Mission Summary
Hurricane Erin
20010910H Aircraft: N42RF

Scientific Crew:

Lead Project Scientist	Frank Marks
Radar Scientist	Jason Dunion
Workstation Scientist	Paul Leighton
GPS-sonde Scientist	Sim Aberson
CCN scientist	Jim Hudson (DRI)
SFMR Scientist	Alex Zhang (UMASS)

Aircraft Crew:

Pilots	Tennesen, Taggert
Flight Engineer	Bast
Navigators	Newman
Flight Director	Shepherd
Engineers	McMillan, Delgado, Carpenter, Rogers
Others	McFadden

MISSION BRIEF:

HRD scheduled a synoptic surveillance mission into Hurricane Erin with N42RF and the NASA DC-8 and ER-2 aircraft for 10 September 2001. N42RF would take off at 1400 UTC from MacDill AFB and recover in Providence, Rhode Island. The NASA aircraft would take off at the same time from Jacksonville. N42RF and the ER-2 would do a coordinated pattern in the core of Erin, while the DC-8 would fly a star pattern around the storm at radii between 180 and 240 nm from the center. The ER-2 would fly a butterfly pattern with six 120 nm radial legs from the center. N42RF would do a figure-4 pattern with 60 nm radius legs and then complete a surveillance pattern out to 240 nm east and north of the storm before recovering in Providence (see Fig. 1). N42RF would try to do a coordinated west-east leg with the ER-2's final east-west leg attempting to underfly the ER-2 track. The ER-2 would drop GPS-sondes in the eye and at the end points of each of the six radial legs. N42RF would drop GPS-sondes at the end points of each leg, in the eyewall, in the center within the storm, and at eight points in the surveillance pattern.

MISSION SYNOPSIS:

N42RF departed MacDill AFB at 1418 UTC, passing through bands of convection as we transited over Florida and just off the east coast of Florida. Along our transit to the storm we realized we would pass over the southern portion of an upper level disturbance so we decided to drop three GPS-sondes, spaced roughly 2° of longitude apart along our track. Just before we got to the third drop the radar system went down. Sean McMillan restarted it and it worked fine the rest of the flight. At 1648 UTC, between the second and third drop, we monitored the ER-2 communicating with the DC-8 as the ER-2 started its first penetration. At 1729 UTC, the third drop (34°N, 68°W), we were about 175 nm from the storm and just northwest of Bermuda (see

Fig. 2). We were able to get a good radar fix on the center. We heard the ER-2 lining up his second penetrations as we were approaching our IP. We realized the center he was heading for was slightly different than our radar fix and Carl Newman passed our radar fix up to the ER-2 pilot. We were approaching our IP at 19,000 ft after deviating 10 nm south of our intended IP to stay out of a rainband. We decided to descend to 14,000 ft for the figure-4 in the core to avoid lightning.

After dropping a GPS-sonde at the IP from 19,000 ft we descended and started the first coordinated pass, the ER-2 tracking 150° through the eye from the NNW, while we tracked 360° from our IP 70 nm south of the center. We dropped a GPS-sonde in the south eyewall, which was very narrow, at 1815 UTC using the SFMR surface wind peak to locate the drop. The ER-2 passed through the eye 3-4 minutes ahead of us and dropped a GPS-sonde. We fixed the center at 1819 UTC and circled in the eye, which was about 27 nm wide, dropping a GPS-sonde in the center at 1824 UTC. The west side was nearly vertical with a fishbowl appearance, while the east side had a stadium appearance with a large tilt from the vertical. The cloud tops did not seem that high (12-13 km on the tail radar). We dropped another GPS-sonde in the north eyewall at 1828 UTC when the SFMR surface wind peaked at 81 kt. (about 1 minute before the flight level wind peaked at 75 kt). The GPS-sonde had a 10-m wind of 87 kt after peaking above 100 kt during the descent. We reached our turn point at 1830 UTC, 60 nm north of the center. As we passed the ER-2 on that leg we started trying to coordinate the timing of our second leg with the ER-2's final leg.

