Mission Summary
Hurricane Bret
Landfall
9908022I Aircraft: 43RF

Scientific Crew:		**Aircraft Crew:**
Chief Scientist	Peter Dodge	Pilots: CAPT Gerry McKim, CDR Ron Philippsborn, LCDR Tim O'Mara
Doppler Scientist	John Gamache	Flight Engineer: Steve Wade, Butch Moore
Dropsonde Scientist	Mike Black	Navigator: LCDR Dave Rathbun
Workstation:	Mike Black	Flight Director: Barry Damiano
AXBT	Joe Cione	
Observer:	Pete Davies	Engineers:Terry Lynch, Jim Barr,
SRA	Ed Walsh,	Dale Carpenter
	Wayne Wright	Radio: Damon Sans Souci

Mission Briefing:

After two Extended Cyclone Dynamics flights in Hurricane Bret, it was time to capture Bret's landfall on the south Texas coast. The day before we drew up plans for two flights. The first flight would map out the wind field before the storm made landfall, including a rainband inflow module designed by Gary Barnes (U. Hawaii) that had been flown in Hurricane Bonnie (1998), and the second plane would follow up by mapping the onshore and offshore flow in the atmospheric boundary layer along the coast, while also measuring wave height and storm surge with Ed Walsh's Scanning Radar Altimeter (SRA).

On the morning of the 22 August, however, it was apparent that the storm would make landfall much earlier than we had hoped. Sam Houston redesigned the flight track for the first flight, combining the figure-4 wind field mapping with the coastal patrol (Fig. 1). Mike Black's soundings of the inner edge of the eye had been very successful the day before, so we decided to add two circles in the eye to the flight track. N43RF was picked to fly first, with a take off time of 1730 UTC, and N42RF was tasked for a possible follow-on flight that evening, if the storm had not moved too far inland. Texas Tech had deployed two towers, one at the Corpus Christ WSR-88D radar (KCRP) and the other at Kingsville Naval Air Station Annex (KAS, Fig. 2a)

Mission Synopsis:

N43RF left MacDill Air Force Base at 1738 UTC, and descended to 12,000' at our IP off the south Texas coast at 2013 UTC. The hurricane was 0.5° latitude south of the expected position, so the IP was adjusted to allow for an east-west run into the center (Fig. 2a). At 2032 UTC we dropped the first GPS sonde and AXBT ~20 km outside the east eyewall, where flight level winds were already 96 kt. The east eyewall sonde and AXBT drops at 2035 UTC had max winds of 120 kt, and sea-surface temperature (SST) of 26.6° C. Terry Lynch noted that the Step Frequency Microwave Radiometer (SFMR) winds agreed well with winds at the splash of the eyewall sonde. The aircraft then circled upwind in the eye and Mike selected the next three sondes to fall just on the inner edge of the eye at flight level. The aircraft exited west out of the

eye at 2050 UTC, and the SFMR had winds of 62 m s^{-1} (124 kt) on the west side. We proceeded west to a point about 15 km inland (30 km west of the barrier islands) and at 2055 UTC slowly turned to head southeast. Two sondes were deployed over land (after consultation with AOC crew), west of Port Mansfield and near the Laguna Atacosa National Wildlife Refuge, and a third was dropped over the Intercoastal Waterway north of Port Isabel. These three sondes should provide information on the offshore flow. At 2108 UTC we dropped the third AXBT and turned to head north for the second leg of our figure-4. After passing through the eye at 2118 UTC and dropping the 4th AXBT, and then dropping the 5th AXBT and several sondes in the north eyewall, N43RF tracked north along the coast and completed the figure-4 at Port Aransas (PTAT2) at 2037 UTC.

