A Comparison of Various Processing Techniques for 915-MHz Profiler Winds

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Introduction

The Nauru99 Intensive Operational Period (IOP) took place from June 16 (Day 167) to July 15, 1999 (Day 196) on and near the Republic of Nauru (0.5° S, 166.9° E). One goal of Nauru99 was to improve our understanding of the effects of small islands on atmospheric processes. Wind profilers were operated on the southern edge of the island's plateau and also aboard two research vessels (R/Vs) that were stationed at varying distances from the island. The profilers were operated by three different groups and the wind data collected was initially processed by three different methods. The simultaneous operation of these nearly collocated platforms provides a fine opportunity to evaluate the effects of the various processing methods on the long-term wind fields.

Data and Methods

Two ship-based 915-MHz wind profiling Doppler radars were deployed during the Nauru99 IOP, one aboard the R/V *Mirai* and another aboard the R/V *Ronald H. Brown* (Fairall et al. 1997). In addition, a 915-MHz profiler has been collecting data on Nauru since 1992, first during the Tropical Ocean Global Atmosphere-Coupled Ocean Atmosphere Response Experiment (TOGA-COARE) IOP (Parsons et al. 1994) and afterwards as part of the Trans-Pacific Profiling Network (TPPN) operated by the University of Colorado and the National Oceanic and Atmospheric Administration Aeronomy Laboratory (NOAA/AL). Some specifications for the three systems are shown in Table 1. All three systems operated in a multi-beam 105-m pulse length mode; the R/V *Ronald H. Brown* and Nauru profilers also collected multi-beam data at 420-m and 495-m pulse lengths, respectively. Those two profilers operated as Doppler Beam Swinging (DBS) systems throughout the experiment. The R/V *Mirai* profiler operated in Radio Acoustic Sounding System (RASS) mode for 5 minutes at the start of each hour, in DBS mode for 25 minutes, again in RASS mode for 5 minutes, and then in Multiple Antenna Profiler Radar (MAPR) mode for 25 minutes.

Table 1. Nauru99 915-MHz profiler parameters.

	R/V *Mirai*	**R/V *Ronald H. Brown***	**Nauru**
# Beams	5	3	3
Recurrence Time	2 min 43 sec	6 min 2 sec	4 min 52 sec
Platform Stabilization	Gyrostabilized	Gyrostabilized	N/A
Mode 1		60 m (vertical beam only)	60 m (vertical beam only)
Minimum Height[(a)]		0.192 km ASL[(b)]	0.192 km ASL
Maximum Height[(a)]		6.372 km ASL	6.372 km ASL
Pulse Coding		None	None
Dwell Time		40 sec	40 sec
Mode 2	105 m	105 m	105 m
Minimum Height[(a)]	0.130 km ASL	0.162 km ASL	0.304 km ASL
Maximum Height[(a)]	6.325 km ASL	6.778 km ASL	6.919 km ASL
Pulse Coding	8-bit	4-bit	4-bit
Dwell Time	29 sec	43 sec	43 sec
Mode 3	495 m (vertical beam only)	420 m	495 m
Minimum Height[(a)]	0.120 km ASL	0.485 km ASL	0.519 km ASL
Maximum Height[(a)]	10.065 km ASL	17.495 km ASL	17.529 km ASL
Pulse Coding	None	None	None
Dwell Time	30 sec	45 sec	45 sec

(a) Height information is for the vertical beam.
(b) ASL = above sea level

All three systems use the "POP" program to produce real-time averaged wind files and plots. The horizontal wind data from the R/V *Mirai* has not been post-processed, other than to account for ship motion and direction in graphical displays. The R/V *Ronald H. Brown*'s data has been post-processed using a modified version of the Weber-Wuertz algorithm (Weber and Wuertz 1990). The horizontal wind data from Nauru has been post-processed and quality controlled using algorithms developed at NOAA/AL for the data collected by profilers during TOGA-COARE (Riddle et al. 1996). Table 2 points out some of the significant steps in each method. It also gives information about the "native" temporal resolution of the winds produced. Because only DBS winds will be used in this comparison, only half-hour averages are possible for the R/V *Mirai* data. However, the POP software is capable of hour-averaging winds.

Table 2. Processing applied to 915-MHz profiler winds collected during Nauru99.

	R/V *Mirai*	**R/V *Ronald H. Brown***	**Nauru**
"Native" Processing:	POP	"Modified Weber-Wuertz"	"TOGA-COARE"
Moment[(a)] Calculation	Moments calculated from highest peak after ground clutter removed	Moments calculated from highest peak after ground clutter removed (i.e., POP moments used)	Moments calculated using multiple peak finding and checks for ground clutter, sea clutter, and RFI
		Time-height check on moments	
Ship Motion	No ship motion correction applied	Moments corrected for ship speed, course, heading	See Note 1
Wind Calculation	Consensus average of moments into winds	Moments averaged into winds	Moments averaged into winds after outliers tossed (e.g., low signal-to-noise ratio)
		Time-height check on winds	Time-height consistency check on winds
Averaging Period for Winds	Half-hour (see Note 2)	Hour	Half-hour (hour possible)
Number of Scans per Average	10	10	7

(a) The moments referred to are: (0) signal power, (1) Doppler velocity, and (2) spectral width.

Note 1: When ship data are put through the TOGA-COARE processing, moments are corrected for ship, speed, course, and heading.

Note 2: POP will allow half-hourly average winds to be computed; however, the R/V *Mirai* operated in DBS mode for only 25 minutes per hour, so hour-average winds are unavailable from that particular profiler.

The data from the two ships are being post-processed with the TOGA-COARE algorithms. All three data sets may also be processed with the algorithms used by Angevine et al. (1993) for midlatitude profiler winds.

Future Work

Once the post-processing is complete, we will be comparing the winds produced by the various methods in several ways. We plan to look for differences in:

- wind profile statistics during the IOP
- height coverage
- the daily cycle of winds
- performance on individual days or parts of days when specific phenomena or conditions were present

    - clear air
    - rain
    - ship underway
    - "reef clutter" (shipboard systems)
    - other non-atmospheric targets.

The results of these studies will enable us to provide Nauru99 researchers with a recommended, internally consistent profiler-based IOP wind data set. The recommendations should be applicable to the 915-MHz profilers operating at other Atmospheric Radiation Measurement (ARM) Program sites, including the Tropical Western Pacific (TWP) site on Manus. The results will also be of interest to the profiler community at large, which has not yet developed a consensus on which processing method(s) provides the best research-quality winds.

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