ATRAD and the University of Adelaide

The Adelaide University Physics Department has been a pioneer in the development of Windprofiler technologies over many years. Many leading scientists in the field and at least four companies can trace their roots back to Adelaide.

ATRAD was originally established to commercialise, under license, techniques developed within the University.

ATRAD is now owned by Prof's Iain Reid and Robert Vincent, both highly accomplished scientists in the field of atmospheric physics.

In 2004, ATRAD bought out its license agreement and as a consequence has full control of its intellectual property.

ATRAD continues to enjoy an excellent collaborative relationship with the University. In fact three of the radars in the Australian Profiler network are owned by the University.

Using the Spaced Antenna Technique

The Spaced Antenna (SA) technique is well established from a scientific perspective and most of the Boundary Layer Windprofilers in Australia use the Spaced Antenna technique.

But Australia is unique in this regard and most Windprofilers around the world use the Doppler Beam Swinging (DBS) technique.

The Spaced Antenna technique has many advantages over Doppler which arise from the fundamental difference in operation. Doppler radars essentially produce a sequence of orthogonal off-zenith beams. Vector maths are used to decompose measured velocities into the component wind directions.

In the Spaced Antenna case, a single vertically directed signal is transmitted and the backscattered signals form a diffraction pattern on a receiver array. A correlation analysis is used to retrieve the wind information.

The Spaced Antenna Windprofiler has no switched beams - not only does this considerably simplify the radar electronics (and hence reduce cost), it also means the profiler is able to sample the winds more rapidly than its Doppler counterpart.

As there is no need to form a narrow beam, the antenna arrays can be smaller—which also means that winds can be obtained from lower range gates than an equivalent Doppler Windprofiler. Whereas a 50MHz DBS radar will typically obtain returns from 1000m upwards, a Spaced Antenna profiler can typically obtain returns from 300m upwards.

Overall, the Spaced Antenna and DBS techniques yield similar results in terms of accuracy and resolution.

The main disadvantage of the Spaced Antenna technique is a tendency to underestimate winds by 5-10%. Usually this can be corrected with a fixed, *a-priori* compensation. However, the underestimation is known to increase over time if the radar antenna array is not adequately maintained.

ATRAD recommends annual re-tuning of the antenna array, a task which can be accomplished in around four hours.

Considering that the price of a Spaced Antenna Windprofiler is usually around 30-40% of its DBS counterpart, this seems like a small inconvenience.

Return of a familiar face

Rob Silva served as Chief Executive of ATRAD until 2004 when he left after completing a major restructure of the organisation.

During his absence, Rob established an export facilitation business and a management consultancy.

It is through the latter enterprise that we welcome Rob back to ATRAD in the role of Business Development Manager.

rsilva@atrad.com.au

ATRAD Reaches for Space

Several ATRAD radars are in use in support of satellite launch facilities and supersonic research programmes.

In June 2007, Australia's Defence Science & Technology Organisation (DSTO) successfully launched an experimental Scramjet engine, which reached MACH-10 during the experiment.

The picture below shows the TALOS rocket carrying the HyCAUSE scramjet experimental payload as it lifts off the launch pad at Woomera.

The successful launch marks the beginning of a series of launches planned over the next 5 years.

In 2005, The **J**apanese **A**erospace e**X**ploration **A**gency (JAXA) completed a trial of its NEXST-1 Scaled Supersonic Experimental Plane. This successful trial marked the end of a 5-year experimental programme.

ATRAD originally installed a VHF ST Radar for JAXA at the Woomera Test Range to support their launch programme. When JAXA completed their programme, they gifted the Woomera radar to the Australian Bureau of Meteorology (BoM) who are now operating it for DSTO.

The Woomera Radar is a High Power Doppler radar operating at 55MHz. Typically, it produces wind profiles up to 18km or more.

When installed for JAXA, the purpose of the radar was threefold: firstly to provide a record of atmospheric conditions at the Woomera site; secondly to provide input data to the pre-launch decision-making process and thirdly, to collect real-time wind and turbulence data in the atmospheric volume traversed by the aircraft. This data was used to calibrate information produced by onboard aircraft sensors.

While the first two purposes were ably satisfied using standard software modules, ATRAD needed to develop new radar experimental modes and software analysis modules to produce the turbulence data needed to meet JAXA's exacting requirements.

For the Scramjet experiments, the radar is used primarily for pre-launch decision making. Of particular importance is a high speed jet-stream often experienced at the Woomera site.

ATRAD has also worked closely with Vaisala to install another three radars of similar capability at three satellite launch sites in China.

