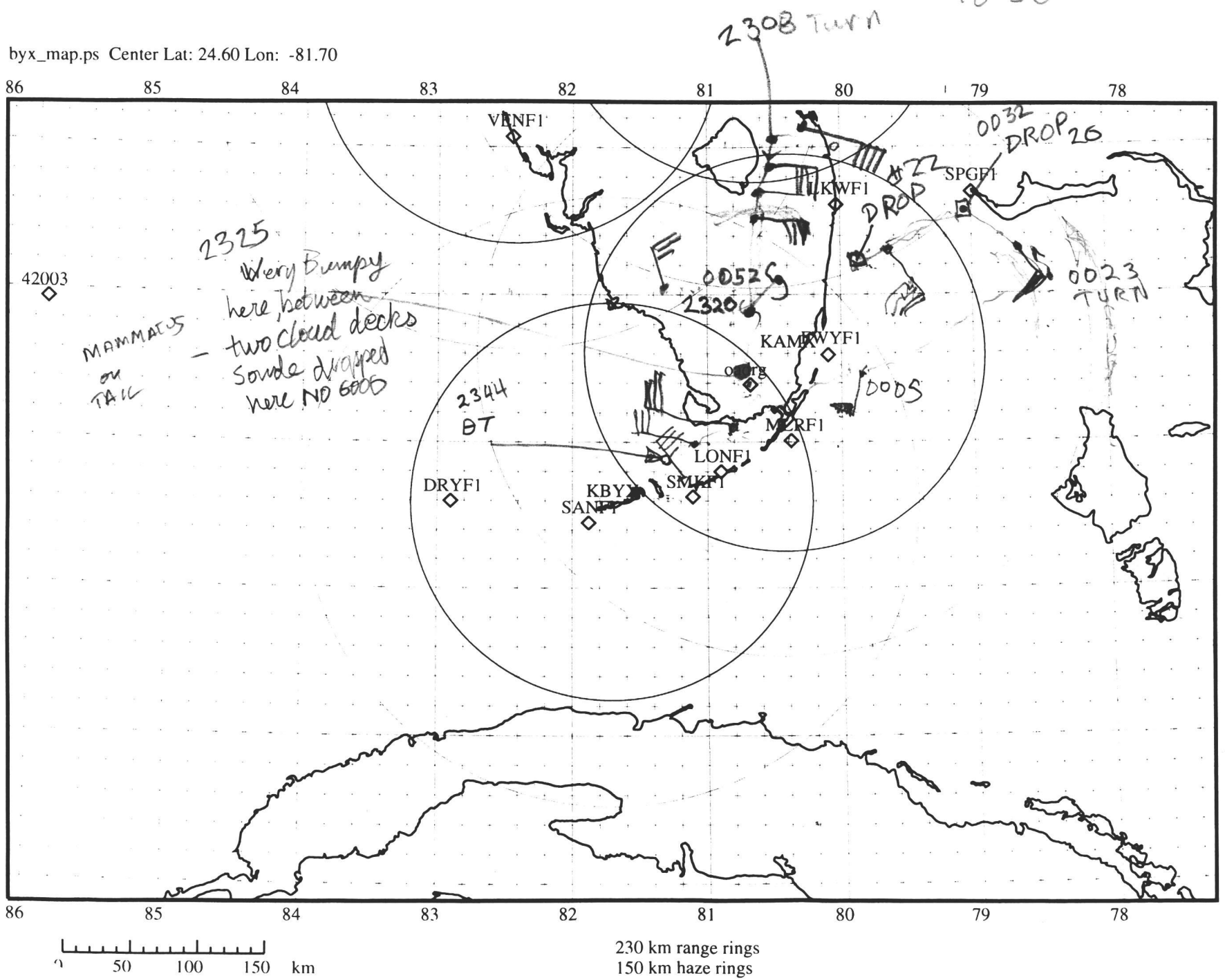
byx_map.ps Center Lat: 24.60 Lon: -81.70

