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Annual Report 2012

Editorial

A deep depression at the turn of the year was followed by the appearance of the first pollen for 2012 during a warm January and the most severe cold front since 1985 in February. The weather was just as changeable as the reform process at MeteoSwiss. With the support of the new Head of Department, Alain Berset, the revision of the law on meteorology was submitted to Parliament. Although Parliament did not review the draft law, our planning work over two years was not lost: central calls for change, such as the liberalisation of data, improved cost transparency and enhanced customer proximity may be pursued further. With its adapted mandate MeteoSwiss continued its reforms and implemented important strategic and organisational measures for renewal in 2012.

Just like 2012, the future will be shaped by change. MeteoSwiss is ready for it.

Daily business operations also underwent many changes. The expansion of the radar network and the automation of the surface observation network progressed very well. National climate scenarios were published for the first time in cooperation with ETH Zurich. We continued to develop our high-resolution COSMO weather forecast model and accepted a new and challenging task by joining the international CLIMANDES development project that was launched recently. The move of the weather service from Zürichberg to the Zurich airport in autumn 2012 introduced major change and began the relocation of the Headquarters that will take place at the beginning of next year. Conditions therefore remain changeable for now – MeteoSwiss is ready.

Christian Plüss
Director General MeteoSwiss

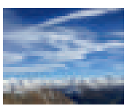
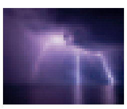

Photo series
Lenticular clouds, cirrostratus and jet trails on a day of foehn in October 2012 above the Weissfluhjoch (photo: Yves-Alain Roulet). Spectacular flashes of lightning illuminate the night sky at the upper end of Lake Geneva on 1 August 2012 (photo: Dean Gill).

Contents

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Rad4Alp stands for the latest radar technology, across-the-board coverage and innovative applications for even more reliable weather warnings.

Urs Germann, Rad4Alp Project Manager
Maurizio Sartori, Radar Engineer and Research Associate

One step ahead of the storm thanks to radar

Weather radar is much more than just a colourful picture. Radar data lies at the heart of a large number of quantitative applications, such as rainfall and flood warning systems. MeteoSwiss developed such a system for a rock fall area in Ticino.

May 15th, 2012 – a date unlikely to be quickly forgotten by the inhabitants of Preonzo in Ticino: in the early morning hours, about 300,000 m^3 of rock broke off the Valegion mountain and crashed down to the valley floor. This was not, however, the end of the threat. Gravel still clinging to the steep mountain slope was threatening to slide down during the next heavy rains and bury the main road and parts of the town. But when can heavy rains be expected in the area above Preonzo?

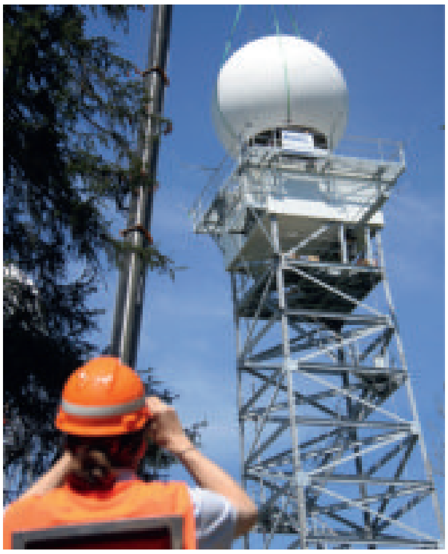
The cantonal authorities contacted the MeteoSwiss experts in Locarno. Together they developed an automatic warning system designed to raise the alarm when heavy rains are likely in this region. Radar data lies at the heart of this warning system.

Much more than just colourful pictures

Swirling, colourful clouds that show where it is raining heavily and which direction the bad weather is moving in – this is the usual picture associated with radar data. However, very few people know what is behind these colourful pictures and to what uses the radar data can be put.

The principle was the same in the 1960s when the first weather radars were installed in Switzerland: a signal is sent out, reflects against a raindrop, and bounces back as an echo. However radar technology has developed at a rapid pace since the 1960s and current radar products are much more complex – thanks to intensive research and innovation, by MeteoSwiss amongst others. In the beginning, radar data was hardly more than colourful pictures allowing specialists to localise pockets of rain, but today there are a large number of quantitative applications for radar data. In addition to rain measurement and weather detection, radar can also be used to collect information on wind fields, the strength of rain clouds and the size of hailstones.

Renewal and expansion of the Swiss radar network are already well advanced. After 18 years of use, the current radar installations are being modernised and two additional installations are planned. The fourth generation of Swiss weather radars is a springboard for another 18 years of innovation and research in the field of radar-based flood and storm warnings.



Precision work *with the construction crane: Renovation of the radar on the Albis mountain in May 2012.*

Life comes to the Plaine Morte: *Construction work on the fourth Swiss weather radar started in the high mountains of the Valais in autumn 2012.*

Radar data has become a permanent fixture in the process of monitoring natural hazards. Because it can be used to predict the short-term development of rainfall patterns, it serves as the basis of warnings for large thunderstorms, heavy rain, flash floods, and floods and is useful when assessing situations and planning interventions in serious cases. Radar data is an important parameter for hydrological discharge forecasts and forms the backbone of sophisticated flood warning systems. The large Löwenstrasse construction site at Zurich's main station uses an automatic system of this type to warn of floods on the Sihl river. Radar-based warning systems are also used in Alpine areas where there is a risk of debris flow or rockslides, such as at the town Preonzo. The "debris flow tool" developed by MeteoSwiss for the Ticino authorities in the aftermath of the Valegion rockslide combines radar data, measurements at ground stations and model forecasts and automatically sends out warnings of heavy rainfall. The authorities are also in regular contact with the weather forecast centre in Locarno-Monti in order to make sure that critical situations can be recognised at an early stage.

Better view in the Alps

The growing number of complex applications requires ever more precise and higher resolution data sets in space and time. MeteoSwiss meets this need by renovating and expanding the Swiss radar network as part of the Rad4Alp project. State-of-the-art instruments have been operational at all three existing radar locations – Monte Lema in Ticino, La Dôle near Geneva and Albis close to Zurich – since 2012. They differentiate between raindrops, snow and hailstones and record their intensity and location in space to exactly one kilometre in a radius of 247 kilometres every 2.5 minutes. By way of comparison, the longest north-south distance in Switzerland is approximately 220 kilometres.

There will be additions to the fourth generation of Swiss weather radars: two new radars will soon be operational in Valais at the Pointe de la Plaine Morte and at Weissfluh in Graubünden. The ground-breaking ceremony for the Plaine Morte radar already took place in autumn 2012. These two new radar stations will improve coverage of the inner Alpine regions. This represents important progress, as natural hazards usually occur more often in mountainous regions. Also, if operation of one of the current radars is interrupted, the new radars can easily bridge the gap. Uninterrupted radar coverage translates into more reliable warning systems and improved protection for the population.

> Radar data has become a permanent fixture in the process of monitoring natural hazards. ”

In Preonzo, the mountain is keeping the authorities and the population in check. Parts of the rock mass have since slid down into the valley, but higher up the next landslide is poised to strike. The radar-based warning tool of MeteoSwiss will therefore remain in operation – for the protection of the people living at the foot of Valegion.

When weather prediction benefits from computer games

Meteorologists use complex computer models to forecast weather developments. In a bid to make sure that forecasts become even more precise in future, MeteoSwiss is constantly improving its COSMO numerical forecast model. Only a supercomputer has the massive computing power that is needed for these calculations.

Colette and her son Colin share a passion for flying – with the flight simulator on their computer. They usually fly to Samedan, preferably when weather conditions are quite challenging.

What does Colette and Colin's hobby have to do with professional weather forecasts? A lot, at least in the immediate future. These two activities are connected by the computer hardware that is used. The games industry is driving the market for graphics cards, which are destined to benefit the field of high performance computing (HPC). In future, supercomputers will increasingly use graphics cards or graphics processing units (GPUs) in addition to their traditional central processing units (CPUs). GPUs can do more calculations per second and have a bigger data bandwidth than CPUs.