From PTAT2 we flew south along Padre Island collecting SRA data (Fig. 2b). We deviated southeast to hit the eye again, and then at 2207 UTC we turned east of Brownsville (KBRO) to head for buoy 42020, where we dropped a sonde at 2230 UTC. Then we headed back to PTAT2. Now there was a vigorous rainband between CRP and PTAT2, so the pilots flew a circle around Corpus Christi Bay (Fig. 2c) and then back to the coast where we resumed another SRA run, adjusting the track at 2253 UTC to go through the eye. At 2314 UTC we turned east of KBRO to do a final pass through the eye. We spent about 10 min circling in the eye, to collect more inner edge soundings, and at 2344 UTC we made our last pass through the north eyewall in heavy rain, with 118 kts flight level winds. A lower fuselage reflectivity sweep (Fig. 3) shows how small the storm was. Our last sonde was dropped offshore at 2355 UTC, in the rainband that was over Corpus Christi. We continued along the coast, and at 0005 UTC passed on the eastern edge of the strongest reflectivity feature we saw during the whole flight, a rainband crossing the middle of Matagorda Island. There was a 13.8 m s^{-1} updraft in the cell, and the tail radar sweeps had narrow high reflectivity elements similar to the features observed in a rainband off Moorehead City, North Carolina, during research flights in Hurricane Bonnie. At 0009 UTC N43RF climbed to head home and landed at MacDill at 0253 UTC, 23 August 1999.

Evaluation:

Hurricane Bret was the most intense hurricane that we have flown the TC Windfields at Landfall Experiment in. Because the inner core was so small, and moved inland in a sparsely populated region we had considerable freedom to deploy sondes and to maneuver the aircraft. Figure 4 shows the distribution of mean boundary layer wind data from the sondes that was received at the Tropical Prediction Center in real time; this does not include 7 other sondes that were not transmitted. The SFMR software had some problems, so the real-time data were not available, but they will be re-processed to yield detailed estimates of the coastal winds. Initial reports form the Southern Region of the National Weather Service (NWS) are that both Brownsville and Corpus Christi radars successfully archived Level-II data. The Southern Region also archived 1-min data from the CRP, ALI, PIL, BRO, and HRL ASOS stations. The Texas Tech towers recorded data successfully. This will be an excellent data set to examine wind fields in a landfalling hurricane. In addition, the eyewall soundings will add to the data set that Mike Black is compiling to study variations in vertical profiles of winds in tropical cyclones.

Acknowledgements:

Barry Damiano, Dave Rathbun and the flight crew agreed to every change in the flight pattern that we requested (there were many). Terry Lynch kept the radar running, and Jim Barr and Dale Carpenter managed to keep with our evolving plans for GPS sonde drops.

Mike Black called most of the sonde drops, and also added his upwind inner-edge eye circle drops to the mix. Joe Cione kept track of the AXBT data, and John Gamache minded the radar. Sam Houston and Frank Marks made the initial flight tracks, and Pete Black and Barry Damiano helped us tune up the pattern just before the pre-flight briefing. 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-min ASOS data. NWS staff at Corpus Christi and Brownsville were quite helpful in letting us know the status of the radar data soon after the storm.

Problems:

The workstation had a few problems with the sonde processing icons (since fixed). The tail radar had a bad AFC circuit, and the engineers had to continually reset the tail radar to restore the reflectivity. The Doppler data do not appear, at first glance, to be seriously affected. The lower fuselage reflectivity also seems low when compared with Brownsville WSR-88D dBZ images. Three sondes had no winds and another failed early. The SFMR winds transmitted in real time had problems, but the software has since been fixed by Eric Uhlhorn and AOC.

Peter Dodge
9/7/99

Table 1. Storm positions near Landfall

Time	Lat	Lon	Comment
2020	26° 43'	97° 03'	Air Force Reconnaissance
2143	26° 45'	97° 06'	947 mb Air Force Reconnaissance
2302	26° 42'	97° 19'	AOC estimate

