

Research and development prevents the future taking us by surprise



Applied research, development and exploitation of new knowledge within DMI's field of activity are preconditions if DMI is to be able to maintain rational production and to fulfil its obligations to Danish society. This work is carried out by the Research and Development Department and the institute's other departments and is integrated with the operational activities. The work currently encompasses weather and climate models and oceanographic models, which serve as the basis for the daily forecasts issued by the Forecasting Services Department. Research and development at DMI is internationally acknowledged, and DMI receives extensive financial support from abroad, especially the EU. DMI has participated in 33 projects under the EU's 5th framework programme for research and development. Half of all the funding for research and development at DMI derives from external sources, and the international cooperation is important for maintaining and developing DMI's expertise and exploiting Danish and foreign research findings. Naturally, DMI is planning to participate in the EU's 6th framework programme for research and development.

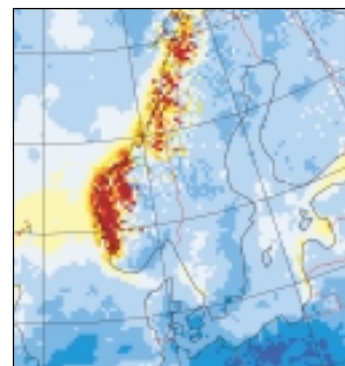
IMPROVED ANALYSES AND FORECASTS

Numerical computer models of the atmosphere are one of the Forecast Services Department's most important tools for producing the daily weather forecasts. The Research and Development Department is therefore continually striving – among other means through the international HIRLAM project – to improve DMI's detailed regional weather model DMI-HIRLAM (High Resolution Limited Area Model) for forecasting the weather in Denmark, Greenland and the Faroes up to two days ahead.

Modelled increase in precipitation in the year 2075 relative to the present.

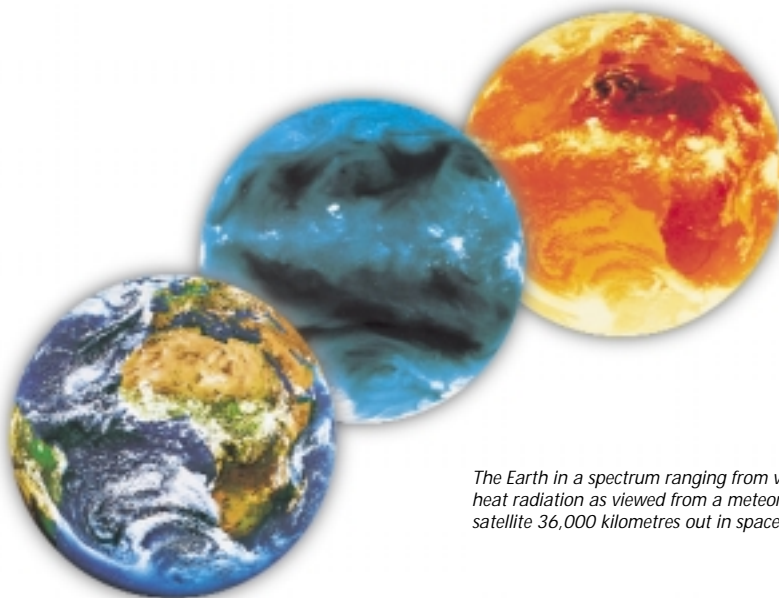
THE FUTURE CLIMATE AND THE GREENHOUSE EFFECT

Work is also being conducted on global and regional climate models, among other reasons to improve monthly and seasonal forecasts. Another important aim of climate research is to be able to assess future natural and man-made climate changes. This particularly applies to regional climate modelling by coupling the HIRLAM model to global climate models so as to enable calculation of regional climate changes resulting from an enhanced greenhouse effect. The Danish Climate Centre, which was established by DMI in 1998, had strengthened national and international cooperation on calculating the anticipated effects of the future climate.



STORM SURGES AND SEA CURRENTS

Storm surges along the Danish coasts can cause considerable damage. This can be limited if the storm surge and raised sea level are predicted some time in advance. Storm surge



The Earth in a spectrum ranging from visible light to heat radiation as viewed from a meteorological satellite 36,000 kilometres out in space.

warnings have been issued by DMI since 1973. The warning system is coupled to DMI's detailed weather model DMI-HIRLAM. DMI now draws up more precise forecasts 12–18 hours or more in advance. The coupled weather and storm surge models can also produce forecasts for sea currents, e.g. for use in combating oil pollution from ships. DMI maintains a 24-hr contingency for warning of oil spills.

