Report to the UNFCCC regarding Sweden's participation in Global Climate Observing Systems (GCOS) and on systematic observation in Sweden

22 November 2001

Preface

The Swedish Government views the combat against climate change, both nationally and internationally as a top priority. Science plays a key role in supporting policy decisions aimed at minimising climate change and its impacts. A precondition for sound science and understanding of global climate change is the work undertaken in the areas of Global Change Observing Systems (GCOS) and systematic observation.

Sweden has a long tradition in the area of systematic observation and Swedish engagement in various aspects of GCOS is considerable. Continuous, long-term, engagement in these areas is in line with the Swedish Governments prioritisation of research and development.

This report to the UNFCCC regarding Sweden's participation in GCOS and on systematic observation in Sweden has been prepared with the view to meeting all requirements of the guidelines for reporting on GCOS and systematic observation (UNFCCC/CP/1999/7).

The report has been prepared jointly by the Swedish EPA (Naturvårdsverket), the Swedish Hydrological and Meteorological institute (SMHI) in co-operation with the Geological survey of Sweden (SGU), the National Survey of Sweden (Lantmäteriverket) and the Swedish National Space Board (Rymdstyrelsen). During their work, these agencies have consulted with information from a number of agencies, universities and research institutes. The report has been subject to Government review.

Stockholm 22 November 2001.

Table of contents

General approach to systematic observation

The Conference of Parties of the UN Framework Convention on Climate Change has encouraged GCOS[1] to initiate an intergovernmental process to identify the priorities for action to improve global observing systems for climate and options for their financial support. GCOS has developed an Implementation Strategy that later was approved by the GCOS Steering Committee. The Strategy emphasises the need to foster ownership by national governments in implementing a multidisciplinary and multi-domain global climate observing system by stressing the cost effectiveness of building on existing national systems that in many cases have been implemented for other purposes. The Conference of Parties will encourage the national co-ordination of all aspects of climate observations across the various disciplines and domains.

In Sweden a large number of monitoring activities and systematic observations are taking place with relevance for GCOS to characterise climate and to detect climate changes. Presently the responsibility to develop, implement and maintain these systems is divided between several agencies and organisations, with different objectives and tasks.

In 1993, a Government bill proposed an enhanced co-ordination between Swedish institutes and agencies regarding the observations, collection, processing and control of environment related data. Government commissions set up to investigate the future of systematic observations of climate related parameters and environmental monitoring have recommended action programmes to improve the effectiveness and fulfilling the objectives. (SOU 1994:125 and SOU 1997:34[2]). However, the Government has not yet issued new directives or instructions following these commissions' recommendations. An increased co-ordination between state authorities and institutions has partly been a natural process in a rationalisation of the national and regional infrastructure of measurements. Data and systematic observations collected by governmental and most non-governmental organisations are to a great extent considered as public domain.

Since 1995 Sweden is a member of the European Union and extensive data series and information on systematic information are available in a European context over the European Environment Information and Observation Network (EIONET, http://eionet.eea.eu.int)

The Government is presently considering strengthening the Swedish organisation towards GCOS through the creation of a national focal point. This new organisation may start from 2002, and be fully operational within a few years.

Organisations in charge of systematic observation

Naturvårdsverket - Swedish Environmental Protection Agency

Naturvårdsverket is the central agency for the implementation of governmental environmental policies and programmes. It is also the central agency for the development of the scientific and technological basis for the setting of new policies. The agency has the overall responsibility to co-ordinate all environmental monitoring in Sweden, which comprises monitoring at the national and regional level. The objective for the co-ordinated monitoring programmes is to:

- Form the basis of information for the follow-up of the national environmental objectives decided by the Riksdag, the Swedish parliament.
- Be designed to satisfy the needs of society to protect the environment in a cost-efficient and action-oriented way
- Be efficiently designed to adequately

[1] As agreed by the responsible agencies (World Meteorological Organisation (WMO), Intergovernmental Oceanographic Commission (IOC) of UNESCO, United Nations Environment Programme (UNEP) and International Council for Science (ICSU)), the GCOS is made up of the climate observing components of the World Weather Watch (WWW), Global Atmosphere Watch (GAW), World Hydrological Cycle Observing System (WHYCOS), Global Ocean Observing System (GOOS), Global Terrestrial Observing System (GTOS), and relevant observation systems established under the World Climate Research Programme (WCRP) and the International Geosphere-Biosphere Programme (IGBP).

[2] SOU 1994:125 Samordnad insamling av miljödata (In Swedish); SOU 1997:145 Övervakning av miljön (In Swedish)

- describe the state of the environment,
- assess the environmental threats
- give a basis for action programmes and follow-up of actions already implemented
- give a basis for the analysis of domestic and outside sources of pollution.

The agency commissions the actual work within the monitoring programmes to institutes and universities or other governmental agencies. Important programmes are

- monitoring programmes for air, waters and the sea
- national surveys such as the National survey of forest soil and vegetation, the National survey of wetlands and the National survey of key biotopes.

All these programmes contain some element with relevance to the climate change issue.

The majority of the environmental data is available through data hosts of environmental monitoring. Links to the these data centres are provided by the agency at the web page www.environ.se.

Naturvårdsverket is also the National Focal Point of the European wide environmental work within the European Environment Agency (EEA, http://www.eea.eu.int)

SMHI - Swedish Meteorological and Hydrological Institute

SMHI shall supply society with meteorological, hydrological and oceanographic data. SMHI is responsible for national meteorological, hydrological and oceanographic forecast and warning system and preparedness for catastrophes where actual and prognostic information on weather and water conditions is required. The responsibility also includes production of basic information for the general needs of society for research and observations as well as for rational decision-making. SMHI is also responsible for the development and maintenance of national data sets in meteorology, hydrology and oceanography, much of it available at the web page http://www.smhi.se. The institute provides expertise in the area of climate and climate change issues.

SMHI has a strong co-operation with the Swedish Armed Forces as regards the meteorological infrastructure. The Armed Forces is responsible for aerologic stations, surface stations and weather radars – all parts of the Swedish meteorological infrastructure. There is also a strong co-operation between SMHI and the national environmental monitoring programmes operated by Naturvårdsverket on measurements with specific environmental importance.

SMHI is entrusted by the Swedish Government to represent Sweden in the World Meteorology Organisation (WMO), the Intergovernmental Oceanographic Commission (IOC), the European organisation for exploitation of meteorological satellites (EUMETSAT) and the European Centre for Medium-Range Weather Forecasts (ECMWF).

Lantmäteriet - National Land Survey of Sweden

The task of Lantmäteriet, the National Land Survey of Sweden, is to contribute to an efficient and sustainable use of Sweden's real estate, land and water. Lantmäteriet, which was established in 1628, has huge archives containing historical maps of great cultural significance as well as modern maps in different scales. In addition to maps more than 1 million aerial photographs are available covering each part of the country more than five times during a period of 50 year. Time series of satellite data over entire Sweden is also available from late 1970ties, 1980ties and 1990ties. These time series of maps, aerial photographs and satellite data are of great value for terrestrial studies.

Lantmäteriet has specialists in geographic information, land information, cadastral services and geographic information techniques. Lantmäteriet also offer its customers satellite remote sensing products and services, GIS, cartography, database access via Internet (www.lantmateriet.se and visualisation of geographical data. Lantmäteriet is a worldwide distributor of satellite data from several remote sensing satellites and sensors, from low resolution to very high resolution, and is the supplier of satellite imagery to all European countries that are taking part in the update of CORINE Land Cover for the year 2000.

Production of the digital map of Sweden is currently Lantmäteriet's largest task. Work has been in progress during the greater part of the 1990's and is close to completion. When the map is complete it will comprise a number of databases containing the basic geographic data and the digital cadastral index map with direct links to the property register. It will serve as an information technology infrastructure for all activities associated with real property, land and water. By the end of 2003 there will be:

- 11,700 databases containing basic geographic information, with complete information, covering 292,500 km^2.
- All property boundaries in the country and most of the plans, regulations and easements.

- An interface that is used for exchange of data between the State and municipal cadastral authorities.

Lantmäteriet export its products and services through the state owned company Swedesurvey that specialises in the transfer of technology and know-how, often in the form of institutional co-operation. The institutional co-operation activities are concentrated on three main areas: human resource development, technical assistance and consultancy

Lantmäteriet organises and contributes to training programmes, including GIS (Geographical Information System) and remote sensing, aimed for participants from developing countries. One example is the United Nation International Training Course on Remote Sensing, which has been held in Sweden for more than 10 years.

Lantmäteriet is one of the 37 members of EuroGeographics. The aim of this organisation is to strengthen co-operation between European mapping organisations in order to meet the increasing need for geographic information, e.g. for the development of a long-term, sustainable use of natural resources, at the national, European and global level.

Rymdstyrelsen - Swedish National Space Board (SNSB)

The Swedish National Space Board (SNSB) is a central governmental agency under the Ministry of Industry, Employment and Communication. SNSB is responsible for national, bilateral and international space efforts primarily research and development. Basic research is financed via the Ministry of Education and Science. The technical implementation of the national space programme is mainly contracted by SNSB to the state-owned Swedish Space Corporation (SSC).

Although SNSB has no direct responsibility for GCOS matters, it is a partner in several international systems for earth observation from space - where Sweden also has an important role in the ground segment - and it is responsible for the Odin national satellite. In addition, it conducts a research and development programme in remote sensing aimed at promoting the operational use of earth observation data and the growth of a remote sensing service industry in Sweden.

SNSB represents Sweden in the European Space Agency (ESA). SNSB is a full member of the Committee for Earth Observation Satellites (CEOS). CEOS is a Partner in the IGOS Partnership (Integrated Global Observing Strategy).

SNSB is a partner in the European GMES initiative (Global Monitoring for Environment and Security). GMES seeks to establish a coherent and user-driven operational information system that meets specific needs in the field of environment and civil security.

SGU - Geological Survey of Sweden

SGU (*Sw. Sveriges Geologiska Undersökning*), is a national authority responsible for questions relating to Sweden's geological character and handling of minerals.

SGU's objectives are to investigate, document and describe the bedrock, quaternary deposits and groundwater in Sweden in order to provide geological information, particularly within the fields of environment and health, physical planning, economy and supply of natural resources, agriculture and forestry as well as for the Armed Forces. Much of these data are available on the SGU homepage (www.sgu.se). The agency also has the task to work for the best possible use of the country's mineral resources with consideration taken to sustainable development.

SGU manages the settlement of Swedish national stockpile of petroleum products and is also the principal agency for the Mining Inspectorate.

