UN Framework Convention on Climate Change

Swiss Contribution to the Global Climate Observing Systems 2001

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Abstract

As required by the United Nations Framework Convention on Climate Change, this report gives an overview on the Swiss contributions to the systematic observations with regard to the Global Climate Observing System (GCOS) and related programmes.

Swiss authorities encourage and support research and systematic observation on the climate system and its impacts. This support extends to the specialised international organisations and programmes.

Swiss specialised institutions have implemented numerous permanent observation programmes and supporting activities related to GCOS and GTOS (Global Terrestrial Observing System). Main contributions are related to surface and upper air climate, atmospheric constituents and radiation, hydrology, glaciers, permafrost, snow and ecological systems (forest etc.). Quality checked datasets are submitted to the international data centres and exchanged within the scientific community.

Different world calibration, quality assurance and data centres are further operated and funded by Switzerland. Capacity-building activities have been mainly developed in relation with the Global Atmosphere Watch and the Hydrological Programme.

During recent years, the Swiss contribution to different components related to GCOS and GTOS has been significantly increased.

MeteoSwiss acts as the Swiss GCOS focal point and coordinates national GCOS activities whenever necessary.

Foreword

The Third National Communication of Switzerland 2001 under the UN Framework Convention on Climate Change illustrates the high priority set by the government in climate policy and documents the Swiss commitments under the Convention. As a Party to the Climate Convention, Switzerland will continue to progress in the spirit of the Kyoto Protocol.

The climate monitoring initiated by pioneer researchers and continued on a long-term basis by Swiss federal and regional institutions constitutes a noteworthy contribution to the international efforts showing that mankind is beginning to change the global climate. MeteoSwiss – the Federal Office of Meteorology and Climatology – belongs to these institutions and has the responsibility of monitoring the atmospheric part of the climate system. The governmental decision of 1994 ensuring the funding of the Swiss contribution to the Global Atmosphere Watch Programme of the World Meteorological Organisation was an important step towards addressing specifically the Global Climate Observing System as an obligation under the Convention on Climate Change. Many other Swiss institutions greatly contribute to the observation of the climate system and its manifold impacts. This report gives a detailed overview of the Swiss contributions to the systematic observations with regard to the Global Climate Observing System (GCOS) and related terrestrial programmes (GTOS). It has been compiled by MeteoSwiss based on the contributions of many other institutions.

It is the first time that such a detailed report is required from all Parties to the Convention. These national reports on observations will undergo an international reviewing process. The final goal is to determine how much progress has been made during recent years in defining and implementing observing systems and to assess how the needs of the Convention are met. I am convinced that this report will demonstrate the high level of the ongoing GCOS/GTOS observation programmes in Switzerland and will contribute to their long-term continuation.

Zurich, October 2001

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Introduction

For readers not familiar with the objectives and structure of GCOS, it is worth introducing it briefly; more information can be found on its internet home page (http://www.wmo.ch/web/gcos/gcoshome.html).

The Global Climate Observing System (GCOS) was established in 1992 to ensure that the observations and information needed to address climate-related issues are obtained and made available to all potential users including the United Nations Framework Convention on Climate Change (UNFCCC). It addresses the total climate system including physical, chemical and biological properties, and atmospheric, oceanic, hydrologic, cryospheric and terrestrial processes. GCOS is co-sponsored by the World Meteorological Organization (WMO), the Intergovernmental Oceanographic Commission (IOC) of UNESCO, the United Nations Environment Programme (UNEP) and the International Council for Science (ICSU).

GCOS builds upon and works in partnership with other existing and developing operational observing systems and also draws upon proven networks established under research programmes. The GCOS Partners include:

- the World Weather Watch (WWW),
- the Global Atmosphere Watch (GAW),
- the Hydrology and Water Resources Programme (HWRP),
- the Global Ocean Observing System (GOOS),
- the Global Terrestrial Observing System (GTOS),
- the Global Environmental Monitoring System (GEMS),
- the Global Resource Information Database (GRID),
- the World Climate Programme (WCP, including data and monitoring, applications and services, impacts and responses, and WCP-Water),
- the World Climate Research Programme (WCRP),
- the International Geosphere-Biosphere Programme (IGBP),
- the Intergovernmental Panel on Climate Change (IPCC),
- the Committee on Earth Observation Satellites (CEOS),
- the Integrated Global Observing Strategy-Partners (IGOS-P),
- and the United Nations Framework Convention on Climate Change (UNFCCC).

GCOS integrates satellite observations provided by national and international agencies together with surface based observations through its participation in the Integrated Global Observing Strategy (IGOS) partnership. One of its major activities is the establishment of operational performance standards for its contributing networks. These enable GCOS to assess and report upon the actual effectiveness of those networks in meeting the needs of the users (WMO, 2000).

GCOS has endorsed the representation of all the global observing systems in the UNFCC arena. GCOS therefore prepared reporting guidelines for the Parties to this Convention, in order to help them prepare their national report with regard to global climate observing systems and development of observational networks. For the first time, the Parties have to submit such a detailed national report as part of their third National Communication 2001.

These national reports will form the basis for assessing the status and deficiencies of the global observing systems.

The present report is based on the Supplementary Reporting Format prepared by national GCOS co-ordinators at Melbourne, August 2000 (GCOS, 2000), which goes beyond, but in no way replaces the guidance adopted as an Annex to Decision 5/CP.5 and published as UNFCCC Reporting Guidelines on Global Climate Observing Systems in document FCCC/CP/1999/7.

The present report collects the contributions of many Swiss institutions. The official reporting guidelines focus predominantly on the baseline and other designated observation networks associated with GCOS and characterising global climate. The supplementary guidance extends the scope of the enquiry to national - or even sub-national-levels - and lists a large number of climate related parameters. Considering the wealth of climate and environmental monitoring activities in Switzerland, it has been decided to restrict this report to systematic observations and not to include research on climate and global change. These research activities are presented in chapter 8.1 of the Third National Communication of Switzerland 2001, while chapter 8.2 contains a summary of the present GCOS report.

After a first chapter devoted to the general approach to systematic observation, this report presents the meteorological and atmospheric observation programmes in chapter 2, and the terrestrial observation programmes including hydrology and most relevant aspects of ecology in chapter 3. Chapter 4 is devoted to space-based observing programmes while chapter 5 provides some concluding remarks. Additional tables requested by the supplementary guidance are placed in the Appendix. The basic tables requested by the guidance can be found on pages 22 and 31. No chapter is devoted to the Global Ocean Observing System (GOOS), as Switzerland, although having some oceanic research activities, makes no direct contribution to oceanic observing networks.

1 General approach to systematic observation

General environmental aspects

Switzerland has implemented a very broad and diversified observation system in relation with the sources and the consequences of man-made pollution. The collected environmental datasets help to define the legislation, its provisions and efficiency controls according to the OECD-model "Pressure – State – Response". Many legal texts involve environmental observation.

The Swiss Agency for Environment, Forest and Landscape (SAEFL) has the leading responsibility in the evaluation of environmental quality. In order to support its objectives, a governmental information and co-ordination committee (IKUB) was set up 1996 in the field of environmental monitoring, bringing together the national and regional data producers as well as the users, and taking into account international requirements. National workshops with governmental and research representatives help in defining a national strategy for environmental observation.

The SAEFL operates an information system of environmental metadata, which is also used at the European level (http://www.ch-cds.ch/e/home.htm). The latest "State of the environment in Switzerland" represents the year 1997 (SFSO-SAEFL, 1997, http://www.statistik.admin.ch/stat_ch/ber02/umwelt/etfr02.htm). An update will be published in 2002. Furthermore, environment and territory represent one of the four core fields of the national statistics (http://www.statistik.admin.ch/stat_ch/ber02/eber02.htm).

At the international level, SAEFL is the national focal point for the governmental environmental observation programmes (e.g. UNEP).

National plans and support to the observation of global and national climate and of its impacts

Swiss authorities encourage and support research and systematic observation on the climate system mainly in the framework of their climate policy in order to better understand climate changes and the related consequences. This support extends to the specialised international organisations and programmes. Furthermore, it takes into account related capacity-building needs in developing countries.

The Swiss climate observing systems in the atmosphere and the terrestrial observing systems linked to the impacts of climate change constitute a part of the general environmental monitoring. They are mainly under the responsibility of federal agencies committed to their operation on a long-term basis with federal resources: e.g. the Federal Office for Meteorology and Climatology (MeteoSwiss), the Federal Office for Water and Geology (FOWG) and SAEFL. As an example of such a commitment directly linked to GCOS, it is worth pointing out the federal GAW-CH project started in 1994 under the leadership of MeteoSwiss that aimed at a more effective contribution to the Global Atmosphere Watch and to related atmospheric radiation programmes. After a development phase ending in 2000, the resources and the organisation for the transition of that project into a permanent monitoring and research programme have now been fixed.

The following table 1 summarises the main responsibilities and long-term commitments at the national level. GCOS related observations (climate change and its impacts) are not often explicitly addressed in federal laws and regulations, but are mostly embedded in the more general problem of air and environmental pollution. More information can be found in the next chapters.

Table 1: Main responsibilities and long-term commitments at the national level

Monitoring networks/domains	**Responsible agencies**	**Long-term commitments**
Meteorological land surface and upper air observations	MeteoSwiss	Federal Law on Meteorology and Climatology
Atmospheric constituents (GAW and WCRP programmes), including: • Greenhouse gases and oxidants • World Radiation Data Centre WRMC	- MeteoSwiss - SAEFL - Swiss Federal Institute of Technology, Zurich (ETHZ)	- Governmental decision (21.12.1994) related to the Climate Convention and GCOS - Commitment under the Climate Convention - Agreement between ETHZ and WMO
Hydrological observations	Federal Office for Water and Geology (FOWG)	Federal Law on Water Protection
Glaciers and Permafrost monitoring, as well as the World Glacier Monitoring Service (WGMS)	Swiss Academy of Science (Glaciological Commission, Permafrost Co-ordination Group, University of Zurich, ETHZ)	- Partly federal and regional regulations. - Partly pending (pilot projects)
Forest ecosystem network and snow observation	SAEFL and Swiss Federal Institute for Forest, Snow and Landscape Research WSL	Federal Forest Law (art. 33-34), Ordinance on the Federal Institute for Forest, Snow and Landscape Research
Ecological observations and environmental indicators	Different agencies and institutions	Federal laws and regulations
Land use changes and statistical indicators	Swiss Federal Statistical Office (SFSO)	Federal laws and regulations
Satellite-based observations (ESA, EUMETSAT)	Swiss Space Office, Swiss Academy of Science (Commission for remote sensing) MeteoSwiss	Federal laws and regulations Commitment under ESA/EUMETSAT Convention
Proxy, lake sediments, boreholes, ice cores…	Research institutes	Mainly research programmes

Regional administrations contribute mainly to the regional environmental monitoring, but they have provided some of the historical environmental time series. Research institutes (e.g. EMPA, PSI, PMOD/WRC, WSL, ETHZ, Universities of Zurich and Bern) contribute significantly to worldwide and national monitoring efforts, under direct federal contracts, their own budget or through other research funding sources (e.g. National Science Foundation). In the latter case, funding is subordinate to project allocation. Otherwise

research institutes are especially active in climate research projects and programmes, warranting the necessary scientific level for the methodological and instrumental developments, as well as in process studies and assessment analyses. The Swiss Academy of Sciences (SAS) organises different long-term observation activities besides its research promoting function.

