DYNAMO Aircraft Operations

Aircraft: NOAA WP-3D, "Kermit" N42RF

Flight hours: 105 science mission hours + 70 ferry hours

Aircraft operation base: Diego Garcia (7.3°S, 72.5°E)

Operation period: 45 days

Aircraft Science Team

Coupled air-sea boundary layer processes (ONR, funded):
Q. Wang, D. Khelif, S. Chen

Deep convection/MJO initiation (NOAA, TBD):
S. Chen, D. Jorgensen, A. Vintzileos

Dropsonde boundary layer and convection study (NSF, TBD):
Q. Wang, S. Chen

Aircraft Measurements Objectives

1) to obtain boundary layer, surface, and upper ocean measurements to address various issues associated with coupled air-sea processes in different cloud conditions and MJO phases.

2) to characterize deep convective processes and understand the complex feedback processes among surface forcing, cloud dynamics and thermodynamics, radiation, and environmental conditions in various phases of the MJO.

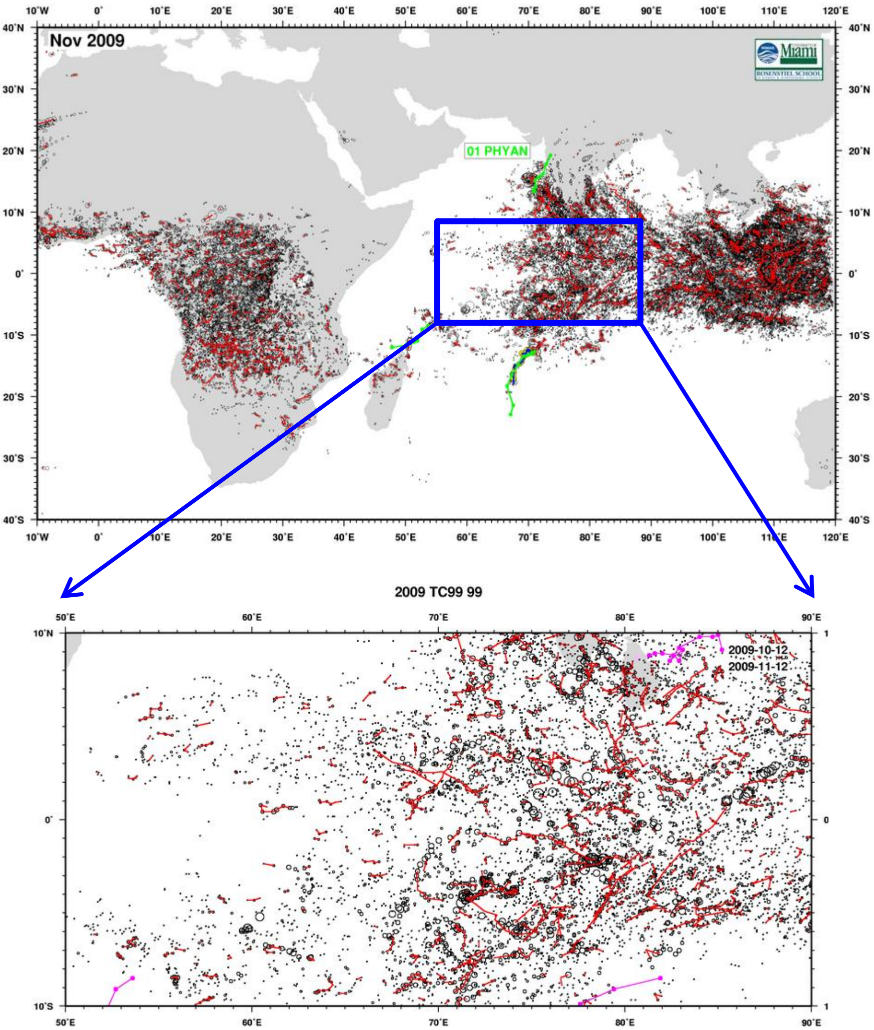
3) to extend point measurements on island and ships to a broader area near the DYNAMO region.

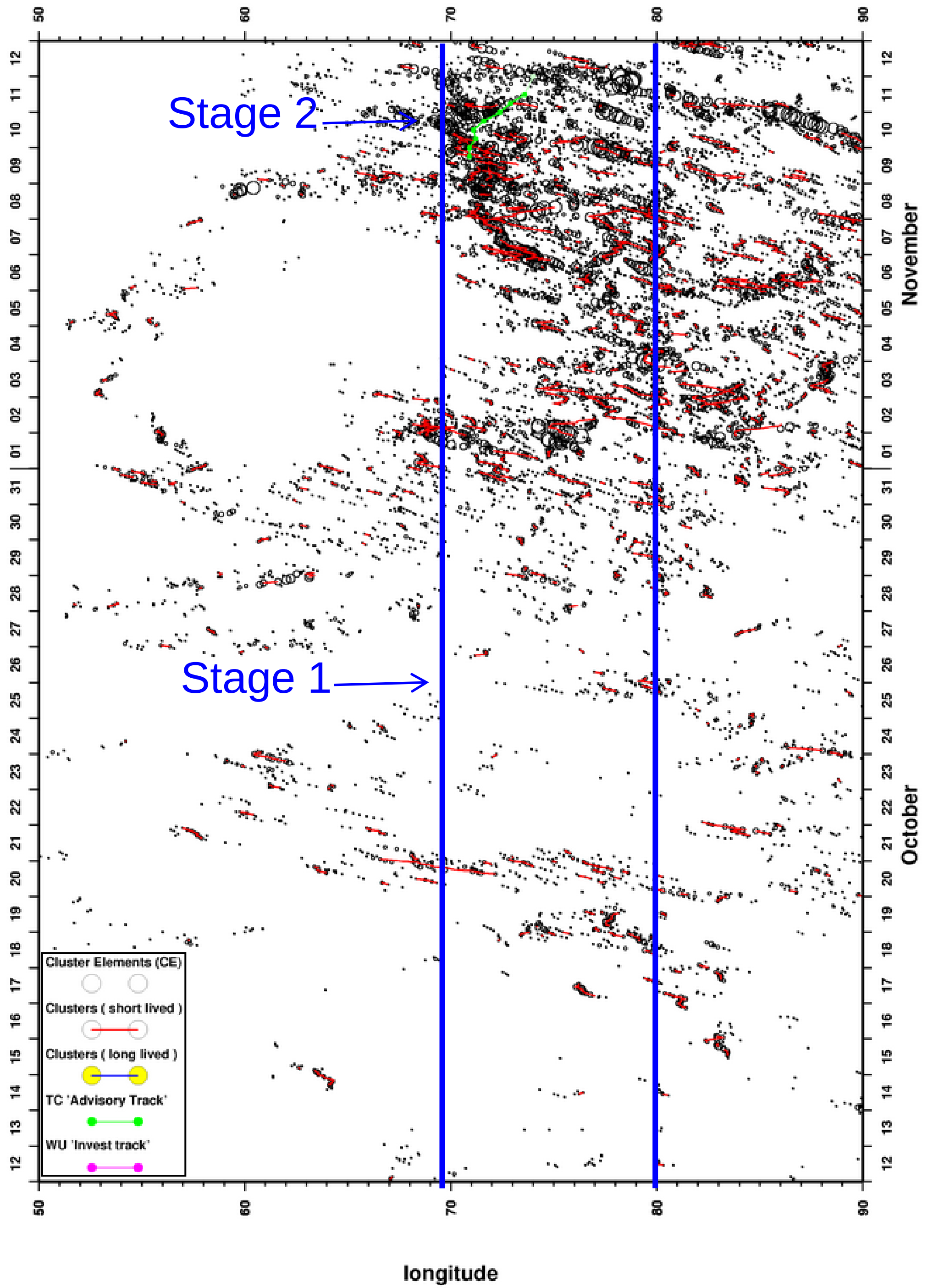
4) To obtain a suite of measurements suitable for model evaluation/validation as well as data assimilations.

