Mission Summary
990828H Aircraft 42RF
XCDX/Air-Sea Interaction

Scientific Crew (42RF)

Lead Scientist/Radar	F. Marks
AXBT/Cloud Physics	S. Aberson
Dropsonde	C Landsea
Workstation	P. Leighton
Observers	1 from Discovery Channel

Mission Briefing:

On Saturday 28 August N42RF was tasked to do a single plane XCDX/Air-Sea Interaction experiment into Hurricane Dennis while it passed just NE of Abaco, Bahamas and just E of FL with a takeoff from Bermuda at 1730 UTC recovering at MacDill AFB around 0230 UTC. The plan called for 150 nm legs with GPS drops on the ends of the legs, 75 nm from the center, and in the eyewall on all cardinal directions. Two drops were also planned in the eye on the first and fourth (last) pass through the center and near any buoys or CMAN sites (Table 1 lists locations). We also planned to drop 3-4 dropsondes on the ferry to augment the N49RF surveillance mission. At the same time N49RF was tasked to do a synoptic surveillance mission to sample the environmental circulation surrounding Dennis with a takeoff from Bermuda at 1730 UTC and recovering at MacDill AFB in Tampa around 0230 UTC.

Mission Synopsis

We took off from Bermuda (TXKF) at 1738 UTC and landed at MacDill AFB 0225 UTC. After takeoff we climbed to 16000 ft to ferry direct SW to the IP 150 nm NE of the center. Unfortunately, as in the previous day we had ATC problems with NY Center and had to deviate due S until we reached 29°N, 69°W, then track W toward the IP. Sim shifted the surveillance drop locations to our new track to insure we covered as much of the hole in N49RF's pattern as possible. We reached the W turn point at 1853 UTC, dropped our second sonde and tracked W toward the IP. At 1918 UTC we dropped our 3rd sonde and started having AVAPS problems. Sonde 3 had no launch detect and neither did the backup sonde so we reset the data system at 1922 UTC. After that we had only minor problems with the dropsondes. As we approached the IP we noticed the storm was farther N than expected and our original IP was in a major rainband 110 nm NE of the center (Fig. 1). At 1954 UTC we started our descent to 14000 ft and turned NW along the outer edge of the big rainband (Fig. 2) to try to lengthen the first leg some. Given all of the track deviations we had so far and the proximity of strong rainbands, I didn't feel it was prudent to extend the leg to 150 nm. So at 2009 UTC we started our pattern turning to track SW roughly 115 nm NE of the center.

The first dropsonde in the pattern was at 2015 UTC, roughly 100 nm NE of the center just inside the major rainband (drop 5). This sonde had poor winds so we backed it up at 2019 UTC (drop 6). The LF radar showed a rather large eye (~55 nm diameter) with a small "hub cloud" in the N portion of the eye (Fig. 1), suggesting Dennis was completing an eyewall replacement

cycle. The strongest precipitation appeared to be N and E of the center. Because the storm was further N than expected, and our first sonde was only 100 nm out from the center, we just dropped and AXBT 75 nm NE of the center (SST 28.5°C). We dropped a sonde in the NE eyewall at 2032 UTC (7) and an eye drop at 2040 UTC (Table 2). There was no apparent SW eyewall so we proceeded to the drop 75 nm SW of the center at 2058 UTC (9). We passed very close to CMAN SPGF1 and dropped a sonde just upwind at 2105 UTC (10). We reached the point 150 nm SW of the center and dropped a sonde at 2117 UTC just 30 nm E of Ft. Lauderdale. We tracked ESE to a point 150 nm S of the center crossing a number of Cays in the Bahamas.

At 2139 UTC we dropped a sonde 150 nm S of the center (12) and turned to track N. I realized we were flying 14000 ft RA and shifted to 13500 ft PA for this leg. We dropped a sonde 75 nm S of the center at 2157 UTC (13), just S of the NW tip of Abaco Island, Bahamas. With no clear S eyewall we just proceeded through to the center at 2214 UTC. On the northbound leg from the center we dropped sondes in the N eyewall at 2226 UTC (14), 75 nm N of the center at 2231 UTC (15), and 150 nm N of the center at 2250 UTC (16). The last two were combos with AXBTs, both of which worked giving SSTs of 29.1°C and 29.2°C, respectively. We turned WSW and tracked to a point 150 nm NW of the center dropping an AXBT halfway along the downwind leg at 2300 UTC. Unfortunately, this AXBT failed as it was very close to the area of the mixed layer floats deployed by Eric D'Asaro (University of Washington) the day before.

