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The Australian Bureau of Meteorology 1280 MHz Wind Profiler

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Introduction

The basic concepts for wind profiler radars are now well developed. However, the design of most profilers operating at UHF frequencies and boundary layer profilers in particular now date back about 10 years. The last decade has seen considerable advances in affordable state of the art DSP technology and fast components allowing for example fully digital receiver systems and digitising the radar signal at IF frequencies. These advances allow for a system that is less sensitive to interference and the application of technologies such as pulse coding which can be designed into the system from the start. Furthermore, we are now much more aware of the potential impact of birds on the quality of the data, which in turn impacts upon the basic design parameters of the radar.

Profiler Hardware

The Bureau of Meteorology has produced a modern 1275 MHz wind profiler system. The heart of the profiler is a fully digital signal generation and receiver system that resides on a single DSP card within a PC. The software has been constructed to allow for easy modification and inclusion of algorithms at all stages of the data acquisition, processing and display.

The transmitter is a 500 W peak power valve system. Three separate 3.5 m diameter dishes are used. The use of large dishes is to give as small a beam width as possible to improve system sensitivity and to illuminate as small a pulse volume as possible in minimising interference from birds.

The signal processing system consists of a PCI TMS320C6201 DSP card and an acquisition board. The acquisition board provides all radar timing, a 70MHz Transmit exciter pulse whose characteristics can be selected from 16 pages of waveform memory, a receiver AGC output, 16 status and 16 control lines, 6 programmable pulse outputs, and a 70MHz balanced receiver IF input.

The receiver input provides band limiting for under sampling, a 40Ms/s 12 bit ADC, an out of band noise source and a double buffered memory connection to the DSP. The 10MHz centered digital IF samples are transferred to the DSP using a DMA channel and are down converted to base band. They are then filtered to match the selected transmit pulse bandwidth and coherently averaged. The averaged I&Q bins are then transferred to the PC over the PCI bus. All

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parameters are programmed via the profiler software's GUI. The DSP card also provides an output for RASS. The RASS audio is generated on the DSP board, amplified with a commercial PA amplifier and fairly standard drivers and dished are employed.

Profiler Software

The I and Q outputs are sent to a PC and all further processing is performed there to allow maximum flexibility. The code is modular and built around several distinct stages, time series filtering for the first stage clutter rejection, windowing and power spectral calculation and averaging. An image processing approach is taken to separate atmospheric signals and clutter. The spectral moments of the weather signals are then calculated, followed by wind estimation and then output. At present a consensus averaging approach is used, but a Weber and Wuertz (1991) style approach on the moments will be implemented shortly. The output data can be archived at several levels, from the time series, averaged spectra, moments and averages. Averaged winds and power are then forwarded to the Bureau's real time data system for display and archiving automatically Fig 1 shows two examples the real time profiler display system. The profiler was running with reduced sensitivity at this time and using a 1 micrsec pulse-length. The examples are chosen to illustrate the RASS performance (top panel) and the selection of weather echoes discriminated against a ground clutter spectral peak. The peaks near a speed of 7 ms^{-1} in the lower heights are due to 50 Hz modulation of the transmitter power combined with the large clutter signal. The clutter problem is being addressed on the hardware side, with improved antenna feeds and a clutter fence that will substantially reduce the clutter contamination, as well as with more sophisticated filtering of the time series at low heights (at present a simple linear trend is being removed from the I and Q time series).

The processing system is flexible. For example sampling with a large Nyquist velocity can be performed, but the processing will only look at a velocity window of interest. The benefits of this approach include decreasing the probability of interference affecting the data. A period of system development is planned. Further improvements will include the kinds of data processing mentioned above and the implementation of coded pulses to improve the system sensitivity. The current height coverage for wind measurements is from about 400 m up to 2-3 km depending on conditions. The minimum height will be improved by minimising the clutter as discussed above, the use of short pulses (~0.5 microsec) and other system improvements. The maximum height coverage will include coded pulses improving system sensitivity by ~ 10 dB. The RASS height coverage is from 200 m up to 800 m-1km. The lower minimum height for the RASS is an indication of the performance that can be achieved, even with a quite long pulse for boundary layer measurements.

The data produced is sent to the Bureau for ingest into NWP systems and display within the Bureau's Australian Integrated Forecast System. The profiler display shows time height sections of the winds and power and includes hodographs and other diagnostics(fig 2). There is also a stand alone version of the display that operates on a Linux PC.

