Mission Summary
990915I Aircraft 43RF
XCDX/Air-Sea Interaction

Scientific Crew (43RF)

Lead Scientist/Radar	F. Marks
AXBT	P. Davies (author)
Dropsonde	C Landsea
Workstation	M. Black
Air-sea interaction Scientist	E. Walsh (NASA/GSFC)

Mission Briefing:

On Wednesday 15 September N43RF was tasked to do a single plane XCDX/Air-Sea Interaction experiment into Hurricane Floyd while it passed E of Jacksonville, FL with a takeoff from Tampa International at 1830 UTC recovering back in Tampa (this mission was almost scrubbed the night before because of equipment problems during the surveillance flight, but AOC was sure they could fix those in time to get this mission off). The plan called for three rotated figure-4 patterns at 8,000 ft altitude with 120 nm legs with AXBT and GPS sonde drops on the ends of the legs, 75 nm from the center, near any C-MAN or buoys (see Table 3), and in the eyewall on all cardinal directions. Three drops were also planned in the eye on the first and fourth, and sixth (last) passes through the center. We also planned two legs along the coast on the NW side of the storm where the radial legs were abbreviated for storm surge mapping and to collect some off-shore flow GPS sondes to augment the windfields at landfall experiment on the next flight. There were also three instrumented towers and a DOW (see Table 1) along the coast that we hoped to overfly. Unfortunately, no synoptic drops are available for this mission as N49RF was tasked to do a synoptic surveillance mission in Hurricane Gert.

Mission Synopsis

Takeoff was delayed till 1945 UTC to allow the AOC engineers to work on the main and radar data system problems from the previous flight. The delay was exacerbated by the fact that the planes were at Tampa International because of cross winds the night before. The delay worked to our advantage as it gave us more possible overlap with the Windfields at Landfall mission scheduled for an 0300 UTC takeoff later that night. The delay also worked to NHC's advantage as it put our mission in between the two AFRES missions, providing data at a critical time <12 h before landfall. The AOC engineers did a phenomenal job and we only took off a little over an hour later than originally scheduled.

We took off at 1948 UTC and tracked to an IP 120 nm SW of the storm center. We reached the IP <45 min later (2030 UTC) descending to 8,000 ft. After dropping a sonde we tracked NE to the center (Fig. 1) running the TA radar in F/AST so the flight director (Damiano) could get a good fix. The LF radar showed the radar eye was still very large (60-70 nm diameter) with the strongest reflectivities N of the center extending >200 nm from the center (Fig. 2). The S eyewall reflectivity was fairly weak, but it still appeared closed, with the same major band from the day before extending 100-160 nm from the center. We dropped our first eyewall sonde (see Table 4) followed by the first AXBT (which failed, attached log) SW of the center at 2053 UTC with surface winds of 63 kt which agreed fairly well with the SFMR estimates. At 2059 UTC we fixed the center (see Table 2) dropping a sonde and AXBT (SST 28.1°C, MLD 90 m). The sonde had very little wind (peak winds of 8 kt) and a central pressure of 950 mb (18 mb higher than the day before). We continued tracking NE doing an eyewall drop and AXBT (SST 27.8°C, MLD 90 m) on the NE side of the storm at 2104 UTC with a peak wind of 104 kt well above the surface. We hit our turn point 100 nm NE of the center at 2130 UTC dropping a sonde and then tracked W to a C-

MAN FBLS1 (Folly Island, SC) roughly 100 nm NW of the center passing over and dropping a sonde on buoy 41004 at 2147 UTC. The second leg of the first figure-4 started at 2202 UTC roughly 100 nm NW of the center along the SC coast. This run to the center we set the radar in normal scan mode for EVTD and instructed the flight director to not making any major track changes. As we approached we dropped two AXBTs outside the eyewall to sample the Gulfstream (see attached log). We did an eyewall drop and AXBT on the NW and SE side of the center, but we passed about 10 nm SW of the circulation center at 2225UTC. We dropped two more AXBTs on the outbound leg to the SE reaching a point 120 nm SE of the center at 2252 UTC where we dropped a GPS sonde only. Unfortunately, the eyewall was too large to do an EVTD analysis so one was sent back to NHC.

