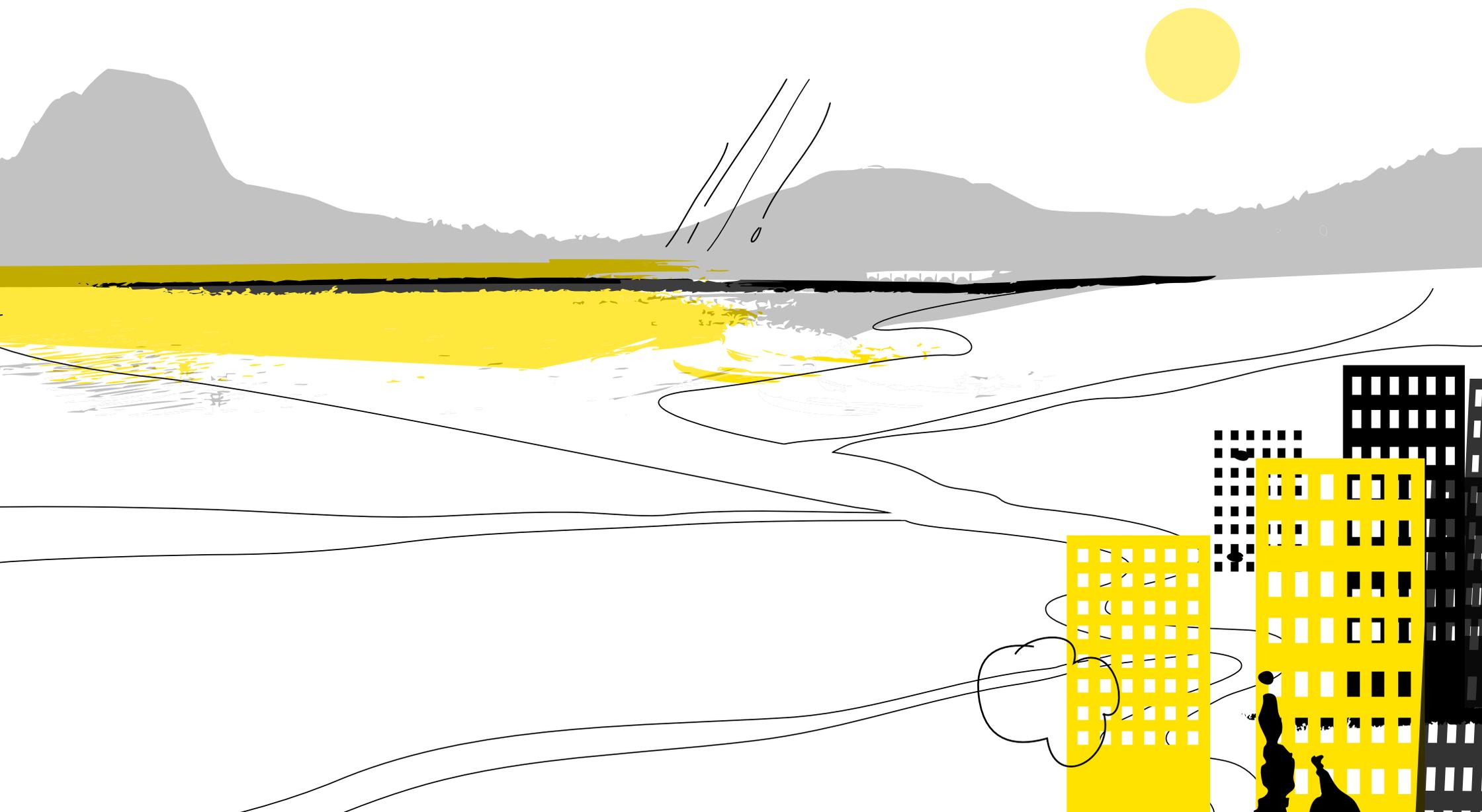


# SMHI 2010

SWEDISH METEOROLOGICAL AND HYDROLOGICAL INSTITUTE



# DIRECTOR GENERAL'S OUTLOOK



SMHI's mandate is to produce decision support to promote good planning, reduce vulnerability in society, and help achieve the Swedish Environmental Objectives. We produce easily accessible information and knowledge, adapted to user situations. Accomplishing this entails the ongoing development of our activities and our ability to serve customer needs.

