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Federal Department of Home Affairs FDHA
Federal Office of Meteorology and Climatology **MeteoSwiss**

National Climate Observing System (GCOS Switzerland)

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ESA Summer School 2010, Frascati (I), 3 August 2010



About me ...

- Head of Swiss GCOS Office, Federal Office of Meteorology and Climatology MeteoSwiss (since 2006):
 - Member Swiss UNFCCC delegation
 - Member Swiss ESA delegation (Programme Board Earth Observation)
 - Member Swiss Federal Commission on Space Affairs
- PhD thesis: Ground- and satellite-based multi-view determination of 3D cloud geometry, Prof. A. Gruen, Institute of Photogrammetry and Remote Sensing, ETHZ, 2003
- Visiting Advisor, MISR Science Team, NASA-JPL, 2004
- Visiting Scientist, EUMETSAT, 2004, 2005
- Postdoc Research Scientist, ESA, 2005-2006



Outline

- Global Climate Observing System (GCOS)
- GCOS & Satellites
- GCOS Switzerland
- Use of satellite-based products within GCOS Switzerland
 - Cloud cover
 - Glaciers
- Conclusions and Outlook



ments in this Article, the necessary

9. The Parties shall take full account of the specific needs and special situations of the least developed countries in their actions with regard to funding and transfer of technology.

10. The Parties shall, in accordance with Article 10, take into consideration in the implementation of the commitments of the Convention the situation of Parties, particularly developing country Parties, with economies that are vulnerable to the adverse effects of the implementation of measures to respond to climate change. This applies notably to Parties with economies that are highly dependent on income generated from the production, processing and export, and/or consumption of fossil fuels and associated energy-intensive products and/or the use of fossil fuels for which such Parties have serious difficulties in switching to alternatives.

Article 5
RESEARCH AND SYSTEMATIC OBSERVATION

In carrying out their commitments under Article 4, paragraph 1 (g), the Parties shall:

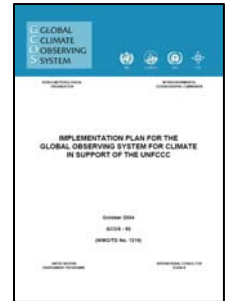
- (a) Support and further develop, as appropriate, international and intergovernmental programmes and networks or organizations aimed at defining, conducting, assessing and financing research, data collection and systematic observation, taking into account the need to minimize duplication of effort;
- (b) Support international and intergovernmental efforts to strengthen systematic observation and national scientific and technical research capacities and capabilities, particularly in developing countries, and to promote access to, and the exchange of,

→ GCOS Secretariat at WMO = International Coordination
→ Swiss GCOS Office at MeteoSwiss = National Coordination



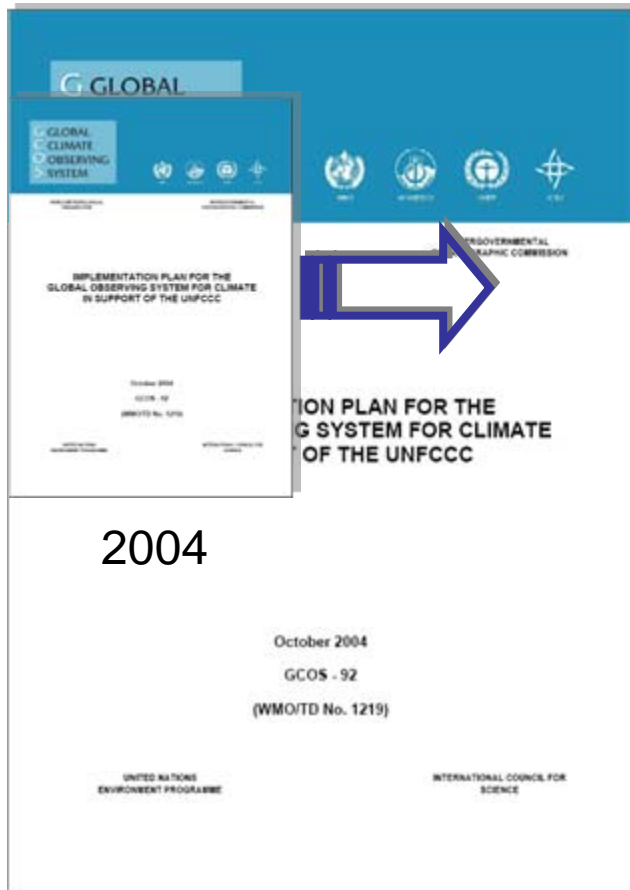
Global Climate Observing System

- Second Adequacy Report (2003)
 - GCOS Essential Climate Variables (ECVs)
- GCOS Implementation Plan (2004)
 - GCOS Monitoring Principles (10 +10 satellite)
 - Importance of national and regional actions
 - Need for a major, sustained, satellite component





GCOS & Satellites



2004

GCOS Implementation Plan

2004

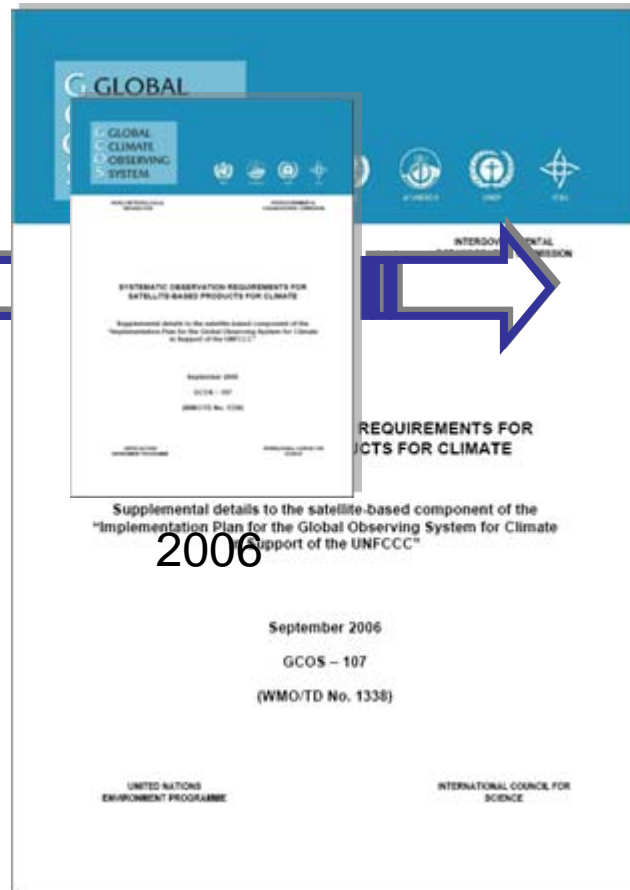
Action C10: Earth Observation Satellites:
*“... A detailed global climate record for the future critically depends upon a **major satellite component**. ...”*



GCOS & Satellites



2004



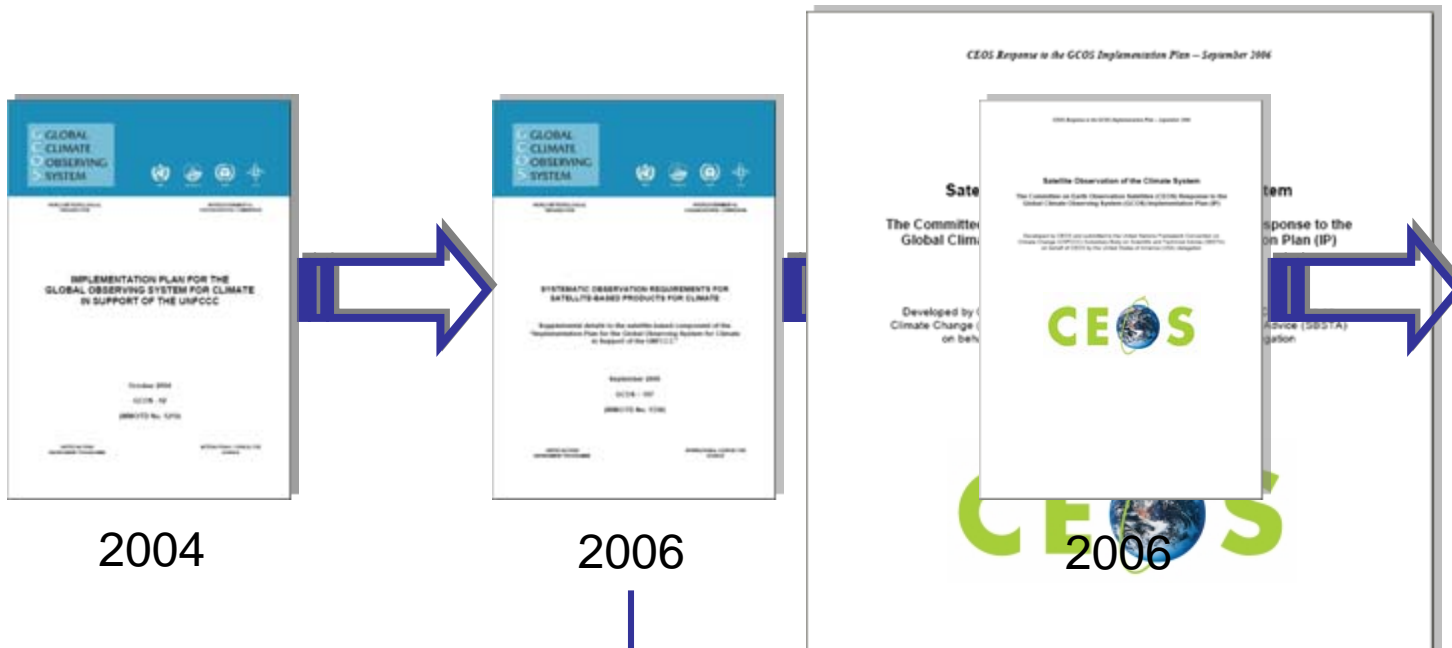
2006

GCOS
"Satellite Supplement"

2006



GCOS & Satellites



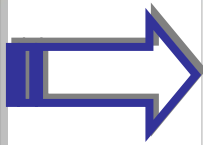
Conclusions COP12, Nairobi:
 2009: Guideline for the Generation of Satellite-based Datasets and Products
 -The SBSIA invited *the Parties that support space agencies to enable these agencies to implement, to the extent possible, the actions identified in the CEOS report and to continue responding in a coordinated manner through CEOS to the efforts to meet these needs.*"