The second figure-4 started at 2311 UTC (Fig. 3). We turned inbound to the W and dropped a GPS sonde tracking W to the center. We dropped two more AXBTs outside the E eyewall and a combo (GPS sonde and AXBT) in the E and W eyewall and an AXBT in the eye (#14) at 2340 UTC. We finished the outbound leg with a combo drop 60 nm W of the center and then a GPS sonde drop at 0008 UTC 120 nm W of the center. We tracked SE to a point 120 nm S of the center reaching it at 0040 UTC, dropped a GPS sonde and tracked N to the storm center. We dropped 3 AXBTs on the inbound leg the last one 60 nm S of the center. We dropped an eyewall sonde S of the center at 0103 UTC and a center drop at 0109 UTC. The eyewall sonde had very little wind all the way to the surface and a mean boundary layer wind of 0 kts and a 951 mb central pressure. We proceeded N to the coast dropping 2 GPS sondes in the N eyewall and at the endpoint 100 nm N of the center near KLTX (see table 3) at 0134 UTC. Also on this leg we dropped our last two AXBTs in the N eyewall and 60 nm N of the center.

After completing the first two figure-4s we decided to leave out the last figure-4 out, in favor of a third leg along the coast N of the storm to capture the storm surge as the center was only 75 nm offshore (the N eyewall was only 45 nm off shore). After the second figure-4 we tracked SW along the beach mapping the surge with Ed Walsh's scanning radar altimeter (SRA) dropping GPS sondes in the offshore flow near Folly Island (FBLS1) and in a heavy rainband near Savannah, GA.(Fig. 4). From there we tracked to the center over buoy 41004, then from the center NE on a radial toward the WRS-88D KMHX (Moorehead City, NC) and C-MAN CLKN7 (Cape Lookout, NC) passing over C-MAN FPSN7 (Frying Pan Shoals). From there we tracked WSW along the coast for SRA mapping of the storm surge from CLKN7 to a point due S of the WSR-88D KLTX (Wilmington, NC) passing very close to the 3 instrumented towers and the DOW (see Fig. 4). From there we flew a radial from KLTX to the center, departing the storm to return to MacDill AFB.

Accomplishments

WOW!! After the mission the previous day this mission was pure heaven. The only major change from the plan was leaving the last figure-4 out, adding a third leg along the coast N of the storm to capture the storm surge as the center was only 75 nm offshore (the N eyewall was only 45 nm off shore). This extra leg allowed Ed Walsh and the AOC crew to get some experience trying to fly along the coastline in the dark and a lot of heavy rain. This portion of the mission was joy to experience as the navigator (Rathbun) and pilots (McKim and Kenul) worked closely with Ed to have the plane weave back and forth across the beach keeping all turns <10° so the SRA beam stayed near the beach

We managed to get GPS sondes at the extremities of the pattern on all the legs providing a very good mapping of the edges of the vortex. Overall the GPS sondes worked nearly flawlessly, the one exception being when the CNN reported picked up the Airphone on the coastal run at the end of the first figure-4 causing us to lose signal completely on 2 sondes (one a backup of the first) and partially on a third over C-MAN FBLS1 (Folly Island, SC). The AXBT drops also were very good, with 17/22 providing excellent SST and MLD info as the storm interacted with the Gulf Stream as it approached landfall. The Doppler radar data on the last coastal leg would be excellent for comparison with the two WSR-88Ds and the DOW which started recoding near the time of our overpass.

Problems:

Thanks to the phenomenal job the AOC engineers (Terry Lynch, Jim Barr, and Richard McNamara) did after all of the problems we encountered during the previous mission, no major problems were encountered. The main data system worked nearly flawlessly, the radar data system suffered only a few brief hangups (the TA reflectivity was still 6-8 dB low), and the AVAPS and HAPS communications were great! The only disappointment was caused by a CNN reporter using the Airphone without permission causing us to lose signal completely on 2 sondes (one a backup of the first) over C-MAN FBLS1 (Folly Island, SC) and partially on a third when we were on our first coastal run.

Frank Marks

Table 1: Locations of University 10 m meteorological tower deployments. A DOW was also located at the Topsail Beach location. Mobile mesonets operated in the Cape Fear area of southeastern North Carolina.

Tower location	Latitude (N) (deg min)	Longitude (W) (deg min)	University
Southport Airport	33 55	78 15	Texas Tech
Wilmington Airport	34 16	77 55	Texas Tech
Topsail Beach.	34 23	77 39	University of Oklahoma tower and DOW

Table 2: Center fixes for Floyd from N43RF and the Air Force (AFRES) on 15-16 September (*Landfall occurred over Bald Head Island at Cape Fear). Sea level pressures were provided in some eye drops. N43RF did not get a center fix on the second pass through the center (~2225 UTC).

