Mission Summary
940924I Aircraft 43RF

Scientific Crew (43RF)

Chief Scientist	Marks
Doppler Scientist	Willoughby
Cloud Physics	R. Black
Dropwindsondes	Franklin
Workstation	Griffin
Observers	Fremmel (Radian Corp.)
	one IMAX
	Mexican AF meteorologist

Mission Briefing:

In the morning of 24 September Olivia was an intensifying hurricane ~680 nm WSW of Puerto Vallarta, tracking WNW at 5 m/s. Over the preceding 6 h the storm appeared to be tacking a more northerly track, indicating that the storm might be starting to recurve. Unfortunately, the storm was too far west (location 15.2°N, 117.3°W) to be a candidate for the Vortex Motion and Evolution (VME) Experiment. Hence, we opted for the Inner Core Dynamics Experiment from the 1992 Operation Plan (a forerunner to VME), designed to study the evolution of the inner core over 3-4 h. We briefed for a takeoff at 1030 local time (1630 UT). The intended flight tracks were the "rotating Figure 4" pattern with 50 nm radial legs about the storm center. N42RF would enter the pattern from the N and maintain 5 kft RA throughout the flight, while N43RF would enter the pattern from the E and maintain 10 kft RA. N43RF would drop one ODW along the ferry, one ODW at the end of the flight legs in each of the four cardinal locations around the storm, and one ODW in the eye. If possible, each drop would include an ODW and a Radian LOD2 for intercomparison.

Mission Synopsis:

Departure from Puerto Vallarta was delayed until 1652 UT. The approach to Olivia was from the E with an expected ETA of 1900 UT near 15.4°N 118.4°W, with an IP 50 nm E of that position. The ODW/LOD2 drop along the ferry was canceled because of a LOD2 system failure. At 1910 UT, ~200 nm from the IP, we fixed the center with the lower fuselage (LF) radar at 15.7°N 117.9°W, farther N and approximately 40 nm closer to Puerto Vallarta than expected. The LF indicated that there was a definite eye 15-20 nm in diameter with relatively intense reflectivity in the S quadrant. There was a principal rainband spiraling from 50 nm NE of the center out to ~100 nm SW of the center. John Gamache and I decided to adjust the aircraft altitudes because of the small eye size and the intense reflectivities. N42RF would maintain 10 kft PA and N43RF 14 kft PA. PA was chosen because of a RA failure on N43RF during the ferry.

N43RF reached the IP (15.75°N 117.1°W) at 1933 UT, dropped an ODW just outside the principal rainband, and tracked W across the eye encountering 122 kts winds in the E eyewall. Both aircraft crossed the center of the eye 1944 UT, within 15 s of each other, fixing the center at 15.8°N 117.9°W. The eye was relatively clear below the aircraft altitude, but was covered by thin cirrus. The inner edge of the eyewall cloud, at a radius of ~9 nm from the center, was not very distinct, with a lot of cloud protruding into the eyewall above the aircraft altitude. The second ODW was dropped at the westernmost point in the first leg (2) in the midst of a number of weak rainbands embedded in an extensive stratiform rain region that extended ~200 nm S and W of the center.

The second leg was from a point 50 nm SW of the center (2), on a NE track through the center. In the SW portion of the eyewall we encountered a very broad (50 s) updraft >10 m/s, with a peak 1-s value of 21 m/s. The updraft was just upwind of the most intense reflectivities in the S quadrant of the eyewall. We passed through the eye at 2019 UT (15.85°N 118.0°W), within 10 s of N42RF and encountered 126 kts winds in the NE eyewall. The radar system failed at 2032 UT during the downwind leg to a point 50 nm N of the center (5). We orbited at 5 until the radar system was restarted and then started our third leg at 2042 UT, dropping an ODW at 5. We passed through the eye at 2052 UT (15.9°N 118.1°W), within 15 s of N42RF. We encountered heavy rain, graupel and lightning as we passed through the intense reflectivity in the S eyewall, dropping another ODW at the point 50 nm S of the center (6). On leg 4, which started 50 nm SE of the center (7), we encountered heavy rain, graupel and lightning once again. We dropped an ODW in the eye at 2124 UT (15.95°N 118.15°) as we saw N42RF pass beneath us. The splash pressure was 950 mb.

We finished up the day with three legs oriented E-W across the center. The first E-W leg started at 2145 UT, 50 nm W of the center (2), passing through the eye at 2155 UT (16.05°N, 118.2°W). The second E-W leg started at 2209 UT 50 nm E of the center (IP), passing through the eye at 2223 UT (16.1°N 118.3°W), 20 s ahead of N42RF (the worst synchronization of the day). The final E-W leg started at 2238 UT at 2, passing through the eye at 2248 UT (16.15°N 118.4°W), 6 s behind N42RF (the best synchronization of the day). At 2300 UT we ended the pattern at 1 and climbed to our ferry altitude back to Puerto Vallarta. The navigator computed a storm motion of 310° at a speed of 8 kts over the three hours of the experiment.

