In this issue

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Front Cover

ECMWF's new web site is covered in this issue *(see the article on page 11)*.

Editorial

On page 2, Roberto Buizza discusses the trends in performance of the Ensemble Prediction System over the eight years of daily operational forecasting from 1994 to 2002. The results indicate that, over the past five years, the average rates of predictability gain have been about 2 days per decade in the Northern Hemisphere and about 1.5 days per decade in the Southern Hemisphere.

On page 6, an interview with Dr Ivan Obrusnik, Director of the Czech Hydrometeorological Institute, outlines some of the anticipated practical benefits that will flow from the Czech Republic becoming a Co-operating State of ECMWF.

The first of a series of articles about programming for the new IBM High-Performance Computing Facility (see ECMWF Newsletter 93 – Spring 2002) on page 9 discusses the implications for the programmer of several hardware features of the computer, together with some performance comparisons. On page 11, Andy Brady, Carlos Valiente and Daniel Varela provide an overview of ECMWF's new web site and its access control system, and details of some new items available on the web site are listed on pages 16 and 17.

Peter White

Changes to the Operational Forecasting System

There have been no changes to the medium-range forecasting system since April 2002.

Seasonal forecasting system

Following its running in pre-operational mode since October 2001, the seasonal forecasting 'System 2' has been given operational status, replacing the 'System 1' version. The main characteristics of the new system are higher-resolution ocean and atmosphere models (T_L95L40, Cy23r4), and retuned ocean data assimilation (including corrections to salinity when temperature is assimilated, and to velocity when density is updated). The ensemble is now made of five different ocean analyses perturbed by wind anomalies. From each analysis, eight perturbations to sea surface temperature are made, creating an ensemble of 40 members, all starting from the same date ('burst mode').

Calibration has been done for this system using a five-member ensemble of hindcasts run from 1987 to 2001. The list of products available from this new system has been significantly enhanced: new Nino3.4 and Nino4 areas in addition to Nino3 for sea surface temperature plumes, probabilities for terciles (below, near and above normal) and large anomalies (Q15 and Q85).

Both System 1 and System 2 forecasts are offered to ECMWF Member States and Co-operating States on http://www.ecmwf.int/products/forecasts/seasonal/. System 1 is, however, likely to be discontinued by the end of 2002. Verification data for both systems are also available from this site, and will be updated regularly. Please note, however, that System 2 40-member ensembles have been run in hindcast mode for November and May only; verification statistics from other months (February and August) use five-member ensembles only.

François Lalaurette

Trends in ensemble performance

The Ensemble Prediction System (EPS) has been part of the ECMWF operational suite since 19 December 1992, when operational production started with 33 members run at T63L19 resolution (spectral triangular truncation T63 with 19 vertical levels). Until 30 April 1994 the EPS was run three times a week (on Fridays, Saturdays and Sundays), while from 1 May 1994 the EPS has been running daily, with 12 UTC as the initial time. Table 1 lists the dates of the major changes applied to the EPS operational configuration (changes in the ECMWF model and data-assimilation systems may be found in the paper by *Simmons & Hollingsworth*, 2001, and references therein).

The EPS resolution and ensemble size were changed twice, in 1996 and in 2001: on 11 December 1996 the EPS was membership was increased to 51 members and the resolution to 51*T_L159L31 (spectral truncation T159 with linear grid). On 21 November 2001 the EPS resolution was further increased to 51*T_L255L40. The EPS initial perturbations were modified several times, in 1993, 1995, 1996, 1998 and 2002. On 20 February 1993 the computation of the initial perturbations was restricted to the Northern Hemisphere extratropics, to optimise their computation during the warm seasons. On 14 March 1995 the resolution of the initial perturbations was increased from T21 to T42. On 4 March 1996 a second set of perturbations growing in the Southern Hemisphere extra-tropics was added to the Northern Hemisphere perturbations. On 25 March 1998, evolved singular vectors were added to the initial singular vectors to generate the EPS initial conditions so that both the direction of fastest error growth during the past two and the future two days are sampled. On 22 January 2002 tropical singular vectors designed to sample the fastest-growing perturbations in the tropical region were added to the EPS initial perturbations. Model uncertainties were not explicitly simulated until 21 October 1998, when a scheme to simulate random model errors due to parameterised physical processes was implemented.

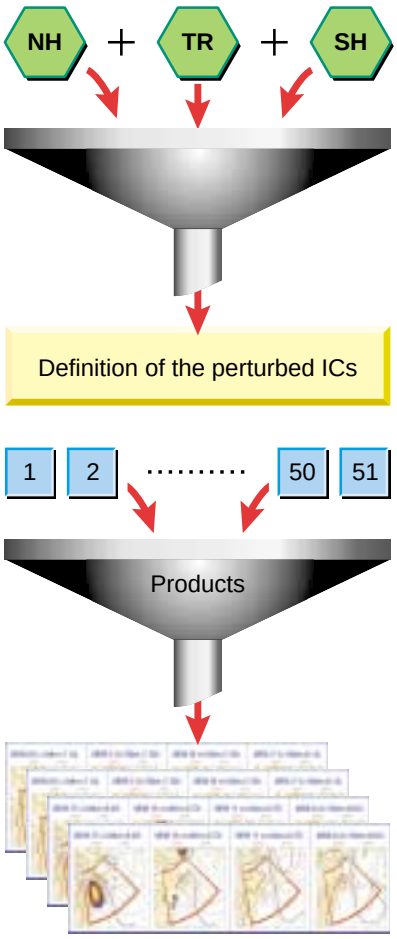

Figure 1 Schematic of the ECMWF Ensemble Prediction System.

Date	Description
19 Dec 1992	Operational EPS: 33 members, T63L19 resolution; three times a week, global T21L19 initial perturbations.
20 Feb 1993	Localization of the initial perturbations to the extra-tropical Northern Hemisphere only.
1 May 1994	Daily EPS.
14 Mar 1995	Initial perturbations' resolution increased from T21 to T42.
4 Mar 1996	Inclusion of Southern Hemisphere extra-tropical perturbations.
11 Dec 1996	Ensemble size from 33 to 51 members, horizontal resolution from T63 to T_L159, vertical resolution from L19 to L31.
25 Mar 1998	Inclusion of the evolved singular vectors.
21 Oct 1998	Simulation of random model errors due to parametrized physical processes (stochastic physics).
12 Oct 1999	Vertical resolution from L31 to L40.
21 Nov 2000	Horizontal resolution from T_L159 to T_L255.
22 Jan 2002	Inclusion of tropical singular vectors.

Table 1 EPS milestones.

Figure 1 is a schematic of the current EPS configuration. Perturbations growing fastest over the Northern Hemisphere, the Southern Hemisphere and the Tropical region are computed separately and then combined to generate the EPS initial perturbations. The initial perturbations' amplitudes are set to be locally comparable to analysis error estimates provided by the ECMWF 4D-Var data assimilation system. The control 10-day forecast is integrated, starting from the unperturbed analysis (which is defined by interpolating the operational T_L511L60 analysis to the ensemble T_L255L40 resolution) while the 50 10-day perturbed forecasts start from analyses modified by adding the initial perturbations to the unperturbed analysis. Forecasts are then post-processed to generate deterministic and probabilistic products. A subset of these products is distributed to the Member States, which

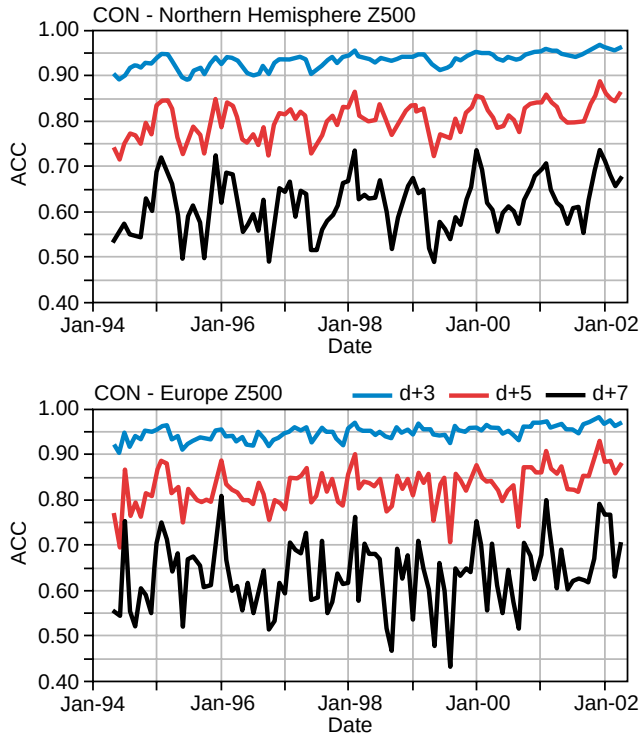

Figure 2 Time series of monthly-average anomaly correlation coefficient of the EPS control forecast over the Northern Hemisphere (top) and Europe (bottom). Scores for the 500 hPa geopotential height forecast for d+3 (blue line), d+5 (red line) and d+7 (black line) are shown from May 1994 until April 2002.

can generate customized products by accessing directly the single 51 forecasts using MARS (the ECMWF Meteorological Archival and Retrieval System).

