ECMWF

European Centre for
Medium-Range Weather Forecasts

Annual Report 2011

ECMWF ANNUAL REPORT 2011

Foreword

This year has been one of transition for the European Centre for Medium-Range Weather Forecasts (ECMWF). We have published our new Strategy 2011–2020, new staff have joined us, our supercomputer is being upgraded, new improved versions of our forecasting system have been introduced, and the skill of our forecasts has been improving. We said farewell to Dominique Marbouty who spent 12 years here, including seven as Director-General. Dominique presided over a very successful time for ECMWF and we thank him for his huge contributions.

Our Annual Report paints a picture of what ECMWF's talented workforce have achieved in 2011. It is impossible to reflect here all the activities that are vital to ECMWF's success; those that are not mentioned are no less important. These highlights rely on the bedrock of ongoing operational, research and administrative work that underpins what we do.

ECMWF works extremely closely with the national meteorological services in Europe and the forecasts we produce form a backbone of what they need to inform society about the weather and to provide warnings of severe events. In 2011, the intense rainfall and flooding in Genoa in November was but one of many examples. European citizens are increasingly vulnerable to weather-related hazards and ECMWF has a vital role in the mitigation of the detrimental impacts. Our data are also used by companies to help them plan and be more productive.

ECMWF has clear goals and quantitative measures by which to assess its performance. In 2011, there was strong progress in improving the skill of our weather forecasts for days and months, up to a season ahead; ECMWF is the world leader in global medium-range forecasting. Our research is also developing ways to produce, for example, air quality and hydrological predictions. We will continue this progress in 2012 both by our own efforts but also by collaborating with our many partners, such as the national meteorological services, space agencies, and universities.

Alan Thorpe
Director-General

François Jacq
President of Council

Key events of the year

The year has been marked by expansion of the membership of ECMWF. Also a wide-ranging programme of research and development has led to the upgrading the forecasting system, both for medium-range and seasonal forecasts. At the same time, upgrading of the supercomputer, extending reanalysis and securing continuation of the atmospheric composition project have been key developments that keep ECMWF as a world leader in numerical weather prediction.

New co-operation agreement in force (February)

A co-operation agreement between ECMWF and the former Yugoslav Republic of Macedonia comes into force.

Accession agreement with Slovenia signed (April)

On 8 April, Roko Žarnić, Slovenian Minister for Environment and Spatial Planning, and Dominique Marbouty, Director-General of ECMWF, sign the "Agreement between the Government of the Republic of Slovenia and ECMWF on the accession of the Republic of Slovenia to the ECMWF Convention" in Ljubljana.

New forecasting model version (May)

A new version of the ECMWF forecasting and analysis system is successfully implemented. It introduces a number of meteorological changes as well as major technical changes, such as improved use of satellite data and an enhanced data assimilation system.

Iceland becomes Member State (June)

On 1 June, the Republic of Iceland becomes ECMWF's 19th Member State following the signing of the accession agreement by Svandís Svavarsdóttir, Minister for the Environment of Iceland, and Dominique Marbouty, Director-General of ECMWF, in Reykjavik on 9 March. This marks a new chapter in the long relationship between ECMWF and Iceland, which has been a Co-operating State since 1980.

New Director-General (July)

Professor Alan Thorpe takes over as Director-General of ECMWF from Dominique Marbouty on 1 July. After being involved in meteorological research for many years, Alan was Chief Executive of the United Kingdom's Natural Environment Research Council from 2005 to 2011.

Extension of reanalysis (August)

The ERA-Interim reanalysis dataset is extended by a decade and now includes data from 1 January 1979 to the present. This extension makes the dataset even more useful for climate-related studies and climate-change monitoring, as it now covers a period exceeding three decades.

Second weekly run of the monthly forecast (October)

The monthly forecast is produced every Monday to provide an update to the main Thursday run. A new set of web pages shows graphical products from both Thursday and Monday runs.

Continuation of MACC project (October)

The grant agreement for the continuation of the project Monitoring Atmospheric Composition and Climate (MACC) enters into force. This means that a second phase of funding for the pre-operational GMES atmospheric monitoring and forecasting services is secured until July 2014.

Accession agreement with Croatia signed (November)

The accession agreement between the Government of the Republic of Croatia and ECMWF is signed by the Minister for Science, Education and Sports of the Republic of Croatia, Dr Radovan Fuchs, and the ECMWF Director-General, Professor Alan Thorpe, in Zagreb.

New forecasting model version (November)

A new version of the ECMWF forecasting and analysis system is successfully implemented in operations, containing a collection of improvements to the forecast model, data assimilation and ensemble predictions. This version also includes a new dynamical ocean model with a variational assimilation scheme.

Upgrade of seasonal forecasting system (November)

A major upgrade to the ECMWF seasonal forecasting system is made operational. The new system is at higher resolution, represents the full stratosphere as well as the troposphere, the ocean and the land surface, and utilises a slightly larger ensemble and longer calibration period than the previous system.

Upgrade of computer system (November)

The upgrade of the high-performance computer system starts: ECMWF receives the first delivery of nine frames of computer equipment.