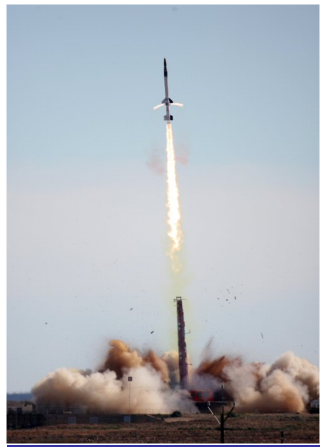

Image: DSTO

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15-61005 July 2007

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July 2007

Reflections

Leaders in Ground-Based Atmospheric Remote Sensing

News In Brief:

Conferences:

- *ATRAD is a proud sponsor of the 33rd Conference on Radar Meteorology, Cairns, Australia, 6-10th August 2007*

Upcoming Installations:

- *Boundary Layer Profiler to be installed at East Sale, Australia in October 2007*
- *ST Windprofiler, Meteor Radar and MF Spaced Antenna to be installed in China in September 2007*

Recent News:

- *Mt. Gambier Upper-Air Windprofiler celebrates 10 years of operation in October 2007*
- *Woomera Upper-Air Profiler supports successful ScramJet test launch at Woomera*
- *ATRAD takes on extra staff to keep up with production demand*
- *EMDR8-20 Enhanced Meteor Radars installed at opposite ends of the world: King George Island (62.2°S) and Bear Island (75.5°N)*
- *King George Island Meteor Radar routinely counts over 20,000 meteors per day*
- *ST Windprofiler installed at Wuhan University research facility in Wuhan, China*
- *With Vaisala as lead partner, ATRAD installs an ST Windprofiler at the Chinese Xichang Satellite launch facility, adding to earlier installations at Jiuquan and Huayin*
- *ATRAD launches new generation 'STX-II' series radar transmitters*

Special 33rd Conference on Radar Meteorology Edition

ATRAD is proud to be a sponsor of the 33rd Conference on Radar Meteorology held in Cairns, Australia.

For much of ATRAD's early life, its core business was the development of radars and techniques to support atmospheric research.

Since the late '90s, ATRAD radars have increasingly made their way into operational networks. In fact, the first Upper-air Windprofiler that ATRAD installed in Australia (Mt. Gambier) will celebrate its 10th Birthday in October this year.

Nevertheless, ATRAD's first Boundary Layer Windprofiler, installed at Sydney's Kingsford Smith airport for the Australian Bureau of Meteorology in 1999, holds the record for the longest period of uninterrupted service—seven years and counting.

Last year, ATRAD completed development on a second generation of operational radar products to further enhance their operational reliability & maintainability while retaining their capability and flexibility for scientific applications.

Today, it seems that Windprofilers have finally 'arrived' and now account for the majority of ATRAD's revenues.

The Bureau has established a network of profilers around Australia, matching their counterparts in the USA and Japan, while China, Korea, India and Canada are making major investments in meteorological Windprofiler networks.

Reviewing the conference programme, there is a clear trend to larger networks of instruments, clustering of instrument types and higher resolution mesoscale models assimilating real-time data.

These trends confirm ATRAD's optimistic view of the future for radar Windprofilers and this is just one of the reasons we are pleased to be associated with the 33rd Conference of Radar Meteorology.

Yours Sincerely,
Prof. Iain Reid
Executive Director

A New Generation of Operational Radars

The new radars are built around a new generation STX-II series solid-state pulse radar transmitter, combining the flexibility required for scientific applications with the performance and reliability demanded by 24x7 operational use. Notable features include:

Modularity The STX-II is built around a 4kW Power Amplifier (PA) module. A basic 20kW amplifier block consists of six of these PA modules, an RF Driver and a Controller unit.

Graceful Degradation The radar will fully functional even if a transmitter module fails (albeit at reduced output power) until a repair visit can be scheduled.

Redundancy Telecommunications Grade switch-mode modular Power Supplies are used, providing N+1 redundancy capability (optional).

Flexibility Radars can be provided in any power output from 4-160kW. Power combiners and PSU capacity are matched to the application's total power, duty cycle and redundancy requirements.

Reliability & Repairability Self-protecting against over-temperature, open- and short-circuit outputs, excessive VSWR and Duty Cycle and Over/Under AC Mains voltage.