Evaluation:

Fantastic flight!! Bob Burpee says that the mission was probably one of the 4-5 best missions HRD/AOC has flown in the last 15 years. The aircraft coordination was outstanding, with the AOC flight directors and navigators deserving the lion share of the credit. Achieved seven complete mappings of the inner core within 50 nm radius of the storm center for true dual Doppler analyses over a 3.5 h period. The EVTD analyses performed on the aircraft showed that the storm was intensifying during the mission, with the azimuthally-averaged tangential winds increasing from 50-55 m/s on the first pass through the center, to over 60 m/s by the last pass. As the wind speed increased, the radius of maximum winds contracted, from 20 km radius on the first pass through the center to 16 km radius on the last pass. Six ODWs were dropped as planned, of which all were either good or recoverable. The ODW drop in the eye (950 mb central pressure) showed similar structure to those dropped in the eye of Hurricanes Gloria, Emily and Gilbert. There was a distinct inversion at ~875 mb, with relatively warm dry air above the inversion and nearly saturated air below.

This data set will be outstanding for studies of inner core dynamics and evolution. The storm's small size and intensity, were ideal for this experiment. The inner core out to at least three eye radii distance were within the domain mapped by the Doppler radars. The seven complete mappings over the 3.5 h (one analysis every 33 min) while the storm was intensifying should provide an excellent opportunity to study the temporal evolution of the primary and secondary secondary circulations in the eyewall. These data should also help improve our understanding of the interaction of the inner core and the environment as the storm starts to recurve.

N43RF also transmitted three radar composites and 5 of the 6 ODWs back to NHC via ASDL. All the radar composites were received and decoded for the hurricane specialists. They were very happy to receive all the information as it confirmed that the storm was intensifying and starting to recurve.

Problems:

1. VCR for the right side video camera failed. No video from that camera was recorded.

2. LOD2 system failed to come up. Jim Fremmel worked on it the whole flight - no luck. May be a bad receiver.

3. RA (APN-159S) failed after takeoff. Terry Lynch switched systems during the ferry. The new system worked well during the flight.

4. The radar system locked up at 2032 UTC on the downwind leg NE of the storm (between 4 and 5). Terry Lynch restarted the system at 2042 UTC at 5, 50 nm N of the center.

Frank Marks

Olivia

Marks

SEP 24 1994

E.2 Lead Project Scientist (On-Board)

E.2.1 Preflight

1. Participate in general mission briefing.
2. Determine specific mission and flight requirements for assigned aircraft.
3. Determine from CARCAH or field program director whether aircraft has operational fix responsibility and discuss with OAO flight director/meteorologist and CARCAH unless briefed otherwise by field program director.
4. Contact HRD members of crew to:
   a. Assure availability for mission.
   b. Arrange ground transportation schedule when deployed.
   c. Determine equipment status.
5. Meet with OAO flight crew at least 90 minutes before takeoff, provide copies of flight requirements and provide a formal briefing for the flight director, navigator, and pilots.
6. Report status of aircraft, systems, necessary on-board supplies and crews to appropriate HRD operations center (MGOC in Miami or FGOC at remote recovery location).

E.2.2 In-Flight

1. Confirm from OAO flight director/meteorologist that satellite data link is operative (information).
2. Confirm camera mode of operation.
3. Confirm data recording rate.
4. Complete Form E-2.

E.2.3 Postflight

1. Debrief scientific crew.
2. Report landing time, aircraft, crew, and mission status along with supplies (tapes, etc.) remaining aboard the aircraft to the appropriate HRD operations center (MGOC or FGOC).
3. Gather completed forms for mission and turn in at the appropriate operations center. [Note: all data removed from the aircraft by HRD personnel should be cleared with the OAO flight director.]
4. Obtain a copy of the 10-s flight listing from the OAO flight director. Turn in with completed forms.
5. Determine next mission status, if any, and brief crews as necessary.
6. Notify the appropriate operations center (FGOC or MGOC) as to where you can be contacted and arrange for any further coordination required.

On-Board Lead Project Scientist Check List

Date 9/24/94 Aircraft 43RF Flight ID 940924I

A. Participants

HRD Function	HRD Participant	OAO Function	OAO Participant
Lead Proj. Sci.	Marks	Flight Director	Parrish
Cloud Physics	R. Black	Pilots	Tenison / Mckim
Radar	Willoughby	Navigator	Rathburn
Doppler	Griffin	Sys. Engr.	Bast
Photographer		Data Tech.	Lynch
Omegasonde	Franklin/Freumuel	El. Tech.	Pradas/Delgado
AXBT/AXCP		Other	2TMAX / Alberto

8.8h

Take-Off ~~165152~~ 1645 Location PVR Landing ~~013110~~ 01 Location PVR

B. Past and Forecast Storm Locations

Date/Time	Latitude	Longitude	MSLP	Max. Wind
24/13Z				
24/18Z				
24/19Z	15.4°	118.4°		70
24/21Z	15.7°	118.3°	955	100 kts 290/10
24/00Z				

C. Mission Briefing

Inner core Dynamics (last years book p19)
43RF 10 kft RA enter from E
42RF 5 kft RA enter from N

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D. Equipment Status

Expendables	Equipment	Pre-Flight	In-Flight	Post-Flight	
1 Dat	Aircraft	↑	↑	↑	
2 Dat	Radar	↑	↑	↑	– radar down from 2032-2042 NE key
1 Dat	Cloud physics	↑	↑	↑	
	Data system	↑	↑	↑	– RA glitch on TO and ferry
6 ODW	Omegasondes	↑	↑	↑	– LOD2 down for flight
	AXBT/AXCP	—	—	—	
	Doppler	↑	↑	↑	
2 VC	Photography	↑ no right side video	↑	↑	

REMARKS:

— VCR to right camera failed – No right side video

— radar system locked up at 2032 between 4 & 5 restarted at 2042 at 5 changed DAT

— LOD2 system failed to come up – worked on it the whole flight – may be bad rcvr.