The final report of the National Research Programme 31 “Climate Changes and Natural Disasters” gives an overview of the main results of that 6-year interdisciplinary undertaking, as well as an extended list of related publications (Bader, Kunz, 1998).

A National Competence Centre of Research (NCCR) on Climate Change started in April 2001 with federal funding for a maximum of 12 years (http://sinus.unibe.ch/nccr/index.html). The NCCR on Climate Change addresses broader issues of natural climate variability and predictability by combining the relevant disciplinary contributors into an integrated network of competence. This network includes expertise from the physical, chemical, biological, economic and sociological disciplines. It will also give a new impulse to the interpretation of the collected observational datasets.

More information on climate related research activities can be found in chapter 8.1 “Research“ of the Third National Communication of Switzerland 2001, as well as from the climate information system operated by ProClim, the Forum for Climate and Global Change of the Swiss Academy of Science (http://www.proclim.unibe.ch/). ProClim’s main objective is to facilitate both integrated research activities and the necessary linkages among scientists, policy-makers and the general public at home and abroad.

Ensuring information transfer between science, policy makers and the public is an important task. Thus an Advisory Body to the federal administration on climate change research and policy (OcCC) was formed in 1997 under the auspices of the Swiss Academy of Sciences. It is funded by the SAEFL. Its secretariat is located at ProClim.

International services and capacity building

During recent years, high priority has been given to contributions to international and national activities ensuring and maintaining the required high data quality standards and the exchange of data. Two world calibration centres, a Quality Assurance / Scientific Activity Centre, two world data centres and a metadata centre are operated in and funded by Switzerland. The ozone station at Arosa hosted several international Dobson comparisons dedicated to the calibration of the world monitoring network of the ozone layer. Furthermore, many individual specialists contribute to international working and co-ordination groups within the GCOS affiliated programmes. For example, Swiss scientists are active within GAW Science Advisory Groups, within the GAW German-Austrian-Swiss collaboration, as well as for the Strategic Plan of GAW. Others are in charge or co-responsible for monitoring networks related to glaciers and permafrost or act as focal points for GTOS. Contributions to international projects are numerous.

Capacity building has been strengthened, especially in relation with the GAW programme. The Swiss international GAW centres (QA/SAC and world calibration centres mentioned above) as well as the Data Centres for other GCOS-components contribute significantly to capacity building. Furthermore, the twinning arrangement with Kenya for the training of personnel at the ozone sonde station of Nairobi has been successful. In the hydrological field, a FOWG project related to the Aral Sea is worth mentioning.

International exchange of information

Once collected and quality controlled, the data sets are documented with metadata, processed and archived using modern computer technology. Most of them are already regularly submitted to the operational world data centres and exchanged within the scientific community. In some cases, quality control or scientific publication can somewhat delay this task. Submission of pending data to world data centres will be carried out in 2002. Due to the high priority of this task, additional efforts will be performed where needed. Most contributors maintain a web site with up-to-date information. Furthermore, as already mentioned, Swiss institutions operate world data centres and are internationally active in the field of metadata.

Funding

No specific evaluation of the amount of funding used within GCOS related observations has been performed, mainly because many of them are embedded within other tasks (e. g. weather prediction) or within more general environmental activities (e. g. terrestrial and ecological observations). As already stated, federal funding is generally ensured at the present level, but project funding at research institutions is subordinate to project allocation.

National GCOS structure

Although many climate monitoring activities have been developed in Switzerland within the different programmes affiliated to GCOS, there is no Swiss GCOS office. MeteoSwiss acts as national focal point for GCOS, due to its role as permanent national WMO representative. Different Swiss scientists act as national focal points for monitoring networks within GCOS and partner structures like GTOS.

2 Meteorological and atmospheric observation

2.1 GCOS Surface Network (GSN)

Switzerland has a dense network of surface climatological stations, some of which have been in use for more than 130 years. The whole Swiss synoptic and climatological network is presently made up of:

- 67 automatic stations with full measuring programme (+5 with high masts), presented on figure 1, see also e.g. http://www.meteoswiss.ch/de/wetter/?messwerte
- 44 automatic stations with reduced programme (mainly wind)
- 25 conventional climate stations
- 353 raingauge stations (+75 accumulative raingauges)
- 160 phenological stations, 14 pollen stations
- 16 stations of different types for civil aviation purposes

The measurement concept and planning is updated about every 10 years. The need for continuous long-term series within the different Swiss climate regions meeting the GCOS principles belongs to the priority goals of MeteoSwiss. The new network concept 2010 is underway. It will reduce the number of automatic stations with a full measuring programme to 45, but will extend the total number of automated stations to 130. Reference stations meeting the GCOS principles will stay in long-term operation. Their choice is currently reviewed taking into account results of the newest climate projects.

The statistics of four stations (Zurich, Geneva, Lugano, Säntis) are regularly submitted to the world data centre on a monthly basis (CLIMAT reports). The reports from the station Gd-St-Bernard will be transmitted soon. Their homogenised dataset 1961-1990 was submitted in 1994 to the world data centre in Germany. The full homogenised dataset, including metadata, has still to be submitted. Observations from more stations are transmitted internationally on a real-time basis (SYNOP messages).

According to the WMO list, there are two GSN Swiss stations, both being mountain stations: Säntis (2490 m asl) and Gd-St-Bernard (2472 m asl). Payerne would be an appropriate choice for another Swiss GSN station, due to its role as GAW and BSRN station. However, it does not provide an historical time series.

The data of one GSN station are submitted through the WMO global telecommunication system. The additional annual submission including metadata is pending. The climatological time series are also transmitted to researchers according to WMO 40 regulation.

The supplementary tables S1 and S2 in the Appendix provide additional information on these observations.

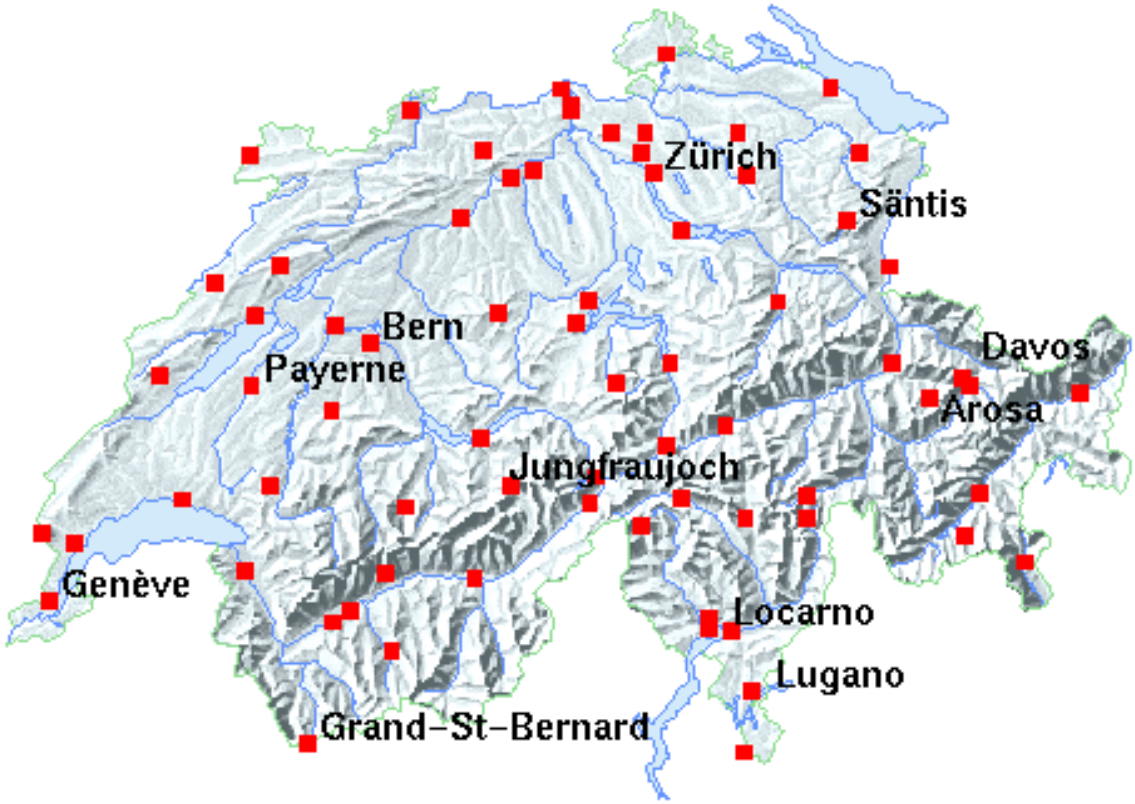

Figure 1: Swiss Network of automatic meteorological surface stations with full measuring programme (squares). In addition, surface stations mentioned in chapter 2.1, upper air stations (chapter 2.2), as well as GAW, BSRN and NDSC sites (chapters 2.3 and 2.4) are named on this map.

Many climatological investigations have been performed with Swiss datasets. During the last decade, in the framework of the international standard climate period 1961-1990, 381 series of 49 climate and of 86 precipitation stations were evaluated and homogenised for that time period, taking into account the parameters of temperature, precipitation, sunshine, global radiation, air pressure, wind and air humidity (project KLIMA90). More recently, within the project Norm90, the longest temperature and precipitation series (> 100 years) have been homogenised for 12 reference stations, as well as shorter series (81 for temperature and 427 for precipitation).

Previously, most of the data sets contained variations due to non-climatic factors such as site relocations, modifications of instruments, changes in the environment of a station and so on. The inhomogeneities were often of the same magnitude as the climatic signals to be detected. Therefore the homogenisation procedure was necessary before any analysis could be done in order to avoid misleading interpretation. The MeteoSwiss project KLIMA90 (Aschwanden et al., 1996) as well as newer projects within the National Research Programme “Climate Changes and Natural Disasters” allowed significant achievements on that matter. A purpose-built homogenisation tool has been developed (Begert et al., 1998),

which contains a graphical user interface and has access to a library of mathematical functions. The package allows the performance of every necessary step in homogenising data series, including basic graphical and statistical analysis of the data, selection and calculation of reference series, a variety of homogeneity tests, the adjustment of shift and trend inhomogeneities, as well as the corresponding documentation (metadata). Various homogeneity tests are used since their ability to detect shifts and trends in time series depends on the structure of the examined data and on the unknown number of inhomogeneities.

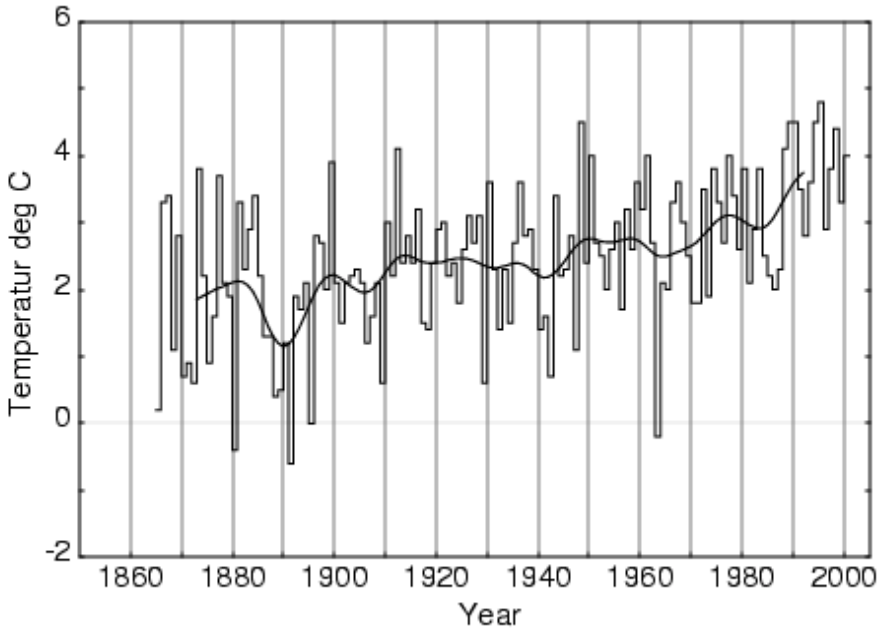

Figure 2: Time series of the mean temperature in the Swiss Mittelland for the winter semesters (mean of three stations). The smoothed line is a 20 – year Gaussian filtered value fit.