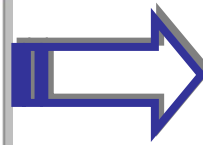
GCOS & Satellites



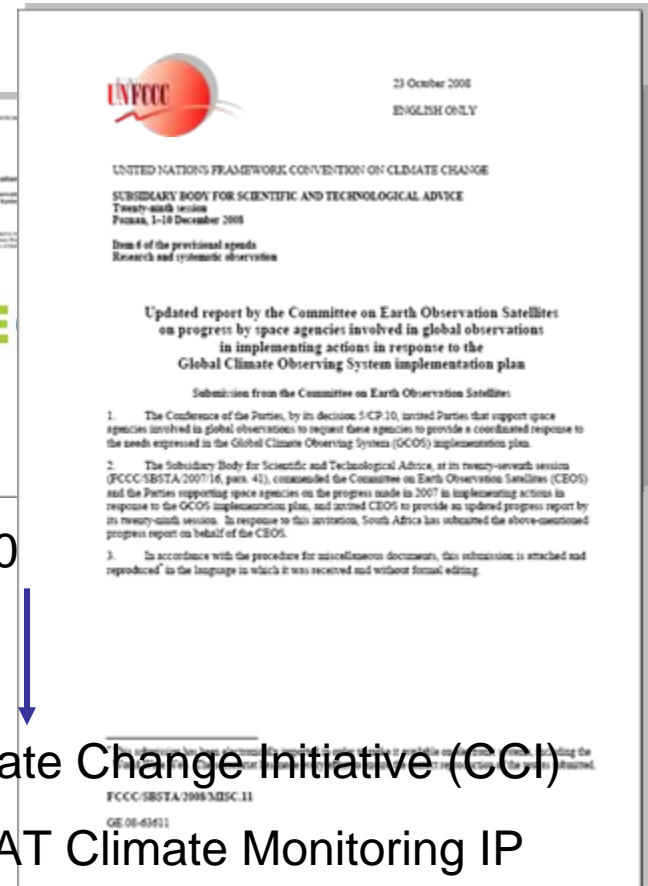
2004



2006



2008

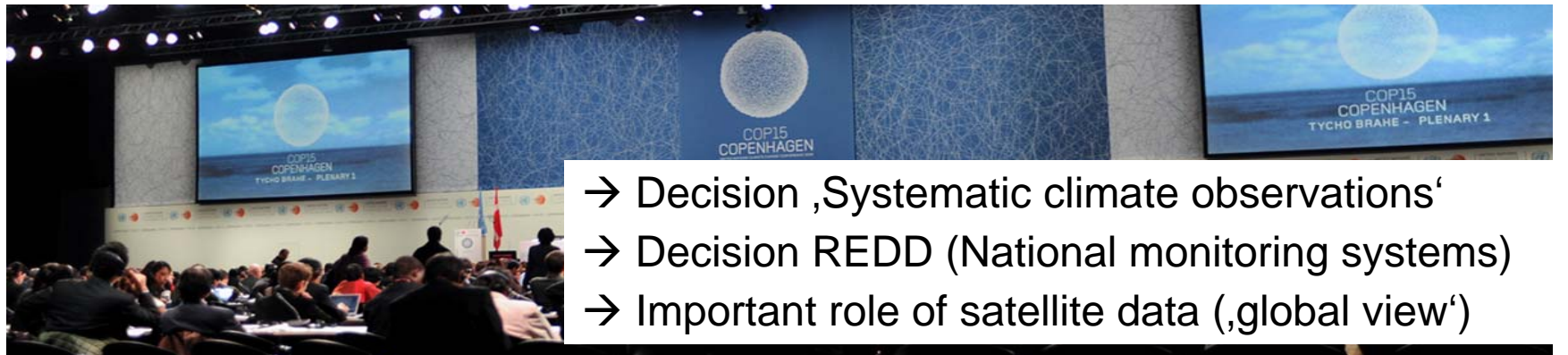
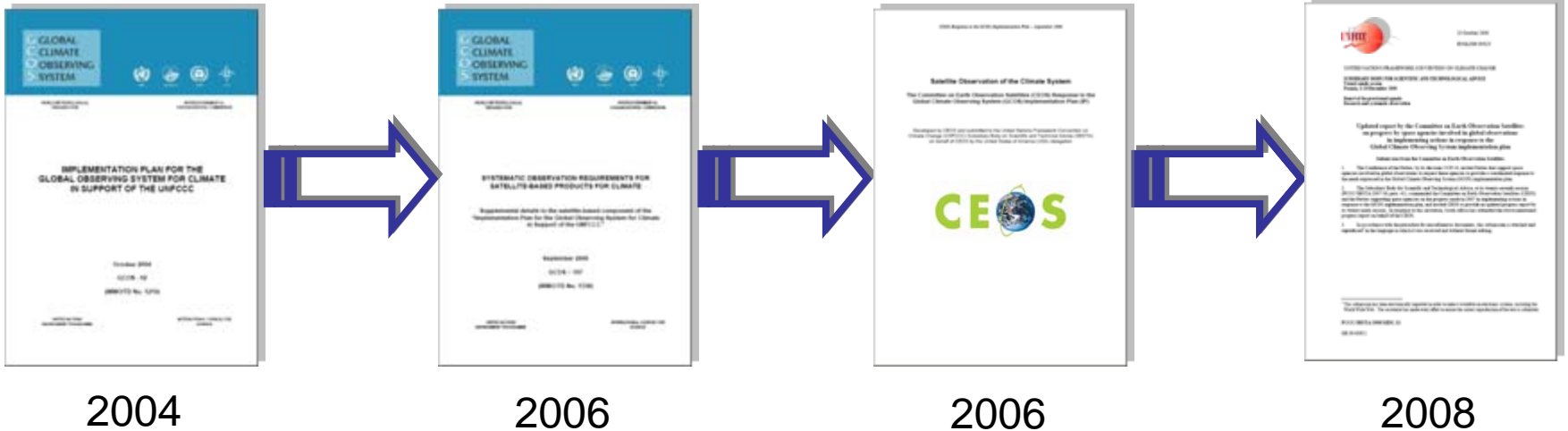


- ESA Climate Change Initiative (CCI)
- EUMETSAT Climate Monitoring IP

CEOS
Progress Report
COP14 Poznan 2008



GCOS & Satellites



- Decision 'Systematic climate observations'
- Decision REDD (National monitoring systems)
- Important role of satellite data ('global view')

COP15 Copenhagen 2009



GCOS Essential Climate Variables (ECVs)

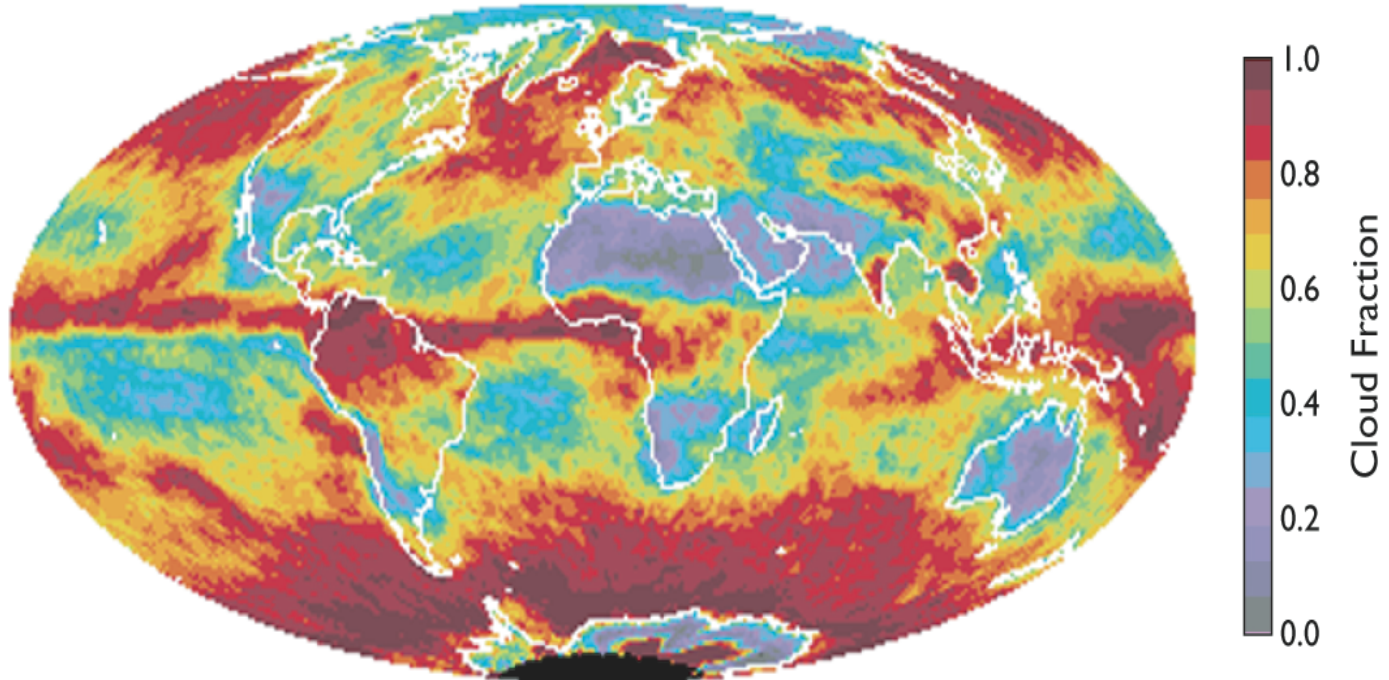
Domain	Essential Climate Variables
Atmospheric (over land, sea and ice)	<p>Surface: Air temperature, Precipitation, Air pressure, Surface radiation budget, Wind speed and direction, Water vapour.</p> <p>Upper-air: Earth radiation budget (including solar irradiance), Upper-air temperature (including MSU radiances), Wind speed and direction, Water vapour, Cloud properties.</p> <p>Composition: Carbon dioxide, Methane, Ozone, Other long-lived greenhouse gases²¹, Aerosol properties.</p>
Oceanic	<p>Surface: Sea-surface temperature, Sea-surface salinity, Sea level, Sea state, Sea ice, Current, Ocean colour (for biological activity), Carbon dioxide partial pressure.</p> <p>Sub-surface: Temperature, Salinity, Current, Nutrients, Carbon, Ocean tracers, Phytoplankton.</p>
Terrestrial	River discharge, Water use, Ground water, Lake levels, Snow cover, Glaciers and ice caps, Permafrost and seasonally-frozen ground, Albedo, Land cover (including vegetation type), Fraction of absorbed photosynthetically active radiation (fAPAR), Leaf area index (LAI), Biomass, Fire disturbance.