— RA – APN 159S failed after TO – switched during ferry – worked better during mission

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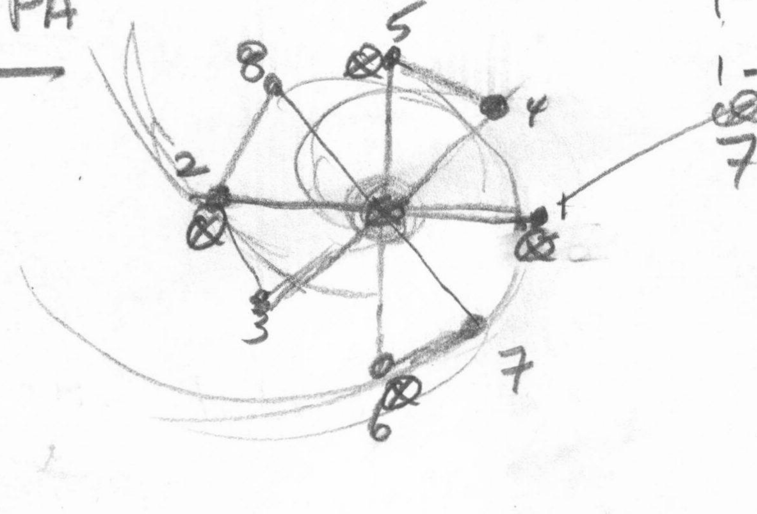
E. I. Proposed Flight Pattern (sketch or designate by number)

see attached sheet from p19
1993 HFP

E. II. Actual Flight Pattern

14 kft PA



1-2-3-4-5-6-7-8-2
1-2-1

7 penetrations

⊗ ODW, 6 ODW3

①

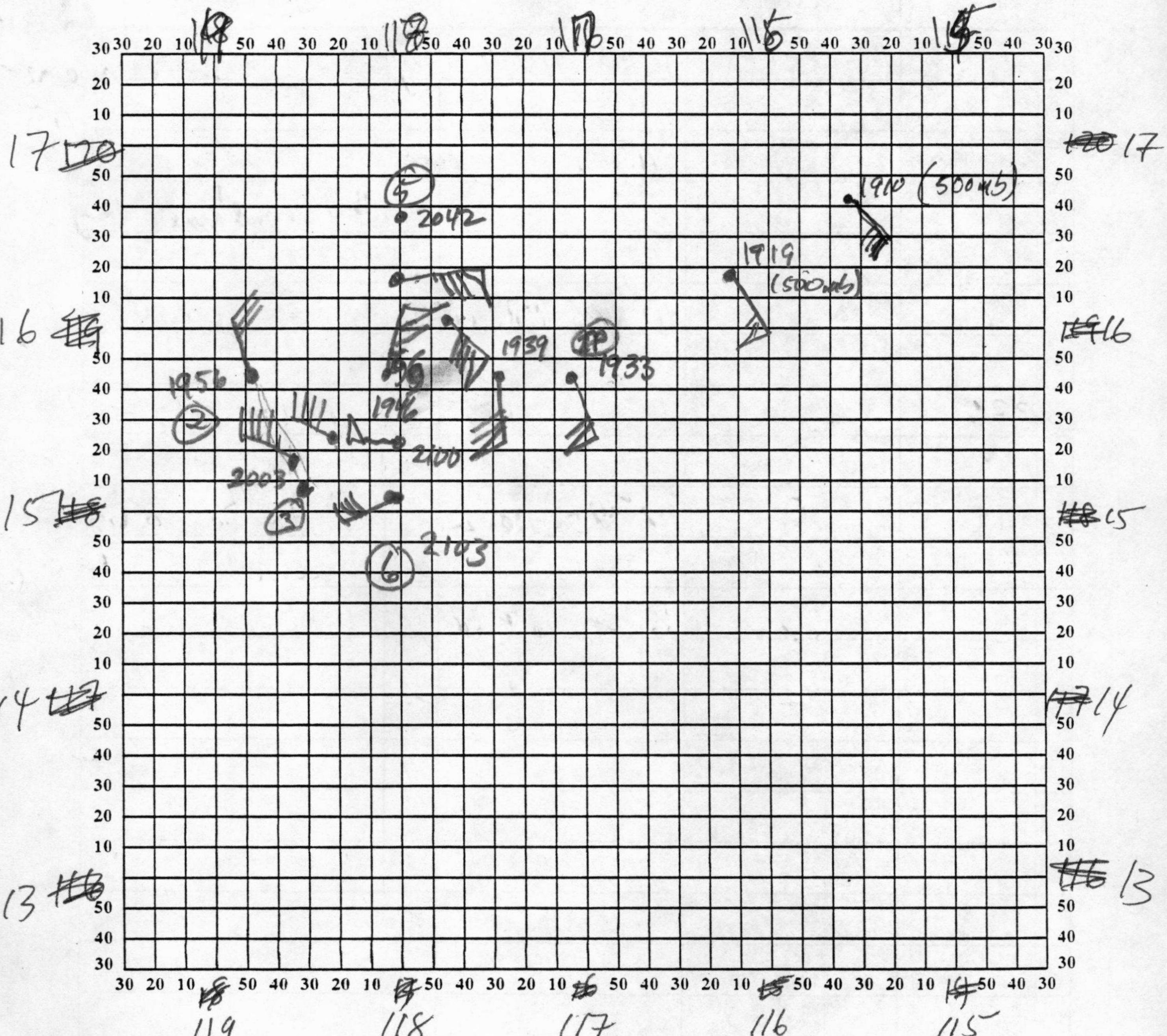
Form E-2
Page 4 of 5

SEP 24 1994

Hurricane Recco Plotting Chart

True at 25° Latitude, in Degrees and Minutes of ϕ and λ.