Improving skill

ECMWF is proud of its worldwide reputation for providing the most accurate and reliable medium-range, global weather forecasts. This is underpinned by a wide-ranging programme of research and development aimed at improving the forecasting system and making full use of satellite data. To assess the impact of these activities, it is essential to continuously monitor the forecast skill using objective and quantitative measures.

For many years the quality of the high-resolution and probabilistic forecasts has been monitored using two headline skill scores. In both cases the very high scores achieved during 2010, compared with those of previous years, have been maintained through 2011.

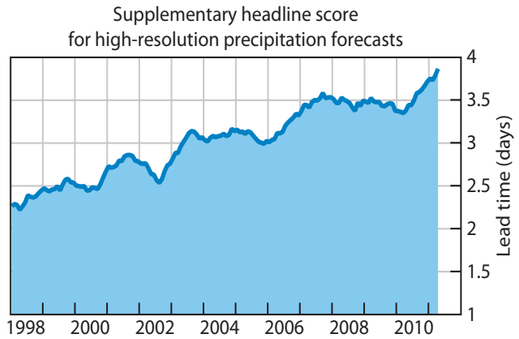
Four scores were added to the headline set in June, which focus on precipitation and severe weather. These reflect the way forecasts from numerical weather prediction (NWP) models are used by Member and Co-operating States as a basis for providing products and services to their users. For both the high-resolution and probabilistic forecasts of precipitation the skill has increased in the last two years, primarily as a result of enhancements to the forecasting system implemented in 2010. Predictions of the location of tropical cyclones and their surface wind speeds have also improved.

These headline scores are complemented by a wide range of other scores that are used to monitor performance and to diagnose where improvements to the forecasting system are required. Also these scores help users interpret and make best use of ECMWF products.

As well as considering how the quality of forecasts varies with time, it is also important to make comparisons with other NWP centres. Such comparisons are produced using procedures specified by the World Meteorological Organization. The results show that ECMWF has maintained its world-leading position, even though the forecasts from all NWP centres have improved.

HEIKKI JÄRVINEN (SAC CHAIRMAN)

“The Scientific Advisory Committee is very satisfied with the progress made in the research in 2011. The performance of the prediction systems has been excellent. Also the research activities have been in line with the Centre’s four-year plan and the longer-term goals of the strategy.”



Improving skill of precipitation forecasts. *The increasing quality of precipitation forecasts can be measured by the time into the forecast for which the skill remains above a given threshold. Shown are the results for one of the new headline scores concerned with the high-resolution forecast. There is an upward trend in the skill of the precipitation forecasts. The results for the probabilistic forecasts show a similar trend.*

Forecasting severe weather

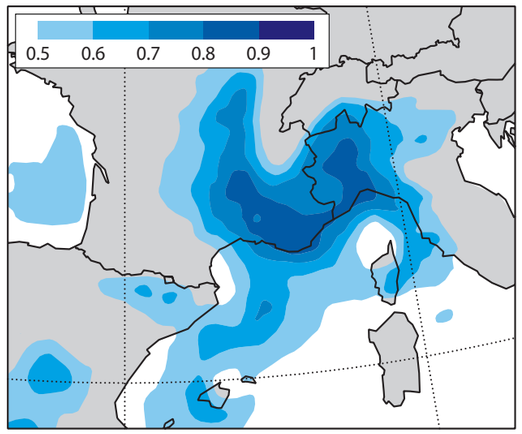
ECMWF’s forecasts are used by its Member and Co-operating States to provide early warnings of severe weather to their customers, including civil protection agencies and the public. The benefits are significant: contingency plans can be put in place to mitigate the potential for damage to property, loss of life, and reduced economic activity. Producing reliable forecasts of severe weather across the medium range is thus a key aim of ECMWF.

The Extreme Forecast Index (EFI) was developed at ECMWF as a tool to provide general guidance on potential extreme events. By comparing the NWP ensemble forecasts with the model’s climate, the EFI indicates occasions when there is an increased risk of an extreme event occurring.

A good example of the ability to forecast severe weather occurred in early November, when there was prolonged heavy rainfall that caused widespread, severe flooding in north-west Italy and south-east France. For example, 183 mm of rain in Genoa over three days produced flash floods that left seven people dead and caused major disruption to transport and infrastructure across the region. Thousands of people were evacuated in both France and Italy. Both high-resolution and probabilistic forecasts gave clear and consistent predictions of this event up to five days ahead.

Liguria, a coastal region of north-western Italy, also suffered from devastating flooding on 26 October and both the high-resolution and probabilistic forecasts provided good predictions of the event well in advance.

Providing guidance about significant changes in the weather regime is important even if there are no hazards involved. There was a period of unusually warm weather in western Europe at the end of September and early October. Indeed, in the UK some places broke their record for the highest temperature in October. The transition to the regime giving these unusually high temperatures was very well forecast over a week ahead.