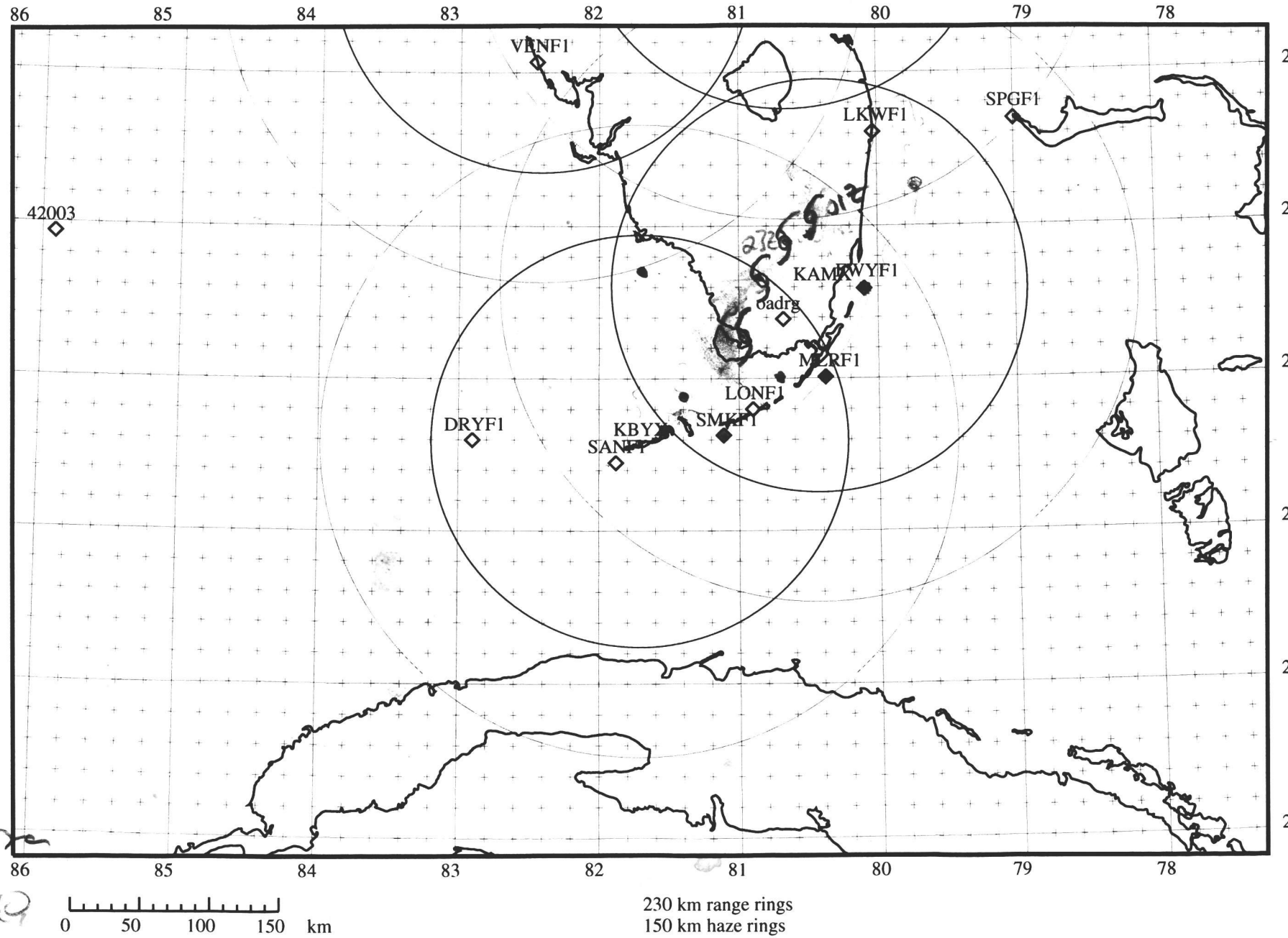


0 50 100 150 km

230 km range rings
150 km haze rings


(2) irene 9910151
LKWF1 26°61' = 26°36'
80°03' = 80°02'
byx_amx_map.ps Center Lat: 25.00 Lon: -81.00
84
83
82
81
80
79
78
26
25
24
SPGF1
LKWF1
D14
HEAVY SHIT
2227 RADAR FIX
KAMX
WYF1
D13
oadrg
D12, BT
LONF1
SMKF1
D11
DRYF1
KBYX
SANF1
D9
D10
0
50
100
km
230 km range rings
150 km haze rings


③ 9910151
SPGF1 26°38' 78°58'
2308 Turn
byx_map.ps Center Lat: 24.60 Lon: -81.70
86 85 84 83 82 81 80 79 78
27 26 25 24 23 22
VENF1
KIWF1
SPGF1
0032 DROP 26
#22 DROP
0023 TURN
42003
2325 Very Bumpy here, between two cloud decks Sonde dropped here NO GOOS
MAMMATUS on TAIL
0052
2320
KAMF1
MLRF1
0005
2344 BT
LONF1
SMKF1
DRYF1
KBYF1
SANF1
50 100 150 km
230 km range rings
150 km haze rings


byx_map.ps Center Lat: 24.60 Lon: -81.70
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0
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km
230 km range rings
150 km haze rings