Key Aircraft Instruments

Flight Level *in situ* Sensors:	**Navigational parameters** **Pressure and thermodynamic parameters** **Mean winds and turbulence** **High-rate T, q, CO_2 perturbations** **Cloud physics** **Radiation**
Radars:	**Lower fuselage C-band Doppler radar** **Tail X-band Doppler radar**
Expendables:	**GPS dropwindsonde atmospheric profiling system** **Airborne eXpendable Bathythermographs (AXBT's)** **Airborne eXpendable Conductivity Temperature and Depth probes (AXCTD)**
Others:	**Riegl LMS Q240i scanning lidar** **Stepped Frequency Microwave Radiometer** **Radiometric SST**

Cloud Clusters During MJO Initiation
(Stage 1-2 in Oct-Nov 2009)





Flight level vertical stacks (FVS)

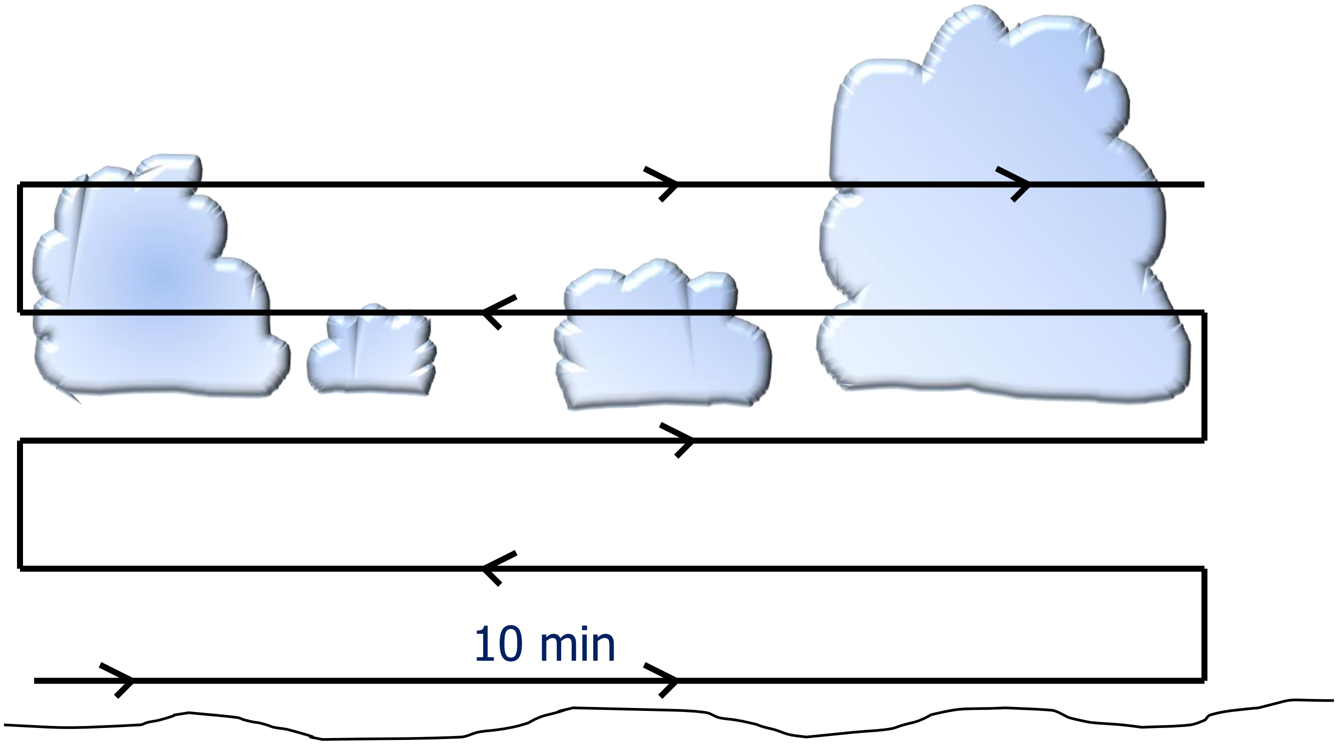


Fig. 2a Side view of flight level vertical stack (FVS) module for boundary layer turbulence gradient.