SGU takes part in the co-operation between geological surveys within EU, EuroGeoSurveys, (EGS). A pertinent example of the work carried out within EGS is the project on Geological Electronic Information Exchange System (GEIXS). The objective is to create a common database, accessible via Internet, containing geo-data from different geological surveys.

SGU takes part in the European Marine Sediment Information Network (EUMARSIN) whose goal is to create a common database for marine geology.

The geological surveys in Europe have an organisation, Forum of European Geological Surveys (FOREGS) for exchange of information and for conducting geological projects of common interest.

SGU also takes part in the direction of the international commission on environmental geology, COGEOENVIRONMENT.

SGU is a part of the National Reference Centre for Inland Waters, which reports to the European Environmental Information and Observation Network (EIONET).

SCB - Sweden Statistics

The task of SCB is to produce and make available official statistics relating to different areas of society, which can serve as a basis for decisions, public debate and research. These statistics are to be objective, reliable, comparable, up-to-date and easily accessible, e.g. over Internet (www.scb.se). SCB have particular responsibility for official statistics in certain broad social fields, e.g. the labour market the economy, trade and industry, prices population and welfare housing and construction.

For many areas the responsibility to hold, maintain and archive statistics is shared with other agencies, e.g. for environment statistics the responsibility is shared with Naturvårdsverket. In several other areas we have entered into co-operation agreements with various other public authorities that have statistical responsibilities and produce the official statistics in these areas on their behalf.

SCB also bears the overall responsibility for co-ordinating and supervising official statistics and elaborating statistical nomenclatures and classifications. The agency holds many of the long time series and historical data as well as other statistics, most of it available on the web. (http://www.scb.se/eng/)

Universities and research institutes

The main task of universities and institutes is to teach academics and to undertake research. There is extensive co-operation between universities and research institutes and the central administrative agencies in Sweden. Universities and research institutes have an important role in the development of new technologies and the interpretation of systematic observations. The main task of universities and research institutes is to educate students and to perform research. Often the long time series and systematic observation have started as research projects in co-operation with agencies. Numerous data series of systematic observations are presently only available at research institutes.

Some examples of universities and institutes with importance of systematic observations in Sweden:

The *University of agricultural sciences* (SLU) has recently formed a centre on environmental data (Sw. Miljödatacentret) with the objective to increase public access of environmental information. The centre has thematic information on forests, agriculture, lakes and hydrology, wetlands, mountains areas and landscape. (http://www.md.slu.se/)

The *Marine centres of Göteborg, Stockholm and Umeå* co-ordinate research and environmental monitoring in the three coastal and high sea areas around Sweden (Skagerrak and Kattegat, Baltic Proper and Gulf of Bothnia). One central task of the Amrine Centers is to assist the national and regional authorities in the monitoring of the marine environment (http://www.smf.su.se/english/)

Stockholm University, Department of Meteorology, initiated in 1950-ties research on the long term changes of atmospheric constituents and precipitation chemistry caused by human activities. Later this research has been expanded to include climate and greenhouse gases.

IVL, the Swedish Environmental Research Institute, is an research institute financed by industry and the government. The objective of the research is to develop scientifically based decision-making bases to support the task of achieving a sustainable society. IVL's business concept is, through its project and research activities, to supply the community quickly with new knowledge to support the task of improving the environment. IVL is also the host of environmental data on air quality and atmospheric deposition.

Regional and local authorities

Some of the monitoring and systematic observations are part of activities of regional or local authorities. Often the observations are made in co-operation between authorities and central agencies and in same cases joint with industry.

Water management associations (*Sw. Vattenvårdsförbund*) are groups of municipalities, agencies and industry and other interested parties which join forces to monitor environmental changes in water sheds or rivers. Generally there has been an environmental concern or the need to protect specific endangered species in the monitoring activities. Parameters monitored may be physical, chemical as well as biological. Some of the data but not all are public domain. The publicly available data are available at central agencies like SMHI or SLU-miljödatacentret.

Air management associations (*Sw. Luftvårdsförbund*) are groups of municipalities, agencies and industry which join forces to monitor air quality and precipitation. IVL plays an important role in the co-ordination of the measuring activities in most of the air management associations and the data are available on the web (http:// www.ivl.se).

Principles of systematic observation

The principles for setting up and operating systematic observations depend on the purpose of the systematic observation. Some of the observations have been established to follow up a specific objective such as in environmental monitoring programmes. Others have been established to obtain basic information of the climate and the environment and its development over time. The principles of the systematic monitoring set up by GCOS have often been applied directly or indirectly in Swedish systematic observations.

Meteorological and atmospheric observation

Sweden has a long tradition in meteorological and atmospheric observations. There is, however, like in other parts of the world not a thorough system designed exclusively to observe climate variability in Sweden. The Swedish meteorological and atmospheric observing systems provide mainly data for the production of real time services like weather services and warnings to the general public and specific users. SMHI has the responsibility to provide the national infrastructure for these systems. This responsibility also includes international exchange of basic meteorological data and products, as defined in WMO Programmes.

A basic part of the system is the Swedish contribution to, and part of the WMO World Weather Watch (WWW, which was launched as a programme 1963). WWW is the backbone of WMO's activities. WWW offers up-to-the-minute worldwide weather information through Member-operated observation systems and telecommunication links. It comprises about 10,000 land based observation sites and about 7,000 ship stations and in addition moored and drifting buoys carrying automatic weather stations. The observation system part of WWW, the Global Observing System (GOS), provides, from all parts of the globe and from outer space, high-quality, standardised observations of the state of the atmosphere and ocean surface. GOS comprises observing facilities

- at stations on land
- at sea
- on aircraft
- meteorological satellites
- other platforms.

These facilities are owned and operated by the 185 Member countries of WMO. GOS is the most important source of information on the atmosphere.

Data from GOS are used in support of environmental programmes everywhere. Today, as a part of WWW/GOS is an Environmental Observation Satellite network included with five operational near-polar-orbiting satellites and five operational geostationary environmental observation satellites. Satellite sensors, communications and data assimilation techniques are evolving steadily so that better use is being made of the vast amount of satellite data. Improvements in numerical modelling in particular have made it possible to develop increasingly sophisticated methods of deriving the temperature and humidity information directly from the satellite measured radiances.

The WWW data are also the backbone of the GCOS. Data are stored and archived in databases around the world. There is, however, beside GSN, GUAN and GAW (see below), no dedicated and complete network of databases or infrastructure for the climate monitoring purposes. Databases are established partly on national or regional initiatives. Archive networks comprising global datasets are established as a result of global re-analysis projects.

NCEP/NCAR[3] Reanalysis: http://wesley.wwb.noaa.gov/reanalysis.html

ECMWF Reanalyses: http://www.ecmwf.int/research/era/

The real-time processing requirements are strong factors forming an accelerating renewal of the Swedish meteorological observation systems. These requirements are results of scientific achievements and change in application/user needs, technical development and economic boundaries. The consequential development results in new parameters, improved temporal and spatial resolution as well as improved quality in datasets. One example that should be mentioned is investments by SMHI and the Scandinavian Airline System (SAS) on Aircraft Meteorological Data Reporting (AMDAR) with frequent and high quality profile and *en-route* data of temperature and wind at high latitudes. Another example is the new precipitable-water information from a network of Global Position System (GPS) stations.

Sweden has as regards meteorological observations realised a rapid change to more automatic techniques. The network of SYNOP-stations has been reduced from around 100 to 20 during the last decade. The radiosounding stations are today modern autosond stations. Most of these developments satisfy the new climate monitoring needs. However, it is realised that there are special requirements beside those of the weather analyses, forecasts and warnings on a day-to-day basis. The Baltic Sea and its drainage area is a natural multinational focus area for Sweden and also for SMHI. Sweden participates strongly in the GEWEX/BALTEX. This experiment results in climate monitoring datasets and it is also supposed to contribute to new long-term requirements.

[3] National Centre for Environmental Prediction/National Center Atmospheric Research

There is a focus on current and newly introduced systems in this report. However, of very great importance is the old datasets. The importance of these has grown as a result of improved methods to assimilate digitised data in new (re-) analysis schemes. SMHI has a continuous work with digitising older data sets. SMHI will continue to search for relevant information to be digitised. This includes upper air soundings from the time when radiosounding where not as established as today.

An important aspect is quality long-term monitoring. Changes in networks, instrumentation and measured variables occur every year. From a climate change assessment perspective, this is undesirable. An early detection of changes requires homogenous and accurate measurements. Another application of quality measurements is for validation of less accurate methods and models.

Space-based remote sensing observations will play and have already played a critical role in support of atmospheric observations. Over the last one to two decades, satellites have proven their observational capabilities to accurately monitor many aspects of the Earth's systems. There is a capability unmatched by surface based systems limited to land areas and covering only about 30% of the planetary area. While this section focuses on *in-situ* observing systems, a complementary information of Swedish contribution to satellite observing can be found in the section *Space-based observing programmes* of this report.

Participation in Global Climate Observing System

The observation systems described above are growing with an increasing pace. For meaningful analyses of trends and as indicators of climate change on different scales, there is a strong need to have an observational material with continuity as well as very high quality to be a reference to global re-analyses (like ERA-40) and other analyses. The special GCOS networks as GCOS Surface Network (GSN) and GCOS Upper-Air Network (GUAN) play an important role as the long lasting pillars in the meteorological and atmospheric observing systems.

The main objective of GAW is to provide data and other information on the chemical composition and related physical characteristics of the atmosphere and their trends. The GAW data are required to improve understanding of the behaviour of the atmosphere and its interactions with the oceans and the biosphere. The data collected at the GAW monitoring stations are particularly essential to understand the relationship between changing atmospheric composition and changes of global and regional climate.

Global Surface Network - GSN - Stations

Sweden has six GSN stations that collectively should represent the temperature and precipitation variability of the country. There is a change in two stations from 2001. The old ones are reported together with the new official sites. In addition to these, SMHI also distributes to the GSN Data Centres data from another six climate stations. The six principle ones, and at least four additional should continue to operate through 2005.

Global Upper Atmosphere Network - GUAN - Stations

There are totally 100 upper air stations around the globe dedicated for GUAN but no Swedish stations are included.

Global Atmospheric Watch - GAW

Data are reported from 12 stations to the World Radiation Data Centre (WRDC) in St. Petersburg under GAW.

Ozone data have been collected at Vindeln and Norrköping since 1991 and 1988 respectively. These stations are within the World Ozone Observing System under GAW. Data are reported regularly to World Ozone and UV-radiation Data Centre in Toronto.