26.7

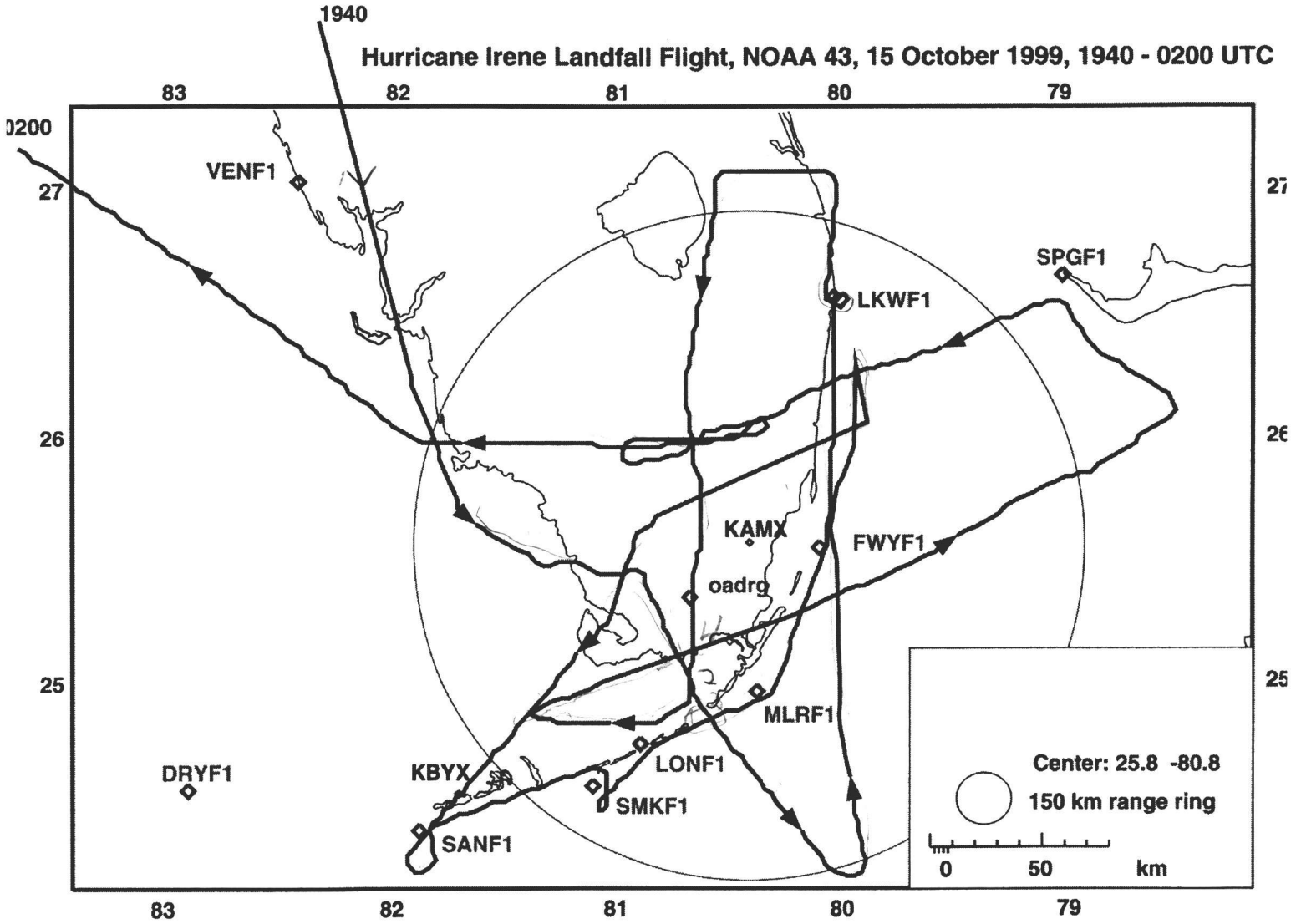
40.03

.00

57

26.5

20


1940
Hurricane Irene Landfall Flight, NOAA 43, 15 October 1999, 1940 - 0200 UTC
83
82
81
80
79
0200
27
26
25
VENF1
SPGF1
LKWF1
KAMX
FWYF1
oadrg
MLRF1
LONF1
SMKF1
KBYX
SANF1
DRYF1
Center: 25.8 -80.8
150 km range ring
0
50
km

Mission Summary
Hurricane Irene
Landfall
991015I Aircraft: 43RF

Scientific Crew:		**Aircraft Crew:**	
Chief Scientist	Peter Dodge, Mike Black	Cockpit:	LCDR Brian Taggert, CDR Phil Kenul, Greg Bast, Steve Wade,
Doppler Scientist	Mike Black		Dewie Floyd
Dropsonde Scientist	Mike Black, Joe Cione	Navigator:	LT Carl Newman
Workstation:	Mike Black, Joe Cione	Flight Director:	Jack Parrish
AXBT	Joe Cione		
Observer:	ADM Evelyn Fields	Engineers:	Sean McMillan, Jorge Delgado,
SRA	Ed Walsh		LT Phill Hall

Mission Briefing:

