Mission Summary
970718I1 Aircraft: 43RF
Hurricane Danny
First "Landfall"

Scientific Crew:		Aircraft Crew:	
Chief Scientist	Peter Dodge	Pilots	LCDR Tim O'Mara, LCDR Phil Kennedy
Doppler Scientist	John Gamache	Flight Engineer	Butch Moore
Cloud Physics	Joe Cione	Navigator:	LCDR Steve Kozak
Dropsonde Scientist	Mike Black	Flight Director:	Stan Czyzyk
Workstation:	Paul Leighton	Observer:	Jack Parrish
Observer	Paul Reasor	Engineers:	Terry Lynch, Jorge Delgado, Richard McNamara

Mission Briefing:

At 6 am EDT, 18 July 1997, we briefed the AOC flight crew for a Tropical Cyclone Windfields at Landfall research flight in Hurricane Danny, which at that time was just making landfall near Grand Isle on the coast of Louisiana. The goal of the flight was to collect flight-level, radar and GPS dropsonde data to capture the structure of the wind field in a landfalling hurricane. We were especially interested in the onshore flow because of the possible storm surge in Lake Ponchatrain and Mobile Bay.

Sam Houston suggested that we should try to drop GPS sondes near several marine surface stations to obtain boundary layer data, especially with a drop at BURL1, for onshore flow, and a drop in Breton Sound, just off the opposite shore of the peninsula, to get the modified offshore flow (see Fig. 1). Because the storm was forecast to be near or overland during the flight, we decided to operate at 14,000', where AOC agreed to fly overland through the storm. I could not provide a full flight plan for the whole flight, because of the uncertainty of storm position and strength, so I designed an initial figure 4 pattern to take us over stations 42007, GDIL1, BURL1, and a spot NE of BURL1, in the offshore flow, and then on a Doppler radial towards the New Orleans WSR-88D (KLIX). I said that after the initial pattern, we would decide how best to fly the storm for the rest of the mission. The AOC crew agreed to this flexible plan. I think it helped that both Stan Czyzyk and Jack Parrish had been on the Fran landfall mission last year.

Mission Synopsis:

We left MacDill at 1230 UTC and started recording radar at 1257[1]. By 1329 we were in the Central Dense Overcast (CDO) and we turned west near Panama City to head for Buoy 42007, our first GPS sonde drop (Figure 1 shows the flight track and locations of the sonde drops). Ten minutes later we were in heavy rain where we experienced at least one electric discharge and an updraft of 15 m s^{-1} followed by a 6 m s^{-1} downdraft. We descended to 14, 000' after that. At 1354 the LF radar died. Terry Lynch changed the R/T and had the system back up by 1409, about three minutes before we entered the eye. We dropped our first sonde at 1404, quite near 42007. Stan Czyzyk fixed the center at 1414. (See Table 1 for Stan's center positions). The eye was small, a closed circle of echo > 25 dBZ, but there did not appear to be much deep convection (Figure 2). The SW eyewall had flight-level winds ~ 60 kts, and this region was usually where we had our maximum flight-level winds during our flight.

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[1] all times are UTC.

At 1423 we dropped our second sonde near GDIL1. Unfortunately the workstation crashed at 1427, while this sonde was in the air. Soon after we were in clear air, and there was a beautiful CB that may show up in the nose video at about 1436; it looked almost like an isolated chunk of eyewall. The workstation was back up by then, but there continued to be problems getting the sonde data to the workstation. (Table 2 lists all the drops.). We turned back E and then NE to drop near BURL1. The idea was to drop two sondes quickly, one on either side of the peninsula. The BURL1 drop went OK but the next sonde (#4) was late, about 30 km NE of the coast. Our second center fix was at 1512 and we continued on to KLIX, where we turned and headed back to the center for our third fix at 1538. The NW eyewall had winds ~55 kts. The TA Doppler data from the two KLIX radials should give us excellent dual-Doppler analyses when combined with the KLIX 88D Level II data.