ECVs largely dependent upon satellite observations

Source: GCOS Implementation Plan 2004,
GCOS Satellite Supplement 2006



Global products: cloud cover

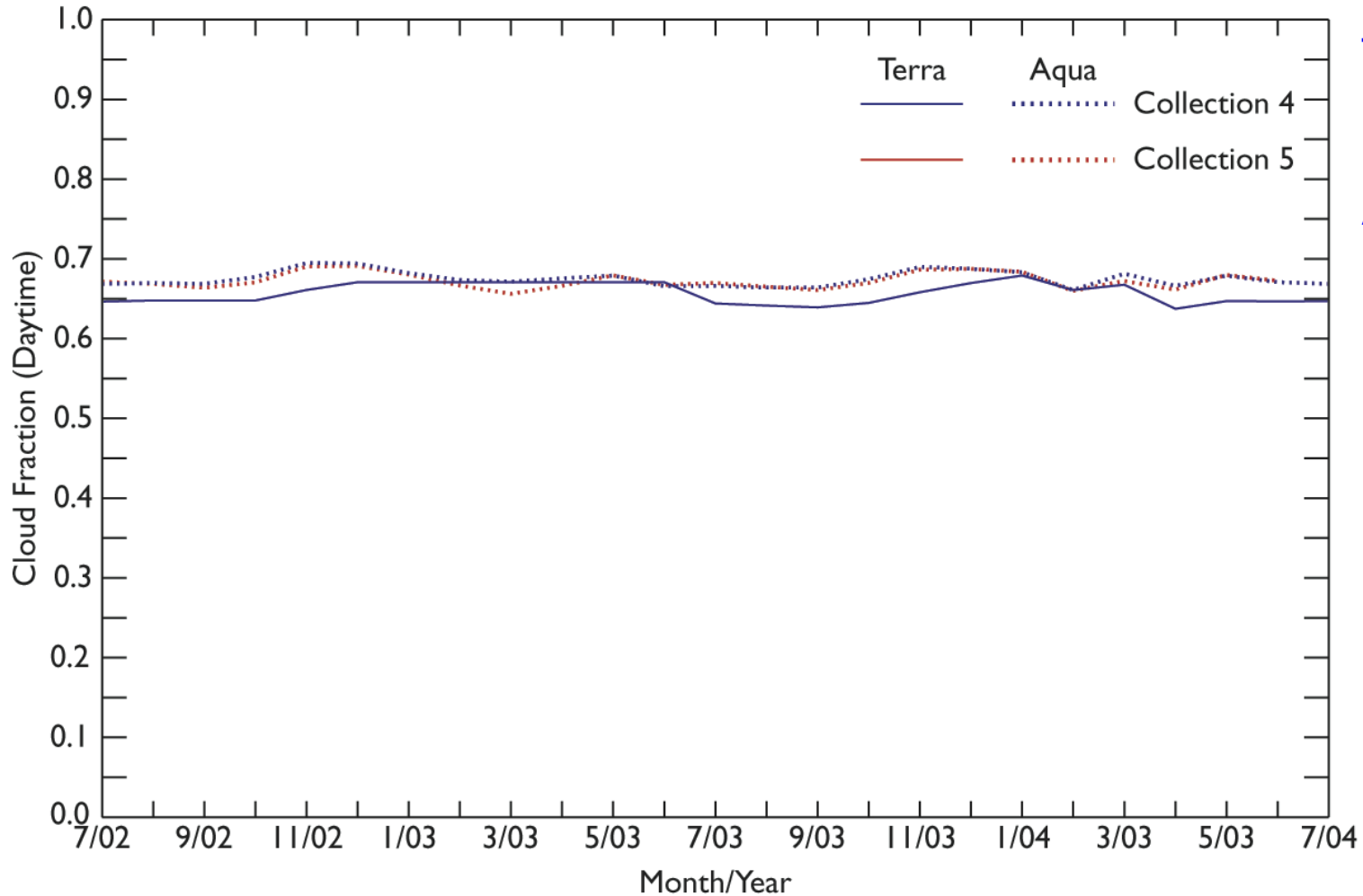


- MODIS (onboard Aqua)
- Monthly Mean Cloud Fraction product (Daytime), April 2005 (Collection 5)

(M. D. King, S. Platnick et al., 2006 – NASA GSFC)



Global products: cloud cover



Terra:
~ 10.30 am

Aqua:
~ 13.30 pm

July 2002 – July 2004

(M. D. King, S. Platnick et al., 2006 – NASA GSFC)



GCOS Switzerland

- Ratification of **Kyoto Protocol** by Swiss Parliament in 2003
→ National Focal Point for GCOS at **Federal Office of Meteorology and Climatology MeteoSwiss**
→ since 1 February 2006: **Swiss GCOS Office**
- **Swiss GCOS Office** = National GCOS Coordination
- Annual **National GCOS Round Table**: Federal Offices, Research Institutions and Universities



→ Ensure the continuation of important long-term measurement series and international data centers as well as foster new measurement techniques and data series

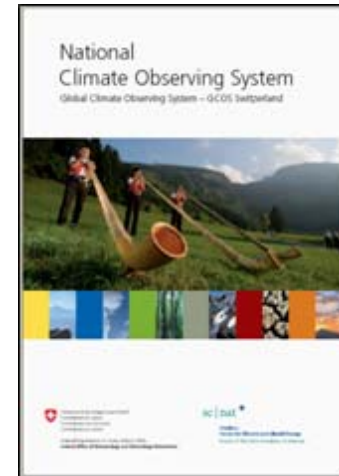


GCOS Switzerland

Report “National Climate Observing System (GCOS Switzerland)” (Seiz and Foppa, 2007)

→ Inventory of

- a) Long-term measurements in Switzerland
 - b) International Data and Calibration Centers
 - c) Support of measurements in other countries
-
- Available in German, French and English
 - Regular update of the inventory online at www.gcos.ch





National Climate Observing System

2.2 Precipitation

Precipitation, together with temperature, is a key indicator of changes in the climate. As long time series are available for precipitation in Switzerland, data can be used to assess the long-term value for the water cycle.

Long time series and their importance
Systematic recording of precipitation in Switzerland began in 1863 with the operation of initially about 70 weather stations equipped with a precipitation gauge. The total number of stations subsequently rose sharply, and by around 1900 precipitation was being measured at 1000 stations. In mountainous areas, the total data represent important additional precipitation information.

3.10 Forest ecosystem

Forests are not only a natural resource – they also fulfil protective and recreational functions. A changing climate affects forests by altering the length of the vegetation period – affect long-term observations.

Long time series and their importance
The LWLF project, involving permanent monitoring and experimental sites, improves our understanding of the impacts of air pollution and climate change. The systematic sampling grid of the Swiss inventory has become less dense over the years. Around 8000 trees were measured in 2007. In addition, the data are being used to assess the impact of climate change on forest ecosystems.

2.1 Air temperature

Temperature is a key indicator of changes in the climate. As long time series of measurements of ground-level temperature in Switzerland are available, dating back to the mid-19th century, long-term trends can be analysed. These analyses provide a sound basis for investigating the contribution of anthropogenic factors to global warming.

Long time series and their importance
At many of the sites chosen in 1863, stations are still in operation today. In the NCRMSO project, for each of Switzerland's twelve major climate regions, a station was selected where measurement data have been collected since at least 1900. These long time series were analysed for artificial discontinuities and trends caused, for example, by station relocation, change of instrumentation and calibration, and homogenized. In order to increase the density of stations, particularly in the Central Alpine region characterised by large differences in altitude, 16 additional stations were selected with time series from at least 1900 (exception: Jungfraujoch only from 1930). These stations of the greatest climatological importance (28 in all) were designated as the Swiss National Basic Climatological Network (NBKN).

Legal basis

Under the Federal Act on Meteorology and Climatology (MetC), the Federal Office for the Environment (FOEN) is responsible for the implementation of the law. They are also to be consulted on meteorological and climatological matters. They are also to be consulted on meteorological and climatological matters. They are also to be consulted on meteorological and climatological matters.

Legal basis

With the partial revision of the Federal Act on Meteorology and Climatology (MetC), the Federal Office for the Environment (FOEN) is responsible for the implementation of the law. They are also to be consulted on meteorological and climatological matters. They are also to be consulted on meteorological and climatological matters.

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Measurements in Switzerland

Air temperature at ground level is now measured by MeteoSwiss at almost 1300 stations. In some cases, these systematic measurements extend as far back as December 1863, when Switzerland's first nationwide meteorological observation network came into operation. Some monthly values are also available as paper records from earlier periods, e.g. for Basel from 1753, Geneva 1768 or Grand St. Bernard (1817). Since 1980, a number of these stations have been automated (ANET2). The roughly 70 ANET2 stations are currently being upgraded in line with the most technological developments, and the other stations in the network are also to be converted to automatic operation by 2012 (SwissMetNet project). Alongside the MeteoSwiss stations, air temperature is also measured at numerous other weather stations by cantonal and communal authorities and private operators.

As well as meeting climatological needs, the MeteoSwiss stations provide services for other user groups, e.g. warning, aviation, weather, and data for civil protection, agriculture and tourism. The network of stations has been continually reviewed on the basis of analyses of requirements (Measurement Concepts 1980 and 2010), and the distribution of stations across the country and various altitudes has been optimized.

At each automatic MeteoSwiss station, values are recorded every 10 minutes and transmitted to the central database in Zurich. The temperature observations are used to calculate hourly, daily, monthly and annual means, together with maxima, minima and numerous other parameters, such as frost days or heat days.

In order to understand changes in atmospheric temperature conditions, soundings are carried out several times a day in addition to ground-based monitoring. Increasingly, these vertical temperature profiles are supplemented by ground- and satellite-based remote sensing measurements and in-situ sensors mounted on commercial aircraft (~2.7 Water report).