Providing an early indication of extreme rainfall affecting southern Europe in November 2011. *The Extreme Forecast Index for 4 to 6 November from the forecast from 00 UTC on 31 October gave a clear indication of the areas at risk of extreme rainfall (the darker the colour the higher the index). There was a similar though weaker signal of an extreme event in the forecast from two days earlier. Subsequent forecasts showed an increased likelihood of extreme rainfall for the period from 4 to 6 November.*

Bringing research through to operations

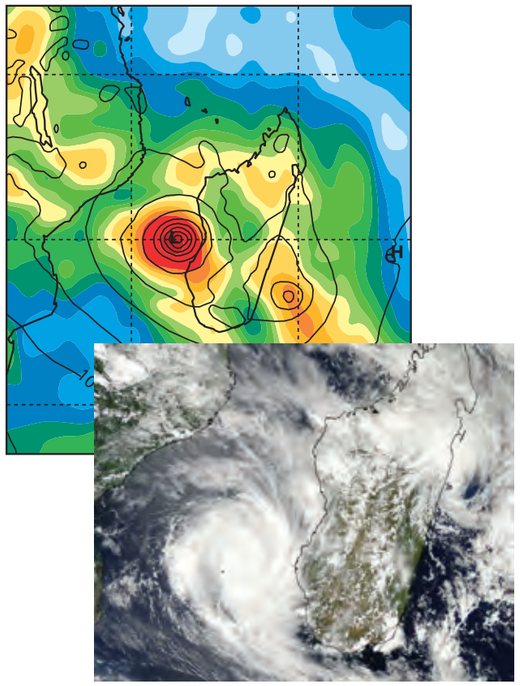
The success of ECMWF depends crucially on its ability to develop and operationally implement innovative techniques in numerical weather prediction. This is supported by world-class research and strong links with the research community and space agencies. ECMWF has progressively improved its medium-range forecasts to a level where it forms the basis of a broad range of applications.

Monitoring developments within the scientific community helps identify the most promising lines of research. But the options available are wide and varied, so the priorities are guided by feedback from users, diagnostics from the forecasting system that highlight where improvements could be made, and new insights and ideas from collaborating scientists.

The forecasting system is normally upgraded three times a year. Some of the changes are straightforward; these are aimed at correcting or modifying a certain aspect of the system, with only a slight impact on the forecasts. At other times, however, sustained research at ECMWF leads to major changes that significantly increase the quality of the forecasts. One such development affected the data assimilation system – the system used to initialise the forecasts. This was the recent operational implementation of the Ensemble of Data Assimilations (EDA), for which research activities started in 2005.

Analysis uncertainty is the main source of forecast uncertainty from the initial time and into the medium range. The EDA provides good estimates of this uncertainty, taking into account the density and accuracy of observations and the flow dynamics. This information improves the performance of the data assimilation system used for the high-resolution forecasts, with the skill of these forecasts increasing significantly as a result. Also it provides better initial conditions for the Ensemble Prediction System (EPS).

The EDA is just one example of research being brought through to operations. Other research activities have resulted in operational changes in 2011 and current research will provide the basis for further improvements to the quality of the forecasts.



Providing estimates of analysis uncertainty. *The information from the Ensemble of Data Assimilations (EDA) gives an estimate of the error-of-the-day and influences how observations are used in the analysis. This is especially important in the proximity of active weather systems. Shown is the EDA-based analysis uncertainty for surface pressure near tropical cyclone Fanele. There is a clear maximum near the centre of the storm as it approaches the coast of Madagascar. Implementation of the EDA in the forecasting system in May 2011 had a positive impact on the skill of the high-resolution forecast and contributed to making the upgrade one of the most successful of the past decade.*

Responding to feedback

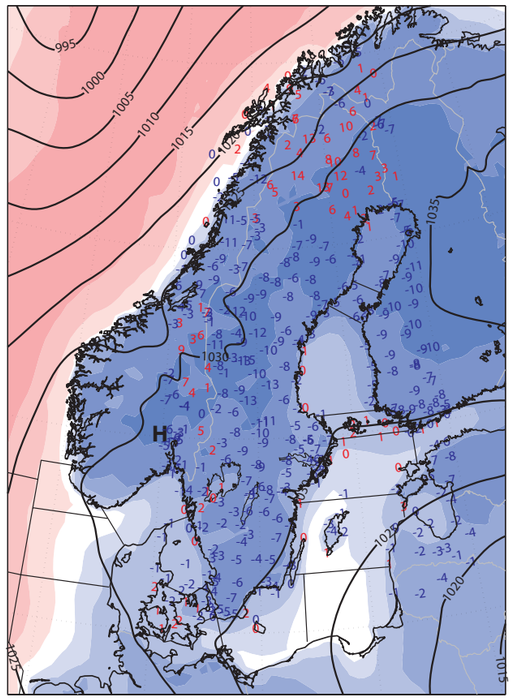
All changes to the forecasting system undergo extensive testing. Initially our research scientists assess the impact of any proposed changes. Then the complete set of changes undergo independent validation by operational staff. During this phase the experimental system is run in parallel with the operational real-time forecast and attention is paid to any significant differences between the forecasts.

Before operational implementation, the experimental system is tested over historical cases to cover all seasons and a large range of weather types. However, no matter how extensive the testing regime, there is always the possibility that in some particular location or weather situation the changes might have an adverse effect. Consequently, getting feedback from users about the impact of any operational changes is vital.

During the winter of 2010/11 feedback was received from Member States and other users concerning significant cold biases in the near-surface temperature forecasts, particularly in very cold weather.