Joe Cione thought a drop near buoy 42040, ~ 100 km SE of the storm center, would be interesting for the air-sea interaction further away from land, so we planned a segment to drop near the buoy, then up towards the Mobile 88D (KMOB), then back SW to hit the center again and then repeat the BURL1 onshore/offshore drops. The 42040 sonde was no good though, so another was dropped at 1601 UTC, ~90 km S of Mobile and ~90 km E of Danny. This sonde was OK, with winds below 725 mb. This pass north took us between the eyewall and the next rainband to the east. After passing near Mobile at 1612, we passed through the center at 1630. The storm was now moving more east than north. The NE eyewall seemed to be composed of 3 or 4 thin rainbands. The SW eyewall had sustained winds of 63 kts at flight level on this pass. We turned after emerging from the CDO and repeated the offshore drop at BURL1 at 1651 and the offshore drop on the opposite coast at 1657. Unfortunately the winds were bad on both these sondes. The thermodynamic data were good, so we still obtained data that could help describe differences in onshore and offshore boundary layers.

After passing through the center again at 1704, we decided to simplify the patterns by flying a couple of triangles: the SW-NE leg would pass east of the center, ending near Mobile Bay, followed by a leg west to KLIX, and finishing with a NW-SE pass through the center. The next center fix was at 1753. John noted that the eyewall now had a squashed look to it, with heaviest reflectivity on the SW side. There were sustained flight-level winds of 64 kts in the SE eyewall. After turning west of the mouth of Mobile Bay, we dropped our ninth sonde near the Dauphin Island C-MAN station (DPIA1); this sonde had good winds.

We hit the center for the seventh time at 1850. Stan noted that the estimated minimum sea-level pressure had fallen ~1 mb to 987 mb. The stratiform precipitation in the rainbands seemed to be getting heavier and there was stronger reflectivity in the southern eyewall that rotated from the SW to the SE side, similar to what we have seen in much stronger hurricanes. John reminded me that we wanted to finish with another figure 4, so we decided that we would turn at Mobile Bay and head back for the center, instead of KLIX. Mike wanted some vertical incidence data, so we took the tail radar out of F/AST mode at 1914 as we headed SW to the center. Mike and Joe suggested that we do a drop in the eye and just outside the eyewall. The tenth drop at 1927 was our eye drop, with a splash pressure of 987 mb. The next drop at 1932 was no good. After completing the SW leg we turned NW of BURL1, tracked east until we were south of Danny, and then headed north towards Biloxi. The last sonde went out at 1954, south of the eyewall; the data were good and revealed a wind speed maximum of ~36 m s^{-1} only 200 m above the surface. Our last center fix was at 1958 (Figure 3), and we had a beautiful view of the surf hitting the beaches in the Chandeleur Islands. The last pass finished at 2006. We then turned and headed east along the coast. At 2010 we changed altitude to 13,000. We passed just north of Dauphin Island at 2019, when I noted some decent cells south of us. We landed back in Tampa at 2141 UTC.

Evaluation:

The flight went very well. Although the overland portions required us to stay at 14,000', which did not allow the flight-level data to be used for real-time analyses, the Doppler data should greatly help in the reconstruction of the three-dimensional wind fields. The dropsondes should

provide details of the changes in boundary layer structure as the wind flowed over the peninsula into Breton Sound Figure 4 shows one of the 25 real-time surface wind analyses that were provided to the forecasters at NHC for use as guidance in their advisories and forecasts of Danny's surface wind field. It will be interesting to see how the structure changes when winds from the Doppler analyses and sondes are added to the brew.

We now have two data sets collected over land in weak hurricanes. I still think we must be very cautious about flying in stronger hurricanes overland. It is difficult to interpret the LF display when at 14,000' because strong echo can be caused either by convection or bright band echo. The Dopplerized nose radar may help in discriminating the nasty places from the merely bumpy.

Acknowledgments:

The AOC crew were fantastic. Stan Czyzyk and Steve Kozak were agreeable to every change in the flight patterns that we requested. Jack Parrish gave us several useful suggestions during the flight. Terry Lynch did a great job keeping the radar running, and Jorge Delgado and Richard McNamara managed to keep with our evolving plans for GPS sonde drops. Paul Leighton worked hard to keep the workstation going, to send back LF composites. I hit a mental slump about 3/4 of the way through the flight and fresh ideas from Mike Black, Joe Cione and John Gamache helped decide what we did in the last hour in the storm. Sam Houston's analyses and comments helped set up the first part of the flight for the briefing, and his comments after the flight helped us understand a little bit better what we had just flown through! Frank Marks and Hugh Willoughby helped plan the flight, and reminded us to be careful on this first hurricane flight of the 97 season.