New COSMO model in development

This is also of interest to MeteoSwiss. With the continued development of its numerical weather prediction system as part of the COSMO-NexT project that was launched at the beginning of 2012, the future will see a massive increase in the computer resources that are needed. Not only because the new COSMO-1 model with a grid spacing of one kilometre has a substantially higher resolution than the current prediction models, but also because COSMO-NexT will include an ensemble system (COSMO-E) which will make it possible to estimate the uncertainty of a forecast.

Higher resolution, more realistic simulations

Simulations can be improved thanks to the model's higher resolution. Important atmospheric phenomena can be modelled in more detail and the effect of the Earth's surface on weather developments can be observed more closely. The result is higher resolution wind fields, better-structured temperature and humidity fields, and more realistic life cycles for cloud and precipitation systems.

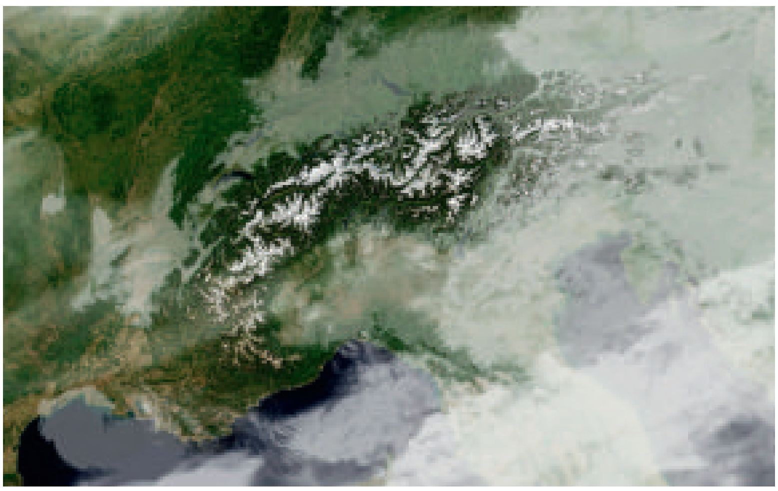
The COSMO-NExT project therefore lays the foundation for more realistic and improved numerical weather prediction. However, as this requires more computing power, MeteoSwiss and its partners are investigating the application of the latest HPC technologies as part of the national HP2C initiative.

Who knows, one day soon Colin and his daughter Cora may also be able to benefit from these technologies by using the GPUs on their computer to calculate the day's weather for the flight to Samedan in real time.

A super computer *as tall as a man in Lugano prepares the weather forecast models of MeteoSwiss.*

Supercomputer in Lugano

The COSMO model is being developed further as part of the international «COnsortium for Small-scale MOdelling» project. In 2012, COSMO's annual general meeting took place in Lugano, the new location of the Swiss National Supercomputing Centre CSCS where the COSMO models of MeteoSwiss are computed.



Higher resolution, more exact forecasts: *The COSMO-1 model can calculate the development of the weather in the Alpine region exactly to one kilometre.*

Well-rehearsed cooperation when facing natural hazards

When the weather becomes a threat, speedy measures are required. To ensure smooth cooperation and coordination, MeteoSwiss and the other federal specialist units for natural hazards regularly simulate worst case scenarios.

"The secondary depression Odin is expected to move eastwards over the north of Switzerland tomorrow morning," says the Weather Operations Director. The tension among the division heads that attend the early morning briefing of MeteoSwiss's operational unit (EO Met) runs high. "Wind speeds of more than 120 kilometres per hour over the plain to the north of the Alps and up to 180 in the Jura and the Alpine foothills can be expected, accompanied by heavy rainfall," the weather service representative describes the situation. A storm warning at the second-highest level has already been sent to the authorities and operational units of the cantons. Should a warning to the Swiss people for distribution via radio and television and a media release also be issued? What other measures are needed?

A high degree of cooperation

The procedure followed by EO Met and the specialist unit for natural hazards, made up of members of the federal natural hazards teams, is the same as that of the managing entities of the cantons and municipalities. The high degree of cooperation makes it possible to react quickly and cope successfully with events involving natural hazards. The federal specialist units – MeteoSuisse, the Federal Office for the Environment (FOEN), the Institute for Snow and Avalanche Research and the Swiss Seismological Service (SED) – are actively involved in the harmonisation of procedures. Warnings comply with uniform standards, including the five-level hazard scale, naming conventions, structure and scale of distribution. Bulletins on natural hazards also follow uniform guidelines or are prepared jointly by the specialist units when a threat requires combined action. Such as with the current EO Met exercise.

A natural hazard seldom occurs in isolation

After the substantial snowfall of the past few days the weather is now changing rapidly. As it is difficult for EO Met to estimate the impact of the serious risk of avalanches in the Alps on the overall situation, a decision is taken to contact the SLF and the FOEN for advice so that a holistic assessment can be made.

But time is up. "We will stop here," decides the Head of EO Met, and asks the participants to discuss the exercise with the instructors of the Federal Office for Civil Protection.

The next storm *is on its way.*

Until the danger is past, *the EO Met keeps a close eye on the weather and discusses any measures that might be needed with the other specialist units for natural hazards.*

Uniform warning regions

On the instructions of the Steering Committee Intervention against Natural Hazards (LAINAT), the federal natural hazards specialist units are standardising their warning regions. This harmonisation is being implemented in a number of different steps. The warning regions of MeteoSwiss and the Institute for Snow and Avalanche Research were defined at the end of October 2012, and will be operational in spring 2013. The country-wide hydrologic warnings issued by the Office for the Environment will need more time for development.

Short articles

At night, flying weather is forecast by SMART

Meteorological observation is absolutely essential to ensure safe flying conditions. Information is made available in coded form by observers at the different airfields, and is then compiled in METARs (Meteorological Aviation Routine Weather Reports). These weather observers have the support of SMART (System for Meteorological Automated Reporting), a software program developed by MeteoSwiss with configurable data capture capability, sensor monitoring and a rule engine that can be updated as needed. This allows the observers to optimise the proposals made by SMART and prepare even more precise METARs.

***Weather information is essential for pilots** and is provided by the Aviation Weather Service. With the SMART software, weather reports can increasingly be generated automatically.*

During the night, outside the operating hours of the aviation meteorological service, weather reports can be automatically generated and sent out using the SMART system. The AUTO METAR has been published at the regional airfields for quite some time. The quality of these reports is already good enough for observers to increasingly refrain from manual intervention during the day while the system is automatically sending out METARs. As part of the AUTO METAR II project, MeteoSwiss uses algorithms and weather rules, logical prioritisation and optimisation to improve SMART to such an extent that autonomous night operations can also be introduced at Geneva airport.

***Federal Councillor Alain Berset** visits the Aviation Weather Service, which was recertified in 2012.*

Certificate for aviation weather service

At the end of the 1990s, the European Union launched a programme to optimise the European airspace called Single European Sky. The objective of this initiative is to restructure air traffic flow by organising the airspace into a limited number of functional blocks. The EU has since issued several directives for air traffic controllers, which also apply to Switzerland.

As the aviation weather service, MeteoSwiss is part of air traffic control in Switzerland. The Federal Office of Civil Aviation (FOCA) carries out regular audits to monitor the implementation of the EU directives. As MeteoSwiss received certification at the end of 2006, its entire service package was due for recertification this year. The audit was performed from August 27th to 30th 2012. This was a special challenge to MeteoSwiss at a time when its operational service was undergoing important changes due to restructuring measures. From this perspective, the result of the audit can be described as quite satisfactory: MeteoSwiss's certificate was renewed for two years.

The climate is changing; and, as it is easier to adjust to change if the processes are understood, they are the subject of our research.

Francesco Isotta, Research Associate Climate Studies
Andreas Fischer, Senior Scientist Climate Forecasts

”

A decade of progress in Swiss climate research

The National Research Programme NCCR Climate, which was finalised in 2012, has sustainably changed the landscape of Swiss climate research over the past 12 years. MeteoSwiss has made a substantial contribution to this process.

As Switzerland cannot escape the effects of climate change, the Swiss National Science Foundation established the National Research Programme NCCR Climate in 2001. As an active partner in this scientific network, MeteoSwiss has made a substantial contribution to a number of research projects and helped Swiss climate researchers to make considerable progress.