Research and scientifically anchored methods are the basis for SMHI's development. In this report, you will meet some of SMHI's researchers and find a brief description of our ongoing research and development activities.

## COOPERATION INCREASES UTILITY

Dialogue and interaction with authorities, companies, and international partners increased in 2010. SMHI oversees externally funded projects examining, for example, climate effects on the air and water environments as well as adaptation to changed climate. Researchers at SMHI are building, together with European actors, solutions for modelling city scenarios including, for example, flooding and air pollution.

## EASILY ACCESSIBLE DATA

Environmental data should be easily accessible to authorities and other stakeholders, according to the EU INSPIRE Directive. SMHI is working with some

twenty Swedish authorities to develop a common basis for information sharing.

An increasing number of SMHI climate data and tools, such as maps, statistics, and calculation systems, are made available via the SMHI website.

## SMHI INVESTS IN DEVELOPMENT

As SMHI grows, revenues increase. Our competence and services are in demand. We have carried out special initiatives, for example, in archiving climate data and providing new web services, which have led to an anticipated economic shortfall covered by margins from earlier years. The new website, launched in 2009, has continued to develop in content and form. Many engaged users have provided feedback that helps us improve the support we provide to decision makers and the public.

## READINESS IN ALL TYPES OF WEATHER

The year 2010 was one of the warmest globally. In Sweden, however, it was cold, especially at the beginning and end of the year, and snow and wind created disturbances for many. SMHI provides forecasting and early-warning services in meteorology, hydrology, and oceanography. Through cooperation with various operative actors and authorities, we contributed to decreased vulnerability and improved safety in Swedish society. SMHI has 24/7 preparedness.

  
Lena Häll Eriksson/ Director General

# CLIMATE

Climate continues to be an urgent issue for our target groups. SMHI is working on the frontiers of climate science, and dialogue and knowledge transfer are emphasized. Research contributes by developing climate models for projecting future climate and conducting effect studies at various scales. Internationally, we provide support in the form of expertise, research, and data.

A special target group is the County Administration Boards in Sweden. Seminars have been held to determine their information and support needs. County climate analyses, complemented by climate indicators, ensemble projections and climate information for Sweden's main runoff areas, are available on the web.

## KNOWLEDGE AND COMMUNICATION

SMHI is participating in a European project to map ongoing research into climate change vulnerability, impacts and adaptation. Research needs are also being identified. To that end, SMHI held a workshop on the communication and handling of uncertainties in climate models in November 2010 in Stockholm. Researchers and decision makers from the national and regional levels in Europe participated.

Other themes discussed at seminars include the use of climate scenarios in effect studies and entrepreneurship based on climate research. Politicians, researchers, and business and NGO representatives meet and interact at the seminars.

## CLIMATE MODELS FROM THE GLOBAL TO THE LOCAL SCALE

Calculations made using the EC-EARTH global climate model will form part of the basis of the next IPCC evaluation. This model has been developed in cooperation with

European research groups. The regional climate models developed at the Rossby Centre are being refined in terms of the physical model descriptions and the calculation resolution. Model handling has also been simplified to facilitate use by international research groups.

Vegetation and climate interact via complicated processes. A vegetation model has been linked with a high-resolution climate model to study how these interactions influence future climate projections. Calculations indicate that, when vegetation is taken into account, the climate signal remains the same but tendencies can be weaker or stronger. One example is increased heating in mountainous areas of Sweden due to establishment of birch forest.

An example of a local-scale issue is the future load on sewage systems. Results of a study of Stockholm indicate that 10–30% increased volumes can be expected. In combination with increased urbanization, problems may arise around 2050.