Flight level Cross-Section (FSC) profiles

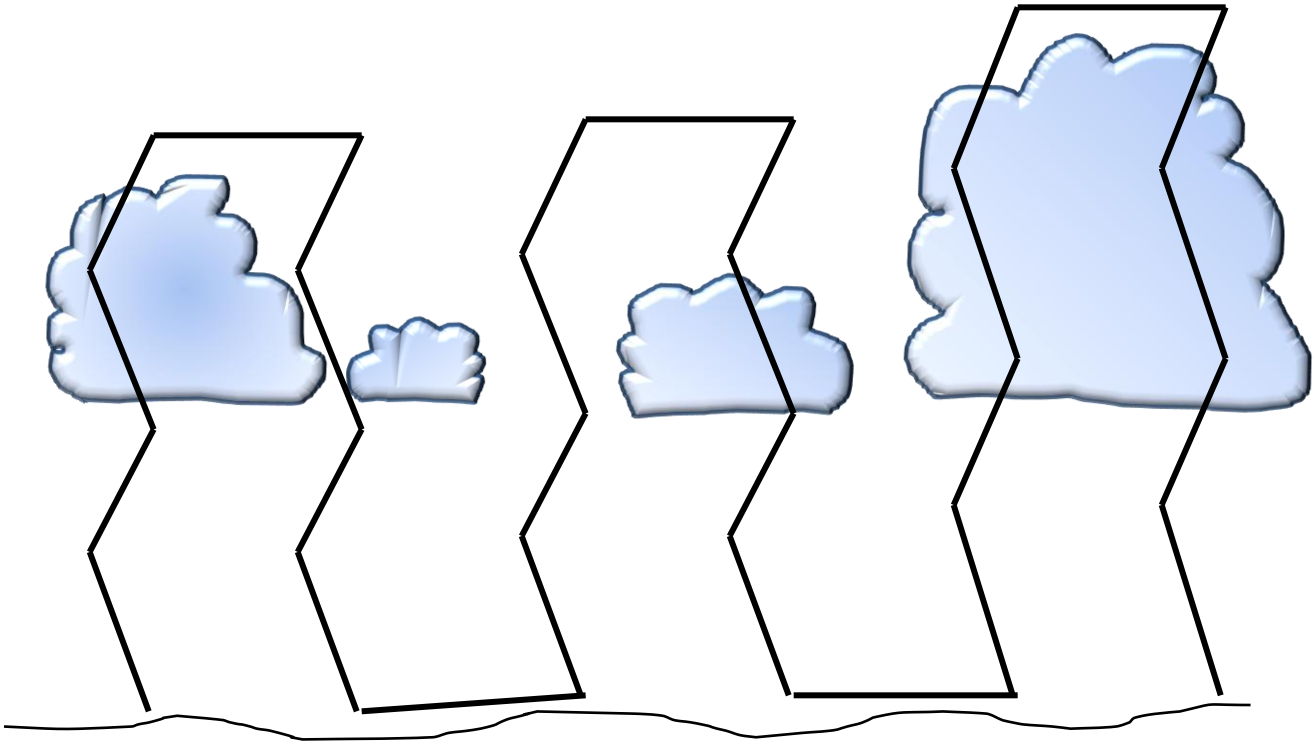


Fig. 2b Side view of flight level cross-section (FCS) profiling module.

Flight level Flux Mapping (FFM)

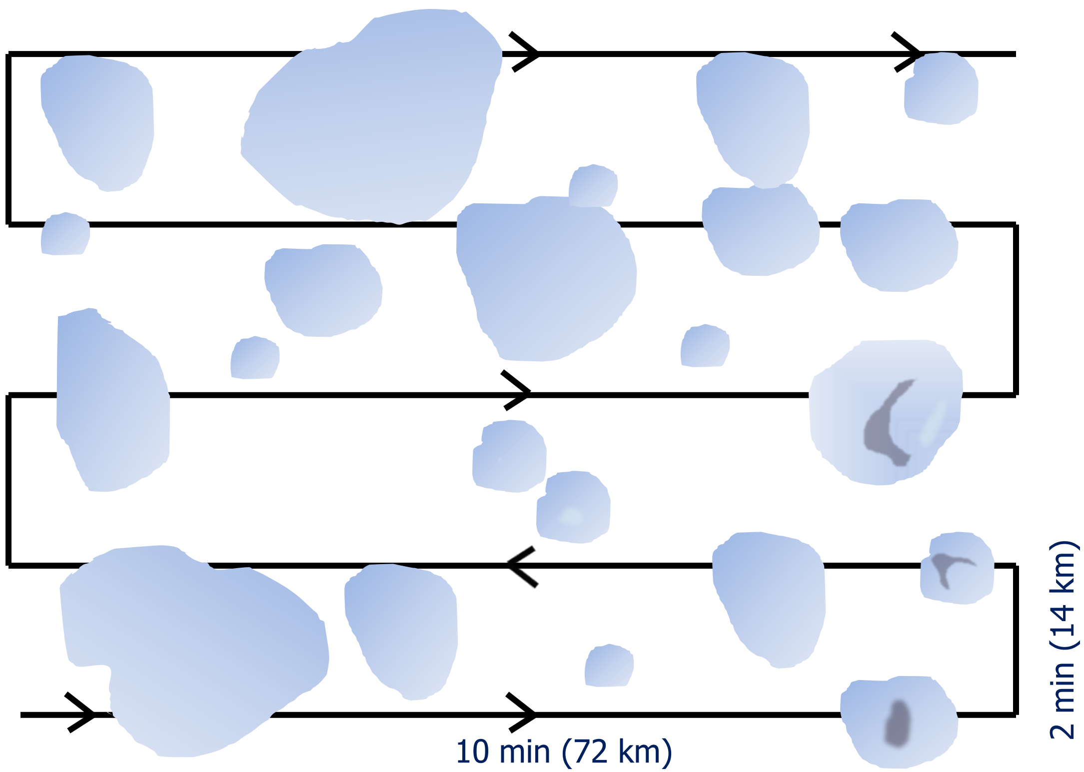


Fig. 2c Top view of flight level flux mapping (FFM) module. Depicted here includes 5 10-min legs (72 km), separated by 2-min (14 km) short legs. The total time needed for this module at a single level is 60 minutes. This module should be used at the lowest level (200') followed by a second one in the boundary layer.

Module for Radar Survey of Convective conditions (RSV)

