Genesis Software Pty Ltd ABN 68 060 198 450

10 Marian Street
North Adelaide SA 5006
AUSTRALIA

Tel: (08) 8267 3493
Fax: (08) 8267 3039
Email: genesis@gsoft.com.au

Int.: +61 8 8267 3493
Int.: +61 8 8267 3039
Web: http://www.gsoft.com.au

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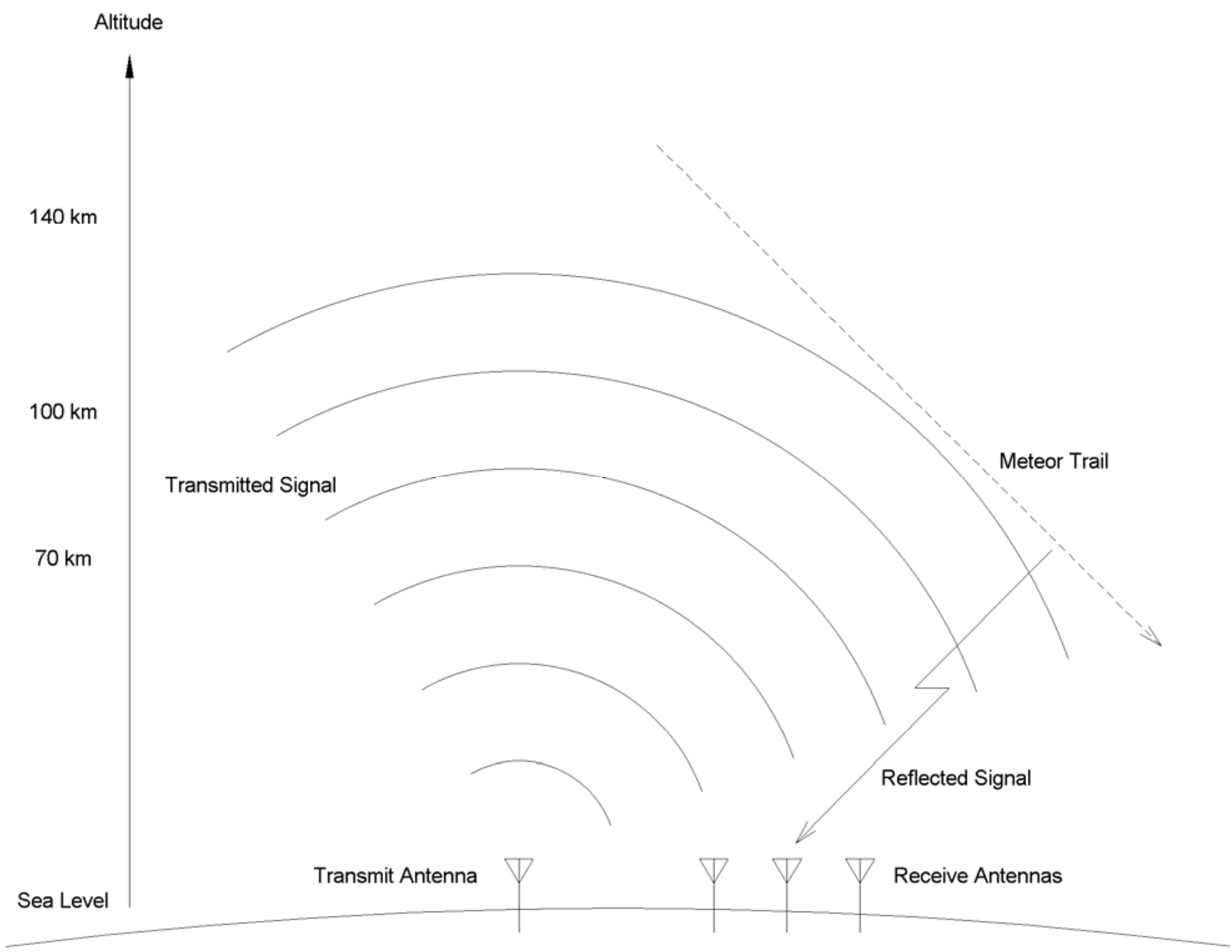
SKiYMET Meteor Radar

Apparatus Licence Application Notes

Overview

The SKiYMET meteor radar is a scientific instrument that is used for measuring dynamical parameters of the upper atmosphere. It makes these measurements by using radar techniques to observe the trails of ionised gas and dust that form when meteoroids enter the earth's atmosphere.