We tracked southwest to a point 60 nm west of the center. It was apparent that a large intense rainband was at that point so we picked our way through intense cores, dropping a GPS-sonde in the band which had a peak in the SFMR surface winds. Carl Newman talked to the ER-2 and found he was a little slower than expected so we loitered briefly to insure we started the leg together. Carl passed the ER-2 our expected center location on the pass. We turned around and passed through the band again on our way back to the eye, once again dropping a GPS-sonde in the heavy rain and strong surface winds. We dropped another GPS-sonde in the west eyewall at 1916 UTC and fixed the center at 1919 UTC at 35.8 N, 65.4 W. There were two low-level swirls at the surface (see Fig. 3), one tucked up against the west eyewall and the other in the center of the eye. We found our wind center near the western swirl and dropped a GPS-sonde there at 1923 UTC. Jim Hudson also stated that the eye was extremely dirty, with CCN concentrations of 2000 l^{-1}, much higher than he had seen in Chantal or Oliver in 1992. We turned and tracked east through the eyewall as the ER-2 came overhead. We had a good visual on the ER-2 and Carl vectored him to our fix location for his final eye drop (a beauty! Fig. 4). We dropped a GPS-sonde in the east eyewall at 1928 UTC at the location of the SFMR surface wind peak, 1.2 minutes before the flight level wind peak. We reached our point 60 nm east of the center at 1939 UTC, dropped a GPS-sonde and climbed to 19,000 ft to complete our surveillance pattern 4° east and north of the center (see Fig. 2).

Penetrations: 2
Expendables: 19 GPS-sondes/ 1 bad (the last one didn't open a chute)
4 video tapes, 1 flight level DAT, 1 radar DAT and 1 Cloud Physics DAT

SUMMARY

A very good mission! Good coordination with the ER-2 by the N42RF crew (primarily Carl Newman and Tom Shepherd). We completed the pattern as briefed with a few wrinkles to maintain coordination with the ER-2 and flight safety. On the first inbound leg from the south we moved the IP 10 nm further from the center to stay outside the rainband at 19,000 ft and avoid any static discharge. We descended to 14,000 ft after we dropped the GPS-sonde and maintained that altitude throughout the figure-4. We did a figure-8 in the eye on our first fix to adjust our timing to maintain coordination with the ER-2 and get a good eye fix and GPS-sonde. We descended to 13,000 ft in the large rainband 60 nm west of the center to avoid static discharge, and extended the leg to 70 nm to maintain time coordination with the ER-2. Finally we did a circle in the eye on our last fix to insure a good center location for the ER-2 drop and to maintain coordination.

Interesting variations in the radius of maximum wind at the surface and flight level were found on the north and east side of the storm. The maximum SFMR surface winds were at much smaller radii (8-12 km) than the maximum 14,000 ft winds. This difference was evident in the GPS-sondes in the eyewall. We also found two low-level circulation centers evident in the low-level cloud field (see Fig. 3). The surface wind and pressure center appeared to be in the circulation closest to the west eyewall. There was only one apparent wind and pressure center at 14,000 ft, which was closer to the other surface cloud circulation. CN measurements indicated that the eye was relatively dirty with concentrations ~2000 l^{-1}.

PROBLEMS:

1) The 2D-P had alignment problems from the time we took off until the end. AOC engineers recognized the problem but could not repair it or come up with a solution before the flight. They are looking into a solution right now.

2) The radar system crashed at 1642 UTC during the ferry. Sean McMillan restarted the system and it was back up by 1653 UTC. It worked perfectly the rest of the flight

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11 September 2001

TABLES:

Table 1. GPS-sondes dropped during mission and their splash locations.