This report documents the progress of the EPS performance during the first eight years of daily production, from 1 May 1994 until 20 April 2002. Attention is focused on the performance of EPS deterministic and probabilistic forecasts of the 500 hPa geopotential height (Z500). Results are based on fields interpolated on a regular 2.5° grid and on probabilities binned into 1/N categories, where N is the ensemble size. Monthly-average forecast scores over Europe and the Northern Hemisphere are discussed.

Time-series of the accuracy of EPS deterministic products

The two most immediate products that can be generated using the EPS are the control and the ensemble-mean forecasts. Figure 2 shows the time evolution of the skill of the EPS control forecast measured by the anomaly correlation coefficient (ACC); according to this measure, a perfect forecast would have ACC = 1. Results indicate an upward trend in forecast skill for both areas with, for example, d+5 forecasts above the 0.80 ACC level after the EPS upgrade to 51*TL255L40 (and the upgrade of the analysis resolution) in November 2000. Figure 3 shows a scatter diagram of the skill of the EPS control and the operational high-resolution forecasts (top) and of the EPS control and the ensemble-mean (bottom) at d+5 and d+7 over the Northern Hemisphere (top panel). Results indicate that the high-resolution forecast is more skilful than the EPS control at d+5 while the two forecasts have rather similar skill thereafter. It might be noted that high-resolution forecasts tend to have an advantage over the EPS control at d+7 in relatively good cases, while the converse is true for relatively poor cases. The ensemble-mean scores better than the control for both forecast times. Results for Europe are similar (not shown).

Time-series of the accuracy of EPS probabilistic products

The accuracy of probabilistic products have been assessed using three accuracy measures, the Ranked Probability Skill Score (RPSS), the area under the Relative Operating Characteristic curve (ROC-area) and the Brier skill score (BSS). All three measures are positively oriented, with perfect forecasts reaching a value of 1 for all measures. The Brier score is essentially the mean-squared error of the probability forecasts for a dichotomous event (i.e. an event with only two possible outcome), while the ranked probability score is an extension of the Brier score to a multi-event situation. The area under the ROC-curve measures the capability of the system to discriminate between hit and false alarms. For the RPSS and BSS, positive (negative) score values mean that the EPS is more skilful (less skilful) than a forecast based on climatology, while for the ROC-area, a value of 0.5 indicates that the EPS cannot distinguish between hits and false alarms. The reader is referred to Wilks (1995) for a review on forecast verification and score definition, and to the EPS-published literature for their applications.

Figure 3 Scatter diagram of the monthly-average anomaly correlation coefficient of the EPS control and the high-resolution forecasts (left) and of the EPS control and the ensemble-mean forecasts (right) over the Northern Hemisphere. Blue diamonds identify 500 hPa geopotential height d+5 forecasts and red triangles d+7 forecasts from May 1994 until April 2002.

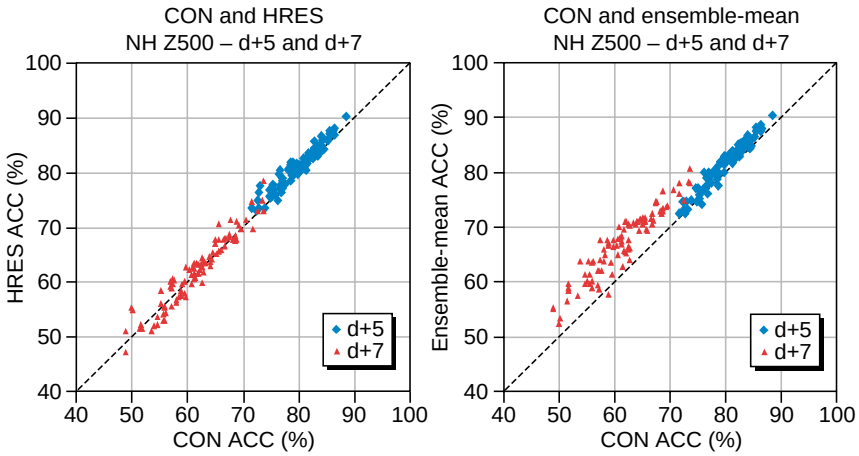

Figure 4 shows that for both areas the RPSS has been increasing. For the Northern Hemisphere, the d+5 RPSS reaches now the 0.7 level, which was reached by the d+3 forecast in 1994 and 1995. Similarly, the d+7 RPSS reaches the 0.6 level, which was reached by the d+5 forecast in 1994 and 1995. Results for Europe are more variable, but still indicate a substantial improvement. Figure 5 shows the ROC-area for the prediction of the event '500 hPa geopotential height above the climatological value'. Northern Hemisphere results confirm that the quality of the EPS probability forecasts have improved by a similar amount. Results for Europe confirm the positive trend. Figure 6 shows the BSS for the prediction of the same event. Again, results confirm the improvement of the EPS probability forecasts. The ROC-area and BSS have been computed for two other events, '500 hPa geopotential height positive anomalies larger than sigma' and '500 hPa geopotential height positive anomalies smaller than sigma', where sigma is a measure of the monthly variability. Results for these two events (rarer compared with the first event considered) confirm the positive trend (not shown).

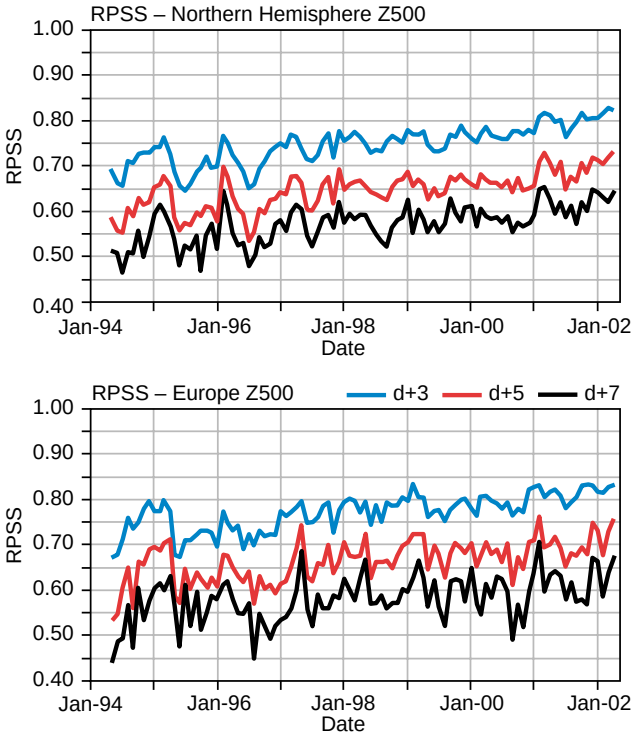

Figure 4 Time series of monthly-average RPSS of EPS forecasts over the Northern Hemisphere (top) and Europe (bottom). Scores for the 500 hPa geopotential height forecast for d+3 (blue line), d+5 (red line) and d+7 (black line) are shown from May 1994 until April 2002.