In 2001, when the research programme started, Swiss temperatures reached record highs for the first time. At the time, the international research community cautiously attributed the global warming that was observed to anthropogenic causes. At this stage, climatologists at MeteoSwiss focused on the analysis of data sets relative to Switzerland. The homogenisation of data and the climate atlas, a collection of seasonal maps of various climate parameters for the period from 1931 to 1995, took centre stage.

This focus changed with MeteoSwiss' participation in the National Research Programme. Its active participation in NCCR Climate gave MeteoSwiss the opportunity to modernise its applied climate research and to establish itself nationally and internationally as a competent partner in the field of Alpine meteorology and climate research.

Improved assessment of climate risks

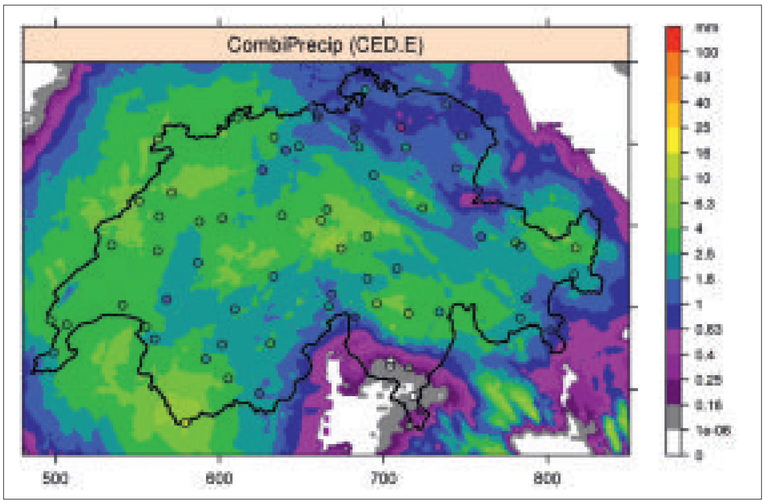
At the beginning of the NCCR programme, interest focused on the development of risk management tools for extreme climate and weather events and for seasonal climate fluctuations. Although it became clear that the quality of seasonal forecasts for Europe was very limited, the systems that were developed have since been successfully implemented in the insurance sector and for weather derivatives in a global context.

To improve the warning system for winter storms such as Lothar, MeteoSwiss developed a new product based on the first probabilistic regional model (COSMO-LEPS) as part of the NCCR Climate programme. Today, the probabilistic maps are used both in operational weather forecasting and in the field of hydrology by the Federal Office for the Environment to issue warnings of heavy precipitation. It will be replaced by an own model system in the coming years.

Scenarios and data

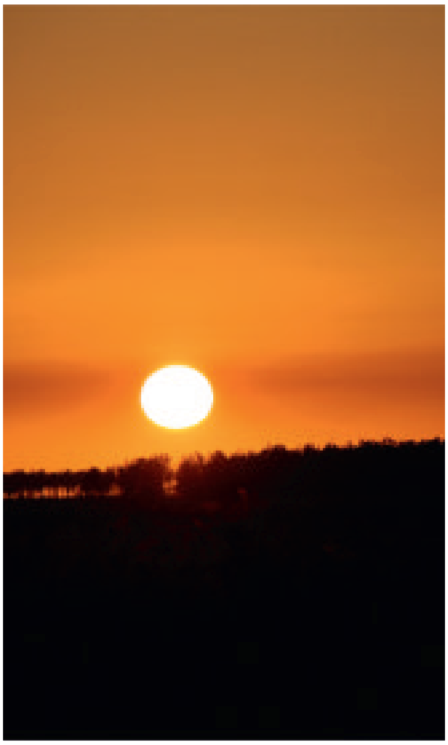
In the course of the NCCR Climate research programme, the MeteoSwiss' focus shifted to the question of how the weather in Switzerland has changed, how it can be expected to change over the coming decades and what effects this could have, for example on the agricultural sector. This resulted in the new CH2011 Swiss Climate Change Scenarios, which were produced in close cooperation with ETH Zurich and C2SM. They serve as the basis for studies on the impact of climate change and are absolutely essential to the Confederation's adjustment strategy.

MeteoSwiss carried out an impact study of this type with the participation of the Agroscope Research Institute. This study shows that, in a future climate scenario, one of the most common fruit pests, the codling moth, is likely to occur in larger numbers and to be active in the orchards for longer periods.



***CombiPrecip, one of many achievements** of the NCCR, uses a combination of radar data and ground measurements to prepare a high-resolution precipitation analysis.*

In addition to scenarios, modern data sets provide the foundation for weather and climate risk management. The preparation of such data sets for mountainous regions represents a special challenge. In the NCCR Climate programme, radar data and ground measurements were combined to develop a product that makes it possible to prepare area-wide, high-resolution precipitation analyses taking into consideration the complex effects of the Alpine environment. Precipitation maps for the entire Alpine region were also prepared as part of a European project.



***What is the impact of global warming** on Switzerland? The NCCR investigated this issue.*

Climate services gain in international importance

The work done as part of the NCCR Climate programme laid the foundation for new, science-based climate services that help customers cope better with weather and climate risks. In this regard, close cooperation with the end users is of central importance. With the launch of the Global Framework for Climate Services GFCS, the World Meteorological Organisation (WMO) underlined the importance of this issue.
At its 2012 Congress, the WMO defined the framework conditions that would make it possible to better meet the demand for climate services at the national level in future.

Taking part in the NCCR MeteoSwiss has made a major contribution to the progress in Swiss climate research. ”

Weather satellites at the service of Switzerland's energy future

The sun provides us with energy every day. But when and where can the sun be used to generate electricity and heat and how much? This information will soon be available from the Solar Map that is being jointly developed by MeteoSwiss, the Swiss Federal Office of Energy and the Federal Office of Topography, swisstopo.

Blue, green, orange, red – every rooftop on the map has a colour, depending on its solar energy potential. But the colourful rectangles hide much more. The Solar Map quantifies the solar potential for every rooftop: meaning the amount of usable sunlight that falls on each rooftop. This figure is provided as an annual as well as a monthly total. The Solar Map also compares the solar energy potential of a rooftop to the other rooftops within the municipality or in the rest of Switzerland. This map helps municipalities and cantons, operators of solar plants, architects and private homeowners to take decisions and plan their solar projects.

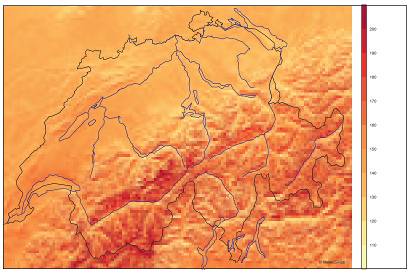
Global radiation and surface model

The amount of usable solar radiation varies according to the seasons and cloud cover as well as the tilt and exposure of the rooftop. We therefore need to know not only how much solar radiation reaches the surface of the earth, but also its composition. To calculate solar potential the global radiation data of MeteoSwiss is combined with the building surface models of swisstopo.

Calculation from satellite data

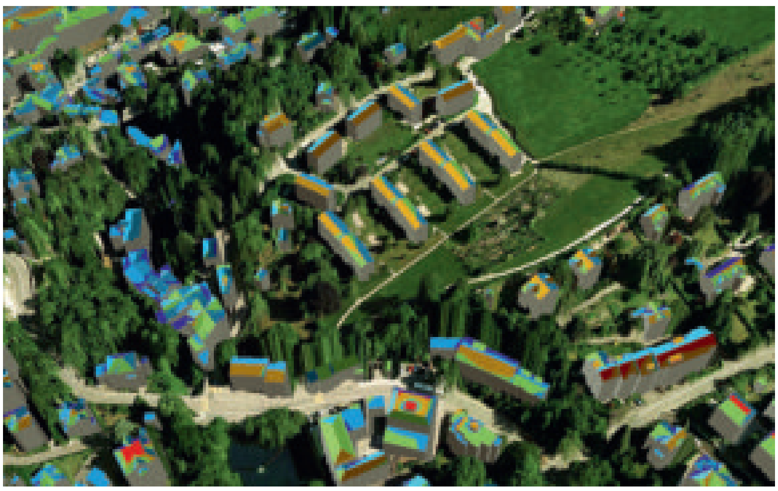
Global radiation climatology at MeteoSwiss provides high-resolution data sets in space and time on solar radiation at any place in Switzerland over months and years, from 1983 to today. Global radiation is calculated by combining satellite-based data on cloud cover and a model of a cloudless sky. The effects of snow, cloud cover and the Alpine topography are also taken into consideration. The values calculated from the satellite data are checked and corrected if necessary against measurements taken at ground stations, which are very precise for the locations in question. The analyses of MeteoSwiss also include other radiation components necessary for the optimal configuration of a solar plant.