Problems:

The workstation crashed and it took Paul quite a long time to get the GPS software to recover. We did not lose sonde data, because we copied it from the AVAPS system to floppies, but we were not able to send back may sonde messages in real time. The DAT drive died on the PMS system, and the hard drive filled up after 15 minutes, so we did not collect a lot of cloud physics data. The HRD GPS bag did not have floppies for AVAPS backups, so we had to borrow AOC's. Terry had to switch the LF R/T early in the pattern. Towards the end of the flight the background color of TA display turned orange and the menu captions disappeared, but this should have no effect on the data.

The workstation and cloud physics seats share one headset, so Paul felt a bit out of it without a headset. I was remiss in keeping Paul aware of what we were planning next. I also should have asked the radar operators to make sure that they noted each turn (and we had a lot of those) so that they could help Paul decide when to start and stop the LF composites and EVTD legs. I also failed to arrange who we would contact when we landed, so that Howie was left in the dark because I talked to Sam, Hugh, and Frank instead.

Peter Dodge

Table 1. Centers determined by AOC Flight Director and Navigator

Time (UTC)	Lat.	Long.	Comments
1414	29.60°	89.30°	Fix at wind shift
1512	29.65°	89.27°	
1538	29.67°	89.23°	
1631	29.67°	89.18°	
1704	29.62°	89.13°	within 1' of Air Force fix at 1500'
1753	29.63°	88.98°	
1850	29.68°	88.90°	
1928	29.72°	88.80°	
1959	29.75°	88.77°	

Table 2. GPS Sondes in Hurricane Danny, 18 July 1997

#	Sonde File	Time (UTC)	Latitude	Longitude	Comments
1	g621532402.avp	140515	30.065°	-88.807°	good
2	g385400137.avp	142326	29.247°	-89.959°	good
3	g970150300.avp	145826	28.890°	-89.459°	good
4	g970150236.avp	150733	29.438°	-88.974°	**no winds**
5	g970150298.avp	155340	29.217°	-88.283°	**no winds**
6	g970150275.avp	160126	29.829°	-88.410°	good winds below 725 mb
7	g625432702.avp	165103	28.848°	-89.460°	**no winds**
8	g965120026.avp	165801	29.280°	-89.043°	**no winds**
9	g385400027.avp	181719	30.324°	-88.214°	good
10	g624233305.avp	192736	29.713°	-88.812°	good, Eye Drop
11	g970150244.avp	193159	29.480°	-89.049°	only pressure, relative humidity
12	g970440005.avp	195450	29.466°	-88.879°	good, has wind max at 200 m.

- AOC Sonde Techs: Richard McNamara, and Jorge Delgado
- Launch time, lat. and long. were obtained from the comments of each *.avp file In this list the time and position for sonde # 5 were adjusted. The position in the launch comments was off by ~0.5°, and the launch time was early by ~6 minutes.

