**P10.4** PROFILER AND SCANNING RADAR OBSERVATIONS OF A TROPICAL OCEAN SQUALL

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## 1. INTRODUCTION

Two wind profilers, a vertically pointing S-Band radar, and a C-Band scanning radar were deployed on the JAMSTEC research vessel, the Mirai, near the equatorial Pacific island of Nauru (0S,167E) for the Nauru99 campaign. This large campaign, sponsored by the U.S. Department of Energy's Atmospheric Radiation Measurement (ARM) program, made intensive observations of the atmosphere and ocean in this area using a variety of instruments from ships and other platforms. The campaign was carried out in late June and early July of 1999.

Conditions were generally suppressed for the campaign with only occasional convective activity observed (Brown et al 2000, Parsons et al, 2001). A few brief squalls were observed however, and observations from one of these is presented here.

## 2. RADARS

There were two 915 MHz wind profilers on the Mirai for the cruise, a Doppler Beam Swinging (DBS) system and MAPR (Multiple Antenna Profiler Radar). MAPR (Cohn et al, 2001) is an advanced profiler that uses spaced antenna techniques to make wind measurements on time scales of a minute or less, much faster than conventional DBS profilers. This system also supplies continuous measurements in the vertical, which allows uninterrupted observations of vertical motion within and in the vicinity of convection. Both profilers were mounted on stabilization platforms and had peak power of 400W. Only MAPR observations are presented here.

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Also on board for this cruise was an S-Band vertically pointing radar from NOAA/ETL.

The C-Band weather surveillance radar is a Mitsubushi RC-52B model with Sigmet processing, a $1^{o}$ beam width, 250kW power, and has Doppler capability. It is mounted permanently on the Mirai and is operated by JAMSTEC.

## 3. OBSERVATIONS OF A SQUALL

Figures 1 and 2 show observations of a squall on 27 June 199, when the Mirai was approximately 200 km west of the island of Nauru.

The upper three panels of figure 1 show time-height plots of measurements made by MAPR. The total panel is reflectivity; the scale is approximately in dBZ units, loosely calibrated using comparisons with the well calibrated C-Band radar. The second panel is vertical motion; the crosses indicate upward motion. The third panel shows 5 minute consensus averaged winds. The bottom panel shows winds as measured by an anemometer mounted on a ship's mast about 20 metres above the sea surface.

Two squalls are shown in figure 1, at about 0640 UT and 0805 UT. The second event is the event of interest here. Periods of updraft can be seen around both squalls; of particular interest here are the updrafts preceding the second squall at about 0730 – 0800 UT. In fact during the whole period between the squalls, there are oscillations in the vertical velocity with a period of about 5 – 10 minutes which appear to be gravity waves. Similar oscillations can be discerned in high resolution plots of MAPR winds (not shown). As the second squall approached the upward phase of this oscillation became stronger suggesting mesoscale lifting.

The rapid wind measurement capability of MAPR allowed it to observe the arrival of gust fronts with the squall. The brief period of rain aloft at 0755 UT had northeasterly gusts of about 15 m/s. More gusts were seen aloft as the main squall arrived at 0805 UT. The strongest gusts were in excess of about 25 m/s in the upper part of the system. A radiosonde sounding at 0900 UT observed similar gusts.

The surface winds were light before 0800 UT and picked up with the arrival of the main squall. The strongest gusts at the surface (about 15 m/s) occurred about 0820. The temperature at the surface dropped about 4$^{o}$C during the squall.

Figure 2 shows a CAPPI from the C-Band radar and several squall cells can be seen. The deepest contours in the cells is about 40-45 dBZ, the contour around the edge of the cells is 7 dBZ. The range rings are at 50 and 100 km from the Mirai, and upward on the plot is towards the north. The cells exhibited loose organization and evolved considerably as they moved. Their motion was predominantly westward at about 10 m/s. The cell just to the east of the Mirai is the one that passed overhead.

## 4. DISCUSSION

Several aspects of the observations of this squall are interesting and are being further investigated.

The apparent gravity waves and mesoscale lifting ahead of the second squall support theoretical work on gravity wave response to convective heating and cooling. For example, the gregarious convection model of Mapes (1993) showed how gravity waves propagating out from a convective system can lead to lifting which favors the formation of additional convective systems and the continued propagation of the squall line.

Also interesting are the very high fall speeds seen by MAPR at about 0820UT, coinciding with the strongest wind gusts seen at the surface. Fall speeds were in excess of 10 m/s with some components of the Doppler spectra up as high as 15 m/s where velocity folding was occurring. The S-Band radar saw similar fall speeds at this time. Neither radar saw a strong increase in reflectivity with the higher fall speeds. These observations suggest a strong convective downdraft occurred.

Doppler spectra from MAPR taken during the squall are also being examined. For some periods a clear-air echo can be separated from the precipitation echo allowing fall speed distributions to be determined. This work will be aided with Doppler spectra from the S-Band profiler. A video disdrometer was also operating during the squall. It is intended to compare the profiler and disdrometer observations to gauge how well drop size distributions can be determined from MAPR for this event.