Table 1. Participation in the global atmospheric observing systems

	GSN*	GUAN	GAW
How many stations is the responsibility of the Party?	6 (+2+6)	0	12+2
How many of those are operating now?	6 (+2+6)		12+2
How many of those are operating to GCOS standards now?	6 (+2+6)		12+2
How many are expected to be operating in 2005?	6 (+4)		12+2
How many are providing data to international data centres now?	6 (+2+6)		12+2

Note: * There are officially six reported. The year 1999 SMHI announced a change in the network. Two new stations were introduced 2001. The two old ones are also still reported to provide an overlap for continuity reasons. Another six are today reported to the GSN Data Centre.

National programmes

The national weather and climate monitoring network

As described above, the meteorological and atmospheric observation programme for real time needs is also a basis for climate analyses and trends at a national scale. In the section *Meteorological and atmospheric observation*, we have described the trends in this system. On a national scale, there is also a contribution from other observations. The Swedish Civil Aviation Administration (http://www.lfv.se/eng/index.asp) is responsible for weather stations at airports (METAR). The Swedish National Road Administration (http://www.vv.se/for_lang/english/index.htm) has the responsibility of traffic ability and safety on the road network and has therefore established a special observation network along the roads, VViS. The co-operation with the Swedish Armed Forces and Naturvårdsverket is mentioned in the beginning of this document. The main part of the official meteorological data is included in the meteorological analyses, such as the Mesoscale Analysis System of SMHI (MESAN). The development of the co-operation, the sophisticated use of different datasets and the archiving of data relevant for climate monitoring will continue since the issue is better understood today than before.

Climate reporting stations

The special observation systems for climate purposes are traditionally oriented toward gathering of data for climate spatial and temporal variability analyses rather than climate monitoring. The number of Swedish stations for temperature, precipitation and other parameters is seen in Table S1. Here also there is not a complete continuity due to different reasons. One reason is that farming and fishing population and settlements (the historical locations of many climate stations) nowadays is not as stable as before. The network is changing, as well as the very local climate and also the technique.

For climate spatial and temporal variability analyses as well as for climate monitoring, new analysis techniques are developed. On the global scale, ERA-40/ECMWF and NCEP/NCAR have been mentioned. At a regional scale the BALTEX reanalysis project (SMHI and the Finnish Meteorological Institute, FMI) should be referred to. Also, at the national scale Sweden has started to make use of models describing consistency between different parameters and the influence of topography and physiography on temperature, precipitation etc. By making use of such models, data from remote sensing (i.e. weather radar and satellites) are integrated in the analysis. Through 12 weather radars, an almost complete national coverage is obtained. Also incorporated in these analyses are data from observations made by other Swedish authorities. The dense network for weather data along the Swedish roads established by the Swedish National Road Administration, is a source with the potential of further improvements of weather and climate analyses.

The results from re-analyses will be a database in grid form (See Table S3. MESAN). In general, the re-analysis techniques on global as well as more local scales are expected to be important tools in climate analyses and climate monitoring. This will in turn result in new requirements on the observation system. Data that today are not included in the traditional climate data set will be of new importance also for these purposes.

Long time series

On the national scale the SMHI database system KLAR (*Sw. Svenskt Klimatarkiv* http://www.smhi.se/) represents all climatological databases and retrieval systems and contains

- SYNOP - synoptic observations
- Precipitation and snow data
- Temperature data
- Radiation data

These are digitised data from 1961 until the last year. The radiation data, however, are from 1983. The content list of the database can be seen in the Economic Interest Grouping in Meteorology - ECOMET Catalogue of Sweden: http://www.meteo.oma.be/ECOMET/members/Sweden.html

Work with digitising of older data is ongoing.

The radiation network

The radiation climate is directly coupled to the composition of the atmosphere and the radiation is an essential part of the energy balance. In many cases, the radiation measurements are the only quantifiable physical quantity of the cloud impact on radiation. Cloud type, the base and the amounts are all descriptive and subjective in their form. SMHI's direct radiation measurements are therefore essential components in climate monitoring and in validation of parameterisation of clouds and energy balance. In situ measurements shall be seen as a backbone in the radiation climate analyses where the satellites provide the spatial coverage. Data are reported to the World Radiation Data Centre (WRDC) in St. Petersburg under GAW.

Turbidity measurements

SMHI has a unique material and knowledge regarding atmospheric turbidity (Aerosol Optical Depths, AOD). Some of these data have been recorded since the world pioneer Professor Ångström started to develop advanced techniques in the area. A digitalisation and processing of these historical data will give a valuable contribution to the understanding of long-term changes in atmospheric turbidity.

Today AOD at three wavelengths is measured at Norrköping and by using a model, an estimate of the turbidity can be retrieved from the 12 sites of the solar radiation network.

Constituent observing systems

The Stockholm University Department of Meteorology is monitoring a number of climate parameters at the Mount Zeppelin (78°58 N 11°53 E) on Svalbard, a station which is operated jointly with Norway. The objective of the long term monitoring is to obtain base line values of constituents with relevance for the climate issue and the Arctic atmosphere. Monitoring is focused on carbon dioxide, and aerosols (nephelometers, particle counters, filters). Other research projects are performed in parallel addressing the issues of long range transport of pollution and the source/sinks of carbon dioxide and particles in the region and to understand how human activities and climate change perturb the global carbon cycle. The data from the Mount Zeppelin are reported to the World Data Centre for Climate to be evaluated in a global context (Reference: http://www.nilu.no/niluweb/services/zeppelin/ and kim@misu.su.se

Ground level ozone is monitored within the national monitoring programme to give an overall picture of the ozone level in Sweden. In addition monitoring stations have been set up by municipal authorities to monitor local scale ozone behaviour. In total there are about 25 ground level ozone monitoring stations in Sweden, predominantly using the UV photometric absorption (UV photometers and DOAS systems). The quality of the data is considered to be high since Sweden has one of the UV reference photometers. (Reference: http://www.ivl.se)

Air quality and precipitation chemistry has been monitored to assess the air quality in urbanised areas and to assess the load of acidifying and eutrophying substances to land and aquatic ecosystems. The data have been collected as part of research and national monitoring programmes and later under the auspices of the European Monitoring and Evaluation Programme (EMEP , http://www.emep.int). The number of stations in the precipitation network has varied over the years, the network started in 1983 and presently there are about 30 stations. In addition a network with some 250 stations of through-fall monitoring of acidifying substances is operated by IVL. The through-fall monitoring started in 1985.

Aerosols, particles suspended in air have been monitored only at one research stations over a longer time period. The network for this monitoring is presently under development in Sweden. Total particle burden and major and minor constituents of particle mass have been quantified within an air chemistry network, part of the European Monitoring and Evaluation Programme (EMEP). Also other parameters of air chemistry and precipitation chemistry are monitored within the frame of EMEP or national programmes. (Reference: http://www.ivl.se)

Ozone monitoring

SMHI operates two stations, one in Northern Sweden (Vindeln) and the other in Southern Sweden (Norrköping) within the national environmental monitoring programme. Data have been collected since 1991 and 1988 respectively. These stations are within the World Ozone Observing System under GAW. Data are reported regularly to World Ozone and UV-radiation Data Centre.

Satellite systems

ODIN-The Swedish combined aeronomy and astronomy satellite- has the objective to study the chemistry and physics of the stratosphere. The focus will be on odd-oxogen chemistry in particular the ozone chemistry. Species like water vapour, ozone, nitrogen oxide and chlorine oxides will be monitored with remote sensing instrument. A more detailed description ODIN satellite may be found on the web (http://www.misu.su.se/~martin/odin.html).

Sweden also hosts strategic satellite receiving stations in northern Sweden. Important data from satellite instruments such as TOVS data for the global monitoring of ozone are received at these stations.

Table S1. Atmospheric observing systems for climate at the land surface (meteorological land surface observations).

Systems	*Climate Parameters* (e.g. Temp, Precip, other)*	*Total # Stations*	*Appropriate for Characterising National Climate? (tick one box)*			*Time Series #stations/platforms (Fraction of Data Digitised[4])*			*Adequate Quality Control Procedures? (tick one box)*			*Metadata available Total # Stations (% Digitised)*	*Continuity # expected operational in 2005*
			Fully	*Partly*	*No*	*30-50y*	*50-100y*	*>100y*	*Fully*	*Partly*	*No*		
Stations Useful for National Climate Monitoring Purposes (Specify parameters observed)*	*Temp*	*250*		*P*		*100 (80)*	*50 (0)*	*25 (0)*	*F*			*230 (50)*	*200*
	Air pressure	*100*	*F*			*50 (80)*	*25 (0)*	*10 (0)*	*F*			*95 (80)*	*90*
	Cloud amount/height /type	*25*			*N*	*20*	*15*	*10 (0)*		*P*		*20 (0)*	*20*
	Description/ occurrence of weather	*150*			*N*	*20*	*15*	*10*		*P*		*20 (0)*	*20*
	Humidity	*125*		*P*		*75*	*50*	*10*		*P*		*20 (90)*	*100*
	Precipitation (liquid	*800*		*P*		*300*	*160*	*50*	*F*			*790 (10)*	*700*
	Precipitation (solid)	*800*		*P*		*300*	*160*	*50*	*F*			*790 (10)*	*700*
	Radiation	*12*		*P*		*12 (100)*			*F*			*12 (100)*	*12*
	Sunshine	*12*		*P*		*12 (100)*			*F*			*12 (100)*	*12*
	Surface air temperature												
	Visibility	*125*		*P*		*75*	*25*	*10*		*P*		*120 (90)*	*100*
	Wind run												
	Wind speed and direction	*125*		*P*		*75*	*25*			*P*		*120 (90)*	*100*
Stations Reporting Internationally		*45*				*45*				*P*			*45*
CLIMAT Reporting Stations		*14*							*F*				*10*

[4] The original table given by the supplementary guidelines requires # Data Digitised, which could not be unambiguously determined. Hence the number in brackets give the fraction of stations in percent that are available as digitised data.

Reference Climate Stations		*0*											

** Refer to Appendix S1 for a list of possible climate parameters*

Comments:

1. *Only ongoing observations are reported*
2. *Data are collected for 25 manual synoptic stations, 100 automatic synoptic stations, 75 climatic stations, and 50 road authority automatic stations and about 800 manual precipitation stations*
3. *For column 5 Time series sub-column 1 include sub-column 2 and 3 stations, sub-column 2 include sub-column 3 stations*
4. *Daily data are digitised from 1961*

Table S2. Available homogeneous data sets for meteorological land surface observations.