After the NOAA P3 reconnaissance flight on 14 October 1999, it was apparent that Hurricane Irene would hit Florida. Although the model runs on the 14th predicted landfall near Naples, by noon it was clear that Irene would have an impact on Florida Bay, and the Keys and the east coast of South Florida might experience tropical storm force winds. Frank Marks, Pete Black and Sam Houston designed a flight track to measure waves, storm surge and winds. An initial figure 4 through Irene was to be followed by runs along the Keys and the coast. If possible we would fly over the land as the storm moved North up the center of the state, over the Everglades. The goals were to collect more wave and storm-surge data with Ed Walsh's Scanning Radar Altimeter (SRA), and to collect GPS sonde data near the C-MAN and other surface stations to improve real-time and post-storm surface wind field analyses. The pattern was designed to take advantage of the the Miami (KAMX) and Key West (KBYX) WSR-88D radar data, and Step Frequency Microwave Radiometer (SFMR) surface wind estimates would be transmitted back to the Tropical Prediction Center in addtion to the flight level data. 8000' was selected as the flight level to reduce the SRA footprint and to provide flight-level winds suitable for reduction to 10m for the real-time surface wind analyses; the Air Force would be at 5,000'.

By1730 UTC the center of Irene was only 40 km SW of Cape Sable, so we modified the pattern for the briefing. Jack Parrish agreed that after our intial pass through the storm, followed by a leg north to Fowey Rocks, that if it looked safe we could do the second leg on a SW pass over land. He and the flight crew also agreed that 8,000' would be a good altitude for the flight. Because tropical storm-force winds were still expected at MacDill AFB, NOAA 43 would recover in Gulfport, Mississippi after the mission.

Mission Synopsis:

NOAA 43 left MacDill Air Force Base at 1934 UTC, and descended to the 8,000' flight level at 1953. Figure 1 shows the flight track. The first sonde and BT were dropped at 2009, south of Cape Romano. Jack fixed the center at 2030 UTC. We proceeded SE over Florida Bay, where we dropped a sonde and the second AXBT, and then to a point 150 km SSE of KAMX, and then turned to head north. At Fowey Rocks Light (FWYF1) we dropped the third AXBT and a sonde. At 2105 we passed through a strong rainband with 80 kt winds at flight level, near Hollywood, and then turned back south. Conditions seemed to be OK over land, so we then headed SW, passing near Opa Locka and Miami International airports before fixing the center again at 2131, where we also dropped the seventh sonde. We concluded the initial figure 4 with a leg to KBYX. At 2138 we experienced some good bumps in the clear air over the Ten Thousand Islands region. The vertical velocity calculation on the data system was bad briefly, and the SRA went down when Ed's foot hit the wave guide switch as we bounced around.

The SRA was up again at 2158 and we turned at 2200 south of Key West and then dropped the ninth sonde near SANF1. The aircraft then flew up along the keys, deploying sondes and AXBT's at the C-MAN sites. At 2224 we could see waves breaking on the reef line between Long Key (LONF1) and Molasses Reef. The flight continued along the coast. After dropping sondes near FWYF1 and in the wind max near Pompano Beach, we launched the 15th sonde at the Lake Worth Pier (LKWF1), conitinued north to Hobe Sound, turned west and then at 2303 we turned south at Indiantown, just east of Lake Okeechobee, to make our third pass

through the storm. This track was Mike Black's excellent suggestion, to map more of the overland wind field. Flight level winds in the northern eye wall were only 48 kts. Jack fixed the center at 2320. The first three fixes had Irene moving 35° at 9 kts. Once again we bounced around in the clear air south of the center. At 2328 a drop was deployed in this region (#16), but it had no winds. We tracked west and deployed an AXBT (#6) north of Big Pine Key at 2345.

The last part of the flight was designed to examine the rainbands over the Gulf Stream. Our NE track took us near the Flamingo tower and then over Homestead. At 0023 we turned SE of Grand Bahama Island after crossing a rainband where two sondes were dropped, only one of which had winds (#19), and headed for SPGF1, where the 20th sonde was dropped at 0032. The pilots reported St. Elmo's fire at 0015, but I could not see it. We turned and headed WSW for our last pass through the storm. A sonde and AXBT were launched at 0037 over the Gulf Stream, but no winds were recorded by the sonde. At 0043 Mike Black noted that the east eyewall was over Miami Beach. Figure 2, a lower fuselage radar composite for 0050, shows the strong rainbands over the ocean and the weaker reflectivitiy in the SW eyewall. Jack made his 4th fix of the evening at 0052, purtting the center west of Davie and just south of Alligator Alley. The data system froze briefly. The 23rd sonde drop, in the western wind max had no winds, so at Mike's urging, we reversed course to try to get a good sonde in this region. The 24th sonde at 0105 also had no winds. Jack took us into the center for a 5th fix, because he did not think the 4th was that good becuase of the data syetm problem. At 0109 he found the center over Davie and in the relative calm Jorge Delgado was able to dig out some sondes from a new box underneath the luggage. The 26th sonde was dropped at 0116 in the west eyewall and it had good winds. At 0118 the plane climbed to 3250 m for a smoother ride, and we dropped our final sonde just offshore of Marco Island at 0131, turned, climbed and headed for Gulfport, Mississippi, where we landed at 0311, 16 October.