Date 940924 I Longitude ______ Observer Marks



Note: Label full degrees according to location of flight area.

7 penetrations

SEP 24 1994

Form E-2
Page 5 of 5

③

Lead Project Scientist Event Log

Date 9/24/94 Flight 940924I LPS Marks

42 fix
2158
16°03"
118 96"

Time	Event	Position	Comments
~~2155~~ 30	9	16°04" 118 94"	graupel on the way out
2208 00	①	16°03" 117° 17"	extend leg 1 min to
220930			better coordinate leg
			TK 270 to ②
2223	9	16°05.6" 118°96.5"	2221 graupel
~~2235~~	②	16° 7" 119° 12"	90/270 TK 090
2238			all up to W side
2248	9	16°09.5" 118° 22.3'	good visual 42 passed 6s
			all down to E side
2300	①	16°07" 117° 27"	climb for home

310/8.9 kts
good
down

saw 42
in
eye
20s behind

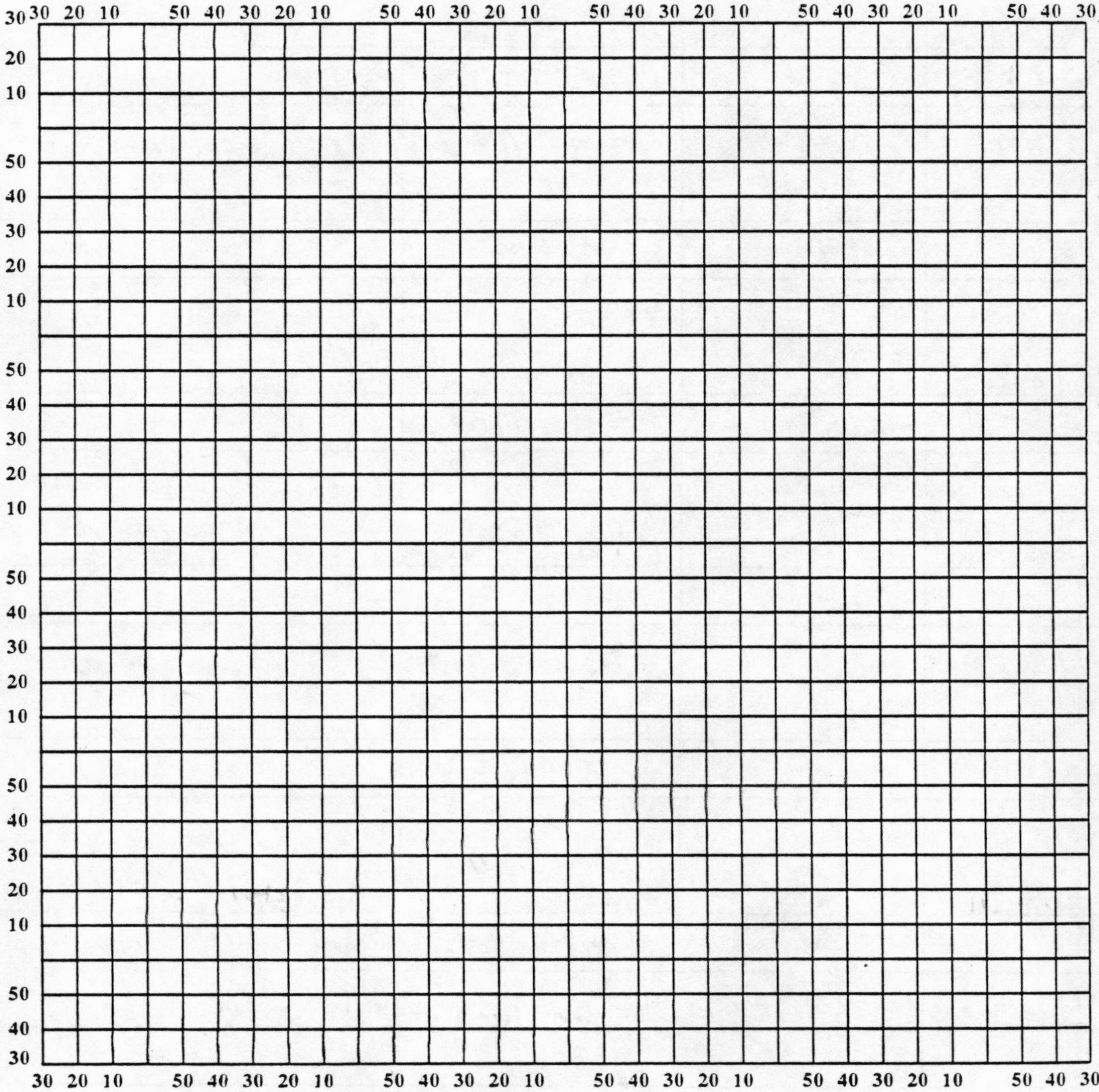
>10 m/s
for 45s
ahead of us

<-5 m/s
for 15s

Hurricane Recco Plotting Chart

True at 25° Latitude, in Degrees and Minutes of ϕ and λ.