Data Set Name	*Climate Parameters*	*# Stations or Grid Resolution and Region covered*	*Time Period*	*References*
KLAR	*Physical*	*All stations, Sweden*	*1722-*	*http://www.smhi.se/sgn0102/n0202/db_luft.htm*
NORDKLIM (Nordic Climate Analysis Co-operation)	*Temp, preci*	*80, Nordic countries*	*1722-*	*http://www.smhi.se/hfa_coord/nordklim.html*
*The Meuller Database**	*Temp, press,cloudiness,humid, preci, radiation*	*49.5°N-71.5°N 07.5°E-39.5°E Grid. Res. 1.0° in lat&long*	*1978-*	
MESAN	*Several*	*22 km Sweden*	*1998-*	*http://www.smhi.se/sgn0106/if/meteorologi/mesan.html*

*Comment: *Database at SMHI based on analysis of SYNOP for general climate and environmental purposes in the Baltic Basin. Time resolution 3h.*

Table S3. Atmospheric observing systems for climate above the surface (meteorological upper air observations).

Systems Useful for National Climate Monitoring Purposes	*Total # Stations or platforms*	*Appropriate for Characterising National Climate? (tick one box)*			*Time Series #stations/platforms (# Data Digitised)*				*Adequate Quality Control Procedures? (tick one box)*			*Metadata available Total # Stations (% Digitised)*	*Continuity # expected operational in 2005*
		Fully	*Partly*	*No*	*5-10y*	*10-30y*	*30-50y*	*>50y*	*Fully*	*Partly*	*No*		
Radiosonde stations	*4*		*P*			*4 (100)*			*F*				*3 or 4*
Wind-only stations	*0*												
Stations reporting Internationally	*4*												
CLIMAT TEMP reporting stations	*0*												
ASAP stations	*1*				*1*					*P*			*1*
*Profilers**	*0*												
*Aircraft (land locations)**	*63*									*P*			*>50*
*GPS**	*25*				*21*				*F*				*>25*
Others (e.g. satellite-based) ODIN (Stratospheric NO, ClO, H2O, O_3)*	*1*												
Total Upper Air Network		*F*											

Comments:

1. Aircraft are 51 over Europe and 12 global

Table S4. Available homogeneous data sets for meteorological upper air observations.

Data Set Name	*Climate Parameter*	*# Stations or Grid Resolution and Region covered*	*Time Period*	*References*
Swedish Temps	*Vertcal profile of temperature* *Rel hum* *Wind*	*4 stations regularly* *3 stations not regularly*	*1980-*	*KLAR/BÅK at SMHI*
The HIRLAM-BALTEX data assimilation	*Components crucial for the water and heat budget*	*The Baltic Drainage Area*	*The BALTEX/BRIDGE period (October 1999 - October 2000)*	http://hirlam.fmi.fi/bridge/ *The HIRLAM-BALTEX data assimilation is organised by the meteorological services of Finland (FMI) and Sweden (SMHI)*

Table S5. Atmospheric constituent observing systems for climate.

Constituent	*Total # Stations or platforms*	*Appropriate for Characterising National Climate? (tick one box)*			*Time Series #stations/platforms (#Data Digitised[5])*				*Adequate Quality Control Procedures? (tick one box)*			*Metadata available Total # Stations (% Digitised)*	*Continuity # expected operational in 2005*
		Fully	*Partly*	*No*	*10-20y*	*20-30y*	*30-50y*	*>50y*	*Fully*	*Partly*	*No*		
Carbon dioxide (Svalbard station)	*1*			*N*	*1*				*F*			*1 (100)*	*1*
Ozone (surface)	*9*		*P*		*6*				*F*			*9 (100)*	*9*
Ozone (column)	*2*		*P*		*2 (100)*				*F*			*2 (100)*	*2*
Ozone (profile)													
Atmospheric Water Vapour													
Other Greenhouse Gases													
Aerosols	*1*			*N*	*1*				*F*		*1*	*1 (100)*	
Other -National air quality and precipitation chemistry network	*30*		*P*			*30*			*F*			*30 (100)*	*About 30*
Other - Through-fall of acidifying substances	*250*		*P*			*250*			*F*			*250 (100)*	*No information*

[5] The original table given by the supplementary guidelines requires # Data Digitised, which could not be unambiguously determined. Hence the number in brackets give the fraction of stations in percent that are available as digitised data.

Table S6. Available homogeneous data sets for atmospheric constituents

Data Set Name	*Constituent*	*# Stations or Grid Resolution and Region covered*	*Time Period*	*References*
MISU Svalbard CO2 and atmospheric data set	Carbon dioxide and aerosols (PM10)	*1 (Arctic - Svalbard)*	*1989--present*	*Dept. of Meteorology, Stockholm university, 106 91 Stockholm, Sweden,* http://www.misu.su.se/~kim/index.html
National ground level ozone programme	Ozone	*1 station (Rörvik - Göteborg)* *1 station (Aspvreten-Stockholm)*	*1984 - present (Rörvik)* *1985 - present (Aspvreten)*	*Naturvårdsverket, 106 48 Stockholm* *IVL Göteborg, Box 470 86, S- 402 58 Göteborg (http://www.ivl.se)*
	Water Vapour			
	Other Greenhouse Gases			
Background aerosol	*Aerosol PM10*	*1 (Aspvreten Stockholm)*	*1990 - present*	*ITM, Stockholm university, S-106 91 Stockholm (http://www.itm.su.se)*

Oceanographic observations

Participation in Global Climate Observing System

SMHI represents Sweden in Intergovernmental Oceanographic Committee (IOC) and World Meteorological organisation (WMO). SMHI has a responsibility for the National Oceanographic Data Centre within the IOC's International Oceanographic Data and Information Exchange (IODE) network (http://ioc.unesco.org/iode/structure/nodc/nodc_browser.htm). One of the main objectives is now to participate and contribute in questions related to the development of Global Ocean Observation System (GOOS). SMHI is also member of the European component of the Global Ocean Observing System (EuroGOOS, http://www.soc.soton.ac.uk/OTHERS/EUROGOOS/eurogoosindex.html) and the Baltic Operational Oceanographic System (BOOS, http://www.boos.org/) in order to work with similar and GOOS-related issues on a regional and a sub-regional/national scale.

Table 2. Participation in the global oceanographic observing systems

	VOS	SOOP	TIDE GAUGES	SFC DRIFTERS	SUB-SFC FLOATS	MOORED BUOYS	ASAP
For how many platforms is the Party responsible?	35		28	0	0	2	1
How many are providing data to international data centres?	0		22	0	0	0	0
How many are expected to be operating in 2005?	35		22	0	0	2	1

Note: See appendix 1 for explanation of acronyms

Comments:

VOS was reporting to international databases until 1998. Today data are transmitted via GTS and thereby archived in databases where general WWW data are stored.

The moored buoys were set out 2001.

National programmes

The national oceanography programme -high sea programme

Over the oceans the Global Observing System of WMO/WWW (GOS) relies on ships, moored and drifting buoys and stationary platforms. Observations made from ships recruited under the WMO Voluntary Observing Ship (VOS) Programme comprise much the same variables as those made from land based stations with the important additions of sea surface temperature, wave height and period. SMHI has an important national responsibility to maintain the quality of the VOS Programme. The number of Swedish VOS ships is difficult to maintain at a sufficiently high level since the total number of Swedish ship on the oceanic routes as well as the staff size required to operate each ship have decreased over the years.

SMHI is together with the Icelandic counterpart responsible for one ASAP on the route between Iceland and North America.

In the waters close to the Swedish mainland, there is a network of stations of sea-level gauges, moored buoys, wave stations, current measurements, sea surface temperature measurements and ice observations.

Wave data: 6 stations from 1978. Today only 3. Data series not continuous.
Sea level: Series from 19th century with data every hour.
Sea surface temperatures: Measurements from 1969.
Ice observations along the coast: Observations from 1931. There is also some older series.
Current measurements: 8 stations, now 2 with Acoustic Doppler Current Profilers (ADCPs).

In addition, SMHI produces every day during the winter an ice chart based on observations and satellite information. In cooperation with other institutes around the Baltic Sea, observations are archived in national databases.

Arctic and Antarctic Research Institute (AARI) has a role under WMO Global Digital Sea Ice Data Bank to develop and maintain a data bank for sea ice in the Baltic Sea. SMHI delivers products to this data bank and older data sets are digitised to form an improved historic data set.

Oceanographic paleoclimate data

In Sweden the carbon content has been determined in marine sediments since about 1930 beginning with the investigations carried out by Stina Gripenberg. A rough estimate is that 20,000 to 30,000 samples of marine sediments taken from the Baltic and the Swedish parts of the Skagerrak and Kattegat have been investigate until today, many with respect to total organic carbon (TOC).

Many of the recent investigations have been reported to the International Commission for Exploration of the Sea.

Between 1946 and 1947 a Swedish expedition ”Albatross” conducted studies of marine sediments, including carbon content, on a global scale. The leader of the expedition was professor Kullenberg.

The Coastal Zone programme

The systematic monitoring of the coastal zone has recently been set up on the West Coast of Sweden around Göteborg and on the East Coast around Stockholm. There is presently insufficient data for climate studies.

Monitoring

SMHI and three marine centres conduct the national oceanographic monitoring (East, West and North) under co-ordination by Naturvårdsverket. The station network to be surveyed consists of 25 main stations as well as 68 mapping stations. The main stations, at which hydrographic, chemical and biological parameters are measured, are generally visited on a monthly basis. The mapping stations are visited once during the winter season for monitoring the nutrient distribution, and/or once in the autumn to determine the oxygen situation. The conditions in the seas around Sweden, based on measurements taken at SMHI's main and mapping stations, are briefly described in expedition reports as well as in annually, quarterly and climatological reports. SMHI also performs oceanographic surveys for a number of Regional Coastal Monitoring Programmes. Joint cruises with the National Board of Fisheries (Fiskeriverket) are also conducted on a regular basis.

Data

Data collection and information exchange takes place on a national as well as international level. Naturvårdsverket has appointed SMHI as National Oceanographic Data Centre for hydrographic and chemical marine data. SMHI obtains data from the national monitoring programmes collected by the Marine Research Centres in Gothenburg, Stockholm and Umeå. The Data Centre also manages the hydrographic data obtained from the joint cruises with the National Board of Fisheries. In addition, a number of regional coastal monitoring programmes use SMHI as data host.