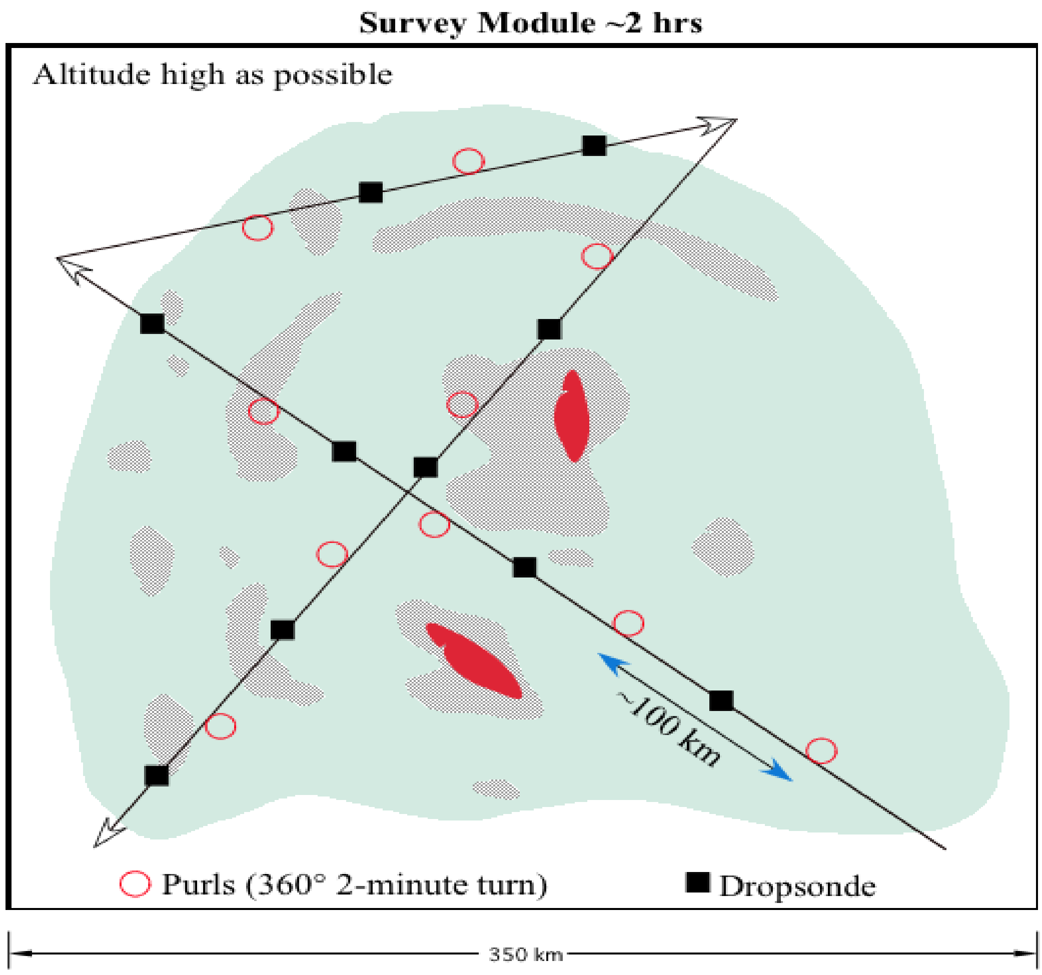


Fig. 3 "Survey" module to sample the larger scale aspects of the convective systems.

Module for convective elements (RCE)

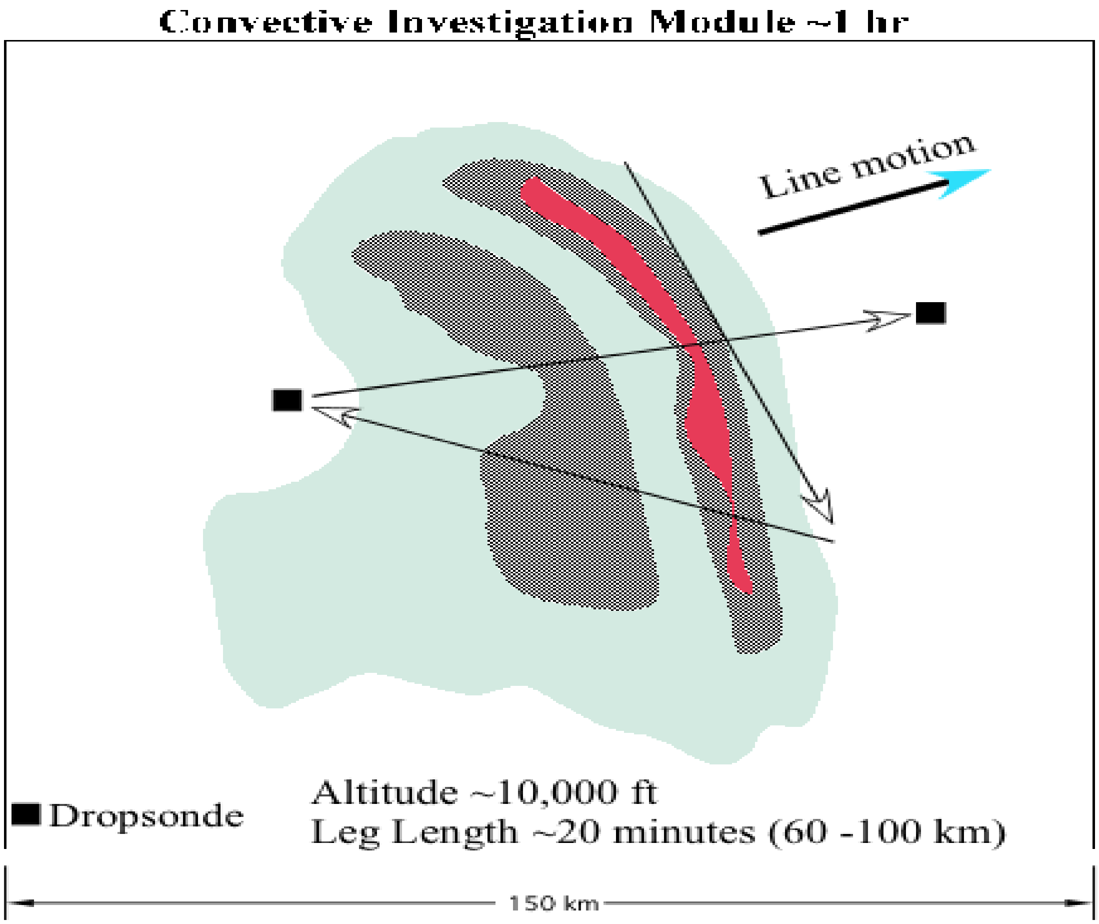


Fig. 4 The RCE module aims to investigate a particular convective element (e.g., linear feature) as shown above.