At 2312 UTC we turned inbound 150 nm NW of the center, dropping a combo dropsonde (17) and AXBT (failed). We shifted the sonde 75 nm NW of the center to coincide with location buoy 41010, where we dropped another combo sonde (18) and AXBT (SST 29.4°C). We dropped a sonde at the W tip of what appeared as a new eyewall forming (Fig. 3) at 2341 UTC (19). Throughout the flight Jim Carswell was calling out the UMASS S'FMR surface wind estimates. So on this eyewall drop I suggested we use the S'FMR to call the eyewall drop locations based on the trend in the surface wind estimates (Fig. 4). This approach seemed to work really well on this leg. There was no SE eyewall drop, just one 75 nm SE of the center at 0002 UTC (20), just inside of the major band (Fig. 3). We reached the end of the leg 150 nm SE of the center at 0020 UTC, dropped a sonde (21) and tracked NNE to a point 150 nm E of the center in heavy stratiform rain along the outer edge of the major rainband. This leg had excellent cloud microphysics data (Fig. 5) and even some lightning.

We started our last penetration (E-W) at 0046 UTC, dropping a sonde 150 nm E of the center (22). We crossed the major rainband at 0053 UTC and the SFMR showed the surface winds peaked on the outside of the band rather than on the inside in the eyewall bands. At 0102 UTC we dropped a sonde 75 nm E of the center (23). We entered the E eyewall at 0109 UTC, experiencing some lightning and St. Elmo's Fire. We dropped the E eyewall sonde at 0110 UTC (24) and in the eye at 0120 UTC (25) with a central pressure of 970 mb. As we proceeded out of the eye it was clear that a new smaller eyewall was forming with a radius of about 40 nm (Fig. 5). Even though the last eye drop pressure was 1 mb higher than the first, it was apparent that the storm was intensifying. On the outbound leg to the W the SFMR surface wind peaked to >80 kts at 0126 UTC and we dropped the W eyewall sonde at 0127 UTC (26) which had a mean boundary layer (MBL) wind of 93 kt and a 10-m wind of 76 kt. We continued W dropping sondes 75 nm W of the center at 0137 UTC (27), and 150 nm W of the center at 0152 UTC (28). The last sonde was dropped 9 nm E of Cocoa Beach, FL.

Accomplishments

A successful mission! We filled in some drops for the surveillance coverage provided by N49RF and had a very successful XCDX mission with good GPS sonde coverage out to 150 nm from the storm center. While the AXBTs were not that successful (50%) we did manage to get some SST and MLD observations N of the storm in the vicinity of the floats deployed the day before by Eric D'Asaro from the University of Washington. Dennis was a slowly intensifying category 2 hurricane with a ~50 nm eye and a large stratiform rain area to the N of the center. It appeared that the storm had just undergone an eyewall replacement before we arrived. On our last E-W penetration we observed peak mean boundary layer (MBL) winds of 93 kt (drop 26) and 10-m winds from GPS sondes of 76 kt (drop 28) in the E and W eyewall, respectively. Despite the strengthening winds the central pressure at the beginning of the flight was 969 mb and at the end of the flight it was 970 mb.

We dropped 30 GPS sondes, 28 of which were processed and sent via ASDL. Both failed sondes (no launch detect) were at one of the surveillance drop locations and were backed up. Several others had late launch detects or no winds. We dropped 5 sondes in eyewall situations where we had good comparisons with the S'FMR surface wind estimates. Also we dropped a number of sondes close to a buoy (41010, drop 20) and a CMAN site (SPGF1, drop 12). We also dropped 6 AXBTs, 3 of which worked providing SST and mixed layer depth (MLD) estimates N of the storm. We transmitted 5 LF radar composites.