The national meteorological services (NMSs) in Finland, Sweden and Norway use ECMWF high-resolution forecast products to serve large numbers of customers. However, for the large errors experienced in the winter of 2010/11, it was difficult for forecasters to apply corrections to the temperatures.

Staff from ECMWF visited the three NMSs to better understand the problems and the impact they had on customer trust and key performance measures. At the same time there were intensive investigations at ECMWF. It was found that in very specific circumstances the changes implemented in November 2010 to make the cloud scheme more physically realistic could cause the cold bias. In November 2011 changes were implemented in the forecasting system to reduce the large negative temperature errors in these specific wintertime situations.



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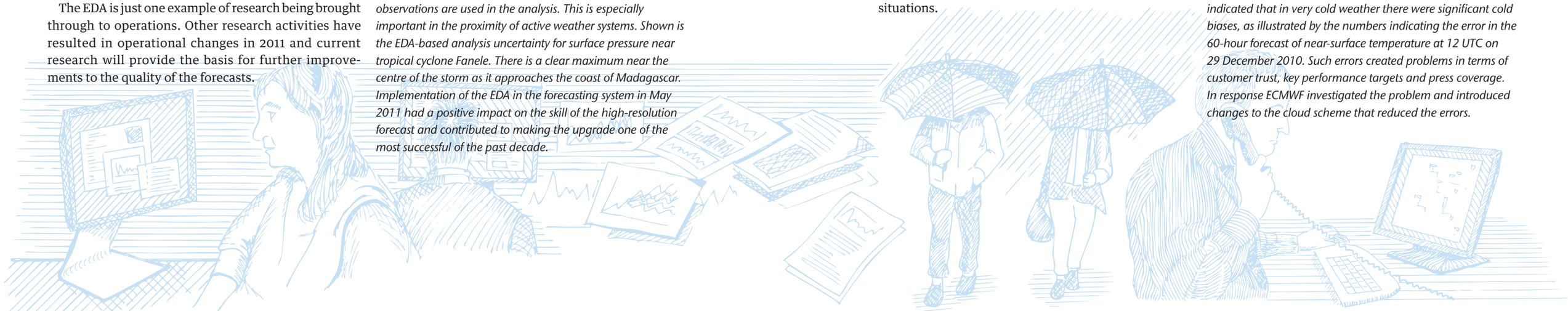
Dealing with cold biases in temperature forecasts in the 2010/11 winter. *Feedback from some Member States indicated that in very cold weather there were significant cold biases, as illustrated by the numbers indicating the error in the 60-hour forecast of near-surface temperature at 12 UTC on 29 December 2010. Such errors created problems in terms of customer trust, key performance targets and press coverage. In response ECMWF investigated the problem and introduced changes to the cloud scheme that reduced the errors.*



Working with Member States

From its inception ECMWF has worked in partnership with its Member States and been driven by their requirements. In order to keep abreast of changing requirements, ECMWF is in continual contact with its users. Also ECMWF's strategy and plans are extensively discussed with representatives of the Member States in various committees before consideration by the Council.

The aim is for ECMWF to remain a world leader in global medium-range NWP so that the best possible forecast products can be provided to Member States, particularly national meteorological services. Indeed, Member States increasingly rely on output from ECMWF as a basis for providing services, especially for early warnings of severe weather.

There are many ways in which ECMWF's activities and the evolution of its products and services are discussed with users. For example, the visits to Member States by ECMWF staff, workshops at ECMWF on particular topics, and the annual *Forecast Products Users' Meeting* help shape ECMWF's research and development programme.

Opportunities are sought to collaborate with national meteorological services, international organisations and other institutions, particularly within Europe. With Météo-France there has been a fruitful and long-standing relationship involving an initiative to develop a sophisticated data assimilation system, known as 4D-Var. There are regular co-ordination and technical meetings to share expertise and agree on programmes of work and development priorities.

In the rapidly developing field of ensemble data assimilation, informal collaboration exists. For example, information is being exchanged with researchers in the meteorolgical services of France, Germany, Italy and the UK. In addition, there is collaboration with AEMET, the Spanish Weather Service, on research areas such as model uncertainty and ensemble-based assimilation methods.

During 2011 a joint project was initiated to restructure the computer code of the complex forecasting systems used at ECMWF and several other European weather forecasting institutes. This will make it easier for their forecasting systems to be managed and developed.

FLORENCE RABIER (MÉTÉO-FRANCE)

"The implementation of the Ensemble of Data Assimilations at ECMWF is a major achievement. Similar developments were implemented at Météo-France a couple of years ago, which also showed a benefit for both the quality of the high-resolution forecasts and the performance of the short-range ensemble prediction system. The strong collaboration between Météo-France and ECMWF on this topic was found to be highly beneficial."

JEAN-NOËL THÉPAUT (ECMWF)

"The close collaboration between ECMWF and Météo-France goes back many years to the original design of ECMWF's current forecasting system and the development of the 4D-Var assimilation scheme. In particular, the secondment of many Météo-France scientists to ECMWF has contributed to an efficient sharing of expertise. The story continues, and our recent implementation of the Ensemble of Data Assimilations clearly illustrates how active this collaboration remains."

