DYNAMO

NOAA P-3 Science Summary for Mission #6, 24 November 2011

Strong Westerly Winds and Equatorial Convection during the MJO Convective Active Phase

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Note: This report is based on preliminary results and may be updated as new information becomes available.

Following the onset of convective activity near the equator within the DYNAMO domain on 22 November, large convective cloud systems are more widely spread and westerly winds are strengthening. The P-3 Science Mission #6 on 24 November was aimed to observe the MJO convective onset phases when wide spread convective systems characterized by 208K cloud clusters increased significantly in terms of numbers and sizes of the clusters (Fig. 1). The NOPP P-3 flow a 10-hrs research mission with a take off at about 0130 UTC on 24 Nov.

Fig. 1 Cloud clusters identified by the IR cloud top temperature threshold 208 K (black circles, proportional to the equivalent diameter of each clusters). The NOPP P-3 aircraft flight track on 24 November is shown in the magenta lines.
1. Enhanced equatorial westerly winds

The large-scale environment over the DYNAMO domain is dominated by the equatorial westerlies as shown by the ASCAT surface wind fields in Fig. 2. The pattern of the equatorial westerlies accompanied by a twin cyclonic gyre on both side of the equator represent a typical equatorial Kelvin-Rossby wave complex.

Fig. 2 ASCAT surface winds and METEOSAT7 IR imagery at 0400 and 1600 UTC 24 Nov. 2011.
2. Horizontal and vertical wind and water vapor distributions

The equatorial region is generally moistened by the increased deep convection in the DYNAMO domain since 22 November when the P-3 Science Mission #5 took place. The dry air region in the southern part of the domain has been retreated farther south (Fig. 3). The NOAA P-3 conducted three long transect sections to observe the vertical structure of the wind and moisture distribution using dropsondes deployed from 6,000-8,000 m.

The first section is from DGAR toward the R/V Revelle (Leg 1, Fig. 4). Several interesting features are noteworthy in the vertical wind and RH section in Fig. 4: 1) the dry layer near DGAR is above 3000 m and descends toward lower levels close to the surface at the center of the domain, 2) the wind is westerlies from the surface to 3,000 m and easterlies above 4000 m over the southern part of the DYNAMO domain, and 3) deeper westerlies toward the equator.

The second section is along the equator from near Revelle to Gan (Leg 2, Fig. 5). It shows a strong westerly jet from mid-upper troposphere to surface from west to east. The wind speed reaches 40-45 kts from 700-1500m levels west of R/V Revelle.

The last one is a meridional section from Gan to DGAR (Leg 3, Fig. 6). Again, it confirms the deep and strong westerlies near the equator, whereas the upper tropospheric easterlies prevail above 4000 m (~650 hPa) from 4-6 degree south. There is sharp shear zone between 3000-4000 m where a thin dry layer is located.

Fig. 3 Total Precipitable Water (TPW) at 0300 UTC on 24 November 2011 (UW-CIMSS).
Fig. 4 Leg 1 (top) vertical cross section of P-3 dropsonde measured RH and wind fields from Diego Garcia (A) to NE to near the equator (B). White arrows indicate predominant circulation.
Fig. 5 Same as in Fig. 4, except for Leg 2 transect.

Fig. 6 Same as in Fig. 4, except for Leg 3 transect.

3. Convective systems with extensive stratiform regions

Large convective systems are seen as groups of 208-K cloud clusters as indicated in Fig. 1, mostly over the northeastern part of the DYNAMO domain. The P-3 took off from DGAR at about 0130 UTC and is near the first convective target RCE-1 at about 0300 UTC as shown on the METEOSAT7 IR image at 1.0S and 77-79E (Fig. 7) and later for the 2nd convective system RCE-2 at about 0700 UTC near 0.2N and 78-79E (Fig. 8).

The LF radar on P-3 showed that RCE-1 consists large area of stratiform rain and mixture of convective and stratiform rain with about 20-40 dBZ (Fig. 9). The initial targeted leading line of convection has quickly evolved into stratiform rain. The P-3 descends to 200 and 400 ft to fly two air-sea flux legs in the original rear region of the leading line.

To better observe the vertical profiles of mass flux/heating in convective system, the P-3 flown several “purl” patterns that can take advantage of the Doppler radar analysis (Fig. 9).

Dropsondes are deployed at 2-3 min interval in locations perpendicular to the initial convective lines in both RCE-1 and RCE-2. In contrast to the convective systems on 22 November, the dropsonde data indicate that convective cool pools are mostly absent or
very weak in both RCE-1 and RCE-2 varying from 25-26 C, while the environmental sondes that are not near convective cool pool are 26-27 C (Fig. 9).

Fig. 7 METEOSAT7 IR imagery of Tbb at 0300 UTC on 24 November 2011. RCE-1 is the first convective system module conducted by NOAA P-3 aircraft.
Fig. 8 METEOSAT7 IR imagery of Tbb at 0730 UTC on 24 November 2011. RCE-2 is the 2nd convective system observed in detail by P-3.

Fig. 9 The NOAA P-3 LF radar reflectivity (color in dBZ) and flight tracks for RCE-1 at 0400 UTC and (upper left) and RCE-2 at 0730 UTC (lower left), the GPS dropsonde measurements of temperature and dewpoint temperature 0300-0750 UTC 24 November 2011 (right panels).