Contents

Publication policy

The *ECMWF Newsletter* is published quarterly. Its purpose is to make users of ECMWF products, collaborators with ECMWF and the wider meteorological community aware of new developments at ECMWF and the use that can be made of ECMWF products. Most articles are prepared by staff at ECMWF, but articles are also welcome from people working elsewhere, especially those from Member States and Co-operating States. The *ECMWF Newsletter* is not peer-reviewed.

Editor: Bob Riddaway

Typesetting and Graphics: Rob Hine

Any queries about the content or distribution of the *ECMWF Newsletter* should be sent to Bob.Riddaway@ecmwf.int

Guidance about submitting an article is available at www.ecmwf.int/publications/newsletter/guidance.pdf

Contacting ECMWF

Shinfield Park, Reading, Berkshire RG2 9AX, UK

Fax: . . . . +44 118 986 9450

Telephone: National 0118 949 9000

International . . . . +44 118 949 9000

ECMWF website . . . . http://www.ecmwf.int

A more open IFS

Several requests have been voiced recently, in particular from our Scientific Advisory Committee, for a more open access to the Centre's Integrated Forecast System (IFS). It is interesting to note that this is allowed by the Centre's Convention which gives the Member States all access rights to any software developed by ECMWF. In other words they can simply request the whole IFS, including 4D-Var, should they want to use it themselves within any of their national entities. In fact this does not happen simply because the running costs, in terms of computing resources and managing permanent updates, are significant and better met through a shared facility such as ECMWF.

The transmission and sharing of software is generally not easy and can only happen if some effort is put, by its owner, into making it possible. Such efforts include writing the software in a modular, easily understandable and transferable way, and providing support to those willing to import it – or part of it. Interestingly there is a case for making such an effort.

The main point is that many elements of the IFS can be shared with other NWP centres, including those developing a higher-resolution system for limited areas (i.e. all our Member States). Of course supporting NWP activities in its Member States is within ECMWF's remit. It is also in its own interest, as exchanges also take place the other way: for example IFS is benefitting from non-hydrostatic development already made in regional models. The development of such interoperability between the IFS and European regional models is in everybody's interest and is the rationale for our involvement in the SRNWP (Short Range Numerical Weather Prediction) Eumetnet programme, although short-range NWP is not one of ECMWF's tasks.

Another important aspect is the request to make available an easy-to-use, well-documented, openly available version of the IFS for academia. Again this is a win-win situation. It would give the research community access to a major atmospheric tool. In return ECMWF would benefit even more from such usage, through identification of issues and easier import of academic developments. An effort of this kind is currently being done with the EC-Earth consortium which is developing a climate modelling system based on the IFS. Benefits from using an atmospheric system such as the IFS, which is validated, updated and computer-efficient, are clear. Important feed-backs are expected. They include lessons learnt from such climate runs and developments such as coupling with a sea ice model.

There are other areas where an easier access would be beneficial. It includes the data assimilation system, in particular in the version used for reanalyses, allowing the development of more experiments in support of climate monitoring.

Having a more open IFS needs very positive consideration. But it is clear that such a development does not come for free. The first requirement is that ECMWF be able to provide the necessary support to the teams wanting to use the software. In the longer run, it will also require some reorganisation of the codes to facilitate co-operation and scientific developments. In the end, a large user base for the IFS framework will be of benefit to many, including ECMWF.

Dominique Marbouty

New items on the ECMWF website

ANDY BRADY

Converting from GRIB edition I to edition 2

New documentation is available regarding the conversion from GRIB edition 1 to 2. Included is a list of the parameters recognised by GRIB API with GRIB edition 1 and 2 descriptions. Moreover a detailed documentation of the GRIB API keys is available for both editions along with a list of the edition-independent GRIB API keys.

- http://www.ecmwf.int/publications/manuals/grib_api/

Forecasting system horizontal resolution increase

ECMWF upgraded the horizontal resolution of its forecasting systems on 26 January 2010.

- http://www.ecmwf.int/products/changes/horizontal_resolution_2009/

ECMWF Calendar 2010

The 2010 ECMWF Calendar has been released and will be updated throughout the year as new events are organised or existing events are changed. All educational events, workshops, technical and scientific meetings, and committee meetings are listed. The page that is on our web site is the definitive version of this information.

- http://www.ecmwf.int/newsevents/calendar/

First General Assembly of the MACC Project

The '*First MACC General Assembly*' was held at ECMWF during the week of 11 to 15 January 2010. It aimed to review and present the project's progress to date and plans for the coming year. This was achieved through a set of parallel meetings on individual themes, followed by plenary presentations and discussions. The Assembly included a plenary session devoted to user requirements, plans and initial feedback.

- http://www.ecmwf.int/newsevents/meetings/workshops/2010/MACC/

Workshop on assimilating satellite observations of clouds and precipitation

The ECMWF/JCSDA Workshop on '*Assimilating satellite observations of clouds and precipitation into NWP models*' will be held from 15 to 17 June 2010.

- http://www.ecmwf.int/newsevents/meetings/workshops/2010/Satellite_observations/

ECMWF Seminar 2010

Every year ECMWF organizes a seminar with a pedagogical objective, whereby a selected topic related to numerical weather prediction is highlighted. The subject of the seminar this year is '*Predictability in the European and Atlantic regions from days to years*'. It will be held from 6 to 9 September 2010.

- http://www.ecmwf.int/newsevents/meetings/annual_seminar/2010/

ECMWF Training Programme

ECMWF has an extensive education and training programme to assist Member States, Co-operating States and WMO National Meteorological and Hydrological Services in the training of scientists in numerical weather forecasting, and in making use of the ECMWF computing and archive facilities. The 2010 programme has now been finalized.

- http://www.ecmwf.int/newsevents/training/2010/

Latest supercomputer systems

ECMWF's High Performance Computing Facility (HPCF) now comprises two identical but independent IBM Cluster 1600 supercomputer systems based on the new POWER6 processor.

- http://www.ecmwf.int/services/computing/overview/ibm_cluster.html

ECMWF Interim Reanalysis (ERA-Interim)

As of the 12 November 2009, daily and monthly products are available as part of the ERA-Interim dataset, for the period 1 January 1989 to 31 August 2009.

- http://www.ecmwf.int/research/era/

12th Meteorological Operational Systems Workshop

This year the workshop on '*Meteorological Operational Systems*' had a strong focus on the role of observations. The workshop reviewed the state of the art of observation handling in meteorological operational systems and addressed future trends in the role of observations in verification of medium-range forecast products, data management and meteorological visualisations on workstations.

- http://www.ecmwf.int/newsevents/meetings/workshops/2009/MOS_12/

ECMWF/GLASS Workshop on land surface modelling

Presentations are available from the ECMWF/GLASS Workshop on '*Land surface modelling, data assimilation and the implications for predictability*' which was held at ECMWF from 9 to 12 November 2009.

- http://www.ecmwf.int/newsevents/meetings/workshops/2009/Land_surface_modelling/7

Changes to the operational forecasting system

DAVID RICHARDSON

New cycle (Cy36rl) – major resolution upgrade

A new cycle of the ECMWF forecast and analysis system, Cy36r1, was introduced in operations on 26 January 2010. This cycle includes major increases in horizontal resolution for the deterministic and EPS forecast systems. Changes for this cycle include:

- Deterministic forecast and analysis horizontal resolution is increased from T799 (25 km) to T1279 (16 km).
- EPS horizontal resolution is increased from T399 (50 km) to T639 (32 km) to day 10, and from T255 (80 km) to T3l9 (63 km) beyond day 10.
- Global wave model resolution is increased from 0.36 to 0.25 degrees in the deterministic model, and from 1.0 to 0.5 degrees for the EPS.
- Correction of short-wave radiation interaction with clouds.

Impact of the upgrade

Objective verification shows statistically significant improvements in terms of 1000 and 500 hPa height for Europe and for both extra-tropical hemispheres out to day 7. Also there is a systematic improvement of temperature at 850 hPa. In many cases the location and intensity of synoptic features are improved. Also:

- The frequency of occurrence of intense rainfall events has increased, resulting in better agreement with observations.
- The wind fields are better at representing features such as tropical storms, fronts and land/sea transitions which translates into better wave forecasts.
- Tropical cyclone track and intensity forecasts are generally improved in the higher-resolution system.

Probability scores for the EPS are consistently improved for 500 hPa height anomalies, 850 hPa temperature anomalies and precipitation. The EPS spread is in general unchanged, while ensemble-mean errors are consistently lower, resulting in some overestimation of spread in terms of 500 hPa height and a better tuned spread in terms of 850 hPa temperature.

72nd Council session on 8–9 December 2009

MANFRED KLÖPPEL

Chaired by its President, Dr Adérito Vicente Serrão from Portugal, the ECMWF Council held its 72nd session in Reading on 8–9 December 2009.

The Council was very satisfied with the overall performance of the Centre's forecasting system and the progress made with regard to extended-range forecasts (monthly and seasonal) and forecasting of severe weather events. It congratulated the Centre on the successful installation of the new supercomputer system with two clusters running and providing an excellent service.

Besides several decisions made on financial and staff matters (such as adoption of Reports from the Co-ordinating Committee on Remuneration), the main results of this session were as follows.

72nd session of Council. Dr Adérito Vicente Serrão (President) and Mr Dominique Marbouty (Director) during the Council session held at Reading on 8–9 December 2009.

- *Co-operations.* The Council unanimously authorised the Director to extend the Co-operation Agreement with ESA for another five years.
- *Amendments to the Convention*. Good progress had been made on the ratification process within Member States, with only one ratification missing that will allow the amended Convention to come into force. The Council urged Austria to proceed with its internal procedure for ratifying the amendments.
- *Four-year Programme of Activities*. The Council unanimously adopted the updated 'Four-Year Programme of Activities' for the period 2010–2013 (http://www.ecmwf.int/about/programmatic/).
- *Budget 2010*. The Council approved the budget for 2010 as proposed by the Centre.

Other important results of this session were as follows.

● ***Reduced maximum charge licence.*** The Council unanimously agreed on the introduction of a reduced maximum charge licence for national meteorological and hydrological services (NMHSs) using ECMWF products for non-commercial purposes such as the protection of life and property, research activities and educational use. The information fee for such a licence will be 10% of the standard maximum charge.

● ***ABC and IPSAS.*** The Council unanimously agreed on the introduction of an Activity Based Costing (ABC) system and the implementation of 'International Public Sector Accounting Standards' (IPSAS)

● ***Data Handling System.*** The Council unanimously approved the extension of the 'call off' option of the contract for the Data Handling System with IBM for three additional years, until the end of 2014.

● ***Essential ECMWF products.*** The Council unanimously agreed on the list of ECMWF products declared as 'essential' (see page 13 for the list of ECMWF products made available to national hydrometeorological services of WMO Members).

● ***Election of President and Vice-President.*** The Council unanimously elected Mr Wolfgang Kusch (Germany) as President of the Council and Mr Daniel Keuerleber-Burk (Switzerland) as Vice-President of the Council, both for a first term of office of one year.

● ***Auditor.*** The Council appointed Mr Wascotte (Belgium), as auditor and Mr François as his deputy for the financial years 2010–2013.

● ***Charter of Ethics.*** The Council welcomed the ECMWF Charter of Ethics as an important living document.

● http://www.ecmwf.int/about/basic/

● ***Scientific Advisory Committee.*** The Council appointed Dr Trond Iversen to the Scientific Advisory Committee for a first term of office.

Dr Adrian Simmons (Co-ordinator for ECMWF activities in GMES) gave a lecture to Council on '*The contribution of Reanalysis to Climate Services*'.

ECMWF's plan for 2010

DOMINIQUE MARBOUTY

The ECMWF plan for 2010 flows directly from the four-year programme of activities 2010–2013, adopted by the ECMWF Council at its 72nd session in December 2009 (the programme itself is available at www.ecmwf.int/about/programmatic). The main drivers of this programme remain as follows.