#	Sonde ID	TIME (UTC)	Lat.	Lon.	150-m wind	DLM wind	MBL wind	Comments
1	003438024	1557	29.56	-75.00	09511	21002	10511	
2	990845048	1638	31.39	-71.99	09002	25504	08002	LST WND 012
3	003155003	1729	34.15	-68.07	33020	32521	33521	
4	003135326	1758	34.29	-64.95	24045	25054	24051	
5	003438051	1815	35.45	-65.10	22590	24590	23594	EYEWALL 180
6	003438054	1824	35.66	-65.38	28016	30013	28516	LST WND 047
7	991018020	1828	35.91	-65.50	04091	07575	05096	LST WND 017 EYEWALL 000
8	003115057	1838	36.71	-65.53	06055	09070	06564	RAINBAND
9	003338058	1857	35.48	-66.54	-999	-999	-999	No winds
10	003438002	1903	35.64	-66.81	34549	35049	34049	LST WND 035 RAINBAND
11	003115060	1916	35.76	-65.59	32069	33559	32572	EYEWALL 270
12	003115055	1923	35.85	-65.43	18009	19005	18009	LST WND 043
13	003115061	1928	36.01	-65.18	12085	16080	13096	LST WND 011 EYEWALL 090
14	003135044	1938	35.99	-64.18	15056	17567	15562	RAINBAND
15	003338013	2008	35.94	-61.33	17020	18522	17520	
16	003515028	2056	39.83	-61.37	06004	09510	06505	
17	003515027	2117	39.84	-63.73	09014	11020	10015	
18	003338067	2138	39.85	-66.06	05517	11020	06516	
19	003338010	2158	39.53	-68.24	-999	-999	-999	Fast fall