Date________________ Longitude ________________ Observer ________________



Note: Label full degrees according to location of flight area.

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2

Form E-2

Lead Project Scientist Event Log

Date 9/24/94 Flight 940924I LPS Marks

Time	Event	Position	Comments	
200435	3	15°10" 118°31.5'	outside turn TK 040	purl #1
			what an updraft	>18 ms⁻¹
201926	6	15°51" 118°00'	126 kts going out	for 5-6 s
	4			
2032			radar down	
204200	5	16°38" 118°00	radar up TK 5	orbited
			ODW #4	white
205146	6	15°56" 118°06'	graupel 2054 lightning 205433	fixing radar
210307	6	15°6" 118°6'	TK 070 ODW#5	310/7 kts
211022	7	15°18" 117°30"	TK 315	
212334	6	15°58" 115°08"	graupel in SE eyewall lightning	
		ODW#949mb	ODW#6 saw 42 pass	in front of us
213640	8	16°38" 118°49.6'	TK 210	
2145	2	16°00' 118°58	TK 090	

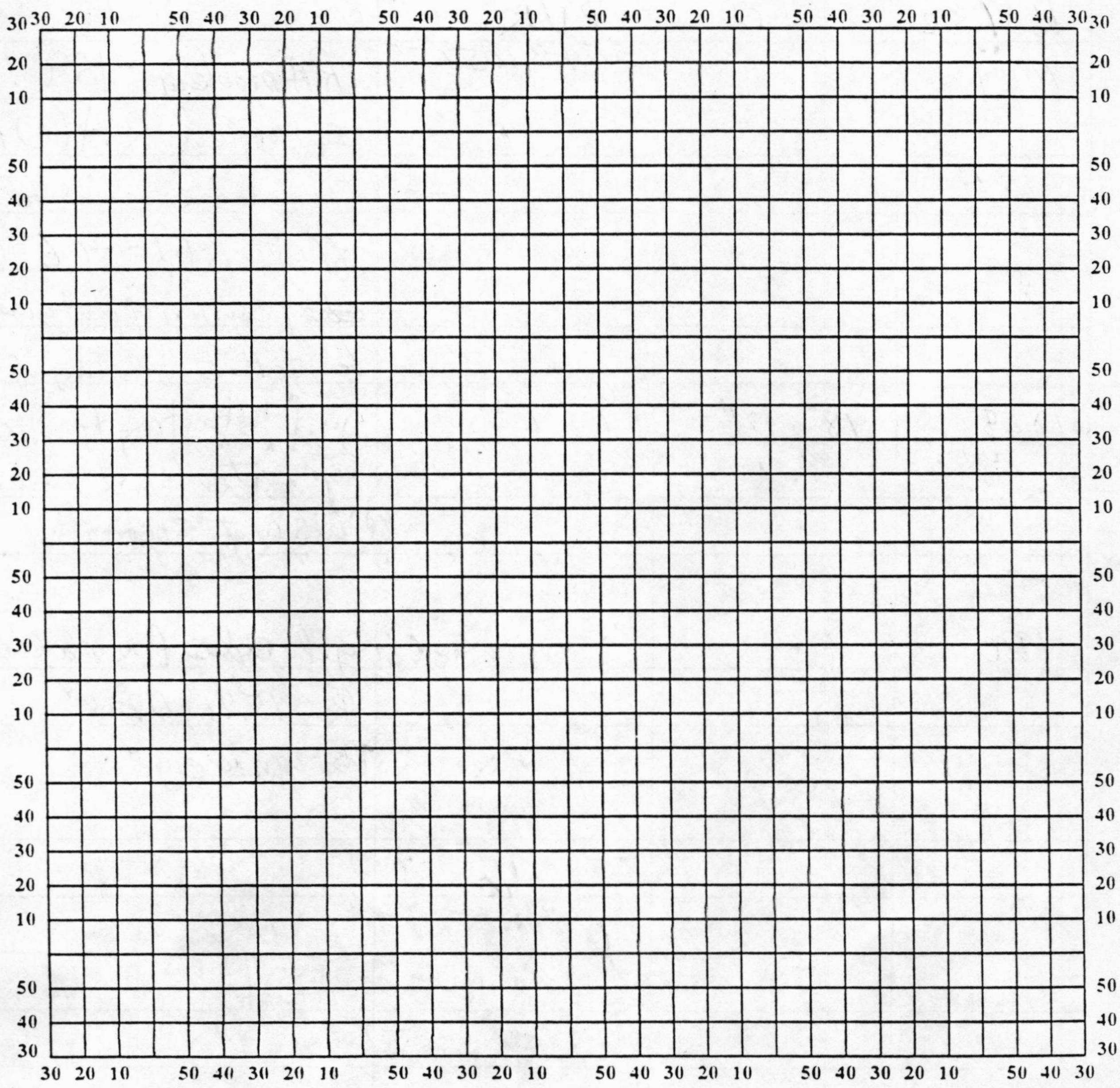
Form E-2

SEP 24 1994

Hurricane Recco Plotting Chart

True at 25° Latitude, in Degrees and Minutes of ϕ and λ.

