The Wuhan ST and meteor radar

Iain Reid (1,2), J.F. Wang (3), Z.Y. Zhao (3) and C.C. Tang (3)
(1) School of Chemistry and Physics, University of Adelaide, Adelaide, Australia
(2) ATRAD Pty Ltd, Thebarton, South Australia, Australia
(3) Department of Radio Science and Technology, College of Electronic Information Science, Wuhan University, Wuhan 430072, China

Introduction

A new ST Doppler radar with meteor capability was installed at a site near Wuhan in China in October 2006. Here we briefly describe this new radar.

System Description

Background

The radar system is configured for dedicated Doppler operation utilising the Doppler Beam Swinging (DBS) Technique. The Doppler beams are set for a fixed off-zenith angle of 15° with a nominal beam width of 7°. The antenna array itself has been designed to minimize the antenna side lobes.

The Radar

The base radar is a single receive channel 100 kW tube transmitter system that operates at a maximum 5% duty cycle (square pulse). There are six transmitter modules which each feed two rows or columns in the array. The Doppler mode antenna array consists of 144 three-element Yagi antennas grouped into twelve rows or columns (the antenna configuration is switched between row and column configuration under software control). For vertical beam operation, all rows/columns are fed with a constant phase angle. For off-zenith operation, the rows/columns are phased in order to achieve a 15° beam angle. The off-zenith beam can be steered in the North, East, South or West directions or pointed vertically under software control. The antenna layout is shown in Figure 1 below.

The Meteor Interferometer array consists of five linearly polarized receive antennas connected in a classical interferometer arrangement and a separate crossed-dipole transmit antenna. During Meteor mode operation, one of the six transmitter outputs is switched to the Meteor Transmit Antenna.

In the event of a single transmitter failure, operating performance will be degraded due to distortion in the beam shape and loss of output power but the system will continue to operate.

Data Acquisition System and Radar Controller

The data acquisition system used is the ATRAD M62-Adapative Data Acquisition and Control (M62-ADAC) system. This is based on an Innovative Integration M62 board.

The radar controller is a PC running Windows NT, and the data analysis occurs in the ATRAD Display and Analysis (D&A) suite. This runs on a second PC running Linux. The system can be remotely configured and operated via a network or via a modem. The system is essentially "turn-key" and is designed for long-term continuous unattended operation.

Data Products

The data analysis software can present analysed data in a number of formats, including wind field, vertical wind profiles and wind barb displays. Raw data can be archived as required for later analysis or re-analysis.

Analysed data is logged in one of several standard ATRAD formats or in BUFR format.

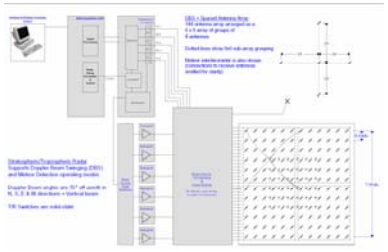

Figure 1. Schematic diagram of the radar showing the basic organization of the system and the antenna arrangement

Figure 2. ATRAD ST radar installations using the same basic system architecture as the Wuhan ST radar

Other Installations

The Wuhan radar is very similar to a number of other ATRAD radar installations. These are shown in Figure 2 above. The VTX transmitter installed at the Wuhan site will be the last constructed by ATRAD. This series of transmitters has been replaced by the STX-II solid state transmitter shown in figure 3a (below left).

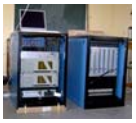

Figure 3a. Photograph of the ATRAD MDR meteor radar showing the STX-II transmitter (right hand side rack).

Figure 3b. Radar installation at Xian

Figure 3c. Antenna installation at Xian

Figure 4a. (Left) Photograph of a section of the antenna array showing the meteor transmit antenna (center of image).
Figure 4b (Below) Photograph of a transmit antenna of the same design at the Buckland Park Field Site.

Figure 5. (Below) Photographic montage of the main antenna array showing the equipment hut.