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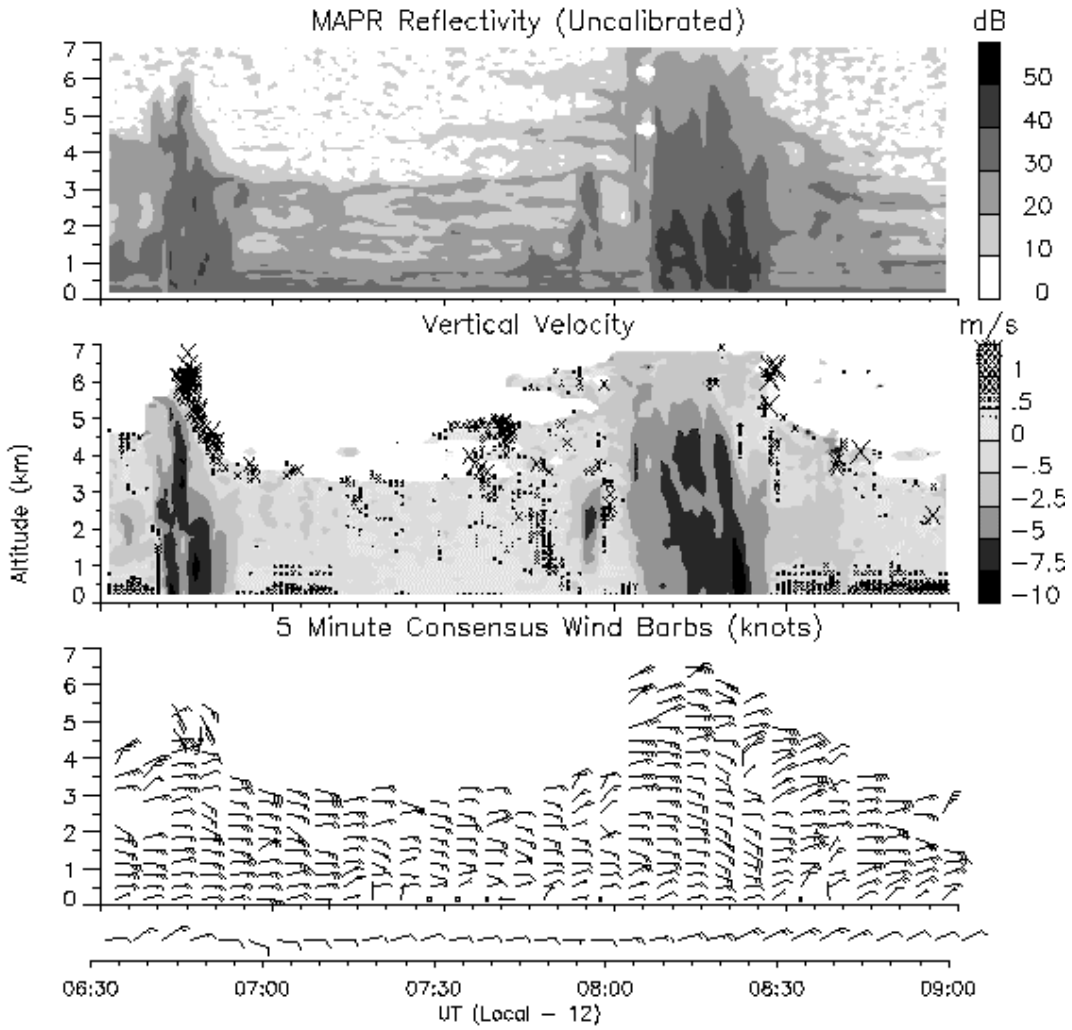


Figure 1 : MAPR observations (upper 3 panels) and surface winds, 27 June 1999.

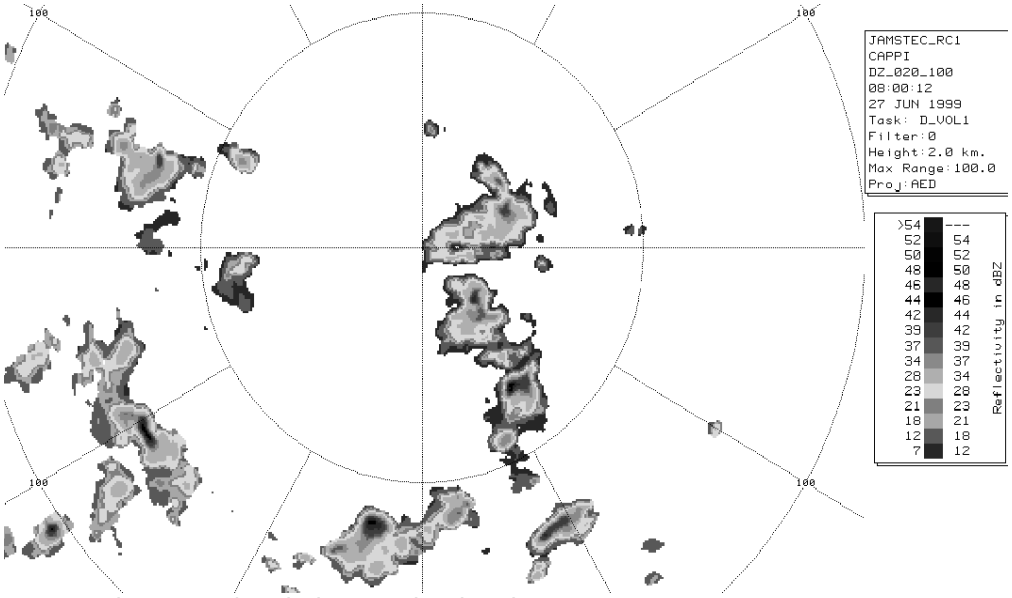


Figure 2: R/V Mirai C-Band radar 2km CAPPI 27 June 1999, 0800UT