Penetrations:	4
GPS sondes:	30, 2 failed
AXBTs:	6, 3 failed

Problems:

No significant scientific problems were encountered. We had to reboot the AVAPS in the beginning of the flight after having launch detect problems with two sondes, but had no major problems afterward. GPS sondes that failed to provide winds were quickly replaced. All but two of the sondes were processed and transmitted for use in the models.

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9/18/99

Table 1. Buoy, C-MAN, and WSR-88D locations for the 19990828H Dennis flight.

Site ID	Latitude (°N)	Longitude (°W)	Location
41009	28.50	80.18	CANAVERAL
41010	28.89	78.55	CANAVERAL EAST
SPGF1	26.70	78.99	Settlement Point, GBI
FWYF1	25.59	80.10	Fowey Rocks, FL
KMLB	28.1133	80.6542	Melbourne, FL WSR-88D

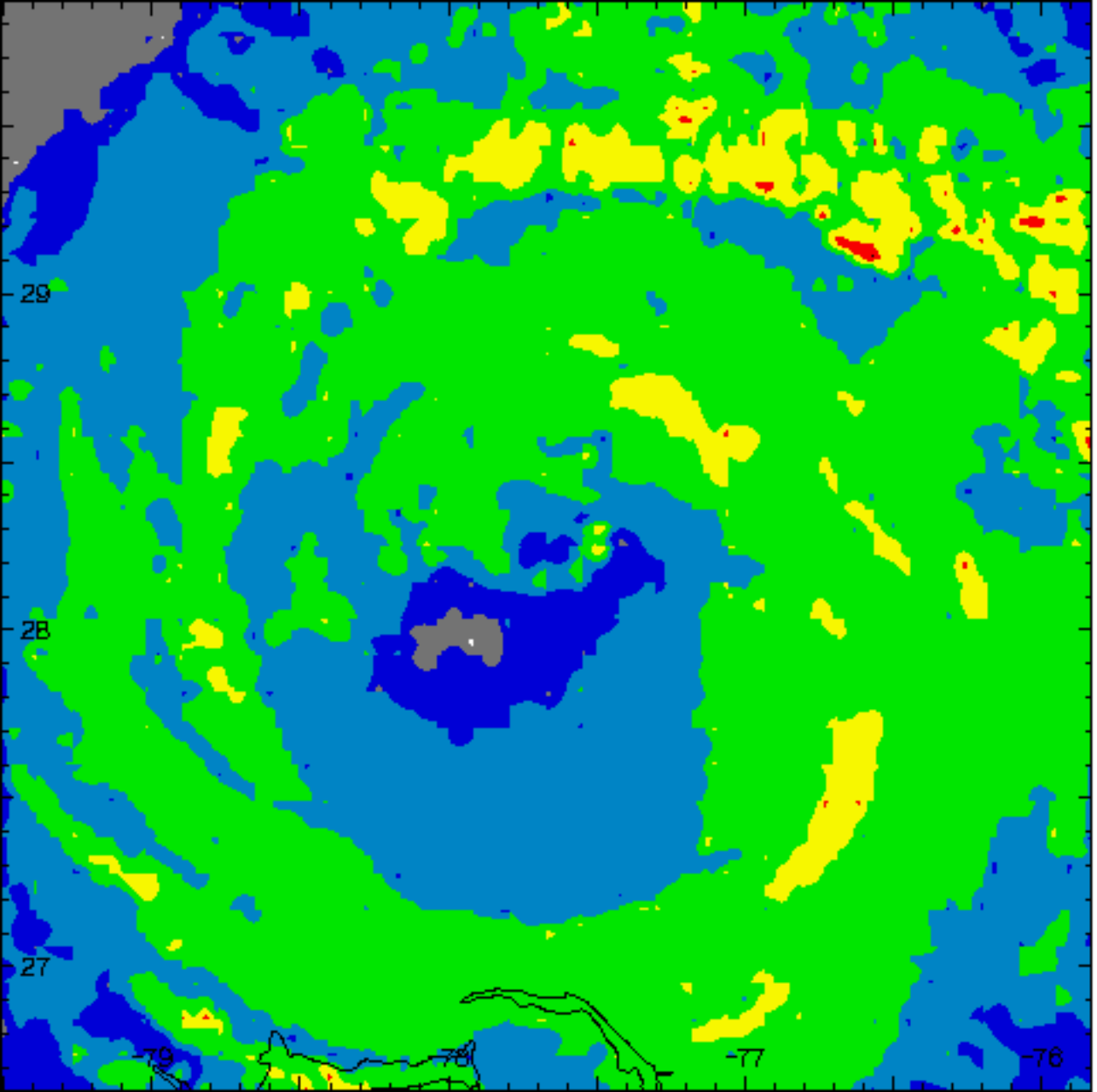
Table 2: Center fixes for Dennis from N42RF and AFRES on 28 August. Sea level pressures were provided in some eye drops.