## DATA SERVICES

Homogenous and quality-assured data series for historical weather are in demand. Following climate development requires so-called re-analyses, and these are based on SMHI's weather analysis, forecast calculation, and observation systems. SMHI is participating in a European project to create detailed time series covering Europe.

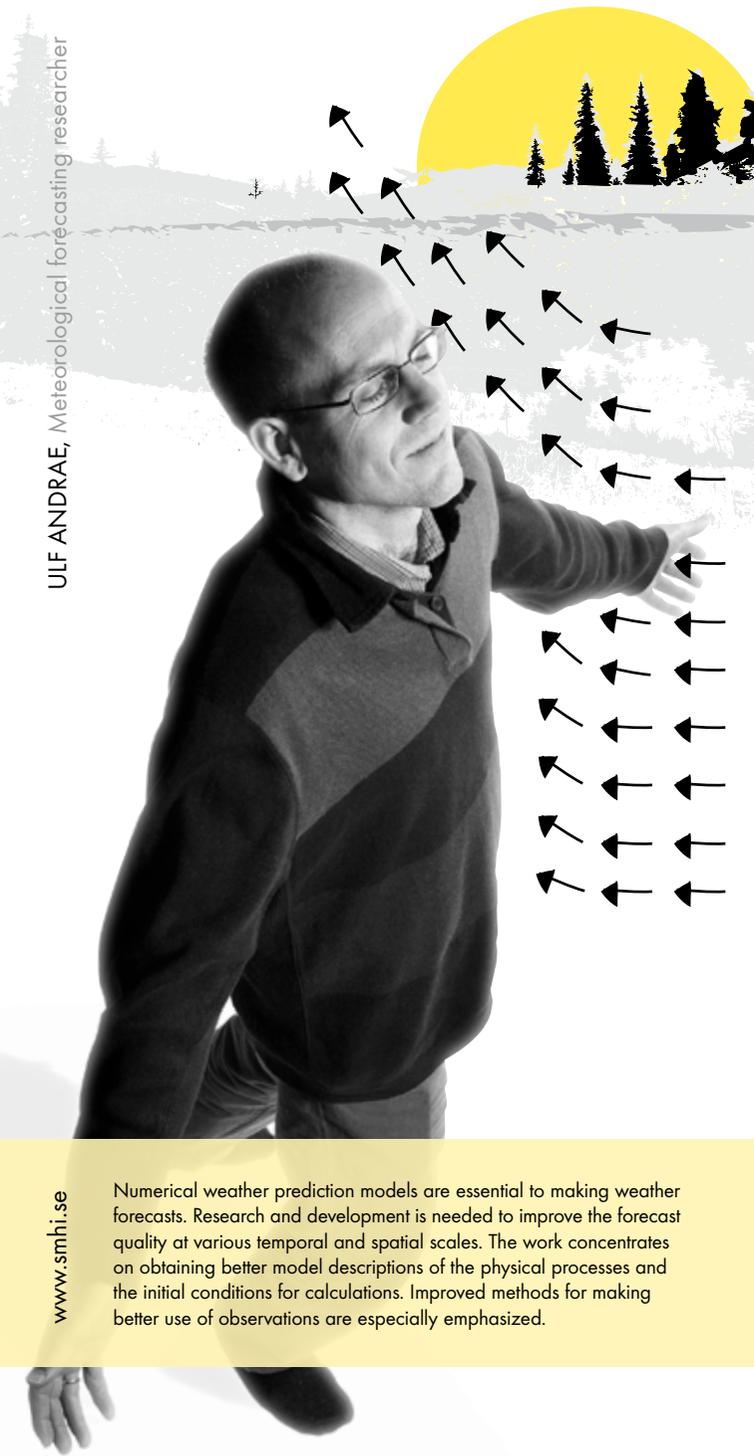
SMHI is developing a new national resource by hosting, storing, and making available data from Swedish climate and environmental research. This resource has been commissioned by the Swedish Research Council.

## EXPERT SUPPORT INTERNATIONALLY

SMHI is contributing to the scientific part of the IPCC Fifth Assessment Report and providing expert support to Swedish delegations in international climate contexts. SMHI has joined in preparing a new global framework for climate services.



