

## Kiruna and Svalbard

# A safety alternative for data transference

The European Space Operations Centre (ESOC) is responsible for monitoring satellites with very different trajectories also the so-called polar orbits, the orbit type ENVISAT uses. ESOC in Darmstadt has a world-wide network at its disposal, with eight ground stations on four continents. The locations of the ESA ground stations have been arranged in such a manner on the Earth's surface that data reception as well as commanding of the spacecraft can be guaranteed to be constant or with minimal interruption. To further better the communication, last autumn ESA launched the Artemis satellite, a communication satellite in geostationary orbit, which will transmit most of the data traffic between ENVISAT and the ground. However, about 25% of the time ENVISAT is in the Earth's shade for Artemis, and data must be stored onboard for later transmitting. In addition, it is necessary to establish backup communication possibilities if the communication satellite fails.

ESA established before launch of ERS-1a ground station, the Salmijärvi Station, near Kiruna in Northern Sweden, and the station is in recent years also upgraded to be the main station for the ENVISAT-project. The placing of the station, north about the polar circle, ensures the coverage of 11 of the 14 daily orbits for the satellite.

The station is equipped for tracking, telemetry and command operations as well as reception, recording, processing and dissemination of data from the sensor instruments on-board the satellite, and it operates in S-band for uplink and downlink and in X-band for downlink only. In addition to the normal TTC functions of a ground station the functions include a reference measurement system for routine measurements of S-band and X-band satellite signals from the satellites. The station is connected to the Mission

Management and Control Centre (MMCC) at ESOC via dedicated voice and data circuits. The station is remotely monitored and controlled from the MMCC under nominal operating conditions, but a mini control centre is located at the station to provide backup in the event of a serious problem being encountered at ESOC.

ESA Station Director, Bjørn Ericsson, told to us that

about 30 million ECU have been invested to upgrade the station for ENVISAT. Among these is a new 13 metres antenna, and new buildings including upgraded technical equipment. ENVISAT will transmit stored data from the instrument on board in every pass where the satellite is visible from the station. That will be ten minutes for eleven daily orbits. Data from the rest of the orbits will be sent to the Norwegian receiving station at Svalbard. Data from Kiruna will be forwarded via the terrestrial network.

### Norwegian Antenna Closes Gap in Reception



The Salmijärvi station in Sweden, which is principally responsible for the operation of ENVISAT, is situated too far south in some cases, and cannot see the satellite in every orbit and a complimentary station is necessary to keep track the whole time. This is why an antenna at Spitzbergen will provide a remedy to the situation. There the Norwegian Space Centre maintains a ground station, the Svalbard Satellite Station (SvalSat). The Norwegian company Tromsø Satellite Station (TSS) operates the centre.

From 2002 and onwards, the new TSS Antenna then can take over the operations of ENVISAT from the most ideal place for a ground station for polar orbiting satellites. Due to this, an agreement between ESA and the company TSS, is being prepared. This antenna rental marks an organizational sea change at ESA, because up to now all ground stations of ESOC have also been its property. An exception has been the so-called NDIUs, Network Data Interface Units, which were installed as interfaces in all stations. The operator in the control centre in Darmstadt can deal with the data flow from and to such stations just like ESTRACK's own installations. In contrast, at the SvalSat Station there are no pieces of equipment from ESA, but rather a gateway that secures the transmission to Darmstadt.

**The Salmijärvi Station, near Kiruna in Northern Sweden below and one of the antennas at Svalsat at the right.**



# Tracking, control, and data receiving

For the next ten years Envisat will sample and transmit to Earth a petabyte of data (1000 000 000 000 000 bytes), data which is going to transmit more precisely to Earth. This calls for an accurately and well-known positioned satellite, and that all the instruments are well functioning. In addition, one must be able to receive, store, and distribute very large quantities of data on a daily basis. European Space Operations Centre (ESOC) in Darmstadt, Germany and the European Space Research Institute (ESRIN), Frascati, Italy, are instrumental in ensuring the research community proper value for money spent as well as invested resources in the project.