● Improving and verifying early warning for severe weather.

● Supporting our Member States, in particular by developing interoperability, providing them with relevant products and giving feedback into the observing system.

● Preparing ECMWF for future challenges, in particular by adapting our codes for massively parallel supercomputer architecture and evolving towards green computing.

Following the increase in the horizontal resolution to 16 km (T1279) for the deterministic forecast and to 32 km (T639) for the EPS in early 2010, the vertical resolution increase will be prepared: the number of levels is not finalised but is expected to be around 136 for the deterministic forecast and data assimilation, and 91 for the EPS and the seasonal forecast. It should be ready for operational testing after the summer and be implemented early 2011.

The model physics will continue to be upgraded. The major topic this year will be the introduction of rain and snow prognostic variables. It is expected that this will allow significant progress in precipitation forecasting. Other developments will target some model deficiencies such as biases in the monsoon areas, problems in the interaction with the orography (in particular in the Himalaya) and surface temperature biases. Our efforts will also address the development of the EPS, with a focus on improving the ensemble spread of surface parameters.

In line with ECMWF policy to obtain the best possible value from satellite data, efforts will be dedicated to assimilating data from new instruments that become available during the year. In addition more data will be assimilated from existing instruments: a specific emphasis will be on improving the usage of cloudy and rainy infrared radiances, as they have the potential to increase the amount of usable data, in particular in poorly observed areas.

Major efforts will be dedicated to the future of our assimilation system. Spread over several years, these will include:

● Building upon the EDA.

● Reviewing the 4D-Var algorithms

Key developments in 2009

The plan for 2010 builds upon developments realised in 2009, in particular:

● The preparation of the horizontal resolution increase which was implemented on 26 January 2010, and of the Ensemble Data Assimilation (EDA) which will be implemented soon after the resolution increase.

● The implementation of two new cycles of the Centre's Integrated Forecast System (IFS) in March and September, which had a significantly positive impact on the forecast scores.

● Some important achievements in long-range forecasts, with successful forecasts of Madden-Julian oscillations and a 12-month forecast of the current El Niño event.

● The installation of the first phase of the new supercomputer and of the new automatic tape library.

● The smooth transition between the GEMS project and the MACC (Monitoring of the Atmospheric Composition and Climate) follow-up project, which was an important step towards fully operational GMES atmosphere services.

and organisation to improve its computer efficiency.

- Developing a weak-constraint, long-window 4D-Var to account for model errors.
- Developing an ensemble Kalman filter assimilation system for comparison with 4D-Var.
- Reorganising the IFS toward object-oriented programming, a necessary step to allow future developments and testing of new solutions.

Several other major software projects will concern observation handling based on the ODB, development of METVIEW 4, replacement of SMS and migration to GRIB2. The most visible one for our users will be the re-engineering of our web offerings to provide operational reliability, much improved interactivity and on-demand services.

Computing is an area in constant development. Following the installation of the new systems in 2009, we will now prepare for phase 2 of the supercomputer, migrate our archive to the new tape library, and start preparing for the next supercomputer procurement. How to further improve energy efficiency will be a major consideration. An initial step is to monitor energy usage in detail to enable the Centre to plan more concrete measures. Green-computing solutions will be explored in a joint study with the UK Met Office and later in a subgroup of the Technical Advisory Committee (TAC).

In terms of management practice, the focus this year will be on three items. The activity-based costing model developed mainly for externally funded projects and Third Party Activities will enter into operation. We will start the transition to International Public Sector Accounting Standards (IPSAS), which are expected to be implemented in 2012. Finally, the possibility of achieving quality management certification will be evaluated, thanks to the simplification introduced with the ISO 9000:2008 standard.

We will review and update our 10-year strategy, as it will reach its mid-term at the end of the year. This will include, in particular, a revision of the performance measures used to define our targets, bringing them closer to our user requirements, and a full staffing review, making sure that ECMWF will have the required resources to meet our Member States' expectations. A particular aspect will be to draw up a comprehensive building programme, necessitated by the expected increase in the number of Member States, the development of new activities (in particular with the European Community in the GMES initiative), the increase in conference and training activities, and the green computing-challenge.

Our governing bodies will also have a challenging year. The activities of three subgroups have already been mentioned: they will develop guidance to the Centre on severe weather verification and headline scores, green computing and the building programme. Another TAC subgroup will review the Optional Project on Boundary Conditions for Limited-Area Modelling. Concerning data policy, it was also agreed to review the implementation of the Oslo Declaration and to consider the products provided to WMO Members, in particular to the Severe Weather Forecast Demonstration Projects and to hydrological project in developing countries.

The process of accepting the amended Convention has made good progress and is expected to enter into force early in 2010, as only one completed acceptance is now outstanding. Once in force, the amendments will open ECMWF's door for new States to join as full Members. Most of the current Co-operating States are planning to do so and are already preparing for it. This will allow them to fully benefit from this ambitious plan, which is unanimously supported by the ECMWF Council. We will do our utmost to achieve its goals and further increase ECMWF's benefit to its Member States and to the global research community.

Understanding the processes involved in biomass burning

JOHANNES W. KAISER (ECMWF)
MARTIN G. SCHULTZ (FORSCHUNGSZENTRUM JÜLICH, GERMANY)
MARTIN J. WOOSTER (KING'S COLLEGE LONDON, UK)

Smoke from vegetation fires constitutes a major source of trace gases and aerosol particles that greatly influence the composition of the atmosphere and impacts human health and security (cf. *Bowmann et al.*, 2009, Science, **324**, 481–484). Recent advances in the space-based observation of vegetation fires mean that there is the potential for establishing innovative ways of quantifying fire emissions and other effects. In particular, the availability of new sensors and retrieval techniques provide the opportunity to derive more accurate information on fire occurrence, behaviour, severity and impacts. At the same time, fire and atmospheric modelling capabilities have greatly improved on scales from very localized chemical reactions to inter-continental transport.

The EU's GEMS project and its successor MACC (Monitoring of the Atmospheric Composition and Climate), both coordinated by ECMWF, use fire radiative power observations to derive emission fluxes that constitute essential boundary conditions for the atmospheric composition models (see articles in *ECMWF Newsletters No. 106*, 17–20, *No. 114*, 15–17, *No. 116*, 20–24 and *No. 119*, 9–15). During the data assimilation step, the model data is combined with

Participants in workshop concerned with biomass burning. The Exploratory Workshop on '*Improved Quantitative Fire Description with Multi-Species Inversions of Observed Plumes*' was held at Farnham Castle, UK, on 14–16 September 2009. *Photo courtesy of Adrian Simmons.*

satellite-based observations of several smoke constituents to correct the atmospheric fields, including the smoke plumes. The subsequent forecasts can provide quantitative information suitable for environmental and health services such as guidance related to air quality. In addition, guidance can be generated related to fire spread that can be useful for emergency services. Furthermore, climate simulations can benefit as these now include more detailed vegetation models and interactions with fires.

To improve the collaboration between the very diverse disciplines studying biomass burning, the European Science Foundation (ESF) funded the Exploratory Workshop on '*Improved Quantitative Fire Description with Multi-Species Inversions of Observed Plumes*' under its Standing Committee for Life, Earth and Environmental Sciences (LESC). The workshop was held in Farnham Castle, UK, on 14–16 September 2009 and brought together 24 scientists from nine European countries, Brazil and the United States. The discussions explored opportunities for a better quantitative understanding of the processes involved in biomass burning and sought new and innovative ways to exploit the recent developments in remote sensing, modelling and data assimilation. The most pertinent research questions during the discussions are outlined in the box.

It became clear that research on wildfires has become increasingly fragmented since the 1990s because of the diversity of scientifically productive approaches to the problem. All participants agreed that a closer inter-disciplinary collaboration now bears great potential for their individual research. There was a broad consensus that such collaboration would lead to improved quantitative air quality forecasts, assessments of global air pollution transport patterns, climate change observations, climate change predictions, and guidance for managing large-scale fire situations. Key contributions to these improvements would come from the following.

- The quantification of the relationships between emission factors and physical parameters that are available from remote sensing or provided from operational systems with data assimilation (e.g. humidity, accumulated precipitation, wind, spectral characteristics of fire observations, topography and vegetation characteristics).
- The derivation of estimates for other fire parameters (fuel consumption, fire spread, fire intensity and change in vegetation on longer time scales) from remote sensing data and NWP models.

Some key research issues concerning biomass burning

- There appears to be a major discrepancy between the fire emissions estimated by bottom up models calculating emissions by simulating the combustion of vegetation and top down approaches using inversions based on retrievals of satellite observations of atmospheric components, mainly CO and aerosols.
- Fire and CO plume observations over South Africa display an unexplained shift of one month.
- There is a discrepancy between the emission factors (relating species emission and biomass combustion rates) derived in the laboratory or observed in-situ and those inferred from satellite observations for several species (e.g. aerosols). Furthermore, the chemical and microphysical evolution of the smoke on the 15–30 minutes to one-day scale has not been fully understood.
- There is a need to disentangle fire emissions from other sources, for example the observed seasonal cycle of smoke is additionally shaped by biofuel emissions.
- The combustion efficiency is another key uncertainty in emission estimates.
- Generally, a more systematic approach is needed to tie fire satellite observations, which generally miss small fires and cannot observe biomass combustion in closed systems, with emission inventory estimates, which often rely on incomplete statistical data and generally neglect fires of natural origin.
- Given that the accuracy of single-species flux inversions are still being assessed, the general view was that multi-species inversions are currently too challenging. An additional complication in CO_2 inversions is introduced by the large diurnal cycle of CO_2 in the boundary layer.

Workshop participants being taken on a guided tour of Farnham Castle. The workshop was held in one of the oldest continually inhabited buildings in Southern England. Farnham Castle was the home of the powerful Bishops of Winchester for over 900 years. *Photo courtesy of Martin Schultz.*

- A better integration of biogeochemical fire science with socioeconomic research and investigation of the role of driving parameters such as population density, GDP, land ownership structures and the use of wildfires as a landscape management tool.

The participants agreed that a coordinated and funded research network is needed to establish the necessary inter-disciplinary collaboration in Europe, and increasingly beyond. Such a network could build on the previous achievements of field experiments during the 1990s, most of which were coordinated in the BIBEX programme, and more recent research in several European, international and national projects. Coordinated activities should lead to interdisciplinary laboratory measurements and field campaigns that integrate ground-based and airborne observations as well as detailed analyses of satellite data and numerical modelling results. Meteorological analyses play a crucial role in relating fire and subsequent smoke plume observations when they are hundreds or thousands of kilometres apart.

Opportunities exist in Europe and elsewhere to organize field campaigns around prescribed burns as well as exploiting situations with very high likelihood of wildfire occurrence. Different fire regimes will need to be sampled with small experiments. Also up-scaling to satellite-based remote sensing and the global scale will require additional large experiments. The ultimate goal would be to establish a worldwide collaboration with field experiments on several continents. Coordination is also needed to integrate the results from the laboratory and field studies into numerical systems for forecasting and monitoring atmospheric composition and land surface properties and to further improve the parameterisations for fire emissions applied in these systems.

The final Scientific Report and all presentations are publicly available at:

- http://www.ecmwf.int/newsevents/meetings/workshops/2009/ESF.

Also the workshop proceedings will be published in the MACC project report series.

The workshop was very successful. There is no doubt that it has helped develop enhanced understanding of biomass burning and will lead to better environmental and health services. Most of all it has enhanced collaboration between scientists working in diverse disciplines, all of whom are interested in fires and their impact. Indeed, following the workshop, the participants and other colleagues have prepared and submitted a joint proposal for an ESF Research Network for the collaborative exploitation of fire experiments and model improvements.

The overall outcome of the workshop can be best captured by the statement "If we joined the different approaches and aspects together, we could learn so much more!"