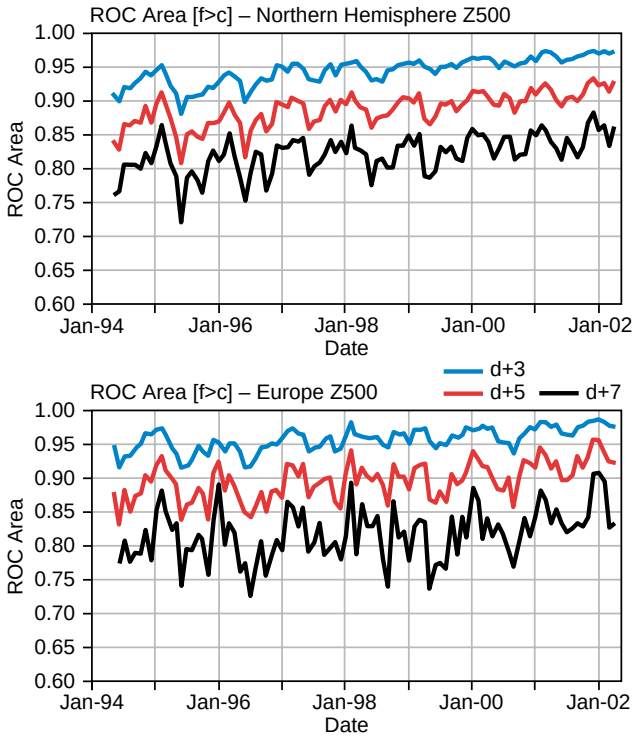

Figure 5 Time series of monthly-average ROC-area values of EPS forecasts over the Northern Hemisphere (top) and Europe (bottom). Scores for the prediction of the event '500 hPa geopotential height above the climatological value' for d+3 (blue line), d+5 (red line) and d+7 (black line) are shown from May 1994 until April 2002.

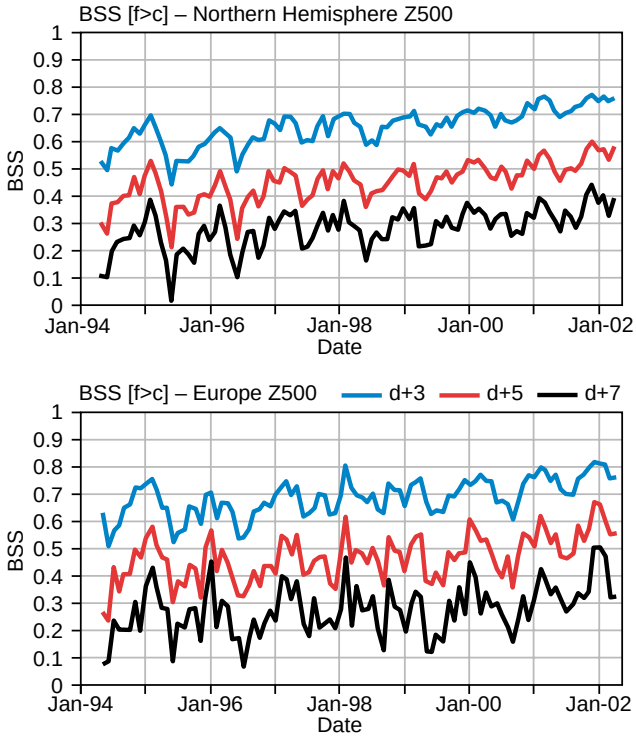

Figure 6 As figure 5 but for BSS values of EPS forecasts over the Northern Hemisphere and Europe.

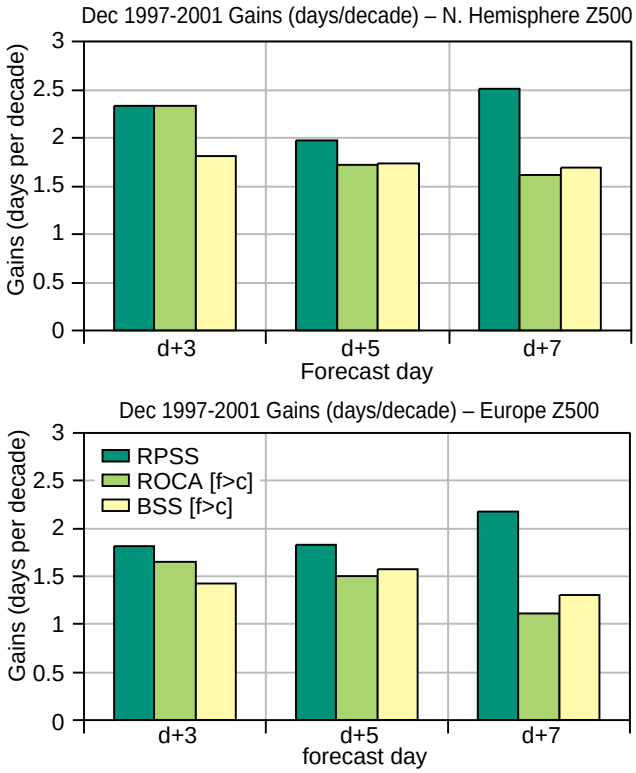

Figure 7 5-year average (December 1996–December 2001) predictability gains of EPS probability products computed using RPSS (dark green bar), ROC-area (light green bar) and BSS (yellow bar) over the Northern Hemisphere (top) and Europe (bottom). Results are based on 500 hPa geopotential height probabilistic forecasts and are expressed in days per decade.

Trends in EPS probabilistic scores

The positive trends in the probabilistic scores have been quantified by least-square linear fitting and transformed into day-gains of predictability. Figure 7 shown the 5-year average (December 1996 to December 2001) predictability gains (expressed as days per decade) computed using all three probabilistic accuracy measures, RPSS (blue bars), ROC-area (black bars) and BSS (red bars), at d+3, d+5 and d+7. Results indicate that gains are slightly higher for the Northern Hemisphere than for Europe, and for the shorter than the longer forecast range.

Consider, for example, the Northern Hemisphere. The RPSS and ROC-area d+3 results indicate a gain of ~2.5 days/decade; in other words, the RPSS and ROC-area d+3 values in December 2001 are about the same as at d+1.75 in December 1996. The BSS d+3 results indicate a smaller gain of ~1.75 days/decade. Similar considerations can be made for the other forecast steps. Results for Europe are similar, with gains about 10% smaller.

Acknowledgement

A. Hollingsworth and A. Simmons are thanked for their comments. The ECMWF Ensemble Prediction System is the result of the technical and scientific work of many ECMWF staff and consultants: the EPS improvement over the past eight years has been achieved thanks to their work.

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Roberto Buizza

Joining the ECMWF improves the quality of forecasts

Český hydrometeorologický ústav

This interview with Dr. Ivan Obrusnik, Director of the Czech Hydrometeorological Institute, was originally published in Meteorologické Zprávy (Meteorological Bulletin) 54 (2001), and is reproduced here in English translation with the permission of the Editor. The interviewer was Dr Z. Horký.

Q1 *The Czech Republic became a Co-operating State of the European Centre for Medium-Range Weather Forecasts (ECMWF) in Reading in August 2001. The management of the Czech Hydrometeorological Institute (CHMI) had been trying to join ECMWF for a quite long period, but the realization was delayed, particularly for economic reasons. Could you tell us why joining ECMWF has been so important for our Service?*

The conclusion of a Co-operative Agreement with ECMWF is important for CHMI, and even for the whole Czech Republic, for several reasons. First of all, it is an attempt to improve the quality of the forecasting and warning service of CHMI for cases of floods or states of emergency caused by severe meteorological phenomena. Another reason is an effort to extend the lead-time of forecasts based on numerical weather models from about five days to as far as ten days ahead. Up to now we have been using high-quality forecasts and products (from the regional model ALADIN) computed at CHMI applicable up to 48 hours ahead only, and forecasts from global models that have so far been applicable up to five days ahead. In addition to the above-mentioned prolongation of the forecast interval we hope that data from ECMWF 'ensembles' will improve forecast objectivity in general, especially in cases of extreme phenomena, and will help to realize a gradual transition towards probabilistic forecasts as well. Also, users of our forecasts, both the public and companies, will profit from improved forecast quality. Finally, co-operation between CHMI and ECMWF will bring better contacts between our meteorologists and their Western European colleagues, and permit full access to all the data and products of ECMWF – it will lead, not only to the improvement of the level of operational meteorology and climatology, but also to an enhancement of research in these fields in general. I have in mind here the research throughout the Czech Republic, not only in our institute. I should also not forget to mention the possibility of access to experimental seasonal forecasts originating from 'ensembles'. A final, but significant, contribution is more on a political level - our meteorologists will obtain tools of the same quality as their colleagues in the European Union (EU) and, similarly, the users of our services will gain a better access to the data and information on a European level. I think it is possible to consider it as one of the steps of the Czech Republic towards joining the EU.