MeteoSwiss, with its climate expertise, makes an important contribution to the Solar Map ordered by the Federal Council.



***The global Solar Map** shows the potential for generating solar energy in Switzerland.*

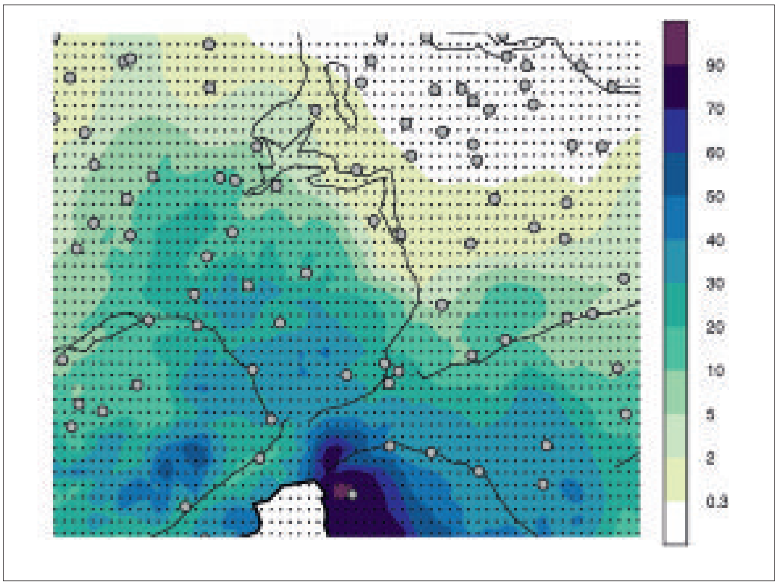
The Solar Map will be published as a pure solar map on the Confederation's map viewer in 2013. The map will be progressively upgraded until 2016 to include all data down to rooftop level. You will then be able to see if your own rooftop is blue, green, orange or a true red.



***This map shows where the installation** of a solar plant would be worthwhile. Whether a rooftop is red or blue, i.e. well or poorly suited, also depends on the pitch of the roof.*

A digital history of Swiss weather

What is the water inflow for the reservoir? What level will the river rise to in extreme conditions? Is the regional climate suitable for the cultivation of a specific crop? Quantitative weather and climate data provides a central planning tool for the energy industry, flood control, and the agricultural sector. New data products by MeteoSwiss deliver this information for all of Switzerland.



Gridded data provides across-the-board information, *for example on precipitation, even for locations where there are no surface observation stations.*

Weather parameters such as temperature, precipitation, and hours of sunshine are captured without interruption at more than 130 MeteoSwiss surface observation stations. Many planning tasks, however, require nationwide weather data or weather data for locations without observation stations, often going back for several decades.

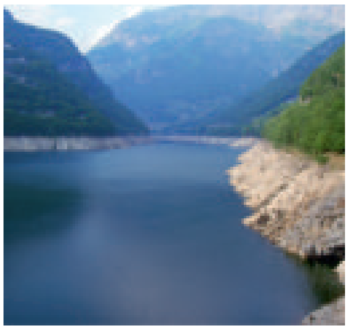
Weather and climate at 13,000 grid points

MeteoSwiss has been working to provide inclusive and comprehensive long-term temperature, precipitation and sunshine duration data for all of Switzerland since 2006. The spatial distribution of the data was calculated on a grid with a uniform spacing of two kilometres. Currently, this gridded data is available for all three parameters for every single day since 1961 and is constantly updated.

Gridded data provides a kind of digital history of the weather in Switzerland. The data depicts the development and distribution of weather patterns – on a daily basis for the last 50 years or so. The records refer to warm weather in the Alpine foothills on foehn days, heavy rains in Ticino when the wind blows from the south and a lack of sunshine in the Mittelland on days with low stratus clouds. The high spatial resolution data adds substantial value to many applications, as it makes the complex interpolation of station data and the difficult selection of suitable observation stations superfluous.

The Alpine climate is a tough nut to crack

The mountainous landscape and complex weather patterns in Switzerland vary much more than in other countries and present a great challenge when it comes to the preparation of gridded data, and MeteoSwiss has had to develop a tailor-made statistical process that takes into consideration the landscape and unique weather phenomena when interpolating station data.



The water inflow for a reservoir *can be calculated from gridded data.*

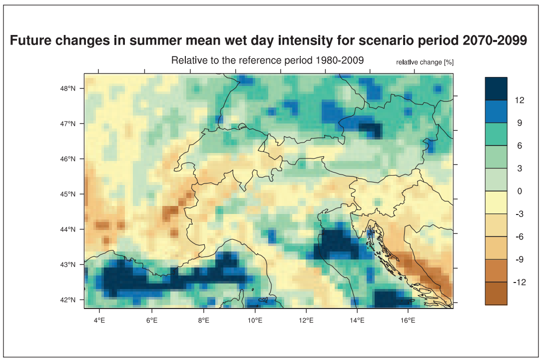
Depending on the data product and the measured values, the process also incorporates satellite or radar data.

The development of gridded data and its use in climate monitoring to estimate climate change and its consequences also form part of international research projects in which MeteoSwiss actively participates. For the EU research project EURO4M, the climate experts at MeteoSwiss compile gridded precipitation data for the entire Alpine region, which is then used to research the frequency of intensive precipitation over the past few decades.

Short articles

Scientific network for climate research

The Centre for Climate Systems Modelling C2SM is a scientific network established by the Swiss Federal Institute of Technology Zurich (ETH Zurich), MeteoSwiss and the Swiss Federal Laboratories for Materials Science and Technology (Empa). Founded in 2008, C2SM's aim is to promote and coordinate the development and application of climate models. As a founding member, MeteoSwiss is represented on the Steering Committee and involved in various research activities, such as the HP2C project which is revising the computer code of COSMO, the numerical weather model of MeteoSwiss, to get it ready for the next generation of high performance computers (page 9). MeteoSwiss and C2SM also recently published the latest CH2011 Swiss Climate Change Scenarios, which are now available to the Confederation, the business world and the Swiss people.



Climate models are the focus of C2SM, *a scientific network co-founded by MeteoSwiss.*

In 2012, the CHIRP II research project started at the ETH, with the goal of improving the modelling of the current and future water cycle. Along with the ETH, a doctoral student is investigating the COSMO weather model at MeteoSwiss to find out how this model can simulate events such as thunderstorms, hoping that it will soon be possible to more accurately forecast precipitation throughout the course of the day.

At C2SM, MeteoSwiss is also sponsoring a dissertation on how to improve the details of climate change scenarios for Switzerland. These climate scenarios use high-resolution data sets in space and time to improve the quantification of the effects of climate change.

The big February cold front

February 2012 saw the most extreme cold front of the past 27 years. MeteoSwiss measured an average temperature of –9.9 degrees Celsius for this cold spell lasting from February 1st to 14th at the Zurich-Fluntern observation station. This makes it one of the ten coldest two-week periods in Zurich since measurements began to be recorded in 1864. And it was actually the second coldest period since the middle of the 20th century – the average temperature over 14 days was only lower during the cold spell of January 1985.

Apart from 1985, the most extreme cold fronts were experienced in 1879, 1929, 1956, and 1963. They usually occurred in January and February, except for the massive cold front in December 1879. And nature at that time knew no mercy, because only two months later Switzerland was engulfed by another intensive cold spell.

If we look at the pattern since the recording of measurements began, it is clear that cold spells lasting for more than two weeks have become rarer over the past 150 years. During the past four decades in particular, they have come along appreciably less than before. The strong rise in winter temperatures in Switzerland falls into the same time span.