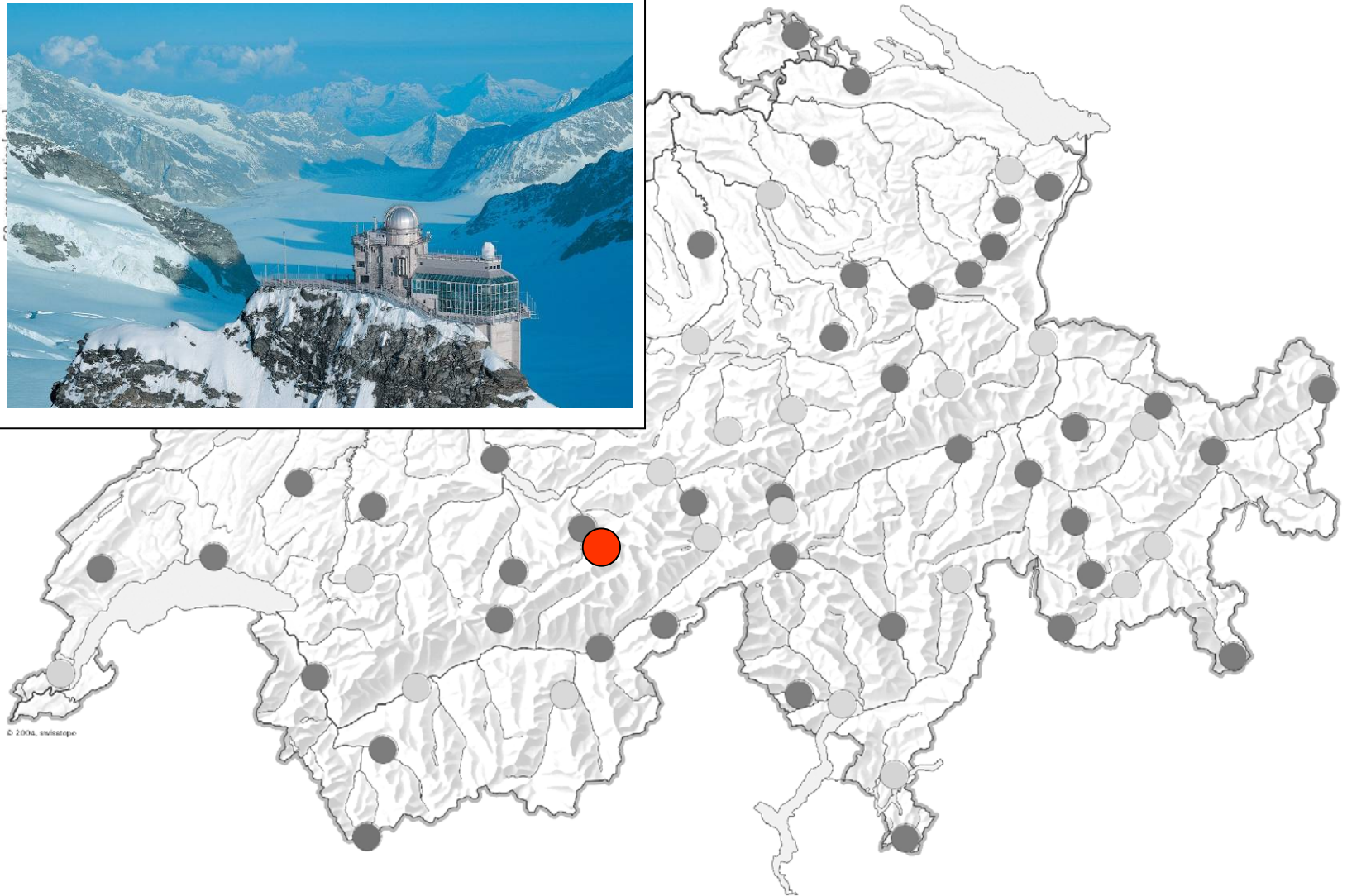
International Integration

Within the GCOS Surface Network (GSN), temperature and precipitation are measured at around 1000 stations worldwide and transmitted on a monthly basis to the GSN Monitoring Centre at the Japanese Meteorological Agency (JMA) in Tokyo (temperature) and the German Meteorological Service (DWD) in Offenbach (precipitation). At about a quarter of the stations, the data are additionally made available on a daily basis. In Switzerland, two NBKN stations were selected as GSN stations – Sion and Grand St. Bernard. Seven NBKN stations (Sion, Grand St. Bernard, Geneva, Sion, Basel, Zurich and Lugano) belong to the Regional Basic Climatological Network (NBKN) of the WMO.

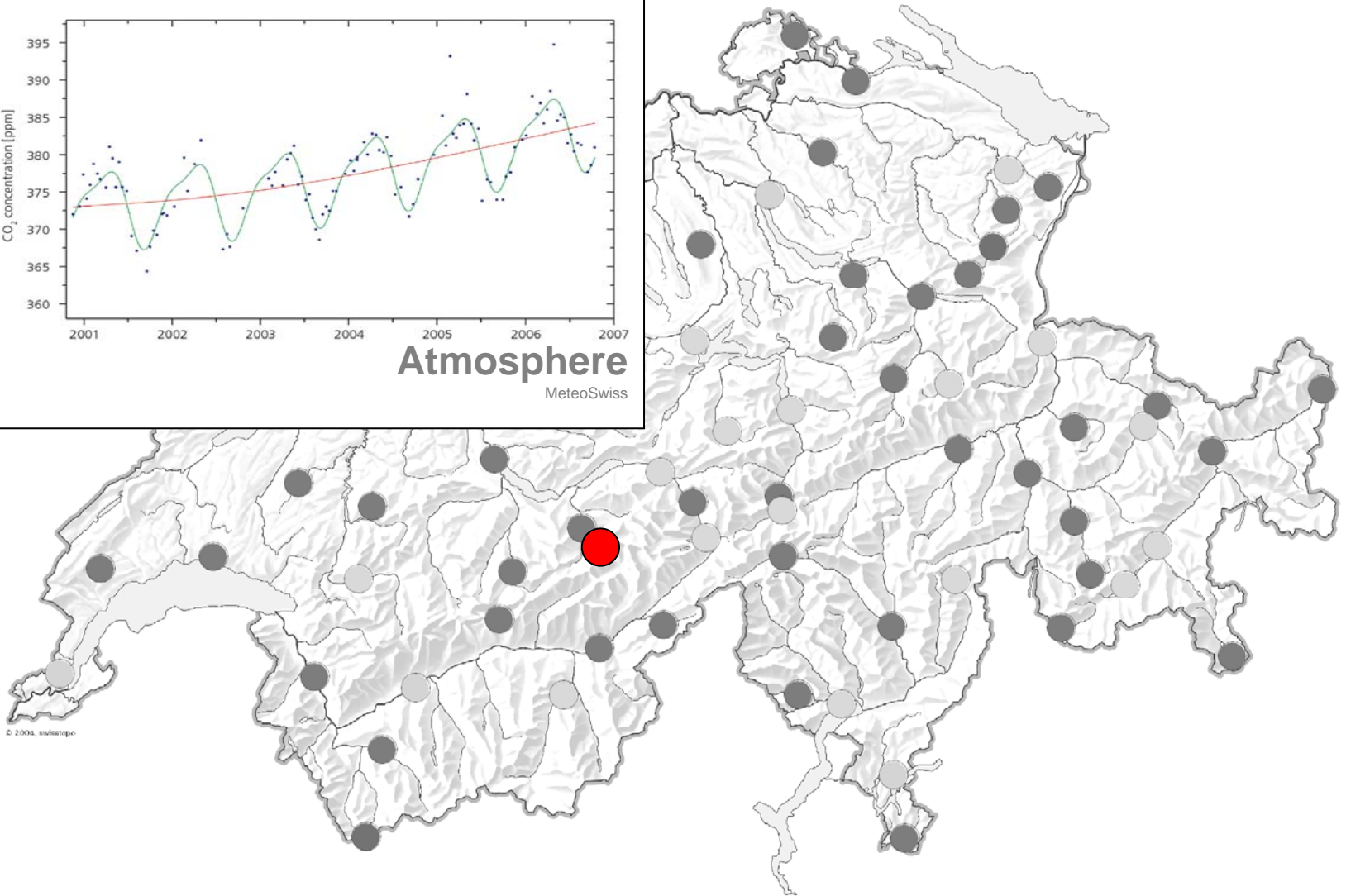
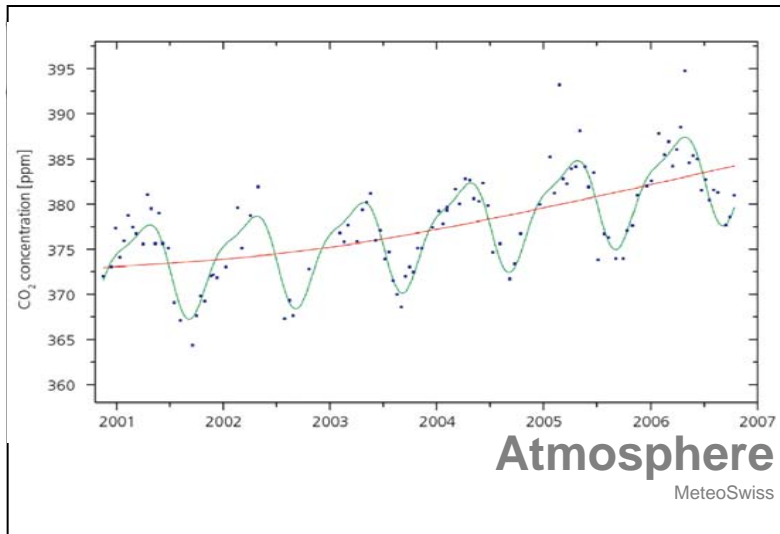
Resources required
Operation of the NBKN stations is assured under the legal mandate of MeteoSwiss. However, in the case of station networks, it has been shown that budgets do not always cover the parallel measurements required for a 3-year period to meet GSN standards. Additional funds need to be set aside for such extraordinary tasks.

- 25 ECVs describing:
- **Atmosphere** (surface, upper air, composition)
 - **Land** (hydrosphere, cryosphere, biosphere)
 - legal basis
 - measurement networks
 - long time series and importance for GCOS
 - international integration
 - assessment of future prospect
 - **International centers**
 - **Measurements outside Switzerland**

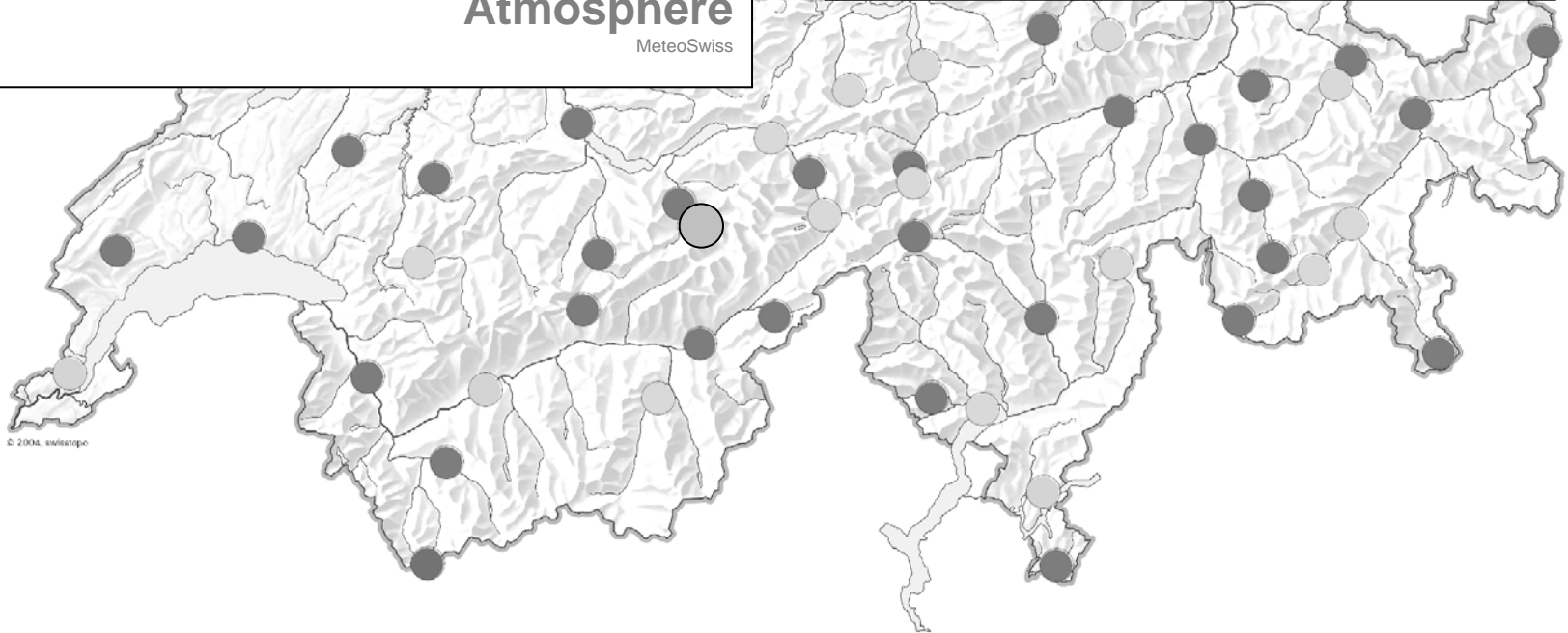
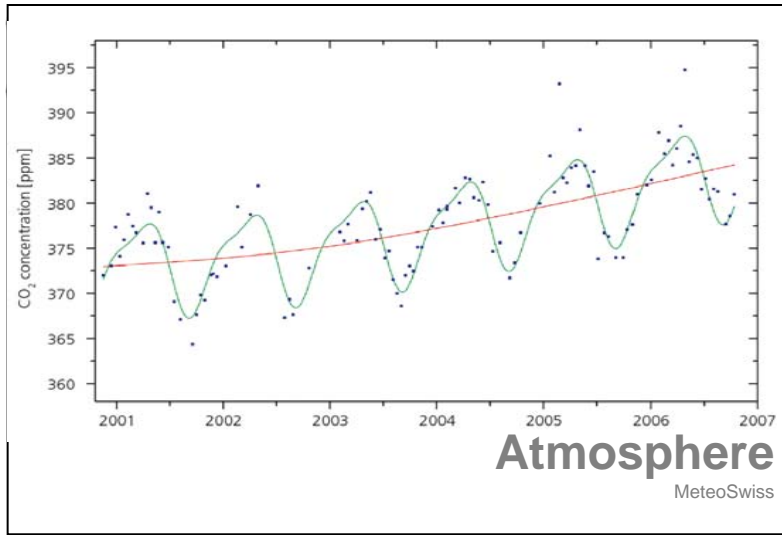