TOWARDS IMPROVED AIR POLLUTION WARNINGS

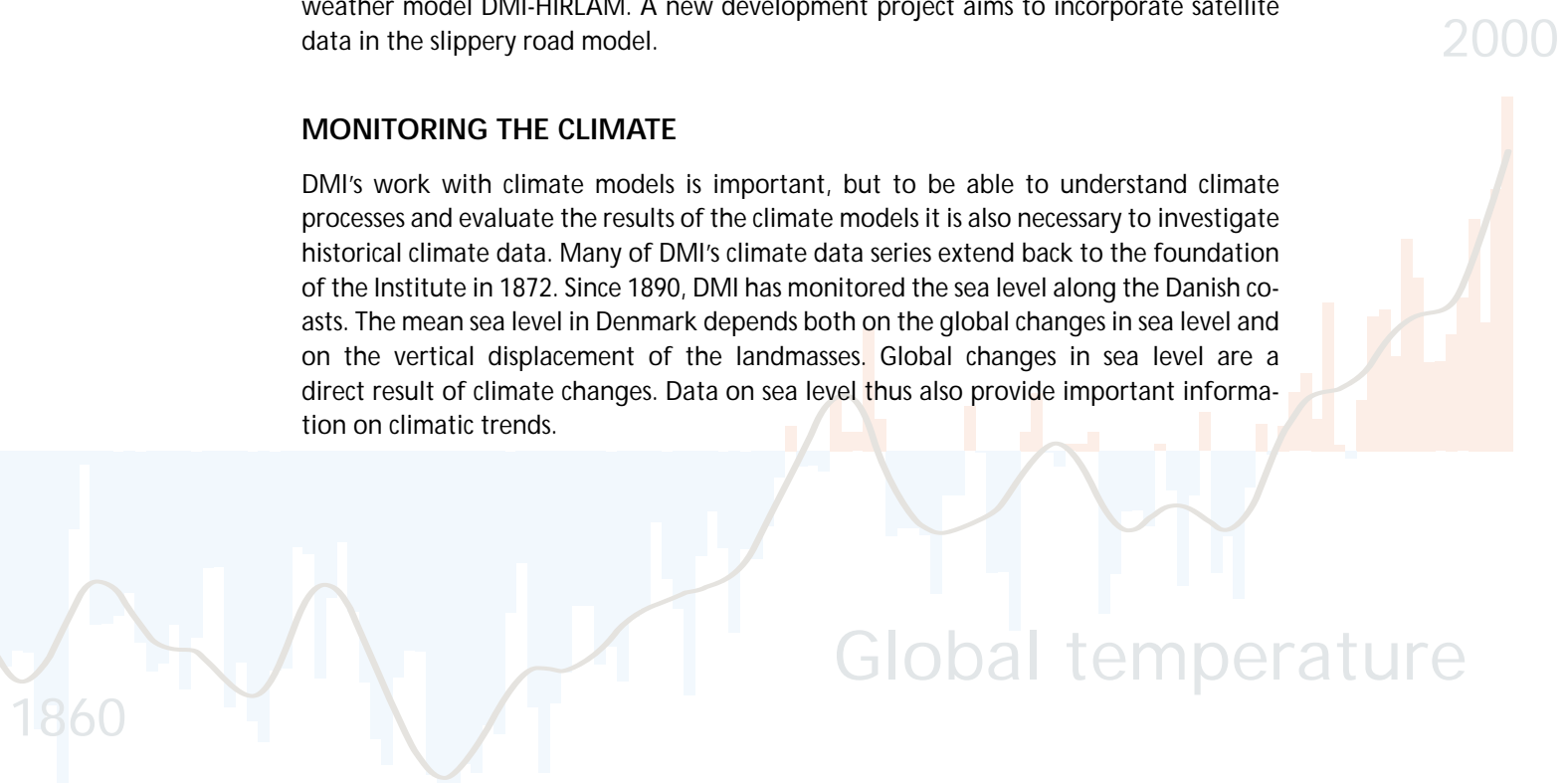
Allergenic pollen, fungal spores, smog concentrations and the dispersal of biological, chemical and radioactive material are main elements in the efforts of the Research and Development Department to create better forecasting systems for airborne pollutants. The Department cooperates nationally and internationally with special models to calculate transport and dispersal of substances on the basis of prognoses from weather models. Chemical processes are also incorporated into the models.