A cold front like the one in 2012 *has not been seen for 27 years. Near Lake Geneva, the freezing spray covered cars with a thick layer of ice.*

Every ten minutes we know what the weather is like at some 120 locations in Switzerland – thanks to automated observation stations.

Antoine Vessaz, Research Assistant Measurement Technology

In the past, observers noted the details of the weather by hand, several times a day, but today this process is mostly automatic. With the automation, modernisation, and expansion of the surface observation network as part of the SwissMetNet project launched in 2003, MeteoSwiss is meeting the growing demand for comprehensive, realtime weather data. SwissMetNet will be completed in 2014/2015.

Automation is in the air

In a world where we want everything and we want it now, meteorological data is no exception. Clients' needs tend also to be about data being available everywhere and in real time. MeteoSwiss has taken up this challenge by automating its measurement networks as part of the SwissMetNet project. In 2012, around 30 measurement sites have thus been renovated.

MeteoSwiss has now been taking weather measurements for over 150 years. Some measurement series date back to 1840, when human observers were responsible for monitoring the principal meteorological parameters several times a day, every day of the year. Even today, some MeteoSwiss weather stations still work this way. But finding people who are prepared to carry out this restrictive task is becoming increasingly difficult. Moreover, there is an ever-increasing demand for meteorological data to be available in realtime. These two reasons are driving meteorological services to automate some of their measurement sites.

The three-pronged approach of SwissMetNet

Begun in 2004, the construction of SwissMetNet uses a three-pronged approach: standardisation, densification, and automation. Firstly, there is the modernisation of the original automatic stations, thereby standardising the infrastructure. Secondly, new stations complement the original ones to expand the network and meet clients' new needs. For example, this denser network of stations allows coverage of a total of 152 warning regions which can raise the alarm should dangerous meteorological phenomena occur on Swiss territory. Finally, the numerous sites with human observers are automated, meaning that a greater number of parameters can be measured and with improved temporal resolution: automatic measurements are taken every 10 minutes, as opposed to three manual measurements a day.

Researching sites is a challenge

The main challenge in switching to automatic weather stations is ensuring the continuity of the measurements to sustain the long series of current data. The continuity and homogeneity of data sets are two factors which are crucial to the quality of climate services. The fixed framework conditions restrict the choice of where to site

***Station automation** must be done manually, but then the measurements are taken automatically.*

a new station, which must be close to the manual station in order to be able to homogenise the data.

However, it is normally inevitable that stations must be re-sited, as the infrastructure changes from a conventional shelter with a wind mast and manual rain gauge to a measuring site requiring a greater surface area. The selection of a new site also has to take into account the criteria established by the standards of the World Meteorological Organisation (WMO). The Leroy classification, for example, allows a site to be classified in terms of the environmental influences on the measurements. The work involved in researching suitable sites is therefore a critical step in designing a new network.

Every drop of water counts

Precipitation is undoubtedly the meteorological parameter with the greatest spatial and temporal variability and its quantification is crucial to the management of water resources, so MeteoSwiss also operates a network of manual precipitation measurements. Within the context of SwissMetNet, the stations in this network are currently undergoing automation thanks to a new generation of automatic rain gauges that work on the basis of weight.

Every drop of water, hailstones or snowflakes that fall into the receptacle is weighed by high-precision scales and converted into a quantity of water. Like the meteorological stations themselves, the automation of rain gauges allows the collection of high temporal resolution data. Since 2010, this type of station has been installed in the canton of Valais as part of a project involving cantonal institutions responsible for monitoring natural hazards.

Millions of data collected

At the end of 2012, the automatic SwissMetNet network comprised some 120 complete weather stations and 25 precipitation stations. By the end of the project, in 2014, no less than 150 complete stations and 90 precipitation stations will have been constructed. All these stations will be linked to the same acquisition and data communication platform, which uses the mobile phone network as well as satellite and fibre optics, allowing centralised management of the network.

The main challenge in renovating weather stations is ensuring the continuity of measurements.

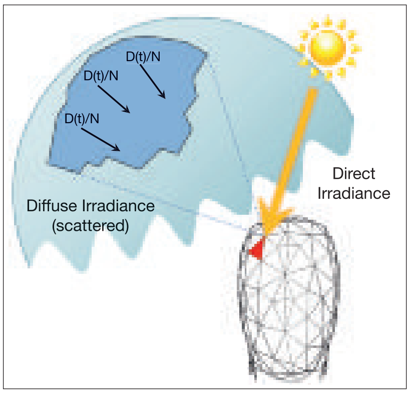
The millions of meteorological data collected annually, monitored and ultimately used in products mean that clients' current and future needs can be met effectively, offering a fast, cost-effective and high-quality service. Thanks to its new network, MeteoSwiss is adding its own building block to the WMO's global framework of climate services.

***The weather can be measured** with automatic observation stations in even the most remote regions in the Alps.*

UV exposure modelled from head to toe

Without the sun there would be no life. But too much ultraviolet (UV) radiation is harmful. Determining the UV dose received by the population is very important for public health. MeteoSwiss takes up the challenge.

"Everything is poison, nothing is without poison; only the dose makes that a thing is no poison." Paracelsus could easily be describing the complexity of UV radiation's effect on human health. At low doses, it prevents vitamin D deficiency, but it is estimated that 50–90 per cent of skin cancers are caused by excessive exposure.



***The level of scattered radiation** contributes substantially to UV radiation.*

How do you know how much UV you have been exposed to if you work outdoors or if you do outdoor sports?

Modelling a complex reality

UV measurements are usually taken on a flat surface. The reality is much more complex, however, with the many possible orientations of body parts and the differences between those parts exposed to the sun and those in the shade. It is possible to use dosimeters attached to people's bodies, but such studies are expensive and difficult to extrapolate.

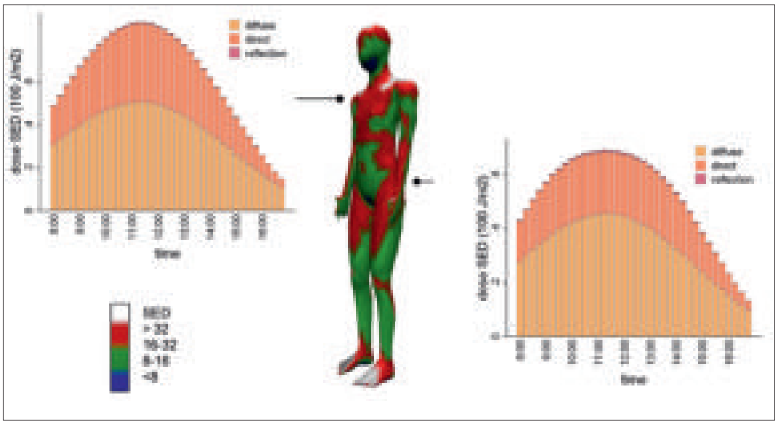
At some of its stations, MeteoSwiss measures both the UV radiation coming directly from the sun, and diffuse radiation from the sky. The latter is important because, even in good weather, it represents about half the total UV radiation.

A collaborative project between the Institute for Work and Health, MeteoSwiss, IT specialists from the University of Geneva and the University Hospital of Lausanne was established in order to integrate the data into a model employing light rendering techniques developed for animation.

Diffuse UV is underestimated

This model allows UV dose measures taken on a virtual mannequin to be converted. The results from the virtual mannequin were compared with measurements taken in parallel by dosimeters on a real mannequin and an equivalent level of accuracy was shown between the two. Then exposure doses for a person working outside every day were evaluated for a full year. This study showed that a major part of chronic exposure is due to diffuse radiation, and the erythemal threshold (the point at which sunburn occurs) is exceeded most days, including when clouds are present.

It is such innovative collaboration that enables MeteoSwiss to contribute to the well-being of the Swiss population in areas that are not directly related to meteorology. This collaboration is on-going and explores different exposure scenarios (work, leisure, etc.), including looking at ways to extrapolate the data and apply it to the whole of Switzerland.



