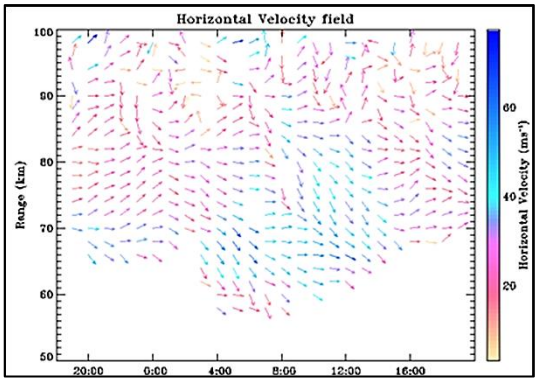
MF/HF Partial Reflection Radar 1.8 to 3.6 MHz

ATRAD radars provide a highly cost-effective measuring solution with a very low total cost of ownership. Ongoing maintenance requirements are minimal, operation is unattended and there are no recurring consumable costs. The radar may be remotely controlled from a central location. ATRAD has more experience than any other company with MF/HF partial reflection radars. More than 25 have been installed at all latitudes, from the Arctic to the Equator, to the Antarctic.

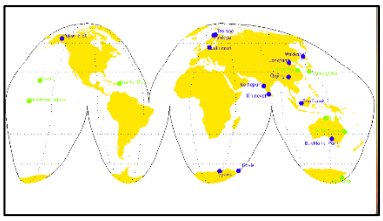
(Above) 128 kW MF radar with 6-channel digital transceiver



(Above) Typical wind results from one day of operation of a high latitude 25 kW, four channel MF radar operating in SA FCA mode. Note that winds are recovered down to 58 km. Coverage at lower heights at these latitudes often relies on particle precipitation.

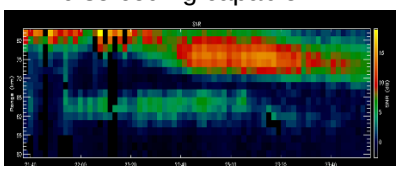
KEY FEATURES

The ATRAD MF radar uses spaced antenna and Doppler techniques to provide real-time vertical profiles of horizontal wind speed and direction in the 50 to 110 km height region. It operates in the upper MF / lower HF frequency range.



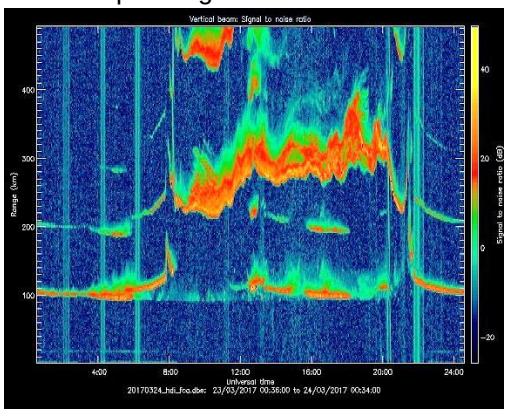
(Above) Selected ATRAD MF radars. Green indicates retired or relocated radars, blue radars currently in operation.

- Spaced antenna radar operation, with analysis using:
  - Full Correlation Analysis (FCA)
  - Spatial Correlation Analysis (SCA)
  - Imaging Doppler Interferometry (IDI)
- Doppler radar operation with:
  - Conventional beam steering
  - Hybrid Doppler Interferometry (HDI)
- Differential Absorption and Differential Phase (DAE/DPE) operation to measure electron densities
- Frequency Domain interferometry (FDI) capable
- Pulse coding capable

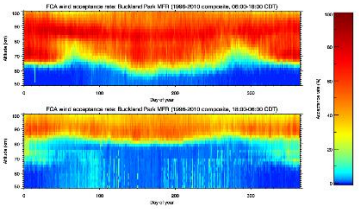


(Above) D-region returned power showing the C-layer

- Real-time Wind Profiles
- Superior performance
- Remote Monitoring and Control
- Fully Automated
- Unattended Operation
- Low Operating Costs



(Above) Remote MF radar observations from a mid-latitude site for E and F-region studies. (Below) Data acceptance rates for a 14-year period (day, top; night, bottom)