Use of GIS/OGC standards in meteorology

STEPHAN SIEMEN,
BAUDOUIN RAOULT

The second '*Workshop on the Use of GIS/OGC standards in meteorology*' was held in Toulouse on 23–25 November 2009. It was jointly organised by Météo-France, the UK Met Office and ECMWF. Over 140 participants from various organisations across the world attended the workshop with the aim of considering the work in progress from last year's workshop at ECMWF.

There were over 40 talks which reflected the progress achieved over the last year. Within the Open Geospatial Consortium (OGC) a MetOcean Domain Working Group (MetOcean DWG) has been established to resolve issues surrounding the application of OGC standards in meteorology which has its own special challenges. The various presentations and three working groups demonstrated that more work needs to be done to achieve interoperability, and plans to achieve this over the coming years have been proposed. The MetOcean DWG is

MetOcean DWG

The MetOcean Domain Working Group (MetOcean DWG) is a recently established community orientated working group of the Open Geospatial Consortium (OGC). This is not a group that directly revises OGC standards, but rather enables collaboration and communication between groups with meteorological interests. The MetOcean DWG maintains a list of topics of interest to the meteorological community for discussion, defining feedback to the OGC Standards Working Groups (SWG), and performing interoperability experiments.

Taken from the MetOcean DWG website.

looking for other interested parties to contribute to its work.

More information can be found on the MetOcean DWG web page at:

- http://external.opengis.org/twiki_public/bin/view/MetOceanDWG/WebHome

This page contains presentations from the Toulouse workshop and previous OGC meetings. Also it has a mailing list to discuss issues regarding OGC standards in the field of meteorology.

One major recommendation of last year's workshop, the establishment of a Memorandum of Understanding between the OGC and WMO, was signed during the meeting. This will raise awareness of the work of the MetOcean DWG within the meteorological community.

ECMWF presented the development work it has carried out: the support of an OGC web map service in its experimental web reengineering project (WREP) and the use of Magics++ to generate the meteorological maps on-demand. The on-going work to develop a client for OGC standards in Metview 4 was also presented.

The workshop finished with a work plan for the next 12 months. During this period an OGC *Interoperability Experiment* will be organised to test meteorological web map services between various servers and clients. The results of the experiment will be presented at the next workshop hosted by the UK Met Office.

WMO CBS Co-ordination Group on Forecast Verification

DAVID RICHARDSON

Members of the WMO CBS Co-ordination Group on Forecast Verification. The group met for the first time on 24–26 November 2009 at ECMWF.

The WMO Commission for Basic Systems (CBS) has recently established a Co-ordination Group on Forecast Verification (CG-FV), chaired by David Richardson, Head of the Meteorological Operations Section at ECMWF. The priority for the Group is to review the existing standard procedures for verification of deterministic NWP forecasts (defined in the WMO Manual on the Global Data-Processing and Forecasting System). These procedures are used by global NWP centres, including ECMWF, to produce a standard set of verification scores that are exchanged monthly between the centres. However, the standard procedures have not been reviewed for over ten years and are currently not implemented consistently at all centres. This means it is difficult to compare the performance of different centres using these scores.

The first meeting of the CG-FV was held at ECMWF on 24–26 November. The meeting reviewed the current procedures used by global NWP centres to produce the standard set of scores that are exchanged monthly between centres and considered the implementation of these procedures in different centres. The meeting developed a proposed update to these procedures that will make the results more consistent and relevant for current NWP. The recommendations include:

- An increase in resolution of the grid used for verification (currently 2.5°×2.5°).
- Use of a defined interpolation method to retain features at the scale of the verifying grid but not introduce additional smoothing.
- Use of a common climatology for anomaly correlation (ERA-Interim is proposed).
- Introduction of additional scores to measure forecast activity.

The meeting proposed the establishment of a Lead Centre for Deterministic NWP Verification that will collect, process and publish the scores, and will be responsible for maintaining the consistent implementation of the procedures across centres.

The meeting agreed that the main surface parameters should be precipitation accumulated over 24 hours, and 2-metre temperature and 10-metre wind at 6-hourly intervals.

The proposals will be reviewed by the relevant participating global NWP centres and presented to the next CBS meeting in autumn 2010.

Future work of the Group will include developing standard procedures for verification of surface parameters and severe weather events.

Terms of Reference of the Coordination Group on Forecast Verification as defined by CBS-XIV (2009)

(a) In consultation with the relevant Expert Teams, review procedures for verification of the performance of forecasting systems to ensure that they are adequate and meet CBS needs;
(b) Ensure that verification systems are appropriate to emerging forecast types such as probabilistic forecasts, very high resolution NWP products, and nowcasting products;
(c) Develop suitable verification procedures for severe weather forecasts and warnings;
(d) Review Lead Centre activities and provide guidance as appropriate;
(e) Liaise with WWRP/WGNE as required;
(f) Provide guidance on how to implement verification systems.

Land surface modelling, data assimilation and the implications for predictability

ANTON BELJAARS (ECMWF),
GIANPAOLO BALSAMO (ECMWF),
PATRICIA DE ROSNAY (ECMWF),
BART VAN DEN HURK (GLASS),
MARTIN BEST (GLASS)

An ECMWF/GLASS workshop on '*Land Surface Modelling, Data Assimilation and the Implications for Predictability*' took place at ECMWF from 9 to 12 November 2009. The workshop was organized in cooperation with the GLASS (Global Land/Atmosphere System Study) scientific panel, operating under the GEWEX (Global Energy and Water Cycle Experiment) integrated research programme.

The objectives of the workshop were to review the state-of-the-art and to highlight new developments in the area of land surface modelling, data assimilation and predictability related to land surface, as well as to address future research priorities.

In the presentations, recent research was reviewed on land atmosphere modelling, land data assimilation, new observations (e.g. ESA's Soil Moisture and Ocean Salinity mission), and the role of soil moisture and snow in predictability in the sub-seasonal time range. Quality assessment of models by standardized procedures for model verification and benchmarking was also addressed. It is clear that a wide range of physical processes at the surface are relevant for improving predictions.

The working groups were explicitly asked to make recommendations on priorities for further research at ECMWF and within the GLASS community. The workshop particularly endorsed the Centre's plans for further integration of the atmospheric model and the land data assimilation system, and the use of new soil moisture related observations.

Working Group I: Land surface modelling and applications

The ECMWF land surface model has been substantially improved in the past few years with the introduction of a revised soil hydrology (H-TESSEL)

Participants in the ECMWF/GLASS workshop. About fifty leading scientists from outside ECMWF participated in the workshop. There were twenty-seven invited oral presentations and twenty-six poster presentations.

and a new snow scheme. ECMWF is encouraged to continue with the development of land surface modelling, with particular focus on hydrological modelling (by including a representation of lakes and rivers), to help provide accurate land-atmosphere and land-ocean water flux predictions.

Cold processes (particularly snow accumulation and melting in heterogeneous terrain) and warm processes (e.g. evaporation and soil heat transfer) were highlighted as providing great potential for improvements in NWP. Their impact is expected to improve the representation of the diurnal cycle.

The realism of land surface models will benefit also from an increasingly higher spatial resolution, supported by Earth Observation datasets. This will help establish process-oriented schemes to replace schemes based on effective parameters or dominant land-use type. Finally interactive vegetation and carbon processes have to be accounted for in modern land surface schemes in an effort to bridge the gap between NWP schemes and Earth-System models.

Working Group 2: Land surface data assimilation

Current improvements in the ECMWF surface data assimilation system open a wide range of possibilities to take advantage of the past, current and future satellite data. Exploiting synergies between the different types of data (soil moisture, vegetation, snow, albedo and land surface temperature) has been identified to be of high interest for land surface analysis activities. To achieve this, the working group acknowledged that ECMWF is in very good position to implement a multi-variate land surface data assimilation system for NWP. It was agreed that diagnostics on the land data assimilation system would be important for evaluating the self sensitivity of different observation types (e.g. a study of the Degrees of Freedom for Signal or Forecast Sensitivity).

Stand-alone (without atmospheric analysis) and offline (forced by atmospheric fields) surface analyses are under development at ECMWF. These procedures will be of particular interest for seasonal forecasting and re-analysis activities. In this context it was suggested that a first Project of Inter-comparison of Land Data Assimilation Systems (PILDAS) should be initiated as a new GLASS activity.

Working Group 3: Observations for terrestrial surfaces

ECMWF is collaborating with Space Agencies to use satellite observations for the operational land surface analysis (e.g. ESA: SMOS or EUMETSAT: ASCAT). It was agreed that it is important to investigate the benefit of assimilating albedo, vegetation parameters, land surface temperature and snow cover extent using satellite data. Physiographic information (e.g. land-use and elevation maps) also needs to be included in land surface modelling and data assimilation systems.

Using established ground-based observation networks (e.g. flux tower data as archived in the FLUXNET and CEOP projects) to compare with model and data assimilation results would be very useful. ECMWF was encouraged to create a structured set of ground data to verify land surface modelling and analysis results on a systematic basis. Satellite data provides two-dimensional information that is relevant for verification of radiative and evaporative fluxes as well as land surface temperature.

Datasets of global meteorological forcing are crucial to support coordinated activities such as land surface model inter-comparisons. Modern re-analyses (e.g. ERA-Interim), with appropriate bias corrections for precipitation, are suitable for this purpose and should be extended to cover multi-decadal periods.

Working Group 4: Contribution of land surface to predictability

Research efforts to improve long-term prediction have indicated the crucial role of the land surface. For example, large multi-model projects such as the Global Land-Atmosphere Coupling Experiment (GLACE) have provided evidence of strong coupling between soil moisture and precipitation in mid-latitude and tropical areas. Results from the current phase-2 (GLACE-2) have helped to quantify the predictability gain coming from accurate land surface initial conditions up to two months in the future.

For seasonal forecasting at ECMWF it was recommended that soil moisture initialization is improved by activating the H-TESSEL scheme and by taking advantage of the new surface analysis structure (stand-alone version) to run surface re-analysis. The contribution of land surface and meteorological forcing (e.g. precipitation) errors to the uncertainty in seasonal forecasts could be addressed by adopting perturbed initial conditions (e.g. soil moisture) in the Ensemble Prediction System (EPS).

More accurate snow cover and snow depth are considered to be a high priority for model initialization. Snow processes impact on temperature profiles in northern latitudes and have tele-connections with large-scale circulation patterns such as the Indian monsoon. Consequently a strong influence on predictive skills can be expected from improved models and initial conditions. It would be highly relevant to investigate both local and remote impacts of snow through GLACE-type experiments.

Further information

More detailed reports on the working group discussions are in preparation and will be published in the forthcoming proceedings together with short papers on the individual contributions.

Presentations from this workshop can be found on the following web location:

- http://www.ecmwf.int/newsevents/meetings/workshops/2009/Land_surface_modelling/presentations.html

The organizers would like to thank all the participants for their contributions to the workshop.

Applying for computing resources for Special Projects

UMBERTO MODIGLIANI

Each year users within one of ECMWF's Member States may apply for computing resources as a 'Special Project'. These are of a scientific or technical nature and are likely to be of interest to the general scientific community. Such projects can be undertaken in co-operation between several institutions, nationally or internationally. The decision to treat a project request as a Special Project application is made ultimately by the Director of the National Meteorological Service of the project's Principal Investigator. European organisations with which ECMWF has concluded Co-operation Agreements may apply for resources for a Special Project, with such a request to be considered by the Director of ECMWF. The Special Projects that are continuing or starting in 2010 are given in the item starting on page 34 of this edition of the *ECMWF Newsletter*.

The allocation of computing resources for Special Projects is decided by the ECMWF Council. The guidelines for distribution currently state that a maximum of 10% of the computing resources available to Member States may be allocated to Special Projects. 20% of that 10% is set aside as a reserve for allocation by ECMWF directly (following consultation with the Chairs of the Technical Advisory Committee and the Scientific Advisory Committee) either to late applicants or to projects which have exhausted their allocation before the end of the year.