Date________________ Longitude ________________ Observer ________________



Note: Label full degrees according to location of flight area.

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(1)

Form E-2
Page 5 of 5

Hur. Olivia

Lead Project Scientist Event Log

Date 9/24/94 Flight 940924I LPS Marks

Time	Event	Position	Comments
165652	TO	PVR	
1654		20°41" 105°15"	RA problem -1595
			swapped RA OK
			— TA antenna seems to be
			offset in tilt -0.6° (have to
			~~add~~ position of antenna at 0.6°
			to get ~0 velocity of ground
1825	18° 02"	112° 11"	just starting to pick
			up outer bands on LF
			80nm WSW of Socorro Is.
1910			get radar fix on Olivia
			43 15°41", 117°54"
			15-20 nm eye
192420		16°06" 116°34"	start descent to 14kft.
193155		15°49" 117°05'	ODW#2
193301	IP	15°46" 117°05'	IP start TK 270 to 9
194405	9	15°47" 117°55"	~956mb
195625	2	15°45" 118°50"	TK 155

ODW#3

42
15°52"
117 57

John asks us to ~~go to~~ 14kft 42 to 10kft. (PA) because of our RA problems

122kts

1946 42
1547 fix
11755

Form E-2

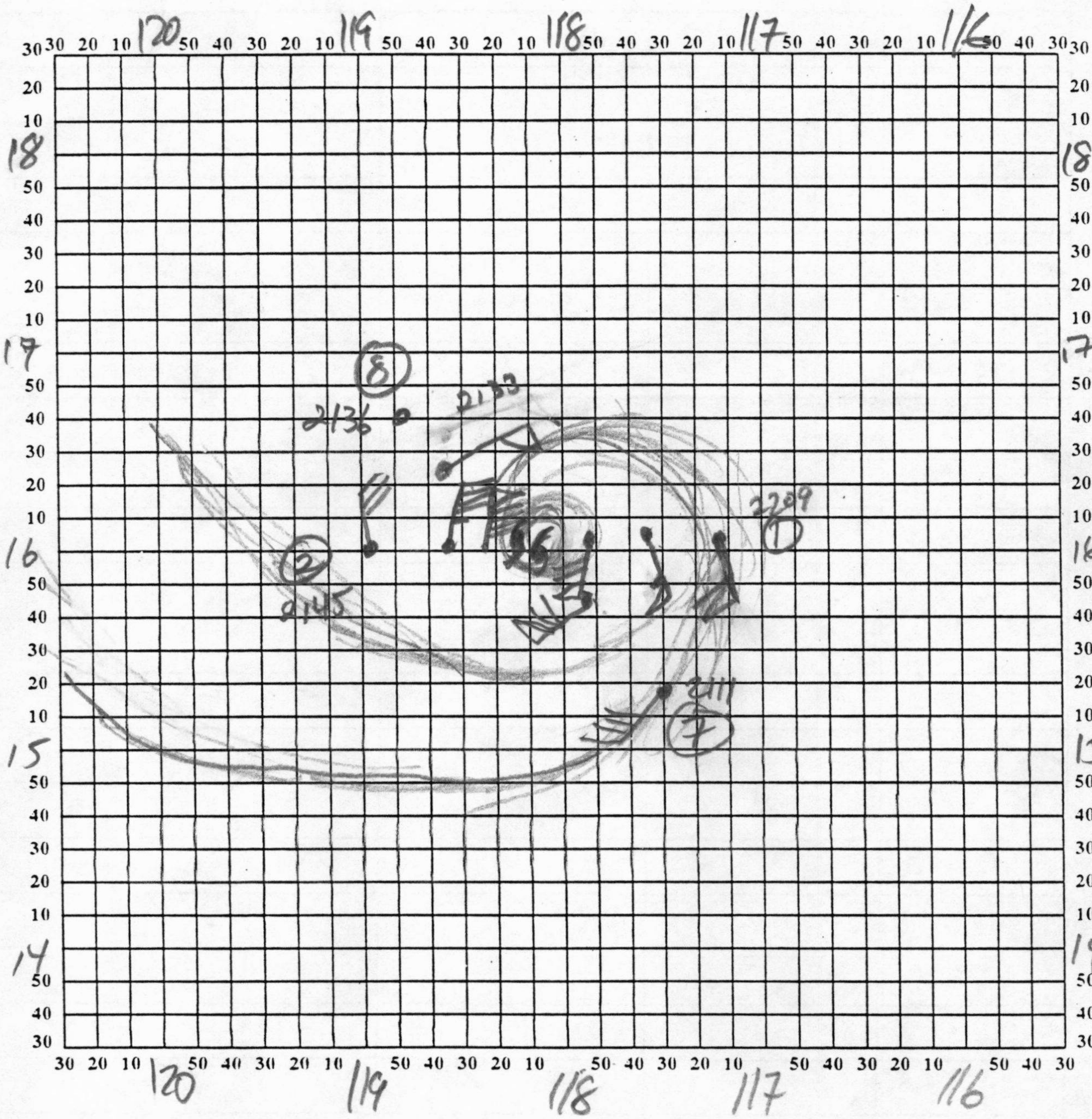
SEP 24 1994

2

Hurricane Recco Plotting Chart

True at 25° Latitude, in Degrees and Minutes of ϕ and λ.