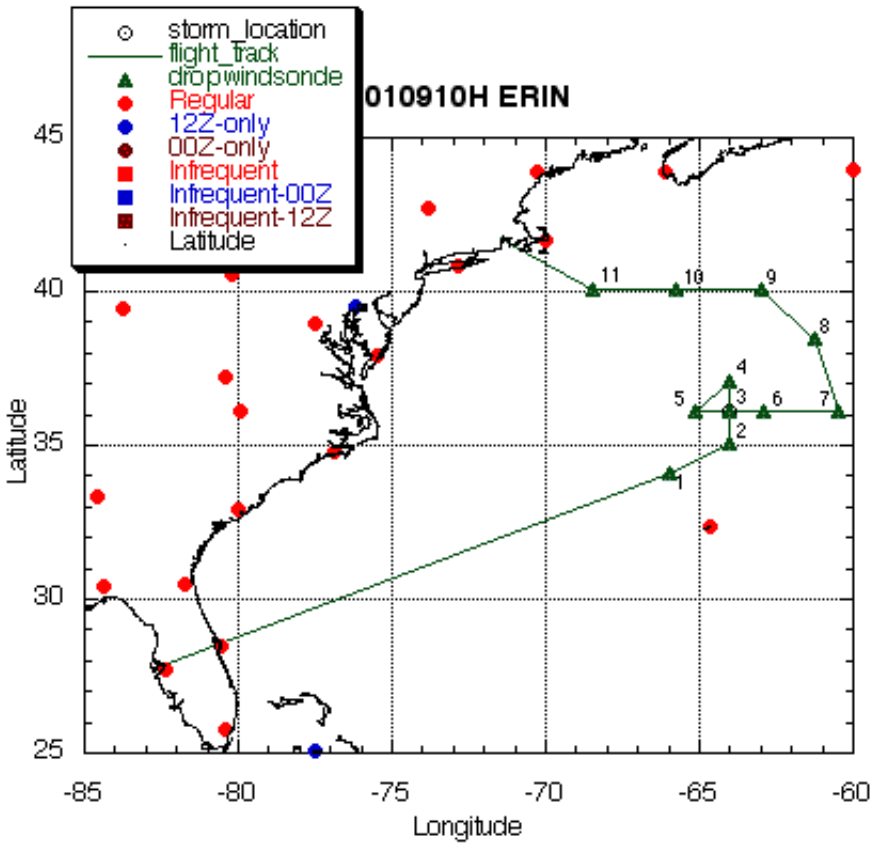

Fig. 1. Planned flight track for N42RF

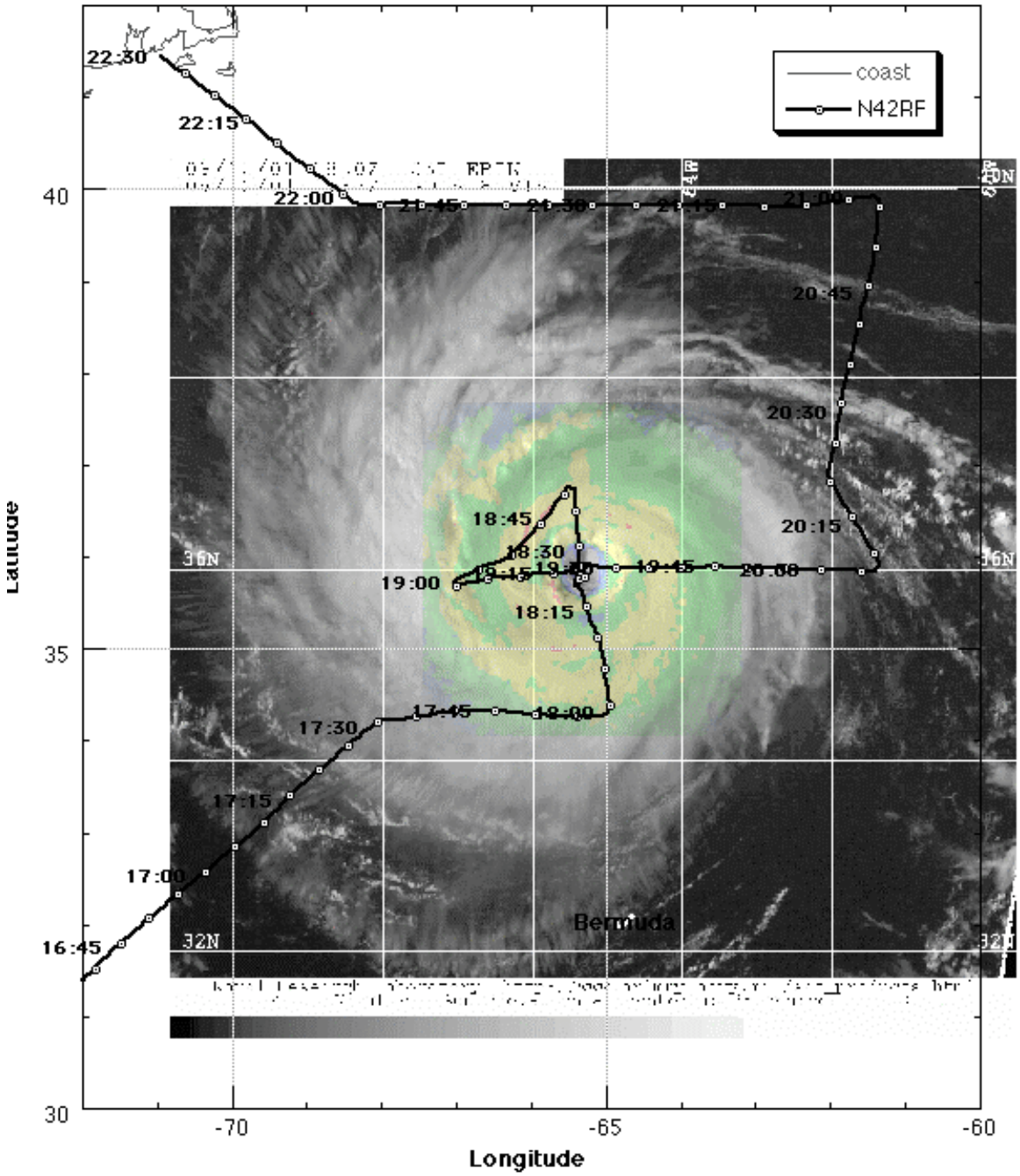

Fig. 2 N42RF flight track on 10 September 2001 superposed on visible satellite image at 1930 UTC and LF radar composite from 1910-1932 UTC.