Rain is the issue that arouses the most interest regarding future climate change. Calculations from SMHI's climate modelling research unit, the Rossby Centre, together with historical data constitute the basis for information and products developed by SMHI and other actors. These calculations also support international cooperation in climate issues.



# FORECASTING

More detailed forecasts are required, which calls for new model development and immense computer capacity. SMHI's competence in forecasting services provides crucial support in the event of various emergencies. A good example is the volcanic ash event in spring 2010. Interaction among Swedish authorities increases within the areas climate adaptation, risk, and crisis. Enhanced Nordic cooperation is evolving in the forecasting area. SMHI is also helping build a global system for atmospheric, sea, and water observation.

The operational model for the past 25 years has increased in resolution. Improved physical descriptions and initial state handling have led to better precipitation forecasts and slightly better temperature and cloudiness forecasts. In the interest of more geographically detailed forecasts, a new model generation is being introduced via international cooperation. A new computer cluster at SMHI makes it possible to run high-resolution meteorological and oceanographic models.

## ENSEMBLE TECHNIQUE

Forecasting uncertainties need to be better described. By running several possible weather forecasts (ensemble predictions) from a perturbed initial state, we can determine the probability of a particular weather development, for example, the risk of very cold weather or large amounts of precipitation. This technique is used in meteorological, oceanographic, and hydrological applications.

## WARNINGS AND RISK PREVENTION

Maintaining a properly functioning early-warning service is one of SMHI's fundamental tasks. Since 2008, all class 2 and 3 warnings have been evaluated for technical and

functional quality. Directly questioning various operative actors produces direct feedback on SMHI's ability to provide support in severe situations. A new production and distribution system has been introduced, giving better geographical warning precision and more distribution channels for the receiver.

The aviation weather service at SMHI monitors Sweden's air space and issues warnings when needed. During the volcanic ash event in spring 2010, forecasters and researchers cooperated to give support to customers, media, authorities, and the public.

Iceing is a problem for the wind energy sector in the winter. SMHI is participating in a research project to geographically map the risks. This mapping needs to be very detailed, since ice forms in response to local conditions.

## NATIONAL AND INTERNATIONAL COOPERATION

Swedish authorities have increased their cooperation regarding disaster prevention and climate adaptation. SMHI is active in the national platform for work on natural hazards. Cooperation with the Swedish Civil Contingencies Agency has intensified concerning the possible deployment of early-warning systems for extreme weather events. The Swedish Maritime Administration and SMHI are working towards the joint administration of marine data.

The Nordic countries are working together to use their resources more efficiently. SMHI and the Norwegian Meteorologisk institutt are planning to open a shared numerical weather prediction and computer facility in 2014.

SMHI represents Sweden in the World Meteorological Organization (WMO), the European Organisation for the Exploitation of Meteorological Satellites (EUMETSAT), and the European Centre for Medium-Range Weather Forecasts (ECMWF). In developing global monitoring services with the Group on Earth Observations (GEO), SMHI contributes in the atmospheric, sea, and water areas.

Numerical weather prediction models are essential to making weather forecasts. Research and development is needed to improve the forecast quality at various temporal and spatial scales. The work concentrates on obtaining better model descriptions of the physical processes and the initial conditions for calculations. Improved methods for making better use of observations are especially emphasized.

# ENVIRONMENT

Information from SMHI guides the management of Sweden's lakes, rivers, and coastal areas. It also provides strong support for work related to the EU Water Framework and Marine Strategy Framework directives. At a larger scale, SMHI supports efforts to improve the Baltic Sea and North Sea environments and the air environment in population centres. Much related work is being done via international cooperation.

Higher environmental standards and the demands of a changing climate call for environmental monitoring and the development of decision support tools.

## **SUPPORTING SWEDEN'S WATER MANAGEMENT**

SMHI continues to support the creation of a web-accessible and operationally reliable, quality-assured information and production system for Sweden's water management. The national network of hydrological stations has been extended by the addition of fifty temporary stations reporting data in real time. To improve the quality of simulated discharges, a method has been developed that updates the model calculation with upstream observations.