Time (UTC)	Latitude (N) (deg min)	Longitude (W) (deg min)	Aircraft
~1900	27 53	77 33	AFRES
2040	27 57	77 37	N42RF, 969 mb
2214	28. 02	77 37	N42RF
2344	28 12	77 44	N42RF
0120	28 20	77 45	N42RF, 970 mb

Table 3: Splash locations of sondes transmitted during the 19990828H Dennis mission. Here MBL = mean boundary layer wind (fffdd; fff = wind direction in deg and dd = wind speed in kt), and LST WND = height of last wind (meters).

#	Sonde ID	Time (UTC	Lat (°N)	Lon (°W)	Comment
1	984325568	18:19:00	30.910	67.060	LST WND 010 MBL WND
2	984715328	18:52:00	29.040	69.040	LST WND 010 MBL WND
3	984325376	19:18:00	29.100	71.400	NO WINDS
4	984325309	19:21:56	29.050	71.720	no launch detect
5	984325526	19:24:18	29.033	71.850	no launch detect
6	984325504	19:44:00	29.050	73.700	LST WND 010 MBL WND
7	984325248	20:14:00	29.000	76.200	NO WINDS
8	990415424	20:19:00	29.030	76.450	LST WND 010 MBL WND
9	990415232	20:31:00	28.480	77.300	LST WND 010 MBL WND
10	990845120	20:40:00	27.930	77.610	LST WND 010 MBL WND
11	990435520	20:57:00	26.950	78.510	LST WND 010 MBL WND
12	990435520	21:05:00	26.560	78.960	LST WND 010 MBL WND
13	990845056	21:16:00	25.980	79.540	LST WND 010 MBL WND
14	990415424	21:39:00	25.470	77.580	LST WND 010 MBL WND
15	990415424	21:56:00	26.740	77.550	LST WND 010 MBL WND
16	990415360	22:26:00	28.850	77.790	LST WND 015 MBL WND
17	990845120	22:32:00	29.280	77.740	LST WND 012 MBL WND
18	990415040	22:49:00	30.540	77.820	LST WND 010 MBL WND
19	990415232	23:12:00	29.790	79.730	LST WND 010 MBL WND
20	990845056	23:31:00	28.760	78.570	LST WND 010 MBL WND
21	990845120	23:40:00	28.310	78.040	LST WND 010 MBL WND
22	990415232	00:01:00	27.370	76.700	LST WND 010 MBL WND
23	990415232	00:20:00	26.510	75.680	LST WND 010 MBL WND
24	985158016	00:45:00	28.540	75.020	LST WND 010 MBL WND
25	990435520	01:02:00	28.460	76.350	LST WND 010 MBL WND
26	990844992	01:10:00	28.480	76.980	LST WND 010 MBL WND
27	990415296	01:19:00	28.330	77.730	LST WND 010 MBL WND
28	990435456	01:27:00	28.230	78.370	LST WND 010 MBL WND
29	990415040	01:37:00	28.270	79.150	LST WND 015 MBL WND
30	990844992	01:52:00	28.250	80.410	LST WND 010 MBL WND