The profiler has been developed for Bureau use, but as the system matures it will also be available commercially as an end to end system including the displays and simple archiving. The system itself is being improved with modifications to the antenna to reduce clutter problems, pulse coding for greater height coverage and improved software.

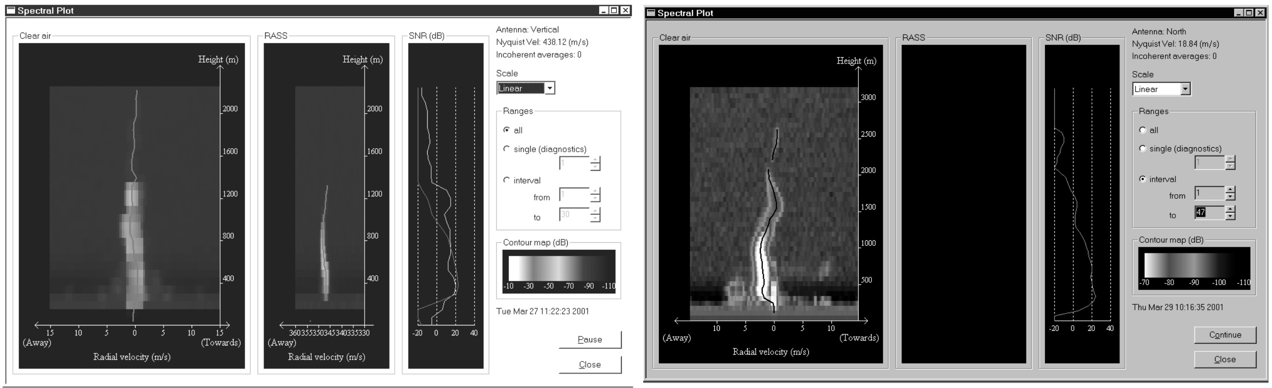

Fig 1. Real time radar display showing RASS (left) and a north beam (right). Note the resistance of the algorithm to clutter and interference signals in the low gates.

References

Weber, B. and D. Wuertz, 1991: Quality control algorithm for profiler measurements of winds and temperatures, NOAA Tech Memo, ERL, WPL-212.

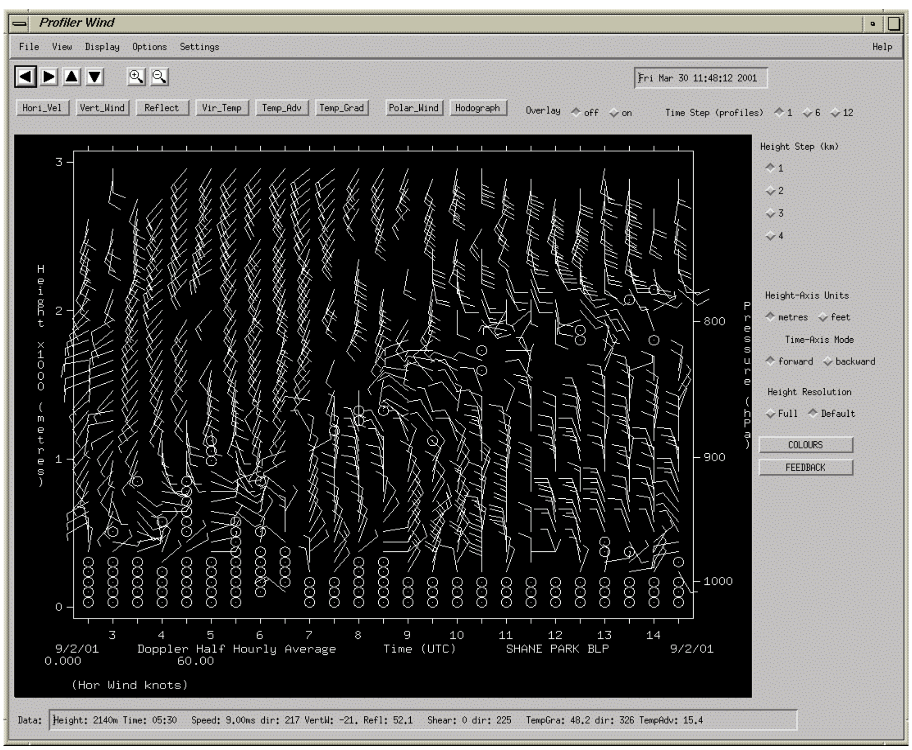

Fig. 2. Real time display within AIFS. Forecasters can overlay reflectivity, vertical motion and diagnostic fields. The display may be colour coded for speed. Hodographs are also available within the package.