A coastal zone model has been used for several years to calculate the environmental status along the coast. The model has been upgraded to calculate turnover time in coastal basins and for both surface and bottom water. The information is used, for example, to estimate sensitivity to emissions of environmental pollution.

SMHI's operational systems supporting water management received good grades in a scientific evaluation. An international panel of experts concluded that the systems were state of the art and could serve as models for other EU countries working within the Water Framework Directive.

## **GROWING DATABASES**

Intense work has been done to delineate water bodies and their corresponding catchment areas in Sweden. The number of surface water bodies represented in the Swedish Water Archive database now totals 23,426. Other databases store model-calculated data on rivers, lakes, and coastal zones amounting to several hundred million values.

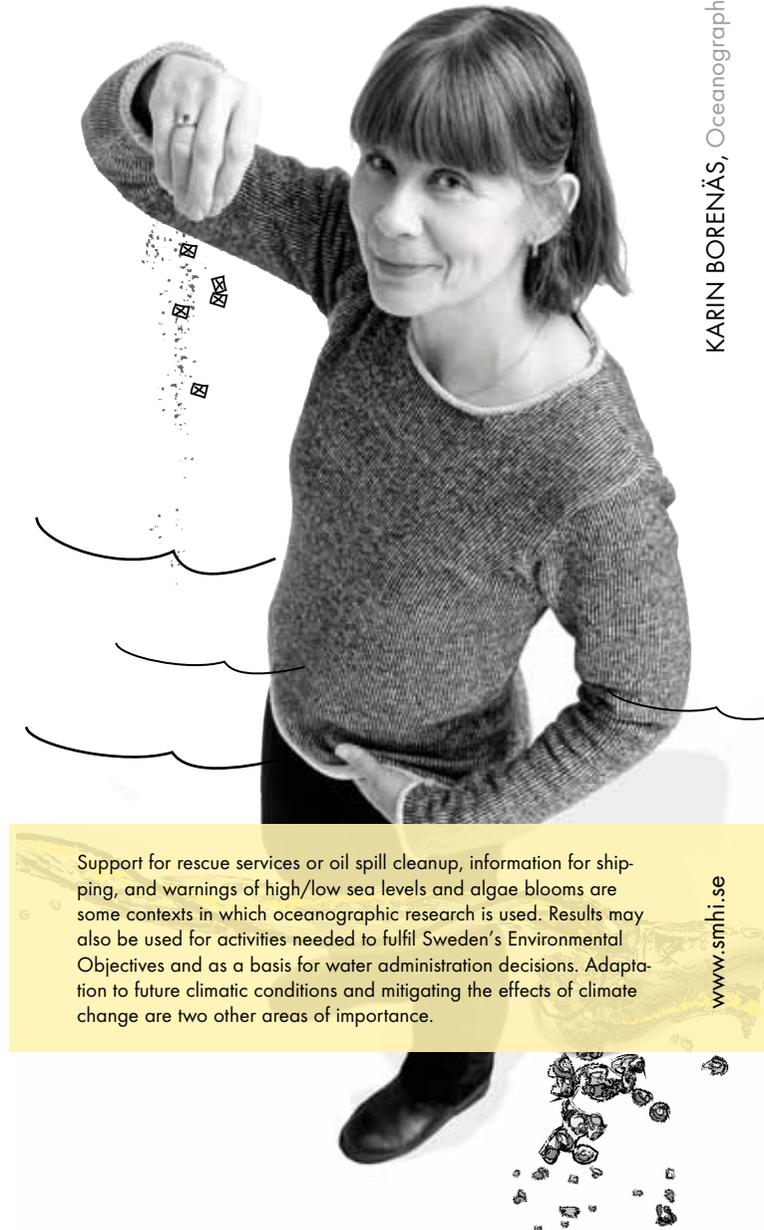
## **HYDROLOGICAL PREDICTIONS FOR THE BALTIC AND EUROPE**

SMHI is going further, developing model concepts for flows at the Baltic and European scales. Water and nutrient flow time series for rivers and coastal zones in the Baltic Sea basin are available for free download. The system can be used as decision support and for studies of historical development and climate change. A first version of a high-resolution pan-European hydrological model is operational in the SMHI production environment. The model is based on readily available global databases, which include some uncertainty, but the infrastructure is now available and open for improvement.