Note: Sondes 4 and 5 had no launch detect and were not transmitted



990828h1

DENNIS3

201711 Z to
204357 Z

Figure 1

48
41
35
28
21
15 Alt 4212 m

dBZ

Slat 28.25 N
Slon 77.67 W

360 X 360 km

produced by
HRD / AOC

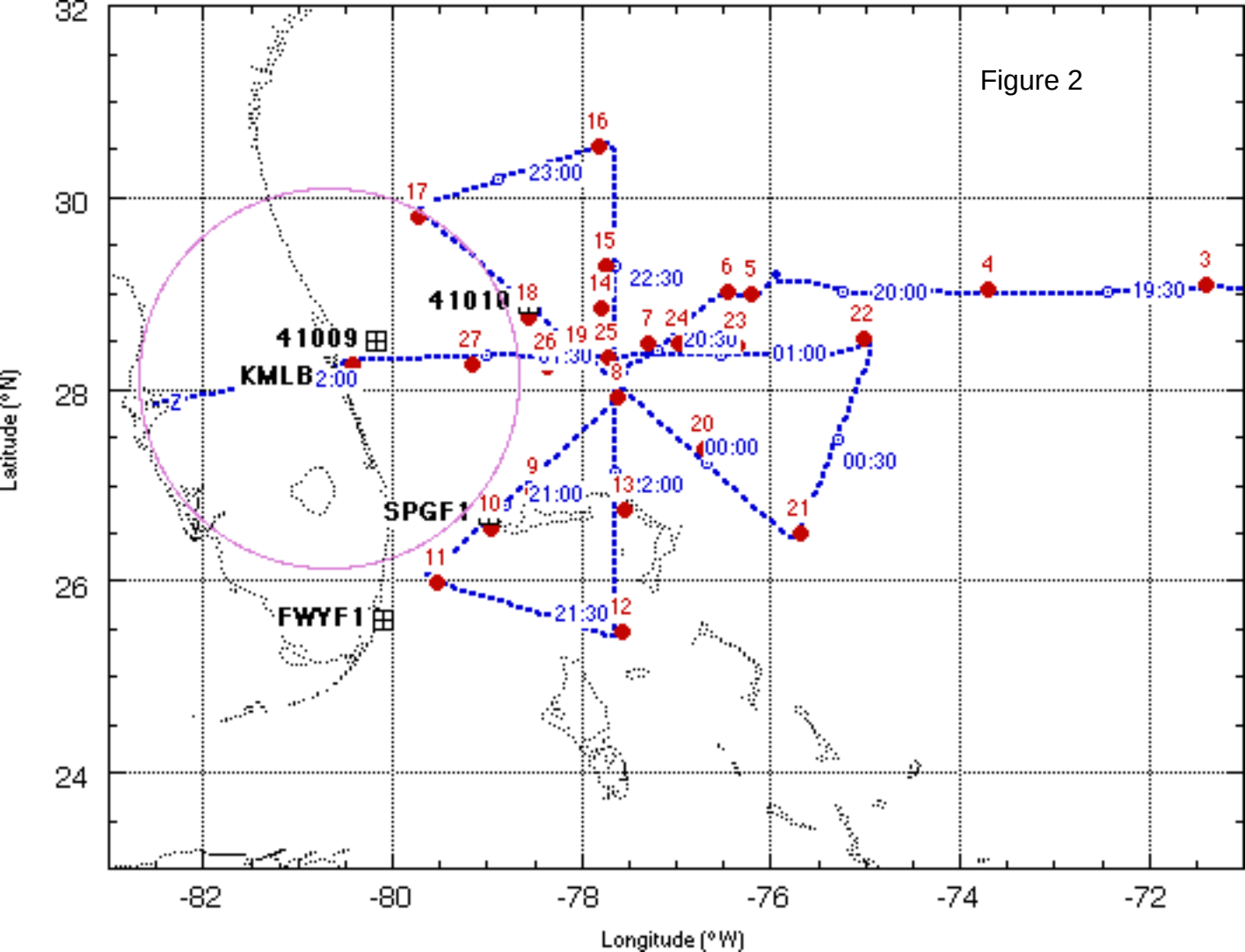
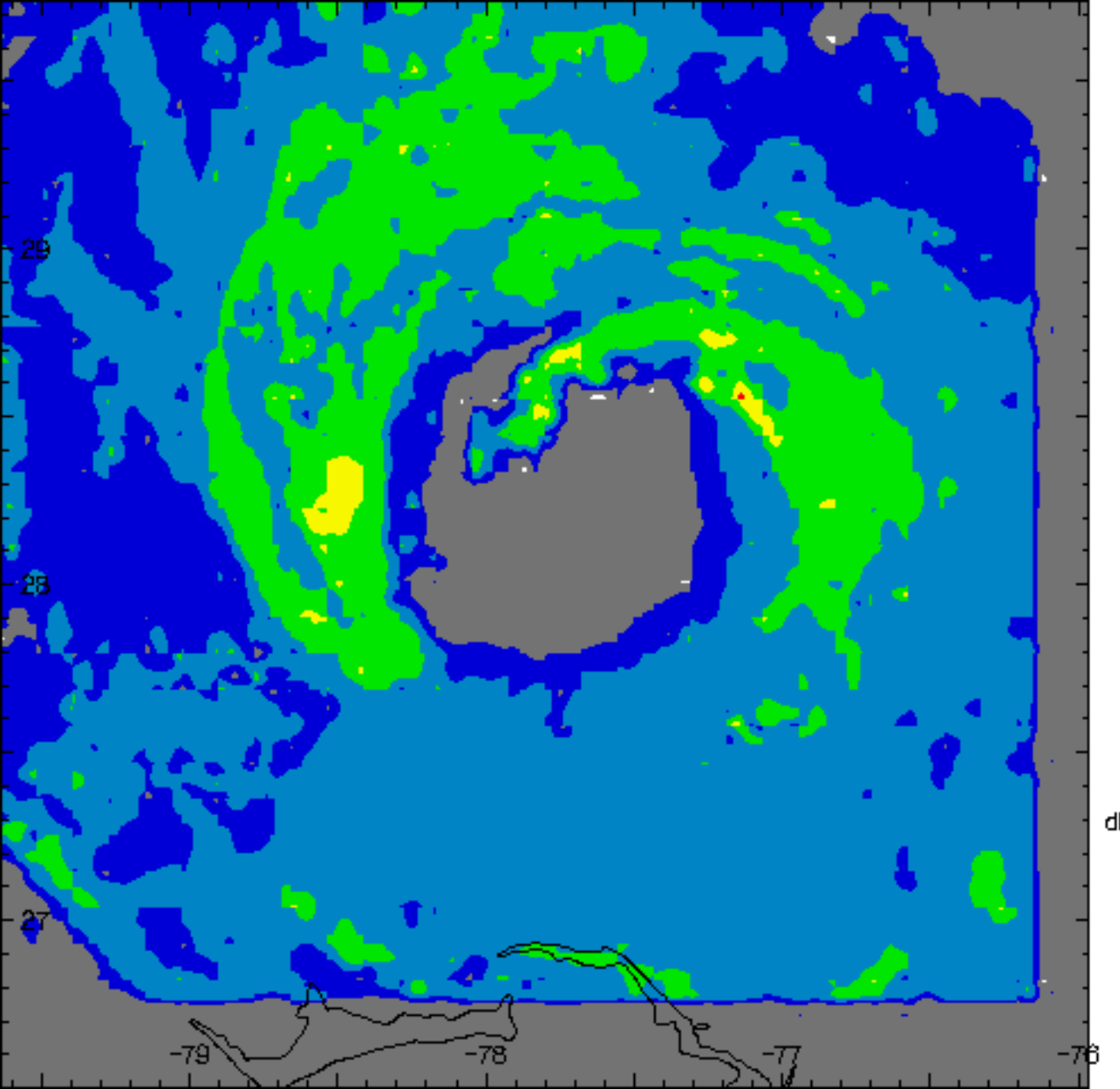