Time (UTC)	Latitude (N) (deg min)	Longitude (W) (deg min)	Aircraft
2059	31 20	78 56	N43RF, 950 mb
2302	31 49	78 46	AFRES, 950 mb
2340	32 01	78 41	N43RF
0109	32 16	78 34	N43RF, 951 mb
0229	32 44	78 08	N43RF
0343	33 04	78 18	N43RF

Table 3. Buoy, C-MAN, and WSR-88D locations for the 19990915I Floyd flight.

Site ID	Latitude (°N)	Longitude (°W)	Location
41001	34.68	72.64	E. HATTERAS
41002	32.28	75.20	S. HATTERAS
41004	32.51	79.10	EDISTO
41009	28.50	80.18	CANAVERAL
41010	28.89	78.55	CANAVERAL EAST
DSLN7	35.15	75.30	Diamond Shoals Light, NC
CLKN7	34.62	76.52	Cape Lookout, NC
FPSN7	33.49	77.59	Frying Pan Shoals, NC
FBIS1	32.68	79.89	Folly Island, SC
KLTX	33.9894	78.4289	Wilmington, NC WSR-88D
KMHX	34.7761	76.8761	Moorehead City, NC WSR-88D
KCLX	32.6555	81.0422	Charleston, SC WSR-88D

Table 4: Splash locations of sondes transmitted during the 19990915I Floyd mission. Here MBL = mean boundary layer wind (fffdd; fff = wind direction in deg and dd = wind speed in kt), LST WND = height of last wind (meters), and SST = sea surface temperature (tenths of °C).

#	Sonde id	Time (UTC)	Lat. (°N)	Lon (°W)	Comments
1	992435213	2029	30.03	80.59	LST WND 010 MBL WND 32064
2	992455375	2053	30.97	79,10	LST WND 010 MBL WND 31077 EYEWALL 225
3	992435029	2058	31.35	78.92	LST WND 010 MBL WND 00000 **EYE** SST 281
4	992455377	2103	31.62	78.72	LST WND 010 MBL WND 10583 EYEWALL 045 SST 279
5	992435021	2114	32.09	78.15	MBL WND 12072 LST WND 010 RAINBAND SST 287
6	992455378	2129	32.82	77.27	MBL WND 13057 LST WND 013 RAINBAND
7	992435141	2147	32.68	78.90	LST WND 010 MBL WND 08554 RAINBAND
8	992435017	2201	32.49	80.16	LST WND 010 RAINBAND
9	992455373	2220	31.55	79.07	LST WND 010 MBL WND 34592 EYEWALL 270 SST 275
10	992435030	2230	31.16	78.33	LST WND 011 MBL WND 22598 EYEWALL 135
11	992435060	2251	30.22	77.14	LST WND 010 MBL WND 20568 SST 265
12	992435142	2328	31.97	77.80	LST WND 010 MBL WND 15099 EYEWALL 090 SST 284
13	992435145	2311	31.81	76.47	LST WND 010 MBL WND 16566 SST 283
14	992435144	2344	32.01	79.06	LST WND 010 MBL WND 36087 EYEWALL 270 SST 283
15	992435212	2349	32.06	79.42	LST WND 010 RAINBAND SST 275
16	992435146	0007	31.87	80.77	LST WND 010 MBL WND 35054
17	991515069	0108	32.27	78.57	LST WND 010 MBL WND 01502 **EYE**
18	992455379	0039	30.27	78.37	LST WND 010 MBL WND 25545
20	990838041	0053	31.25	78.38	LST WND 010 MBL WND 27569 SST 277
21	991515070	0102	31.89	78.38	LST WND 048 MBL WND 25089 EYEWALL 180
22	984925203	0114	32.64	78.67	EYEWALL 315LST WND 010
23	991845324	0116	32.77	78.66	LST WND 010 MBL WND 05582 EYEWALL 315 SST 26
24	991845309	0134	33.82	78.58	MBL WND 06041 LST WND 010
25	991845302	0146	33.12	79.20	MBL WND 35568 LST WND 010 RAINBAND
26	990838039	0154	32.69	79.85	MBL WND 34073 RAINBAND
27	991845323	0225	32.54	78.66	MBL WND 31586 LST WND 028 EYEWALL 270
28	991845308	0234	33.04	78.23	MBL WND 09597 LST WND 014 EYEWALL 000
29	991435052	0245	33.49	77.64	MBL WND 12071 LST WND 013 RAINBAND
30	991845166	0306	34.69	76.84	MBL WND 12549 LST WND 010
31	991218016	0336	33.43	78.41	MBL WND 06076 EYEWALL 315
32	991845310	0338	33.30	78.42	MBL WND 03589 EYEWALL 315

Floyd
Weds 15 September
AXBT drops from 43, flight 15.48 to 01.10 Thurs a.m. (local time)
Pete Davies' incomplete, unscientific, and frankly incompetent record thereof

Notes.