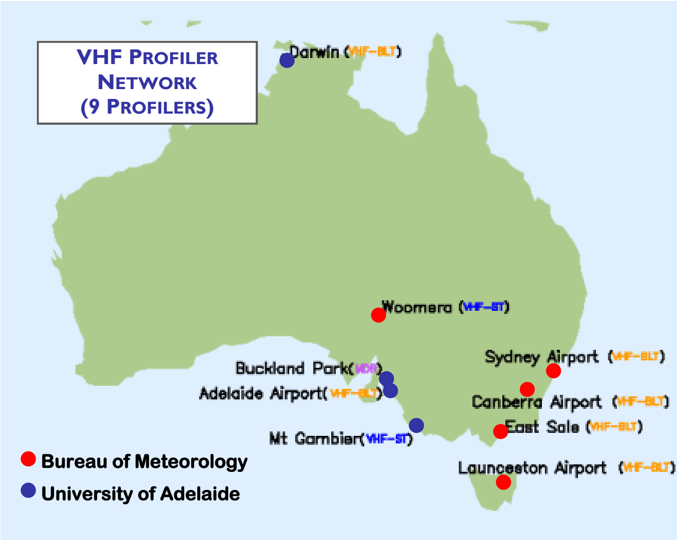
A faulty module typically be replaced in less than 5 minutes.

Monitoring & Control Remote parameter setting and monitoring of current temperature, voltages, forward power and return loss.

Battery Standby The PSU can charge standby batteries where the radar is required to operate continuously during a power failure or until a backup generator can be brought online (optional).

Leaders in Ground-Based Atmospheric Remote Sensing

Radar Windprofilers Come Of Age



Radar Windprofilers have come a long way since the first mysterious backscatter returns were noticed at Jicamarca Radio Observatory in 1961.

For many years after that, the Windprofiler developed primarily as a research tool used by scientists to investigate the behaviour of the atmosphere.

Gradually, Windprofilers made their way into operational service as a meteorological instrument, with much research effort being devoted to assessing and improving their performance and accuracy.

While huge efforts were being made to develop increasingly sophisticated weather forecasting models, Windprofilers quietly developed along their own path. Research and development networks grew while reliability, accuracy and consistency all improved.

Then, for a while at least, it seemed that the usefulness of Windprofilers was limited by the inability of forecast models to assimilate the high-quality, real-time data they could produce.

But in more recent years, there have been huge advances in weather forecasting, with ever finer forecast scales being developed. The long-term impact of Windprofiler data on forecasting skill has also been evaluated and its value proven.

This, combined with an increasing trend to deploy networks and clusters of instruments has finally seen the Windprofiler come into its own.

In recent years, the US National Profiler Network (NPN), the European 'Coordinated Wind Profiler Network in Europe' (CWINDE), and Japanese WINDAS profiler network have all proven their value and are here to stay. Australia too has made a significant investment in Windprofilers and across the world, major investments are being made in Korea, China, Canada and India.

ATRAD has been involved in the development of these networks from the beginning.

ATRAD installed Windprofilers at Kiruna in Sweden (1996), a sister Windprofiler at Mt Gambier in Australia (1997) and a higher power Windprofiler at Kühlungsborn in Germany.

These profilers were capable of both Doppler and Spaced Antenna operation, the latter technique having been pioneered by the University of Adelaide and commercialised by ATRAD. A similar profiler was then installed at Wakkanai in Japan (2000).

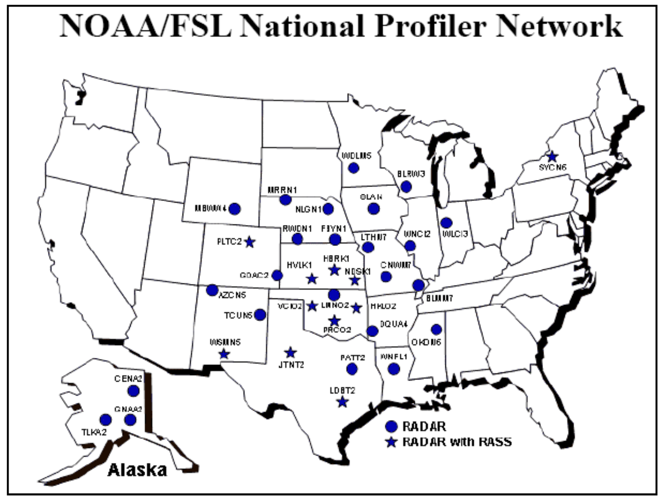
All were originally used for research purposes—largely to develop and evaluate their efficacy as meteorological instruments.

The Spaced-Antenna technique showed particular promise in Boundary Layer applications as a low-cost, small footprint Windprofiler.

In 1999, ATRAD installed its first VHF Spaced Antenna Boundary Layer Windprofiler for BoM at Sydney airport.

The Sydney profiler proved highly successful and has been in continuous operation since its initial installation, providing reliable coverage from 300m to 5-6km Above Ground Level.