Supporting users

ECMWF is a user-driven organisation – this involves not only responding to user requirements but also providing support to users so that they get full benefit from ECMWF's products. Running training courses and workshops, making visits and aiding technical experts and researchers all have a key role in supporting users as well providing a means of obtaining feedback.

Each year ECMWF offers training courses on the *Use and Interpretation of ECMWF Products* to assist staff in Member and Co-operating States who use ECMWF products either directly as duty forecasting staff, or in research and development work. A similar course is also run for forecasters world-wide, focusing on developing countries that use ECMWF products available to Members of the World Meteorological Organization.

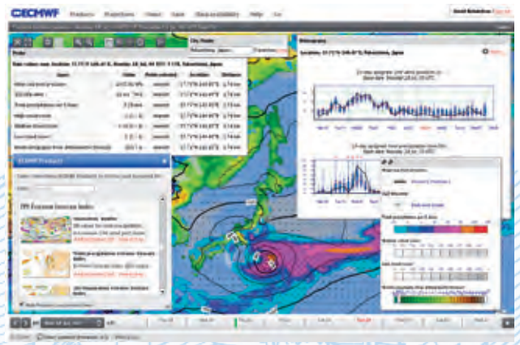
Published in October, the fifth edition of the *User Guide to ECMWF Forecast Products* provides advice about how to make best use of both the high-resolution and probabilistic information from the forecasting system. Ongoing meteorological support is also provided through the contact points in the Member and Co-operating States.

Each year ECMWF organises training to introduce users to its computing and archive systems. Also advanced training in numerical weather prediction is provided. In 2011 the annual seminar gave an excellent opportunity for young scientists to learn about recent advances in data assimilation from leading experts.

Visits to Member and Co-operating States by ECMWF staff, the annual *Forecast Products Users' Meeting* and biennial *Workshop on meteorological operational systems* are important events for sharing knowledge and expertise, and for users to express their requests for new products. In response to such feedback, a new system was implemented that provides forecasters with enhanced access to ECMWF products using a web-based interactive tool. With this forecasters can also prepare their own tailored material.

Support is given to technical experts and researchers in Member States who use ECMWF's computing facilities. An example of this is the help given with the introduction in 2011 of three time-critical applications that are run on ECMWF's supercomputer on behalf of Member States. This involved extensive testing of applications and continuous monitoring.

Using and interpreting ECMWF products. *In October 2011 twelve participants from Africa, Asia and Oceania participated in a week of intensive activities designed to improve their understanding of the ECMWF products that are available to Meteorological and Hydrological National Services of WMO Members.*



Providing an interactive web facility for forecasters. *With the new ecCharts facility forecasters can easily zoom and pan to relocate the map to any geographical area of interest. Also they can display a wide range of fields from the high-resolution and probabilistic forecasts. Time series can be displayed by clicking on any point or using the city finder tool.*

Monitoring the climate

The reanalysis technique is used for reprocessing past observations to produce a record of the state of the atmosphere that is consistent, coherent and comprehensive. Since reanalyses are produced with fixed, modern versions of data assimilation systems used for numerical weather prediction, they are suitable for monitoring the climate. Reanalyses also support a wide range of activities such as seasonal prediction and model development.

For many years ECMWF has been at the forefront of reanalysis activity, based on the expertise of its staff and the quality of its forecasting system. The latest ECMWF atmospheric reanalysis is ERA-Interim, which extends back to 1979 and continues to be updated close to real-time.

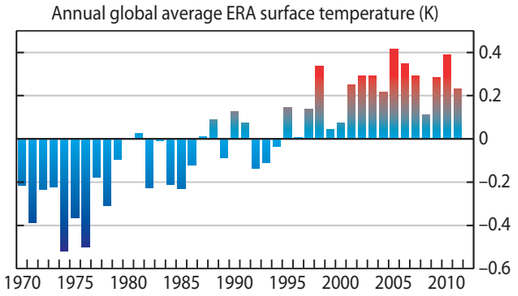
The popularity of the ERA-Interim dataset continues to grow: new applications are emerging regularly and the number of registered users is now over 9,000. In particular, there is increasing use of ERA-Interim data for climate monitoring. To support this work and encourage greater use of the data, ECMWF has implemented a new high-capacity public data server.

ECMWF leads the three-year European project, ERA-CLIM, to prepare a new global climate reanalysis extending back to the early 20th century. The project started in January 2011 and involves nine partners. ECMWF is building the data assimilation systems used for the reanalysis and will develop the facility by which users can access the reanalysis data products and the observations.

A major focus of ERA-CLIM is rescuing instrumental observations. Several project partners are uncovering large volumes of early weather observations that are not currently available in digital archives. These include highly valuable upper-air observations in tropical and high-latitude regions made in the first half of the 20th century. This laborious and painstaking process of digitising the data is carried out using a variety of tools and techniques plus a great deal of human quality control.

DICK DEE (ECMWF)

“Reanalyses provide the most comprehensive and accurate four-dimensional picture of the atmosphere. They allow the variability and change of global climate to be monitored, thereby contributing to the understanding and attribution of climate change.”