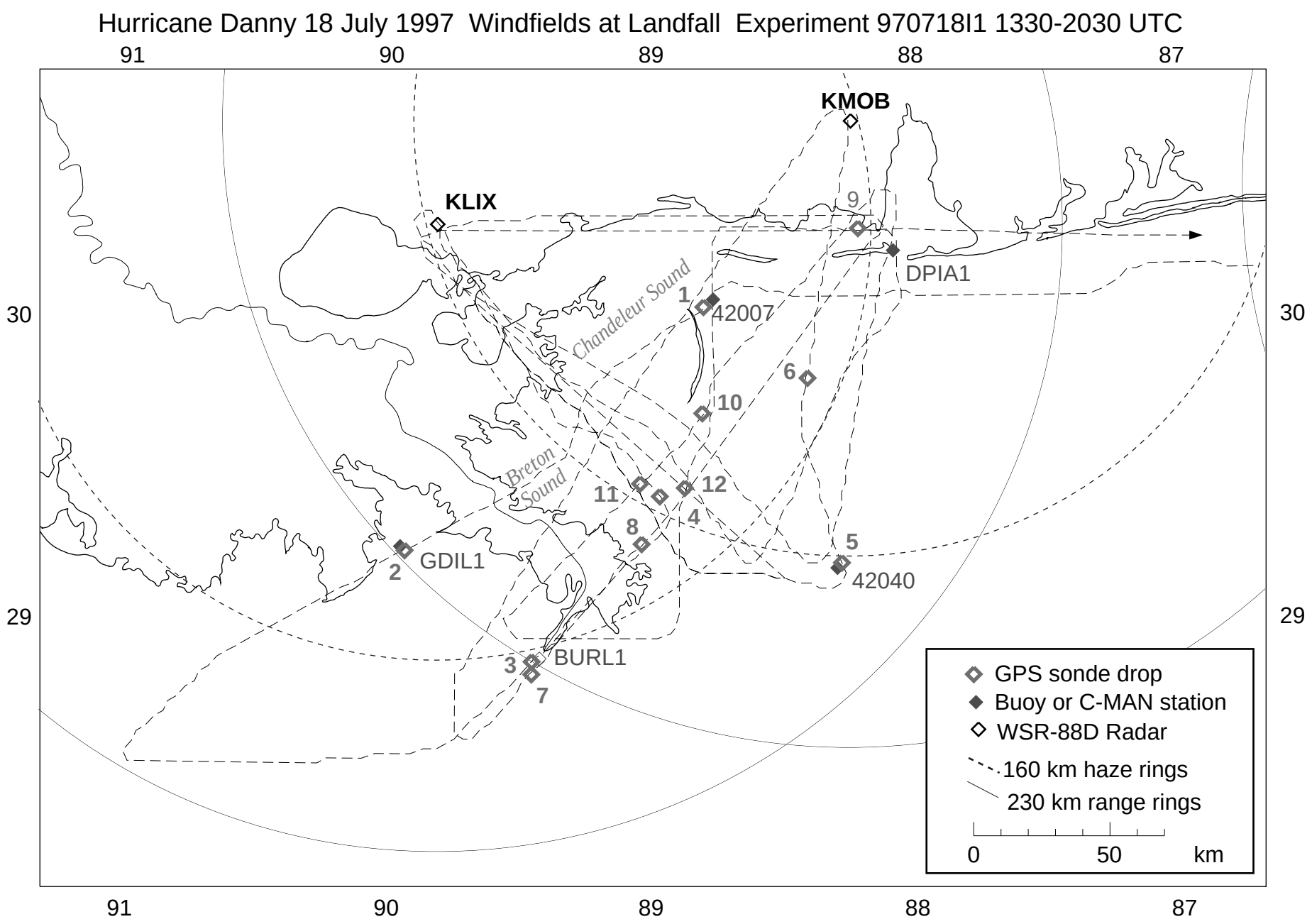
Figures:

