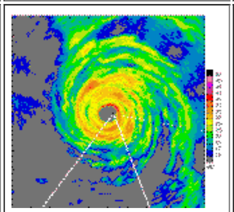
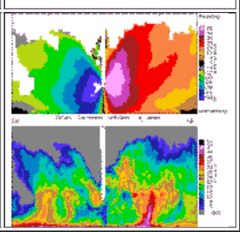
WP-3D Radars

Each WP-3D aircraft has three radars: nose, lower fuselage and tail. The nose radar (a solid-state C-band radar with a 5° circular beam) is used strictly for flight safety and is not recorded for research purposes. The lower fuselage and tail radars are used for research purposes and the data are recorded on 9-track tape prior to 1993 and on Digital Audio Tape since 1993. The lower fuselage and tail radar characteristics are:

Device	*Parameter*	*Units*	*Lower Fuselage*	*Tail*
Transmitter	Frequency	MHz	5370	9315
	Wavelength	cm	5.59	3.22
	PRF	Hz	200	1600-3200
	Pulse Length	μs (m)	6.0 (1800)	0.25-0.50 (75-150)
	Peak Power	kW	70.0	60.0
	Minimum Detectable Signal	dBm	-109	-111
Antenna	Hor. Beam Width	deg	1.1	1.35
	Vert. Beam Width	deg	4.1	1.90
	Gain	dB	37.5	40.0
	Polarization	N/A	linear *(horizontal)*	linear *(vertical)*
	Stabilization	deg	±5 *(pitch, roll)*	±25 *(pitch, drift)*
Radar	Velocity Nyquist interval	m/s	N/A	±12.88 - ±25.6
	Maximum unambiguous range	km	750.	93.75 - 46.0
	Example	Olivia (1992)		

The major drawback of the Lower Fuselage radar is the large vertical beamwidth (4.1°) which causes inadequate illumination of the targets in the beam. Inadequate beam filling is a severe problem in the estimation of the reflectivity of a storm at ranges >60-90 km (see the Appendix of Marks, 1985). The critical parameters that determine the beam illumination of the target storm are the beam's vertical dimension and orientation, and the aircraft altitude. At close range there is little loss because the radar beam is narrow enough to be totally within the strong reflectivity region at lower altitudes in the storm. As range increases, the height of the center of the beam increases and more of the beam is unfilled, or filled with the less reflective portion of the storm. This problem can be solved by compositing a number of radar sweeps in time over a fixed domain (storm- or earth-relative)

The major drawback of the Tail radar is the 3.22 cm wavelength (X-band) and high PRF. X-Band radars suffer from intervening rain attenuation which limit the maximum range at which Doppler estimates are obtained. This problem is remedied by flying close to the area of interest, reducing the distance the beam has to travel through the intervening rainfall. The high PRF, coupled with the short wavelength result in a low velocity Nyquist interval and unambiguous range. The low Nyquist velocity is the hardest of the two to compensate for as intervening attenuation minimizes problems with second trip echoes. The low Nyquist velocity can be overcome through unfolding utilizing the measured component of the air velocity along the radar beam at the aircraft as a first guess. HRD has successfully unfolded velocities as high as 90 m/s using this approach in hurricanes.

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