Table 2. GPS Sondes

#	id	time	comments (locations are splash locations)
1	984715145	2032	not transmitted
2	984715367	2035	26.88 097.01 MBL WND 10621 LST WND 131 EYEWALL 045
3	984715195	2040	26.73 097.21 MBL WND 36121 LST WND 047 EYEWALL 000
4	984715230	2041	26.75 097.22 EYEWALL 000
5	984715148	2042	26.80 097.20 LST WND 287 EYEWALL 000
6	984715221	2050	26.60 097.13 MBL WND 27609 LST WND 054 EYEWALL 225
7	984715151	2051	26.58 097.15 MBL WND 28599 LST WND 021 EYEWALL 225
8	984715312	2057	26.50 097.57 MBL WND 31564
9	984715344	2100	26.31 097.36 MBL WND 28066
10	984715337	2102	26.16 097.21 MBL WND 26054
11	984715140	2108	26.05 096.94 MBL WND 24050
12	984715092	2111	no winds
13	984715015	2121	no winds
14	984715330	2122	26.82 097.30 LST WND 317 EYEWALL 315
15	984715017	2123	26.87 097.32 MBL WND 02108 EYEWALL 000
16	984325545	2131	27.44 097.21 MBL WND 07063 RAINBAND
17	984715035	2138	27.83 097.20 MBL WND 05047
18	984325547	2143	27.49 097.28 MBL WND 08066 LST WND 013 RAINBAND
19	984715145	2151	no winds
20	984715227	2152	26.79 097.32 LST WND 796 EYEWALL 315
21	985035077	2156	26.75 097.02 MBL WND 19119 LST WND 016 EYEWALL 135
22	985035058	2158	26.59 097.01 MBL WND 22088 EYEWALL 225
23	984325383	2200	26.36 097.01 MBL WND 23569
24	985035308	2208	not transmitted
25	985035311	2221	not transmitted
26	984325377	2244	not transmitted
27	984325454	2258	EYEWALL 000=, failed early
28	985035110	2304	not transmitted, not sure if it was launched

29	985035061	2324	not transmitted
30	983503356	2328	not transmitted ??
31	985935060	2337	no winds
32	985035109	2337	26.92 097.48 LST WND 767 EYEWALL 000
33	984325563	2337	26.93 097.44 MBL WND 04123 EYEWALL 315
34	984325447	2344	26.90 097.50 MBL WND 00618 LST WND 017 EYEWALL 315
35	985035111	2355	not transmitted

Note: sondes 24, 25, 26, 29 and 35 did not make it to the Workstation from the AVAPS computer, so could not be processed to transmit. The AOC tech provided us with a floppy disk with those missing sondes. Sonde 28 did not make it to the workstation in correct form; it will be recovered from AOC later.

Table 3. AXBT's

	Launch (UTC)	Lat	Lon	SST (°C)
1	203237	26° 46'	96° 43'	25.1°
2	203520	26° 47'	96° 54'	26.6°
3	210619	25° 56'	97° 05'	27.3°
4	211813	26° 43'	97° 04'	26.4°
5	212239	26° 57'	97° 11'	26.0°
6	213603	27° 46'	97° 03'	28.5°
7	222129	26° 58'	96° 42'	25.6°
8	222700	27° 22'	96° 49'	28.3°

Compiled from Joe Cione's log.

Figures:

1. Flight plan for briefing. (on thor: /users/peter/bret_stuff.d/fig1.ps)
2. NOAA 43RF flight track. (on thor: /users/peter/bret_stuff.d/fig2.ps)
3. Lower Fuselage radar image (on thor: /users/peter/bret_stuff.d/fig3.ps)
4. Mean boundary layer winds from GPS sondes(on thor: /users/peter/bret_stuff.d/fig4ps)