Fig. 3. Photograph taken in the eye around 1917 UTC showing two low-level cloud circulations at the bottom of the eye (photo credit Sim Aberson, NOAA/AOML/HRD).

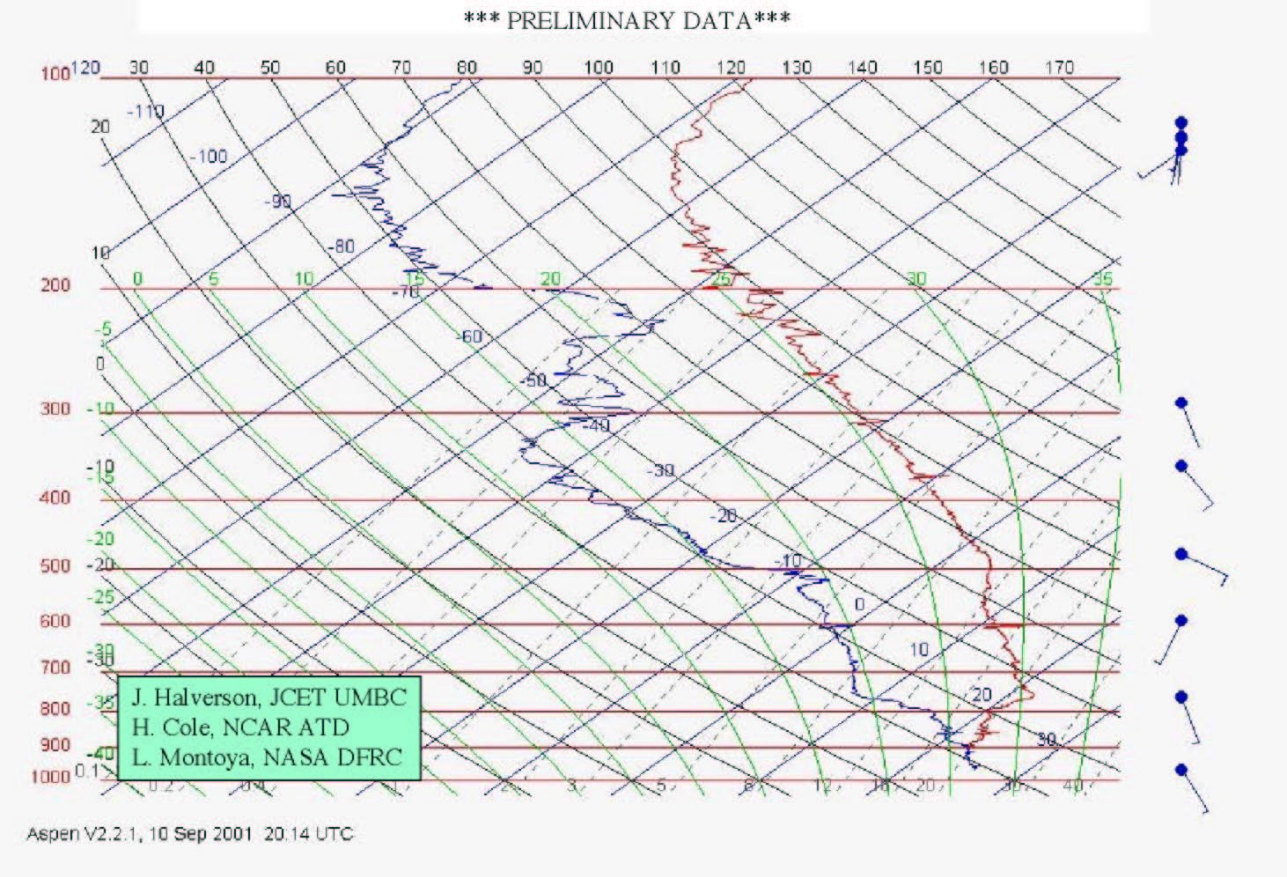

Fig. 4 Skew-T of the GPS-sonde dropped into the eye from the ER-2 at 1928 UTC.