If you wish to begin work on a Special Project in 2011 then an application form should be completed and sent to ECMWF via the Director of the appropriate National Meteorological Service. The form needs to reach ECMWF by 30 April 2010. Requests will be reviewed by the Scientific Advisory Committee and Technical Advisory Committee in October and then approved (or not) by the ECMWF Council at its meeting in December 2010. If the 30 April deadline is missed, applications can still be made as limited resources are set aside specifically for ad hoc allocations. The various application forms are available from:

- www.ecmwf.int/about/special_projects/

Due to the large oversubscription of computing resources available to Special Projects, a new procedure was implemented in 2008 for the handling of applications for computing resources for Special Projects. The main changes are:

- Each project will have a well-defined duration, up to a maximum of three years, agreed at the beginning of the project.
- The amount of resources requested by each project for each year cannot exceed more than 8% of the total amount of resources available for that year. For 2010 the maximum resource that could be allocated to any project was designated as 5,368 kunits of HPCF and 24,000 gigabytes of Data Storage.
- To avoid accepted Special Project requests needing a reduction by more than 20%, the lowest ranking Special Projects requesting large amounts of computing resources may not be accepted.

More information about Special Projects can be found by going to the web address that has already been given.

Development of Meteorological Operational Systems

BAUDOUIN RAOULT,
DAVID RICHARDSON,
STEPHAN SIEMEN, ERIK ANDERSSON

The 12th biennial Workshop on Meteorological Operational Systems was held at ECMWF on 2–6 November 2009. This year there was a strong focus on the role of observations. The workshop reviewed the state of the art of observation handling in meteorological operational systems and addressed future trends in:

- The role of observations in verification of medium-range forecast products (session 1).
- Data management and meteorological visualisations on workstations (sessions 2 and 3).

The workshop was attended by nearly 60 participants from Meteorological Services, WMO, EUMETSAT, research institutions and commercial weather services coming from 22 countries in Europe, Asia and the Americas.

The presentations given in session 1 addressed the changes to the forecasting system, together with developments in the range of products provided by the Centre. There was a focus on tools and products for observation monitoring, and on the use of observations in verification of rare events. Users of the ECMWF forecasts reported on their approach to medium- and extended-range weather forecasting, including the use

and application of ECMWF products.

In session 2, experiences were shared on the management of observation, from collection to applications. New meteorological visualisation applications and updates to existing applications were presented in session 3 and also demonstrated during an exhibition.

During the week, the workshop split into two working groups to discuss issues relevant to the session topics. Some of their key findings were as follows.

Statistical adaptation

- For general public forecasting, high-resolution models may now be good enough to use direct model output for surface temperature and winds in areas of low/smooth orography. However, for more complex terrain, other parameters, and specific users there is still a clear benefit from statistical adaptation.
- Methods are so far generally linear, but there is some work beginning on non-linear or regime-dependent adaptation.
- Some users have begun to calibrate EPS model output using re-forecasts. Initial results are encouraging and show improved performance.

Requirements for observations

- There is a strong need for high-resolution observational data for both validation/verification of models and for use in statistical adaptation. Freely available station data is not at sufficient spatial resolution for all requirements. Most countries have additional local observational data that is not widely disseminated. It would be beneficial if this data could be more widely exchanged.
- All observations need careful quality control. It is important to understand the different aspects of observation uncertainty (observation error, interpolation, representativeness) when using this data for verification.
- There is large potential to use satellite and radar data to give high resolution (space/time) observational information for verification. More work is needed to fully exploit this data.
- For SYNOP observations further harmonisation of reporting practices will be of value (e.g. for reporting snow amounts and wind gusts).

Monitoring of observations

- It would be of value to establish a basic set of monitoring statistics for satellite data and to make this available for comparison between centres in (near) real time.
- Routine exchange of alerts from monitoring at different centres could improve the identification of observation problems.

Graphical Workstations and Data Management

- Google® is providing users with very high expectations. There is access to very large amounts of data and response times are nearly instantaneous
- Analysing/visualising large amounts of meteorological data interactively is very important. A key issue is specifying the requirements for the Graphical User Interface (i.e. in terms of features and functionalities, usability and performance) and deciding how data can be organised to fulfil these requirements.

Cataloguing and discovery

- There is a need to publicise the availability of data and products. WMO mandates the use of ISO19115 but there does not seem to be a lot of uptake by the community as yet. CSW (Catalogue Service for Web, OGC - Hierarchical structure) should be considered for cataloguing ISO19115 records.
- Forecaster workstation could use GISC catalogues to provide forecasters with information about data availability for certain areas of interest. This should be considered as a backup. Operations cannot be based on remote data only.
- The troubleshooting in a service-oriented architecture (SOA) is generally hard, but the following of standards helps training of developers. In SOA applications security and its implications should not be underestimated. SOA is generally vulnerable to network outages but SOA systems can be deployed on a single computer.

Performance

- Efficient data management is the key of good visualisations. Hardware may be the limiting factor (e.g. disks). Large databases may constitute a bottleneck and replicated databases may hit network bottleneck. Good indexing is essential (meta indexing) for good performance.
- Multiple organisations of the data can help optimise response time, but is costly in terms of disk space. Intelligent pre-processing (e.g. clusters, means) is necessary to present large amount of data to the forecaster.

The workshop programme, the presentations and the summaries of the working group discussions, which were presented at the final plenary, can be found at:

- http://www.ecmwf.int/newsevents/meetings/workshops/2009/MOS_12/index.html

ECMWF products made available to NMHSs of WMO Members

BOB RIDDAWAY

At its 71st session the ECMWF Council unanimously adopted the 'Oslo declaration' as a guideline for formulating ECMWF's data policy. This led to a review of the list of ECMWF products declared 'essential' in that they are available on a free and unrestricted basis.

The Council has specified the ECMWF products that are made available to National Meteorological and Hydrological Services (NMHSs) of WMO Members. Of these only a few are classified as 'essential': 500 hPa geopotential, 850 hPa wind components and mean sea level pressure from the deterministic model for forecast ranges of 72 hours and longer.

At its 72nd session the Council decided to include the following as 'essential' products.

- 500 hPa geopotential, 850 hPa wind components and mean sea level pressure available at H+00, H+24 and H+48.
- 850 hPa temperature in 24-hour time steps from H+00.
- Ensemble mean and ensemble standard deviation (spread) from the Ensemble Prediction System (EPS) for 500 hPa geopotential, 850 hPa winds, 850 hPa temperature and mean sea level pressure in 24-hour time steps from H+00.

The table shows the full set of products that are available for NMHSs of WMO Members twice daily from 00 and 12 UTC base times with a product resolution of 0.5° latitude/longitude. This includes the 'essential products' plus additional products in accordance with WMO Resolution 40.

Parameter	Level	Domain	Steps
Based on the deterministic model			
Geopotential	500	G/A	H+00,24,48,72,96,120,144,168,192,216,240
Temperature	850	G/A	H+00,24,48,72,96,120,144,168,192,216,240
MSL pressure	Surface	G/A	H+00,24,48,72,96,120,144,168,192,216,240
Wind components	850	G/A	H+00,24,48,72,96,120,144,168,192,216,240
Wind components	700	G/A	H+00,24,48,72,96,120,144,168
Wind components	500	G/A	H+00,24,48,72,96,120,144,168
Wind components	200	G/A	H+00,24,48,72,96,120,144,168
Relative humidity	850	G/A	H+00,24,48,72,96,120,144,168
Relative humidity	700	G/A	H+00,24,48,72,96,120,144,168
Sig. wave height (SWH)	Surface	G	H+00,24,48,72,96,120,144,168
Mean wave direction	Surface	G	H+00,24,48,72,96,120,144,168
Mean wave period	Surface	G	H+00,24,48,72,96,120,144,168
Divergence	700	T/TA	H+00,24,48,72,96,120,144
Vorticity	700	T/TA	H+00,24,48,72,96,120,144

ECMWF products made available to NMHSs of WMO Members. G=Global; T=Tropics between 35°S and 35°N; A=Four octants centred on Africa; TA=Tropics between 35°S and 35°N and from 90°W to 90°E. Products indicated with * are only available on the ECMWF website in graphical form. The 'essential products' are in red. Products only available for the African Centre for Meteorological Applications for Development (ACMAD) are not shown in the table. For more information go to http://www.ecmwf.int/products/additional/

Parameter	Level	Domain	Steps
Based on the Ensemble Prediction System			
Geopotential* mean/standard dev.	500	G/A	H+00,24,48,72,96,120,144,168,192,216,240
Temperature* mean/standard dev.	850	G/A	H+00,24,48,72,96,120,144,168,192,216,240
MSL pressure* mean/standard dev.	Surface	G/A	H+00,24,48,72,96,120,144,168,192,216,240
Wind components* mean/standard dev.	850	G/A	H+00,24,48,72,96,120,144,168,192,216,240
Prob precip > 10 mm		G	H+00-24,12-36,24-48,36-60,48-72,60-84,72-96,84-108,96-120,108-132,120-144
Prob precip > 20 mm		G	H+00-24,12-36,24-48,36-60,48-72,60-84,72-96,84-108,96-120,108-132,120-144
Wind gusts > 15 ms^{-1}		G	H+00-24,12-36,24-48,36-60,48-72,60-84,72-96,84-108,96-120,108-132,120-144
Wind gusts > 25 ms^{-1}		G	H+00-24,12-36,24-48,36-60,48-72,60-84,72-96,84-108,96-120,108-132,120-144
Prob SWH > 2 m*		G	H+00,12,24,36,48,60,72,84,96,108,120,132,144
Prob SWH > 4 m*		G	H+00,12,24,36,48,60,72,84,96,108,120,132,144
Prob SWH > 6 m*		G	H+00,12,24,36,48,60,72,84,96,108,120,132,144
Prob SWH > 8 m*		G	H+00,12,24,36,48,60,72,84,96,108,120,132,144
Extreme Forecast Indices*		G	H+00,12,24,36,48,60,72,84,96,108,120,132,144
Others			
EPSgrams*			Out to ten days
Tropical cyclone tracks			H+00,12,24,36,48,60,72,84,96,108,120
Seasonal SST			Month 1 to 6

ECMWF workshops and scientific meetings in 2010

BOB RIDDAWAY

ECMWF events

- ECMWF/JCSDA Workshop on *'Assimilating satellite observations of clouds and precipitation into NWP models'* (15 to 17 June 2010)
- Forecast Products – Users' Meeting (9 to 11 June 2010)
- ECMWF 2009 Annual Seminar on *'Predictability in the European and Atlantic regions from days to years'* (6 to 9 September 2010)
- 14th ECMWF Workshop on *'High Performance Computing in Meteorology'* (1 to 5 November 2010)
- Workshop on *'Non-hydrostatic Modelling'* (8 to 10 November 2010)

ECMWF/JCSDA Workshop on 'Assimilating satellite observations of clouds and precipitation into NWP models' (15–17 June 2010)

To date, the assimilation of satellite measurements has mainly focused on the clear atmosphere. However, satellite observations in the visible, infrared and microwave provide a great deal of information on clouds and precipitation as well as the clear regions above the clouds. The issue is how to use this information to improve the initialization of cloudy and precipitating atmospheric regions in NWP models.

The workshop will cover:

- Current status of cloud/precipitation assimilation in NWP.
- Availability and characteristics of relevant satellite observations.
- Radiative transfer modelling developments.
- Cloud and precipitation modelling.
- Special issues related to data assimilation of cloud/precipitation-affected observations.

This workshop is organised in collaboration with the Joint Centre for Satellite Data Assimilation (JCSDA) in the USA. Workshop attendance is by invitation.

- http://www.ecmwf.int/newsevents/meetings/workshops/2010/Satellite_observations/

Forecast Products – Users' Meeting (9–11 June 2010)

ECMWF organizes annually a meeting of users of its medium-range and extended-range products. The purpose of the meetings is to:

- Give forecasters the opportunity to discuss their experience with and to exchange views on the use of the medium-range and extended-range products, including the ensemble.
- Review the development of the operational system and discuss future developments including forecast products.