Switzerland has shown an increase in mean annual temperature over the last 136 years, which is comparable to the one of the Northern Hemisphere mean temperature, although the magnitude of the signal is larger. Despite some exceptional phases, there is a statistically significant linear trend with an increase of the mean annual temperature of 1.3 ^{o}C over the whole period, which is mainly due to winter modifications (see figure 2 above).

2.2 GCOS Upper Air Network (GUAN)

MeteoSwiss has been operating an upper air sounding station at Payerne since 1941 (see Figure 1). But 1948 can be considered as the operational start with one sounding every workday. Since 1954, soundings measure pressure, temperature and humidity twice a day. Additional wind soundings were introduced later on. A couple of climatological analyses were published during the past, but the KLIMA90 project was the first opportunity to collect, digitalize, check, document and partly homogenise the time series up to 1990 (Aschwanden et al., 1996). The corresponding database also contains soundings from surrounding countries and is linked to a project of the University of Vienna (CALRAS: the comprehensive Alpine Radiosonde Data Set). The high-resolution time series 1990-2000 has recently been homogenised.

Trends of temperature and wind components over the 30-year period 1961-1990 have been published in the above-mentioned reference. A statistical significant temperature increase in the troposphere has been found, as well as a decrease in part of the stratosphere.

The GCOS monitoring principles are duly taken into account in the long-term planning of the balloon sounding activities. As Payerne acts also as a GAW ozone sounding station as well as a BSRN station, these principles have high priority. The aerological soundings serve therefore also the long-term atmospheric monitoring objectives. The aerological station at Payerne has not been selected as a GUAN station, but fulfils the observing requirements and the best practice for the GUAN. Payerne appears as reliable non-GUAN station in the GUAN performance statistics. The upper air humidity quality goals still remain a challenge. Due to its role as GAW and BSRN station, Payerne would be an ideal candidate to act as a GUAN station.

TEMP and CLIMAT TEMP messages are transmitted to the world data centres through the WMO global telecommunication system. Sounding datasets are exchanged with researchers according to WMO 40 regulation.

The supplementary tables S3 and S4 in the Appendix provide the requested additional information on these measurements.

2.3 Global Atmosphere Watch (GAW)

Switzerland has a long tradition in research and monitoring of atmospheric ozone and radiation. At Arosa, total ozone has been monitored since 1926 and Umkehr profile since 1956. Ozone profile measurements with radiosondes started in 1966. As an example, the recently homogenised total ozone time series is displayed in figure 3 (Staehelin et al, 1998). Solar radiometry has been investigated for a long time at Davos.

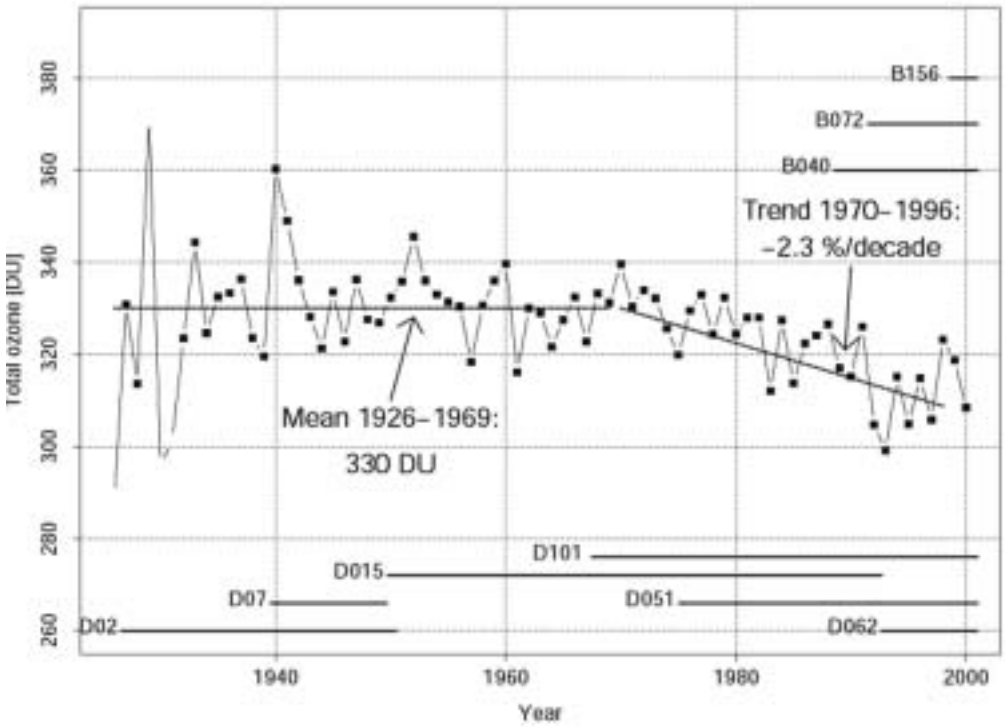

Figure 3: Homogenised annual values of total ozone measurements at Arosa 1926-2000 (world longest time series). Values without black symbol are not representative (too few daily values within the year). "Dnnn", "Bnnn" and the corresponding horizontal lines mark the life time of the different Dobson and Brewer spectro-photometers in operation at Arosa up to now.

After the start of the WMO-GAW programme in 1989, Switzerland initiated in 1995 a national programme and developed its contribution to GAW on the international and national levels under the leadership of a national co-ordinator and a national committee (SAEFL, 1999). In order to keep this report short, only a list of the main activities and measuring programmes is presented below. More information is found on the specified web-addresses.

International services and capacity building
(calibration centres and international cooperation)

- World Optical Depth Research and Calibration Centre (WORCC) at the WRC (Davos), see http://www.pmodwrc.ch/worcc/worcc.html
- QA/SAC and World Calibration Centre (WCC) for Surface Ozone, Carbon Monoxide and Methane at the EMPA (Dübendorf), as well as GAWSIS project (GAW Information System): www.empa.ch/englisch/fachber/abt134/gaw/gawind.htm

- International comparisons of Dobson spectrophotometers for GAW region VI at Arosa in 1995 and 1999 (WMO, 1999)
- Contribution to the different international JOSIE experiments at Jülich and to the ASOPOS project aiming at the improvement of the homogeneity and quality of ozone sounding data and the definition of standard operation procedures for ECC ozonesondes, (see www.fz-juelich.de/icg/icg2/forschung/Josie/josie2000/)
- Cooperation with Germany and Austria (DACH) for a globally relevant data set (see http://www.empa.ch/deutsch/fachber/abt134/projekte/dach.htm), involving the German global station of Zugspitze (2960 m asl) - Hohenpeissenberg (985 m asl), the regional Austrian station of Sonnblick (3106 m asl) and the regional Swiss station of Jungfraujoch (3580 m asl).
- Contribution to the Scientific Advisory Groups (SAG) for Aerosol (with chairmanship) and for Ozone
- GAW Rapporteur of WMO RA VI with the responsibility of the GAW Strategic Plan,
- Contribution to the project SINGADS (Synthesis of Integrated Global Aerosol Data Sets),
- Project aiming at the use and dissemination within the GAW-region VI of satellite-based information on atmospheric constituents (vertical profiles of CO, CH_4... from NASA and ESA new satellites)
- Support to the GAW Nairobi Ozonesonde Station by MeteoSwiss, who regularly controls the data and submits them to the SHADOZ data centre (http://hyperion.gsfc.nasa.gov/Data_services/shadoz/Shadoz_hmpg2.html)
- The QA/SAC and World Calibration responsibilities include – where needed - capacity building during the audits and intercomparison campaigns.

National research and monitoring programme

- Monitoring of Ozone in the Stratosphere and in the Troposphere (total ozone and ozone profile at Arosa and Payerne: total ozone with Dobson and Brewer spectrophotometers, Umkehr profiles with Dobson and Brewer, profiles with ozonesonde since 1967 and microwave since 2000). These sites are shown on the map of figure 1.
- Swiss Radiation Monitoring network (CHARM), with its four main stations at different altitudes performing an extensive measurement programme (see map in figure 1):
  - Payerne: UV (G, D, I, R, UVA), VIS (G, D, I, R), IR (G), Spectral (3 λ)
  - Davos: UV (G, D, I, R), VIS (G, D, I), IR (G), Spectral (12 λ)
  - Locarno: UV (G, D, I), VIS (I), IR (G), Spectral (12 λ)
  - Jungfraujoch: UV (G, (D), I, UVA), VIS (G, (D), I), IR (G), Spectral (16 λ)

  G, D, I, R: global, diffuse, direct and reflected irradiance
  UV: ultraviolet, UVA: ultraviolet A irradiance, VIS: visible, IR: infrared
  n λ: number of wavelengths
  - as well as its additional Alpine Surface Radiation Budget (ASRB) network of eleven stations for longwave radiation (still a research project: see http://www.pmodwrc.ch/asrb/asrb.html).
- Aerosol monitoring at the Jungfraujoch (3580 m asl). The following parameters are measured: aerosol BC mass concentration, aerosol major chemical components, aerosol scattering coefficient at various wavelengths, aerosol absorption coefficient, aerosol

number concentration, aerosol surface area concentration, cloud liquid content (Nyeki et al., 1998, see also http://www1.psi.ch/users/LACWEB/projects/gaw/index.htm).

- Chemical composition of the atmosphere at the Jungfraujoch (one of the 16 stations of the NABEL National Air Pollution Monitoring Network). The following air pollution parameters are measured: SO2, NOx, NO2, NO, O3, CO, TSP, Pb in TSP, Cd in TSP, sulphate (http://www.buwal.ch/~cgiluft/get.pl?f+i0.htm+i0).

All these measurement programmes meet the GCOS and GAW requirements.

The Jungfraujoch observatory is the highest environmental monitoring station in the Alps (3580 m asl). The values measured represent the tropospheric background over Central Europe for most of the time (e.g. Fricke et al. 2000). The Jungfraujoch observatory is becoming a major background atmospheric monitoring station (see http://www.ifjungo.ch/400annu.html) and constitutes, with the other Alpine stations mentioned, a surface based environmental "Alpine profiler" through the atmosphere. The list of international long-term experiments and measurements performed at the Jungfraujoch can be found on the following web-address: http://www.ifjungo.ch/01_exp.htm.

Figure 4: High Alpine station of Jungfraujoch (3580 m asl).
(Photograph: Jungfraubahnen)

According to the WMO-GAW list, Jungfraujoch is a regional GAW station (chemistry, aerosol, radiation); Arosa and Payerne are two ozone GAW stations with complementary ozone measuring programmes. Payerne belongs furthermore to the BSRN radiation network (see chapter 2.4). The two stations of Davos and Locarno of the CHARM radiation network represent an additional Swiss contribution to the atmospheric radiation observation. The altitude differences between all these stations makes for improved early climate change detection.