Using reanalysis data for climate monitoring. *The ECMWF reanalysis data can be used to show changes in global mean near-surface temperatures since 1970. This is one of many climate indicators that are monitored. Each bar shows, for a given year, the difference from the 1970–2011 average. The upward trend in global mean temperature is clearly shown. However, temperatures in 2011 were somewhat cooler than in recent years due to the cooler than normal water temperatures in the Equatorial Pacific Ocean associated with La Niña conditions.*

Providing information about air quality

There is increasing interest in the impacts of atmospheric composition on the environment and, in particular, in recent trends. ECMWF has a key role in a European project concerned with monitoring and forecasting atmospheric composition. The project provides information services covering European air quality and global atmospheric composition, including greenhouse gases, ultraviolet radiation and solar energy.

Monitoring Atmospheric Composition and Climate – Interim Implementation (MACC-II) is the pre-operational Atmospheric Service of the Global Monitoring for Environment and Security (GMES) programme. It will run until July 2014 with the consortium, led by ECMWF, comprising 36 partners from 13 European countries. MACC-II succeeded the MACC project in November 2011.

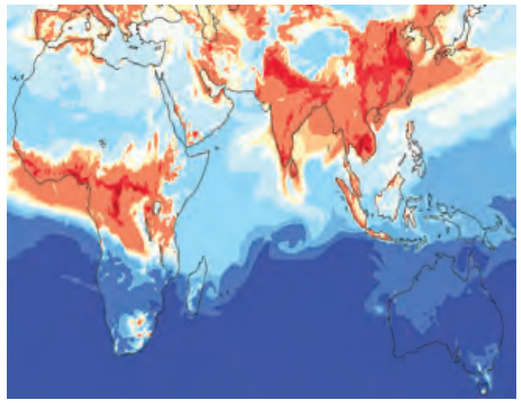
MACC-II provides data for monitoring present conditions and atmospheric composition for recent years, and forecasts of key constituents for a few days ahead. This is achieved by combining state-of-the-art atmospheric modelling with remote-sensing and in-situ data.

MACC has recently completed a retrospective analysis (reanalysis) of atmospheric composition for the period from 2003 to 2010. A large number of users have already taken advantage of this reanalysis.

MACC has helped support the development of forecast products that meet the needs of users who require environmental information. For example, air quality has a direct impact on the well-being of people, thus reliable products are very important for daily decision-making and the development of policies.

The output from MACC is not only being used as the basis for environmental services and scientific investigations, but it also helps improve the representation of processes in ECMWF's forecasting model, one example being the interactions between aerosols and the hydrological cycle. This in turn improves the quality of medium-range, monthly and seasonal forecasts.

The production of services will move from research mode to operations and there will be increased emphasis on communication and user support, in order to be in full readiness for the sustainable implementation phase of the GMES programme.



Providing a tracer of combustion sources. *With an atmospheric lifetime of approximately one month, carbon monoxide is in particular a tracer of combustion sources, such as biomass burning and various anthropogenic activities. The chart shows a simulation of surface carbon monoxide using ECMWF's forecasting system extended with a representation of chemical processes. High values of carbon monoxide are in bright red with dark blue indicating very low values.*

Developing partnerships

The fruitful partnerships with its expanding membership, space agencies and other European institutions underpins ECMWF's achievements. These partnerships help sustain ECMWF's core mission, enhance collaboration and ensure there is a focus on the needs of users. Co-operation was a key reason for the creation of ECMWF and this continues to be at the heart of its remit.

Following the amended Convention coming into force in June 2010, Iceland became the first new Member State, the 19th, on 1 July 2011. Also in 2011, accession agreements were signed with Slovenia and Croatia. They will become Member States once the agreements have been ratified by their parliaments. Discussions continue with other countries about membership of ECMWF.

In recent years the number of Co-operating States has also increased rapidly. In 2011 the former Yugoslav Republic of Macedonia joined the ranks of the Co-operating States, thereby increasing the number to 15.

ECMWF co-operates extensively with the meteorological community in Europe and beyond to develop various elements of its forecasting system. For example, there are the long-duration visits by scientists from Member and Co-operating States, as well as from places such as China, Japan and the USA, to work on topics of common interest.

ECMWF has a key role within the European Meteorological Infrastructure (EMI). Being part of the EMI provides the essential linkage to a wide variety of partners. As well as ensuring ECMWF's activities are driven by feedback from the users and customers, particularly of the national meteorological services, ECMWF can respond to requirements from the broader meteorological community.

ECMWF works particularly closely with the European Organisation for the Exploitation of Meteorological Satellites (EUMETSAT) in maximizing the benefit from its operational satellites, preparing future space programmes and participating in several of its satellite application facilities. In 2011, ECMWF was particularly active in supporting the case for the EUMETSAT Polar System Second Generation programme. Also the partnership with the European Space Agency (ESA) and other space agencies led to further improvements in the use of satellite data. ECMWF has continued to closely collaborate with other international organisations including the European Commission, World Meteorological Organization (WMO) and EUMETNET.