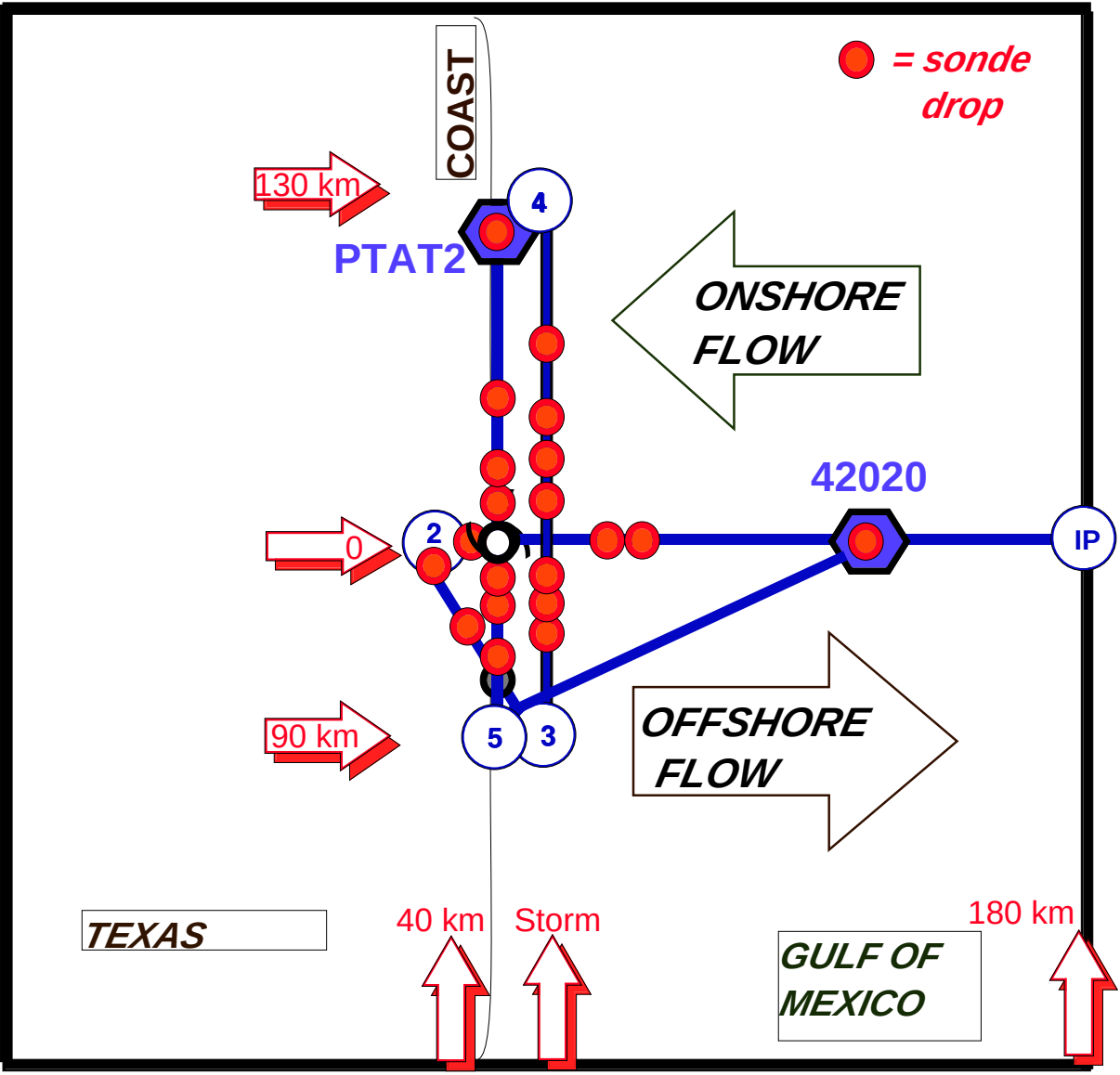


Figure 1. Proposed flight plan for Hurricane Bret Landfall flight on 22 August 1999. Arrows with distances mark estimated leg lengths from storm center.