1. I missed a few, either because they were duds, or because I was trying to write notes on something else at the drop point. Ergo after the first eight I recorded I learned from Barry D that the next drop was #12. So my drop #'s aren't all correct.

2. I started off trying to be over-precise, but rapidly realized that multiplying 55 by 1.5 was too challenging for me to do it too often. Also Mike Black was consistently estimating a shade higher mixed layer depths than me, & as I assumed a fair likelihood that he knew what he was doing better than I did, after that I settled for rounder numbers. With that in mind …

BT#	comment
1	dud
2	28.1C, 77.5meters
3	27.8C, 75 meters, maybe more
4	28.7C, 45 meters, maybe more
5	dud
6	26.5C, and a weird looking graph 90 meters with two big spikes in it
7	28.4C, 30 meters
8	22.6C, rapid drop-off after 10 seconds. Capsized/sunk?
9	
10	
11	realized here I'd missed a few …
12	26.4C, 90 meters
13	28.3C, 60 meters (MB had 28.5C/80 meters on this one)
14	28.0C, 90 meters
15	28.3C, 90 meters
16	28.3C, 30 meters
17	27.6C, 180 meters? Chris Landsea: "Is it floating?" Mike Black: "Write it down. It doesn't make sense."
18	27.1C, 75 meters
19	dud
20	27.7C, 90 meters
21	I think I missed one …
22	25.8C, & appears to be floating again. Or, Frank Marks: "The mixed layer depth is infinity."