## **MARINE MONITORING**

Much of the marine environment monitoring along Sweden's coastline is performed by SMHI. Marine data have been complemented by a monitoring system installed on a commercial ship going between Gothenburg and Kemi in the Gulf of Bothnia. The automatic collection of data and water samples covers the physical state and some chemical and biological relationships of surface waters. A similar system is installed on a research vessel that monitors the Baltic Sea and the West Coast.

Vertical profiles of oxygen content, cyanobacteria, and ordinary plankton have been added to the national monitoring programme.



Support for rescue services or oil spill cleanup, information for shipping, and warnings of high/low sea levels and algae blooms are some contexts in which oceanographic research is used. Results may also be used for activities needed to fulfil Sweden's Environmental Objectives and as a basis for water administration decisions. Adaptation to future climatic conditions and mitigating the effects of climate change are two other areas of importance.

www.smhi.se



Atmospheric pollutants have a detrimental impact on the environment and human health. Good air quality is a prerequisite for sustainable development. SMHI supports Sweden's national authorities and decision makers with calculations and tools in the field of air quality, which implies involvement in both national and international research projects.

A new analytical method has been introduced to survey algae blooms. Data from several satellites are used in combination with observations.

### **INTERNATIONAL MARINE COOPERATION**

SMHI is active in national and international cooperation to develop decision support to improve the marine environment. Areas of importance are the implementation of the Marine Strategy Framework Directive and the development of a European infrastructure for oceanographic data.

Together with Danish colleagues and the Swedish Environmental Protection Agency, demarcations have been suggested for two ecoregions: the North and the Baltic seas. These ecoregions mark the natural limits of the marine conditions to be administered by the Marine Directive.

SMHI participates in reviewing the target descriptors of the Marine Strategy Framework Directive. The criteria for the North Sea are being investigated in a joint project involving other North Sea states.

Research cooperation among the Baltic Sea countries aims at forming a support system for decisions regarding marine initiatives. In the project, led by SMHI, extensive scenario calculations are being made for water level, freshwater, and nutrient flows, for example.

### **COMMUNICATING MARINE ENVIRONMENT**

Three marine environment days were arranged within the framework of international Baltic Sea research. The basic theme was how knowledge of sea processes can evolve further, special attention being paid to how a changed climate affects the marine environment.

The "Baltic Vision" visualization exercise has identified how decreased emissions can influence the combined effects of eutrophication and a changing climate. The content

is based on SMHI model calculations, and presentations have been made, for example, in a mobile theatre dome during World Water Week, and to various Swedish ministries.

### **TOWARDS CLEAN AIR**

Particles, nitrogen oxides, and ground-level ozone are some of the most important air pollutants. SMHI is developing decision support tools to advance efforts to achieve the national clean air environment objective. The working tools are dispersion models at different scales, applicable to different issues.

Air pollutants derive from various sources. Some pollutants come from local emission sources, while others arrive by long-range transport. Several Swedish cities still have problems with air pollution, despite generally lower emissions from road traffic. Local restrictions are thus needed.

Higher levels of ground-level ozone in Sweden are mainly caused by air from continental Europe. A study using a high-resolution dispersion model of Stockholm projects that the highest levels will occur with south-east winds. To follow the EU directive on ground-level ozone, the situation should be studied using high-resolution models in combination with better emission information.

Variations in the chemical composition of the air are decisive for the climate and our health. A European air chemistry forecast service, being established with SMHI as one of the main actors, will build on regional and global measurements and calculations. The data gathered by this service provide a foundation for product development by other actors.