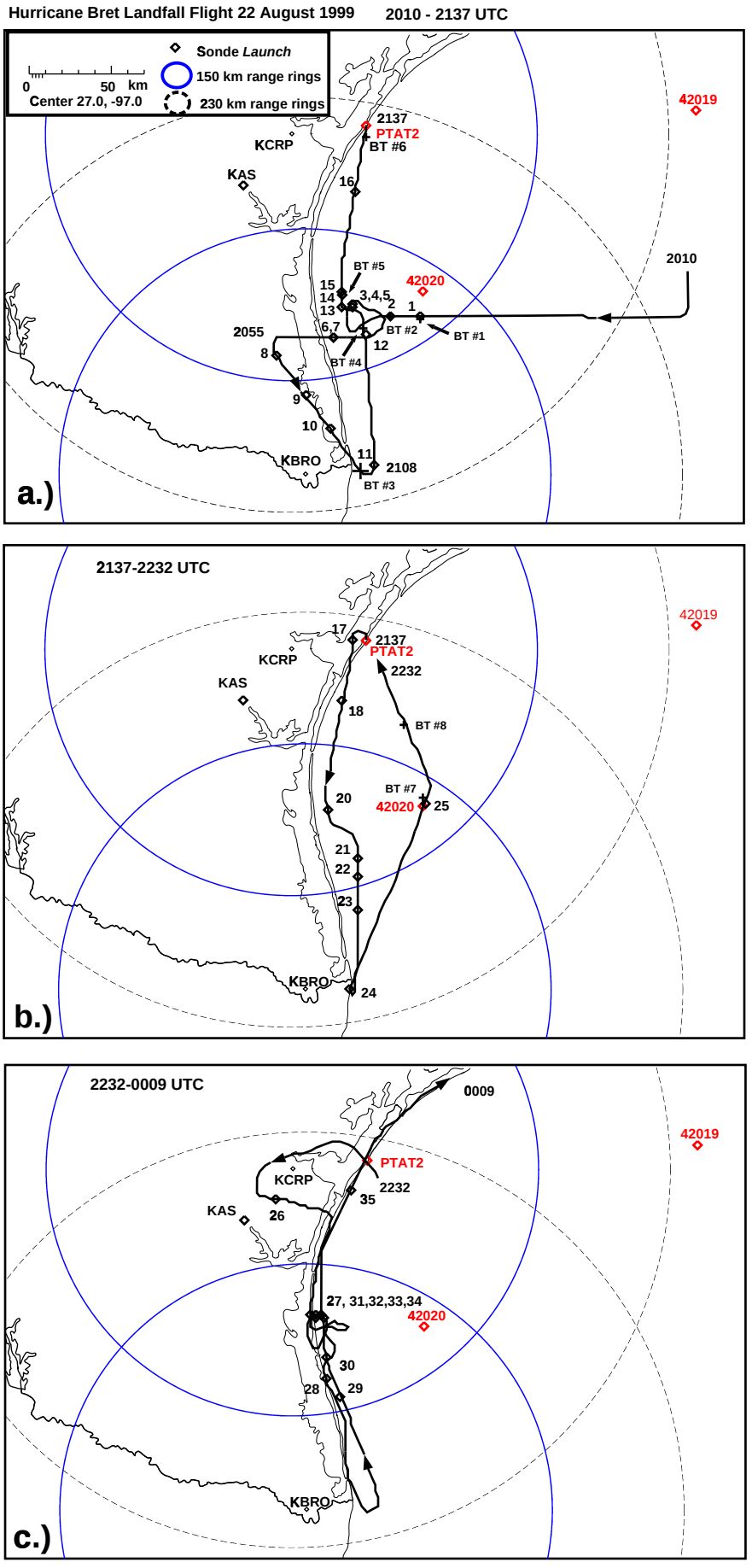


Figure 2. Flight tracks of NOAA 43 in Hurricane Bret on 22 August 1999. Solid circles indicate 150 km range from Brownsville (KBRO) and Corpus Christi (KCRP) WSR-88D radars, and dashed circles are the 230 km range rings. Numbered diamonds indicate launch locations of GPS sondes, AXBT drop locations are also labeled. Texas Tech University wind towers were at KCRP and Kingsville Air Station (KAS). a.) Initial figure 4, 2010-2137 UTC, b.) 2137-2232 UTC, c.) 2232-0009 UTC