SMHI who acts within IODE network, the International Council for the Exploration of the Sea (ICES), the Helsinki Commission (HELCOM), IOC and OSPARCOM mainly conduct the international data and information exchange.

The Swedish Ocean Archive, SHARK, is Sweden's largest oceanographical data bank for physical and chemical data. The data bank, managed by SMHI, is based on observations collected by Swedish and foreign research vessels, Coast Guard vessels, ice breakers, ferries, caissons, light ships and other platforms. SHARK also contains catalogues, cruise reports, etc. For many stations information is available for the last 30-50 years, making the data bank a useful tool for

climatological studies. For some stations, data on temperature, salinity and oxygen goes back to the beginning of the last century.

Satellite observations

Sweden is hosting the satellite receiving station for ENVISAT. One of the instruments, RA-2 (Radar Altimeter) monitors the sea surface level. More information on this application may be found on internet (envisat.esa.int).

Table S7. Oceanographic observing systems for climate.

System Component	*Total # Stations*	*Appropriate for Characterising National/Regional Climate? (tick one box)*			*Time Series #stations/platforms (# Data Digitised[6])*			*Adequate Quality Control Procedures? (tick one box)*			*Metadata available*	*Continuity*
		Fully	*Partly*	*No*	*30-50y*	*50-100y*	*>100y*	Fully	Partly	No	*Total # Stations (% Digitised)*	*# expected operational in 2005*
Sea Level e.g., Tide gauges	*28**	*F*			*13 (100)*	*3 (50)*	*8 (60)*		*P*		*28 (50)*	*28*
SST (e.g., Moored Buoys)	*2*			*N*					*P*		*P*	*2*
Meteorological Obs (e.g., Temp, Precip, Pressure)	*36*		*P*						*P*		*P*	*36*
Sub-Surface Profiles	*23*		*P*		*23 (100)*	*10 (100)*		*F*			*23 (100)*	*23*
Ocean Circulation	*2*								*P*			
Carbon Fluxes												
Energy Fluxes (BALTEX)												

[6] The original table given by the supplementary guidelines requires # Data Digitised, which could not be unambiguously determined. Hence the number in brackets give the fraction of stations in percent that are available as digitised data.

Sea Level Altimetri (ENVISAT)												

**Total number of stations in the historic list is 34.*

Table S8. Available homogeneous data sets for oceanographic observations.

Integrated Data Sets *Name and Brief Description*	*Climate Parameter*	*Platforms and/or Grid Resolution and Region covered*	*Time Period*	*References*
SHARK	*Hydrography*	*23 Swedish open sea*	*1900-*	www.smhi.se/*sgn0102/nodc/nodc.html*
SVAR (Swedish Inland Waters Database)	*Physical*	*Swedish sea areas*	*1886-*	www.smhi.se/*sgn0102/n0204/db_sjoar.htm*

Terrestrial observations

Participation in Global Climate Observing System

There is presently no direct Swedish participation in the terrestrial observations of GCOS.

Table 3. Participation in the global terrestrial observing systems

	GTN-P	GTN-G	FLUXNET	Other
How many sites are the responsibility of the Party?				
How many of those are operating now?				
How many are providing data to international data centres now?				
How many are expected to be operating in 2005?				

National programmes

The national hydrologic programme

The goal of the Swedish hydrological network is to supply information on inland waters for

- describing the hydrology of Sweden for general purposes, initially primarily for hydropower planning
- providing real-time hydrological forecasting and warning services
- creating a database of hydrological information for climatology, investigations and research

Quality-system philosophy is introduced with focus on the process of the whole information flow, from measurement in the field to the end user and to storing corrected data in the database.

When the network was established, the hydropower planning was the basic requirement. Later other functions became equally important. These were environmental monitoring, flood forecasting and protection. Today the hydrologic climate information is also more clearly integrated in a climate monitoring context, as indicator of precipitation climatology and in the water and energy cycle together with meteorological and oceanographic recordings (i. e. BALTEX and follow on frameworks).

Hydrometric network

SMHI has since 1907 the national responsibility regarding discharge and water levels in Swedish lakes and other inland waters. The current basic network consists of 330 stations. Discharge is measured at 324 of those. From the year 2000, SMHI and Svensk Energi (http://www.svenskenergi.se/) have an agreement which implies that about 100 stations owned by different energy companies now are included in the basic national network. The agreement also allows additional measurements to be safeguarded and included in climate analyses.

The series started during the 19th century. One in Lake Vänern, which started 1807, is the oldest. During the two decades from 1900 to1919 a vast number of stations were established and from 1920 there is a network covering the whole of Sweden. The further enhancement of this network has after that continued until around 1980. The last years the number of stations has decreased in a rationalisation work of the networks.

Snow

Systematic observations of snow started around 1900. Today the snow and its depth is recorded at around 400 stations. The positions are relevant stations in the climate network for precipitation. The water equivalent of the snow is calculated out of meteorological data and developed and validated routines. At SMHI and a couple of institutes there is a development of new methods where also satellite data are used. This work is carried out also a complementary activity to the EUMETSAT/SAF on Land Surface Analysis where SMHI is responsible for a new routine snow product.

Ice on rivers and lakes

Ice on rivers and lakes has been very important for transportation of people and goods in Sweden. This is the reason why observation started early. The observation of ice break up in the Torne river is documented from the 17th century and ice formation and ice break-up have been observed on 300 lakes since 1870. Ice conditions along rivers have equally long records. The lake ice thickness is observed on 30 lakes from 1940. Much data on water temperatures in rivers and lakes have also been collected. Today the interest for ice and water temperature are declining but SMHI will argue to have resources to continue as many observations as possible for climate trend analyses.

Ground water monitoring at the Geological Survey of Sweden

SGU has time series consisting of groundwater level and groundwater chemistry are available from the late part of the 1960-ties. Groundwater level is measured 24 times every year at about 400 stations within 80 areas. Groundwater chemistry is sampled and analysed 2 - 4 times every year at about 150 stations. Data originate from two programmes: The National Groundwater Network Programme and the Environmental Monitoring of Groundwater.

The purpose of the programme is to study regional and temporal variations of the amount and quality of the groundwater with respect to geology, topography and climate. The information is available for reference purposes, for making of prognoses, environmental control and estimation of resources. In all about 90 observation areas covering the country have been established. Out of those about 80 are operative today. Groundwater levels are measured in almost all areas, whilst chemical samplings are carried out in about 30 areas. Altogether there is chemical information from about 30 stations. The stations consist of springs, tubes and wells.

The variables measured and analysed within the chemical groundwater programme are temperature, conductivity, O_2, pH, TOC, (COD-Mn), Na, K, Ca, Mg, HCO_3^-, SO_4^{-2}, NO_3^-, NO_2^-, NH_4^+, Fe, Mn and SiO_2.

Since 1978 sampling and analysis of the chemistry of groundwater is carried out by SGU also within the environmental monitoring founded by Naturvårdsverket (Environmental Monitoring of Groundwater). The analyses made within this monitoring programme are the same as those of the Groundwater Network Chemical Programme but with additional analysis of aluminium and some heavy metals. There is information from about 120 stations.

Land cover

Two complete landcover datasets are available over Sweden from Lantmäteriet. One classification was made 1990-1991 based on Landsat Thematic Mapper and SPOT (Satellite Probatoire d'Observation de la Terre) data from 1986-1990, and another classification was made 1994-1999 based on satellite data from 1994-1998. A total of 900 map sheets were produced, each covering an area of 25 by 25 kilometres, in all about 500,000 km^2. The dataset records 13 cover-types on a 25 m grid.

Sweden participates, through Lantmäteriet, in the European Environment Agency's CORINE Land Cover 2000 project, which will produce a homogeneous dataset for all European countries with 44 classes based on satellite data. CORINE Land Cover forms the basis for political decision making on environmental issues in the EU.

The EEA Working Group on Land Cover states in a report dated January 1999 that the interest and demand for using land cover data and geographical information systems as tools for spatial analysis within integrated assessment is strongly increasing at EEA and its European Topic Centres as well as at the Commission services. Especially in areas such as integrated spatial analysis and reporting, strategic environmental assessment of the trans-European network, Natura 2000, Integrated Coastal Management, Water Directives, European Spatial Development Perspective and Eurostat Pressure Indicators.

Sweden has been the lead country for EEA's European Topic Centre on Land Cover during six years, 1995-2000. Since 2001 land cover issues are integrated in the European Topic Centre on Terrestrial Environment.

The Swedish CORINE Land Cover Project involves an innovative approach which combines the generation of the CORINE Land Cover (CLC) database according to the specifications of EEA and its European Topic Centre on Terrestrial Environment, with a considerably more detailed mapping tailored to the requirements of the main Swedish user organisations, Swedish Land Cover Data (SLD). The basic descriptive unit for the SLD product is 1 to 5 hectares rather than CORINE Land Cover's 25 hectares, and the number of thematic classes is 52.

In addition, the production is done using all available data layers, not just satellite data, and with a high degree of automation. It is expected that this will result in the following benefits:

- A documented high level of quality
- The mapping will "agree" with other databases
- It will be feasible to dynamically update the database
- It will be feasible to easily detect and map changes in the land cover.

The project is "user driven". It has been approved by the principal user agencies and has been accepted by Lantmäteriet as part of the national mapping plan. This means that satellite data will be integrated as a data source in the national mapping system operationally on a routine basis.

Lantmäteriet is a partner, in collaboration with a network of partners around the world, in the Global Land Cover 2000 project (GLC2000), which general objective is to provide for the year 2000 a harmonised land cover database over the whole globe. The database will be used for environmental assessments in relation to various activities, and in particular the United Nation's ecosystem-related international conventions. To achieve this objective GLC2000 makes use of the VEGA2000 dataset of 14 months of processed daily global data acquired by the Vegetation instrument on board the SPOT 4 satellite. In GLC2000 Lantmäteriet is responsible for the northern part of Europe, including the Baltic Sea Region (1.8 million km^2).

Lantmäteriet is a partner in the European Forum on Earth Observation use for Environment and Security (EUFOREO), which is a thematic network that will build upon ongoing work by the European Global Monitoring for Environment and Security (GMES) initiative. The GMES initiative deals with the use of Earth observations for the following application sectors: Climate Change and Kyoto Protocol, environmental stress, population pressure and humanitarian aid.

Fire distribution

Some statistics of fire incidence and extent is available from 1942 to 1975 and from 1996 to the present. The origin of the statistics is the Swedish Rescue Services Agency (*Sw. Räddningsverket Räddningstjänsten*) and based on the calls for help. The interruption of the time series and the original purpose of the statistics may reduce their value for climate and climate change purposes.