Dropsonde Area Survey (DAS) module

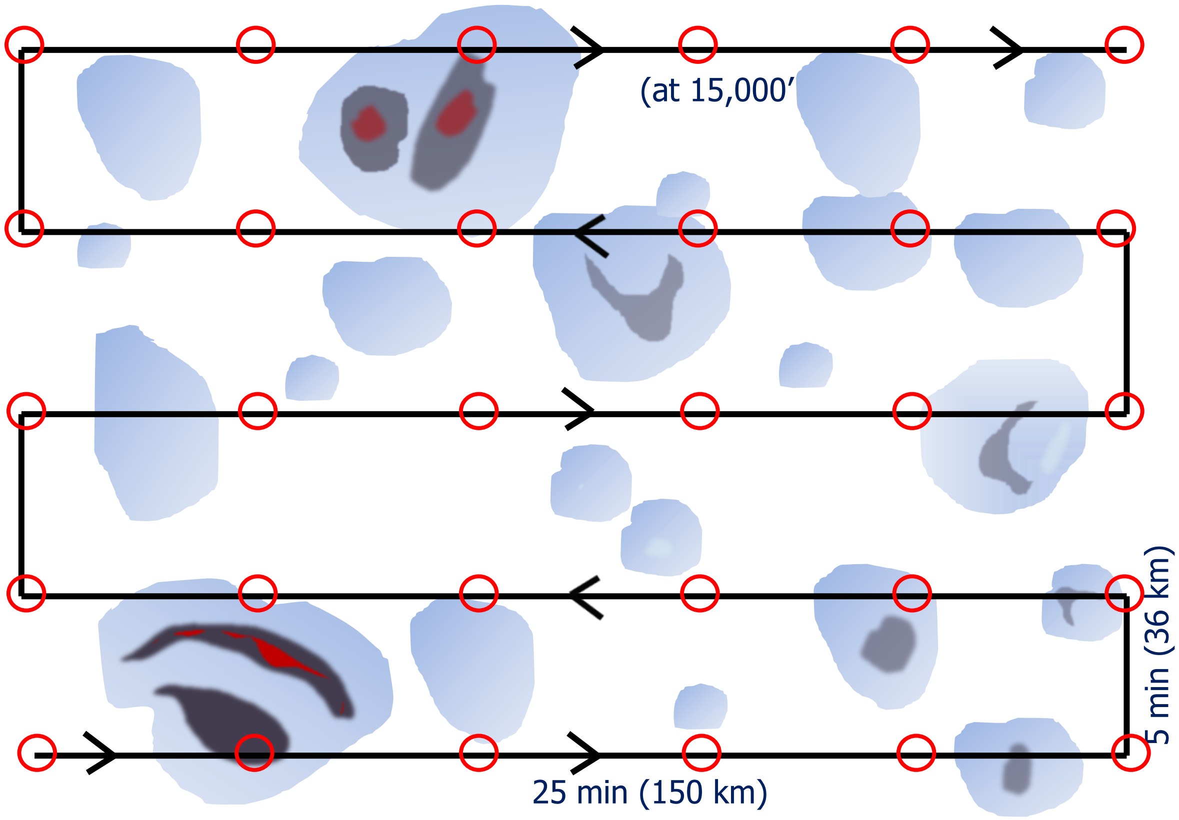


Fig. 6 Top view of gridded dropsonde area survey (DAS) module.

Dropsonde Convective Element module

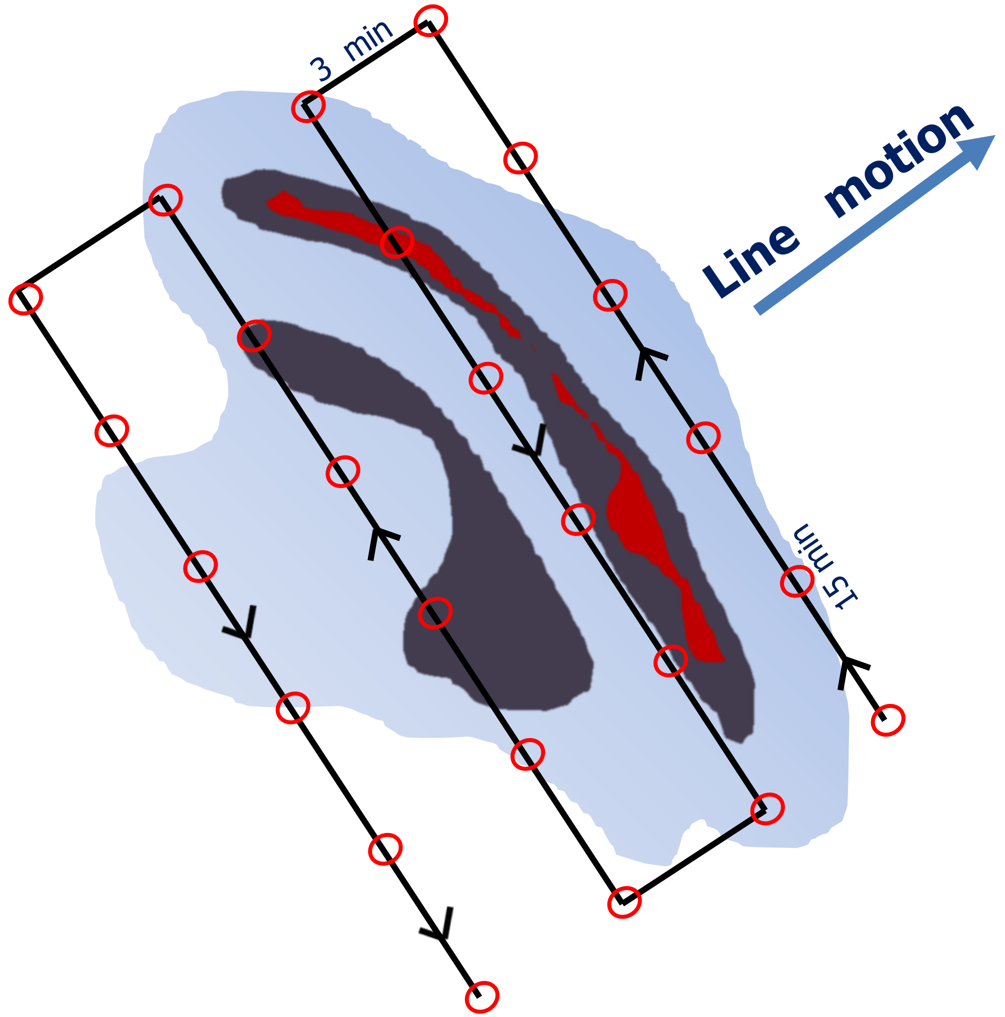


Fig. 5 DCE module at 19,000' altitude.

Issues to be resolved

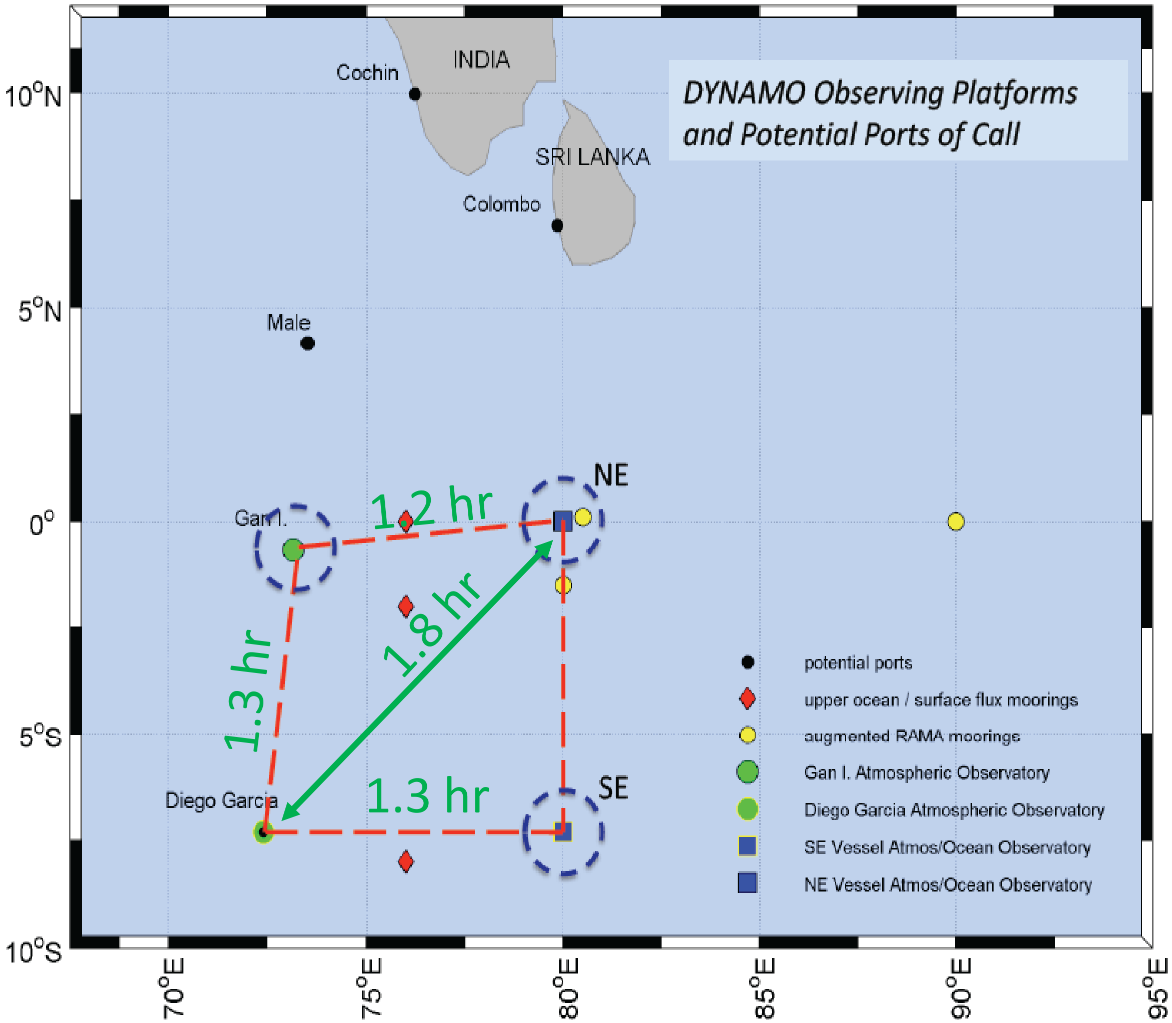
1) P-3 coordination with other facilities/platforms