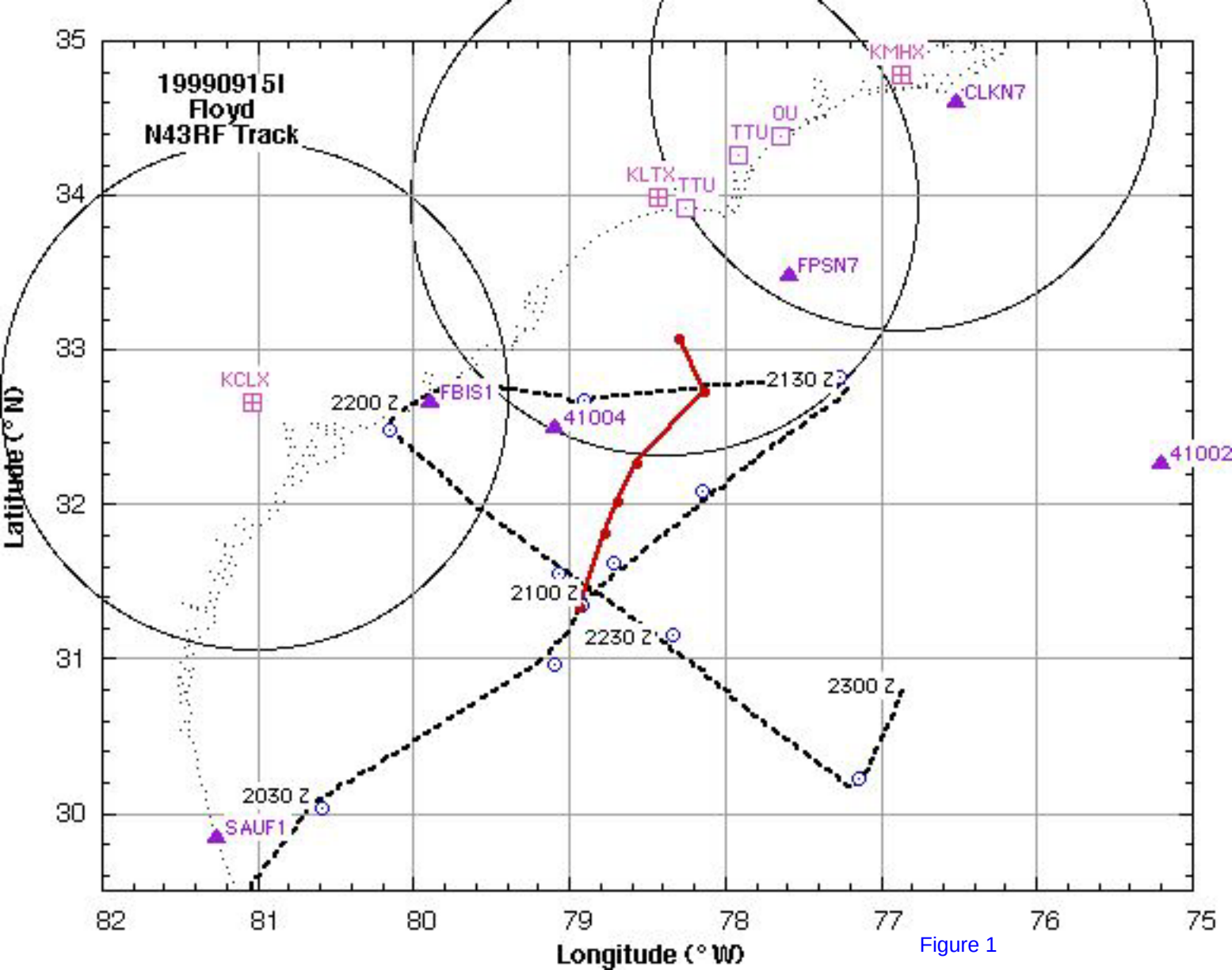
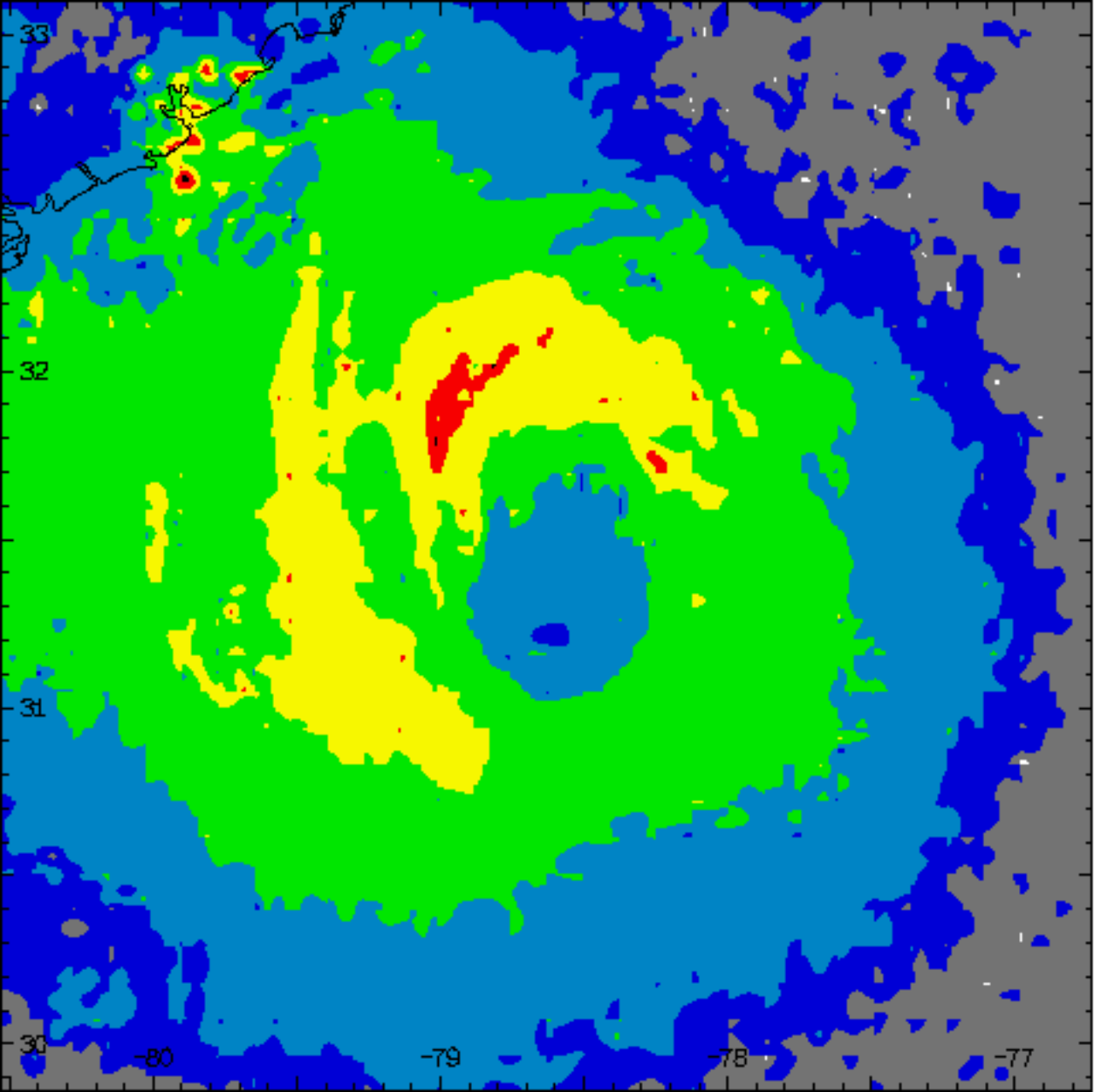