User registration from Member States and Co-operating States should be communicated via the National Meteorological Service of that country. Invitations will be mailed to the Member States early in 2010.

- http://www.ecmwf.int/newsevents/meetings/forecast_products_user/

ECMWF 2009 Annual Seminar on 'Predictability in the European and Atlantic regions from days to years' (6–9 September 2010)

The Atlantic-European region is recognized as a part of the world where the natural, internal variability of the atmosphere tends to dominate over boundary-forced signals. Despite the noticeable improvements of NWP models in predicting phenomena such as Mediterranean storms and European blocking, the prediction of some extreme manifestations of these events remains challenging. Furthermore, extended-range and seasonal forecasts for this region remain a very difficult task. Although this can be partially attributed to an intrinsic limit in predictability, there is increasing evidence of the potential arising from a better simulation of same phenomena (e.g. MJO teleconnections, stratosphere-troposphere interactions and sea-ice variability). This potential might be realized through improved physical parametrizations that would also take into account their inherent uncertainty. On the longer time scale, skilful simulations of teleconnections with tropical Atlantic sea surface temperature may be achieved by a better representation of tropical Atlantic Ocean variability in coupled models.

The seminar will review recent progress in predicting Euro-Atlantic variability on a variety of scales, with emphasis on the links between different regions and various components of the weather/climate system.

A registration form and further information will be available from:

- www.ecmwf.int/newsevents/meetings/annual_seminar/2010

14th ECMWF Workshop on 'High Performance Computing in Meteorology' (1–5 November 2010)

The emphasis of this biennial workshop will be on running meteorological applications at sustained teraflops performance in a production environment. Particular emphasis will be placed on the future scalability of NWP codes and the tools and development environments to facilitate this. The aim is to provide a venue where:

- Users from our Member States and around the world can report on their experience and achievements in the field of high performance computing during the last two years and present plans for the future and requirements for computing power.
- Vendors of supercomputers will have the opportunity to talk to managers and end users of meteorological computer centres about their current and future products.
- Meteorological scientists can present their achievements in the development of parallel computing techniques and algorithms, and can exchange ideas on the use of

supercomputers in future research.

- Computer scientists can give an update on their efforts in providing tools which will help users to exploit the power of supercomputers in the field of meteorology.
- The challenges of creating a computer centre infrastructure for HPC can be discussed.

Workshop attendance is by invitation. If you are interested in attending, go to:

- http://www.ecmwf.int/newsevents/meetings/workshops/2010/high_performance_computing_14th/

Workshop on 'Non-hydrostatic Modelling' (8–10 November 2010)

The workshop will review recent progress made in non-hydrostatic modelling worldwide, with some emphasis on global model developments. It will consider the strengths and weaknesses of different approaches taken in the development of non-hydrostatic dynamical cores and exchange ideas about efficient ways of testing the performance of these models at all scales. The Centre's plans for future improvements to the ARPEGE/IFS non-hydrostatic model will also be presented for discussion. Workshop attendance is by invitation.

- http://www.ecmwf.int/newsevents/meetings/workshops/2010/Non_hydrostatic_Modelling/

Tim Palmer honoured by the AMS

Tim Palmer (Head of Probabilistic Forecasting & Diagnostics Division, right) being presented with the Carl-Gustaf Rossby Research Medal by Tom Karl (AMS President, left). *Photograph: Jenni Girtman/ Atlanta Event Photography; photograph provided courtesy of AMS.*

On 20 January, Tim Palmer (Head of Probabilistic Forecasting and Diagnostics Division at ECMWF) was awarded the Carl-Gustaf Rossby Research Medal at the 90th Annual Meeting of the American Meteorological Society (AMS). This is presented to an individual on the basis of outstanding contributions to the understanding of the structure or behaviour of the atmosphere. The medal represents the highest honour the AMS can bestow upon an atmospheric scientist.

Tim was awarded the prize for his fundamental contributions to understanding the role of nonlinear processes in the predictability of weather and climate, and for developing tools to estimate such predictability.

In his acceptance speech, Tim acknowledged that this award was in recognition of research conducted jointly with colleagues at ECMWF over almost a quarter of a century.

10th Annual Meeting of the European Meteorological Society (EMS)

8th European Conference on Applied Climatology (ECAC)

These meetings will take place on 13–17 September 2010 in Zürich, Switzerland. Go to:
http://www.ems2010.ch
for more information.

The EMS Annual Meetings aim to foster the exchange and cross-fertilization of ideas across the whole meteorological community, focusing particularly on strategic issues relevant to the future of meteorology in Europe. The programme for the meeting features three streams:

- The Atmosphere and Water Cycle
- Communication and Education
- Numerical Weather Prediction

The underpinning theme of the ECAC is the development of climate change services. The programme consists of three programme groups:

- Monitoring
- Understanding
- Services

Programme details are available from: **http://meetings.copernicus.org/ems2010.**

The deadlines are:

- Abstract submission with award/waiver applications: 9 April 2010.
- Abstract submission: 30 April 2010.

Information about the exhibition will be available in due course at: **http://meetings.copernicus.org/ems2010**.

Facilities will be available for groups wishing to hold side meetings. Anyone wanting to take up this offer should contact Martina Junge at: **ems-sec@met.fu-berlin.de** to discuss requirements and options.

Performance of ECMWF forecasts in 2008/09

ERIK ANDERSSON, DAVID RICHARDSON

EACH YEAR, comprehensive verification statistics are prepared to evaluate the performance of all the components of the ECMWF forecasting system. The results for 2008/09 have recently been published in *ECMWF Tech. Memo. No. 606*. A couple of this year's main results are shown here.

A verification summary is presented to the ECMWF advisory committees and the Council. Box A contains the overall view of the Technical Advisory Committee about the recent performance of ECMWF's operational forecasting system.

Overall performance in the medium-range

Long time series of skill scores reflect the combined impact of all the improvements made to the forecasting system over the years: increased resolution, improved forecast model, better data assimilation, and the availability of many more satellite observations.

Figure 1 shows the evolution of the skill of the deterministic forecast of 500 hPa geopotential height over Europe since 1980. Each curve is a 12-month moving average of root mean square (rms) error, normalised with reference to the rms error of persistence (a forecast that persists initial conditions into the future). The last month included in the statistics is July 2009. The resolution of the forecast model was T63 (320 km) initially, and was increased to T106 in 1987, T213 in 1993, T319 in 2000, T511 in 2001 and T799 (25 km) in 2006.

We can see that the skill for the European region has increased substantially: the skill of a 7-day forecast (orange curve) this year is as skilful (on average) as a 3-day forecast (dark green curve) was in 1980. For the most part, there has been a steady improvement since 1997, i.e. over the entire period that 4D-Var data assimilation has been operational. Over the last four years, it is the 5–8 day range that has improved most rapidly over Europe.

Precipitation

There is an increasing emphasis on evaluating forecasts in terms of weather parameters, in addition to the more traditional height scores. Near-surface air temperature, precipitation, wind gusts, clouds and humidity are verified operationally. As ECMWF focuses on providing early warning for severe weather, it is the heavy rainfall events and wind storms that are of special interest. For these parameters, verification is performed through comparison against observations from meteorological stations (SYNOP). For verification of Ensemble Prediction System (EPS) precipitation, however, the 0–24 hour model forecast is used as a proxy for a model-scale analysis.

The long-term trend in precipitation skill for Europe is shown in Figure 2, for thresholds up to 20 mm per day. A consistent improvement in rainfall forecasts has been noted since the introduction of cycle 31r1 in September 2006. For both 10 mm/day (red) and the higher threshold of 20 mm/day (green curve), the exceptional performance over 2007–2008 was matched in 2008–2009. The graph shown here shows a probabilistic score (Brier Skill Score) derived from the EPS for day 4.

Overall view of ECMWF's Technical Advisory Committee, 8–9 October 2009 — A

In regard to its overall view of the operational forecasting system:

i congratulated ECMWF on the very high performance levels of all its forecast systems during the previous year and on its continued leading position in relation to other centres;

ii noted that the skill of the ensemble prediction system had continued to improve and was impressed by the results of recent work on the TIGGE dataset, which showed the ECMWF ensemble to be the best in the world;

iii noted with satisfaction that ECMWF wave forecasts remain the best in the world; also noted the importance of freak wave forecasts and that further progress is needed in this area;

iv was encouraged by the promising results from the use of cloud-affected and surface-affected radiances in the data assimilation;

v welcomed the development work on interactive EFI products and stressed the great potential value of such products for the early detection of high impact weather events;

vi very much appreciated the introduction of new verification statistics for the EFI, showing a positive trend in performance over recent years;

vii with respect to deterministic forecasts of weather parameters:

- welcomed the marked improvement in the skill of precipitation forecasts;
- noted that, although the accuracy of snowfall forecasts has been improved, there is still an overprediction of snow in certain conditions;
- noted, with some concern, a significant cold bias over Europe at night during the last winter and spring;
- appreciated the value of the wind gust predictions but queried whether there is sufficient differentiation in their treatment over land and sea.

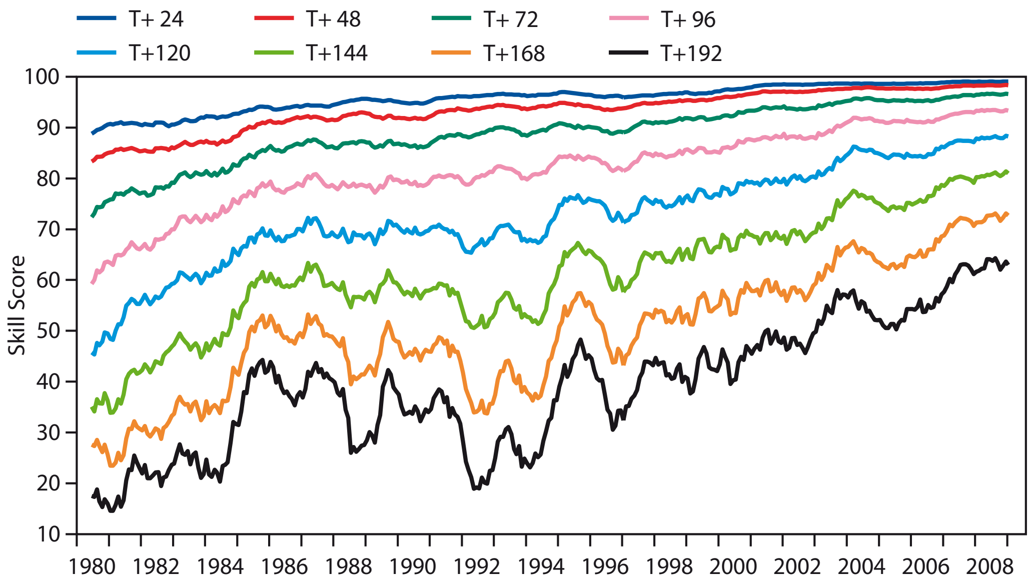


Figure 1 Skill score for 500 hPa geopotential height for Europe from 1980 to 2009. The curves show 12-month moving averages for forecast ranges from 24 to 192 hours (1 to 8 days) in different colours as indicated by the legend. The last point on each curve is for the 12-month period August 2008 to July 2009.