In ESOC the Ground Segment Manager, together with up to 50 other engineers and scientists, are responsible for guiding the environmental satellite in a perfect orbit. ENVISAT's ten instruments are among the most sensitive created by modern sensor technology, but the observations demands the highest degree of precision in satellite orbits.

In space there are many phenomena that disturb the satellites' perfect orbit, such as different gravitational fields, a residual atmosphere, not to mention the solar wind. Most of the changes can be corrected with automatic procedures on board, but in addition it is necessary to regularly, and according to a plan, to correct the orbit. Every ten days, according to the ground manager's estimate, the orbit will have to be adjusted from the operation centre.

## The data flow.

Envisat will gather so much data that even the two 160-gigabyte hard disks would overflow after a few hours. It will therefore transmit its load of data every time it orbits the earth, when it races over the ESA ground station at Kiruna in northern Sweden. The on-board storage will have to be emptied within a period of no more than ten minutes, since Envisat by then will have disappeared over the horizon. If Kiruna is out of commission, the second station at Svalbard in Norway is available.

As an alternative to the giant receiving dishes on the ground, Artemis, the telecommunications satellite parked in a geostationary orbit, will serve as a transmission station. Because Artemis is at an altitude 45 times higher than Envisat, every orbit gives it almost three-quarters of an hour's "eye contact" with environmental satellites, and it can very easily receive all data Envisat might want to unload. Afterwards Artemis sends the data to the ground station in its field of view.

From there an incessant stream of data will flow directly to ESA's data processing centre,

ESRIN, in Frascati, near Rome. Hundreds of programs have been developed to make valuable information available as effectively and quickly as possible. The one petabyte of data ENVISAT produces in the lifetime can be compared to a store capacity of one million hard disks.

Preferential treatment of individual users is ruled out from the beginning. The ESRIN data is sent directly to six processing and archiving centres in England, Germany, Italy, France, Sweden, and Spain. That guarantees equal information status for all participants and long-term security of archiving.

These centres will supply scientists worldwide with raw data for climate research, catastrophe prevention, weather forecasting, and

environmental

observation.

Thanks to the fast

channels of

transmission,

data, like the

analysis of the

ozone-

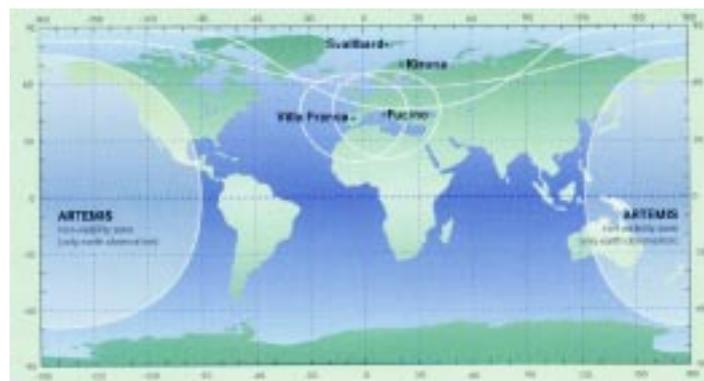
measuring

instrument

GOMOS,

will often

be available within three hours.



There are two ways of getting data from ENVISAT, dependent on scientific or commercial use. The participating scientific institutes receive data at cost, approximately what it costs to copy, with the stipulation that it must be used for scientific purposes and published in its entirety. In this category are all researchers who have proposed an idea to a scientific committee and whose projects have been accepted. An impressive community of several thousand earth observers in Europe and worldwide has taken shape in the last few years. The ESRIN centre will serve as the data distribution co-ordinator for them.

## The economical potential

Envisat also has an interesting economical potential. Analysts believe that environmental observation one day could become a branch of industry at the same scale as satellite navigation. This could well be since, as with GPS, the technology is likely to stimulate the imaginations of users. In order to sound out the market for data, two consortia are receiving selected data from the Envisat Mission: EMMA under the leadership on the Italian company Eurimage, and SARCOM, under the direction of the French company SPOT.