- Ships
- Gan radar supersite (Falcon a more logical choice for this?)
- Sounding array (extending sounding arrays to a larger scale to west of 70 E with dropsondes?)
- Science and operation coordination with Falcon ?
- Requirements from modeling community

2) P-3 operation support

- ONR is working on logistics for basing in DG.
- Dedicated forecaster?
- Satellite imagery products
- Current cloud and weather conditions from ships
- Further refinement of flight modules with input from AOC

NOAA WP-3D and Other Facilities



- Extra slides

Aircraft and Modeling Group Collaboration

- dropsonde data
- aircraft in situ data
- aircraft radar data

Flight Level Instruments

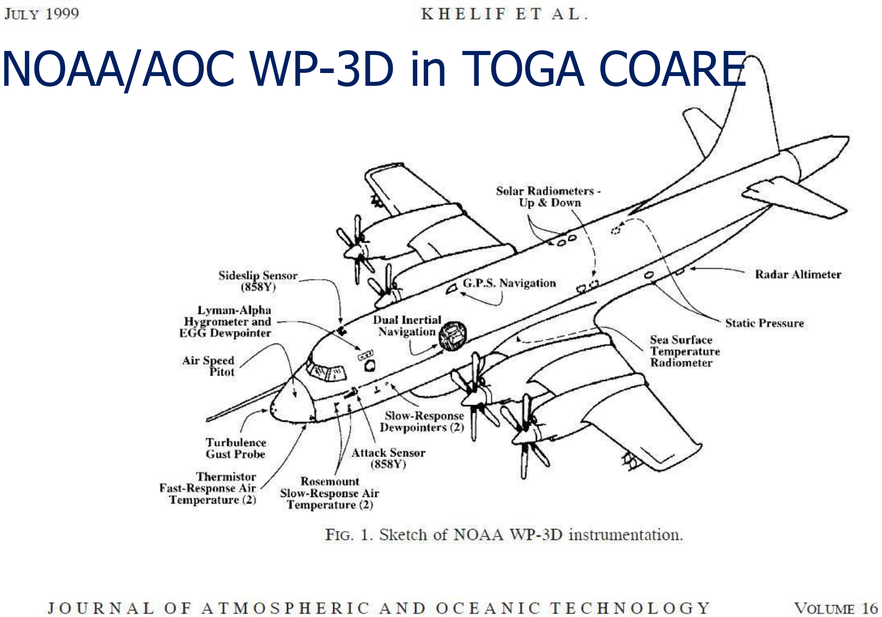
Basic WP-3D Instrumentation

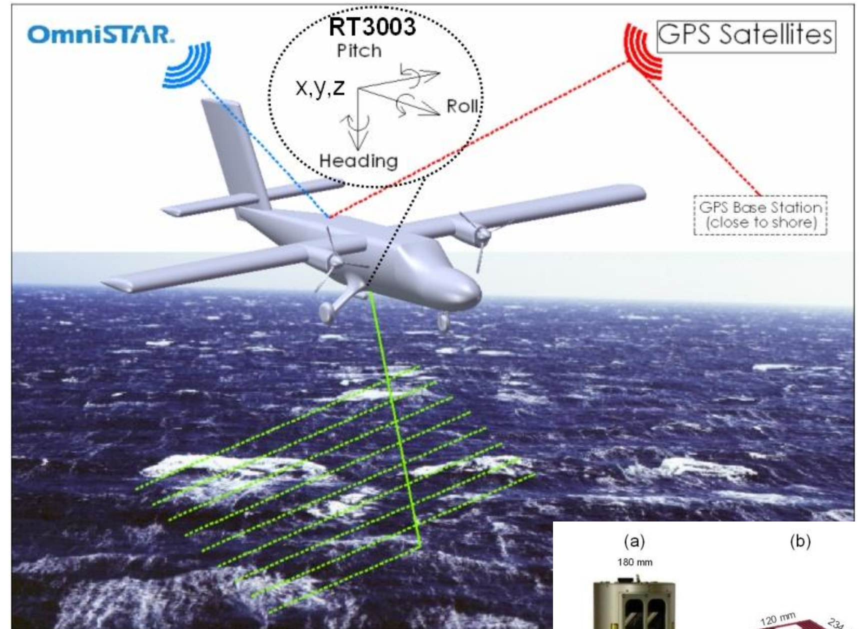
Parameter	*Instrument*	*Accuracy*	*Comments/Known Problems*
Total Air Temperature	Rosemount Platinum Resistance	0.2° C	Wetting in high cloud water regions or precipitation (wet bulb effect)
CO_2 Temperature	CO2 Radiometer modified by AOC engineers	0.5° C	Offset due to heating/cooling of window; can sense wet bulb in rain regions
Dew Point	General Eastern Cooled mirror	0.4° C dew 0.6° C frost	Wetting in high cloud water regions or precipitation; response time ~10 s
Position	GPS/Inertial Navigation	< 1 m ?	"Military accuracy" GPS
Horizontal Winds	Inertial/GPS Navigation and aircraft attitude	1 m s^{-1}	Winds suspect in steep turns/TAS checks needed for dynamic Pressure measurements.
Vertical Winds	Inertial/GPS Navigation and aircraft attitude	0.5 m s^{-1}	Accelerometer drift
Cloud Water Content	Johnson-Williams hot wire	0.20% from 0-6 g kg^{-1}	Senses drops < 40 µm
Total Water Content	"King" Probe (PMS)	??	Presently uncalibrated
Hydrometeor Images	PMS 2-DP, 2-DC and FSSP	16 µm or 32 µm	PMS 'grey probes' and data system purchased for TOGA/COARE
Vertical Profiles	GPS Dropsondes	0.1C; 1m/s	Sensor wetting in rain/clouds?