Evaluation:

The flight went well, perhaps a bit bumpier than folks in the back of the plane would have liked. The sonde data will be helpful in describing the structure of a strong tropical storm/weak hurricane as it moves across land. There were no hurricane-force surface winds in the sonde data (see Figure 3), even though some of the sondes were dropped in regions where flight-level winds were > 75 kts. Mike Black and Joe Cione both have mentioned the rapid drop-off in winds with altitude in the sonde data. The thermodynamic data from the sondes, especially those dropped over the Everglades, will help specify the stability profileswhich may help explain why the higher winds could not mix down to the surface, except in occasional gusts. Careful analysis of the Dopppler radar data may provide details of the three-dimensional windfield to complement the sonde measurements.

Acknowledgements:

Jack Parrish, Carl Newman and the flight crew agreed to every change in the flight pattern that we requested (there were many). Sean MacMillan kept the radar running, and Jorge Delgado managed to work with our evolving plans for GPS sonde drops, despite the rough ride that evening.

Sam Houston, Frank Marks and Pete Black made the initial flight tracks, and Jack Parrish assisted in sketching out the flight track for the briefing. Mike Black suggested several useful modifications and additions to the track during the flight, especially the N-S pass from Lake Okeechobee down to Flamingo Key. Mike called the sonde drops in rainbands and wind maxima. Joe Cione kept track of the AXBT data. Tim Crum, OSF, and Victor Murphy, Southern Region of the NWS, alerted the WSR-88D sites about our experiment. The Southern Region of the NWS also archived the 1 minute ASOS data. At TPC Colin McAdie archived the Level IV products from the KAMX and KBYX WSR-88D radars, and arranged copying the KAMX Level II data tapes after the storm.

Problems:

Only 20 of 26 GPS sondes launched had winds. Unfortunately some of the sonde wind failures were in higher wind regions of the storm. Jorge Delgado thinks that one of the boxes of sondes was from a bad batch. The reflecivity on the tail radar seemed low, perhaps 10-20 dBZ lower than the lower fuselage radar. This has been a problem on NOAA 43 throughout the 1999 season. The Doppler data appear OK.

The SFMR winds seemed too high in some regions of the storm. In some cases this may be caused by RFI, according to Eric Uhlhorn, but Mike Black will be using this data set to investigate whether or not there are some systematic biases in the SFMR winds.

Tables:

Table 1. Some Centers

Time	Lat	Lon	Source	
1913	25° 17′	81° 03′	Air Force	
2019	25° 30′	80° 58′	NOAA	
2131	25° 40′	80° 52′	NOAA	GPS drop # 7
2320	25° 54′	80° 39′	NOAA	982 mb
0052	26° 04′	80° 26′	NOAA	983 mb
0109	26° 06′	80° 23′	NOAA	

Table 2. GPS Sondes

Sonde ID	Launch UTC	Splash Lat	Lon	Comments
1 985035277	2009	25.67	81.70	MBL WND 01557 RAINBAND
2 984325106	2015	25.50	81.30	MBL WND 03055 EYEWALL 315
3 991515021	2028	25.07	80.63	MBL WND 20064
4 984325477	2055	25.14	80.01	MBL WND 17553
5 984325219	2101	25.67	80.05	MBL WND 15552
7 992515737	2131	25.67	80.87	EYE, position from Jack's fix
8 991515252	2139	25.18	81.13	MBL WND 31055 LST WND 011
9 984325386	2201	24.47	81.76	MBL WND 29534
11 984715020	2218	24.81	80.79	MBL WND 24544 SST 278
12 984325236	2225	25.02	80.32	MBL WND 21054 SST 275
13 990415208	2232	25.61	80.08	MBL WND 16561 RAINBAND SST 277
14 991435022	2240	26.24	80.08	MBL WND 10054 RAINBAND
15 984325552	2248	26.61	80.11	MBL WND 09550 LST WND 012 RAINBAND
16 984325460	2328	25.41	80.65	SST 259, 10 m wind 258/45 kts
17 985035020	0010	25.70	79.43	MBL WND 16059 RAINBAND
19 985035218	0019	26.00	78.78	MBL WND 13048 RAINBAND
20 984715021	0032	26.61	79.08	MBL WND 11045 RAINBAND
22 984715323	0044	26.35	79.96	MBL WND 11051 EYEWALL 045
25 984325044	0116	25.98	80.69	MBL WND 02036 EYEWALL 270
26 990415261	0131	25.98	81.86	MBL WND 00543