APPLICATIONS

- Space situational awareness
- Basic atmospheric research
- MLT-region dynamics
- D-region electron densities
- Rocket launch support
- Space weather forecasting

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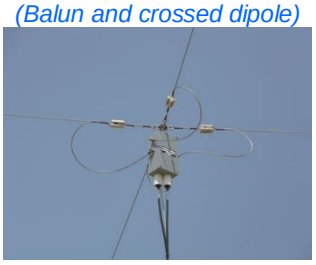
Transceiver
(6-channel Digital receiver)

Transmitter
(16 kW transmitter)

Antenna Array
(Balun and crossed dipole)



General Description

16-Bit Digital Transceiver incorporating Receiver, Exciter, Data Acquisition, Analysis and Display System

Solid-state, Modular, Transmitter, expandable from 8-256 kW in 2 kW increments

An array of from 4 to 128 antennas according to application requirements

Specifications

Receiver: 3 to 24-Channel, 16-bit
Exciter: Single Channel, 16-Bit
Typical Sounding Range:50-110 km
Range Resolution: 1,000 – 4,000 m (software selectable)
Range Gates: Up to 6,000
Operating Modes: Doppler, Spaced Antenna and Mixed-Mode operation

Transmit/Receive Modules:
4 to 128 2-kW Modules with integrated T/R Switch
Operating Modes: Transmit/Receive
Transmit Only
Receive Only
Frequencies: 1.8 to 3.6 MHz fixed at factory.
AC Mains Power: 220-240V or 110-120V AC, Single Phase

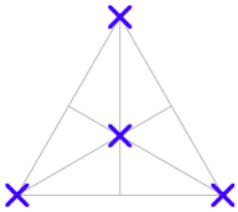
Array Configuration: 4 to 128 Antennas. Individual antennas may be transmit/receive, transmit only or receive only
Standard SA configuration shown below
Beamsteering: Each T/R Module independently electronically phased in 32 steps of 11.25°

Example System – 4-Channel Spaced Antenna

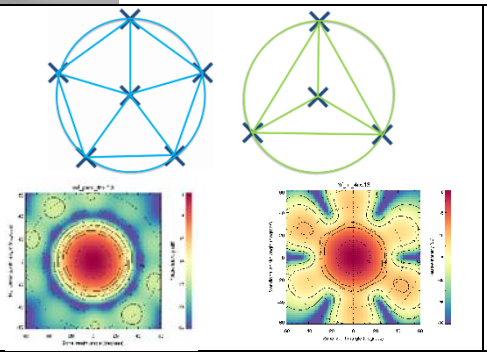
Receiver: 4-Channel, 16-bit
Operating Modes: Spaced Antenna with:
- FCA analysis
- DAE / DPE analysis
- IDI analysis

Transmitter Power: Typically, 32kW or 64kW
Combiner Method:
Octet 2:1 (32 kW) or
2 Quad 4:1 (64 kW)
Wilkinson Combiners
Control Method: Independent phase control on each dipole allows differential modes such as DAE and DPE

Array Configuration: 4 Transmit/Receive Crossed-dipoles, 1.2**λ** baseline. 8 or 16 kW per dipole



Options

GPS Reference		GPS disciplined oscillator (GPSDO) / GPS locked time and frequency (module shown left). Used for bi-static, multi-static, and / or remote receiver operation
Advanced antenna array making use of all six receiver channels. Suitable for ➢ FCA / SCA analysis ➢ DAE / DPE analysis ➢ HDI / IDI analysis		(Top Left) Advanced 6-antenna arrangement (far left), together with the 4-antenna system (Top right) (Bottom left) Polar diagram for advanced 6-antenna MF radar (Bottom right) Polar diagram for 4-antenna MF radar
Large antenna arrays	Large phased arrays, or Mills Cross Style Antennas	

Reference: Reid, I.M. (2015), MF and HF Spaced Antenna radar techniques for investigating the dynamics and structure of the 50 to 110 km height region: A review, **PEPS, 2**, 33, http://dx.doi.org/10.1186/s40645-015-0060-7

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