Q2 *The Forecasting Centre of CHMI uses products from several numerical weather models (ALADIN, British, American, German ones). Recently, an article in the Meteorological Bulletin by our meteorologist Dr. Pavlik dealt with the problems of the use of meteorological data for the warning service. On the basis of an analysis of some particular cases he demonstrated significant differences in estimates obtained from particular models. Could you tell us why you think the European Centre (data, programs, methods) can produce data having higher quality than those from other centres? Based on your information provided to press agencies, it follows that the co-operation with ECMWF will bring more precise forecasts accompanied by prolongation of the lead-time. Is this realistic?*

The establishment of the European Centre itself was based on an assumption that only joint effort and shared financial resources would enable the development and operation of a numerical weather model with a sufficient quality for an extended forecasting interval. The ECMWF model was based on the most advanced climate models and on high-quality data assimilation on a global scale. Other models mentioned in your question have their individual advantages, but only produce forecasts for a shorter period (ALADIN for 48 hours, global models for 3 to 5 days ahead). A good medium-range weather forecast model (5-10 days ahead) was missing until the establishment of the ECMWF. Dr. Pavlik has just demonstrated the fact that by using more models of a similar quality, we can obtain several relatively different results or forecasts. In practice it is very difficult for a meteorologist to decide which model to prefer. This situation cannot be improved just by the use of a still greater number of these models. The solution can be (and papers given at the recent conference on applied meteorology ECAM 2001 at Budapest confirm it fully) that the use of a rather different model of high quality should make the decision easier. I think the ECMWF's model represents such a model. Several Western European meteorological services use, in routine practice, a good limited-area model (like ALADIN) for forecasting 48 hours ahead. Other models, mostly global models, are used rather as complementary forecast information. The European Centre can produce high-quality products as a consequence of greater human resources and massive financial support. The ECMWF starts from good quality observations and an efficient data assimilation scheme, and processes the data by means of a sophisticated model using efficient numerics with good parametrizations, and it has an effective system of ensembles to eliminate errors in input data. Moreover, the European Centre uses very powerful supercomputers, which individual countries cannot afford. I believe that the products of the ECMWF have always been of high quality, and this quality has also been appreciated outside Europe (e.g. in the USA and in Japan).

The recent press release highlighted, in a very reduced form, the expected benefits of the collaboration with the ECMWF: The optimum use of ECMWF products and data, and especially the introduction of Ensemble Prediction System (EPS) products for forecasting extreme situations and for

using probabilities to estimate errors of numerical weather forecasts, will surely contribute to the improvement of the forecasts issued by CHMI. At the same time, the extension of the forecast interval will take place. Certainly it is not possible to expect that all these assumptions will be valid every day. However, I would like to stress that our meteorologists will become quickly acquainted with ECMWF products, and their use and introduction into forecasting practice. I also expect the help of other research institutes in the Czech Republic, as they should benefit from the use of the ECMWF products as well. Finally, we cannot ignore the general improvement in access to other data types at CHMI, like data from observing networks, satellite pictures, radars and also, recently, lightning data. We strongly support the development of nowcasting, radar calibration from precipitation gauges and other forecasting tools. In other words, by stressing the benefits of co-operation with the ECMWF for forecast improvement, we have not stopped the development of other methods and techniques complementing ECMWF products, and I believe that such an integral approach will contribute to an overall improvement of the forecasting system in our country.

Q3 *Now let us come back to your statement in the press: "If we had already had information from the European Centre in the year 1997 we would have known that it would not be raining for only two days, but for six days instead. Then, we would have been able to appreciate earlier the catastrophic size of the incoming flood that also reached Poland and Germany, rather than just preparing for a common regional-size flood." Are you really convinced that the access to ECMWF information would have made it possible to estimate the extent of the flood at that time?*

I think so. In the case of warning, our primary goal is to estimate the danger of an incoming disaster, to decide whether to provide a warning or not and, eventually, to decide how extensively the warning should be issued. Despite the fact that hydrological models for the main rivers were not operationally available in those days (and I am glad that they have been gradually introduced now), we could have probably forecast the devastating character of the flood with the help of the ECMWF precipitation forecasts. Two days of rain instead of six days of rain would have meant that the flood would have only reached a regional level, whereas a flood from several days' rainfall usually results in a disaster. For this reason I think my statement in the press was correct, though it was formulated very concisely and briefly for the press and the general audience, as is usually appropriate in such cases. Furthermore, I would like to point out the fact that the ALADIN model was put into operation shortly before the 1997 flood and its use helped us with issuing warnings, even for the case of a regional flood. It was a great success for the application of a regional numerical model to a real and dangerous flood situation. Moreover, we immediately released the ALADIN output data to Poland, which was hit by the same incoming flood. I think our Polish colleagues highly appreciated our help with ALADIN forecasts immediately after the end of the 1997 disaster.

Q4 *Are there in CHMI all necessary technical and personal conditions for the optimum use of information provided by the ECMWF? I mean especially software, data transmission, and training of the staff of the Forecasting Centre.*

Your question is well chosen. We have been trying to solve all the problems practically immediately. Several of our top research workers are responsible for quick solutions to each of the above-mentioned partial problems. Since August 2001 we have been able to use precipitation forecasts from the ECMWF and, at least qualitatively, outputs from 'ensembles' for this purpose. The ECMWF has immediately made meteograms and a number of other applications accessible to us. We have also made some other products accessible and have started to write software for visualization and general utilization of the ECMWF products by our forecasting centres. We need to decide soon whether to upgrade the existing general software for forecasters (METPRO of American origin) or to tender for similar complex software produced by another company. We need a better scheme for the superimposition of meteorological data, for the distribution of pictorial material and charts and for the possibility of direct output of graphical products on the Internet. I am afraid the biggest problem is the proper training of our forecasters. Many of them have not obtained sufficient knowledge and, especially, practical training in modern applications of dynamical meteorology with the use of models, radars and satellites during their university studies years ago. Therefore, we have established a regular training programme for our meteorologists in some of the above-mentioned fields as the first step towards the gradual retraining and advanced training of our research workers in modern meteorology. The first part of the programme took place in the CHMI training centre at Radostovice in November 2001. Together with the Department of Meteorology and Environmental Protection of the Charles University's Faculty of Mathematics and Physics, we concluded an agreement on a joint comprehensive education programme for meteorologists, including also bachelor and postgraduate studies.

Q5 *Could you tell us your first impression and experience with the use of ECMWF data by CHMI meteorologists after less than two months? If so, could you illustrate positive or negative experiences using some examples?*

The first experience is certainly positive. Already we can now see 'further ahead' in the model output forecasts and we have already been able to release 'prolonged' forecasts for our public in the media, at least in the form of a weather outlook for 9-10 days ahead. It is too short a time from the start of our co-operation with ECMWF to present a more objective evaluation of all the benefits, since the software for all applications has not been finished yet. On the other hand, our aim for prompt and comprehensive use of ECMWF data and information almost immediately after the joining, together with our good preparation for this step, has attracted attention in Reading. I hope that ECMWF material will soon become a standard in our daily forecasting practice. I hope our meteorologists will acquire a more objective approach

to forecasting by using probabilistic data e.g. 'ensembles'. At the beginning of October my Deputy Director for meteorology Dr. Wolek and I took part in the first (for us) session of ECMWF Co-operating States in Vienna. We were pleased by the very warm reception. The Director of the ECMWF Dr D. Burridge informed us about the ECMWF programme for the next few years and we discussed together some problems and proposals for their solution. Generally, we were impressed by the rather pragmatic and strictly working character of this meeting.