Date 940924H Longitude ________ Observer Marks



Note: Label full degrees according to location of flight area.

SEP 24 1994

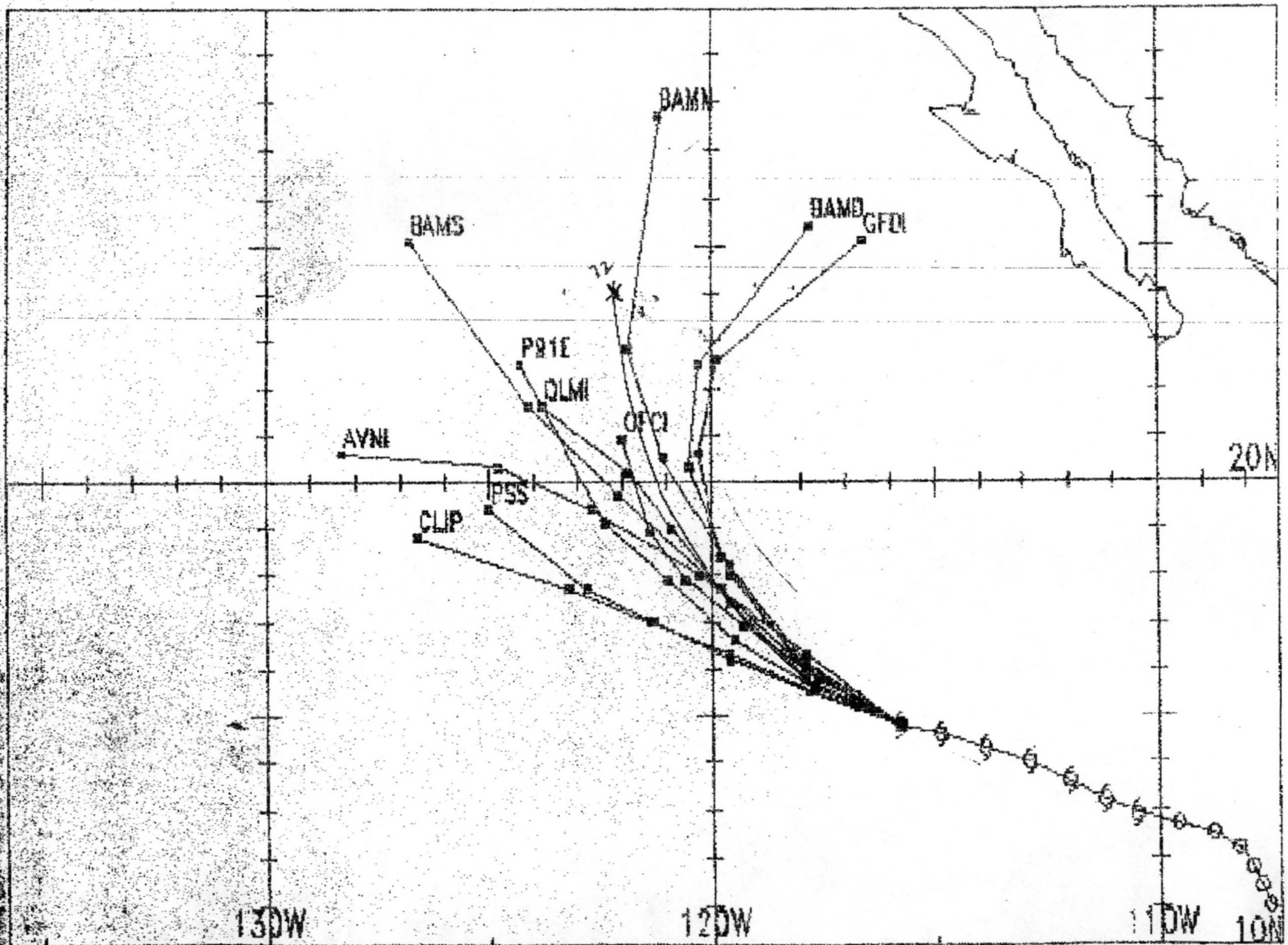
3

Lead Project Scientist Event Log

Date 9/24/94 Flight 940924I LPS Marles

Time	Event	Position	Comments

24/0600Z Olivia



SEP.21 '91 9:18AM P.3

NNNN

ZCZC MIATCDEP2
TTAA00 KNHC 240826
...FOR INTERGOVERNMENTAL USE ONLY...
HURRICANE OLIVIA DISCUSSION NUMBER 8
NATIONAL WEATHER SERVICE MIAMI FL
2 AM PDT SAT SEP 24 1994

DVORAK INTENSITY ESTIMATES ARE AT HURRICANE STRENGH...WITHOUT AN EYE FEATURE. HOWEVER THERE MAY BE AN EYE FORMING OR IT COULD BE A SUCKER HOLE. LAST GOES7 IMAGE WAS 06Z SO I AM IN THE DARK SO TO SPEAK. WITH THE VERY DEEP CONVECTION AND FAVORABLE 200 MB WINDS...I AM UPPING THE MAX WIND IN THE NEXT 72 HOURS TO 85 KNOTS...LAST ADVISORY WAS 75 KNOTS.