Note: Sondes 6, 18, 21, 23, 24 had no winds, and 10 had no launch detect

Table 3. AXBT's (Compiled from Joe Cione's log)

	Launch (UTC)	Lat	Lon	SST (°C)	
1	200926	23° 41′	81° 39′	26.8°	
2	202841	25° 01′	80° 40′	25.5°	Florida Bay
3	210137	25° 38′	80° 03′	27.7°	FWYF1
4	221226	24° 38′	81° 06′	27.8°	SMKF1
5	222506	24° 59′	80° 20′	27.5°	MLRF1
6	234445	24° 53′	81° 22′	26.0°	
7	003801	26° 27′	79° 24′	28.3°	Gulf Stream

Figures: (files are located on thor, in /hrd/dat/irene99)

1. NOAA 43RF flight track. noaa_991015i_map.ps
2. Lower Fuselage radar image irene15lf4.gif
3. Surface winds from GPS sondes sfc_sondes.ps

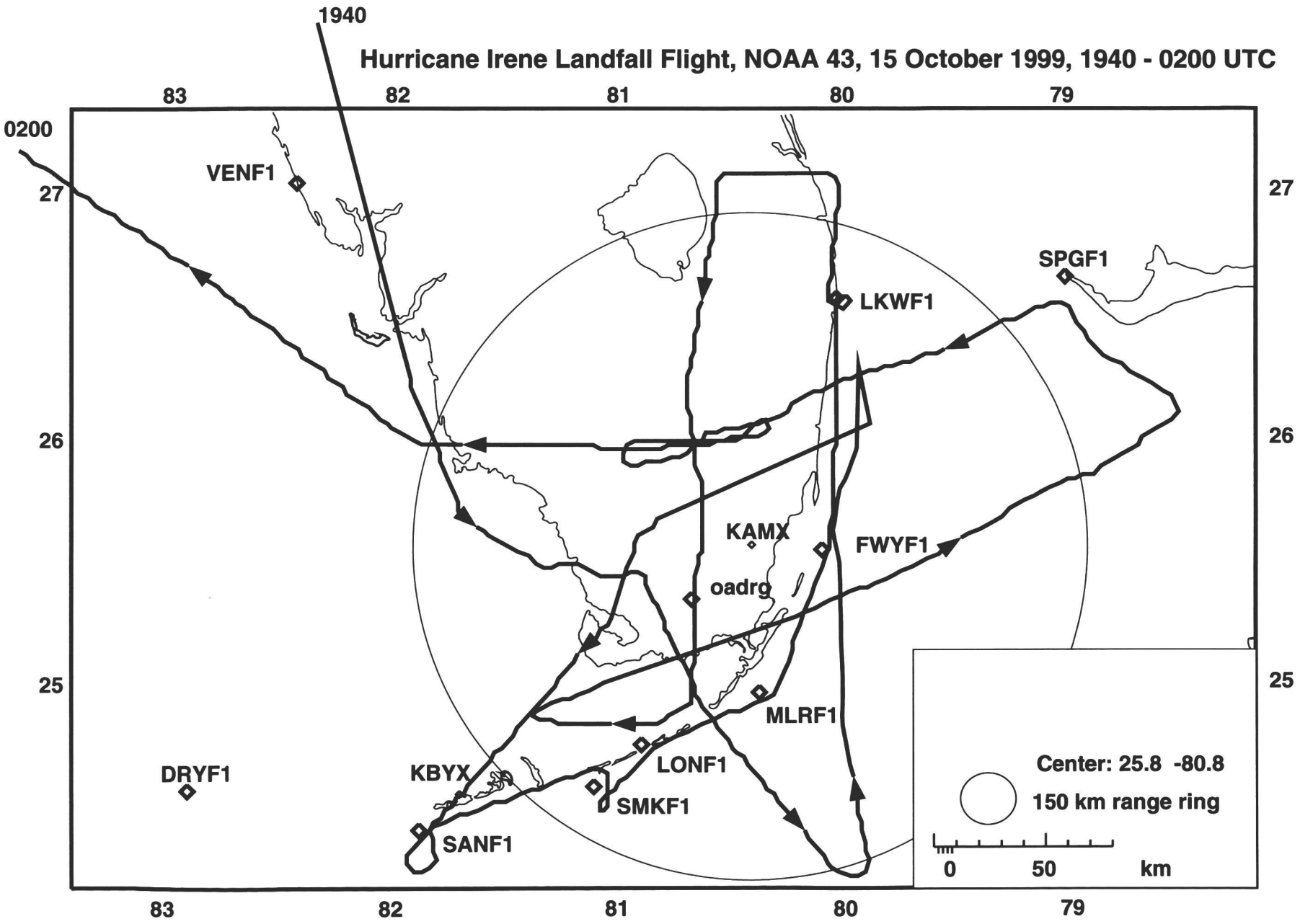

1940
Hurricane Irene Landfall Flight, NOAA 43, 15 October 1999, 1940 - 0200 UTC
83
82
81
80
79
0200
27
26
25
VENF1
SPGF1
LKWF1
KAMX
FWYF1
oadrg
MLRF1
LONF1
DRYF1
KBYX
SMKF1
SANF1
Center: 25.8 -80.8
150 km range ring
0
50
km