19990915I
Floyd
N43RF Track
KMHX
CLKN7
OU
TTU
KLTX
TTU
FPSN7
KCLX
FBIS1
2200 Z
41004
2130 Z
41002
2100 Z
2230 Z
2300 Z
2030 Z
SAUF1
35
34
33
32
31
30
82
81
80
79
78
77
76
75
Latitude (° N)
Longitude (° W)

Figure 1



99091511

FLOYD

221316 Z to
222557 Z

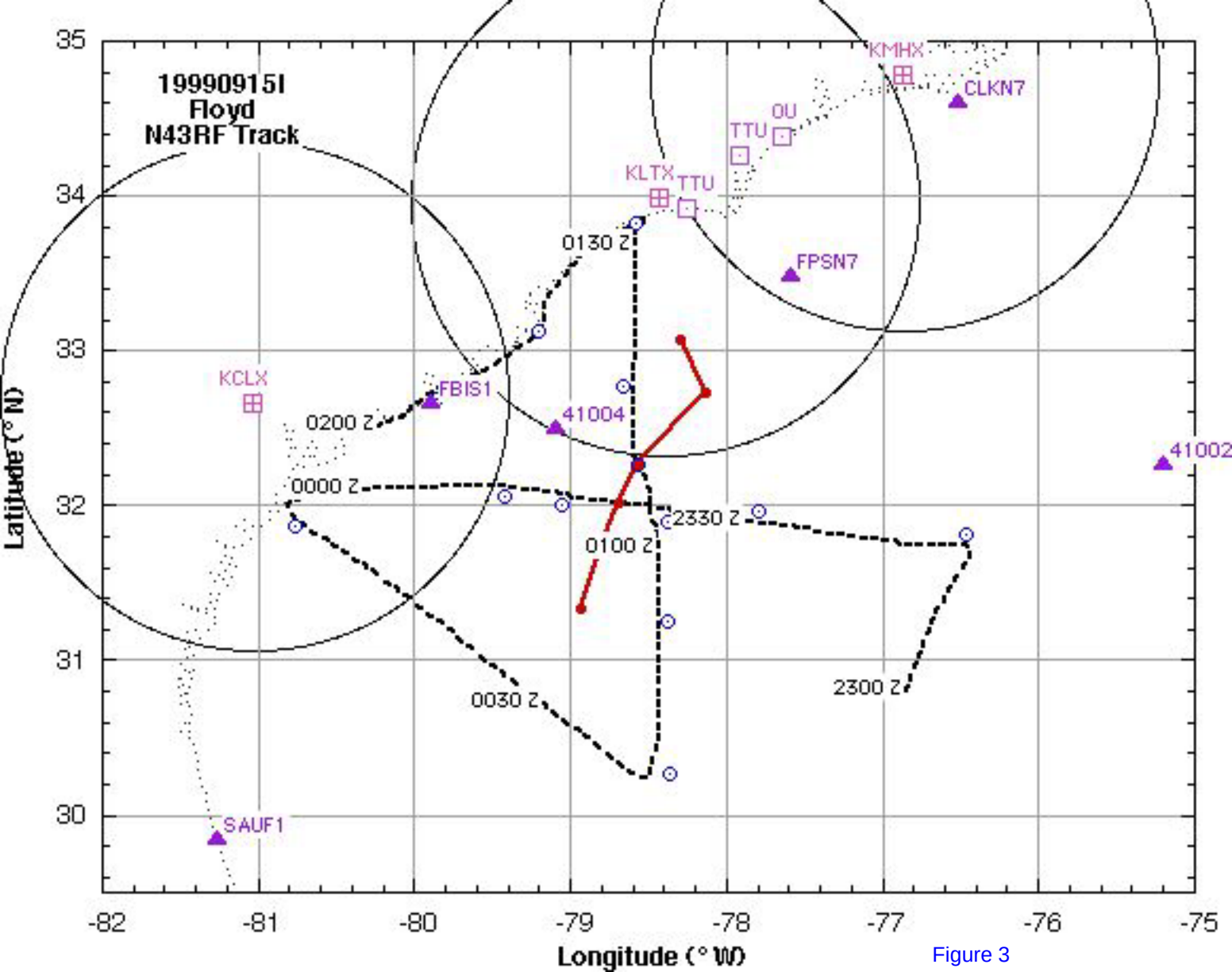
48
41
35
28
21
15 Alt 2094 m

dBZ Slat 31.48 N
Slon 78.63 W