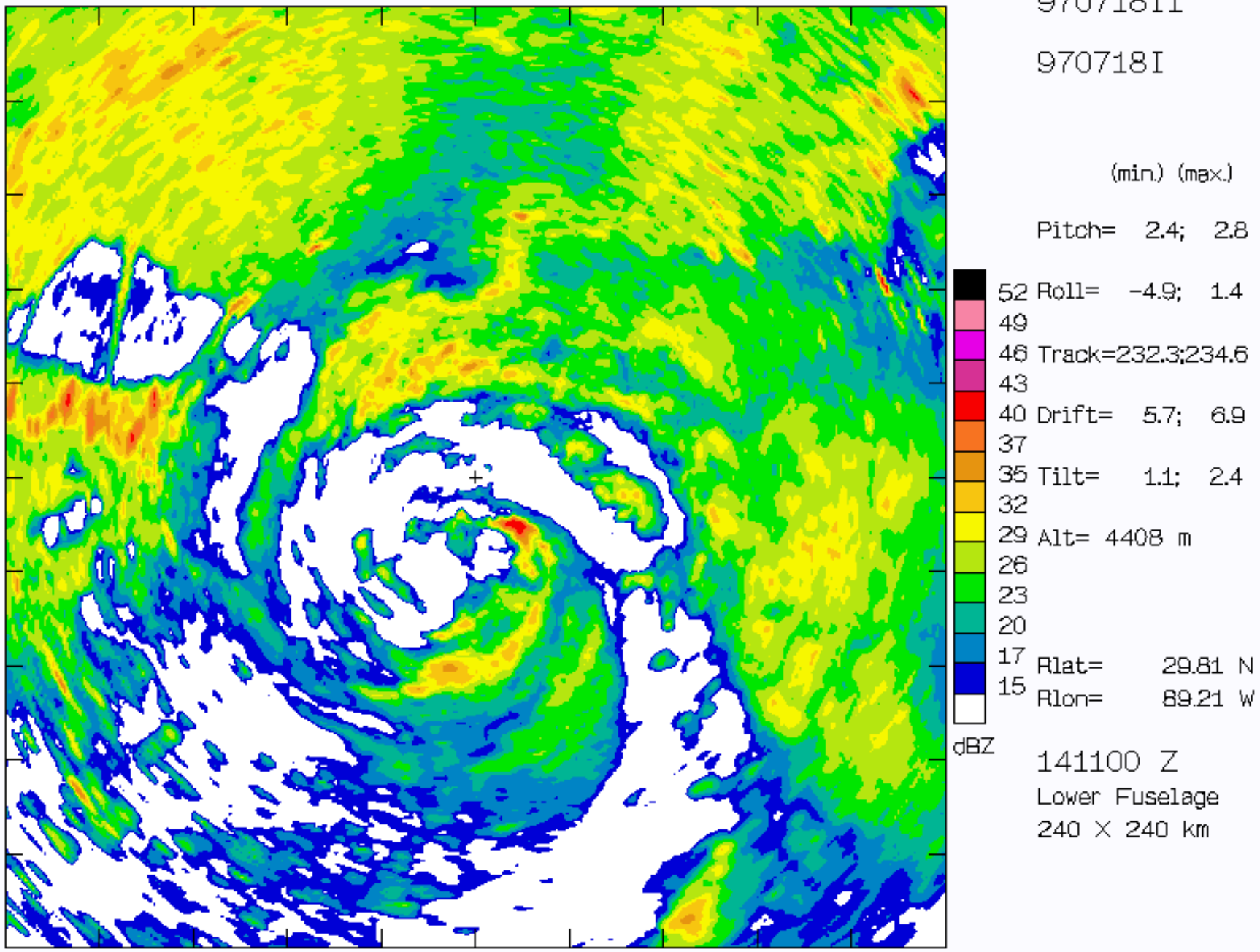
Figure 1. Map showing flight track and GPS sonde drops. {/hrd/dat/danny_flt_map.ps}