Q6 *CHMI forecasting and warning services are closely connected to the so-called Integrated Rescue System, a collaboration with the Fire Brigade, and warning for dangerous weather phenomena forms part of weather forecasts. CHMI carries out its duty to the state administration and the public. Nevertheless in a survey on the subject 'Synoptic meteorology and weather forecasting in the near future' published in the Meteorological Bulletin, some leading specialists agreed that forecasting models could never properly reflect the reality of the atmospheric system. The question arises, are not you afraid of the possible counter-productive disappointment of the public if proclaimed improvements of forecasts are not realized?*

I am not afraid of such disappointment. Moreover, there have been signals about the general improvement of our forecasts, especially for floods and other cases of severe weather. Of course, we can make a mistake even now. On the other hand, we should realize that the problem of the warning service is often not in forecast accuracy (how many mm of rainfall will occur, at what time and in which locality), but whether we have alerted the overall warning system or not. Earlier, we were afraid of possible inaccuracy of forecasts of extreme phenomena and, consequently, warnings were not issued at all. This was usually worse than the opposite, when the forecast phenomenon does not occur or does so to a lesser extent than expected. Besides innovation in the meteorological (hydrological) part of the warning system I especially value the new organization of the CHMI forecasting and warning system within our country based on co-operation between the Central Forecasting Office in Prague and six forecasting offices in the regions, and the very positive and responsible approach of our forecasters to the warning part of their duties.

Q7 *It follows from your previous answers that demands for operations and technical development of the Institute have been constantly increasing. Can the Institute fulfil its tasks with current available means? I would expect that, as a precondition, you would emphasize technological modernization of the service leading to the integration of observing networks, the strengthening of co-operation with specialists from other Czech institutions and the intensification of international collaboration.*

Naturally, we are short of finances, both for modernization and, especially, for operations, and the total volume of the state contribution for CHMI decreases rather than increases. We have been trying to solve the situation continuously, but very often with great difficulties. Automation of the observing networks (both of the 'professional' network and part of the voluntary one) has been in progress, we have built up an integrated and whole-territory database system for all three fields of the Institute, including data transmission unification, etc. On the other hand, it is not possible to create a unified network of stations to carry on meteorological, hydrological and environmental observations at the same place. Good co-operation with military meteorologists has resulted in the creation of the common Integrated System of Warning Services (ISWS). Collaboration with other Czech research institutions has improved too, and a similar improvement has taken place at the international level. In addition to our traditional partners (Météo-France, US Weather Service, Deutscher Wetterdienst, Slovak Hydrometeorological Institute, the Central European joint modelling project (LACE), EUMETSAT etc.) the new co-operation with the ECMWF, the leading multinational European organization, has started. We are also pleased by growing participation of our specialists in national and international R&D projects and, especially, in the projects funded by the EU.

Q8 *In the context of growing international collaboration, the idea for the establishment of a European meteorological service has been appearing again and again. Do you identify yourself with such vision?*

I have to admit that this vision is both very realistic but, at the same time, a little 'dangerous', mainly for meteorological services in small countries which would not be able to grab a sufficient part of a 'common cake' in the preparatory phase of such joint European service. It is evident that a joint European service would be more economical and would lead to improvement in the quality of services and products. The ECMWF is a good example of such an approach in the research field. It is actually the first joint European work place and the benefits from such a common approach unambiguously outweigh the disadvantages. My personal opinion is that the establishment of a joint service may be postponed, especially because of military aspects, and also probably because of a potential rivalry among the biggest services like those in the UK, France, and Germany.

Ivan Obrusnik

Programming for the IBM High-Performance Computing Facility

The article 'The new high-performance computing facility (HPCF)' by David Dent, Neil Storer and Walter Zwieflhofer published in Newsletter 93 (Spring 2002) has described the principal hardware features of the next-generation supercomputer being installed at ECMWF. This article is a short overview of the main differences, as seen by the application programmer.

Hardware features

The basic building block of the system is a node, known by IBM as a p690. The hardware features that are of immediate interest from the point of view of the application programmer are:

1. **The shared/distributed nature of the memory**. Any application that has to utilise more than one processor in order to achieve acceptable run time can be parallelised in two ways. If the processing power available within one node is sufficient, then Fortran compiler OpenMP directives can be inserted, making use of the shared memory within the node.
2. **The interconnect between nodes**. If the power available from (1) is insufficient, the more difficult task of parallelising by means of MPI message passing must be undertaken. For maximum performance, the characteristics of the interconnect hardware must be taken into account when deciding on the message passing strategies. A combination of MPI and OpenMP is also possible, and may deliver the best parallel performance.
3. **The multiple cache hierarchy available to each processor**. Since the time taken to access memory is relatively long, small quantities of faster memory (known as caches) are provided. Best performance is, in general, achieved when the data required by application code reside in one of the caches. It therefore becomes important to reuse data as much as possible while they reside in a cache, and also to avoid 'flooding' the cache by loading many or long vectors of data simultaneously. Modifying code in order to minimise memory accesses is an important optimising technique.
4. **The scalar nature of the processor hardware**. Computations are performed in a 'scalar' way. There is no longer any need to worry about 'vectorising' the Fortran loops, and therefore code that is inherently difficult or impossible to vectorise will probably execute relatively well. Some aspects of the computations are, however, relatively more expensive, in particular DIVIDE and SQRT.

Message passing techniques

On the VPP5000, the Integrated Forecasting System (IFS) has used a simple blocking SEND/RECV mechanism making use of the Fujitsu-supplied system mailbox. The best choice on the IBM machine appears to be buffered/asynchronous message passing, allowing multiple messages to be in transit simultaneously. However, while messages are being transmitted by the internode switch considerable CPU resources are consumed. Competition between the switch requirements and the application computation has the effect of introducing significant load imbalance. Hence, it is currently beneficial to separate completely the message-passing activity from the computation.

Optimising memory access

On both the VPP5000 and p690, accessing Fortran arrays with stride 1 is optimal. However, on cache-based machines such as the p690, the cost of memory access is large and failure to make best use of the caching mechanism can result in poor performance. Consequently, some simple loop-level optimisations can be very beneficial. Additionally, if data are used more than once, it is preferable to re-use them while resident in the cache, rather than reloading again from memory.

The amount of data that can be held in the cache is, of course, limited. Consequently, it is not optimal to load very long arrays, since only a few can coexist in cache. It may be useful to code a blocking mechanism that limits the array lengths to a suitable 'chunk' size. The effect of this in some IFS model runs can be seen in the following figures, where *NPROMA* is the chunk size. It is evident that, on a vector machine, the best times are always achieved with long vectors. However, on a cache-based machine, very short and very long vectors are relatively bad, and the optimal value has to be chosen by experimentation.

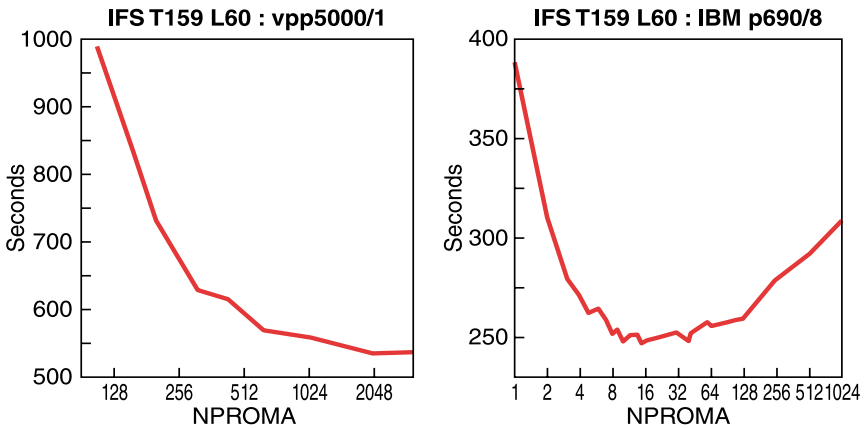

Figure 1 Comparison of computer times using various 'chunk' sizes.

Performance comparisons

The following table is a comparison of some basic operations. Divide and SQRT are not fully pipelined, so for example, the VPP5000 can perform 16 divides every 4 clocks. The relative performance takes into account the difference in clock speeds.

Function	VPP5000	p690	Relative performance
	Operations per clock cycle		
Multiply	16	2	1.85
Add	16	2	1.85
Multiply & add	32	4	1.85
Divide	16/4	2/30	13.85
Square root	48/20	2/36	10

Table 1 Comparison of the performance of the VPP5000 and p690 processors for various operations.

Thus, 1.85 p690 processors are equivalent to one VPP5000 processor for multiply and add operations, but nearly 14 p690 processors are needed for comparable divide performance.

Given the theoretical peak speeds of the machines, it is interesting to compare achieved speeds for relevant applications running on the p690 and VPP5000.