Once collected and quality controlled, datasets are documented with metadata, processed and archived with modern computer technology. Most of them are transmitted to the operational world data centres (WOUDC, WRMC, NILU, WDCGG (underway) and WDCA (pending)) and exchanged within the scientific community.

Many research activities and re-evaluation projects of existing times series have supported these monitoring programmes (see references in the Appendix, as well as publications lists from the mentioned web-sites). The total ozone time series of Arosa 1926-2000 and the ozone profile time series of Payerne 1967-2000 have both been completely re-evaluated (Staehelin et al, 1998; Favaro et al, to be published).

The supplementary tables S5 and S6 in the Appendix provide the requested additional information on these measurements.

2.4 Other Networks (BSRN and NDSC)

Baseline Surface Radiation Network (WRCP-BSRN)

BSRN is a project of the World Climate Research Programme (WMO-WCRP) aimed at detecting important modifications in the earth's radiation field which may cause climate changes. At a small number of stations in contrasting climatic zones, solar and atmospheric radiation is measured with instruments of the highest available accuracy and at a very high frequency (minutes). The objectives of the BSRN are three-fold: 1) to validate and to improve climate models; 2) to provide satellite radiometry with ground-truth; and 3) to detect important changes in radiation in the long term. While the GAW programme deals with a wide spectrum of atmospheric parameters such as air chemistry, aerosols, clouds, precipitation and also radiation, the BSRN programme is dedicated mainly to radiation budget research at the earth surface.

Switzerland has set up at Payerne one of the 21 worldwide BSRN stations providing very accurate radiation measurements. The first measurements were started at the end of 1992. The rest of the set-up was added later on (Heimo et al., 1993). The parameter list is given under chapter 2.3 (GAW). Many additional measurements are carried out between ground and 30 m height. Payerne is also belongs to the national surface radiation budget network (ASRB, see chapter 2.3).

Switzerland is contributing to the BSRN programme on the international level by hosting the World Radiation Monitoring Centre (WRMC) at the Federal Institute of Technology (Zurich, http://bsrn.ethz.ch/). The WRMC is an organisation of the WCRP and committed to act as the data centre of the BSRN. Its responsibilities include accepting the monthly dispatched data from the BSRN stations, checking quality and disseminating the data to users, safeguarding the original data (minute resolution) for 10 years, and providing the WMO World Radiation Data Centre in St. Petersburg with monthly values. The radiation data are stored together with collocated surface and upper-air observations and station metadata in an integrated database (Hegner et al., 1995). High accuracy BSRN radiation measurements (Philipona et al., 1995) are already used to validate the radiation schemes in climate models and to calibrate satellite algorithms. The WRMC acts also as a national data centre for the CHARM network.

The responsibility of the WRMC includes capacity building activities related to the training of station scientists.

The WRMC is financed mostly by ETH Zurich as the ETH contribution to WCRP (Agreement between the President of ETH and the Secretary General of WMO). There are occasional contributions of fund from USA NOAA over WMO.

Network for the Detection of Stratospheric Change (NDSC)

The Network for the Detection of Stratospheric Change (NDSC) is a set of high-quality remote-sounding research stations for observing and understanding the physical and chemical state of the stratosphere. Ozone and key ozone-related chemical compounds and parameters are targeted for measurement. The NDSC (http://www.ndsc.ncep.noaa.gov/) is a major component of the international upper atmosphere research effort and has been endorsed by national and international scientific agencies, including the International Ozone Commission, UNEP and WMO.

Switzerland contributes to NDSC mainly through ozone microwave radiometers developed at the University of Bern. Jungfraujoch and Bern are primary NDSC stations. Bern has been in operation since 1994. The two ozone GAW stations of Arosa (total ozone) and Payerne (ozone profiles; see Calisesi et al., 2001) have recently been admitted as NDSC complementary stations. Swiss datasets are regularly submitted to the NDSC data centre.

Belgian researchers have operated an FTIR radiometer at the Jungfraujoch since several decades (see http://www.ifjungo.ch/012_liege.htm# and …/014_liege.htm).

2.5 Summary table

The following table 2 summarises the Swiss contribution to the atmospheric part of GCOS. The Swiss contribution to international services is also summarised in that table.

Table 2. Swiss participation in the global atmospheric observing systems

	GSN	GUAN	GAW	BRSN	NDSC
Stations					
How many stations are within the responsibility of the Party?	2 [a)]	0 [b)]	3 [c)]	1	2+2 [d)]
How many of those are operated now?	2	0 [b)]	3	1	2+2
How many of those are operating to GCOS standards now?	2	0 [b)]	3	1	2+2
How many are expected to be operated in 2005?	2	0 [b)]	3	1	2+2
How many are providing data to international data centres now?	1	0 [b)]	3	1	2+2
International services					
World data centres				1	
QA/SAC centres			1		
World calibration centres			2	1	

a) An additional GSN station is suggested: Payerne
(other stations operated for national climate monitoring: see chapter 2.1).

b) Payerne is suggested as GUAN station, but at present does not belong to the GUAN list.

c) Jungfraujoch: regional GAW station (chemistry, aerosol, radiation),
Arosa: GAW ozone (total and Umkehr) station,
Payerne: GAW ozone (sounding) and radiation (BSRN) station,
(Davos and Locarno are 2 additional (national) radiation stations of the CHARM network meeting the same accuracy goals).

d) 2 primary and 2 complementary stations, the latter ones being simultaneously 2 ozone GAW stations.

3 Terrestrial observations

Terrestrial and ecological observations cover a very large field of activities and goals, many of which are linked to GCOS. As required by the guidance, a general description of the Swiss hydrological programme is given below, followed by the snow observation programme and the contributions to the Glacier (GTN-G) and Permafrost (GTN-P) networks. A non-complete description of the forest and ecological observation programmes is at the end of this chapter.

3.1 Hydrological observation

The National Hydrological Survey of the Federal Office for Water and Geology (FOWG) is responsible for the hydrological monitoring at a national level (http://www.bwg.admin.ch/service/hydrolog/d/index.htm). Additionally, cantonal and local authorities as well as research institutes monitor hydrological parameters in several hundred stations for their own purposes, especially river discharge and ground water levels as well as water quality of rivers, lakes and of the groundwater. These stations are usually run during a limited time only. On a national level, FOWG has been monitoring about 450 stations, some of them since 1863, on rivers, lakes and in groundwaters in different networks:

- Water level in rivers: 232 stations
- Water level in lakes: 33 stations
- Crest stage gauges: 75 stations
- Discharge in rivers: 205 stations
- Water quality in rivers: 13 stations
- Water temperature in rivers: 39 stations
- Suspended sediments in rivers: 13 stations
- Isotopes in rivers, groundwater and precipitation: 19 stations
- Radioactivity in river waters: 5 stations
- Water level of groundwater: 41 stations
- Water quality in groundwater: 50 stations

The monitoring strategy is:

- to maintain carefully the long-term monitoring network,
- to maintain the network of approximately 50 so-called "benchmark basins" or "representative basins" where runoff and - in collaboration with MeteoSwiss - regional precipitation is measured in order to monitor water balance in the long term in undisturbed basins in the 18 different hydrological regimes of Switzerland,
- to monitor in national programmes water quality in rivers (NADUF), water quality in the groundwater (NAQUA) and peak discharge in small rivers (NPH) in the long term.

For all networks the observations correspond fully to the GCOS/GOOS/GTOS climate monitoring principles, e.g. the National Hydrological Survey is running its own calibration laboratory for hydrometric measuring instruments. Most of the stations monitor

continuously and digitally and transmit their data at least daily, which are immediately freely available on the web site mentioned at the beginning of the chapter.

Data are supplied to or exchanged with international surveillance programmes such as WMO, ERB, UNEP-GEMS (water quality data), GRDC (Global Runoff Data Centre in Koblenz), FRIENDS, and IAEA. FOWG specialists collaborate at the international level in the programmes FRIENDS and AMHY of UNESCO. FOWG is active in the international Rhine hydrology commission (Grabs (eds.), 1997).

Capacity building

The FOWG helped the development and implementation of the national hydrological monitoring networks in the States of the Lake Aral region in Central Asia, and supported the development of the regional data centre and the regional hydrological forecasting centre including remote sensing of snow cover in the river basins. It also trained the local staff in tracer technology for discharge measurements.

3.2 Snow observation

The Swiss Federal Institute for Snow and Avalanche Research (SLF, http://www.slf.ch/) runs a network of stations for avalanche forecasting and for climatological investigations that are spread all over the Swiss Alps. There are about 80 observation stations and about 30 automatic stations. The amount of new snow, the snow cover thickness and partly the water equivalent - all of them required for climatological investigations - are measured manually. The following parameters are either measured automatically or by observers: air and snow temperature (snow: 10 centimetres below the snow surface), penetration depth of the rammsonde, weather and avalanche observations. All these stations are located at altitudes ranging between 230 and 2900 m asl. The yearly measuring period goes normally from November to May, but at some stations from snowing in until melting out.

30 stations have time series lasting for more than fifty years. 50 others have series between thirty and fifty years, the remainder have series shorter than thirty years. The available parameters include the amount of new snow, the snow cover thickness and the water equivalent. The quality of the snow data has been assured for every year up to 1999 by checking for outliers and by comparison with nearby stations. Automatic stations have recently been implemented for avalanche forecast purposes. Their datasets are also available (for example: snow cover depth, air and snow temperature), but the accuracy is still too low for some parameters.

3.3 Glacier and Permafrost Networks (GTN-G and GTN-P)

The Global Terrestrial Network for Glaciers (GTN-G) and the Global Terrestrial Network for Permafrost (GTN-P) are pilot projects of GCOS/GTOS. Switzerland participates in corresponding activities on the international and national level.

International level

The World Glacier Monitoring Service (WGMS, http://www.geo.unizh.ch/wgms/) of ICSI(IAHS)/FAGS(ICSU)/UNESCO and UNEP is in charge of the glacier network **GTN-G**. A complete description of the historical background, the cryosphere in global climate observing systems, glacier observations and the Global Hierarchical Observing Strategy (GHOST) as well as some perspectives are given by Haeberli and others (2000). A network of 60 glaciers representing Tiers 2 and 3 is established, corresponding to the data compilation published in the Glacier Mass Balance Bulletin and now reported annually in electronic form. Such a sample of reference glaciers provides information on presently observed rates of change in glacier mass, corresponding acceleration trends and regional distribution patterns. Long-term changes in glacier length (Tier 4) must be used to assess the representativness of the small sample of values measured during a few decades with the evolution at a global scale and during previous time periods. New detailed glacier inventories (Tier 5) are compiled in areas not covered so far or as a repetition of earlier inventories for comparison. Considerable efforts are presently being made in this direction using the new USGS-led ASTER/GLIMS satellite imagery programme. A new structure is currently being investigated for directing and co-ordinating worldwide glacier monitoring, especially in view to improving the funding basis and adjusting to new formats resulting from modern observational technologies such as laser altimetry.