SLIPPERY ROAD MODEL

Prediction of slippery road conditions is one of the important responsibilities of the Forecasting Services Department. The Research and Development Department has established a warning system for county and local authorities and the Danish Road Directorate based on measured weather and road data as well as data from the regional weather model DMI-HIRLAM. A new development project aims to incorporate satellite data in the slippery road model.

MONITORING THE CLIMATE

DMI's work with climate models is important, but to be able to understand climate processes and evaluate the results of the climate models it is also necessary to investigate historical climate data. Many of DMI's climate data series extend back to the foundation of the Institute in 1872. Since 1890, DMI has monitored the sea level along the Danish coasts. The mean sea level in Denmark depends both on the global changes in sea level and on the vertical displacement of the landmasses. Global changes in sea level are a direct result of climate changes. Data on sea level thus also provide important information on climatic trends.

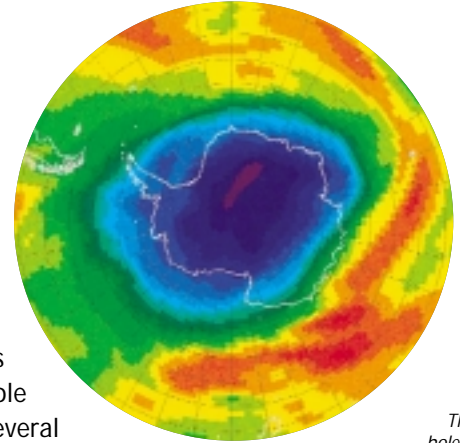


EUROPEAN COOPERATION ON SATELLITE DATA

DMI participates actively in the development of EUMETSAT's Satellite Application Facilities (SAFs) for use in monitoring and warning of ozone and sea ice. In addition, DMI manages EUMETSAT's SAF for GPS meteorology, a very promising new technique that will provide important information about atmospheric temperature and humidity for use in weather forecasting and climate monitoring.

MAGNETIC FIELD AND OZONE LAYER

In addition to heat and visible light, the sun also emits invisible ultraviolet radiation and electrically charged particles. The Earth's magnetic field acts as a shield that hinders the electrical particles from penetrating the atmosphere except at the Earth's poles, where the lines of the magnetic field are almost vertical. DMI participates in the international monitoring of the magnetic field and the processes in the upper atmosphere. The atmospheric ozone layer at an altitude of 15–20 kilometres acts as a shield that reduces ultraviolet radiation. The ozone hole above the Antarctic is known and has been observed for several years. DMI monitors the ozone layer and measures ultraviolet radiation in Greenland and Denmark in cooperation with research institutes in Europe and the USA. DMI investigates the causes of depletion of the ozone layer, the impact of variation in the weather on the ozone layer and the impact of changes in the ozone layer on the climate.



The ozone hole over the Antarctic on 11 October 1999.

SOLAR ACTIVITY AND THE EARTH'S CLIMATE

Transfer of energy from the sun to the Earth takes place through a long series of processes including changes in the composition and motion of the Earth's atmosphere. These processes are studied by DMI, especially those expected to affect the weather and climate. Magnetism data for the past 100 years constitute an important element in these investigations, which reveal a high correlation between the temperature of the northern hemisphere and variation in solar activity until the last decades of the 20th century. In order to be able to differentiate between natural climatic variation and man-made effects it is important to enhance our knowledge of how and to what extent the varying activity of the sun affects the climate.

THE ØRSTED SATELLITE

The Ørsted project is an international project, the scientific part of which is led by DMI. The purpose of the Ørsted satellite is to carry out an extremely precise survey of the Earth's magnetic field and of the electrical currents and charged particles surrounding the Earth at an altitude of 450–800 kilometres. By means of the Ørsted satellite it is possible to investigate the coupling between solar wind and the Earth's magnetic field. DMI's long tradition for running magnetic observatories is a major reason for the institute's interest in the project. The Ørsted satellite has charted the Earth's magnetic field with great accuracy. In addition the satellite is equipped with GPS instrumentation for the development of new methods for measuring atmospheric temperature and humidity for use in weather and climate monitoring.

SPECIALIZED METEOROLOGY LIBRARY

DMI houses Denmark's only library specializing in meteorology. The library contains literature on geophysics, atmospheric physics and oceanography. The collection encompasses just over 30,000 volumes, including books and reports by the World Meteorological Organization (WMO) as well as a number of scientific journals pertaining to DMI's activities.