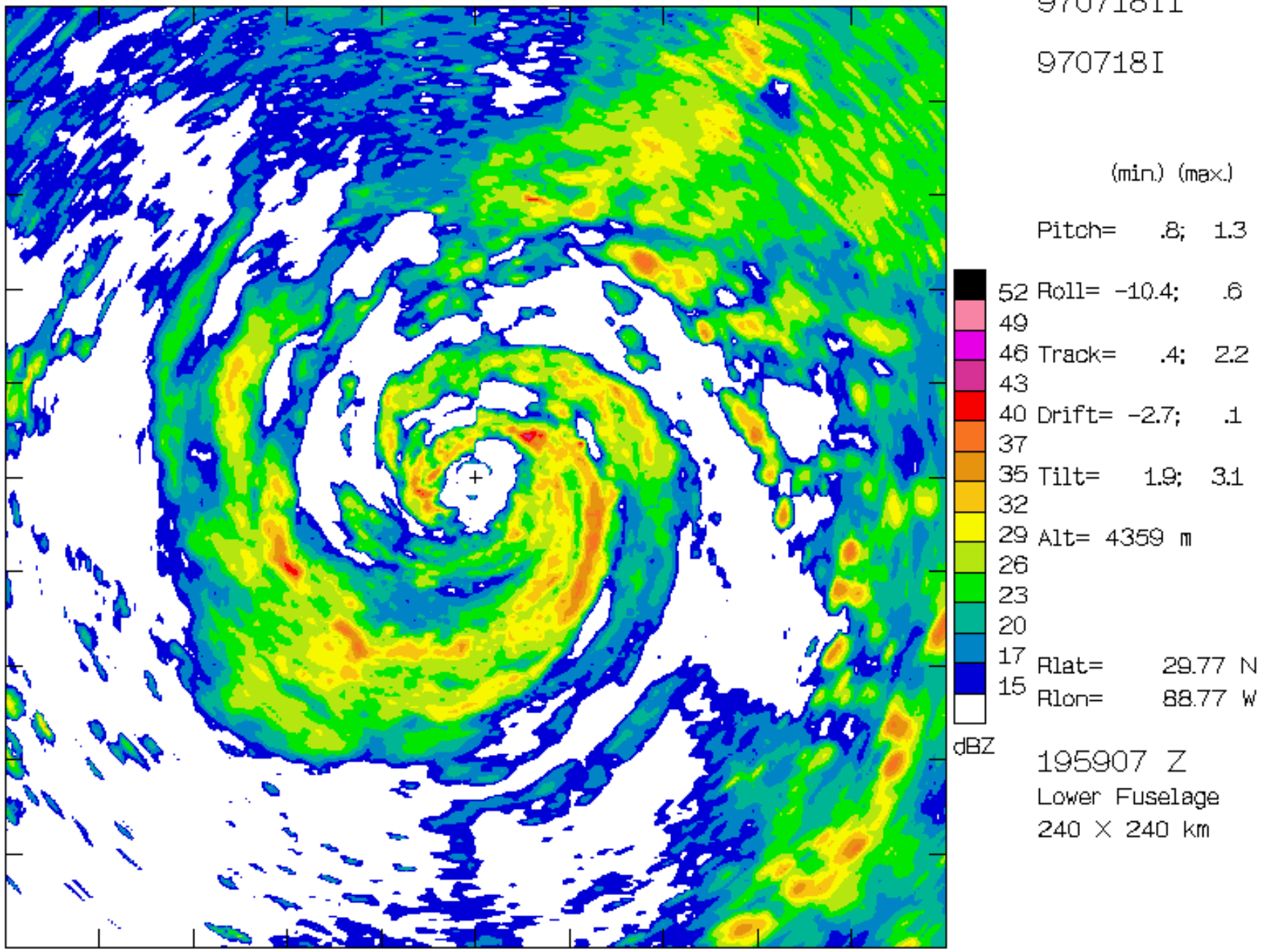
Figure 2. Single sweep from LF radar at 1411 UTC, the first time through the center. {/hrd/dat/danny/dan_lf_1411.ps}

Figure 3. Single sweep from LF radar at 1959 UTC, our last pass through the storm. {hrd/dat/danny/dan_lf_1959.ps}

Figure 4. HRD's real-time surface wind analysis showing streamlines and isotachs (contoured in 5 kt intervals) for Hurricane Danny at 1630 18 July 1977. {/hrd/dat/danny/msus_0718_1630.ps}


Hurricane Danny 18 July 1997 Windfields at Landfall Experiment 970718I1 1330-2030 UTC
91
90
89
88
87
30
29
KMOB
KLIX
9
DPIA1
1
42007
Chandeleur Sound
6
10
Breton Sound
11
12
4
8
5
42040
2
GDIL1
3
BURL1
7
GPS sonde drop
Buoy or C-MAN station
WSR-88D Radar
160 km haze rings
230 km range rings
0
50
km


970718I1
970718I
(min.) (max.)
Pitch= 2.4; 2.8
Roll= -4.9; 1.4
Track=232.3;234.6
Drift= 5.7; 6.9
Tilt= 1.1; 2.4
Alt= 4408 m
52
49
46
43
40
37
35
32
29
26
23
20
17
15
dBZ
Rlat= 29.81 N
Rlon= 89.21 W
141100 Z
Lower Fuselage
240 X 240 km

