

STATUS AND PLANS FOR GROUND INSTRUMENTS AT ESRANGE

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1 ABSTRACT

Scientific ground based instruments are used for long-term measurements, and also as a part of co-ordinated measurements with sounding rockets and stratospheric balloons. Real time data from ground based instruments are often used for final launch decision. Use of ground based instruments from recent campaigns will be shown. Temporary installation of ground based instruments for dedicated unique campaign is also possible. The ground based instruments at Esrange and quick looks of interesting data will be presented. Kiruna Esrange Optical Platform System, KEOPS, a site located 1.5 km west of Esrange is since 1999 used for scientific ground based instrumentation. An optically non-disturbed environment, full field of view and high latitude are important parts of the KEOPS concept. Instruments installed in small huts are operated remotely via Internet. A permanent building with observation domes is planned to be constructed at KEOPS this year. The KEOPS site, status and plans will be presented.

Status and plans for ground based instrumentation at Esrange



1.1 Introduction

Esrange located at 67°53'N and 21°04'E is the space operations centre of the Swedish Space Corporation (SSC), a state-owned limited liability company under the Ministry of Industry. The high latitude, the favourable climate and the relative proximity to every modern convenience makes this site unique in the world and an attractive base for international space related projects and activities. The Esrange facility includes a complete satellite station for TT&C (Telemetry, Tracking and Command), reception of data from various satellites, control station for telecommunication

satellites, and facilities for launching sounding rockets and stratospheric balloons. Launching of rockets and balloons is carried out under the EASP agreement, which is a special project within the European Space Agency (ESA).

Esrange is a well-equipped launching facility and is able to deal with most types of rockets, including large rockets such as Skylark, Terrier Black Brant and Castor 4B. More than 500 rockets have been launched from Esrange since its inauguration in 1966. The impact area of 120 x 75 km on land offers safe landing and recovery. Payloads are speedily recovered by helicopter, normally within one hour after launch. The payload equipment is often re-used on subsequent missions. Most experiments carried out are within the field of microgravity, upper atmosphere chemistry and space physics.

Esrange can launch balloons with a volume of up to 2 million m³, allowing a payload of 2 metric tonnes to be carried to an altitude of 45 km. The balloons are launched using either auxiliary balloons or dynamic release technique. A vast area, comprising the whole of northern Scandinavia and European Russia, is available for impact and recovery. Payload recovery is a standard procedure carried out by helicopter. Balloons at Esrange are mainly used for upper atmospheric research, such as studies of the depletion of the ozone layer. Balloons are also used for validation of satellite instruments, astronomical experiments and testing of technical systems to be onboard space probes for planetary missions.

There has always been a need of scientific ground based instruments. The ground based scientific instruments at Esrange are often operated to support the sounding rocket and stratosphere balloon flights. Co-ordinated measurements by use of ground based instruments and instruments onboard the flying payload is normally performed. The Earth's magnetic activity and the aurora activity are more or less continuously monitored. The Esrange MST-radar, ESRAD, has been in near continuous operation since July 1996, providing information about winds, waves and other phenomena in the lower and middle atmosphere.

A set of other scientific ground based instruments owned by users at Esrange like, the Bonn University Lidar, SKiYMET meteor radar, FP Interferometers by UCL and Hovemere Ltd, IR Interferometer by a Korean

group and a camera for detecting Sprites and Elves by a Japanese group are also operated at Esrange.

For further information please visit our web site, <http://www.ssc.se/esrange>

2 ESRANGE INSTRUMENTS

ESRAD, Esrange MST radar, operating at 52 MHz has been in near continuous operation since July 1996. The radar is capable of detecting very weak echoes from particles and aerosols at altitudes up to 110 km. The antenna array consists of 284 individual antennas. Different techniques like pulse coding and beam swinging is implemented to achieve the best result. ESRAD is operated continuously. IRF, The Institute of Space Physics in Kiruna, is responsible for the scientific data handling and SSC, Esrange is responsible for the maintenance and the operations at Esrange.

A set of basic scientific instruments is operated at Esrange. The magnetometer and the riometers are continuously operated and two photometers are operated during the period September to April. All measured data is archived at the EGIS, Esrange Geophysical information Services, locally at Esrange. Authorised users via Internet can easily access the data.

The magnetometer is a 3-axis flux gate type measuring variations of the Earth's magnetic field up to ± 8000 nT with an accuracy of ± 1 nT.

Two riometers at 27.6 and 35MHz are equipped with wide- and narrow beam antennas for studies of the Ionosphere.

A fixed position four channel photometer equipped with filters for 427.8nm, 486.1nm, 557.7nm and 630.0nm and a meridian scanning photometer with filters for 391.4nm, 552.5nm, 557.7nm and 630.0nm is operated during the full winter season.

A great number of balloon borne radio soundings and ozone soundings are carried out every year from Esrange, in order to get information of the current meteorological situation in the atmosphere. The measurements are used for scientific purpose or to get necessary wind information for the launch of sounding rockets or release of stratospheric balloons. The ozone vertical profile is measured by specially designed balloon borne ozone sondes. Standard radiosondes are used for information of wind, position and PTU data. Ground winds are measured at several levels up to 100 metres. Troposphere and stratosphere winds are measured with radar and radiosondes. Additional wind information is also measured with ESRAD contributing to the UK meteorological offices operational wind profiler network. An extensive archive comprising many years of collected PTU, ozone and wind data is available at Esrange.