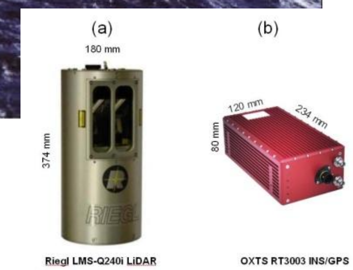
Tail Radar Characteristics

Parameter	*Tail Radar*
Scanning Method	Vertical about the aircraft's longitudinal axis; fore/aft alternate sweep methodology
Wavelength	3.22 cm (X-band)
Beamwidth:	
Steerable antenna:	
Horizontal	1.35°
Vertical	1.90°
CRPE flat plate:	
Horizontal	aft: 2.07°, fore: 2.04°
Vertical	aft: 2.10°, fore: 2.10°
Polarization (along sweep axis):	
Steerable antenna:	Linear vertical
CRPE flat plate antenna:	Linear horizontal
Sidelobes:	
Steerable antenna:	
Horizontal:	-23.0 dB
Vertical:	-23.0 dB
CRPE flat plate:	
Horizontal:	aft: -57.6 dB, fore: -55.6 dB
Vertical:	aft: -41.5 dB, fore: -41.8 dB
Gain:	
Steerable antenna	40.0 dB
CRPE flat plate antenna	aft: 34.85 dB, fore: 35.9 dB
Antenna Rotation Rate	Variable up to 10 RPM (60° s^{-1})
Fore/Aft Tilt:	
Steerable antenna	Variable up to ± 25°
CRPE flat plate antenna	aft: -19.48°, fore: 19.25°
Pulse Repetition Frequency	Variable, 1600 s^{-1} – 3200 s^{-1}
Dual PRF ratios	3/2 and 4/3
Pulses Averaged per Radial	Variable, 32 typical
Pulse Width	0.5 µsec, 0.375 µsec, 0.25 µsec
Gate Length	150 m