Expanding membership of ECMWF. *With Iceland joining, ECMWF now has 19 Member States along with 15 Co-operating States. Negotiations about membership are underway with four states. In addition there are co-operation agreements with seven organisations, including the WMO, EUMETSAT and ESA.*

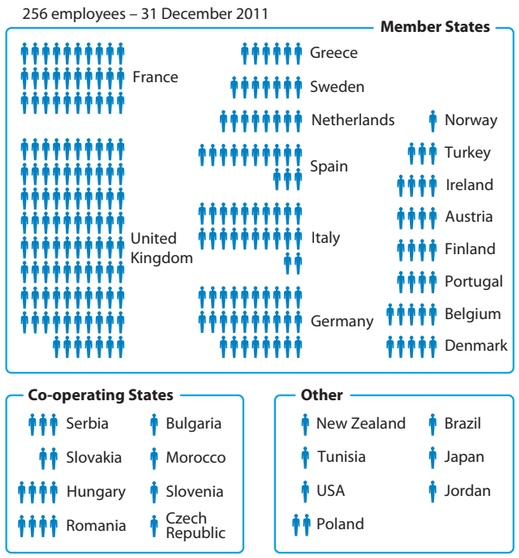
Attracting excellent staff

A key strength of ECMWF is the recruitment and retention of staff who are highly motivated and distinguished in their area of activity. Being able to work in a dynamic environment and having the opportunity to develop expertise are key attractions. Also the exchange of staff between ECMWF and Member States has been of great benefit in sharing and enhancing expertise.

Every effort is made to attract the best staff. Jobs are widely advertised both within Member States and in the broader meteorological, scientific and technical communities. For some highly-specialised posts the adverts are placed in relevant journals. In future the recruitment process will make more use of web facilities.

In 2011 there were 26 vacancies and this led to 666 applications with 26% of them from females. In terms of their origin, 477 applications came from Member States and 82 from Co-operating States, with the remainder from other countries. In 2011 ECMWF welcomed 49 new people from 17 countries. The mix of nationalities and backgrounds provides a stimulating environment for high-quality research, development and operational activities.

Having talented people working at ECMWF has ensured it continues to be at the forefront of applying the latest research and technological developments to meet the demanding requirements of Member States.



KATALIN NOVAK

"Having already worked in a UN agency in Hungary I was keen to continue using my HR expertise in an international organisation. Also working with scientists for the first time was an appealing prospect. As a member of the Personnel Team since September 2011 I have the enjoyable task of helping new members of staff settle into ECMWF's multicultural environment."

VINCENT-HENRI PEUCH

"In 1997, whilst working for Météo-France, I visited the Centre and decided it would be a great place to work. When I joined the Centre as GMES/MACC Coordinator in September 2011, I found that those feelings from long ago were correct. I have been impressed by the high commitment of everyone here and their wanting to work together to ensure ECMWF remains a world leader."

Investing in European weather forecasts

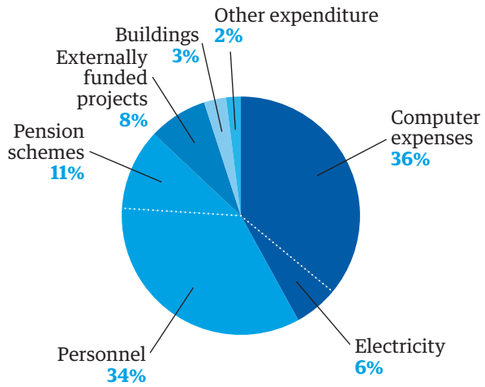
ECMWF was created as a centre of excellence for its Member States. It invests significant parts of its budget in bringing together the best people and computer resources to continue developing and producing the most accurate and reliable medium-range global weather forecasts and delivering them to Member and Co-operating States.

Expenditure

ECMWF invested over £46 million (excluding tax adjustment) in its activities in 2011, of which £20.9 million, or 45% of the total costs, was spent on personnel, including salaries, pensions and training for staff and consultants.

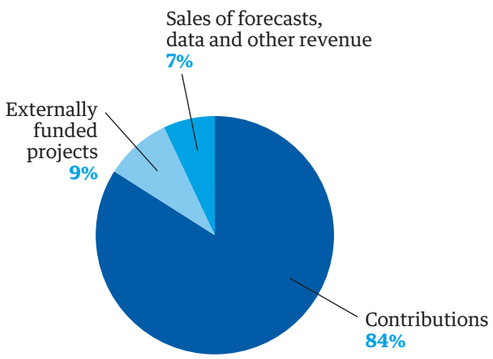
The Centre invested 42% (£19.2 million) of its budget in computing, including operating and developing its high-performance computing facility (HPCF). This is a key element of the success of ECMWF - it underpins both the daily delivery of forecast products to Member and Co-operating States and the ongoing research activities, and also provides access to Member States to perform their own research. This investment included the upgrade to the new IBM power 7 system as well as improvements to infrastructure and resilience.

Of the remainder, £2.4 million was spent on maintaining the premises and the ongoing operating expenses of the Centre. A total of £3.5 million direct costs were associated with externally funded projects.



Revenue

In 2011 ECMWF was funded primarily by contributions from its Member and Co-operating States, amounting to £40 million (84%). Additional funding of £4.2 million (9%) was obtained from participation in a number of research projects funded by other, mainly EU, bodies. A further £3.4 million (7%) was generated from the sale of forecasts and data to commercial and other customers.



Financial information

ECMWF's Financial Statement of Accounts for 2011 has been audited by the Board of Auditors selected from amongst its Member States and approved by the ECMWF Council at its summer session in 2012. The following tables are a summary of the information for 2011 included in those accounts.