360 X 360 km

produced by
HRD / AOC

Figure 2


19990915I
Floyd
N43RF Track
KMHX
CLKN7
OU
TTU
KLTX
TTU
0130 Z
FPSN7
KCLX
FBIS1
41004
0200 Z
41002
0000 Z
2330 Z
0100 Z
2300 Z
0030 Z
SAUF1
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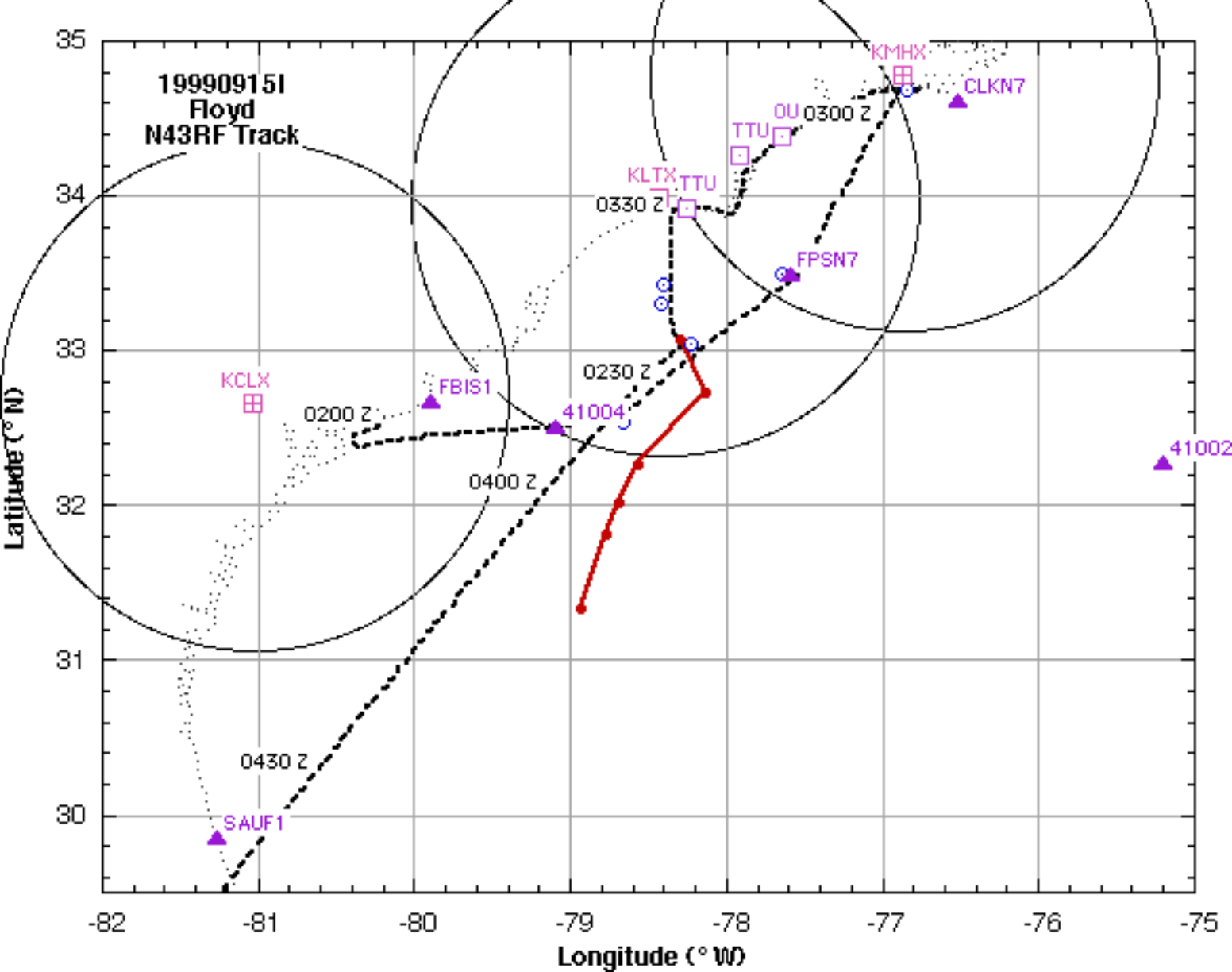
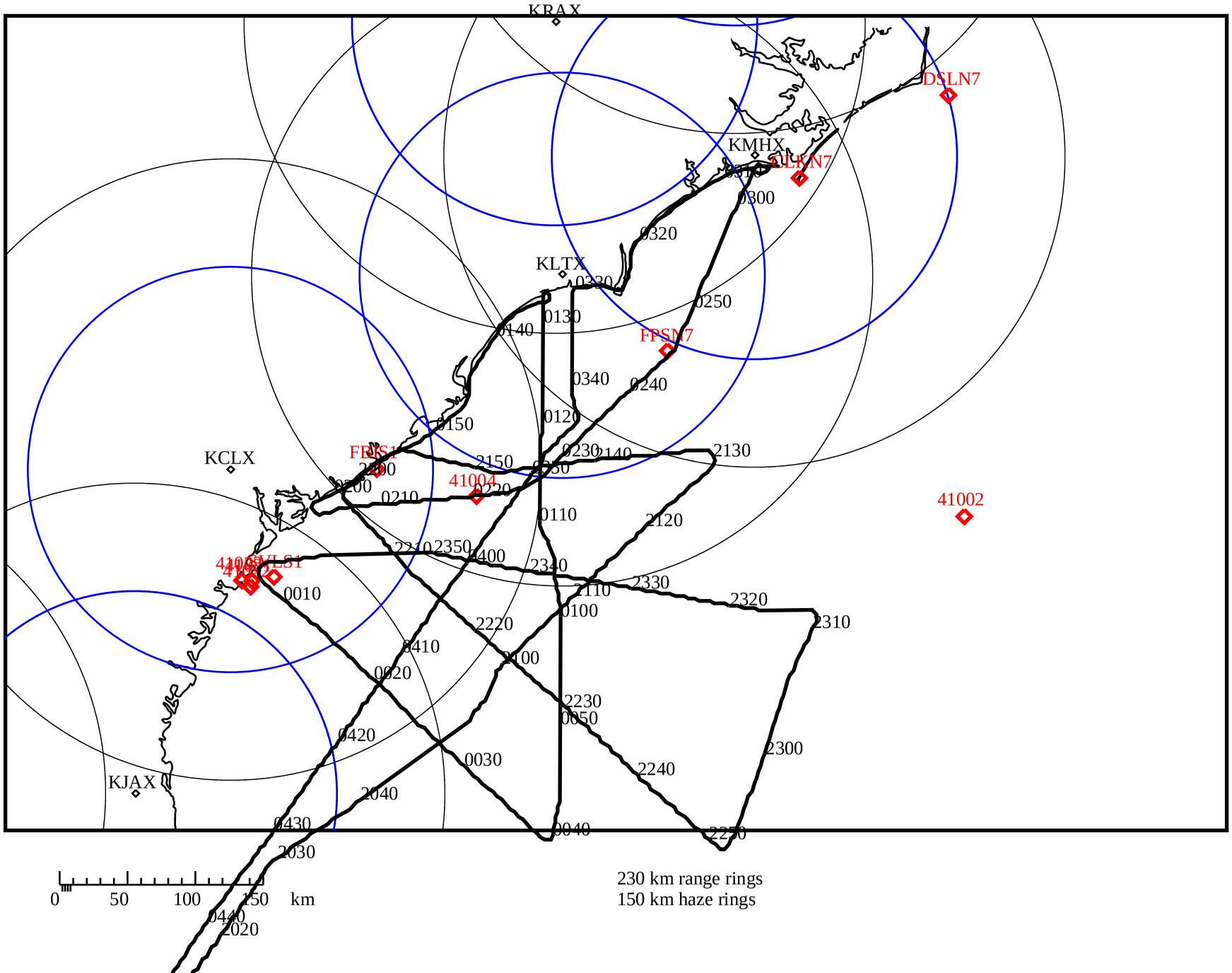
30
-82
-81
-80
-79
-78
-77
-76
-75
Latitude (° N)
Longitude (° W)

Figure 3


19990915I
Floyd
N43RF Track
KMHX
CLKN7
OU
0300 Z
TTU
KLTX
TTU
0330 Z
FPSN7
KCLX
FBIS1
0230 Z
0200 Z
41004
41002
0400 Z
0430 Z
SAUF1
35
34
33
32
31
30
-82
-81
-80
-79
-78
-77
-76
-75
Latitude (° N)
Longitude (° W)

Center Lat: 33.00 Lon: -78.00



990915i Sondes Transmitted to NHC 15-16 September 1999, Hurricane Floyd