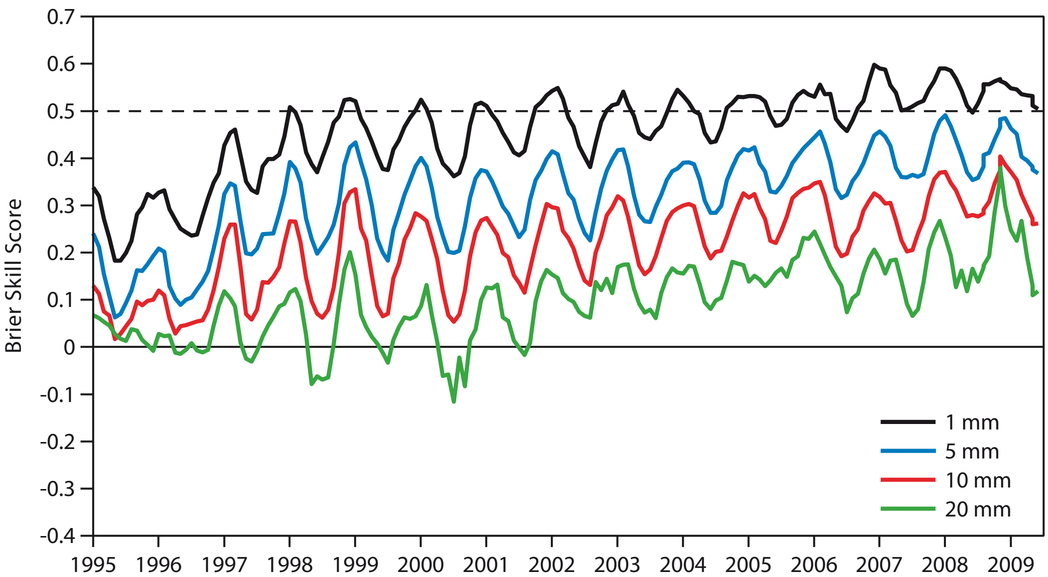


Figure 2 Time series of Brier Skill Score for EPS probability forecasts of precipitation over Europe at day 4 exceeding four thresholds: 1, 5, 10 and 20 mm/day as indicated in the legend. The skill score is calculated for three-month running periods.

Further information

The complete set of annual verification results is available in ECMWF Technical Memoranda on '*Verification statistics and evaluations of ECMWF forecasts*', downloadable from:

http://www.ecmwf.int/publications/library.

The results, starting with those for 2000/01, can be found in *ECMWF Tech. Memo. No. 346*, *No. 414*, *No. 432*, *No. 463*, *No. 501*, *No. 504*, *No. 547*, *No. 578* and *No. 606*.

Verification pages have been created on the ECMWF web server and are regularly updated. Currently they are accessible at the following addresses:

- Medium range: http://www.ecmwf.int/products/forecasts/d/charts/medium/verification/
- Monthly range: http://www.ecmwf.int/products/forecasts/d/charts/mofc/verification/
- Seasonal range: http://www.ecmwf.int/products/forecasts/d/charts/seasonal/verification/

Note that all forecasting system cycle changes since 1985 are described and updated at:
http://www.ecmwf.int/products/data/operational_system/index.html

Assessment of FY-3A satellite data

QIFENG LU, BILL BELL, PETER BAUER, NIELS BORMANN

OVER the last year data from a new Chinese meteorological satellite, FY-3A, has been introduced into the ECMWF data assimilation system to assess the quality of the data. Initial results are encouraging and build confidence that the follow-on series of FY-3 satellites will be widely used for NWP data assimilation.

Satellite FY-3A

Since the launch of China's first polar orbiting satellite (FY-1A) in 1988, China has launched a series of four further polar orbiting satellites and five geostationary satellites. Both polar (FY-3) and geostationary (FY-4) satellite programmes will continue over the next decade and an ambitious schedule of launches is currently planned, accommodating increasingly sophisticated sensors for operational meteorology. FY-3 data will soon become an important component of the global observing system and will provide valuable data for operational NWP, reanalysis and climate research.

FY-3A is the preparatory platform for a subsequent series of seven satellites and was successfully launched from the Taiyuan Launching Center on 27 May 2008. FY-3A carries a suite of 11 instruments. Of particular interest for NWP data assimilation applications are three instruments which make up the Vertical Atmospheric Sounder System (VASS): the Microwave Temperature Sounder (MWTS), the Microwave Humidity Sounder (MWHS) and the Infrared Atmospheric Sounder (IRAS). These instruments are similar in specification to those on NOAA

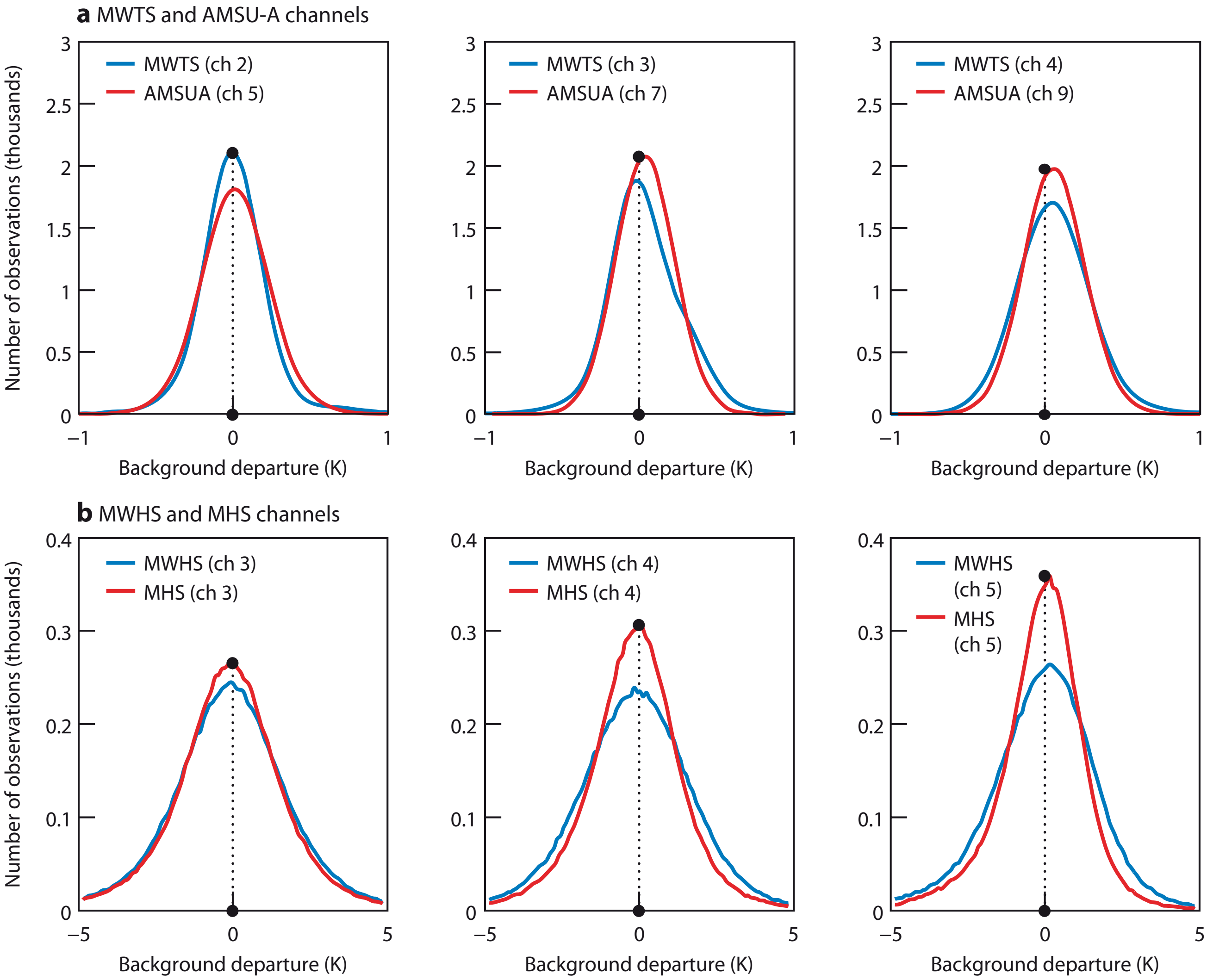


Figure 1 (a) Histograms of background departures for MWTS channels 2 (53.6 GHz), 3 (54.9 GHz) and 4 (57.3 GHz) along with the results for the equivalent AMSU-A channels (channels 5, 7 and 9). (b) As (a) but for background departures for MWHS channels 3 (183±1 GHz), 4 (183±3 GHz) and 5 (183±7 GHz) along with the results from the equivalent MHS channels (channels 3, 4 and 5).

Instruments on FY-3A	Similar instruments on NOAA/NASA platforms
Microwave Temperature Sounder (MWTS)	Microwave Sounding Unit (MSU)
Microwave Humidity Sounder (MWHS)	Advanced Microwave Sounding Unit-B (AMSU-B)
Infrared Atmospheric Sounder (IRAS)	High Resolution Infrared Radiation Sounder (HIRS)
Microwave Radiation Imager (MWRI)	Advanced Microwave Scanning Radiometer (AMSR-E)

Table 1 Some of the instruments on FY-3A and those on NOAA/NASA platforms with similar specifications.

platforms which have been key components of the data assimilation system at ECMWF for the last decade – see Table 1.

Also of interest for NWP is the 10-channel Microwave Radiation Imager (MWRI), an imaging instrument similar in specification to the Advanced Microwave Scanning Radiometer (AMSR-E) currently used in operations at ECMWF and processed via the new *all-sky* assimilation system introduced with cycle 35r2 of ECMWF's Integrated Forecast System (IFS).

As a preparatory platform it is essential that the performance of the FY-3A instruments is assessed carefully, so that any deficiencies in the design or on-orbit performance of the instruments can be rectified in future instruments. As part of a comprehensive calibration and validation programme data from the FY-3A instruments has been introduced into the IFS and assessed by Qifeng Lu from the Chinese National Satellite Meteorology Centre during a successful 12 month visit to ECMWF which ended in December 2009. This work has included a comparison of the FY-3A observations with model equivalents as well as an assessment of the impact of the data on analyses and forecasts, through observing system experiments (OSEs).

Data quality

Histograms of background departures for the three sounding channels of the MWTS (channels 2–4) are shown in Figure 1. Also shown for comparison are the statistics from the equivalent channels for NOAA-18 AMSU-A obtained for the same period. These statistics measure the fit of the ECMWF model to the measured radiances and give a good early indication of data quality as any gross errors in the data would be manifested as a large spread in the back-