Glaciological programmes

The Department of Physical Geography and Quartenary Geology at Stockholm University has monitored the glacier Storglaciären that is situated close to the highest Swedish peak Kebnekaise in northern Sweden. The monitoring has been performed annually since 1945 and includes glacial front, mass and energy balance and run off physical parameters. The purpose of the monitoring is a better understanding of the dynamics of glaciers typical for the Scandinavian mountain ranges and to understand the climate impact on glaciers.

Scandinavia was entirely covered under ice during the last ice age. Sweden has records of the extent of the glacier fronts with high accuracy from about 12,000 years ago to the present.

Soil programmes

The Swedish forest inventory programme (*Sw. Riksskogstaxeringen*) also includes monitoring of the status of soil (chemistry, physical parameters) and ground vegetation (National survey of forest soils and vegetation, *Sw. Ståndortskarteringen*). The programme has run since 1983.

The programme for agriculture soil is focused on factors for the productivity of crops. Important parameters are humus content and nutrient status as well as concentration of minor constituents (metals). The programme includes the top soil as well as the underlying subsoil.

Peat land in Sweden as an Archive for Climate

In the period 1916-1922 an inventory of peat lands was conducted in the southern and middle parts of Sweden. Most of the material has been published by SGU between 1920 to 1930. In addition to stratigraphic data collected in the field, the development of fauna was studied by pollen analysis. The advent of carbon dating has supplemented the datings by pollen analytical studies, however, the main events in the climatological development in Sweden were established already around 1920.

Land use

The CORINE Land Cover dataset gives a basis of land cover and to some extent on the land use.

Agriculture: Long time records of land use exist in Sweden but the data quality may be unsatisfactory before 1927. The Swedish Board of Agriculture (*Sw. Jordbruksverket*) has land-use statistics for the use of agricultural land that covers Sweden and with a high accuracy from about 1950. The statistics also includes the different crops cultivated from 1951/2 and from 1992 and statistics on the areas given subsidies for different uses from 1993 to the present. Closely linked to the use of agricultural soil are the chemical and physical parameters of agriculture soil. Data covering most of Sweden are available representative of the status in the 1990ties (SLU miljödata).

As a follow-up on the agriculture policy in Sweden and also of the EU Common Agriculture Policy, 20 reference areas have been designated to monitor long term changes in the agricultural landscape. Data will be available in GIS for the years around 1900, 1992, 1996 and 2002. *(Sw Livsmedelspolitikens inverkan på miljö)*

Since the 1950-ties a number of experimental fields or plots with carefully monitored and documented agriculture (*Sw. Långliggande fältförsök*) to assess the effect of long term changes of the productivity due to the addition of fertilisers, practices, selection of crops and climate. These activities are made by the Swedish University of Agricultural Sciences in Uppsala (SLU).

National Forest Inventory - Riksskogstaxeringen

Riksskogstaxeringen is a national regularly recurring inventory of the Swedish forested areas. The aim is to quantify growth (biomass change) and health of the Swedish forests. Presently there are about 25,000 areas that are revisited at regular intervals of about 10 years. The inventory programme started in 1923. Since 1983 a programme with fixed plots has been run to improve the homogeneity of the series. Riksskogstaxeringen also to some extent covers the systems of Land cover and of Vegetation type.

Integrated monitoring

Part of the European wide programme under the auspices of the Economic Commission of Europe - Convention of Long Range Transport of Atmospheric Pollution. The original purpose is to detect long term changes due to atmospheric transboundary air pollutants, but also includes the effects of changing climate Presently Sweden is in charge of 4 plots in the IM programme.

Other inventories

National survey on wetlands (including open wetlands and forested wetlands) - presently covers the total land surface except the mountains and the northernmost part, in which the inventory is ongoing. In northern Sweden the inventory includes all wetlands areas larger than 50 ha and in southern Sweden larger than 10 ha. In some counties the inventory includes areas of wetland as small as 2 ha. The inventory includes abundancies of species. Occurrences of which are sometimes related to climate parameters.

National survey of key biotopes- completed in 1998. Inventory of about 32,000 key biotopes and 25,000 areas with high natural values have been identified in the forested areas. The objective of the survey is to make an inventory of biotopes that should be preserved for the protection of habitats of vulnerable species.

National survey of pasture and meadows, first performed in 1927 and repeated in the 1980 ties and 1990 ties. It includes an inventory of species and areas of pastures and meadows. Comparisons have been made between the older and newer inventory. Most of the changes in species and areas is due to the changes in agriculture.

National survey of endangered and vulnerable species (Red List species). The purpose is to identify species that are under threat of being extinguished or vulnerable due to anthropogenic factors.

Phenological observations

Information of phenological observation is scarce in Sweden. Some observations are available from meteorological or weather observers but the consistency and quality is unknown.

PaleoClimate

Long time series are available from paleological data such as peats, dendrochronology and sediment. The purpose of these studies is generally to understand the quaternary era better with respect to variables such as the climate variability and the dynamics of physical geography. Most of the data have been published in scientific literature.

- Dendrochronology; Four distinct time series exist representing four regions of Sweden (Skåne, Dalarna, Jämtland and Torneträsk area). The quality of the data is high and compares well with climate series from other countries. (Stockholm University, Earth Sciences and Geography)
- Peat -oxidation horizons: A long time series representative for southwest Sweden (Värmland) based on horizons with oxidised peat, which indicates periods of sustained drought or insufficient water to maintain a steady growth. (Lund University, Dept. of Natural Geography and Quaternary Geology)
- Peat and pollen record: covering Sweden as a whole, climate records based on pollen occurrence indicative for plant species in the local region. (Stockholm University, Earth Sciences and Geography)
- Lake sediments - glacial lakes sediment records give a picture of the occurrence and status of glaciers in the catchment area. These records cover the entire holocene. (Stockholm University, Earth Sciences and Geography)
- Lake sediments and the occurrance of diatoms and pollen in the sediments. Data mostly covering northern Sweden. (Umeå University, Dept. of Ecology and Environmental Science)
- Lake sediments - lakes in general and lakes with annually layered sediment may be used to characterise the local climate. Sediment cores are analysed on its content of pollen, carbon and other trace elements (such as oxygen isotopes)and related to local and regional climate changes. (Stockholm University, Earth Sciences and Geography)
- Baltic Sea and North Sea sediment cores may also be used to establish time series of climate related parameters, particularly for carbon content. (Stockholm University, Earth Sciences and Geography)
- Speleotenes - deposits in caves, such as stalagmites and stalactites are used to trace climatic changes (temperature and water regime) (Stockholm University, Earth Sciences and Geography)
- Tree line data in the Swedish mountain ranges, the advancement of forest with altitude is critically dependent on climate in spring and early summer. The tree line may be used as an indicator or a proxy for the climate in a specific region. (Stockholm University, Earth Sciences and Geography)
- The level of the sea. During the last 14,000 years the global sea level has increased by 100 m. The present sea level rise is about 1 mm/year. There are several problems involved in measuring sea level changes. The main problem is to separate sea level changes from uplifting or sinking of land. Tidal water fluctuations in most areas of the world also make it more difficult to get detailed results. The tidal effect is very low in Sweden and can be neglected for interpreting geological shore level sites. Recording sea level comprises two different time intervals, the geological and the present development. Several tide gauges in the coastal areas record the present development. One of the longest series of shore level data in the world is from Stockholm, where the shore level has been recorded since 1774. The geological record of sea level development shows that there is an oscillating course of the sea level. The oscillations occur with intervals of about 400 to 500 years. It would be possible to estimate these variations in detail and also to evaluate this course of development into a prediction of natural future development

Table S9. Terrestrial observing systems for climate

Systems useful for national climate monitoring	*Total # stations*	*Appropriate for Characterising National Climate? (tick one box)*			*Time Series #stations/platforms (#Data Digitised[7])*			*Adequate Quality Control procedures? (tick one box)*			*Metadata available*	*Continuity*
		Fully	*Partly*	*No*	*30-50y*	*50-100y*	*>100y*	*Fully*	*Partly*	*No*	*Total # Stations (% Digitised*	*# expected operational in 2005*
River Discharge (Streamflow Gauges)	*325*		*P*		*213 (100)*	*157 (100)*		*F*			*325 (100)*	*325*
Ground Water Storage and chemisty (e.g., Boreholes)	*400*	*F*			*400*			*F*			*400 (100)*	*400*
Snow depth	*400*		*P*		*400 (100)*	*400*		*F*			*400 (100)*	
*Glaciers * (holocene to present ice cover in Scandinavia; Historical record of Storglaciären)*	*1 (Storglaciären)*			*N*	*1 (100)*			*F*			*1 (100)*	*1*
*Permafrost **												
Ice (sea ice, lakes and rivers, coverage, thickness)	*30*											
FluxNet												
*Radiation **												
*Soil * (Ståndortskarteing (chemical and physical parameters), Soil temperature)*	*400*		*P*					*F*			*400 (100)*	*400*
Other (Ground frost)												

** Specify those parameters necessary for climate monitoring (eg. snow variables to consider include Coverage, Depth, and Water Equivalence)*

[7] The original table given by the supplementary guidelines requires # Data Digitised, which could not be unambiguously determined. Hence the number in brackets give the fraction of stations in percent that are available as digitised data.

Table S10. Ecological observing systems for climate

Systems useful for national climate monitoring	*Total # stations*	*Appropriate for Characterising National Climate? (tick one box)*			*Time Series #stations/platforms (#Data Digitised)*				*Adequate Quality Control Procedures? (tick one box)*			*Metadata available Total # Stations (% Digitised)*	*Continuity # expected operational in 2005*
		Fully	*Partly*	*No*	*30-50y*	*50-100y*	*100-300 y*	*>300y*	*Fully*	*Partly*	*No*		
*Phenological **													
*Biomass Change *Forest biomass (riksskogstaxerngen)*	*25,000*	*F (Forest)*				*Riksskogstaxeringen*				*P*		*25,000 (100)*	*25,000*
*Vegetation Type * (Forests veg, types)*		*F (Forest)*											
*Land Cover * (CORINE LANDCOVER)*		*F*							*F*				
*Fire Distribution **													
Land Use Change a.Inventories of agricultural land b. Satellite data from Landsat and SPOT, medium and high spatial resolution		*b. F*	*a. P*						*b. F*	*a. P*			
PaleoClimate # (Dendrochronology, peat and oxidation horizons, peat and pollen, lake sediments, sea sediments, speleotenes, glaciers, tree limit)		*F*							*F*				
Other: Inventories of Wetlands, key biotopes, pastures and meadows, vulnarble species etc		*F*							*F*				
Other: Integrated monitoring			*P*										

** Specify those parameters necessary for climate monitoring – refer Appendix S1 for suggestions. # Paleoclimate is not limited to terrestrial, please consider atmospheric and oceanographic elements when filling this out.*

Table S11. Available homogeneous data sets for terrestrial and ecological observations.