***UV radiation varies considerably** depending on the time of day and the body areas. White and red body areas such as the head, shoulders, and feet receive the most UV radiation.*

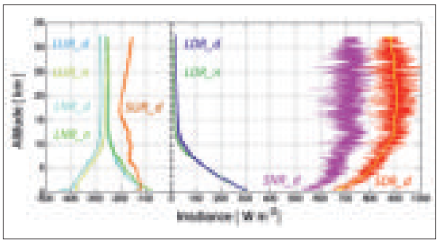
Investigating the greenhouse effect

To fully understand and quantify the greenhouse effect of the Earth's atmosphere it is necessary to know how radiation fluxes change with altitude. MeteoSwiss conducted experiments to measure radiation profiles through the atmosphere.

The Earth's energy budget is determined by the incoming shortwave solar radiation and the outgoing long wave terrestrial radiation. Despite large amounts of existing measurements of those parameters, there are just a few observations documenting how radiation fluxes behave and change through the atmosphere as a function of altitude – crucial information for analysing the greenhouse effect and its impact on atmospheric and surface temperature. For that matter, the two components of thermal long wave radiation are of the greatest importance: the upward radiation from the Earth's surface and the downward radiation remitted by greenhouse gases and clouds.

Balloons scanning the atmosphere

At the MeteoSwiss aerological station in Payerne, weather balloons and radiosondes equipped with specific net radiometers were used to continuously measure radiation flux profiles from the surface of the Earth up to altitudes of 35 kilometres in the stratosphere. The flights were conducted both day and night and combined with continuous 24-hour ground-based measurements. The collected data allowed the creation of radiation profiles of all flux components necessary to fully capture the vertical structure of the Earth's radiation budget.



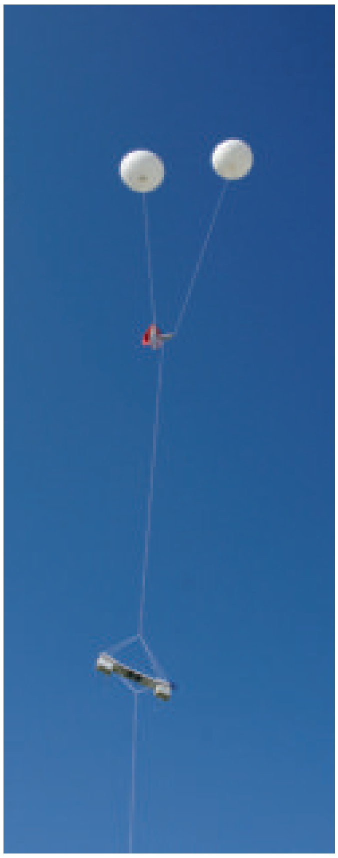
***The radiation profiles** show how the individual radiation components change according to atmospheric height.*

The comparison of radiation profiles revealed that any variation in temperature and water vapour changes long-wave upward and downward radiation. In cloudless situations, the measurements show that long-wave net radiation (upward minus downward component) increases along with rising water vapour, both towards space and towards the ground, where it accounts for enhanced heating on the surface.

A tool for investigating climate change

These results provide evidence of greenhouse forcing: the Earth's energy budget is being disturbed by anthropogenic greenhouse gas emissions. With rising levels of greenhouse gas concentration, long-wave radiation and hence atmospheric temperature increase, followed by rising water vapour as a feedback.

Therefore, long-wave radiation profiles are an excellent tool for monitoring and investigating climate changes. Short-wave radiation profiles furthermore allow the radiated effects of aerosols and of changing cloudiness related to changing atmospheric water vapour to be studied. Radiation profiles will improve radiation codes in climate models and serve as a calibration base for satellite measurements.



***Radiometers on weather balloons** rise up to 35 kilometres in the air to measure radiation flows.*

Short articles

A step towards automatic pollen measurement

Pollen allergies affect nearly 20 per cent of the population in this country. MeteoSwiss, the national reference office, provides pollen data and forecasts. Taking the air-borne pollen count is a long-winded and painstaking manual task: particles are collected on sticky tape and then identified and counted under a microscope. As the current international standard, this method allows precise identification of all pollens, but the delay involved before the data are available limits their use for public information and forecasting.

MeteoSwiss is working to develop automatic analysis procedures, *as it is difficult and time-consuming to measure pollen counts.*

In September 2012, with a view to shortening this period and providing data in real time, MeteoSwiss organised an international meeting in Payerne to review the methods of automatic analysis of air-borne pollen. Different technologies are being studied, from laser counters to immunochemical detectors; however, these still need further development. In 2013, MeteoSwiss will test a sensor based on the analysis of images in its regional headquarters in Payerne, continuing the latter's tradition of evaluating measurement methods as applied to atmospheric sciences.

SPICE: a full-bodied project

It was decided at the 15th session of the CIMO (WMO Commission for Instruments and Methods of Observations) held in Helsinki in 2010, to launch an ambitious programme of solid precipitation measurements in different climates with varying physical characteristics. This is an intercomparison that will identify best practices for measuring this important parameter for the management of water resources. This exercise, which requires perfect coordination between the 15 selected measuring sites, needed a name to match the scale of the challenge: thus SPICE (Solid Precipitation Intercomparison Experiment) was born.

The measuring site on the Weissfluhjoch *is being retrofitted for SPICE.*

Each site is equipped with the same reference instruments, all identically configured to enable reliable comparison. Switzerland, through MeteoSwiss, is actively participating in this project, providing the only measurement site for an alpine climate. An existing site on the Weissfluhjoch was selected and set up, in collaboration with the Institute for Snow and Avalanche Research SLF, to meet the requirements of the project. This included the construction of a DFIR (Double Fence Intercomparison Reference) to provide the reference measurement. Measurements will be taken for two years beginning in winter 2012. The ensuing analysis of the results will optimise measurement networks.

We continue to develop our strategy in order to fulfil our mission as the national weather and climate service even better.

Bettina Durrer, Head of Strategy and Planning

A fresh wind of reform

Parliament did not debate the planned revision of the meteorology law. To expedite the undisputed reform demands, including the liberalisation of data and the restructuring of the service portfolio, MeteoSwiss bundled the various concerns in a new reform programme: Avenir M.

Despite Parliament's failure to debate the revision of the meteorology law, the future of MeteoSwiss will continue to be shaped by change. The Department of Home Affairs, under the management of Federal Councillor Alain Berset, has given MeteoSwiss an amended reform mandate. The undisputed reform issues should be pursued further and the recommendations of the Swiss Federal Audit Office should also be implemented in future.

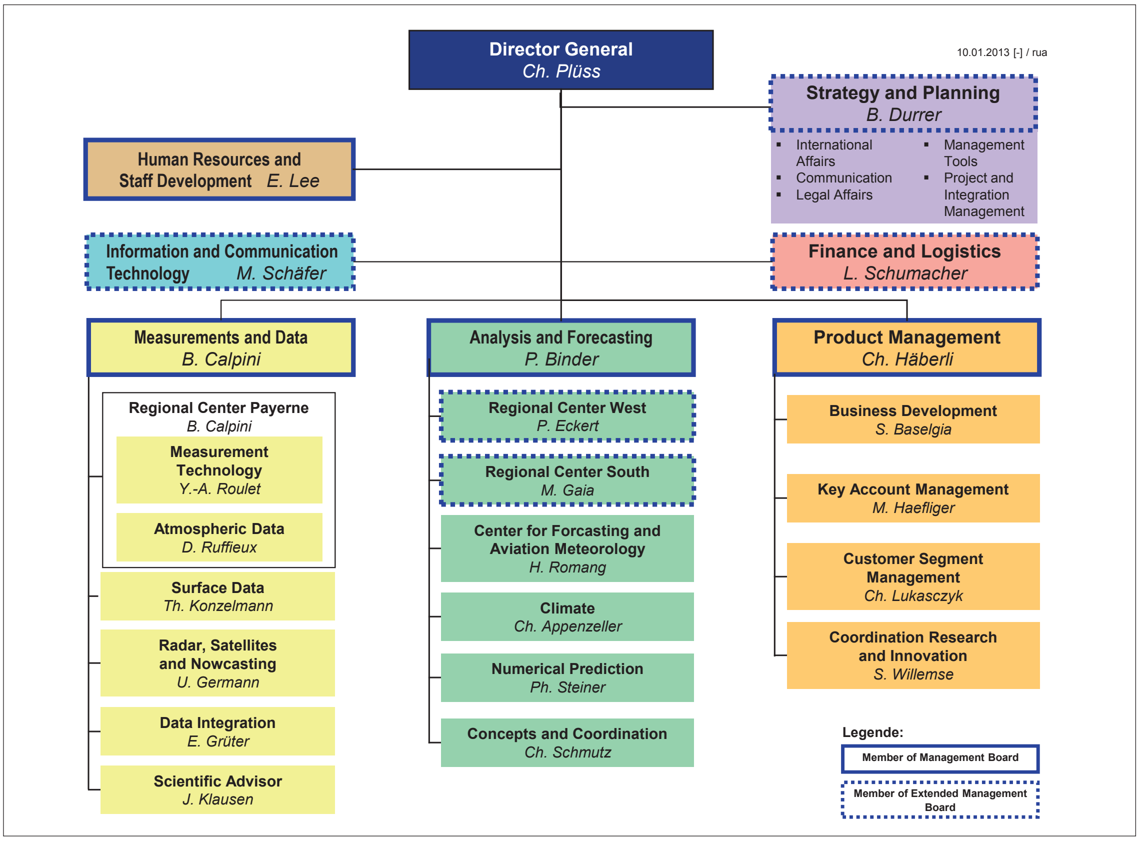
Avenir M, as the new reform programme has been christened, focuses on the revision of MeteoSwiss's basic strategy, the clear division of its tasks between basic services, chargeable services, and external funding, and the development of a data liberalisation concept.