PATRIK LUNDBLAD, Ph.D. student in visualization

# BUSINESS SERVICES

Several actors are on the market, making for competition in almost all product areas. The demand for SMHI business services, competence, and products is still strong, however. The 2010 turnover even increased slightly over that of 2009.

Both investment in infrastructure projects in Sweden and the implementation of EU directives create demand for SMHI business service support. Products are developed to meet customer needs and to help synchronize customer activities with the effects of weather and water conditions. The web and social media have become prominent and viable parts of customer dialogue.

## AVIATION MARKET

Cooperation with the Danish Meteorological Institute has started and, in a few years, will permit the more efficient development and production of aviation meteorological products. SMHI has also, together with other European meteorological institutions and private partners, submitted a tender to Eurocontrol for the development of meteorological products for future aviation.

## PRODUCTS AND SERVICES FOR BETTER DECISIONS

Increased environmental consciousness in today's society has intensified the demand for SMHI's consultation services and products related to wind power.

A new tool to help property owners judge risk for snow falling down from rooftops has been launched. With recent winters' large quantities of snow in mind it has been well-received.

A detailed system has been developed that calculates shipping emissions based on the Swedish Maritime Administration vessel database and emission factors. For shipping worldwide, energy-efficiency is increasingly important. In order to optimize transports a visualization tool, which comprehends a large amount of data concern-

ing various aspects such as speed and fuel consumption, has been developed.

SMHI is studying the consequences of a Baltic Sea gas pipeline on behalf of the Nordstream consortium. The effects of salt water intrusion are being studied as well as the control of dredging work near the Midsjöbanken and Hoburgsbanken Natura 2000 areas.

## PREPAREDNESS FOR FLOODING AND CLIMATE CHANGE

A web-based system has been developed that helps municipalities and rescue services to estimate flood risks and plan related measures. Calculation models and SMHI's database on water bodies, flows, and water levels are combined with temperature and precipitation forecasts. Local forecasts of water flows and levels can be followed up and user scenario calculations made. Seawater levels are included as well as future climate scenarios.

Jointly with the Swedish Geotechnical Institute, SMHI has produced climate and vulnerability analyses for several Swedish counties. These analyses form the basis for ongoing work on climate adaptation at the county level. Climate is also an important consideration in the large infrastructural projects for which SMHI performs calculations on dimensional water flows and water levels. Decision support is also produced for more local-scale problems, such as dam rebuilding.

## INTERNATIONAL COURSES AND COOPERATION

SMHI's international courses on climate change and air quality have expanded further. Seven courses started in 2010, one of which is offered in French. Cooperation with the Botswana Weather Service focused this year on handling observations and climate data analyses. International competence building is funded by the Swedish International Development Cooperation Agency (Sida).

To meet market demand for modern and effective products, SMHI is emphasizing product usefulness and integrating advanced visualization and web techniques. New products are developed and existing ones modernized. For example, for the Swedish Transport Administration, SMHI has developed a tool for presenting road status, including slipperiness due to ice and frost cover. The tool is based on observations and forecasts from more than 770 stations.

[www.smhi.se](http://www.smhi.se)

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### **About SMHI**

The Swedish Meteorological and Hydrological Institute (SMHI) is a government agency operating under the auspices of the Ministry of the Environment. An expert organisation in the fields of meteorology, hydrology, oceanography, and climatology, SMHI aims to provide social benefits by increasing safety, and fostering a more sustainable society.

Air and water are crucial to life on earth and to the environment. Knowledge and advanced information let us meet the challenges presented by our climate, weather, and air and water conditions.

SMHI manages and develops information that provides knowledge and advanced decision-making information for public services, the private sector, and the public. General forecasts and weather warnings, industry-specific services, simulations and analyses, statistics, climate studies, and contracted research are just a few of its many services. SMHI's national and international cooperation is extensive as well.

SMHI operations are funded in various ways, by government subsidy, on contract for other government agencies, by research funding, and on commercial terms through its business services. SMHI has about 650 employees and a turnover of approximately SEK 650 million, of which approximately SEK 210 million is in the business services area.

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