Data Set Name	*Climate Parameter*	*# Stations or Grid Resolution and Region covered*	*Time Period*	*References*
SVAR	*Hydrology*	*About 1000, Sweden*	*1807 -*	*www.smhi.se/sgn0102/n0204/db_sjoar.htm*
Riksskogstaxeringen	*Forest biomass, landcover*	*About 25,000 Sweden*	*1923-* *1983 (permanent plots)*	*SLU miljödata http://www.md.slu.se*
Ståndortskarteringen	*(soil parameters and ground vegetation)*	*About 400 Sweden*	*1983-*	*SLU miljödata http://www.md.slu.se*
Integrated monitoring	*Chemistry, physical parameters, vegetation*	*4*		*SLU miljödata http://www.md.slu.se*
Ground Water	*Level, physical and chemical parameters*	*400, level, Sweden* *150, chemical parameters, Sweden*	*1968-*	*SGU grundvattennät - http:www.sgu.se*

Space-based observing programmes

The global role for satellites in the GCOS

The global network of meteorological satellites constitutes a major portion of the space-based subsystem in the Global Observing System (GOS) of the World Weather Watch (WWW). This network design evolved during the period from 1965 to 1978 as a portion of the Global Atmosphere Research Programme (GARP).

Since approximately 70 per cent of the Earth's surface is water and even the land areas have many regions which are sparsely inhabited, data from the polar-orbiting satellite systems are needed to fill-in the gaps of surface and atmospheric temperature profiles over the areas not adequately covered by conventional observing systems particularly in the Southern Hemisphere and in high latitudes both in the Arctic and Antarctic. Flying in a near-polar orbit, these spacecraft are able to acquire data from all parts of the globe in the course of a series of successive revolutions. With a relatively low altitude, their sensors can acquire higher-resolution data, both spatially and spectrally, than can the high-altitude geostationary satellites. For these reasons, the polar-orbiting satellites have principally been used to obtain specific sets of observations of three main types:

a) daily global cloud cover;

b) measurements of surface temperature

c) most important, the vertical variation of temperature and water vapour in the atmosphere.

The missions and climate relevant parameters are growing with the new generations.

The geostationary satellite systems have been designed to fulfil the following mission objectives:

a) High-resolution imaging of the Earth's surface and of its cloud coverage, in the visible and thermal infrared spectra, and extraction of meteorological information such as cloud motion wind vectors, wind derived from the water vapour displacement, sea surface temperatures, cloudiness and cloud top heights from the image data.

b) Dissemination of cloud cover images and other meteorological information to User Stations.

c) Collection and relay of environmental data from fixed or mobile Data Collection Platforms, located either on the Earth's surface or in the atmosphere.

EUMETSAT and SAFs

EUMETSATs (http://www.eumetsat.de) primary objective is to establish, maintain and exploit European systems of operational meteorological satellites. EUMETSAT is responsible for the launching and operation of the satellites and for delivering satellite data to end-users as well as contributing to the operational monitoring of climate.

The organisation can trace its history to the launching of the first Meteosat satellite by the European Space Agency in 1977. The EUMETSAT Convention entered into force on 19 June 1986. EUMETSAT inherited the Meteosat satellite programme from the European Space Agency (ESA), which included funding until 1995. A series of seven almost identical satellites have with high continuity provided an enormous amount of data. During one period, EUMETSAT has supported the US with an American-Atlantic coverage and today EUMETSAT has a complementary position over the Indian Ocean.

From 2002 the old programme will be superseded by a new programme, Meteosat Second Generation (MSG 2002-2012), with much enhanced capabilities.

From 2005/2006, USA and Europe will share a responsibility for the polar-orbiting satellite system within WWW/GOS when the ESA/EUMETSAT satellite Metop-1 is launched.

A very important EUMETSAT strategy and ambition is to safeguard continuity and development. When new programmes are introduced, the new satellites have partly identical measuring methods. Also, a very important role that is identified by EUMETSAT is the archiving of raw data so that old data set can be used with new algorithms and processing methods in re-analysis programme like the actual ECMWF/ERA-40. In order to safeguard continuity between continents and different part of the globe, the meteorological satellite operators (EUMETSAT, National Oceanographic and Atmosphere Administration (NOAA), Japan Meteorology Agency (JMA), China Meteorology

Agency (CMA)) have a close co-operation, within WMO, in other co-ordinating organisations and directly through contracts or agreements.

From the year 2000 all the 18 member countries of EUMETSAT have ratified the new convention which prescribes that EUMETSAT also has a objective related to climate monitoring and the detection of climate change.

Sweden is member of EUMETSAT. Through this organisation, the Swedish contribution is co-ordinated with that of other parts of Europe. The new satellite programmes have been worked out together with ESA and ESA takes much of the technical risks on the road until the first satellite in a series is in full operation. Swedish space industry have been strongly involved in both space and ground segments of the EUMETSAT programmes. SMHI is appointed by the Government to represent Sweden in EUMETSAT. EUMETSATs headquarters are located to Darmstadt in Germany.

EUMETSAT initiated with start 1997 a number of SAFs[8] (Satellite Application Facilities). These can be seen as the beginning of a decentralised network for the production of a wide set of satellite applications.

Sweden is engaged in four of totally seven SAFs. These are built around the themes:

1. Nowcasting and Short-range Forecasting (NWC SAF)
2. Ocean and Sea Ice (OSI SAF)
3. Climate Monitoring (CM SAF)
4. Land Surface Analysis (LSA SAF).

Other themes are

5. Ozone analyses (O3 SAF)
6. Numerical Weather Predictions (NWP SAF)
7. Processing routines for the new GRAS-instrument (GRAS SAF).

There are many strong couplings between the different SAFs. At least five of the SAFs have important functions directly related to GCOS:

- Improved temperature soundings of the atmosphere
- Improved water vapour soundings of the atmosphere
- New cloud mapping and cloud properties
- Precipitation
- Atmospheric constituencies (ozone)
- Aerosols
- Sea surface temperature
- Ice mapping and ice properties
- Snow
- Albedo
- Vegetation
- Soil moisture

SMHI contributes in all SAFs. The principal and direct contributions of SMHI are cloud analysis and precipitation and in the LSA SAF where the task is snow mapping.

There are often strong links between GCOS and GOOS, and it is obvious that the meteorological satellites as well as other satellites contribute to the GOOS objectives on global as well as regional scale. It is very likely that the first optional programme of EUMETSAT will be a co-operation with USA on JASON-2, a continuity of altimeter data covering most of the global seas. Altimetry is fundamental for the modern oceanographic models and therefore also for

[8] ”EUMETSAT development of a network of Satellite Application Facilities (SAF's) will together with the EUMETSAT central facilities, constitute the future EUMETSAT Application Ground Segments for MSG and EUMETSAT Polar System (EPS). The SAFs will be located in a National Meteorological Service or other approved institute of an EUMETSAT member state. The scope of the SAF activities shall be to deliver products or software to derive these products, at the level of geophysical parameters, based primarily on the satellite data.”

the more advanced understanding of physics/dynamics of the ocean and its coupling to the atmosphere in Global Change Models.

National satellite systems

ODIN

The Swedish Space Corporation (SSC), on behalf of the Swedish National Space Board (SNSB) and the space agencies of Canada (CSA), Finland (TEKES) and France (CNES), has developed a satellite called Odin, aimed for astronomers and atmospheric researchers in the participating countries.

The Odin satellite combines two scientific disciplines on a single spacecraft, aeronomy and astronomy, offering 50% of the observing time to each discipline.

Odin operates from a 600 km sun-synchronous, terminator orbit. It was launched on 20 February 2001 and the nominal life time is 2 years.

Odin will make global measurements of chemical substances involved in breaking down ozone for at least two years. The readings will be taken at a point in time when the content of chlorine in the stratosphere is expected to stop rising. An important part of Odin's aeronomy mission will therefore be to monitor the response of the stratosphere during this time. Odin makes 40 vertical sweeps per orbit in the altitudes between 10 and 120 km. The reconstructed accuracy is 1-2 km.

Processing of spectra on ground will allow the determination of the vertical distribution of the various species. Odin aeronomy data products will be made available to the scientific community at large after careful calibration and validation of the data. The Odin data are the property of the official Odin scientists and associate scientists. The Odin Science Team can decide any distribution outside of this group, after a formal request by a member of the official Odin scientists. At an appropriate time, to be decided by the Odin Science Team, processed and validated aeronomy data will be made available to the wide scientific community.

Specifically, Odin will address scientific problem areas in the stratosphere and mesosphere by making measurements of various trace species. The scientific goals can be summarised as follows:

- Stratospheric ozone science: To elucidate the geographical extent of and mechanisms responsible for ozone depletion in the "ozone hole" region and to study dilution effects and possible heterogeneous chemistry even outside of the polar regions due to sulphate aerosols
- Mesospheric ozone science: To establish the relative role of odd hydrogen chemistry and the effects of ordered and turbulent transport and corpuscular radiation.
- Summer mesospheric science: To establish the variability of mesospheric water vapour including an assessment of the required fluxes for aerosol formation in the polar mesosphere.
- Coupling of atmospheric regions: To study some of the mechanisms that provide coupling between the upper and lower atmosphere, e.g. downward transport of aurorally enhanced NO with its effects on ozone photo chemistry and the vertical exchange of minor species such as odd oxygen, CO and H_2O.

The main instrument on Odin is an advanced radiometer using a 1.1 m telescope. It works in essentially unexplored frequency bands (486-580 GHz and at 119 GHz) with an unsurpassed sensitivity and spatial resolution. For the aeronomy mission the payload is complemented by a spectrograph, named OSIRIS (Optical Spectrograph and InfraRed Imaging System). OSIRIS provides simultaneous observations in two channels; a UV/Visible channel with a passband of 280-800 nm, and an IR channel with a total passband of 30 nm, centred on 1.27 microns.