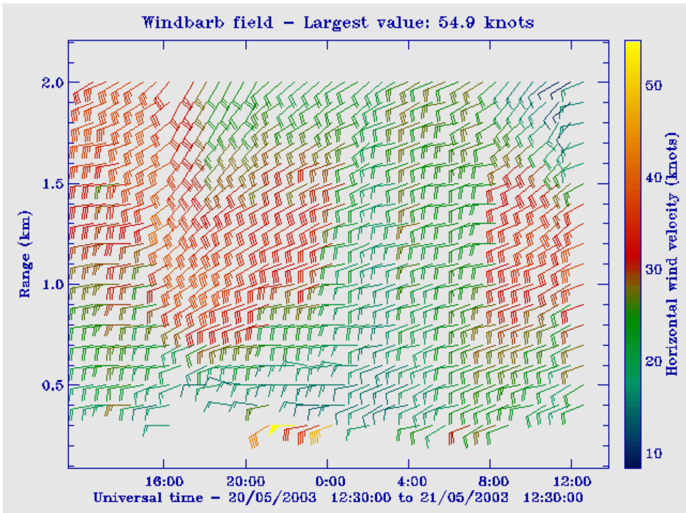
Building on the success of both the Upper-Air and Boundary Layer Windprofilers, ATRAD has recently completed development of a new generation of profilers which give equal weight to the scientific requirement for capability and flexibility and the operational requirement for reliability, repairability and maintainability (see separate story).

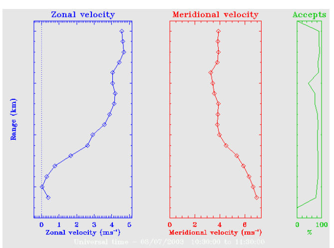


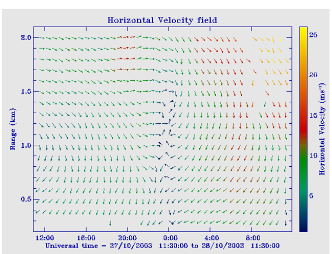
Meteorological Radar Windprofiler Solutions

Boundary Layer Windprofilers

- Small, medium & large array configurations
- 300m—8km AGL range
- Real-time Wind Profiles
- Low Operating Cost
- Fully Automated
- Unattended Operation
- Remote Monitoring & Control
- BUFR Output
- Unaffected by Precipitation, Bird or Insect Migration
- Small footprint & Portable (BLR-3)





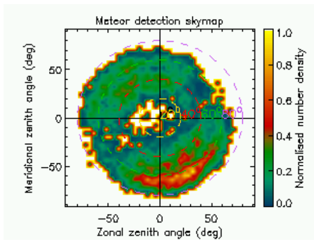


Upper-Air Windprofilers

- 1km—20km AGL range
- 300m Low range with Boundary Layer Option
- Real-time Wind Profiles
- Turbulence & other Parameters available
- Low Operating Costs
- Fully Automated, Unattended Operation
- Doppler Beam Swinging (DBS) Operation
- BUFR Output for easy Data Assimilation
- Unaffected by Precipitation, Bird or Insect Migration

Radars for Atmospheric & Space Research

All-Sky Meteor Radar

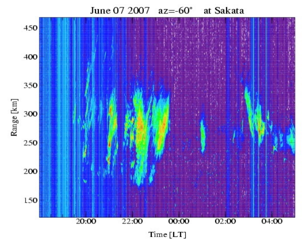


- 20,000+ unambiguous detections per day
- Wind Profiling of the MLT Region
- Meteor Astronomy
- Space Research
- All-Sky Meteor observations
- 70—110km sampling height
- Remote monitoring and control
- Online data analysis
- Optional Spaced-Antenna capability

ST/MST DBS+SA Radars

- Modular, Scaleable Architecture (8kW-160kW Peak Power Output @15%)
- Spaced Antenna (SA) and/or Doppler Beam Swinging (DBS) Modes
- All-sky Meteor observations (Optional)
- Array sizes from 36-1024 Antennas
- Power Aperture Product up to 4×10^8 Wm^2
- Half-Power-Half-Beam width from 1.5º upwards
- 1km—20km sampling range
- 6 complex radar receivers

Ionospheric Radar Systems



- Coherent Doppler Backscatter Radar
- E- and F-region Ionospheric and Meteor Observation modes
- Fixed or Steered Beams
- Peak Power from 8-80kW @15% Duty Cycle
- Option Rx Interferometer for All-sky Meteor observations
- 70—850km sampling range

MF Scaleable Radar System

- Modular, scaleable architecture (8kW-256kW peak power output)
- Doppler and Spaced Antenna capability
- Electronic Beamsteering/Phase Control
- 50-110km height range
- Wind Velocity Estimation
- Electron Density Estimation (DAE)
- Turbulence estimation*
- Momentum Flux (DBS)
- Meteor Winds & Diffusion Coefficient

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