The principle of operation is shown in the following diagram.



The figure above shows a stylised version of the principle of operation

When a meteoroid enters the atmosphere it rapidly vapourises due to friction with the atmosphere and an ionised trail of expanding dust and gas forms along the path of the meteoroid. Whilst the trail is present, it provides a target for the meteor radar and radar signals back-scattered from the trail may be recorded and used to determine information about the atmosphere in which they form. The information may routinely be used to derive measurements of the wind speed and direction in the upper atmosphere and to infer atmospheric temperature. Typical meteoroid trails observed by the radar last for a few hundredths to a few tenths of a second and many thousands of trails per day may be detected by the radar.

The meteor radar is able to make observations in the 80 to 100 km height region of the atmosphere and this region is very difficult to observe on a continuous basis using other techniques. Many scientific investigations may be carried out using information from meteor radar observations including topical investigations related to climate change and global warming.

Similar Installations

The SKiYMET meteor radar is widely deployed on a global scale with several new radars being installed each year. The table below lists the locations and frequency of operation of other SKiYMET meteor radars.

Site	Geographical Location	Frequency	Power
Socorro, New Mexico	34.06N, 106.9W	35.24 MHz	6 kW
Cacheoira Paulista, Brazil	22.75S, 45W	35.24 MHz	12 kW
Delamere, Australia	35.5S, 138.1E	35.24 MHz	12 kW
London, Canada (three radars)	42.97N, 81.25W	17.45 MHz 29.85 MHz 38.15 MHz	6 kW each
Esrange, Sweden	67.9N, 21.1E	32.50 MHz	6 kW
Andenes, Norway	54.6N, 13.4E	32.55 MHz	12 kW
Yellowknife, Canada	62.5N, 114.3W	35.65 MHz	6 kW
Ascension Island, Atlantic Ocean	16S, 5.75W	43.50 MHz	12 kW
Kuhlungsborn, Germany (ST radar slave)	54.1N, 11.8E	53.50 MHz	90 kW max.
Maui, Hawaii, USA	20.8N, 156.3W	40.92 MHz	12 kW
University of Bath (to be installed in Utah, USA)	41.9N, 111.4W	35.00 MHz (TBD)	12 kW
University of Santa Maria, Brazil	29.73S, 53.72W	35.24 MHz	12 kW
Andenes, Norway (ST radar meteor mode)	67.9N, 15.1E	53.5 MHz	36 kW max.
Koto Tabang, Indonesia	100.32E, 0.20S	37.70 MHz	12 kW
Rarotonga, Cook Islands	21.2S, 159.8W	35.24 MHz	6 kW
Kokubunji, Tokyo, Japan	35.7N, 139.47E	33.32 MHz	12 kW
Collm Observatory, Germany	51.3N, 13.0E	36.20 MHz	12 kW
Sao Joao do Cariri, Brazil	7.4S, 36.5W	35.24 MHz	12 kW
Trivandrum, India	8.5N, 36.9E	35.25 MHz	40 kW
Learmonth, Australia	22.2S, 114.1E	35.24 MHz	6 kW
Rothera Base, Antarctica	67.6S, 68.1W	32.50 MHz	6 kW
Costa Rica	10.3N, 85.6W	35.65 MHz	6 kW
Eureka, Canada	80.0N, 85.9W	33.40 MHz	12 kW
Juliusruh, Germany (dual frequency radar)	54.6N, 13.4E	32.55 MHz 53.50 MHz	15kW 15kW
Tierra del Fuego, Argentina	TBA	32.50 MHz (TBD)	60kW

SKiYMET Meteor Radar Installations

Radar Operating Characteristics

The meteor radar operates by transmitting a narrow burst of radio waves on a vertically-orientated antenna or antennas. The radio waves illuminate a broad region of the sky about the zenith. If a meteoroid trail is present and is suitably-orientated with respect to the radar, some of the energy of the radio waves is weakly backscattered towards the radar and may then be observed on a co-located receiving antenna array. Signals picked up on the receive antenna array are amplified and recorded and analysed to determine the location, drift speed and other useful parameters about the nature of the meteoroid trail. This information is then used to derive atmospheric parameters such as wind speed and direction.