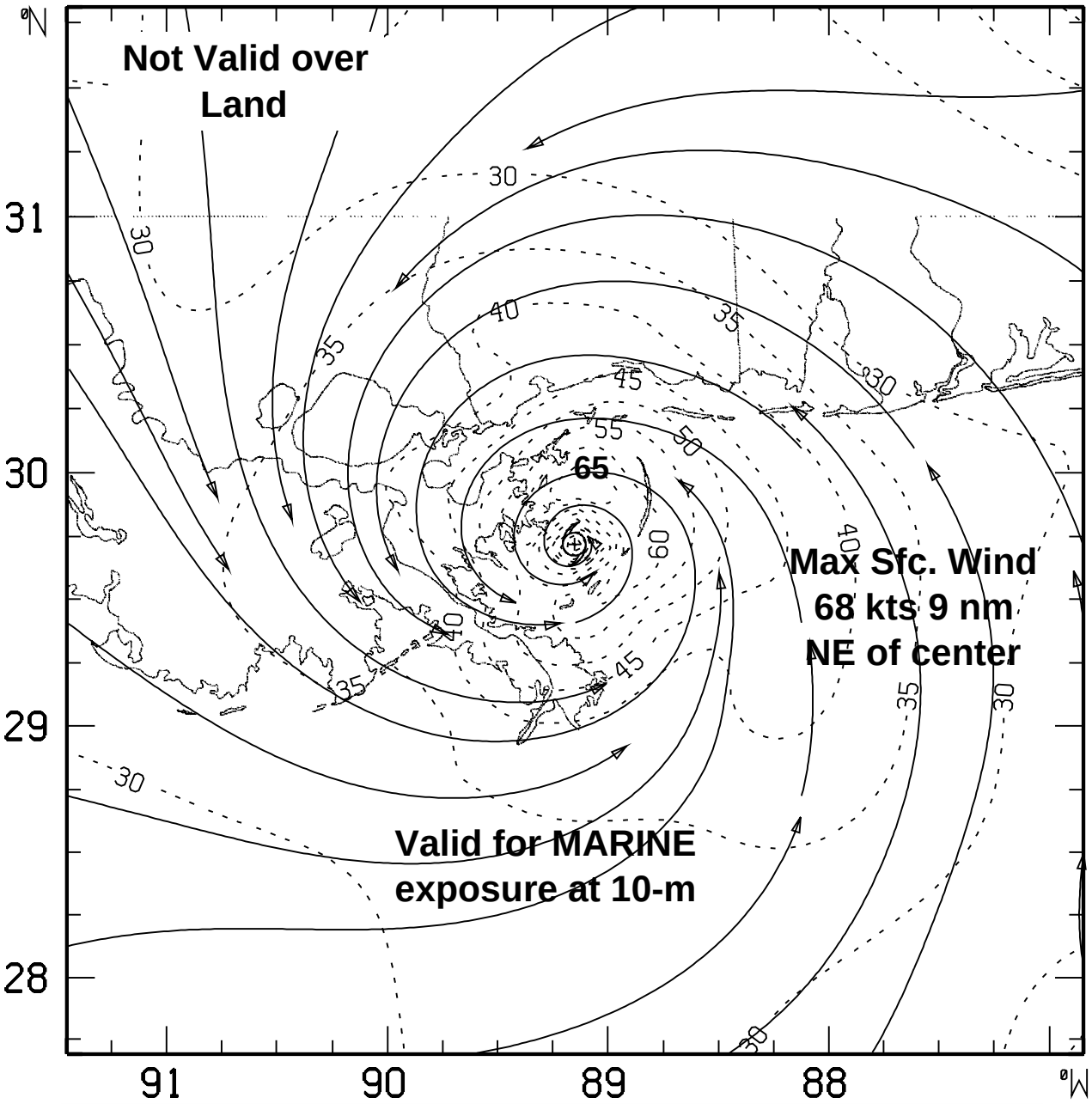

970718I1
970718I
(min.) (max.)
Pitch= .8; 1.3
Roll= -10.4; .6
Track= .4; 2.2
Drift= -2.7; .1
Tilt= 1.9; 3.1
Alt= 4359 m
52
49
46
43
40
37
35
32
29
26
23
20
17
15
dBZ
Rlat= 29.77 N
Rlon= 88.77 W
195907 Z
Lower Fuselage
240 X 240 km

Attention: Hurricane Specialists

Hurricane Danny 1630 UTC, 18 July

Max sustained surface winds (kts) for marine exposure

Analysis based on AFRES C-130 Recon data from 950 mb adjusted to the sfc from 1248-1550;
Ships, NOAA C-MAN, NOAA Buoys, from 1300-1500 UTC, CIMMS GOES 8 for 1300 UTC
1630 UTC position extrapolated from 1452 fix using 055 deg at 4 kt



Experimental research product of :

NOAA / AOML / Hurricane Research Division