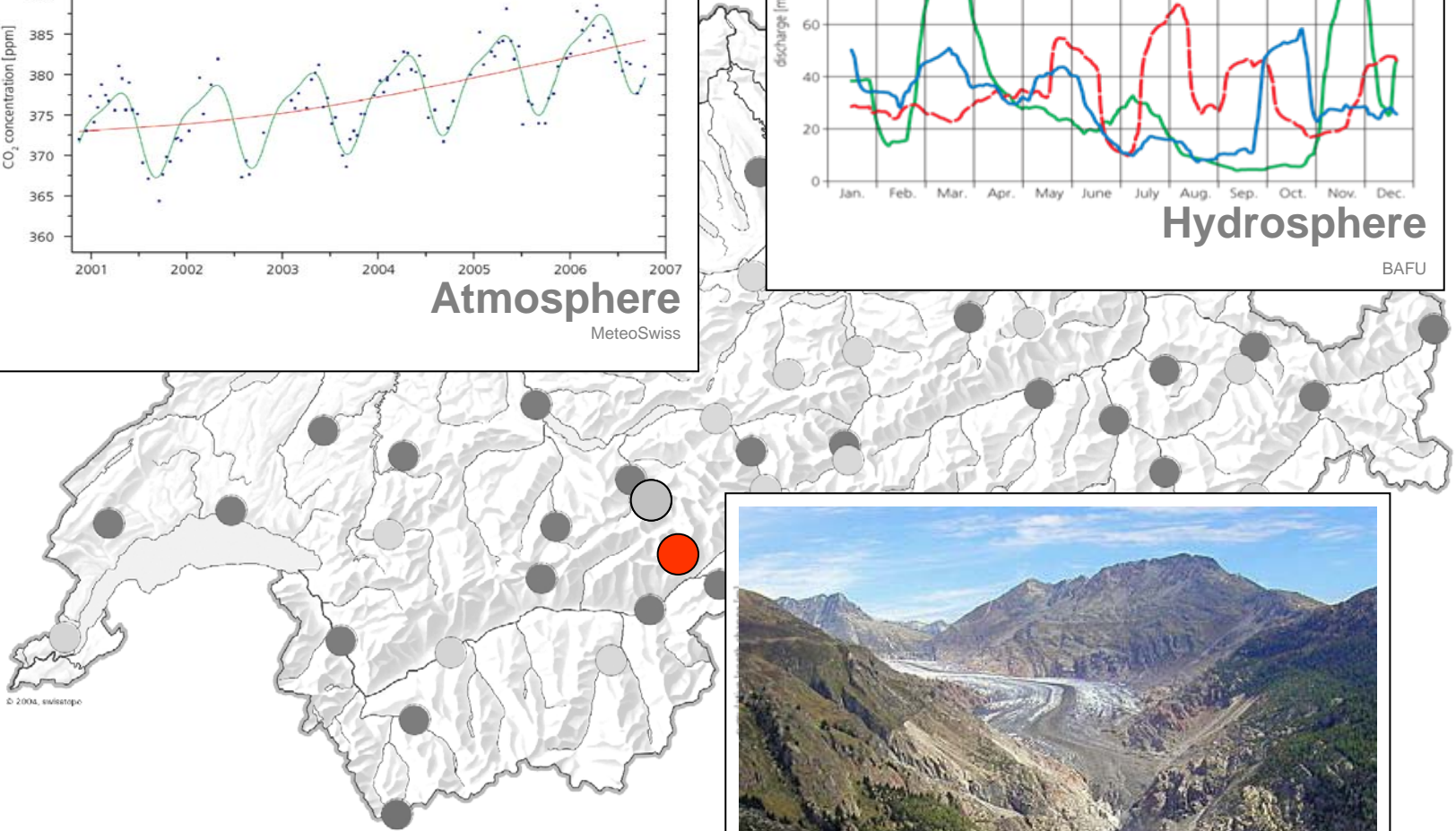
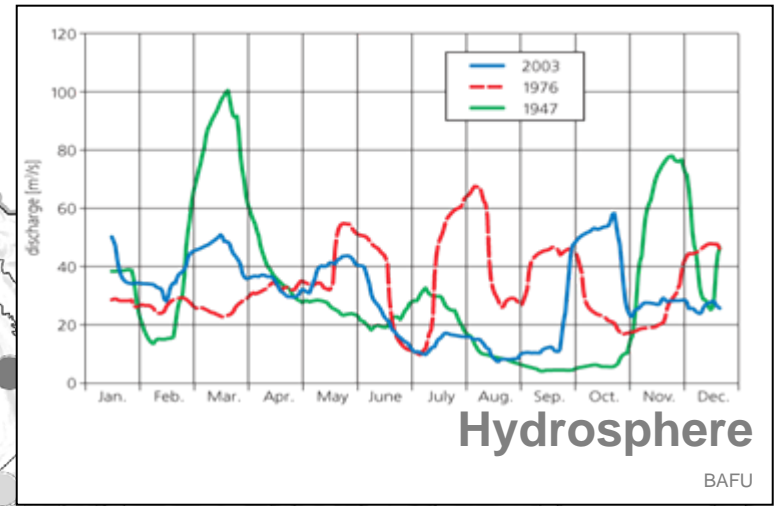
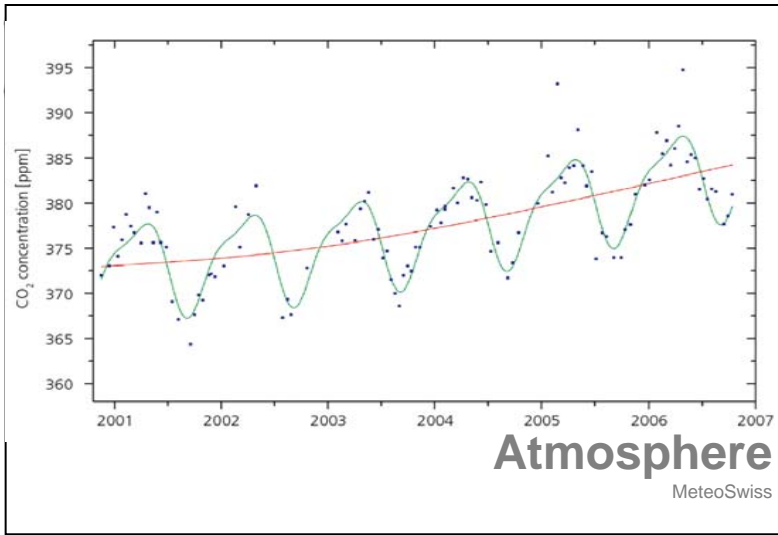


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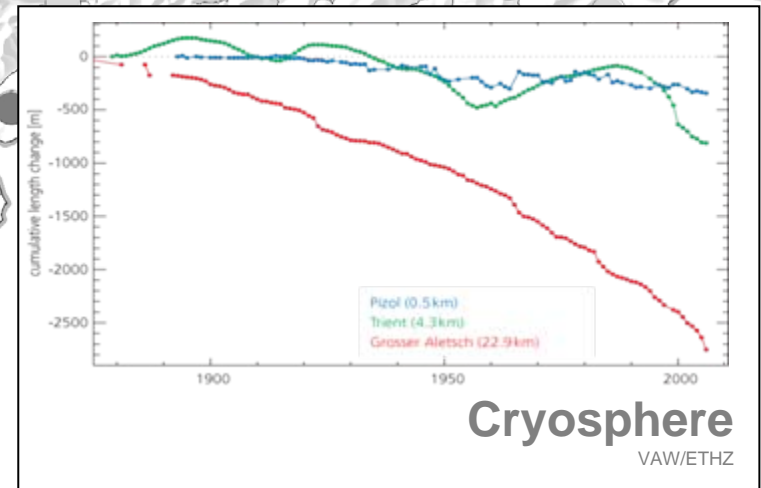
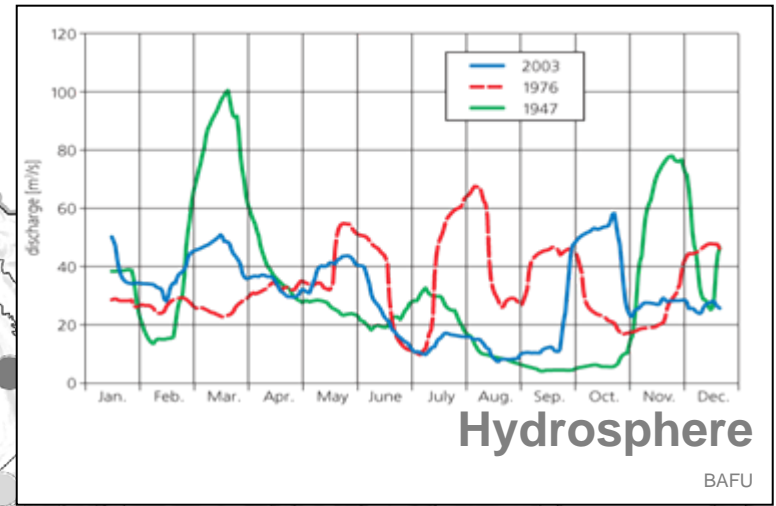
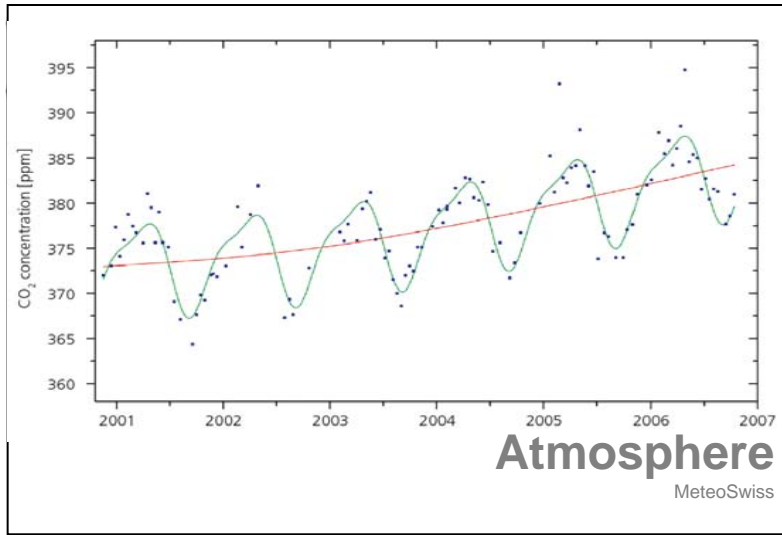