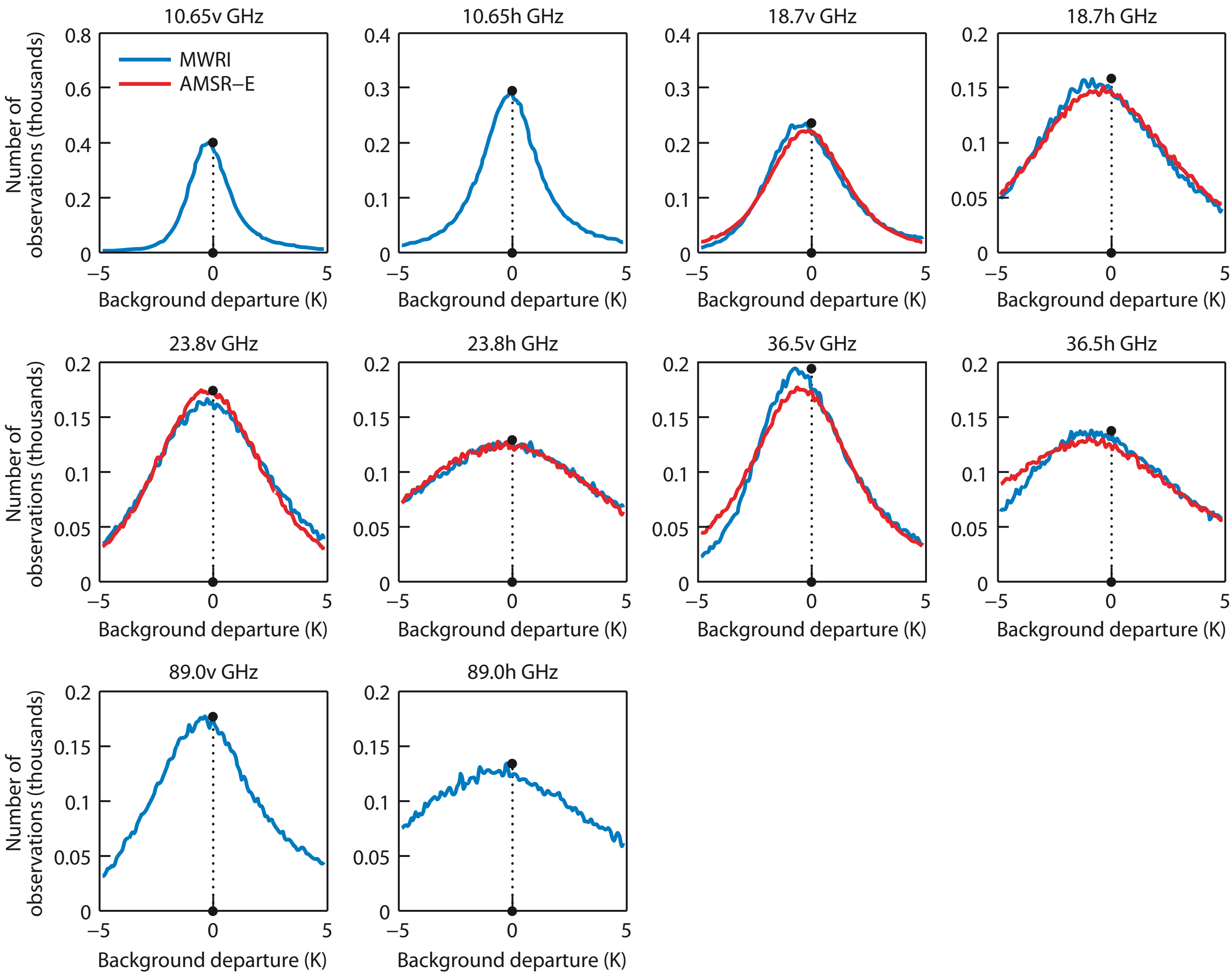


Figure 2 Histograms of background departures for the MWRI channels and equivalent AMSR-E channels where available.

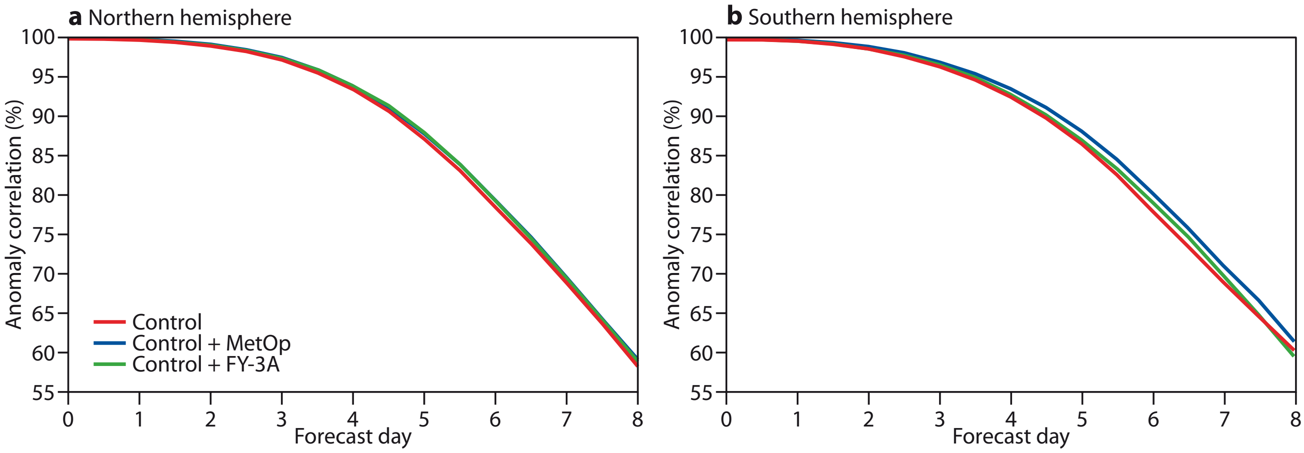


Figure 3 Anomaly correlation for 500 hPa geopotential height in (a) the northern hemisphere and (b) the southern hemisphere for an observing system depleted control experiment (red) as well as experiments in which either FY-3A (green) or MetOp-A (blue) sounding data has been added.

ground departures. The fit of the measured MWTS radiances to the model is better than 0.3 K (standard deviation), only slightly larger than the equivalent AMSU-A statistics. The larger standard deviations are to be expected and result from the higher noise levels in the MWTS measurements, consistent with the instrument's pre-launch specifications. A bias, of up to 2 K, in the MWTS brightness temperatures relative to AMSU-A is under investigation but is adequately corrected by the variational bias correction.

Histograms for the background departures for the Microwave Humidity Sounder (MWHS) are also shown in Figure 1 alongside equivalent histograms for the MetOp-A MHS instrument. The MWHS data is similar in quality to the MHS data and was judged to be of sufficient quality to include in assimilation experiments. Similar analyses of the infrared sounder (IRAS) data exposed some orbital biases in the highest peaking temperature sounding channels (1–3). However, the departure statistics for the channels equivalent to HIRS channels currently used in operations, not shown here, showed the data to be of similar quality.

Histograms of background departures for the Microwave Imager (MWRI) channels are shown in Figure 2. Also shown for comparison are the departures for the equivalent channels of AMSR-E. The MWRI data are of similar quality to the AMSR-E data and build confidence that the instrument design is sound. Due to mechanical interactions with the platform the MWRI has been activated only intermittently and the dataset is therefore relatively sparse, thereby preventing a meaningful assessment through assimilation experiments.

The impact of the FY-3A sounding instruments on analyses and forecasts was assessed in a series of assimilation experiments. In a baseline experiment using an observation depleted system, the impact of FY-3A data was compared with that from the MetOp-A sounding instruments. The following configurations were used.

- Control (conventional observations + NOAA 18/AMSU-A + ozone data + scatterometer data)
- Control + MetOp (AMSU-A (ch.5, 7, 9) + MHS + HIRS)
- Control + FY-3A (MWTS + MWHS + IRAS)

The results in terms of the anomaly correlation of the forecasts in the northern and southern hemispheres over the period 30 July to 1 November 2008 are shown in Figure 3. In the northern hemisphere the impact of the FY-3A data is very similar to that from the MetOp-A instruments. In the southern hemisphere the impact is, for forecast ranges to day 7, positive for the FY-3A data and a significant fraction of that obtained from MetOp-A. In assimilation experiments in which FY-3A data is added to *a full observing system* the impacts are, as expected, neutral.

Future collaboration

Collectively these are very encouraging results and build confidence that, with further improvements in the specification and on-orbit performance of future sensors, FY-3 will soon become an integral component of the global observing systems. This work also marks the beginning of a collaborative programme between the Chinese Meteorological Agency (CMA) and ECMWF, aimed at optimising the benefits of FY-3 data. It is currently planned to monitor FY-3A data as part of the spring 2010 upgrade to IFS cycle 36r3.

Model uncertainty in seasonal to decadal forecasting – insight from the ENSEMBLES project

ANTJE WEISHEIMER,
FRANCISCO DOBLAS-REYES, TIM PALMER

ENSEMBLES is a five-year EU FP6 project concerned with ensemble-based predictions of climate changes and their impacts. The project has more than 60 European partners. It came to an end in December 2009. One of its main objectives was to develop an ensemble prediction system based on global models developed in Europe to produce probabilistic estimates of uncertainty in future climate at the seasonal to decadal and longer timescales. This article describes some of the results obtained from the ensemble prediction system on seasonal to decadal time scales where ECMWF contributed with a set of coupled hindcast experiments and diagnostics of these simulations.

The key question that we were trying to address is how to best account for model uncertainty in dynamical forecasts of the climate from a few seasons to a decade ahead. Can new approaches, like perturbing physical model parameters or stochastically modifying physical parametrizations, be considered powerful alternatives to the well-established but somewhat pragmatic and *ad hoc* multi-model ensemble? To this end, a coordinated set of experiments exploring three methodologies was run and the relative merits of these approaches were assessed (the methodologies are described later). We find that, overall the multi-model ensemble gives the best forecast scores on seasonal to annual time scales, in agreement with preliminary findings (*Doblas-Reyes et al.*, 2009). The perturbed parameter and stochastic parametrization techniques are competitive new physical approaches to the traditional but intrinsically *ad hoc* assembling of single-model ensembles. These two new techniques provide promising indications that a similar level of performance to the multi-model ensemble can potentially be achieved through the application of systematic techniques for the sampling of uncertainties in a single-model system. The optimal strategy for decadal forecast production in the presence of model biases remains an open question for future work.

Ensemble techniques and methodology

The non-linear chaotic nature of the climate system makes dynamical climate model forecasts sensitive to small perturbations introduced to both the initial state of forecasts and parts of the model (e.g. changes to the structure or parameter values in a parametrization scheme). Individual forecasts with one fixed model are thus of limited value and ensembles of forecasts are used to assess the range of possible evolutions of future climate for different timescales. In the ENSEMBLES project, three different techniques to represent model uncertainties and generate ensembles for seasonal-to-decadal forecasting have been explored.

- *Multi-model ensemble (MME).* This combines five single-model ensembles from quasi-independent forecasting models to sample uncertainty due to differences in model formulations and in errors between the individual models (see Box A). An overview of the models contributing to the MME is given in Table 1.
- *Perturbed physical parameter ensemble (PPE).* This uses perturbations to numerical parameter values in physical parametrization schemes and accounts for some aspects of physical model uncertainty (see Box B). The forecasts were generated using the UK Met Office Decadal Prediction System.
- *Stochastic physical parametrization ensemble (SPE).* This is based on the idea of a stochastic representation of the equations of motion at the computational level and as such focuses on uncertainty related to unresolved processes (see Box C). ECMWF's Integrated Forecast System (IFS) coupled to the HOPE ocean model was used.

Each of these three approaches is combined with a single-model ensemble of perturbed initial conditions to address uncertainty in the initial state of the system.

The ENSEMBLES multi-model ensemble (MME) — A

The MME for seasonal forecasts comprises global coupled atmosphere-ocean climate models from the UK Met Office, Météo-France, European Centre for Medium-Range Weather Forecasts (ECMWF), Leibniz Institute of Marine Sciences at Kiel University (IFM) and the Euro-Mediterranean Centre for Climate Change (INGV) in Bologna. All models include major radiative forcings. None of the coupled models has flux adjustments. The atmosphere and ocean were initialized using realistic estimates of their observed states. Table 1 summarises the main model components and their initialization strategies. Additional details on the initial condition perturbations can be found in *Weisheimer et al.* (2009).

We have applied the simplest approach to constructing an MME by combining individual models using equal weights to all contributing models and ensemble members. On the annual-range, forecasts from UK Met Office, Météo-France, ECMWF and IFM contributed to the MME.

Partner	Atmospheric model and resolution	Ocean model and resolution	Initialization		Additional components and comments
			Atmosphere and land	Ocean	
ECMWF	IFS Cy31r1 T159/L62	HOPE 0.3°–1.4°/L29	ERA-40/ operational analysis, atmospheric singular vectors	Wind stress perturbations to generate ensemble of ocean reanalyses; SST perturbations at initial time	Indentical to the operational seasonal forecasting system S3
UK Met Office	HadGEM2-A N96/L38	HadGEM2-O 0.33°–1°/L20	ERA-40/ operational analysis, anomaly assimilation for soil moisture	Wind stress perturbations to generate ensemble of ocean reanalyses; SST perturbations at initial time	Fully interactive sea ice module
Météo-France	ARPEGE4.6 T63	OPA8.2 2°/L31	ERA-40/ operational analysis	Wind stress, SST and water flux perturbations to generate ensemble of ocean reanalyses	GELATO sea ice model
Leibniz Institute of Marine Sciences at Kiel University (IFM)	ECHAM5 T63/L31	MPI-OM1 1.5°/L40	Initial condition permutations of three coupled climate simulations from 1950 to 2005 with SSTs restored to observations		
Euro-Mediterranean Centre for Climate Change (INGV) in Bologna	ECHAM5 T63/L19	OPA8.2 2°/L31	AMIP-type simulations with forced SSTs	Wind stress perturbations to generate ensemble of ocean reanalyses; SST perturbations at initial time	Dynamical snow-sea ice model and land-surface model

Table 1 Overview of models contributing to the new ENSEMBLES multi-model ensemble.