Summary Revenue & Expenditure 2011 (£k)

REVENUE	
Member & Co-operating State Contributions	39,924
Sales of forecasts & data	3,458
Externally funded projects	4,161
Tax adjustment	4,502
Interest	152
Total	**52,197**
EXPENDITURE	
Personnel including pensions	20,949
Tax adjustment	4,502
Computing	19,201
Externally funded projects	3,545
Other	2,359
Total	**50,556**
Exchange rate loss & other items	(123)
Net surplus for the year	**1,518**

Summary Balance Sheet 2011 (£k)

Total current assets	22,947
Total non-current assets	161,806
Total assets	**184,753**
Total current liabilities	29,360
Total non-current liabilities	137,307
Total liabilities	**166,667**
Total net assets/equity	**18,086**
Total liabilities & net assets/equity	**184,753**

Member State Contributions (£k)

Austria	833	Luxembourg	87
Belgium	1,044	Netherlands	1,776
Denmark	721	Norway	822
Finland	547	Portugal	498
France	5,956	Spain	3,063
Germany	7,784	Sweden	1,024
Greece	669	Switzerland	1,114
Iceland	111	Turkey	919
Ireland	472	United Kingdom	6,330
Italy	4,879	**Total**	**38,649**

Co-operating State Contributions (£k)

Bulgaria	60	Lithuania	32
Croatia	50	Montenegro	3
Czech Republic	162	Morocco	81
Estonia	17	Romania	114
The former Yugoslav Republic of Macedonia	39	Serbia	36
Hungary	138	Slovakia	99
Israel	365	Slovenia	46
Latvia	33	**Total**	**1,275**

Looking to the future

In June 2011, the Council, which is the governing body of ECMWF, adopted the Centre's strategy for the period 2011 to 2020. The vision is for ECMWF to be the acknowledged world leader in global, medium-range numerical weather prediction. This is to provide the best possible forecast products to our member countries, particularly to national weather services, for the benefit of society.

The principal goal of this strategy is to improve the Centre's global medium-range weather forecasting systems to provide reliable forecasts of severe weather events. We will also endeavour to meet requirements for high-quality near-surface weather forecast products such as precipitation, wind and temperature.

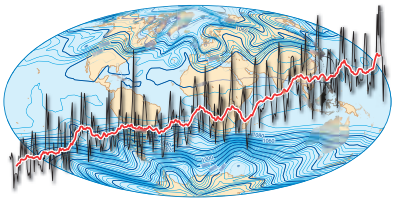
ECMWF will also strive to do the following:

- Improve the quality of its monthly and seasonal forecasts.
- Support climate monitoring with state-of-the-art reanalyses of the Earth-system.
- Contribute towards the optimisation of the Global Observing System.
- Deliver operationally global analyses and forecasts of atmospheric composition.

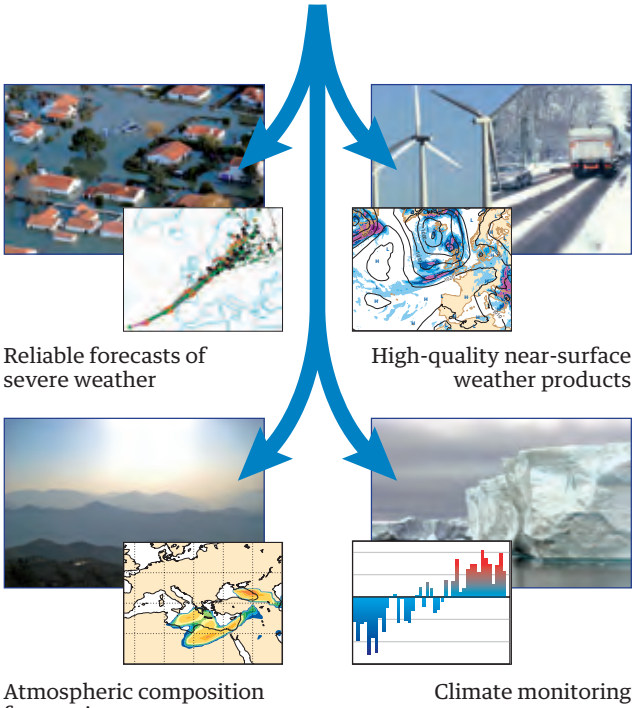
A set of performance measures and targets will support this strategy. In particular a set of headline scores will be used to assess the long-term trends in the skill of ECMWF's operational forecasting systems. This set will be complemented by the development of measures tailored for monitoring progress in the prediction of severe weather in the mid-latitudes.

A major upgrade to the supercomputer system is planned in 2012. Also new versions of the forecasting model are scheduled for implementation in 2012. These will be based on research developments and extensive testing associated with an increase in the vertical resolution.

Underpinning these developments is a continued commitment for ECMWF to be a user-focused organisation where all activities are driven by the requirement to improve forecasting systems and hence the quality of the forecasts. The emphasis will be on meeting the needs of member countries whilst reinforcing partnerships, particularly with space agencies, and maintaining strong links with the research community.



Developing the core forecasting systems



Reliable forecasts of severe weather

High-quality near-surface weather products

Atmospheric composition forecasting

Climate monitoring

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