INITIAL MOTION ESTIMATE IS 290/10. THE MOST RELIABLE GUIDANCE MODELS SHOW A TURN TOWARD THE NORTH OR NORTHEAST AROUND THE PERIPHERY OF AN ANTICYCLONE LOCATED NORTH OF OLIVIA. THE OFFICIAL FORECAST FOLLOWS THIS GUIDANCE BUT NOT QUITE AS FAST AS THE MEDIUM AND DEEP BAM AND THE GFDL MODELS.

LAWRENCE

FORECAST POSITIONS AND MAX WINDS

INITIAL	24/0900Z	15.0N	116.4W	65 KTS
12HR VT	24/1800Z	15.5N	117.7W	75 KTS
24HR VT	25/0600Z	16.5N	119.5W	85 KTS
36HR VT	25/1800Z	18.3N	120.8W	85 KTS
48HR VT	26/0600Z	20.0N	122.0W	85 KTS
72HR VT	27/0600Z	24.0N	122.0W	85 KTS

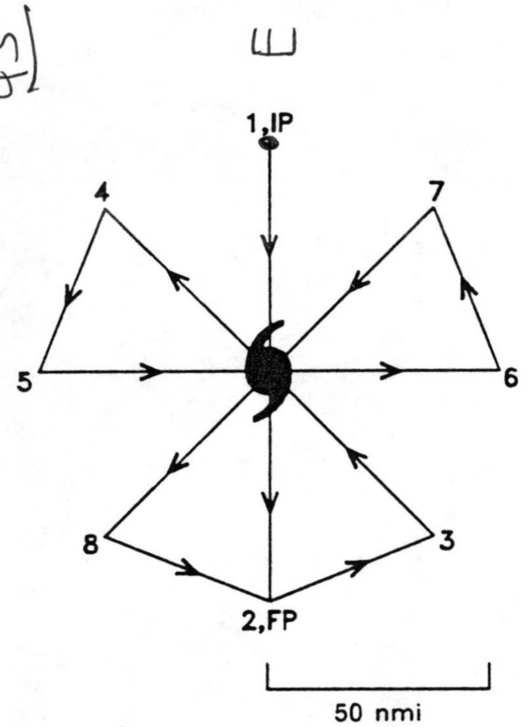
19Z 15.4°, 118.4°

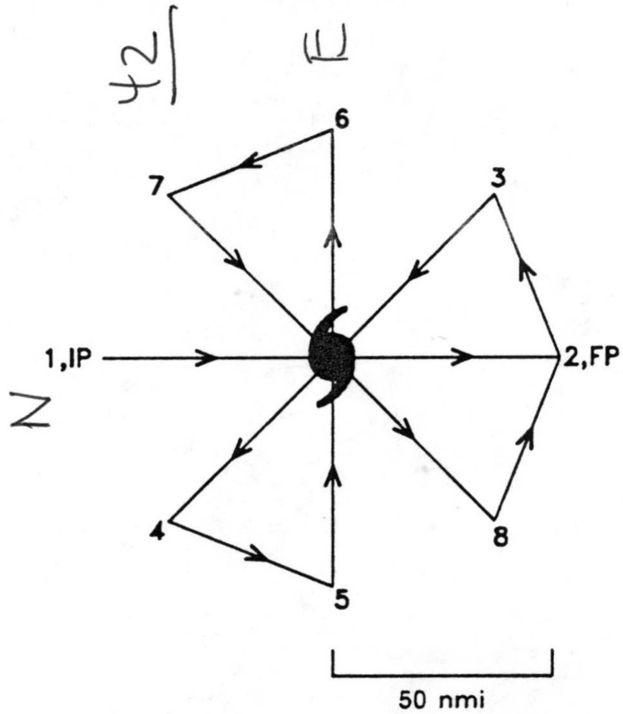
43 10 kft RA

42 5 kft RA

- Shoot for 5 legs across eye (finish where we start)
- Puts at end of downwind legs to coordinate with other a/c

INNER CORE STRUCTURE AND EVOLUTION EXPERIMENT





RA

Fig. 9. Inner Core Structure and Evolution Experiment: Upper aircraft pattern.

Fig. 10. Inner Core Structure and Evolution Experiment: Lower aircraft pattern.

Note 1. AOC upper and lower aircraft fly 1-2-3-4-5-6-7-8-2 in their respective patterns (Figs. 9 and 10, respectively).

Note 2. Each aircraft should be at the designated altitude upon reaching the IP and should maintain that altitude until point 8.

Note 3. True air speed calibration is required (Fig. C-1).

Note 4. The patterns may be entered along any compass heading, but the upper aircraft pattern should always be rotated 90° counterclockwise from the lower pattern.

Note 5. Aircraft may attempt to find a wind center on each pass, but should not "hunt" unless directed to do so. Track deviations should be kept to a minimum (10° or less).

Note 6. Cross checks between the aircraft INE and hard reference points or radio navigation aids are essential.

Note 7. During each pattern, the ODW drop in the eye should occur during the first pass through the center (a backup would be dropped in the second pass). During passes with ODW drops, the upper aircraft should be 5 min behind lower aircraft.

Note 8. During downwind legs, Doppler radar should be operated in FAST (forward/aft scanning technique) mode. (Not applicable to aircraft with dual-beam antenna.)

43
Marks
Willoughby
Griffin
Franklin
Fremmel

42
Gamache
Dodge
Burpee
P. Black
R. Black
Lawrence