The permafrost network **GTN-P** is currently being built up under the leadership of the International Permafrost Association (IPA; Burgess and others 2001). The WGMS director as one of the two vice-presidents of the association is co-responsible for this monitoring programme and another Swiss specialist is a member of the recently established GTN-P Quality Control Group. A major contribution from Europe with important Swiss participation is provided by the now completed PACE project (Permafrost and Climate in Europe). An overview including definitions of the GHOST tier strategy adapted to permafrost measurements is given by Harris and others (2001). A critical component of the PACE project was to establish a transect of instrumented permafrost boreholes across the higher mountains of Europe, from Svalbard in the north through Swedish Lapland, Southern Norway and the Alps to the Sierra Nevada in the south. Together with various other variables, especially long-term glacier observations of the Terrestrial Network for Glaciers, the PACE borehole network may eventually form part of Tier 1 observations as an important high altitude transect along the North-Atlantic region, which forms a key area for global atmosphere-cryosphere-ocean interactions and, hence, influences the entire climate system. Energy-balance and statistical approaches are applied to calibrate models (Tier 2) relating meteorological and snow data with measured ground temperatures, which can then be used for backward reconstruction of probable past evolution of permafrost temperatures and to investigate forward in time permafrost thermal state at depth as a

function of past surface temperatures and possible future climate scenarios. Determination of temperature gradients and heat flux down to about 100 meters in depth (Tier 3) help in estimating secular changes and verifying backward reconstructions using climate/permafrost models as developed in tier-2 studies.

National level

The Swiss Glacier Monitoring Network of the Glaciological Commission of the Swiss Academy of Sciences (SAS) is directed by the delegate for glacier observations within this commission (http://www.sanw.ch/exthp/komglaz/). It combines efforts by the Laboratory of Hydraulics, Hydrology and Glaciology at the Federal Institute of Technology Zurich (mass balance measurements on Silvretta and Gries Glaciers as contributions to GTN-G Tier 3), a great number of SAS-affiliated organisations (observations of length change at more than 100 glaciers as a contribution to GTN-G Tier 4) and the Geography Department of the University of Zurich (glacier inventory work as part of GTN-G Tier 5). The new Swiss Glacier Inventory 2000 is presently being compiled using advanced technologies of high-resolution satellite imagery, automated image processing, digital terrain information and GIS-applications. It serves as a pilot project for similar projects planned within the ASTER/GLIMS programme. A special associated project develops strategies and algorithms for hazard investigation in high-mountain glacier and permafrost regions. An evaluation of the programme is planned for the near future (1-2 years) and a new directing structure with broader distribution of responsibilities to enhance quality control and continuity may be developed. The latest report on annual measurements is given by Herren and others (2001).

The newly established Swiss Permafrost Monitoring Network (PERMOS) involves a number of academic institutions as part of the Permafrost Co-ordination Group within the Swiss Academy of Sciences. Background papers are given by Haeberli and others (1993) and Delaloye and Vonder Mühll (1998). The current pilot phase of 3 years (2001 – 2003) is planned to result in a more definitive form of the observing system, possibly as a combined Swiss Cryosphere Network in combination with the glacier system and perhaps even with snow observations. Borehole measurements combined with a collection of meteorological data (Murtèl-Corvatsch, Schilthorn) are contributed to Tier 2 of GTN-P and a number of borehole temperatures are provided as contributions to Tier 3 of GTN-P. A number of additional indicators (rock glaciers, ice patches, bottom snow temperatures) are monitored and models for spatial simulations of permafrost distribution developed (Hoelzle and others 2001) in order to form a basis for Tier 4 and Tier 5 surveys within GTN-P.

3.4 Ecological observing systems for climate

Background and international services

In 1993, five international organisations - FAO, ICSU, UNEP, UNESCO and WMO - agreed to co-sponsor the planning process for a Global Terrestrial Observing System

(GTOS). An ad hoc Scientific and Technical Planning Group was established in 1993, and a Scientific Secretariat for this Planning Group was set up at the Swiss Federal Institute for Forest, Snow and Landscape Research (WSL), Birmensdorf, Switzerland in June 1994. The Terrestrial Ecosystem Monitoring Sites (TEMS) is an internet database related to terrestrial Sites (TSites) measuring environmental variables related to the 5 GTOS key issues: land quality, freshwater resources, biodiversity, climate change and pollution and toxicity. It was developed at the WSL and has been functioning on the internet since 1995. It is one of the core tools used by GTOS in its endeavour to build closer links between scientists, modellers and the policy community. TEMS facilitates the identification of and access to terrestrial data for use in research, global change studies and natural resources assessment. TEMS was initiated as an international directory of data about monitoring stations and their activities. Currently the database contains information on:

- location of the TSites and names and addresses of people to contact;
- basic environmental information e.g. altitude, geology topography, climatic conditions, etc.;
- the site affiliation with specialised research or observation networks and the contact person for the network;
- a list of environmental variables observed from a core list of ca. 120 variables.

TEMS served the internal needs of GTOS during its planning phase of 1993-1995. However as it developed, a number of requests were received to make the database more generally available. In 1994 TEMS data were updated and re-defined. The original database was expanded from approximately 150 sites to the present 1000 registered sites covering more than 100 countries. A user interface was developed and made available via internet. A second major revision of TEMS was begun in 1999 which involved a major re-design of the database and re-registration of the sites. In addition to facilitating access to data and information, TEMS allows GTOS to:

- assess and analyse gaps in geographic coverage of critical variables,
- evaluate data quality and measurement methods that are used,
- work towards promoting the use of inter-comparable observation techniques,
- identify sites that need upgrading and register new sites where necessary.

In addition to other global and regional research, GTOS is interested in using TEMS as a tool to assist countries in identifying and organizing their own available data and information on terrestrial observation and to take steps in improving its quality and availability. Efforts are presently underway in Central and Eastern Europe and in Southern Africa. A new user interface will be available on the web in 2001.

Presently there is an agreement between GTOS and WSL concerning the TEMS database. WSL will co-operate on actions that can enhance and facilitate common activities.

Forest

The SAEFL and WSL are affiliated to the International Co-operative Programme on Assessment and Monitoring of Air Pollution Effects on Forests (ICP Forests), to the International Co-operative Programme on Integrated Monitoring of Air Pollution Effects (ICP-IM) - both under the Convention on Long-Range Transboundary Air Pollution of the United Nations Economic Commission for Europe (UN/ECE), to the Ministerial Conference on the Protection of Forests in Europe (Resolution of Strasbourg, Helsinki and Lisbon), to UN-ECE/FAO Temperate and Boreal Forest Resource Assessment, and to the UNEP'S Global Resource Information Database programme (GRID).

The Long-term Forest Ecosystem Research Network (**LWF**; ICP Forests Level II) was established in 1994, a joint research and monitoring activity between the Swiss Federal Institute for Forest, Snow and Landscape Research and the Swiss Agency for Environment, Forests and Landscape. The main aim of LWF is to monitor the state of ecosystems and to provide an explanation of changes in terms of causal environmental factors in order to provide a scientific basis for emission controls and other environmental policies. In addition, it aims to develop and validate models for the simulation of ecosystem responses and to use these in concert with survey data to make regional assessments, and to undertake ecological risk analyses in relation to actual or predicted changes in environmental stresses.

The "**Sanasilva" Inventory** (ICP Forests Level I) has been carried out in its current form since 1985. Its aim is to monitor the health of the Swiss forest using crown and tree parameters as indicators of forest condition. The size of the systematic sample grid has been changed twice since 1985. From 1985 until 1992 approximately 8,000 trees were assessed on nearly 700 plots placed on a 4x4 km grid. In 1993, 1994 and 1997 approximately 4,000 trees were assessed on an 8x8 km subgrid. In 1995, 1996 and from 1998 onwards approximately 1000 trees on a 16x16 km subgrid were assessed.

The sites of these observation programmes are presented on figure 5 on the next page.

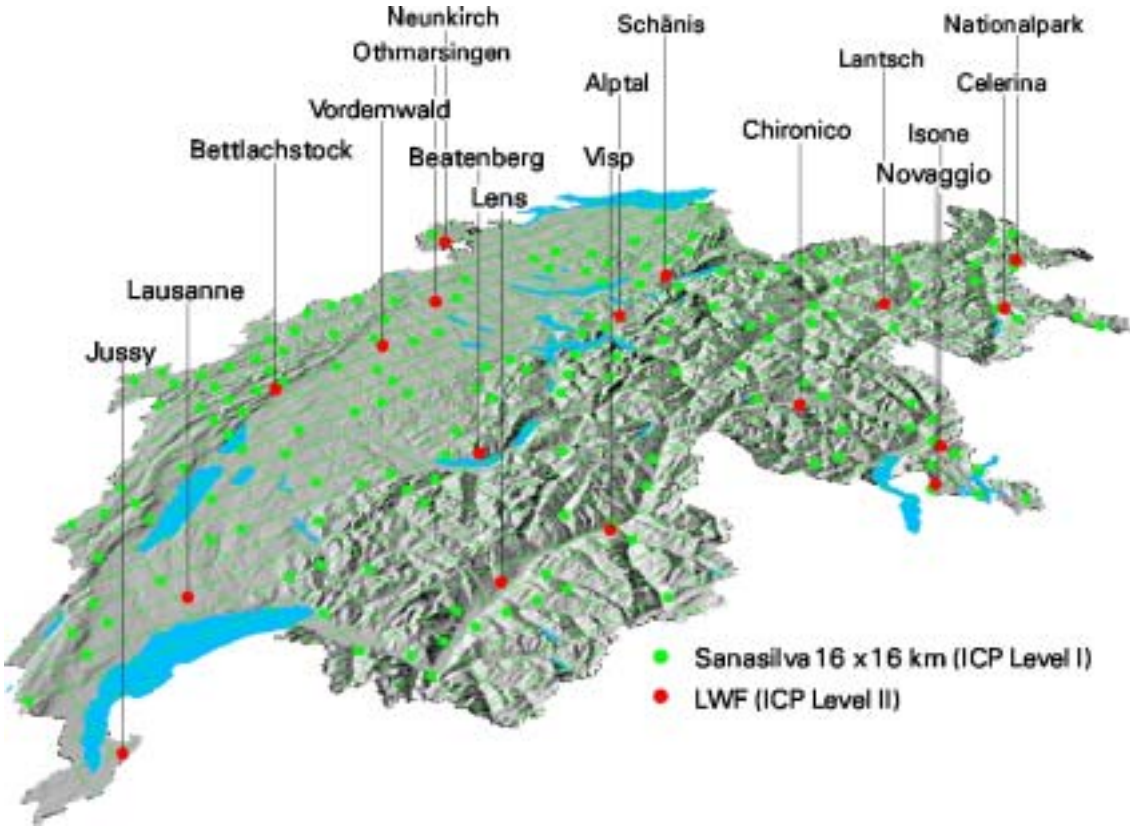

Figure 5: Sites of the Swiss forest observation programmes.

Besides these long-term monitoring activities, different research projects have been set up, for example:

- Scaling carbon fluxes from stands to landscapes: calibrating and testing Biome-BGC along multiple environmental gradients.
- Swiss Canopy Crane Project, where a CO_2 exposure system using the free air enrichment (FACE) approach was developed to fumigate tall canopy trees.

Phytophenology

Extensive phenological observations have been made in Switzerland since 1951. Today the 160 observation posts register 69 phenophases of 26 different plant species. This long-term observation programme focuses mainly on wild growing plants. In addition to these observation programmes, there are two very long phenological series in Switzerland. The foliation of horse chestnut trees in Geneva has been observed since 1808, the full flowering of cherry trees in Liestal since 1894. In recent times the phenological data has been focused upon in connection with the possibility of a global climate change.

Trends for 896 quality controlled phenological time series have been calculated with data from 1951 to 1998. A tendency towards earlier appearance dates in spring and later appearance dates in autumn could be detected. These results are in accordance with those

from the airborne pollen-monitoring network. It must be noted that the different phenophases and plant species react differently to various environmental influences

Soil

The role of the Swiss Soil Monitoring Network (NABO) is primarily to measure and assess the temporal evolution of soil pollution in a long-term monitoring network. It is managed by the Swiss Agency for the Environment, Forests and Landscape (SAEFL) in collaboration with the Swiss Federal Office for Agriculture (SFOA). The contractor is the Swiss Federal Research Station for Agroecology and Agriculture (FAL). More information can be found on its internet address:
http://www.buwal.ch/stobobio/projekte/nabo/e_index.htm.