Figure1

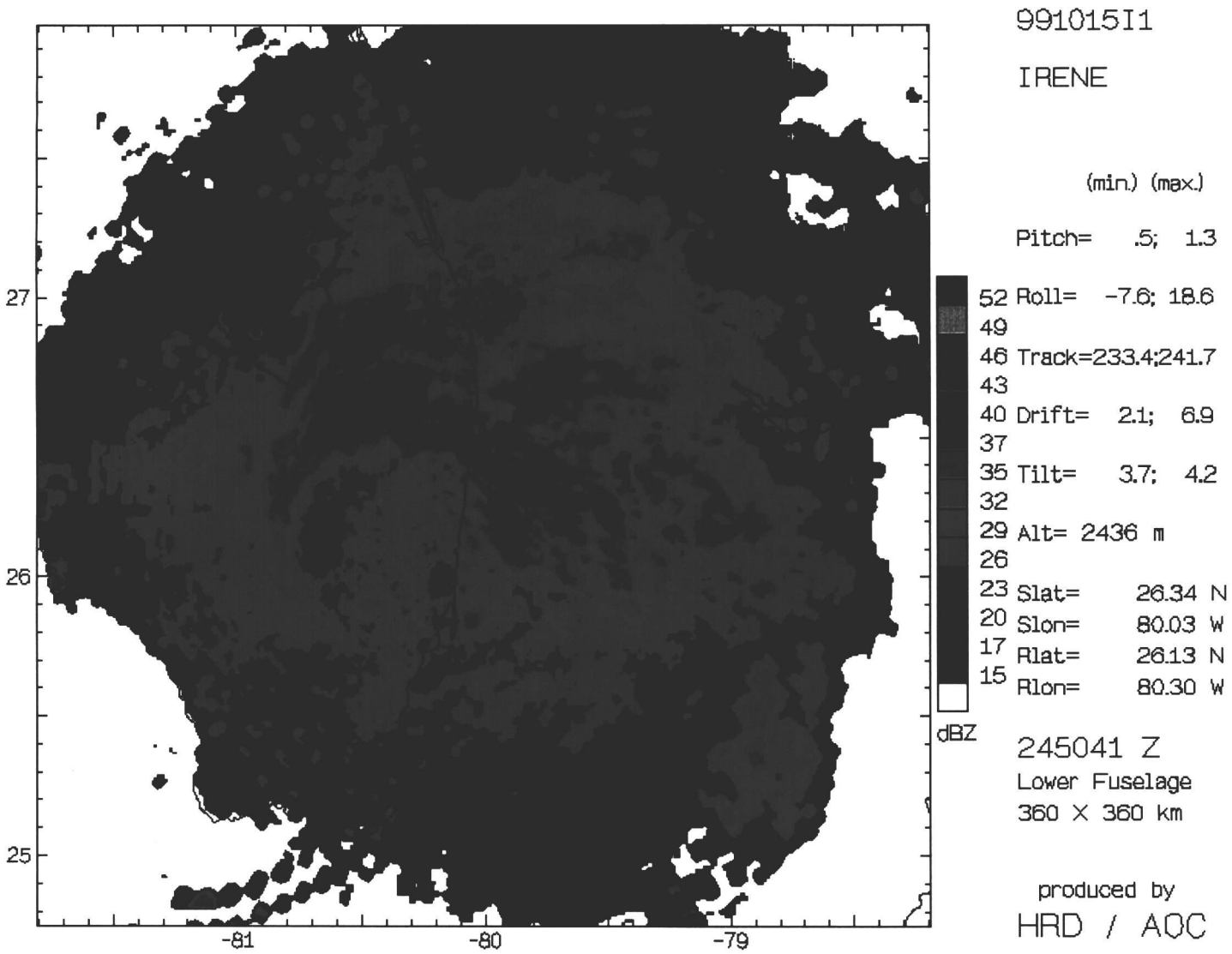

27
26
25
-81
-80
-79
52
49
46
43
40
37
35
32
29
26
23
20
17
15
dBZ
991015I1
IRENE
(min.) (max.)
Pitch= .5; 1.3
Roll= -7.6; 18.6
Track=233.4;241.7
Drift= 2.1; 6.9
Tilt= 3.7; 4.2
Alt= 2436 m
Slat= 26.34 N
Slon= 80.03 W
Rlat= 26.13 N
Rlon= 80.30 W
245041 Z
Lower Fuselage
360 X 360 km
produced by
HRD / AOC