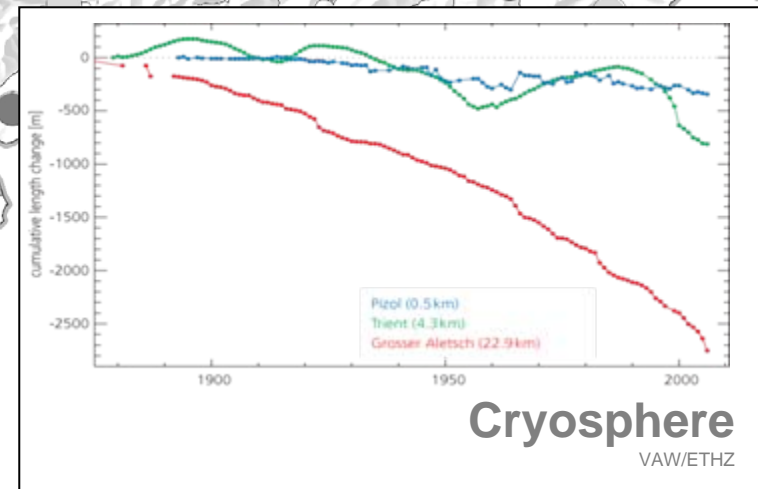
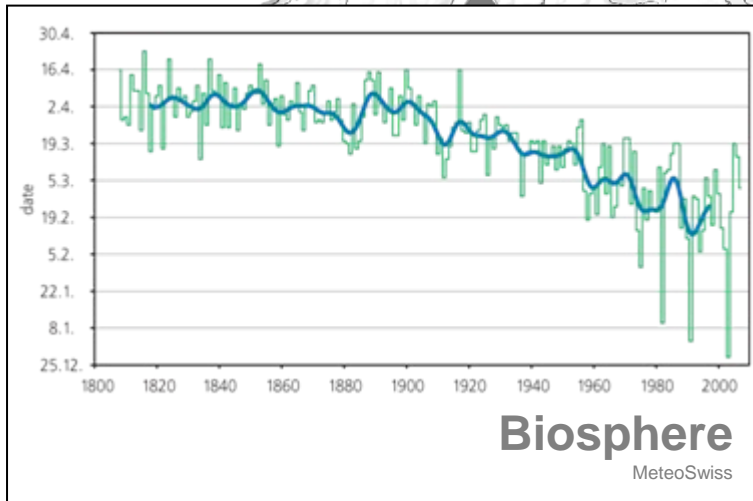
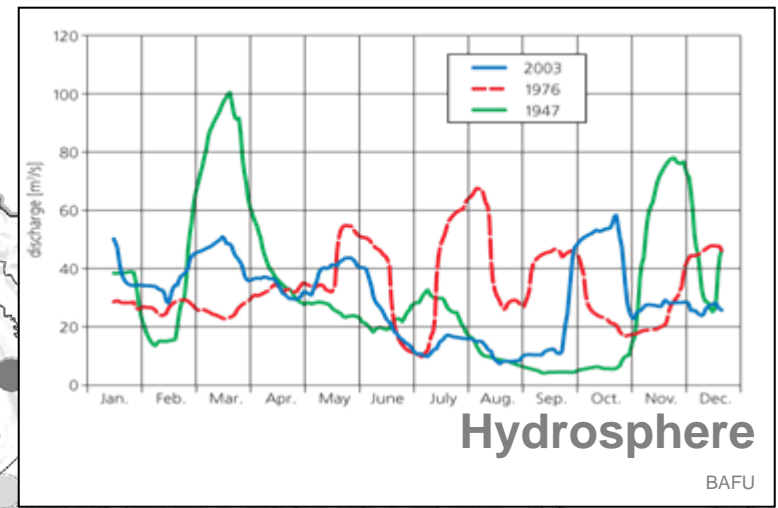
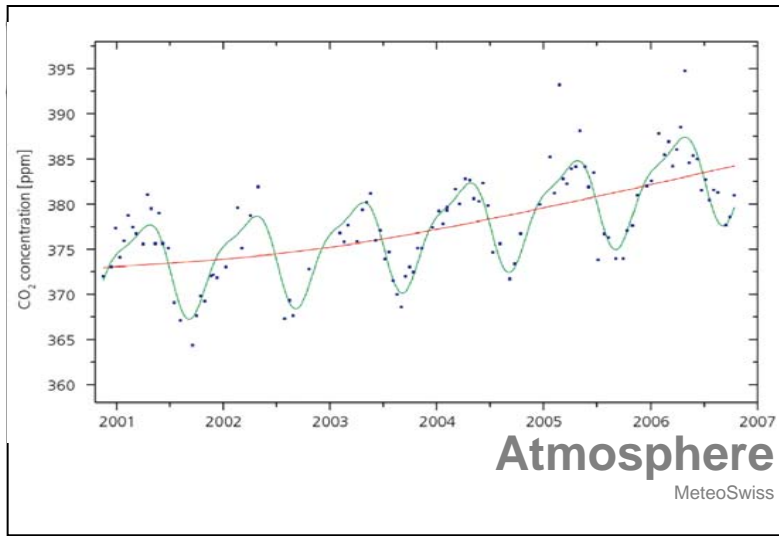
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Role of satellite data within GCOS Switzerland

- Goal: foster use of new measurement techniques within GCOS Switzerland
 - Atmospheric Domain: Radiation, Clouds
 - Terrestrial Domain: Snow cover, Glaciers, Fire Disturbance, Vegetation
- Important: focus on specific issues of mountainous areas

Satellite-based Climate Products for Alpine Studies within the Swiss GCOS Activities

Nando Foppa, André von Asch, Julia Walterspiel, Gabriela Seiz
Swiss GCOS Office, Federal Office of Meteorology and Climatology MeteoSwiss
www.gcoss.ch, gcoss@meteoswiss.ch

The figure is a grid of satellite-based climate products for Alpine studies. It includes several text boxes and charts. The text boxes describe various satellite-based climate products and their applications in the atmospheric, terrestrial, and snow cover domains. The charts show time series plots of various climate variables, such as snow cover extent and glacier area, comparing satellite data with ground-based measurements. The charts are color-coded to match the text boxes they relate to.

GCOS - Global Climate Observing System
Forms an overarching of the climate system, with state-of-the-art long-term systematic observations. GCOS, established in 1992, ensures that the observations necessary to address climate-related issues are defined, obtained and made available to policymakers. Central Climate Variables (CCVs) were defined that have a high impact on the livelihoods of the UN member states and variations on Climate Change (IPCC).

Atmospheric Domain
Satellite data are not equally appropriate for every CCV. Satellite and sensor characteristics such as spatial and temporal resolution, coverage, and stability are key factors to consider when selecting satellite products for climate measurement. The main goal is to provide high-quality satellite products for the atmospheric domain as the following:

Terrestrial Domain
Satellite data are not equally appropriate for every CCV. Satellite and sensor characteristics such as spatial and temporal resolution, coverage, and stability are key factors to consider when selecting satellite products for climate measurement. The main goal is to provide high-quality satellite products for the terrestrial domain as the following:

Snow Cover
Snow cover extent over Europe for the winters 2002/03, 2004/05 and 2007/08 derived from a new satellite snow cover product based on Meteosat SEVIRI data. The values differ in terms of snow cover amount, location and extension.

Glaciers
The glacier outline of 2002 for the entire Alps. The glacier outline of 2002 for the entire Alps.

References
Foppa, N., von Asch, A., Walterspiel, J., Seiz, G. (2008): Satellite-based climate products for Alpine studies. In: *Proceedings of the 10th European Conference on Satellite Meteorology and Climatology*, pp. 1-10.

Acknowledgements
GCOS Level 1 data were obtained from the Level 1 and Atmospheric Archive and Distribution System (AAOS) Web. The glacier figures have kindly provided by Dr. Frank Paul (University of Zurich). The climate data were downloaded from the Global Land Cover Facility (www.landcover.org). The development of the operational MSG snow cover extension chain has been funded under the EC FP6/FP7 Framework.