Figure 2
41010
41009
KMLB
SPGF1
FWYF1
23:00
22:30
20:00
19:30
01:00
00:00
00:30
21:00
21:30
2:00
Latitude (°N)
Longitude (°W)
32
30
28
26
24
-82
-80
-78
-76
-74
-72



990828h1

DENNIS 3

234140 Z to
234140 Z

Figure 3

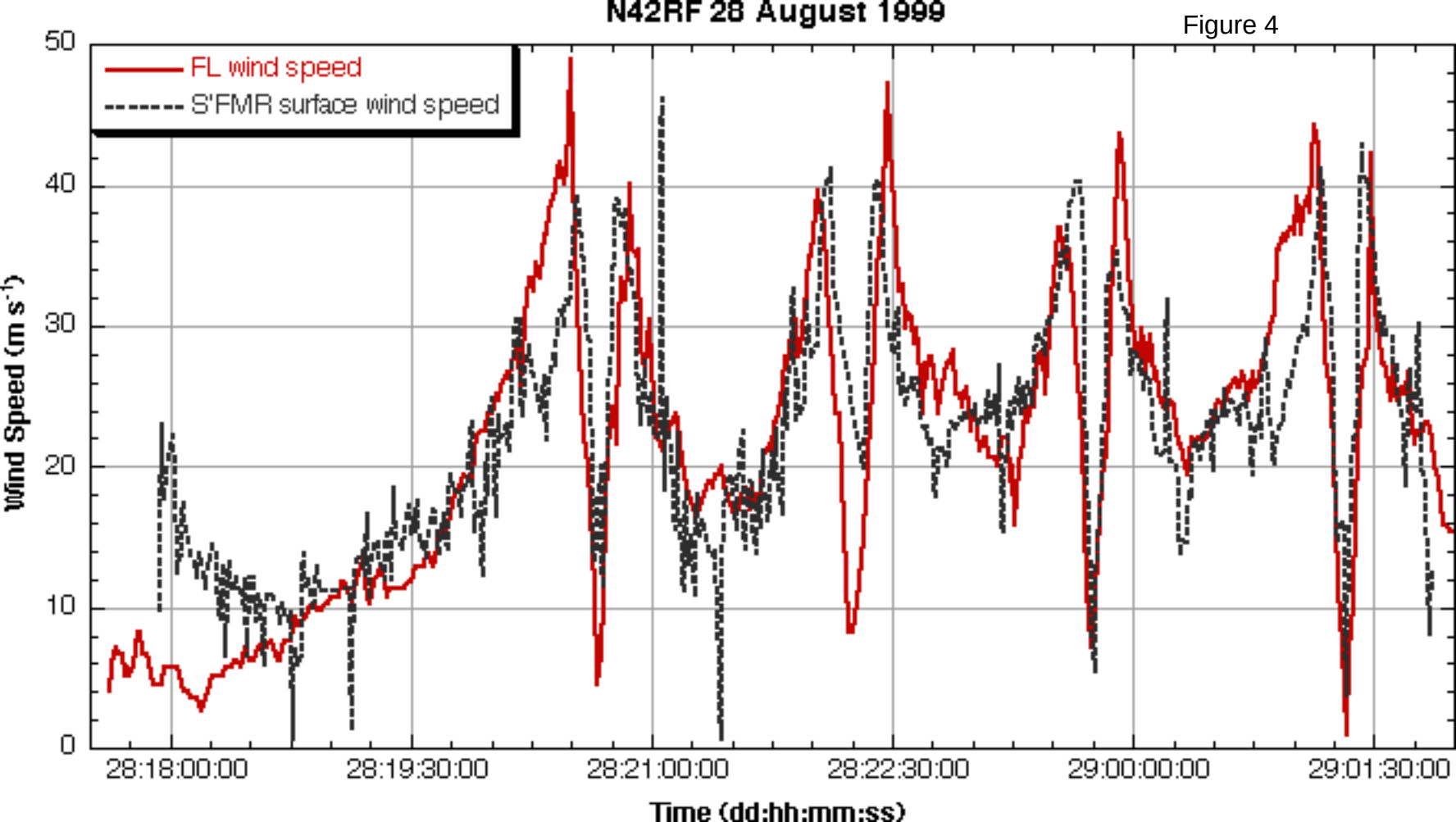
48
41
35
28
21
15 Alt 3915 m

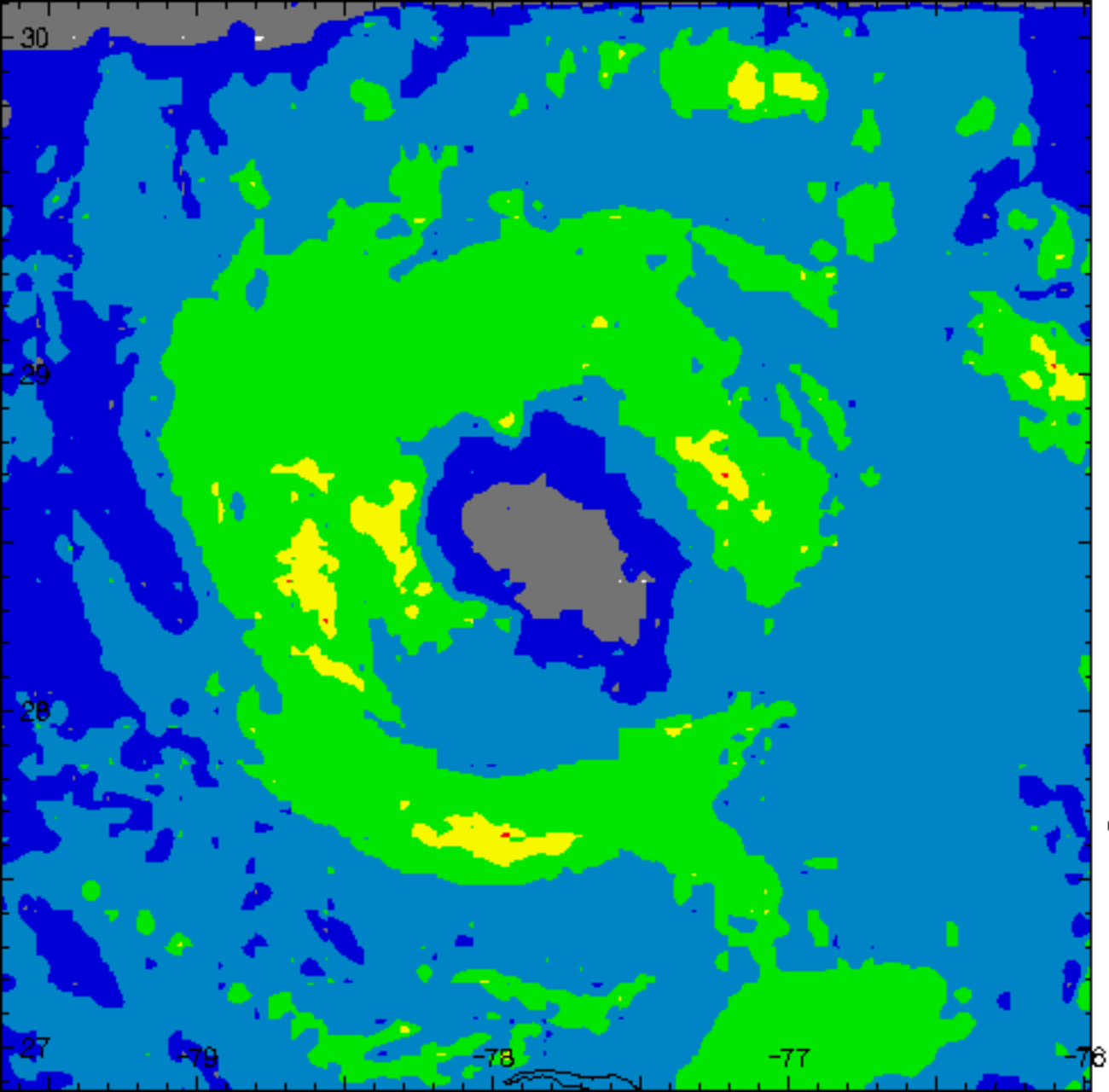
dBZ Slat 28.12 N
Slon 77.80 W

360 X 360 km

produced by
HRD / AOC

Figure 4


N42RF 28 August 1999
FL wind speed
S'FMR surface wind speed
Wind Speed (m s-1)
50
40
30
20
10
0
28:18:00:00
28:19:30:00
28:21:00:00
28:22:30:00
29:00:00:00
29:01:30:00
Time (dd:hh:mm:ss)



990828h1

DENNIS 3

250549 Z to
253038 Z

Figure 5

48
41
35
28
21
15 Alt 3920 m

dBZ Slat 28.49 N
Slon 77.82 W

360 X 360 km

produced by
HRD / AOC