New strategic guidelines

In 2012, the Avenir M programme focused on the revision of the strategic guidelines. The future strategy will be based on a more pronounced differentiation of services, the continued development of the range of services through cooperation projects, and the continuous improvement of all processes. In this context, preparations for the new mandate beginning in 2014 as an MPM department (management by performance mandate and global budget) have been launched. A project for the optimisation of the existing SAP has also been started. This provides the framework for the restructuring of the product and service portfolio, the reduction of the current six product groups to just two, and simplified cost and performance accounting.

At the end of 2012, the Avenir M programme reached its first milestone with the adoption of the new overall and departmental strategies, which also represents an important step towards the future of MeteoSwiss.

There is also a programme for the future. As part of the Avenir M project, MeteoSwiss is implementing reforms. The first was the revision of its basic strategy, which now rests on three strong pillars: differentiation through positioning as the national benchmark for weather and climate issues, increased cooperation and constant optimisation of processes and services.



The new organisation *has three departments: Measurements and Data, Analysis and Forecasting, and Product Management.*

New organisation

At the beginning of 2012, MeteoSwiss changed its organisational structure. The former Support, Weather and Climate departments and the various coordination and interface tasks were moved to the new Measurements and Data, Analysis and Forecasting, and Product Management departments. While the Measurements and Data department handles measurement and observation tasks, the Analysis and Forecasting department processes the data using different forecast models and instruments to produce weather forecasts, warnings, and climate analyses. Product Management is responsible for research coordination, product development, and the management of the service portfolio.

> The undisputed reform issues, such as the liberalisation of data, will be pursued further. ”

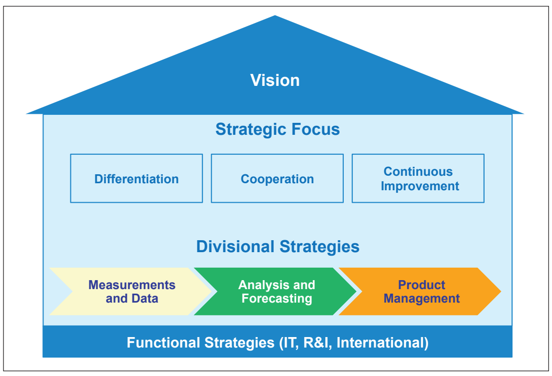
Various changes were also introduced with regard to the management and support functions. After being temporarily assigned to the Resources department in 2012, HR, Strategy and Planning, IT, Finance and Logistics departments have all begun reporting directly to the Director General in 2013.

Vision

In weather and climate issues we are the national reference. We provide services of international standing for the benefit of the Swiss population. We do this in close co-operation with our partners in research, the international community and industry. Our customers and our fellow citizens recognise and value our contributions.

Mission

MeteoSwiss is the Swiss National Weather Service. We record and forecast weather and climate in Switzerland and thus make a sustainable contribution to the well-being of the community and to the benefit of industry, science and the environment.



The keystones of the new strategy *are differentiation, cooperation, and internal optimisation.*

Modern look for the weather centres

Although the new headquarters of MeteoSwiss no longer provide a view over Lake Zurich, the Uetliberg, and the Alps, Operation Centre 1 at the Zurich airport offers a very modern work environment in newly renovated offices.

Apart from the lower rent, proximity to the aviation industry, MeteoSwiss's biggest customer, was the crucial criterion for the decision to move its headquarters. The move from Krähbühlstrasse to the Zurich airport should make it easier to exploit synergies in future.

A satellite picture decorates the wall *of the renovated weather centre at the airport, the new headquarters of MeteoSwiss.*

Satellite view as wall decoration

Project Headquarters started on January 1st, 2012, just a few weeks after the Board of Directors decided to move the head offices. Much was accomplished over the following months, beginning with the conversion work at the flight weather centre which proved to be the most important event. After a construction period of three months, the renovated premises were ready for occupation and in October the offices were handed over to MeteoSwiss by Flughafen Zürich AG. The "new" weather centre with the Analysis and Forecasting department Zurich started operating on December 3rd. The other head office employees are expected to move to Operation Centre 1 in 2014.

The new weather centre is very modern: new furniture, state-of-the-art lighting technology, lime green walls in the break room and entrance, a 6 by 2.8 metre video screen and a tailor-made wall picture of a 360-degree satellite photo of the earth ensures that the room is a real gem.

Forecasts for Ticino from the Minergie building

Moving boxes were also being packed south of the Alps. After a construction period of a year and half, the employees of MeteoSwiss's Regional Centre South returned to their renovated offices in Locarno-Monti in October. The building, built in the 1950s and a milestone in the architectural history of the canton of Ticino, was comprehensively renovated. Amongst others, the old oil-fired heating system was replaced by a geothermal heatpump, whose annual electricity consumption can be covered by the new photovoltaic plant. Thanks to these and other measures, the building now meets the Minergie standard.

The weather centre in Locarno-Monti *was renovated and now meets Minergie standards.*

Modern research infrastructure in Davos

The Davos Physical Meteorological Observatory PMOD/WRC was also renovated. The building in Davos Dorf, which is more than a century old, no longer met the demands of research. With the conversion, which started in 2010, all efforts were made to keep the outside of the historical building as intact as possible and to optimise the use of alternative energies. The event to officially inaugurate the renovated building will be held in April 2013.

Joining forces against climate change

As the developing and emerging countries are affected much more harshly by climate change, MeteoSwiss is involved in international cooperation projects for the establishment and improvement of climate services, in Peru for example.

The effects of climate change are visible everywhere in the world. To meet these challenges, the Global Climate Observing System (GCOS) was set up 20 years ago. Because comprehensive global data sets are needed to formulate theories on the status of the climate and climate change and to prepare strategies for adjusting to this change, the Swiss GCOS Office is involved in the CATCOS project at MeteoSwiss to close the gaps in data relating to the developing and emerging countries.

Global Framework for Climate Services

At the first extraordinary congress of the World Meteorological Organisation WMO in October 2012, governments from all over the world adopted a ten-year implementation plan for the Global Framework for Climate Services GFCS. The main goal of this plan is to optimise global observation systems, subject expertise, and the integration of the collected data in global climate models and to promote the dialogue between the providers and users of climate services. The focus falls on about 70 countries with inadequate climate services that should benefit from this scientific progress.