Other

The Division of Climate and Environmental Physics at the Physics Institute of the University of Bern carried out pioneer work in climate and environmental research by reconstructing the glacial-and interglacial change of atmospheric CO_2 and its dramatic increase over the last 200 years by measuring air bubbles in ice from polar areas (Oeschger et al. 1992, Stocker, 1999). More information can be found on the web-site of that institute (see http://www.climate.unibe.ch).

The Historical Institute at the University of Bern is in charge of the reconstruction of the past climate on the base of proxy data (Pfister, 1999) and has developed the EURO-CLIMHIST database (http://histserver.unibe.ch/euroclimhist/). The EURO-CLIMHIST database is a comprehensive tool for managing, analysing and displaying climatic (high-resolution) proxy evidence from natural and documentary archives. At present more than 100'000 records are already included in the new relational EURO-CLIMHIST database. At present a rather small selection of 5000 records is available on the internet. EURO-CLIMHIST is part of the PALVAREX (Paleoclimate Variability and Extreme Events programme (http://www.giub.unibe.ch/klimet/palvarex.html).

Other networks (radioactivity…) and observation activities (sediment cores, boreholes) have not been specifically included in this report. For more information on activities in the field of paleoecology, see e.g. http://www.botany.unibe.ch/.

3.5 Summary table

The following table 3 summarises the Swiss contribution to the terrestrial and ecological part of GCOS/GTOS, without the hydrological and snow components. The related Swiss contribution to international services is also summarised in that table.

Table 3. Participation in the global terrestrial observing systems

	GTN-P	GTN-G	FLUXNET	ICP Level II
Stations				
How many sites are within the responsibility of the Party?	3	2: Tier 3 > 100: Tier 4 [a)]	0	17
How many of those are operated now?	3	2: Tier 3 > 100: Tier 4 [a)]	-	16
How many are providing data to international data centres now?	3	2: Tier 3 > 100: Tier 4 [a)]	-	16
How many are expected to be operated in 2005?	3 [b)]	2: Tier 3 > 100: Tier 4 [a, b)]	-	17
International services				
World data centres		1 [b)]		1 [c)]

a) In addition, within tier 5, the Swiss Glacier Inventory 2000 includes more than 1800 glaciers being registered in the World Glacier inventory. The decision for the next inventory is pending.

b) Funding pending

c) GTOS TEMS metadata joint world centre

The supplementary tables S9 to S11 in the Appendix provide the requested additional information on these measurements.

4 Space-based observing programmes

The Swiss Space Office is responsible for the implementation of the overall Swiss Space Policy. It is assisted by half a dozen specialised commissions (e. g. remote sensing) and by delegates to ESA groups. A few projects are presented hereafter in addition to those reported in the previous chapters.

Total solar irradiance (solar constant)

The research institute hosting the World Radiation Centre at Davos is strongly involved in satellite-based solar radiometry. Total Solar Irradiance (TSI) has been monitored with absolute radiometers since 1978 on board five different satellites. Each time series was corrected for sensitivity changes and operational influences. Two active-cavity radiometers - DIARAD (Differential Absolute RADiometer) and PMO6-V (V indicates the VIRGO version of the PMO6 type radiometer) - are part of the VIRGO programme to investigate the Total Solar Irradiance (http://www.pmodwrc.ch/solar_const/solar_const.html).

NOAA-AVHRR

The Remote Sensing Research Group (RSRG), Department of Geography, University of Bern, has accessed to NOAA-AVHRR images with its own receiving station since 1980 and has archived them continuously (see http://saturn.unibe.ch). The quality assurance and quality control include a visual check of the received images. The main domains of application are terrestrial investigation (snow cover, land surface temperature and NDVI vegetation index) and atmospheric investigation (aerosol optical thickness). The lifetime of the programme will depend on the lifetime of the NOAA-series.

The RSRG has presently two research projects based on NOAA-AVHRR data. The objective of the SALSA project (Satellite based land surface monitoring of the Alps) is to derive information on snow cover extent as well as variability of the Alps, information on land surface temperature and vegetation index NDVI. The investigations are based on a 20-year archive of NOAA-AVHRR data. The objective of the second project (AEROSOL) is to derive information in real-time on the aerosol optical thickness of the troposphere over the Alps. In a later stage of the project, it is planned to analyse the archived data in relation with changes in the troposphere during the last 20 years.

Data User Programme of ESA (DUP)

Three Swiss projects have been submitted in relation with the ESA satellite programmes. The first one is running: SARSCAPE, Forest Fire Mapping (ENVISAT/ERS). The second should soon run: Pollution Hot Spot Monitoring from GOME Applied to the Po-basin (ENVISAT). A third one has as objectives landslide monitoring and risk assessment using ERS-SAR and ENVISAT-data.

EUMETSAT

MeteoSwiss represents Switzerland within EUMETSAT. It is currently preparing a project related to radiation within the Satellite Application Facility on Climate Monitoring.

5 Concluding remarks

As has been shown, Swiss authorities encourage and support research and systematic observation of the climate system and its impacts. This support extends to the specialised international organisations and programmes, as well as to capacity building. Switzerland has developed numerous permanent observation programmes and supporting activities in favour of GCOS and the climate components of GTOS (terrestrial observation). There are only very few Swiss contributions to systematic oceanic observation (GOOS). Activities in relation with space-based observing programmes have been rather sparse in the past and should be increased in the future in the framework of integrated observations.

Main contributions are related to:

- meteorological land surface and upper air observations,
- atmospheric constituents and radiation,
- hydrological observations,
- glacier, permafrost and snow,
- ecological observations (forestry,...) and general environmental statistics.

They need to be continued on a long-term basis according to the GCOS principles, with high quality goals and a fruitful collaboration between monitoring and research activities. The Alps – with large climate differences on a local scale – are particularly adequate to host GCOS atmospheric and terrestrial observations. It is suggested that GCOS includes Payerne in the global GUAN upper air network as well as in the global GSN surface network.

A couple of world facilities such as calibration or data centres are operated and funded by Switzerland, but long-term funding is pending for international services developed within pilot projects (e.g Glacier Monitoring Service). Contributions to international and national activities ensuring and maintaining the required data quality standards have high priority. Additional effort is still to be made in submitting meteorological and atmospheric data to world data centres as well as to the international scientific community in order to promote better usage of these data.

During recent years, the Swiss contribution to different components of GCOS and GTOS has been significantly increased (GAW, GTN-G, GTN-P). Current monitoring activities related to the physical climate system and to global change are judged to be adequate to fulfil Swiss obligations under the UNFCCC.

MeteoSwiss acts as the national focal point for GCOS, due to its role as national permanent WMO representative (gcos@meteoswiss.ch) and many Swiss scientists are engaged in international GCOS/GTOS groups. Furthermore, a national information and coordination group has been set up in relation with the environmental monitoring activities. Therefore, the existing national structures related to the different monitoring programmes under GCOS and partner structures (GAW, WRCP, WCP, GTN-G, GTN-P, Hydrology, GTOS, ICP) are considered as appropriate in order to fulfil the GCOS commitments. Additional coordination activities under GCOS will be settled each time that it is deemed necessary.

MeteoSwiss collected and compiled the information required within this national report from the different national partners involved in GCOS/GTOS. The report covers not only the Swiss contribution at the global level but also addresses the national level. A clear distinction between these levels was not always possible. Every attempt has been made to cover all relevant activities; any omissions pertaining to this initial report are inadvertent.

At the national level, this report should improve the information flux between the different components of GCOS and GTOS. It highlights present achievements and should promote the long-term continuation of the Swiss contributions to the coordinated and systematic observation of the total climate system.

Appendix

Supplementary Tables

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

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

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

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

Table S5: Atmospheric constituent observing systems for climate

Table S6: Available homogeneous data sets for atmospheric constituents

Table S9: Terrestrial observing systems for climate

Table S10: Ecological observing systems for climate

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

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

Systems	*Climate Parameters*	*Total # Stations*	*Appropriate for Characterizing National Climate? (tick one box)*			*Time Series #stations/platforms (#Data Digitized)*			*Adequate Quality Control Procedures? (tick one box)*			*Metadata available*	*Continuity*
			Fully	*Partly*	*No*	*30-50y*	*50-100y*	*>100y*	*Fully*	*Partly*	*No*	*Total # Stations (% Digitized)*	*# expected operational in 2005*
Stations Useful for National Climate Monitoring Purposes	*Temperature*	*About 60*	*X*			*26 (26)*	*22 (10)*	*12 (12)*	*X*			*50 (25%)*	*45*
	Precipitation	*About 300*	*X*			*200 (200)*	*90 (90)*	*12 (12)*		*X*		*300 (25%)*	*250*
	Sunshine duration	*About 50*	*X*			*26 (26)*	*24 (10)*	*0*	*X*			*50 (25%)*	*45*
	*Other conventional parameters**	**) Global radiation, air pressure, humidity, wind* *Different state for these different parameters. There are only 4 time series longer than 30 years for global radiation.*											
Stations Reporting Internationally	*Automatic* *SYNOP* *WMO40*	*72* *25* *7*				*0* *20 (10) (SYNOP)*	*0* *10 (5) (SYNOP)*	*0* *0 (SYNOP)*		*X*			*45* *25* *7*
CLIMAT Reporting Stations	*As required*	*4*				*0*	*0*	*0*	*X*				*4*
GAW-CHARM radiation network	*Several radiation components*	*4*		*X*		*0*	*0*	*0*	*X*			*4 (100%)*	*4*
ASRB (GAW)	*Long wave radiation*	*11*		*X*		*0*	*0*	*0*	*X*			*11 (100%)*	*4 – 11 (?)*
BSRN	*Radiation (full BSRN progr.)*	*1*		*X*		*0*	*0*	*0*	*X*			*1 (100%)*	*1*

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*
Norm90	*Temperature and Precipitation* *Temperature* *Precipitation*	*12 stations* *81 stations* *427 stations*	*100 years (130 for some of them)* *30-50y: 53 stations, <30y: 28 stat.* *30-50y: 329 stations, < 30y: 98 stat.*	*- Begert, M., Giroud, M., Kegel, R., Seiz, G., Köhli, V. 1998. Operational Homogenization of Long Term Climate Data Series at SMI. Proceedings ECAC, October 1998, Vienna.* *- Project Norm90, MeteoSwiss internal reports* *- Aschwanden, A. , et al. (1996): Bereinigte Zeitreihen. Die Ergebnisse des Projektes KLIMA90. Bd. 1-4, MeteoSchweiz, Zurich* *- Annalen der SMA-MeteoSchweiz 1999*
Niederschlagsreihe Schweizer Mittelland	*Precipitation*	*Mean of 4 stations*	*1864 - 1995*	*- Pfister, C. (1999): Witternachlese. 500 Jahre Klimavariationen und Naturkatastrophen. Verlag Paul Haupt. Bern.*
CHARM (explanation: see p. 18)	*Radiation (different parameters. e.g Payerne: UV (G, D, I, R, UVA), VIS (G, D, I, R), IR (G), Spectral (3λ))*	*1 - 11*	*Partly since 1992 (only partly homogeneous)*	*- Ingold, T. (2000): Monitoring Atmospheric Parameters from Ground-Based Remote Sensing Networks in Switzerland, Thesis, University of Bern.* *- http://www.pmodwrc.ch/asrb/asrb.html* *- Marty, Ch. (2000): Surface Radiation, Cloud Forcing and Greenhouse Effect in the Alps, Dissertation No. 13609, Swiss Federal Institute of Technology.*
IACETH	*Precipitation*	*3.2 – 12 E* *43.2 – 48.8 N* *(25 km, 1000 points)*	*1901 - 1990*	*Schmidli, J., Frei, C. and Schär, C., (2001): Reconstruction of mesoscale precipitation fields from sparse observations in complex terrain. . J. Climate, (in press).*