ESRAD



BONN RMR LIDAR



3 USER OWNED INSTRUMENTS

A Rayleigh-Mie-Raman LIDAR owned and operated by Dr. Fricke at the University of Bonn is located at the radar hill at Esrange. The LIDAR is normally operated during co-ordinated campaigns involving sounding rockets or stratospheric balloons investigating phenomena in the lower and middle atmosphere. This Lidar is capable of operating in three-colour mode covering 355nm, 532nm and 1064nm in night conditions and near daylight conditions. Different atmospheric phenomena, like PSC and NLC in the range from ground up to 100km are monitored.

An All-sky Interferometric Meteor Radar, SKiYMET, owned and operated by Dr. Nick Mitchell, at the University of Bath, UK, is located at Esrange. Echoes are received from the Mesopause region by the ionised trail gases when meteors entering at altitudes between 70-100km. A 6 kilowatt pulsed transmitter is connected to a crossed 4 element Yagi antenna operating at 32.5 MHz. Five receivers are each connected to an individual 2 element crossed Yagi antenna tuned for optimum receiving sensitivity.

Two Fabry-Perot Interferometers owned by University College London, UK, and one owned by Dr. David Rees, Hovemere, UK, are located at Kiruna Esrange Optical Platform System, KEOPS, at Esrange. The FPI's are providing images of the neutral wind flow in the thermosphere and nighttime images of the aurora oval. The measurements are remotely controlled via Internet. The FPI's are tuned for the red and green line at 630.0nm and 557.7nm.

A camera system for detection of the optical phenomena "Sprites & Elves" owned and operated by Dr. Yukihiko Takahashi, Tohoku University, Aramaki, Japan, is installed at the KEOPS site at Esrange. The system is used for investigation of a lightning induced optical phenomena in the middle and upper atmosphere in the polar region.

The measurements are remotely controlled via Internet.

An IR Interferometer for passive detection of the IR emissions, 1000nm – 1700nm, owned and operated by Dr Young-In Won, KORDI, Korea, is installed at the KEOPS site at Esrange. The IR Interferometer is used for detection of the temperature in the Mesopause region near 87km. The measurements are remotely controlled via Internet.

An Air-Earth Current density meter AEC, owned and operated by Prof. Sheila Kirkwood, Institute of Space Physics at Kiruna is installed at Esrange. The AEC density meter is measuring the low current flow between the ground and the air in the lower part of the atmosphere. Variations in the current are observed during strong thunder and lightning near the equator. The current is received with a 100-metre longwire antenna and amplified and stored on a computer. The measurements are remotely controlled via Internet.

4 THE OPTICAL SITE, KEOPS



KEOPS (Kiruna Esrange Optical Platform System) is a new concept for multi-disciplinary high-latitude science based on optical measurements and distributed networking. The main KEOPS optical facility is located on Pahtavaara Mountain at 530m altitude 1.5 km west of Esrange, Kiruna, Sweden. KEOPS-measurements are intended to be unmanned and remotely controlled via Internet optimised for telescience applications, e.g. distributed virtual environment. KEOPS has multi-disciplinary science objectives, optical experiments in several fields, e.g. biology, meteorology, atmospheric and space physics, are welcome.

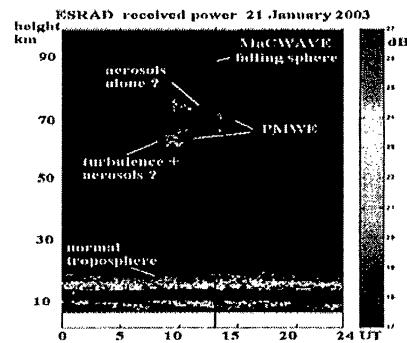
5 SCIENTIFIC DATA

Scientific ground based instruments are often operated in co-ordinated campaigns with launch of sounding

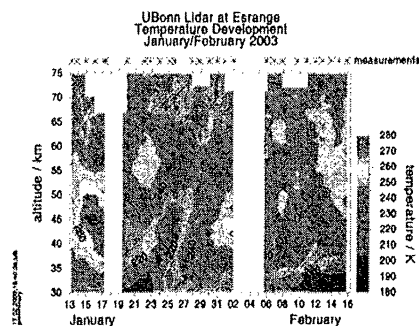
rockets and stratospheric balloons. Some instruments are operated continuously and some are operated during a limited period. Meteorological data like temperature, wind and ozone concentration is needed for predicting flight trajectory, verifying flight sensor data and for weather forecast. The local EGiS server (Esrange Geophysical information Services) is used to store Esrange ground based instrumentation data. Visiting scientific group normally take care of the operation and data handling of their instrument.

In the NASA rocket campaign MaCWAVE at Esrange January 2003 the ground based instruments played an important role. Launch decision and measurements of the atmospheric conditions were taken by use of the ground-based instruments.

Polar Mesosphere Winter Echoes was detected with the ESRAD radar. For more details please contact Prof. Sheila Kirkwood, IRF, Kiruna.



The Bonn University LIDAR at Esrange was measuring the temperature development during the MaCWAVE rocket campaign. The variations of temperature in the stratosphere were successfully measured with a few exceptions during very cloudy days. For more detailed information please contact Dr.K.H. Fricke, University of Bonn.



6 PLANS

Esrange is a well-equipped range, and with the high-qualified staff we are ready to help the user in performing successful science. The level of support is always adapted to the need of the user and confirmed by mutual agreements. Unmanned measurements are normally remotely controlled by Internet.

The KEOPS site is ideal for non-disturbed optical measurements in the sub-arctic region. The location west of the Scandinavian Mountain chain is used for studying lee-waves, PMSE, PSC and other dynamic phenomena's in the Stratosphere and Mesosphere. The number of user owned ground-based instruments at Esrange is increasing.

Six wooden huts are used for installation of instruments up to now. Esrange is now planning for a permanent building on the hilltop at the KEOPS site.

A building with 6 rooms including plastic domes for sky observation is proposed. The facility is planned to be ready for use during year 2004