Participation in international missions

SPOT - Satellite Probatoire d'Observation de la Terre

Sweden is a partner in the French-led SPOT satellite programme since 1978 and manages one of the two principal ground stations in the SPOT system. The station is located in Kiruna in the extreme north of Sweden. It receives, processes, archives and distributes SPOT data to users worldwide. The archive contains well over a million SPOT

scenes recorded during the past 15 years. It is operated by Swedish Space Corporation on behalf of the French space agency. The data can be accessed through the French commercial distributor Spot Image. French data policy applies.

One of the instruments onboard the SPOT 4 satellite is the Vegetation instrument. This sensor was developed jointly by the European Commission, Belgium, France, Italy and Sweden and it was specifically designed to meet the needs of the European Programme for Global Monitoring of Vegetation. There will be a similar instrument on SPOT 5, and Sweden will participate in this instrument too.

The Vegetation Programme allows a daily monitoring of terrestrial vegetation cover through remote sensing, at regional and global levels. The instrument produces high quality images of the ground with a resolution of 1 km. The main mission of the Vegetation system is to continuously observe and monitor the entire continental biosphere and crops. The instrument was specially designed to track the vegetation, particularly in agricultural production, forestry and surveillance of the land environment worldwide.

The Vegetation image is tailor made to answer the needs of information regarding:

- GLOBAL CHANGE: understanding of biosphere processes, interaction with atmosphere and climate
- ENVIRONMENT: land cover / land use analyses and impact of population increase
- AGRICULTURE: monitoring and prediction of crop production, impacts of drought, frost, flood, disease, etc
- FORESTRY: monitoring deforestation, impacts of human activities, influence of tropical, temperate and boreal forests on global change

Data from the Vegetation instrument are used in the European project GLC 2000 (Global Land Cover 2000), where Sweden is one of the participants. The projects is co-ordinated by the European Union's scientific and technical research laboratory JRC, the Joint Research Centre. Its general objective is to provide a harmonised land cover database over the whole globe for the year 2000.

ESA: ERS, ENVISAT and "Third-Party Missions"

Sweden participates in the ESA earth observation satellite programmes ERS and ENVISAT, as well as in those ESA "Explorer" earth science satellites currently under development. In addition, Swedish Space Corporation operates ground segment facilities in Kiruna on behalf of ESA to support ESA and "Third Party" satellites. Among the latter are Landsat (NASA/NOAA/USGS), MOS (NASDA), JERS (NASDA), Terra (NASA) and Aqua (NASA). Kiruna is the principal ground station for ERS and ENVISAT. The data can be accessed through the ESA Earthnet user service centre at ESRIN near Rome, Italy. ESA data policy applies.

ERS-1 was launched in 1991 and ERS-2 in 1995. They have both been very successful in, *inter alia*, pioneering radar technology for earth observation. ERS-2 is still operational in late 2001.

ENVISAT is scheduled to be launched in early 2002. It is a multidisciplinary mission having scientific and application objectives, continuing and extending the ERS-1 and ERS-2 mission objectives, and building up a coherent European Earth observation programme that will provide measurements of the atmosphere, ocean, land, and ice over a five year period.

ENVISAT carries 10 different instruments and has both science and application objectives. The satellite is meant to provide a smooth transition from the measurements taken by the ERS-satellites, but it will also generate new data on marine biology and atmospheric chemistry.

Appendix I: DEFINITION OF ACRONYMS USED IN THE GUIDELINES

ASAP	Automated Shipboard Aerological Programme
FLUXNET	Global Terrestrial Network - Carbon
GAW	Global Atmosphere Watch of WMO
GCOS	Global Climate Observing System
GOOS	Global Ocean Observing System
GSN	GCOS Surface Network
GTN-G	Global Terrestrial Network - Glaciers
GTN-P	Global Terrestrial Network - Permafrost
GTOS	Global Terrestrial Observation System
GUAN	GCOS Upper Air Network
ICSU	International Council for Science
IGBP	International Geosphere-Biosphere Programme
IGOS	Integrated Global Observing Strategy
IOC	Intergovernmental Oceanographic Commission of UNESCO
SFC	Drifters Surface Drifters
SOOP	Ship of Opportunity Programme
Sub-SFC	Sub-surface
UNEP	United Nations Environment Programme
UNESCO	United Nations Educational, Scientific and Cultural Organisation
VOS	Volunteer Observing Ship
WCRP	World Climate Research Programme
WHYCOS	World Hydrological Cycle Observing System
WMO	World Meteorological Organisation
WWW	World Weather Watch of WMO
Argo	*Array for Real-time Geostrophic Oceanography*
CFC	*Chlorofluorocarbon*
CLIMAT	*Climate messages encoded for the WMO network*
CO_2	*Carbon dioxide*
ENSO	*El Niño - Southern Oscillation*
GPS	*Global Positioning System*
HCFC	*Hydrochlorofluorocarbon*
HFC	*Hydrofluorocarbon*
NWP	*Numerical Weather Prediction*
SST	*Sea-surface Temperature*

Appendix II: DEFINITION OF ACRONYMS USED IN THE SWEDISH NATIONAL COMMUNICATION ON GCOS

AARI	Arctic and Antarctic Research Institute
ADCP	Acoustic Doppler Current Profiler
AMDAR	Aircraft Meteorological Data Reporting
AOD	Atmospheric Optical Depth
BOOS	Baltic Operational Oceanographic System
CEOS	Committee for Earth Observing Satellites
CLC2000	CORINE Land Cover
CM SAF	Climate Monitoring Satellite Application Facility (EUMETSAT)
CMA	China Meteorology Agency
CNES	Centre National d'Etudes Spatiales
COGEOENVIRONMENT	Commission on Geological Sciences for Environmental Planning
CORINE	Coordination of Information on the Environment
CSA	Canadian Space Agency
DOAS	Differential Optical Absorption Spectrometer
ECMWF	European Centre for Medium Range Weather Forecast
ECOMET	Economic Interest Grouping in Meteorology
EEA	European Environment Agency
EGS	EuroGeoSurveys
EIONET	European Environment Information and Observation Network
EMEP	European Monitoring and Evaluation Programme
EPS	EUMETSAT Polar System
ESA	European Space Agency
EUFOREO	European Forum on Earth Observation use for Environment and Security
EUMARSIN	European Marine Sediment Information Network
EUMETSAT	European Organisation for the exploitation of meteorological satellites
EuroGeographics	The Association of European Mapping Agencies
EuroGOOS	The European component of the Global Ocean Observing System
FMI	Finnish Meteorological Institute
FOREGS	Forum of European Geological Surveys
GARP	Global Atmosphere Research Programme
GEIXS	Geological Electronic Information Exchange System

GEWEX/BALTEX	Global Energy and Water Cycle Experiment/Baltic Experiment
GHz	Gigahertz
GIS	Geographic Information System
GLC2000	Global Land Cover 2000 project
GMES	Global Monitoring for Environment and Security
GOS	Global Observing System
GRAS SAF	Global Navigation Satellite System (GNSS) Receiver for Atmosphere Sounding - Satellite Application Facility
GTS	Global Telecommunication System
HELCOM	Helsinki Commission
HIRLAM	High Resolution Limited Area Model
ICES	International Council for the Exploration of the Sea
IODE	International Oceanographic Data and Information Exchange
IVL	*Sw. Institutet för Vatten- och Luftvårdsforskning*, Swedish Environmental Research Institute
JASON-2	Second follow-on mission to TOPEX/Poseidon and Jason-1
JMA	Japan Meteorological Agency
JRC	Joint Research Centre of the European Community
KLAR	*Sw. Svenskt Klimatarkiv* Swedish Climate Archive
LSA SAF	Land Surface Analysis Satellite Application Facility
MESAN	Mesoscale Analysis System (SMHI)
METAR	Aviation routine weather report
MSG	Meteosat Second Generation
NCEP/NCAR	National Centre for Environmental Prediction/National Center Atmospheric Research
NOAA	National Oceanographic and Atmosphere Administration
NORDKLIM	Nordic Climate Analysis Co-operation
NWC SAF	Nowcasting and Short-range Forecasting Satellite Application Facility (EUMETASAT)
NWP SAF	Numerical Weather Prediction Satellite Application Facility (EUMETSAT)
O3 SAF	Ozone analysis Satellite Application Facility
OSI SAF	Ocean and Sea Ice Satellite Application Facility (EUMETSAT)
OSIRIS	Optical Spectrograph and InfraRed Imaging System
OSPARCOM	Oslo/Paris Commission
SAF	Satellite Application Facilities

SAS	Scandinavian Airline Systems
SCB	*Sw. Statistiska Centralbyrån*, Sweden Statistics
SGU	*Sw. Sveriges Geologiska Undersökning*, Geological Survey of Sweden
SHARK	*Sw. Svenskt Havsarkiv* Swedish Ocean Database
SLD	Swedish Land Cover Data
SLU	*Sw. Sveriges Lantbruksuniversitet*, Swedish University of Agricultural Sciences
SMHI	Swedish Meteorological and Hydrological Institute
SNSB	Swedish National Space Board (*Sw. Rymdstyrelsen*)
SOU	*Sw. Statens Offentliga Utredning*, Offical investigation set up by the government
SPOT	Satellite Probatoire d'Observation de la Terre
SSC	Swedish Space Corporation
SVAR	*Sw. Svenskt Vattenarkiv*, Swedish Inland Waters Database
SYNOP	Synoptic Observations (WMO)
TEKES	Finnish National Technology Agency
TOC	Total Organic Carbon
UV	Ultraviolet
WDCC	World Data Centre for Climate
WRDC	World Radiation Data Centre
VViS	*Sw. VägVäderinformationsSystem*, Road Weather Information System

Appendix III: GCOS/GOOS/GTOS CLIMATE MONITORING PRINCIPLES

Effective monitoring systems for climate should adhere as closely as possible to the following principles:

1. The impact of new systems or changes to existing systems should be assessed prior to implementation.
2. A suitable period of overlap of new and old observing systems should be required.
3. The results of calibration, validation and data homogeneity assessments and assessments of algorithm changes should be treated with the same care as data.
4. A capability to routinely assess the quality and homogeneity of data on extreme events, including high-resolution data and related descriptive information, should be ensured.
5. Consideration of environmental climate-monitoring products and assessments, such as IPCC assessments, should be integrated into national, regional and global observing priorities.
6. Uninterrupted station operations and observing systems should be maintained.
7. A high priority should be given to additional observations in data-poor regions and regions sensitive to change.
8. Long-term requirements should be specified to network designers, operators and instrument engineers at the outset of new system design and implementation.
9. The carefully planned conversion of research observing systems to long-term operations should be promoted.
10. Data management systems that facilitate access, use and interpretation should be included as essential elements of climate monitoring systems.