	Number of PEs	VPP5000	p690	Ratio
Forecast (10 days)	8	658	5079	7.7
4D-Var (6 hours)	4	2460	11608	4.7

Table 2 Approximate run times in seconds of the IFS model and 4D-Var, at T159.

Note that the p690 performances contain only some of the optimisations used in the benchmark version. They also contain only message passing within the node (no OpenMP) and do not perform any of the relatively more expensive internode communications. The scalar platform is relatively more efficient at handling the scalar/vector mixture of computations in 4D-Var than the highly vectorised model code.

IFS model components

The relative costs of various components of the model have been examined to show how the computational expense is spread. Historically, this has been of interest because of the growth in cost of the Legendre transform as the spectral truncation increases. A comparison carried out on benchmark T799 L90 executions is shown in the following figure. Note that this comparison is made using the Nighthawk2 processors used in the benchmark. Equivalent figures for the p690 are not yet available.

The principal differences between the two machines are:

- Physics and radiation computations perform relatively well on the scalar machine
- Parallel overheads are significantly worse.

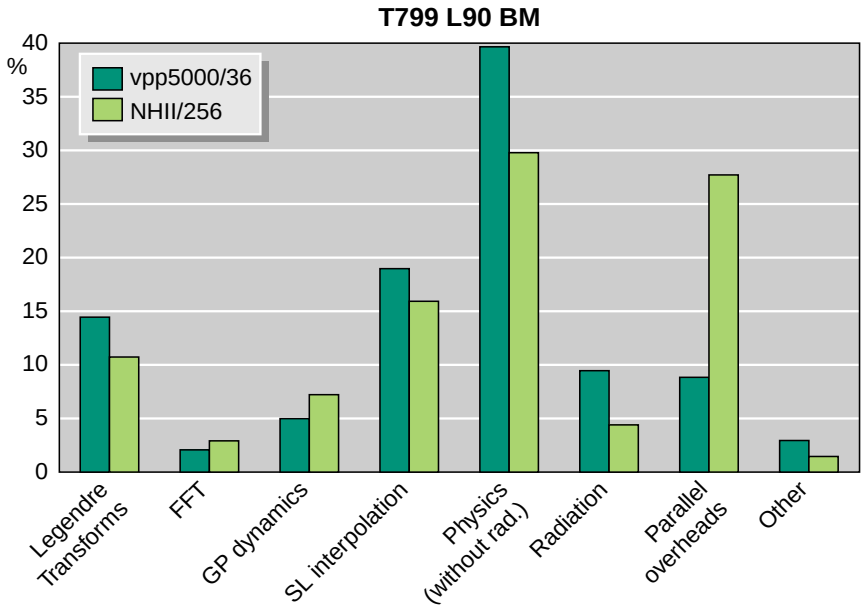

Figure 2 Relative costs of various components of the IFS model.

D. Dent, M. Hamrud, J. Haseler, G. Modzdynski, and D. Salmond

ECMWF's new web site

a Old public web site

b Old wms web site.

c New merged web site.

Figure 1 The home pages of the old and the new web sites.

Merging the web sites

Traditionally, the ECMWF web sites have been divided in two. The first was the public web site (www.ecmwf.int), which offered general information: about us, news, jobs, etc. This site was intended to be used by anyone on the Internet and hence offered little access restrictions.

The second web site was the Member State web site (wms.ecmwf.int), and its intended audience was Member State or other ECMWF registered users. This web site implemented restrictions in order to avoid unauthorized access.

This functional separation between the web sites soon showed itself to be both confusing for the users and hard to manage. It was not easy to move information between the sites, or for a user to know if a given piece of information was in the public or the Member State web site. Also, as work had to be duplicated, information was sometimes published on both web sites, which led to the sites becoming unsynchronized.

The logical solution was to merge the two sites into one, which was accomplished in April 2002. The change has resulted in a new web site that has much higher quality than either of the two old web sites. It includes a new navigation structure and navigation menus throughout the site that let you know where you are, and to where you may be able to go.

A challenge evolving from this change was the growing importance of the access control system, since the new single site would be exposed to the full Internet community.

This article describes the new navigation scheme and how it can be used to explore the exciting content that is being made available both to the public and Member States. It then discusses how you can use the new web site without becoming a victim of the access control system, some of the problems that you may encounter, why they exist, how you may be able to work around them, and why, in some cases, you should not expect to be able to work around them.

The new web site design

The ECMWF web site has been redesigned in order to get both a more pleasant and consistent look, and easier and faster navigation. The organization of the content has also been changed, which makes it much easier for you to find information. This design is especially new for the public since Member State users have already been using it for some time (figures 2 and 3).

Comparing both sites, it can be easily seen that:

- The new site uses a consistent colour scheme throughout, not only in the text but also in every image. This, with a more balanced disposition of the individual elements offers a much more 'professional' impression.
- There are many more menu options available. There is much more information available to the user and it is more easily reachable. This makes getting to the documents that you want much easier, possibly only one click is required.

The improved navigation scheme

The new web site has clearly defined functional areas, which are expected to always show the same type of information, in the same style, in every web page. The main areas are described below.

The page banner (figure 4)

This area is meant to provide quick 'deep' links into all the web site areas ('About Us', 'Products', 'Services', 'Research', 'Publications', and 'News & Events') and into the most popular sub-areas within those areas. The upper part has some links to general web site services, like Login, Site Map or Search.

In the bottom of the header there is a small link 'Home' with a '>' character after is. This is the location menu. This will always keep track of the hierarchy in which the current page is included, allowing direct access to any of the page ancestors.

Figure 2 The old public web site.

Figure 3 The new web site.

Figure 4 A banner on every page helps navigation.

Figure 5 Side navigation menu.

The navigation menu

Figure 5 shows some navigation menus as can be seen in the /products/forecasts/ web site area. The navigation menus, located in the leftmost area of the page, also offer additional links to information related to the current page.

In this case there are three navigation menus. The first one, 'Products', shows all options available under the /products/ area (the current page is one of them). This is called the sibling navigation. The second one, 'See also', links to some other pages of the web site which contain information related to this one and not necessary in the same area. And finally, the third menu, 'Charts', links to a useful service also related to the page.

This navigation menu organization is implemented on all the web site pages, offering the users a 'familiar' interface in order to get the information they are looking for and browse around the web site.

The Search and Site Map

The ECMWF web sites have always had Search facilities. We have now extended this by adding a Site Map. Both of these tools are available from the top banner area of every page. If you cannot find what you are looking for, either the Site Map or Search should help you.

Note that both the Search and the Site Map ignore any access control on the destination documents. Just because the documents are shown in the list, it does not necessarily mean that they are accessible.

The access control system

The access control system is a piece of software, embedded into the web server software, that is executed each time you try to access one of the web site pages. The access control system can respond to requests for pages in any of the following ways:

- It identifies you and allows you to see the page.
- It identifies you and does not allow you to see the page. Your identity is known, but the page cannot be seen by you.

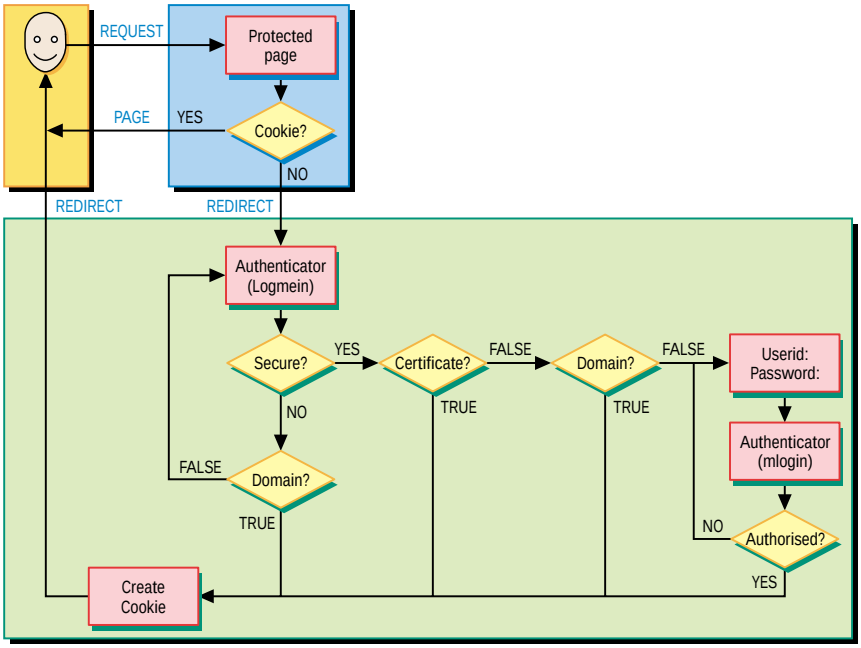

Figure 6 A flow chart of the authentication process that is involved when you try to access a protected page.