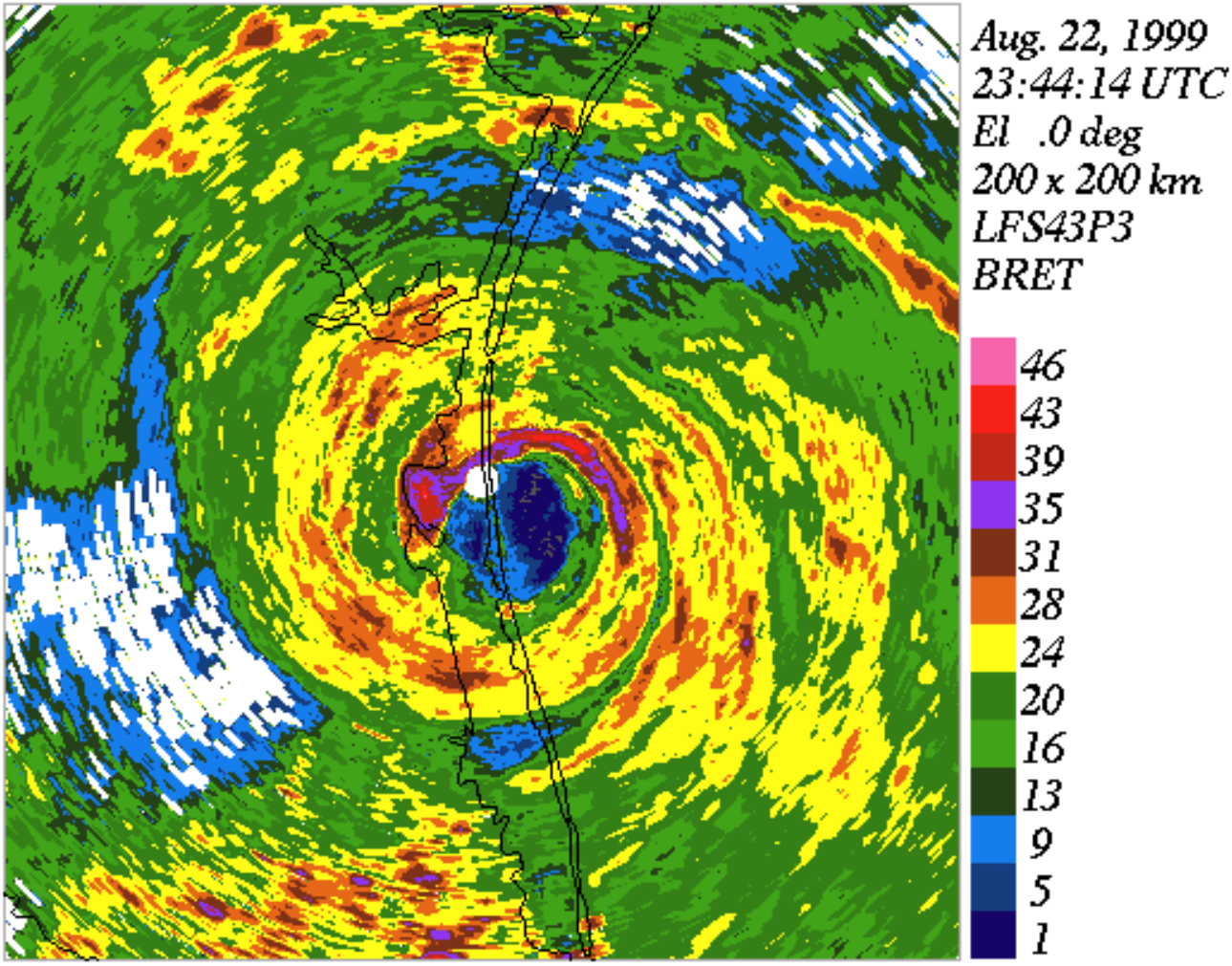
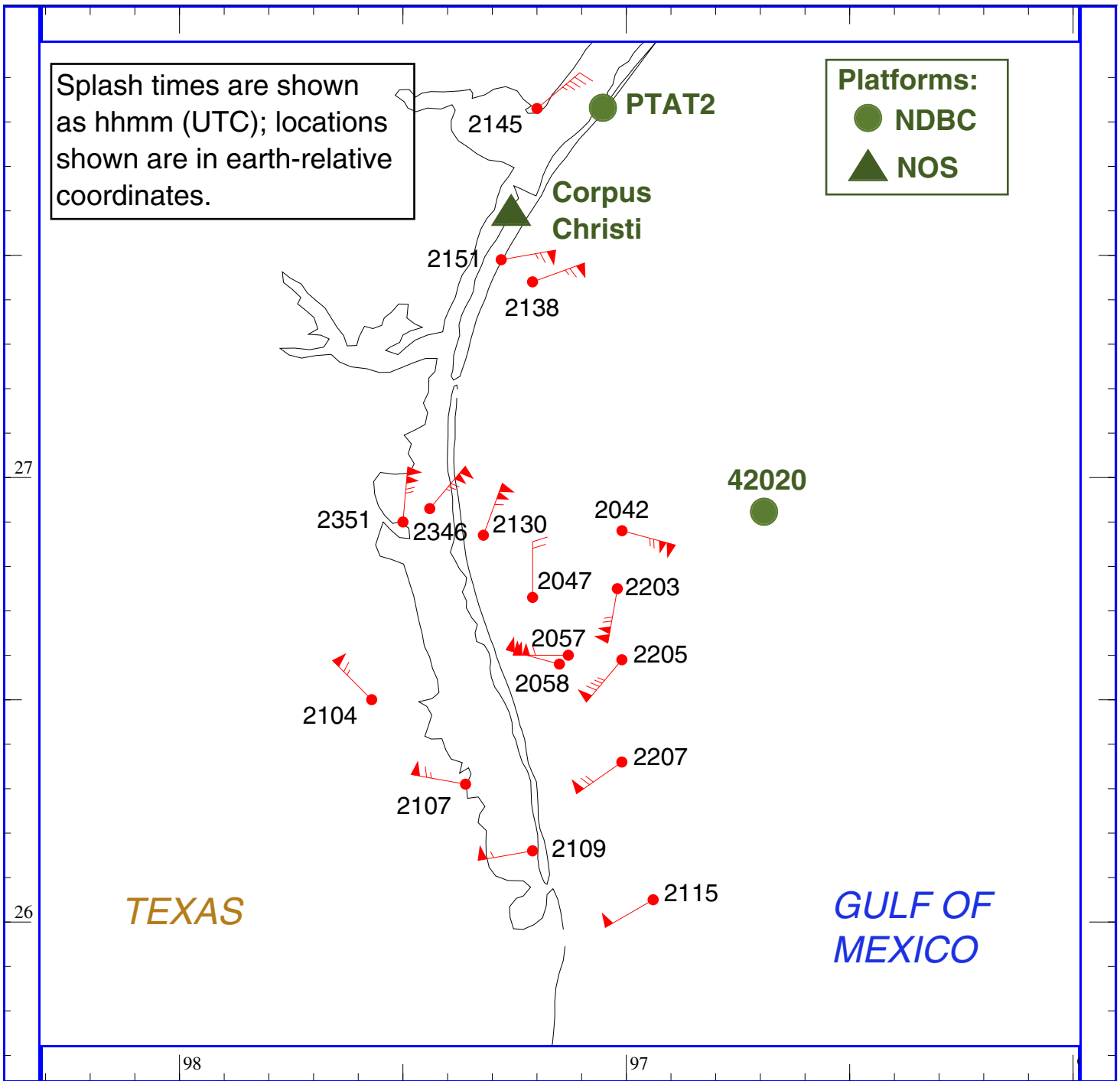


Figure 3. NOAA 43 Lower Fuselage radar image at 2344 UTC, 22 August 1999. The aircraft, denoted by the white circle, was just entering the north eyewall.

Hurricane Bret GPS-sonde mean boundary layer (0-500 m mean) wind observations sent in real-time by NOAA 43 at landfall on 22 August 1999



25.72 - 27.98 N. 95.98 - 98.31 W.

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