Foppa et al. (2008), Seiz et al. (2009)



ECV Cloud Properties



Objective:

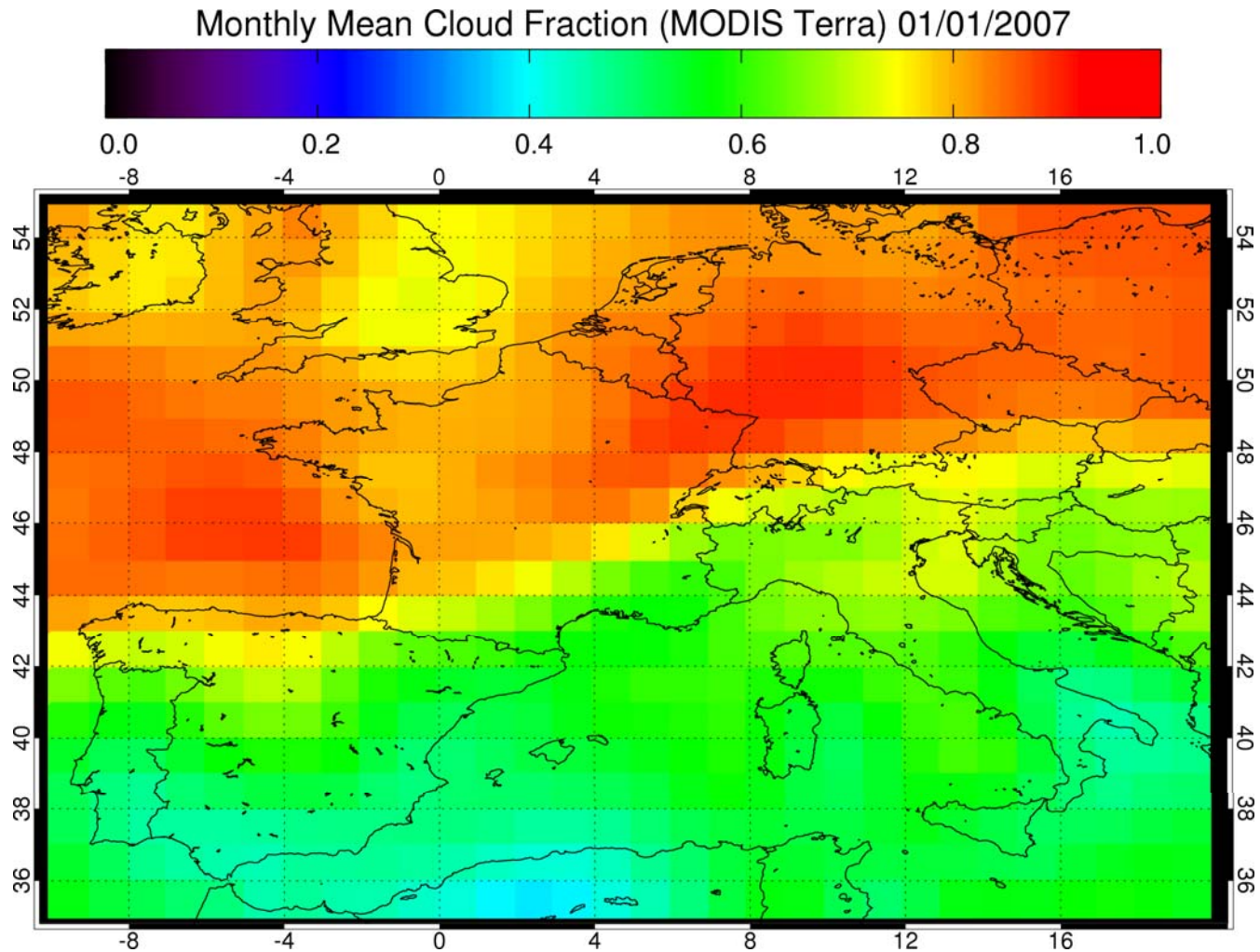
Comparison of satellite-based **cloud cover** from MODIS with other satellite-based products and ground-based measurements and observations

Products/Data:

Cloud Fraction from **MODIS** MOD 08 (Terra), monthly level 3 product, $1^\circ \times 1^\circ$ spatial resolution, period 2000-present