- It cannot identify you but allows you to see the page. This would happen in the public sections of the website.
- It cannot identify you and does not allow you to see the page.

So the three main tasks of the access control system are:

1. Controlling access, avoiding unauthorized use of the resources.
2. Granting access to authorized users.
3. Identifying users and making possible user tracking.

Controlling access to web pages

The first goal of the access control system is to prevent unauthorized users from accessing protected areas in the website. This is done by:

- Assigning all users an access profile.
- Assigning to each profile a list of protected areas.

If the page you are trying to access is defined in the profile that is associated with you, you will be allowed to see the page; if not, you will be redirected to the login page and be required to identify yourself differently.

The following are examples of areas that require a specific access profile:

- /about/committees/council/
  - open for all the internal ECMWF profiles and to the members of the COUNCIL.
- /newsevents/itt/archive/
  - open for almost all recognized users. Public users cannot access this area.

If you try to access these or other protected areas without adequate permissions and cannot be identified automatically, you will be redirected to the login page.

Gaining access to protected web pages

Gaining access to protected documents means moving from a state in which you cannot access the document to another one in which you can. This is needed because by default you will be treated as a public user.

The process of gaining access, which comes together with the authentication process, can be triggered by two different mechanisms:

- An automatic mechanism using web redirects;
- A manual mechanism, which requires user interaction to complete.

An extremely important point to remember is that some documents are completely protected and will trigger authentication, whereas some documents are not protected but are personalized dependent on your current identity, which you will need to have previously obtained by either automatic or manual login. More details on personalization are given later in this article.

Automatic login

While accessing any protected document, the web server may automatically recognize you, and you will subsequently gain access to all the documents that are allowed for your profile. This would happen if you meet one of the following conditions:

- You are connecting to our web site from one of the ECMWF-recognized Internet domains or IP addresses. This will normally be a Member State or Co-operating State internet domain such as meteo.fr, metoffice.com, etc.
- You have an ECMWF-issued user certificate.

These conditions are checked in a sequence, and the satisfying of any of them for the given document that is being accessed, will imply that the remaining conditions are not checked. So, if you come from a recognized IP address or domain for which the access profile is sufficient to see the protected document, your certificate will not be checked.

If you cannot be recognized to be in any of these two groups an automatic redirection to the manual Login authentication page will occur.

Manual Login

You can reach the Login page via two different mechanisms. As seen in the previous paragraph, the access control system may have sent you to this page. But you can also click on the Login link present at the top of all the web site pages. In both cases the page presented to you will be as in figure 7.

In this page there are two interesting areas. The first one is the text saying 'Welcome Guest User'. The meaning of this sentence is that so far you have not been recognized as a user, so your access profile is that defined for public users. Different text will appear, as you'll see later in the article, if you have already been identified as a recognized user.

The next area, just under this, is the proper Login area. There are four different links in this area that you can follow in order to get or change your current identity.

1. Login as guest user. This option will actually reset your access permissions to those of the anonymous public users. Why would you like to do that? Well, maybe for logging out if you are using an untrusted computer and have previously logged in with a web user id and a password.
2. Login with an ECMWF-issued user certificate. A certificate is a piece of data that gets installed in you browser and that permanently identifies you in the ECMWF web sites. You can get a certificate through the ECMWF Certificate Authority (http://w3cert.ecmwf.int), as described later in the 'Getting a user certificate' section of this article.
3. Login with an Internet domain. This option will try to use your Internet domain or IP address in order to identify you. You do not need to take any individual action in order to be able to use this option.
4. Login with a specific web user id and its corresponding password. This option will require you to enter your a web-only user id and a password, both supplied by the ECMWF Call Desk, to verify your identify. This option is available for users outside of Member States, for example, for WMO access to seasonal products or for Special Project users.

Why is a manual login offered for all the options that would normally happen automatically? This is because there are circumstances for some types of documents where a manual login is required before accessing the documents. For example, there are documents on the site that are public but personalized to your current recognized identity. These documents require either a manual login before accessing them or that you have accessed a protected area previously in order to have been automatically identified.

Getting a user certificate

A user certificate is a way of getting more easily and securely authenticated to access the ECMWF web site. To get this user certificate, you first need to have a full registered user-id and a Secure-id card issued by ECMWF. To obtain these, contact your local ECMWF Computer Representative.

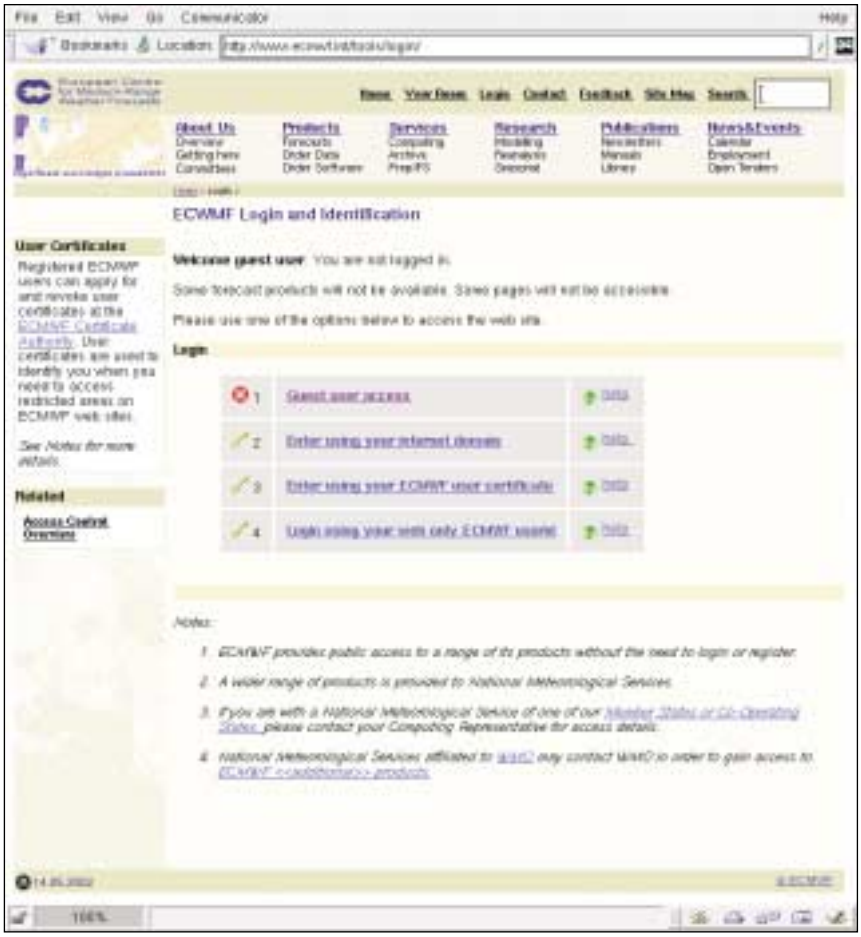

Figure 7 The Login page.

Figure 8 The ECMWF Certificate Authority web site.

In order to obtain a certificate, you should point your browser to the ECMWF Certificate Authority web site (http://w3cert.ecmwf.int) and follow the instructions given (see Figure 8).

Personalization of content

Personalization means that, given the same web site page, differently identified users may see different content, maybe in an automatic way (as in the graphical products under /products/) or responding to options the user chose on a previous occasion (as in the Your Room pages). Personalization relies on authentication. The graphical products area and the *Your Room* pages heavily use the personalization feature.

In the graphical products area there are pages that contain selections of forecast charts. Your identity (and associated access profile that has been defined for you) will determine which graphical products you can see (figures 9 and 10).

Some of the graphical product areas are completely public and will not trigger automatic authentication. As a result you may, by default, see the pages as a Guest User. You will need to go to the Login page in order to become a recognized user.