Figure 2

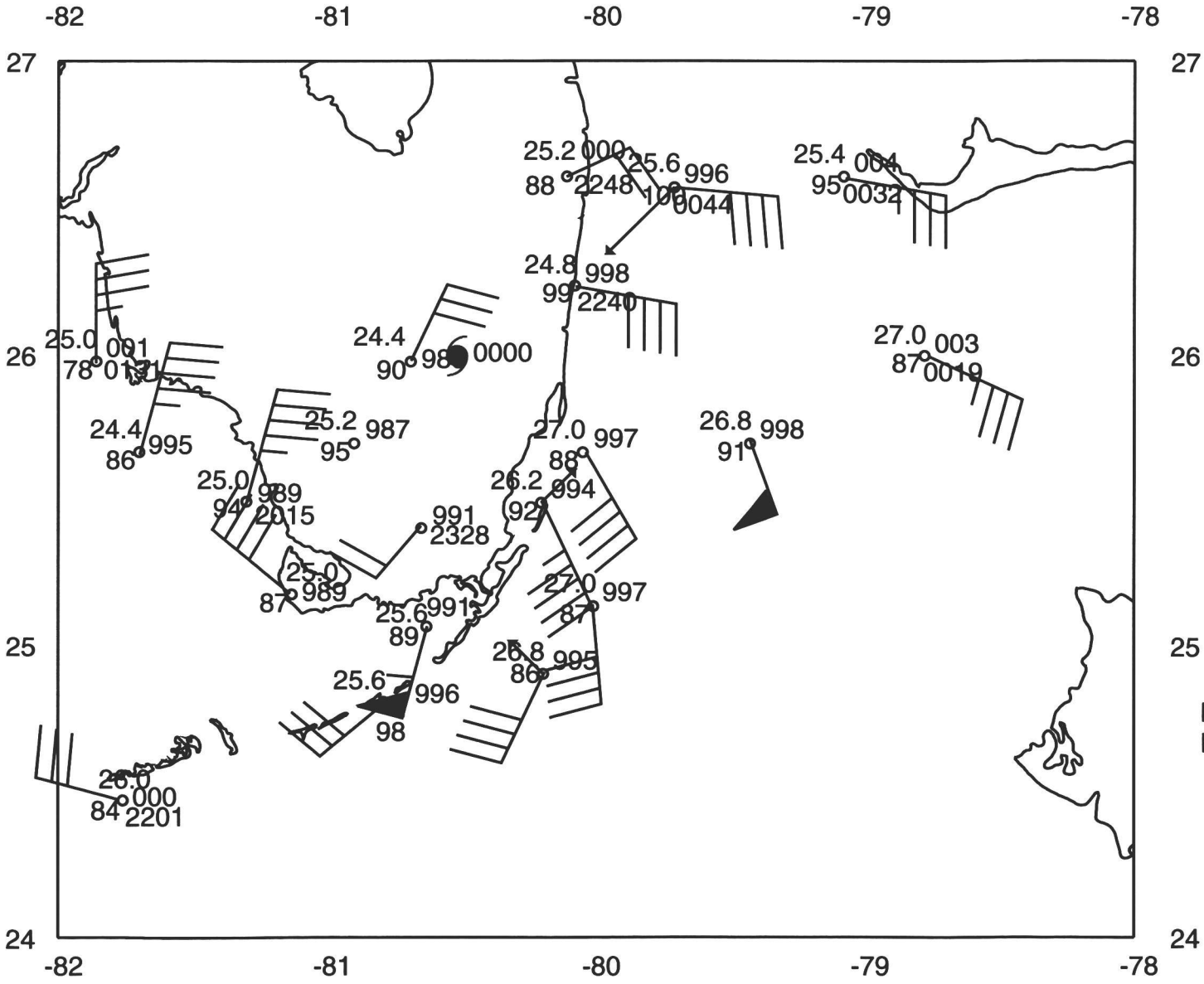

-82
-81
-80
-79
-78
27
26
25
24
25.2 000
88 2248
25.6 996
100 0044
25.4 004
95 0032
24.8 998
99 2240
24.4
90 98 0000
25.0 091
78 0131
27.0 003
87 0019
24.4 995
86
25.2 987
95
26.8 998
91
27.0 997
88
25.0 989
94 2015
26.2 994
92
991
2328
25.0
87 989
25.6 991
89
27.0 997
87
25.8 995
86
25.6 996
98
26.0
000
84 2201
Hurricane Irene
Surface Obs from
GPS sondes
Date: 991015
Time: 18-30 UTC
EARTH RELATIVE
NOAA ERL
HURRICANE RESEARCH DIVISION

Figure 13