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 Characterizing National Climate? (tick one box)*			*Time Series #stations/platforms (#Data Digitized)*				*Adequate Quality Control Procedures? (tick one box)*			*Metadata available*	*Continuity*
		Fully	*Partly*	*No*	*5-10y*	*10-30y*	*30-50y*	*>50y*	*Fully*	*Partly*	*No*	*Total # Stations (% Digitized)*	*# expected operational in 2005*
Radiosonde stations	*1*	*X*						*1 (1)*	*X*			*1 (90%)*	*1*
Wind-only stations	*0*												*0*
Stations reporting Internationally	*1*						*1 (1)*		*X*				*1*
CLIMAT TEMP reporting stations	*1*						*1 (1)*		*X*				*1*
ASAP stations	*0*												*0*
Profilers (LLP wind)	*1*				*1 (1)*				*Presently: European CWIND pilot project (full QC and metadata, but time series not continuous)*				
Aircraft (land locations)	*0*												*0*
GPS (water vapour column)	*0*								*A project is underway with about 10 pilot stations (COST 716)*				
Precipitation radars	*3*	*X*			*3 (3)*				*X*			*3 (100%)*	*3*
Total Upper Air Network		*X*											

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*
RASODA-Payerne	*Temperature*	*1*	*1961-1990*	*- Aschwanden, A. , et al. (1996): Bereinigte Zeitreihen. Die Ergebnisse des Projektes KLIMA90. Bd. 1-4, MeteoSchweiz, Zurich*
OZONE-Payerne	*Temperature, Geopotential, Tropopause*	*1*	*1968 - …*	*- Favaro, G., Jeannet, P., Stübi, R. Ozone sounding of Payerne: re-evaluation, data comparison and trend analysis. MeteoSchweiz Veröffentlichung. To be published.*

Table S5: Atmospheric constituent observing systems for climate

Constituent	*Total # Stations or platforms*	*Appropriate for Characterizing National Climate? (tick one box)*			*Time Series #stations/platforms (#Data Digitized)*				*Adequate Quality Control Procedures? (tick one box)*			*Metadata available Total # Stations (% Digitized)*	*Continuity # expected operational in 2005*
		Fully	*Partly*	*No*	*10-20y*	*20-30y*	*30-50y*	*>50y*	*Fully*	*Partly*	*No*		
Ozone (surface, tropospheric background)	*1*		*X*		*1 (1)*				*X*			*1 (not digitized)*	*1*
Ozone (column)	*1*	*X*						*1 (1)*	*X*			*1 (80%)*	*1*
Ozone (profile, Umkehr)	*1*	*X*					*1(1)*		*X*			*1 (80%)*	*1*
Ozone (profile, sonde)	*1*	*X*					*1 (1)*		*X*			*1 (80%)*	*1*
GAW aerosol progr.)*	*1*		*X*						*X*			*1 (20%)*	*1*
Total suspended matter (TSP) with sulfate, cadmium, lead content	*1*		*X*		*1 (1)*				*X*			*1 (partly digitized)*	*1*
SO_2,NO_x, NO_2, NO, CO (trop. background)	*1*		*X*		*1 (1)*				*X*			*1 (partly digitized)*	*1*
Radiation (GAW, BSRN)	*See Table S1*												

**) aerosol BC mass concentration, aerosol major chemical components, aerosol scattering coefficient at various wavelengths, aerosol absorption coefficient, aerosol number concentration, aerosol surface area concentration, cloud liquid content.*

Table S6: Available homogeneous data sets for atmospheric constituents

Data Set Name	*Constituent*	*# Stations or Grid Resolution and Region covered*	*Time Period*	*References*
Arosa (GAW)	*Ozone (column)*	*1*	*1926 - …*	*- Staehelin, J., Renaud, A., Bader, J., McPeters, R., Viatte, P., Hoegger, B., Bugnion, V., Giroud, M., Schill, H. (1998): Total ozone series at Arosa (Switzerland): Homogenisation and data comparison, J. Geophys. Res., 103, 5827-5841.* *- Staehelin, J., Kegel, R., Harris, N.R.P. (1998): Trend analysis of the homogenised total ozone series of Arosa (Switzerland), 1926-1996, J. Geophys. Res., 103, 8389-8399.*
Payerne (GAW)	*Ozone (profil sonee)* *Ozone profile Umehr)*	*1* *1*	*1966 - …* *1956 …*	*- Favaro, G., Jeannet, P., Stübi, R. Ozone sounding of Payerne: re-evaluation, data comparison and trend analysis. MeteoSchweiz Veröffentlichung. To be published.* *- Weiss, A., Staehelin, J., Appenzeller, C., Harris, N.R.P.: Chemical and Dynamical Contributions to Ozone Profile Trends of Payerne (Switzerland) balloon soundings, J. geophys. Res., submitted to pblication.*
Jungfraujoch (NABEL)	*Ozone*	*1 (tropospheric background Alpine station)*	*1988 - ...*	*- Fricke W. et al. (2000): Filterung luftchemischer Messreihen im Alpenraum zur Charakterisierung ihrer Repräsentanz, DWD Nr. 211, Offenbach 2000* *- Filliger, P., Buchmann, B., Schwarzenbach, B. (1994): Air Pollution measurements at the High Alpine Station Jungfraujoch (3580 m asl), Switzerland, 1973 - 1993. In: Proceedings EUROTRAC Symposium 94, 259-262.*
Jungfraujoch (GAW)	*Other Greenhouse Gases*	*1 (tropospheric background Alpine station)*	*NO, NO_2: 1992 - ...* *SO_2: 1973 - ...* *Sulphate: 1973 - ...*	*See above: Filliger, Fricke.*
Jungfraujoch aerosol (GAW)	*See footnote S5*	*1 (tropospheric background Alpine station)*	*Partly since 1995 (only partly homogeneous)*	*Baltensperger, U., Gäggeler, H.W., Jost, D.T. , Lugauer, M., Schwikowski, M., Weingartner, E., Seibert, P. (1997): Aerosol climatology at the high-alpine site Jungfraujoch, Switzerland, J. Geophys. Res. 102, 19707-19715.*
CHARM	*Radiation*	*See table S2*		

Table S9. Terrestrial observing systems for climate

Systems useful for national climate monitoring	*Total # stations*	*Appropriate for Characterizing National Climate? (tick one box)*			*Time Series #stations/platforms (#Data Digitized)*			*Adequate Quality Control procedures? (tick one box)*			*Metadata available Total # Stations (%Digitized)*	*Continuity # expected operational in 2005*
		Fully	*Partly*	*No*	*30-50y*	*50-100y*	*>100y*	*Fully*	*Partly*	*No*		
Hydrological system *River Discharge (Streamflow Gauges)*	*205*		*X*		*43 (43)*	*159 (159)*	*3 (3)*	*X*			*205 (100%)*	*200*
Ground Water Storage (e.g., Boreholes)	*40*		*X*		*40 (40)*			*X*			*40 (100%)*	*40*
River water temperature	*39*		*X*		*20 (20)*			*X*			*39 (100%)*	*60*
Lake water temperature	*36*		*X*			*5 (5)*	*30 (30)*	*X*			*36 (100%)*	*30*
Crest stage gauges	*75*	*X*						*X*			*75 (100%)*	*70*
Isotopes rainfall	*11*	*X*						*X*			*11 (100%)*	*13*
Isotopes rivers	*6*	*X*						*X*			*6 (100%)*	*8*
Isotopes groundwater	*1*	*X*						*X*			*1 (100%)*	*4*
Snow observation *Snow (new snow and snowcover thickness)*	*109*	*X*			*53 (53)*	*34 (34)*		*X*			*109 (100%)*	*100*
Snow water equivalence	*50*	*X*			*25 (16)*				*X*		*Not digitized*	*50*
Glaciers *(mass balance: 2 stations, length : other stations)*	*121*		*X*		*About 40*	*About 40*	*About 40*	*X*			*121*	*121*
Permafrost *(boreholes+meteo: 3 stat. Boreholestemp. : other)*	*About 15*		*X*					*X*			*About 5*	*About 15*

Table S10: Ecological observing systems for climate

Systems useful for national climate monitoring	*Total # stations*	*Appropriate for Characterizing National Climate*			*Time Series # stations/platforms (#Data Digitized)*				*Adequate Quality Control Procedures?*			*Metadata available Total # stations (% Digitized)*	*Continuity # expected operational in 2005*
		Fully	*Partly*	*No*	*30-50y*	*50-100y*	*100-300y*	*>300y*	*Fully*	*Partly*	*No*		
Phenological network	*160*	*X*			*X*					*X*		*160 (100%)*	*160*
Sanasilva	*16 x 16 km grid*			*X*								*yes*	*16 x 16 km grid*
National Forest Inventory *:* *Vegetation type* *Land cover* *Land use change*	*1.4 x 1.4 km grid*			*X*						*X*		*yes*	*next assessment expected in 2005*
Long-term Forest Ecosystem Research (LWF)	*16*		*X*							*X*		*yes* *Manual of UN/ECE ICP Forests*	*17*
Forest fire assessment	*2*		*X*		*X*	*X*				*X*		*100 % for southern Switzerland*	*yearly assessment by forest service*
NOAA-AVHRR *snow,* *land surface temperature,* *vegetation index NDVI*	*NOAA-AVHRR receiving station*	*X*	 *X* *X*		 *20y* *20y* *20y*					*X*	 *X*	 *-* *-* *-*	 *X* *X* *X*
PaleoClimate (see S11)													
Other (see text)													

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*
Water balance Switzerland	*Runoff, areal precipitation, evapotranspiration*	*5 large river basins*	*1901 – 2000*	*Hydrological Atlas of Switzerland. Federal Office for Water and Geology.*
Hydrological research basins	*Runoff*	*52 basins*	*1972 – 2000*	*Federal Office for Water and Geology.*
SLF-VG	*Snow (new snow and snow cover thickness,...*	*82 (Swiss Alps)*	*10.1945 - ...*	*Metadata: data@slf.ch*
SLF-MS	*Snow (new snow and snow cover thicknes,...s*	*37 (Swiss Alps)*	*10.1930 - ...*	*Metadata: data@slf.ch*
SLF-IMIS	*Snow temperature,...*	*70 (Swiss Alps)*	*10.1996 - ...*	*Metadata: data@slf.ch*
SLF-ENET	*Snow temperature,...*	*11 (Swiss Alps)*	*02.1992 - ...*	*Metadata: data@slf.ch*
SLF-Snowprofiles FF (flat field)	*Snow water equivalent,...*	*About 50 (Swiss Alps)*	*1997 - ...*	*Metadata: data@slf.ch (+ partly 1946 – 1985)*
Glaciers	*Indicator*	*121*	*Partly since 1830*	*Herren, E. Hoelzle, M. and Maisch, M. (2001): The Swiss Glaciers 1997/98 and 1998/99 Glaciological Report 119/120. Glaciological Commission of the Swiss Acdemy of Sciences and Laboratory of Hydraulics, Hydrology and Glaciology at the Federal Institute of Technology.*
Permafrost	*Indicator*	*About 15*	*Partly since 1987*	*Vonder Mühll et al., in preparation*
Phytophenology Switzerland	*Phenophases*	*> 70 stations*	*1951 - 1998*	*Defila, C., Clot, B.: Phytophenological trends in Switzerland, to be published in Int. J. of Biometeorology* *Defila, C, (2001): Do phytophenological series contribute to vegetation monitoring? in Biomonitoring: General and Applied Aspects on Regional and Global Scales. Kluwer Academic Publishers, Dordrecht, Boston, London: 97-105*
National Forest Inventory	*Normalised Differential Vegetation Index, Land Cover*	*national 1.4 x 1.4 km grid*	*1985, 1995*	*Brassel, P. et al., 1999: Inventaire forestier national suisse. Berne* *http://www.wsl.ch/land/products/lfi*
Forest fire assessment		*Assessment of the whole forested area by local forest services*	*Southern Switzerland 100 y, other since 1967*	*Statistique de la Suisse. Le forêt et le bois en Suisse (Annuaire). Office fédéral de la statistique, CH-3003 Bern* *http://www.wsl.ch/sottostazione/incendi-it.ehtml*