In Your Room, you can select charts and arrange them to be shown on return visits. These charts are registered by the system and stored under your identity. So to see the charts that you have placed in Your Room, you need to be recognized correctly. Therefore, it is important that the system has recognized you. If, for whatever reason, your identity is not available you will not be able to access Your Room. Identification can be achieved either automatically (from protected pages you have previously been too) or via the Login page.

User information

This feature enables you to know if and whom the web server is recognising you as. This is very useful when personalization is involved or in order to check if the access rights being currently applied are what you expect them to be.

User information is available in three places:

- The *Login* page
- On some personalized pages
- The manual *Login* page

It is also useful to help solving any access problems a user could be experiencing.

Figures 11–14 show several screenshots of the login page for a public user, a certificate-identified user and a domain-identified user.

Next steps

ECMWF's web site will keep on improving. Some of the next milestones to be reached are:

- Make more use of personalization. More areas within the web site will offer user identification aware content.
- Make the web site more accessible by improving the navigation.
- Increase the number of products and project data accessible through the web site. Some of the next additions will be:
- Data Service

Figure 9 A public personalized page seen as a Guest User. A reduced number of links are shown.

Figure 10 The same public personalized page seen as a registered user. There are more links available.

- More forecast products
- DEMETER
- ERA-40
- Fax/etc product delivery management interface

We recommend that you try the new web site, if you have not already, and see which of the new facilities and information is useful for you. We also recommend that you familiarize yourself with the Login, access control and personalization features, as this is a critical part of the web site.

Also, keep an eye on the web site and future Newsletters, as we will be making more information and facilities available. The web site will increasingly become the primary source for all non-operational information from ECMWF.

We welcome any feedback that you may have or any suggestions that you think will improve the web site.

Figure 11 If you see this in the login page, it means that you have not been identified. You will not have access to the restricted areas of the website or to the personalisations you could have made in any web site area. You may try to get the system to identify you by clicking into one of the 2, 3 or 4 options.

Figure 12 If what you get in the login page resembles this, you have been identified as a domain user. In this specific example the user has been recognized as coming from an ecwmf.int domain, but some other domains will also be recognized, including all those of the Member States. The important keywords here are '... you are a DOMAIN user ...'.

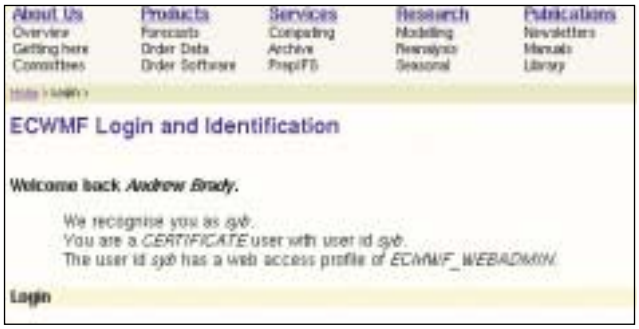

Figure 13 If you have a valid user certificate, you should see a page like this, in which your name is displayed and the fact that you own a certificate is highlighted. If you know that you own a user certificate, but do not see that the system is recognizing you, you may try to use the option 3, 'Enter using your ECMWF certificate'.

Figure 14 And as the last option, if you have logged in with a web user id, you will be recognized with the HTTP or HTTPS keywords and your name, or your organization's name, should also be displayed.

Andy Brady, Carlos Valiente, Daniel Varela

New products on the ECMWF Web Site

/products/forecasts/d/charts/deterministic/world/

From bottom to top you can find the mean-sea-level pressure, wind speed at 850hPa and geopotential 500hPa; these charts are available for Public users. The relative humidity and wind at 700hPa and 850hPa and the mean-sea-level pressure and wind at 200hPa are products accessible by both Member States and WMO users (using a login password); these are made available to WMO countries as GTS additional products (see wms.ecmwf.int/products/additional/ for more information).

/products/forecasts/d/charts/monitoring/radiances/

You can find 'QuikSCAT Time series', which was in the old web page that was only accessible by ECMWF internal users; this product is now accessible by Member State users.

/products/forecasts/d/charts/deterministic/europe/cloud/

/products/forecasts/d/charts/deterministic/europe/msl/

/products/forecasts/d/charts/deterministic/europe/t2m/

/products/forecasts/d/charts/deterministic/europe/z500_t850/

These products for the deterministic forecasts over Europe have been extended to day 10 (they used to stop at day 7) and are accessible by Member State users.

/products/forecasts/d/charts/deterministic/world/z500_t850_gts/

/products/forecasts/d/charts/deterministic/world/vordir_700/

These global charts (the first for 500hPa geopotential and 850hPa temperature in eight areas and the second for the vorticity and divergence at 700hPa, for t+0 to t+144 split into three overlapping areas) are available to WMO users as GTS additional products.

/products/forecasts/d/charts/eps/probabilities/probas_gusts_gts/

/products/forecasts/d/charts/eps/probabilities/probas_rain_gts/

Charts of Ensemble Prediction System probabilities are available to WMO users as GTS additional products. The first provides 10m wind-gust probabilities, and the second provides probabilities of 24h-accumulated precipitation, for t+72 to t+144 north of 20N and south of 20S in six overlapping areas (three to the north and three to the south).

/products/forecasts/d/charts/seasonal/charts/

/products/forecasts/d/charts/seasonal/plumes/

System 2 seasonal forecasts are operational and have been made available to public users. System 1 will still be available to Member States until the end of the year.

/products/forecasts/d/charts/seasonal/verification/

A verification scheme has been created; it includes extensive documentation and numerous deterministic and probabilistic score plots

/publications/library/ecpublications/techmemos/tm00.html

Recently published ECMWF Technical Memoranda are now available to public users for downloading in pdf format.

/newsevents/training/meteorological_presentations/

The slide presentations for the 2002 Meteorological Training Course Lectures are now available for downloading in pdf format to public users.

/publications/manuals/mars/

The new MARS user guide is available to public users in the form of clickable html pages or as a downloadable pdf file.

ECMWF Publications

(A full list of ECMWF publications is available at http://www.ecmwf.int/publications/library/ecpublications)

Technical Memoranda

(Recently published Technical Memoranda can be downloaded in pdf format from the Web at http://www.ecmwf.int/publications/library/ecpublications/techmemos/tm00.html)

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350 **A. Chedin**, **A. Hollingsworth**, **N. Scott**, **R. Saunders**, **M. Matricardi**, **J. Etcheto**, **C. Clerbaux** & **R. Armante**: The feasibility of monitoring CO_2 from high resolution infrared sounders, *November 2001*

351 **A.M. Moore**, **J. Vialard**, **A.T. Weaver**, **D.L.T. Anderson**, **R. Kleeman** & **J.R. Johnson**: The role of air-sea interaction in controlling the optimal perturbations of low-frequency tropical coupled ocean-atmosphere modes, *December 2001*

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353 **M.J.P. Cullen**: Large-scale non-turbulent dynamics in the atmosphere, *November 2001*

354 **M.J.P. Cullen**: Large-amplitude non-linear stability results for atmospheric circulations, *November 2001*

355 **R. Buizza** & **P. Chessa**: Prediction of the US storm of 24–26 January 2000 with the ECMWF Ensemble Prediction System, *January 2002*

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12 **N. Bormann**, **S. Saarinen**, **G. Kelly** & **J.-N. Thépaut**: The spatial structure of observation errors in atmospheric motion vectors from geostationary satellites, *February 2002*

Workshop Proceedings

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ECMWF calendar 2002/3

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Sep 9–13	**Seminar** – *Recent developments in predictability studies*	
Sep 25–27	**Scientific Advisory Committee**	*31st*
(Date to be decided)	**Advisory Committee of Co-operating States**	*8th*
Sep 30–Oct 2	**Technical Advisory Committee**	*32nd*
Oct 14–15	**Finance Committee**	*69th*
Oct 14–18	**Meteorological Training Course** – *Use and interpretation of ECMWF products*	
Oct 17–18	**Policy Advisory Committee**	*17th*
Oct 21–22	**Advisory Committee on Data Policy**	*2nd*
Oct 28–Nov 1	**Computer Users Training Course** – *Use of ECMWF supercomputing resources*	
Nov 4–8	**Workshop** – *Use of parallel processors in meteorology*	
Nov 13–15	**Workshop** – *Role of the upper ocean in medium- and extended-range forecasting*	
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Dec 2–3	**Council**	*57th*

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