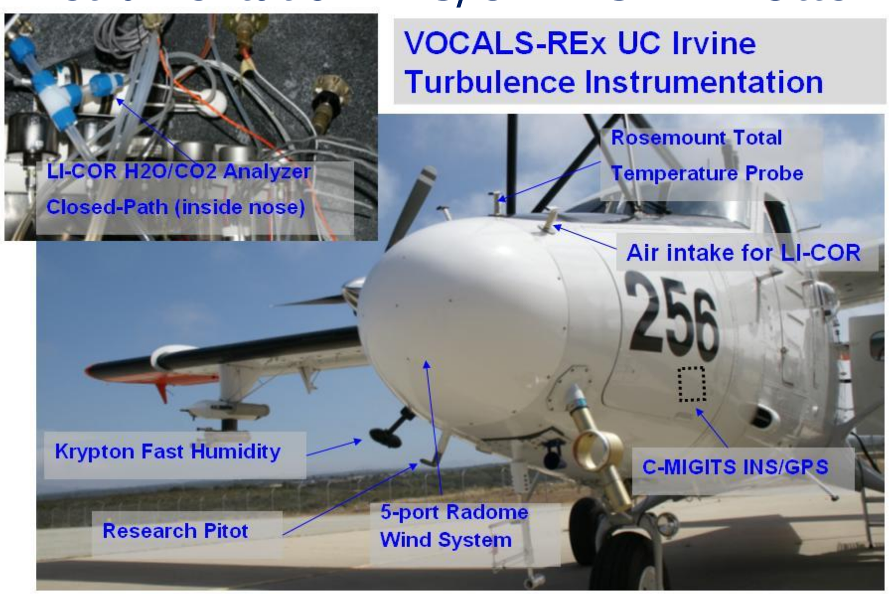
NOAA/AOC WP-3D in TOGA COARE





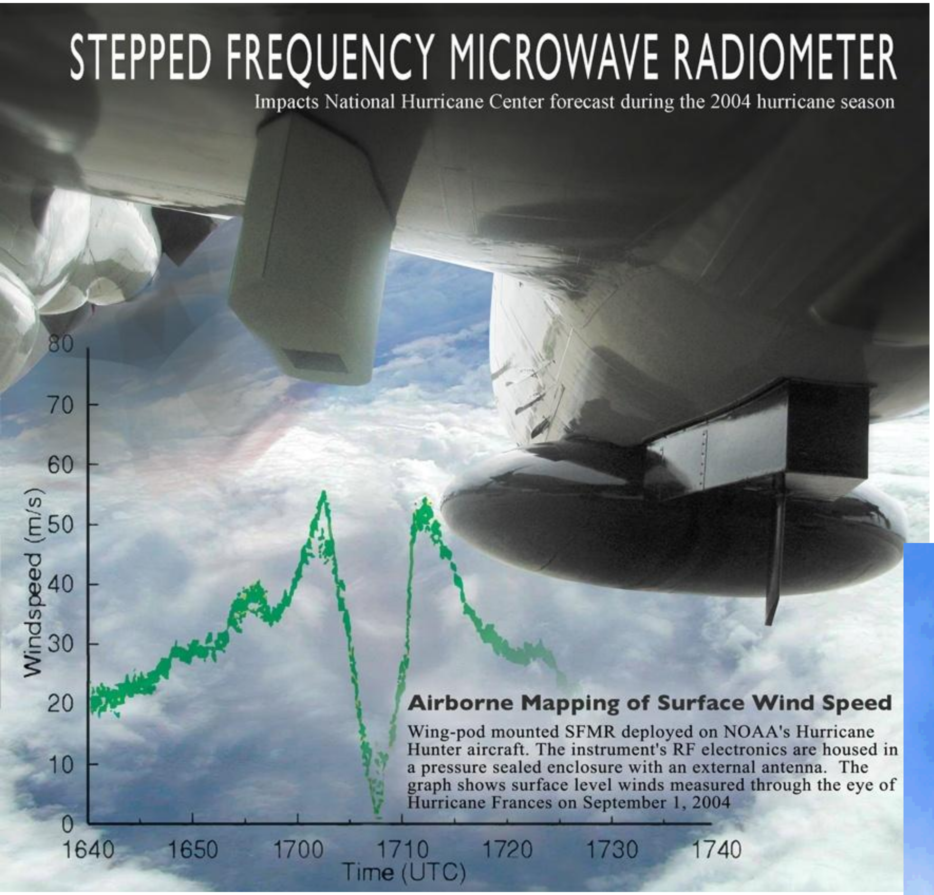


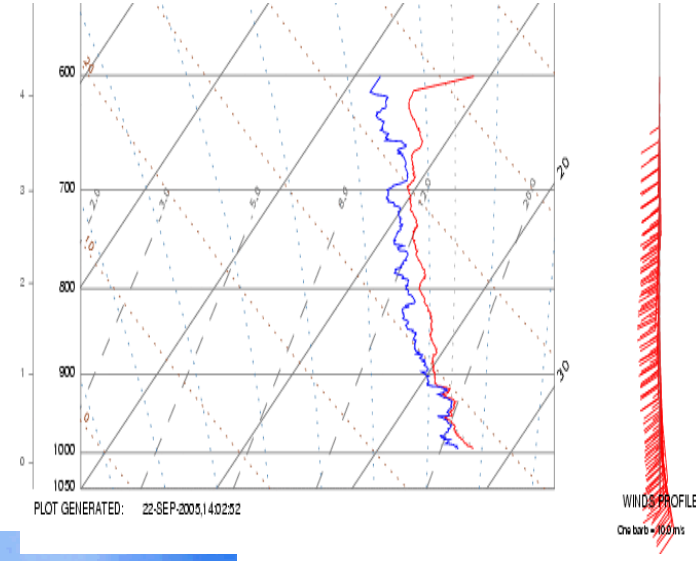
Instrumentation NPS/CIRPAS Twin Otter

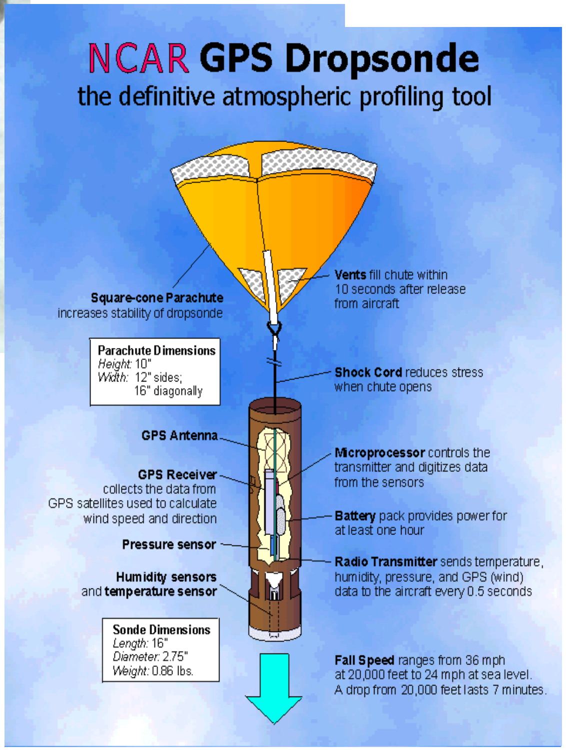


UCI DURIP:
Airborne Scanning LiDAR for 3-D wave mapping to be integrated on WP-3D for MJO DRI.

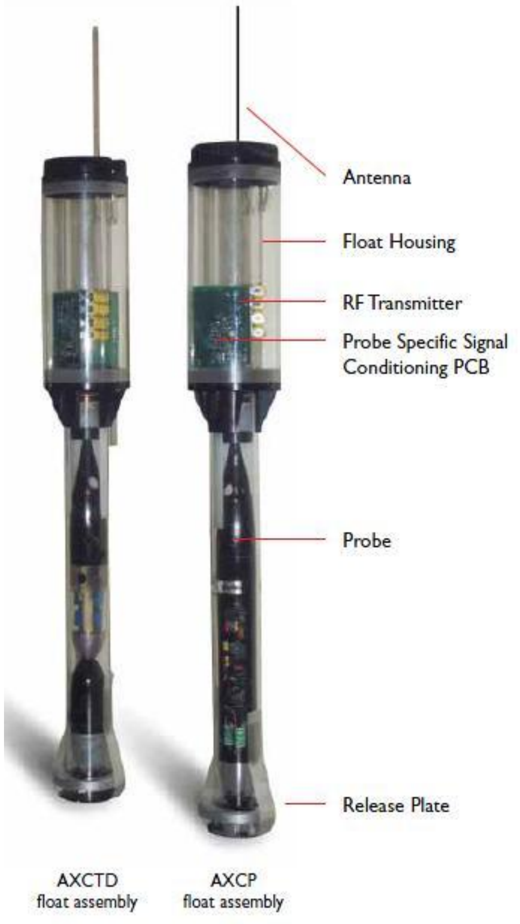
Post-COARE instruments: SFMR, GPS dropsondes, turbulence, etc.

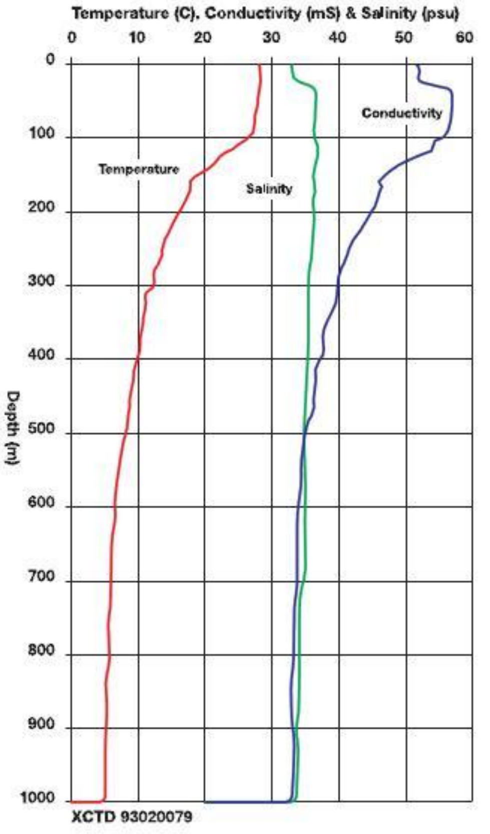






Post-COARE instruments: AXCTDs, AXCPs





An AXCTD profile

PROBE SPECIFICATIONS

PROBE	PARAMETER	DEPTH	ACCURACY	ACQUISITION SYSTEM
AXCTD	conductivity, temperature	1000 m	-0.035 mS/cm,-0.035°C	MK 12
AXSV	sound velocity	850 m	-0.025 m/sec	MK 12
AXCP	current velocity, temperature	1500 m	-1.0 cm/sec RMS,-0.2 °C	MK 10