Figure 6. (Left) Photograph showing the transmitter (right of the image) and receiver rack being assembled (left of image).

Figure 7. (Right) Photograph showing the 36 main feeder cables running to the main array.

Figure 8. (Above) Photograph showing the meteor receive antennas

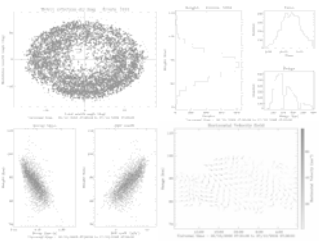

Figure 9. (Above) Meteor observations from the Buckland Park 55 MHz ST / meteor radar which is effectively identical to the Wuhan ST / meteor radar

ATRAD Wuhan ST Radar System Specifications	
Frequency	53.8 MHz
Operating Modes	Doppler Meteor
Transmitter	100kW tube output stage, 6 Channel output Failure of any one transmitter will not prevent system operation□
Number of receivers	Meteor Mode: 5 Doppler Mode: 1 (In Meteor mode, each receive antenna is directly connected to a receiver input. In Doppler mode all received signals are combined into a single receiver input)
Range resolution	User selectable 150m, 300m, 600m, 1200m (not all resolutions available at all heights)
Observation Range	Nominal 1 km to 20km
Observation Products	Horizontal wind field Vertical wind field Backscattered power Meteor Histogram, Sky Map, temperatures
Software Modules	ATRAD Analysis & Display suite Doppler Meteor Pulse-coding
Observation update	Maximum 1 minute, per radial velocity Typically 15, 30 or 60 minutes

Radar Receiver Specification	
Receiver Bandwidth	User selectable in 64 steps between 25kHz and 600kHz
Receiver Noise Figure	< 2dB when used with ATRAD T/R switches
Receiver Recovery Time	Nominally 1μs depending on transmitted pulse
Array specification - Doppler	
Configuration	Dedicated Doppler operation 12 rows and 12 columns
Doppler Beam angles	15° off-zenith in NESW directions Vertical
Doppler Beam width	Nominally 7° at -3dB power points
Antenna Spacing	0.66λ
Array Dimension	7.26 λ
Antenna	144 3-element Yagi antenna
Land Area required	Approx 55m x 55m
Land Flatness	To within 200mm across array site.

Radar Transmitter Specification	
Valve Type	6 x 3CPX1500A7
Operating Frequency	20 - 60 MHz (fixed at factory) The transmitter will operate over a ± 250kHz range around the centre frequency.
Peak Envelope Power Output	Nominal 100 kW ± 1dB *Note: Output power is affected by the selected operating frequency and other installation-specific parameters*
Maximum Mean Power Output	5 kW - (5% maximum duty cycle, square pulse)
Half Power Pulse Width	1 μsec
RF Terminating Impedance	50 ohms per output
Protection	Forward and Reverse Power Monitoring with Drive Reduction
Transmitter/Receiver Switching	External. Transmitter Modules can be individually disabled
Cooling	Forced Air 2000 litres/second (low rate detection)
Mains Power Requirements (maximum)	Three Phase 110/120 or 220/240 Volts AC 12 kW total
Ambient temperature	+5 to +35 Degrees C
Physical Details	Transmitter is housed in a 19" Rack x 2.2 metres high x 0.6 metres deep and weights approximately 250kg.

Array specification - Meteor	
Configuration	Five linearly polarized receive antennas in interferometer arrangement Single Crossed-Dipole transmit antenna
Antenna Spacing	2, 2.5λ
Hut location	Main radar hut
Land Area required	Approx 25m x 25m
Land Flatness	To within 200mm across array site.
Data Acquisition	
Resolution:	16 Bit Flexible Signal Averaging
Misc	
Control	Receiver and Transmitter under separate PC control
Processing	Dedicated PC for Analysis and External Access

For further information

Professor Jing Fang Wang, Department of Radio Science and Technology, College of Electronic Information Science, Wuhan University, Wuhan 430072, China. Email: wjfa@public.wh.hb.cn