Data Set Name	Climate Parameter	# Stations or Grid	Time Period	References
Long-term Forest Ecosystem research (LWF)	*Humidity, Precipitation (total), radiation, sunshine, air temperature, wind speed; nitrogen oxides concentration, ozone (surface), sulfur dioxide concentration, leaf area index, soil moisture, soil temperature, soil type, vegetation type, tree-rings, soil solution and others*	*16*	*since 1996*	*- Cherubini, P.; Innes, J.L. (2000): Switzerland: The Swiss Long-term Forest Ecosystem Research Programme. - In: Gosz, J.R.; French, C.; Sprott, P.; White, M. (eds) The International Long Term Ecological Research Network 2000. Albuquerque New Mexico, US LTER Network Office. 56-59.* *- Long-term Forest Ecosystem Research (LTFER). 9 fact sheets; Swiss Federal Institute for Forests, Snow and Landscape Research Birmensdorf.* *- http://www.wsl.ch/forest/risks/lwf/lwfintro-en.ehtml* *- email : lwf@wsl.ch*
Sanasilva	*1984 & 1992 (subset): tree rings* *1993: soil type*	*national 16 x 16 km grid*	*since 1985*	*- Brang, P. et al. (1998): Sanasilva-Report 1997. Swiss Forests: Their condition and potential threats. Ber. Eidgenöss. Forsch.anst. Wald Schnee Landsch. 345.* *- http://www.wsl.ch/forest/risks/ssiintro/-en-ehtml , email : lwf@wsl.ch* *- Bräker, Otto U. (1996): Tree-ring growth trends since the Swiss forest damage inventory "Sanasilva 1984": Results of a 1992 pilot study. In: Dean, J.S. et al., eds., Tree Rings, Environment, and Humanity. The University of Arizona, Tucson. 363-370.* *- Vanmechelen L; Groenemans R; Van Ranst E. (1997): Forest Soil Condition in Europe. Results of the Large-Scale Soil Survey, Brussels Geneva ICP Forests.*
NOAA-AVHRR time series	*See S10*	*1 km grid / Alps*	*1980- 2001*	*http://saturn.unibe.ch*
Phenophases Switzerland	*Phenological observations*	*896 phenological time series*	*1951 - 1998*	*Defila, C., Clot, B. Phytophenological trends in Switzerland, to be published in Int. J. of Biometeorology* *Defila, C., 2001: Do phytophenological series contribute to vegetation monitoring? in Biomonitoring: General and Applied Aspects on Regional and Global Scales. Kluwer Academic Publishers, Dordrecht, Boston, London: 97-105*
Climate proxy Switzerland	*Temperature* *Precipitation*	*2-3 climate regions of Switzerland*	*1496 - 1995* *1755 - 1995*	*- Pfister, C., 1999. Witternachlese. 500 Jahre Klimavariationen und Naturkatastrophen. Verlag Paul Haupt. Bern.*
Euroclimhist	*Climate and proxy*	*Europe*	*1000 y*	*- http://www.server.unibe.ch/euroclimhist/*
Polar ice cores	*CO_2 , CH_4,…*	*Greeland*	*> 10'000 y*	*- see http://www.climate.unibe.ch*

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Additional references can be found in the Appendix (Supplementary Tables).

Abbreviations

AMHY	Alpine and Mediterranean Hydrolgy (FRIENDS)
ASAP	Automated Shipboard Aerological Programme
ASOPOS	Assessment of Standard Operating Procedures for Ozone Sonde
ASTER/CLIMS	Satellite imagery programme
AVHRR	Advanced Very High Resolution Radiometer
BSRN	Baseline Surface Radiation Network
CALRAS	Comprehensive Alpine Radiosonde Data Set
CHARM	Swiss Atmospheric Radiation Network
CLIMAT	Climate message encoded for the WMO surface network
CLIMAT TEMP	Climate message encoded for the WMO upper air network
CEOS	Committee on Earth Observation Satellites
CORINAIR	Coordination d'information environnementale projet partiel air
COST	European Cooperation in the field of Scientific and Technical research
CWIND	COST European Demonstration Network of Windprofilers
DACH-GAW	Collaboration between Germany, Austria and Switzerland
DIARAD	Differential Absolute RADiometer
DWD	Deutscher Wetterdienst
ECC	Electro-chemical Concentration Cell for ozone
EMPA	Swiss Federal Laboratories for Materials Testing and Research
ENVISAT	Environmental satellite (ESA)
EOS	Earth Observing System (NASA)
ERB	Earth Radiation Budget
ERS	European Remote Sensing Satellite
ESA	European Satellite Agency
ETHZ	Swiss Federal Institute of Technology Zurich
EUMETSAT	European Organisation for the Exploitation of Meteorological Satellites
EURO-CLIMHIST	Database with European historical climate information
EUROTRAC	Transport and Chemical Transformation of Environmental Relevant Trace Constituents in the Troposphere over Europe (European project)
FAGS	Federation of Astronomical, Geophysical and Data Analysis Services

FAL	Swiss Federal Research Station for Agroecology and Agriculture
FAO	Food and Agriculture Organisation
FLUXNET	Global Terrestrial Network - Carbon
FOWG	Swiss Federal Office for Water and Geology
FRIENDS	Flow Regimes from International Network Data
FTIR	Fourier Transform Infrared Radiometer
GAW	Global Atmosphere Watch of WMO
GAW-CH	Swiss programme related to GAW
GAWSIS	GAW Information System
GCOS	Global Climate Observing System
GEMS	Global Environmental Monitoring System
GHOST	Global Hierarchical Observing Strategy
GIS	Geographical Information System
GOME	Global Ozone Monitoring Experiment
GOOS	Global Ocean Observing System
GPS	Global Positioning System
GRDC	Global Runoff Data Centre in Koblenz
GRID	Global Resource Information Database
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
HWRP	Hydrology and Water Resources Programme
IAHS	International Association of Hydrological Sciences
IAEA	International Atomic Enrgy Agency
ICP	International Co-operative Programme on Assessment and Monitoring of Air Pollution Effects on Forests
ICP-IM	International Co-operative Programme on Integrated Monitoring of Air Pollution Effects
ICSI	International Commission on Snow and Ice
ICSU	International Council of Scientific Unions
IGBP	International Geosphere-Biosphere Programme
IGOS	Integrated Global Observing Strategy
IKUB	Swiss information and coordination committee in the field of environmental monitoring

IOC	Intergovernmental Oceanographic Commission of UNESCO
IPA	International Permafrost Association
IPCC	Intergovernmental Panel on Climate Change
JOSIE	Jülich Ozone Sonde Intercomparison Experiment
LLP	Low Level wind Profiler
LWF	Long-term Forest Ecosystem Research Network
MeteoSwiss	Federal Office of Meteorology and Climatology
OcCC	Advisory Body to the federal administration on climate change research and policy
OECD	Organisation for Economic Cooperation and Development
NABEL	Swiss Air Pollution Monitoring Network
NABO	Swiss Soil Monitoring Network
NADUF	Swiss Monitoring Network (water quality in rivers)
NAQUA	Swiss Monitoring Network (water quality in groundwater)
NCCR	National Competence Centre of Research
NDSC	Network for the Detection of Stratospheric Change
NDVI	Normalised Difference Vegetation Index
NILU	Norvegian Institute for Air Research
NOAA	US National Oceanic and Atmospheric Administration
NPH	Swiss Monitoring Network (peak discharge in small rivers)
PACE	Permafrost and Climate in Europe
PALVAREX	Paleoclimate Variability and Extreme Events programme
PERMOS	Swiss Permafrost Monitoring Network
PMO06	Radiometer
PMOD/WRC	Physikalisch-Meteorolisches Observatorium Davos/World Radiation Centre
PSI	Paul Scherrer Institute
QA/SAC	Quality Assurance/Scientific Activity Centre
QC	Quality Control
RSRG	Remote Sensing Research Group
SAEFL	Swiss Federal Office of Environment, Forests and Landscape
SAG	Scientific Advisory Group
SALSA	Satellite based land surface monitoring of the Alps
SAS	Swiss Academy of Sciences
SAR	Synthetic Aperture Radar
SARSCAPE	Forest Fire Mapping (ENVISAT/ERS)

SFC	Drifters Surface Drifters
SFOA	Swiss Federal Office for Agriculture
SFSO	Swiss Federal Statistical Office
SHADOZ	Southern Hemisphere Additional Ozonesondes
SINGADS	Synthesis of Integrated Global Aerosol Data Sets
SLF	Swiss Federal Institute for Snow and Avalanche Research
ENET	Swiss complementary meteorological surface network
SOMORA	Stratospheric Ozone Monitoring Radiometer
SOOP	Ship of Opportunity Programme
Sub-SFC	Sub-surface
SYNOP	Coded surface weather message
TEMP	Coded upper air weather message
TEMS	Terrestrial Ecosystem Monitoring Sites
Tsites	Terrestrial Sites
TSI	Total Solar Irradiance
TSP	Total Suspended Particulates
UN/ECE	United Nations Economic Commission for Europe
UNEP	United Nations Environment Programme
UNESCO	United Nations Educational, Scientific and Cultural Organisation
UNFCCC	United Nations Framework Convention on Climate Change
USGS	U.S Geological Survey
NOAA	National Oceanic and Atmospheric Administration (USA)
VIRGO	Variability of solar IRradiance and Gravitation Oscillations
VOS	Volunteer Observing Ship
WCC	World Calibration Centre
WCP	World Climate Programme
WCRP	World Climate Research Programme
WDCA	World Data Centre for Aerosol (GAW)
WDCGG	World Data Centre for Greenhouse Gases (GAW)
WGMS	World Glacier Monitoring Service (GTN-G)
WHYCOS	World Hydrological Cycle Observing System
WMO	World Meteorological Organisation
WMO RA VI	WMO Region VI (Europe)
WORCC	World Optical Depth Research and Calibration Centre
WOUDC	World Ozone and UV Data Centre (GAW)

WRMC	World Radiation Monitoring Centre (BSRN)
WSL	Swiss Federal Institute for Forests, Snow and Landscape Research
WWW	World Weather Watch of WMO

See also: http://www.wmo.ch/web/gcos/Database/acronyms.html