The frequency of operation of the meteor radar is an important characteristic of the radar. A frequency of operation in the region of 32-35 MHz will provide the best opportunity for observing meteor trails in the height region of interest. At lower frequencies of operation, the performance of the radar may be degraded by interference from ionospheric phenomena and at higher frequencies of operation, the number of meteors observed per day decreases significantly. As can be seen in the above table, most meteor radars installed around the world operate in the low to mid 30 MHz band. There are a few radars operating at higher frequencies (around 50 MHz), however, these are in general adjuncts to radars operating in the 32-35 MHz band and are used to provide complementary information about atmospheric temperature. Meteor radars operating at lower frequencies (less than 30 MHz) are generally used for different purposes related to meteor astronomy.

As a final comment on frequency of operation, it is noted that SKiYMET meteor radars are being used to form a global network of observing instruments and it is important that all radars operate with similar characteristics in order that the information from the global sites may be best used to observe and interpret atmospheric behaviour on a global scale.

Radar Equipment Technical Description

The radar system is made up of a number of subsystems which together operate as a fixed frequency, coherent, pulsed, Doppler radar and interferometer. The principle subcomponents are (1) a solid state pulsed transmitter, (2) a 5 channel coherent receiver system, (3) an antenna system, (4) a data acquisition system and (5) a host computer for data analysis and display. The transmitter is in turn comprised of sub-modules which bring the total transmitter power to the required level. The modulation of the transmitter pulse is managed by a programmable, digital synthesis module which is designed to minimise the spectral occupancy of the system. The transmitter also continuously monitors load conditions to both prevent damage to the transmit hardware in the event of an antenna failure and also to prevent spurious emissions.

The receive hardware is comprised of conventional superheterodyne coherent receivers with programmable post-detection bandwidth and gain. The reference oscillators for the receivers (and transmitter) are derived from a reference and test signal unit which utilises DDS technologies to generate the appropriate waveforms. The analogue outputs of the receivers are routed to the data acquisition system for digitisation and further signal processing.

Apparatus Licence Technical Details

The following is based on the main details that are required for an apparatus licence application in Australia.

Application for Apparatus Licence

Item	Detail	Comment
Applicant details		Name, contact, etc.
Client type		E.g., government agency
Industry category		E.g., government
Required licence period		Number of years you wish to operate, but

		be prepared to be issued on a yearly basis
Type of licence		E.g., scientific (radio-determination would be preferred)
Licencing option (if applicable)		E.g., scientific assigned
Description of service		E.g., meteor detection radar

Station Information

Item	Detail	Comment
Area of operation or site address		
Address		
Map of the radio site showing location of tx antenna		Show centre of tx array
Coordinates		In 'zone', 'easting' 'northing'
Site elevation		
Geographical coordinates		
Site manager or site contact		
Contact details		
Equipment supplier details		
Name of equipment provider	Genesis Software	
Contact details		
Antenna details		
Manufacturer	MARDOC Inc.	
Model	MTX2	
Description	3-element yagi, array of 8 antennas	
Beamwidth	E-plane: 13 degrees H-plane: 24 degrees	This is of the array, not an individual antenna
Gain	15 dBi	
Front-to-back-ratio	0 dB	
Polarisation	Circular	
Tilt	Vertical	This is tilt of the physical antenna
Height above ground	3m	
Azimuth	Not applicable	
Technical details		
Requested transmit and receive frequencies		It is desired to operate the radar within a preferred frequency band. However, given that an allocation within the preferred band will be granted, then a suitable actual frequency *should* be decided on the basis of a spectrum survey at-site
Transmitter power	15 kW	
Fixed losses	Not applicable	
Channel bandwidth	200kHz	
Emission designator	PONXN	
System capacity or data rate	Not applicable	
Communication distance	Not applicable	
Operating mode	Transmitter	
Operation	One frequency	
Type of baseband	Analogue	
Type of modulation	None	
Modulation technique	None	
Stations with which you wish to communicate	Not applicable	