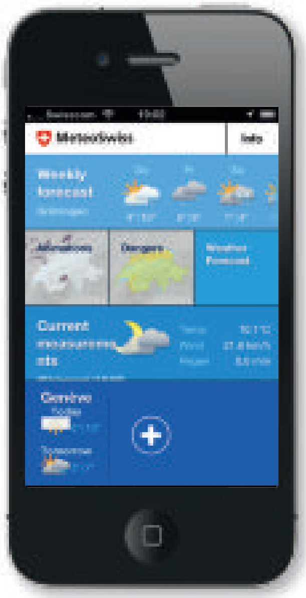
Climate products for decision-makers in the Andes

During the congress, the GFCS pilot project CLIMANDES was launched. The project, which is financed with CHF 3.2 million by the Swiss Agency for Development and Cooperation (SDC) and coordinated by the WMO, will strengthen the partnership ties between the mountainous countries of Switzerland and Peru. The spotlight falls on improving climate services and their availability to local decision-makers. The training offered to meteorologists and climatologists in the Andes countries should also be improved.

***In Peru MeteoSwiss is engaged** in the improvement of climate services with the CLIMANDES project.*

MeteoSwiss plays a central role in the coordination of the Swiss contribution to CLIMANDES, in quality control and the homogenisation of measurement data, and the training of meteorologists. The project will be implemented in Peru by the Peruvian weather service SENAMHI and La Molina University. In addition to MeteoSwiss, the Peruvian partners also have the support of the Institute of Geography at the University of Bern and Meteodat GmbH. In this way, CLIMANDES helps the people of Peru to cope better with the challenges of climate change.

Short articles



The weather always available: *MeteoSwiss now has as an app for smartphones and tablet computers.*

MeteoSwiss now has an app

Everywhere we go and around the clock, we are accompanied not only by the weather, but also by our mobile devices. Therefore there is a great demand for the integration of weather information on smartphones and tablets. The MeteoSwiss website has been available in a version optimised for mobile devices since 2011.

The app that has been made available this year for iOS, Android and coming soon for the Windows phone goes one step further. Whether you want the weather forecast, the latest measurement data, or bad weather warnings, the latest information is already available on the home page. And if you zoom in on the map of Switzerland you can find detailed information for every town.

The rain, temperature, and cloud cover animation shows not only the latest data, but also provides an overview of what can be expected in the next few hours. Favourite locations can be set up quickly on the home page, where you can also subscribe to predefined warning thresholds and various kinds of storm warnings. If you want to make sure that you are not taken by surprise by a storm, these warnings can also be requested as push messages.

Users are helping *to design the new website.*

Users help to design new website

The MeteoSwiss website, which has been in operation since 2005, is being completely redesigned. This project was launched at the beginning of 2012. The relaunch is based, amongst others, on an online survey which made it clear that the current internet site does not entirely meet the needs of its users with regard to the information provided, the structure of this information, and the options for interaction. For example, the respondents would like to be able to personalise the weather pages. This will be possible with the new internet site. It will provide free access to all weather and climate information and meet the Confederation's design guidelines.

The new website, which should come online in mid-2014, follows a user-centred design concept. With this method the users take centre stage, and user needs are repeatedly measured and recorded through tests.

The objective is a website that gives the Swiss easy-to-understand, dialogue-based answers to questions regarding the weather and the climate and provides government authorities, researchers, and the business sector with subject-specific content. The topics will be structured in a web-friendly manner and will be available in the three official languages German, French, and Italian (and often also in English) on different terminal devices – so that first-class information on the weather and the climate can be accessed anywhere at any time.

Key facts and figures 2012

Compared to the budget, the books for 2012 closed with a surplus of CHF 1.8 million.

This is due to additional earnings in the Weather Forecasts and Warnings Product Group and expanded services.

On the other hand, expenses and depreciation were lower than budgeted due to delays to the Rad4Alp and SwissMetNet projects. These delays also meant that scheduled investments were not made.

Income statement in million CHF

	Account 2011	Budget 2012	Account 2012	Absolute deviation from the budget 2012	Relative deviation from the budget 2012
Earnings	**33,6**	**32,5**	**34,3**	**1,8**	**5,5 %**
Funding received	26,0	23,6	25,5	1,9	8,1 %
Internal services charged	7,6	8,9	8,8	–0,1	–1,1 %
Funding not received	0,0	0,0	0,0	0,0	0,0 %
Expenses	**88,6**	**93,8**	**90,2**	**–3,6**	**–3,8 %**
Funding received, therefrom	61,9	64,9	63,4	–1,5	–2,3 %
Personnel expenses	45,0	45,3	45,9	0,6	1,3 %
Operating expenses	16,9	19,6	17,5	–2,1	–10,7 %
Contributions to int. organisations	15,2	15,7	13,8	–1,9	–12,1 %
Internal services charged	8,0	9,2	9,3	0,1	1,1 %
Depreciation/provisions	3,5	4,0	3,7	–0,3	–7,5 %
Balance	**55,0**	**61,3**	**55,9**	**–5,4**	**–8,8 %**

Capital budgeting in million CHF

	Account 2011	Budget 2012	Account 2012	Absolute deviation from the budget 2012	Relative deviation from the budget 2012
Capital outlays	3,8	5,6	3,5	–2,1	–37,5 %

Staff structure

	Number of employees
Women full-time	41
Women part-time	65
Women total	106
Men full-time	178
Men part-time	68
Men total	246
Fixed-term	57
Unlimited	295
Total number of employees	**352**

Mother tongue

	Number of employees
German	228
French	90
Italian	28
Raetho-Romanic	1
English	1
Other	4

Education

	Number of employees
University	192
University of applied sciences	18
Higher professional education	20
Matriculation	13
Vocational education	101
No vocational education	1
Apprentices	7

Age structure

	Number of employees
Under 20	6
20 to 29	28
30 to 39	82
40 to 49	130
50 to 59	88
60 to 65	18

At CHF 13.8 million, contributions to international organisations were lower than budgeted because the contribution to the WMO was smaller due to a programme delay and that reserves from previous years were used for the EUMETNET programme payments.

Contributions to international organisations in million CHF

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
WMO	1,3	1,4	1,4	1,4	1,5	1,5	1,4	1,4	1,4	1,6	2,0	2,2	2,2
EUMETSAT	14,0	14,0	12,7	10,9	10,7	10,3	10,3	9,0	7,9	8,9	10,1	9,8	8,4
WRC	0,8	0,8	0,8	0,8	1,1	1,0	1,1	1,1	1,3	1,3	1,3	1,3	1,4
EZMW	1,6	1,9	1,9	1,7	1,9	1,9	1,9	2,2	2,0	1,7	1,8	1,6	1,6
European Cooperation (EUMETNET, ECOMET)	0,1	0,1	0,1	0,2	0,3	0,3	0,3	0,3	0,4	0,3	0,3	0,3	0,2
Total	**17,8**	**18,2**	**16,9**	**15,0**	**15,5**	**15,0**	**15,0**	**14,0**	**13,0**	**13,8**	**15,5**	**15,2**	**13,8**

WMO	World Meteorological Organization (Geneva, CH)
EUMETSAT	European Organisation for the Exploitation of Meteorological Satellites (Darmstadt, DE)
WRC	World Radiation Center (Davos, CH)
EZMW	Europäisches Zentrum für mittelfristige Wettervorhersage (Reading, GB)
EUMETNET	Netzwerk Europäischer Wetterdienste (Brussels, BE)
ECOMET	European Cooperation in Meteorology (Brussels, BE)

Earnings were CHF 1.8 million higher than the budget for 2012. Thanks to additional sales, the level of cost recovery was better than forecast for the 2012 budget.

As income for services provided to the teaching and research sector and subsidy contributions are no longer recognised in the cost and performance accounting since 2012, the level of cost recovery is lower than in 2011.

Cost and performance accounting in million CHF

	Account 2011		Budget 2012		Account 2012	
	Earnings	Expenses	Earnings	Expenses	Earnings	Expenses
Weather forecast and warning	9,7	27,0	5,8	25,9	6,8	26,4
Aviation weather service	19,7	19,7	19,4	19,4	19,1	19,1
Meteorological data	8,9	17,4	5,2	17,6	5,0	17,5
Climate services	0,3	10,0	0,3	9,5	0,2	9,3
Further services	2,9	2,7	1,8	1,5	3,2	2,5
International tasks	0	0	0	2,5	0	2,1
Total	**41,5**	**76,8**	**32,5**	**76,4**	**34,3**	**76,9**
Revenue to cost ratio		**54%**		**43%**		**45%**

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