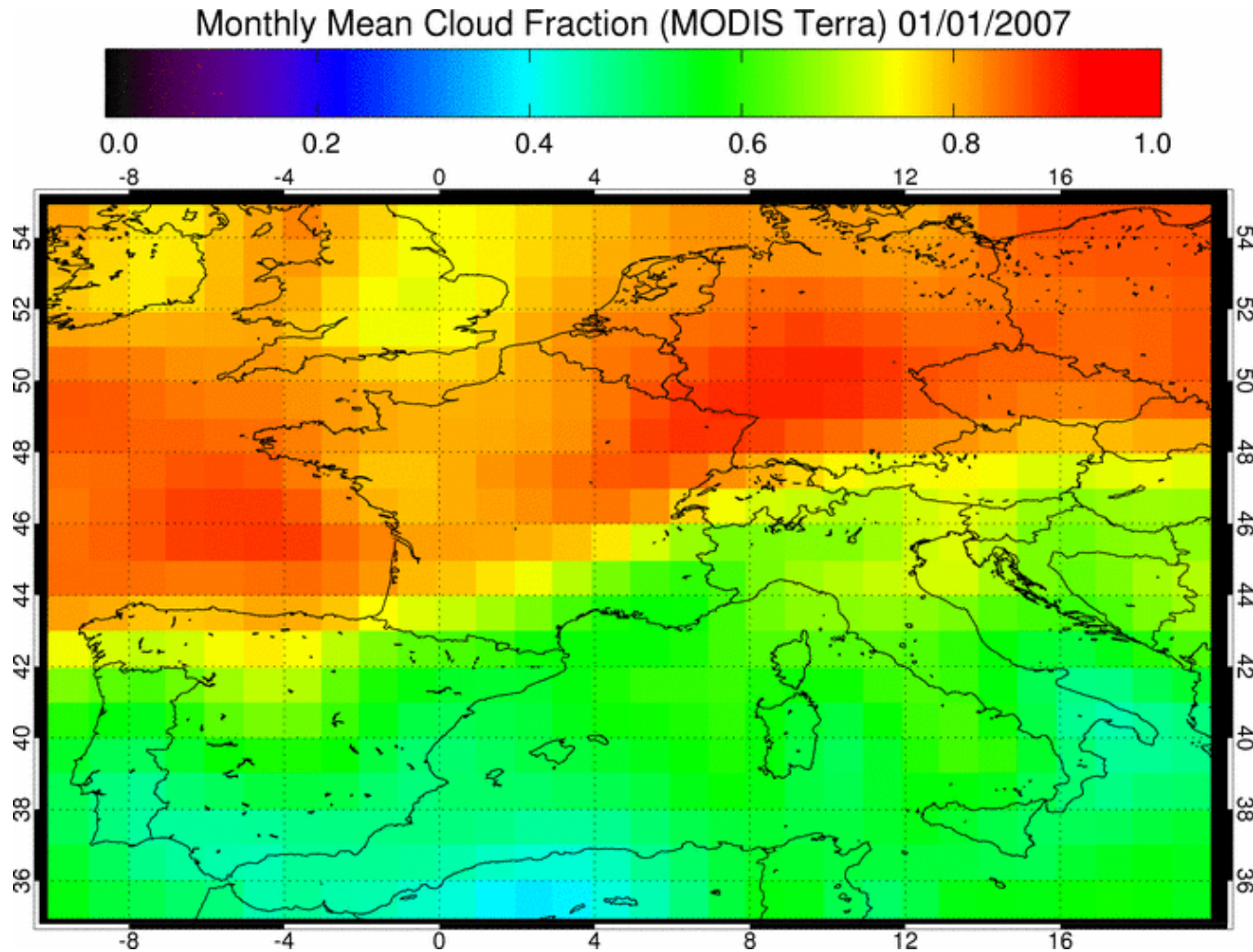
ECV Cloud Properties



MODIS MOD 08, Monthly Mean Cloud Cover, January-December 2007



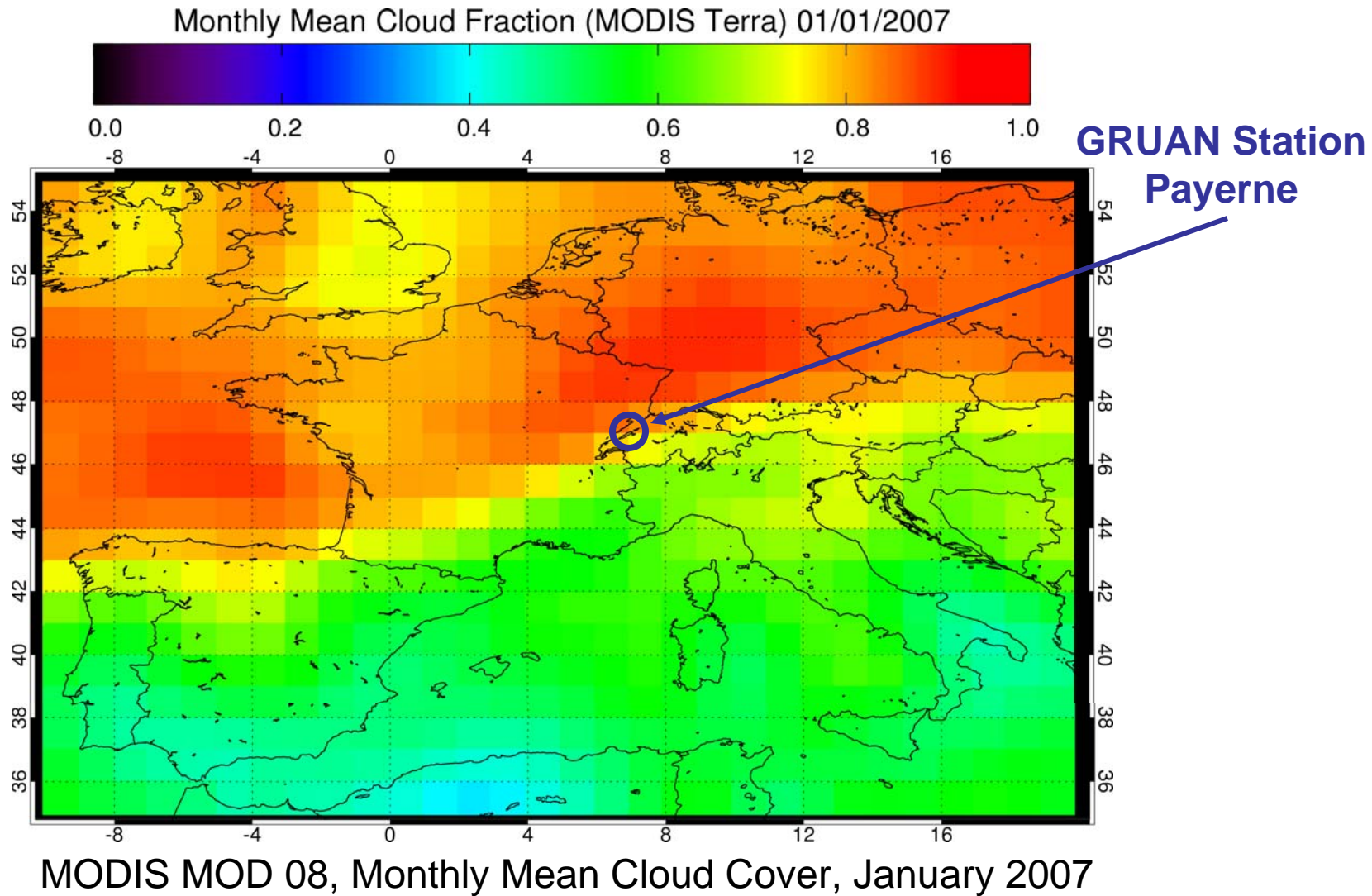
ECV Cloud Properties



MODIS MOD 08, Monthly Mean Cloud Cover, January-December 2007

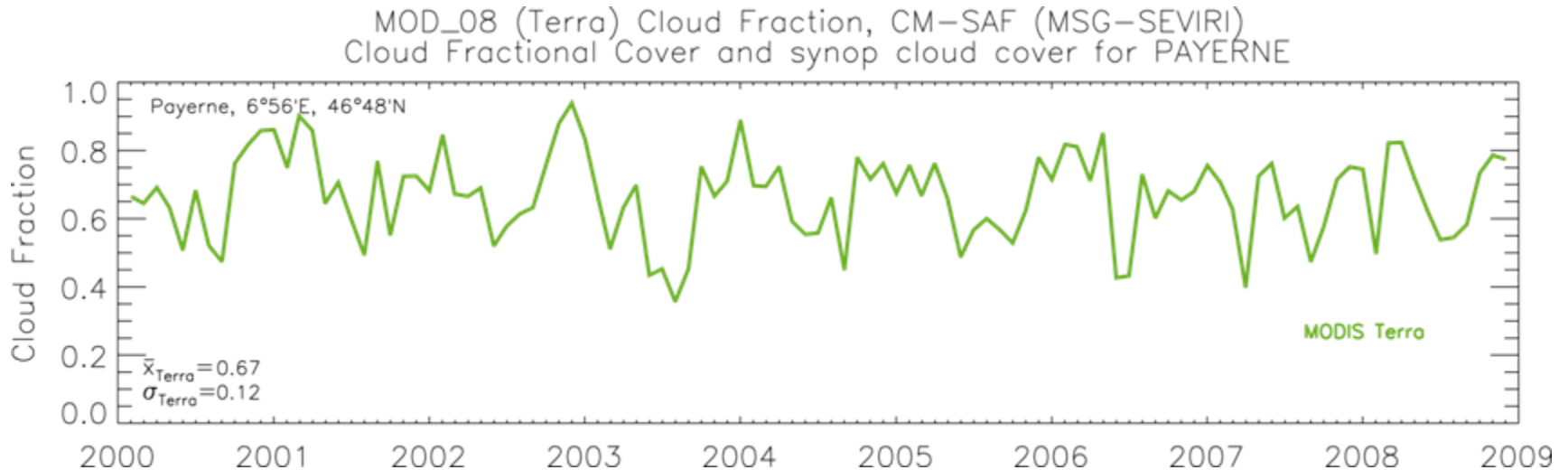


ECV Cloud Properties





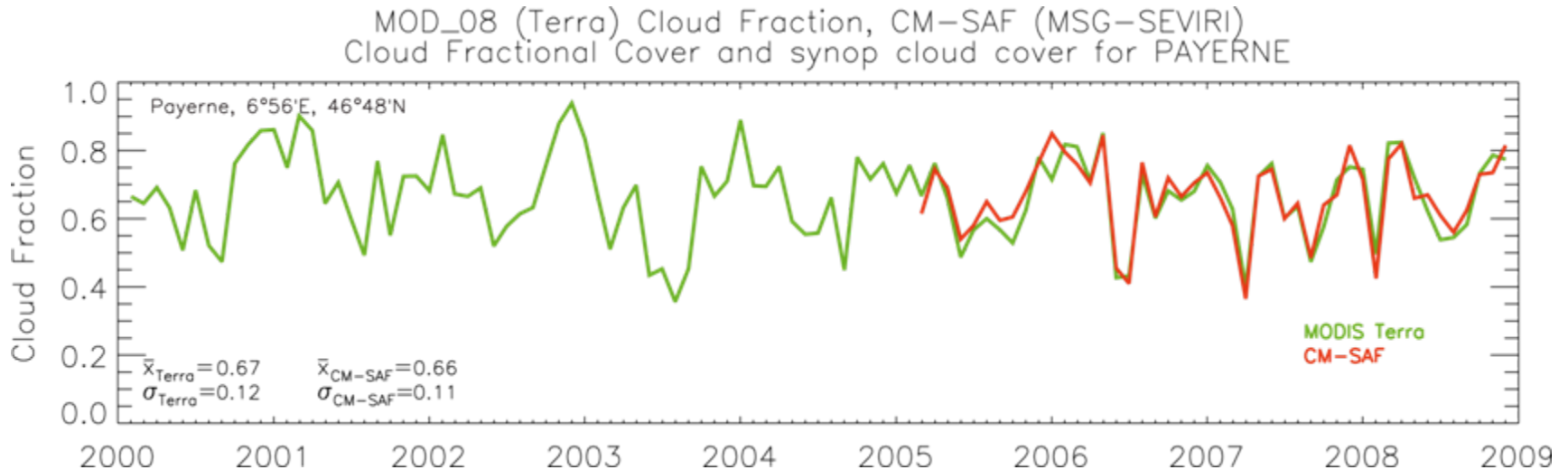
ECV Cloud Properties



- MODIS MOD08 Monthly Mean Cloud Fraction, 2000-2009,
Courtesy: NASA LAADS



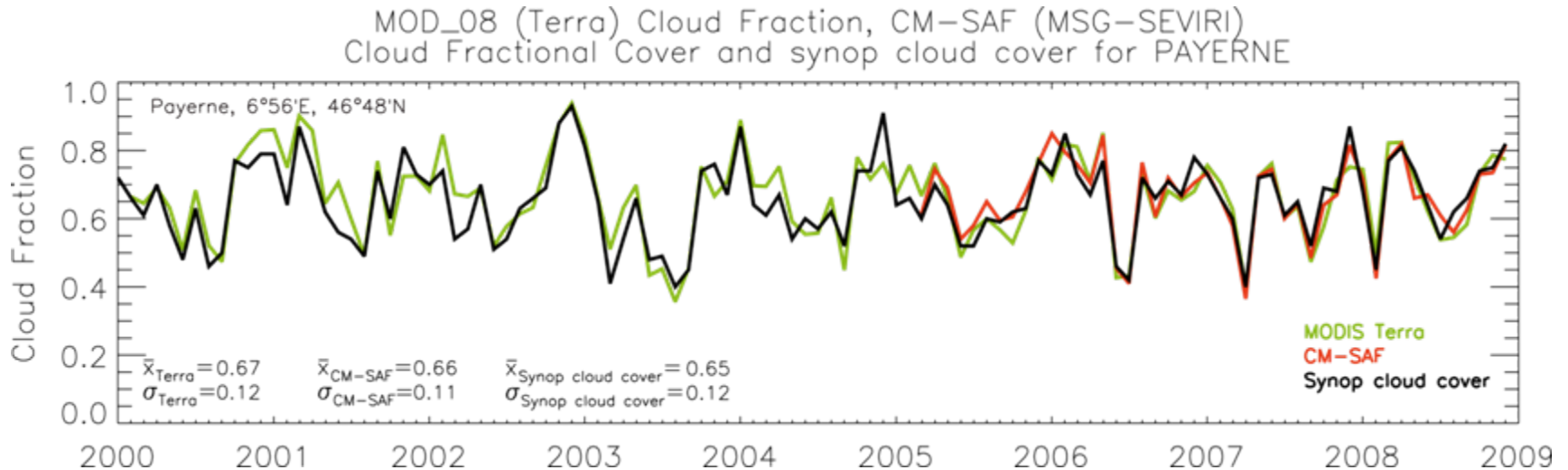
ECV Cloud Properties



- MODIS MOD08 Monthly Mean Cloud Fraction, 2000-2009, Courtesy: NASA LAADS
- CM-SAF Monthly Mean Cloud Fraction (from MSG SEVIRI), 2005-2009, Courtesy: CM-SAF, DWD



ECV Cloud Properties



- MODIS MOD08 Monthly Mean Cloud Fraction, 2000-2009 ,
Courtesy: NASA LAADS
- CM-SAF Monthly Mean Cloud Fraction (from MSG SEVIRI),
2005-2009, Courtesy: CM-SAF, DWD
- Ground-based synop observations, monthly mean, 2000-2009

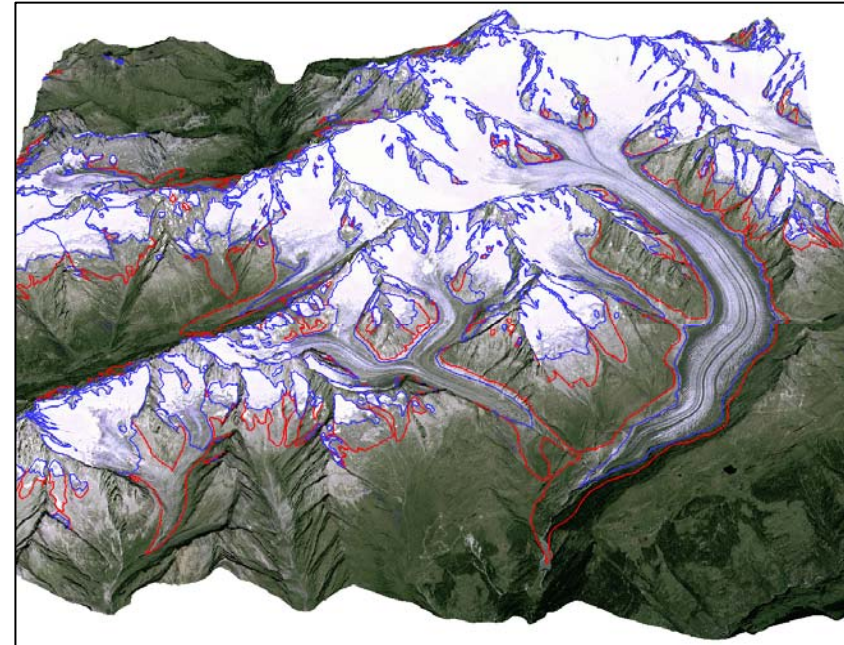


ECV Glaciers



- **Swiss Glacier Inventory**
 - 1850 (red), reconstructed from surveys and aerial photographs
 - 1973 (blue), aerial photographs
 - 2000, satellite-based

→ Paul et al. (2008)



Courtesy: Frank Paul



ECV Glaciers



- **Glacier Inventory worldwide**
 - World Glacier Monitoring Service (WGMS), University of Zurich
 - GLIMS (Global Land Ice Measurements from Space)
- ESA Project GlobGlacier
- ESA CCI ,Glaciers‘



Courtesy: NASA/GSFC/METI/ERSDAC/JAROS,
and U.S./Japan ASTER Science Team



Conclusions and Outlook

- Potential of satellite-based products for climatological analysis over Switzerland
- Limits of current products and sensors, in particular in mountainous terrain and for regional and local scale
- Further analysis of satellite-based products
 - Clouds, Radiation, Ozone, Aerosols, CO₂/CH₄,
 - Lakes, Snow cover, Glaciers, Fire disturbance, Vegetation
 - ESA Climate Change Initiative
 - EUMETSAT SAF CDOP-2
- Use of satellite data for climate services (adaptation, mitigation)



The future ...

«New Earth Observation satellites will complement the established observing systems to provide a more comprehensive integrated Global Climate Observing System for the future.»

John Zillman
Chairman World Climate Conference 3 (WCC-3)
Former Chairman GCOS Steering Committee





Thank you for your attention!



Dr. Gabriela Seiz

Swiss GCOS Office

Federal Office of Meteorology and Climatology MeteoSwiss

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