Retrospective forecasts (re-forecasts or hindcasts) that emulate real-time seasonal to decadal forecast situations for the past were performed in a coordinated experiment using the MME, PPE and SPE. The full hindcast period (called Stream 2) covers the 46 years 1960–2005. For each year, 7-month-long seasonal forecasts starting on 1st of February, May, August and November have been issued. Additionally, the November forecasts from all single-model ensembles (except for those from INGV) were extended to provide a 14-month-long annual forecast. Decadal 10-year long hindcasts were initalised every five years on 1 November, that is they were started in November 1960, November 1965, November 1970 etc. The last decadal forecast was started for November 2005 and will partly be a 'real' forecast (as is the November 2000 start date). By the time of writing, the SPE has completed a subset of the Stream 2 simulations

The perturbed parameter ensemble (PPE) — B

The PPE samples model uncertainty in poorly constrained cloud physics and surface parameters. It was generated with the UK Met Office Decadal Prediction System (DePreSys) which is based on the HadCM3 climate model. The model uses flux adjustments to restrict the development of regional biases in SST and salinity. Eight versions of the model with simultaneous perturbations to 29 parameters were used in addition to the unperturbed version so that each member of the PPE samples a different set of parameter values (*Doblas-Reyes et al.*, 2009).

In order to generate initial conditions for the hindcasts, each model version was run in assimilation mode with atmospheric and oceanic anomalies assimilated. The assimilation integration was itself started with an initial state taken from a simulation of the 20th century climate.

The stochastic physical parametrization ensemble (SPE) — C

Conventional physical parametrization schemes describe the effects of subgrid-scale processes in models of weather and climate by deterministic bulk formulae which depend on local resolved-scale variables. However, through the upscale cascade of energy, the neglected unresolved subgrid-scale variability can have an impact on the larger scales in the model and thus contributes to model errors on different spatial and temporal scales. Stochastic physical parametrization ensembles provide a methodology for representing model uncertainty due to variability of the unresolved scales.

ECMWF has recently revised its stochastically perturbed parametrization tendency (SPPT) scheme and developed the stochastic backscatter scheme (SPBS) (see *Palmer et al.*, 2009). For the SPE, both these schemes have been included in the preliminary set of seasonal hindcasts based on the IFS Cy35r2 coupled to the HOPE ocean model.

- The SPPT scheme applies univariate Gaussian perturbations to the total parameterised tendency of physical processes in the form of multiplicative noise with a smoothly varying pattern in space and time. A two-scale version of the perturbations with a shorter characteristic spatio-temporal scale on the order of 6 hours and 500 km together with a longer characteristic spatio-temporal scale of 30 days and 2500 km has been used.
- The SPBS scheme is based on the idea of backscatter of kinetic energy from unresolved scales. It is formulated in terms of a spectral streamfunction forcing field estimated from the total dissipation rate and uses vertical phase correlations.

consisting of seasonal hindcasts over the 15-year hindcast period 1991–2005 with start dates in May and November.

Each of the individual model ensembles contributing to the MME was run with 9 initial condition ensemble members. Thus, the MME uses 45 members for the seasonal hindcasts and 36 for the annual-range hindcasts. The PPE and SPE were run with 9 ensemble members each.

Hindcast skill on seasonal time scales

The scientific basis for seasonal predictability lies in the slowly evolving components of the climate system, like the ocean or land surface, that act as boundary conditions for the atmosphere with its shorter intrinsic time scales. A prime example of a coupled atmospheric and oceanic phenomenon is the ENSO (El Niño/Southern Oscillation) event in the tropical Pacific, which is the dominant mode of seasonal and interannual climate variability. Because ENSO has, via its well-known teleconnection patterns, remote effects on the weather and climate, assessing the skill of forecasting the sea surface temperatures (SSTs) in the tropical Pacific is essential also for the predictability on seasonal time scale in other parts of the world.

Model drift

Although initialized using observations, seasonal forecast models develop, over the forecast time, systematic errors that lead the models to drift away from the observed state. Figure 1a shows the mean model drift for SST, estimated from all ensemble members and hindcasts, in the Niño3 region (5°S–5°N, 150°W–90°W) for the individual models contributing to the MME for each of the four start months. For comparison, Figure 1b shows the SST drift for a set of previous-generation models from the DEMETER project (an EU-funded project for the development of a European multi-model ensemble system for seasonal to interannual prediction).

It is clear that considerable progress has been made since DEMETER in reducing the systematic SST errors, in particular on longer lead-times. While the SST drift in DEMETER varied between +2° C and –7° C for a lead time of up to 6 months, the ENSEMBLES models have a much reduced drift with overall value of less than ±1.5° C, see also *Weisheimer et al.* (2009).

Results not shown here indicate that the individual model versions/ensemble members of PPE have only a small drift, which is not surprising as its initialization uses observed anomalies rather than full fields. SPE develops a slightly warm drift during the first couple of months and a weak cold drift thereafter. The drift does not exceed ±0.5° C for the 7-month forecast range.

Forecast skill – tropical Pacific perspective

The systematic errors have been corrected for computing forecast anomalies by linearly removing the long-term mean over the hindcast period for a given start date and lead-time. The corrections were applied in cross-validation mode (by leaving one out) in order to emulate real-time forecast conditions as closely as possible. Figure 2 shows the temporal evolution of ensemble-mean root-mean square error (RMSE)

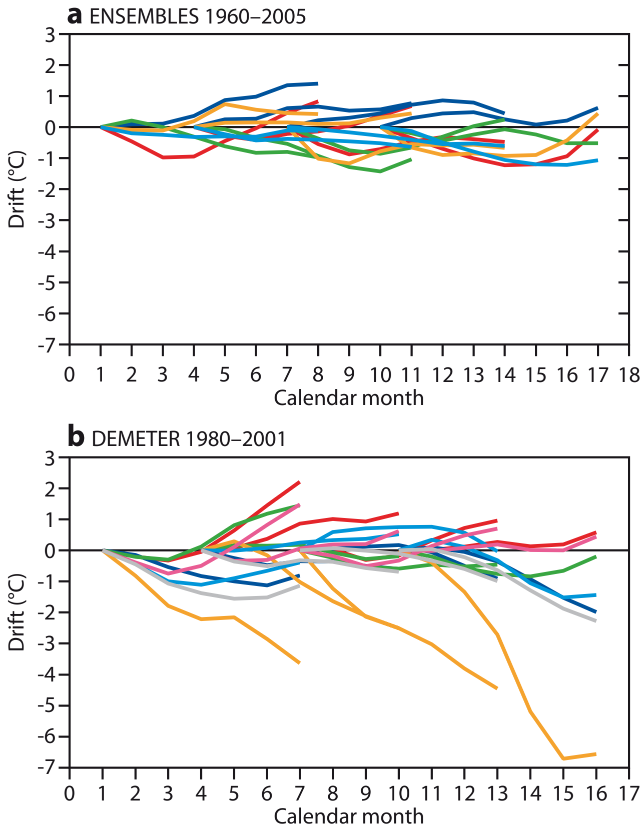


Figure 1 Systematic model errors in Niño3 SST indicated by the drift from the verification over the 7-month forecast time for the individual seasonal forecast models contributing to (a) the ENSEMBLES MME and (b) the DEMETER MME. Results for all four start dates are shown. The drift has been estimated from all available ensemble members for each start date separately over the hindcast periods 1960–2005 (ENSEMBLES) and 1980–2001 (DEMETER). The colour codes are red – Météo-France, dark blue – ECMWF, green – UK Met Office, orange – IFM, light blue – INGV, grey – LODYC and pink – CERFACS (the latter two only used for DEMETER). The abbreviations for the forecasting centres are defined in Table 1. Figure from *Weisheimer et al.* (2009).

and ensemble spread for the SST hindcast anomalies over the tropics and over the Niño3 region for MME, PPE and SPE. For a well calibrated (or reliable) system there should be a close match between forecast error and ensemble spread.

As can be seen in Figure 2, the MME has the smallest forecast errors over all lead times. It is also the best calibrated ensemble in terms of the match between forecast error and ensemble spread. While PPE is systematically under-dispersive for all forecast times (i.e. there is not enough spread in the ensemble), SPE has a good match between the errors and ensemble spread throughout the forecast range. The main improvement of SPE over the corresponding control version of the IFS/HOPE system without stochastic physics consists of a significant increase in spread to an otherwise considerably under-dispersive forecasting system. This increase in spread leads to more reliable forecasts and thus better probabilistic skill scores.

The results from the ENSEMBLES MME confirm earlier findings from the DEMETER project (*Hagedorn et al.*, 2005) that the MME, compared to the single-model ensembles, effectively reduces the RMSE while the ensemble spread is increased leading to overall improved forecast skill.

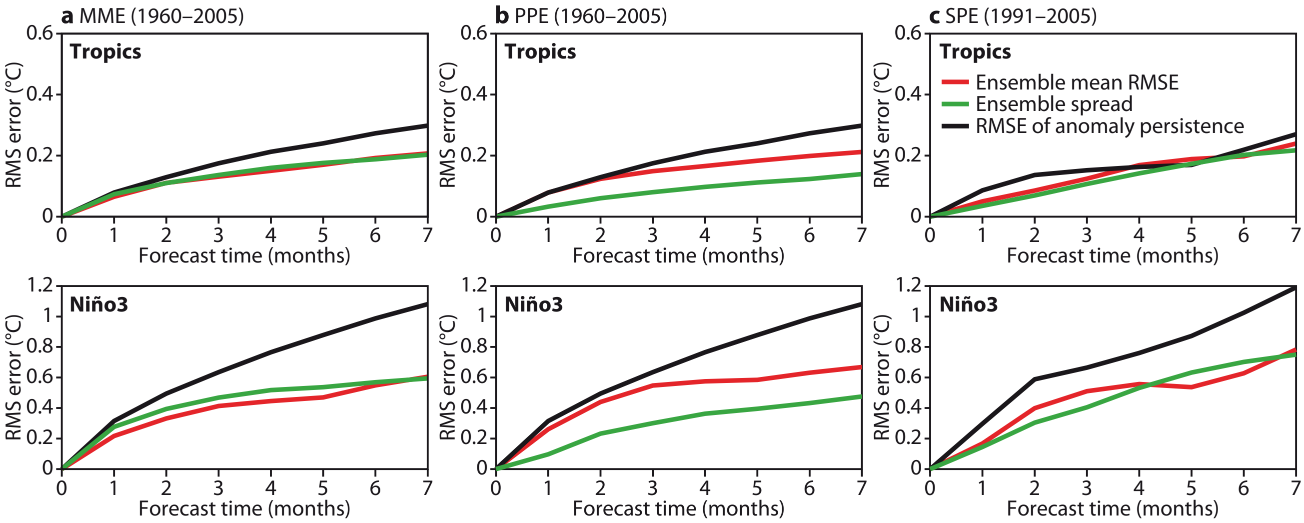


Figure 2 Seasonal-range RMS forecast error and ensemble spread as a function of lead time for (a) MME, (b) PPE and (c) SPE based on all available start dates. Scores are shown for SSTs averaged over the whole tropics (top row) and over the Niño3 region in the tropical Pacific (bottom row). Results are shown for the ensemble-mean RMSE (red), ensemble spread (green) and RMS error based on a simple statistical model of anomaly persistence (black). Scores for MME and PPE have been estimated from the Stream 2 hindcast period 1960–2005 whereas for SPE the reduced period 1991–2005 was used. The bottom panel of (a) is from *Weisheimer et al.* (2009).

Forecast skill – global perspective

As a measure of probabilistic forecast skill Figure 3 shows global maps of the Brier Skill Score (BSS) for near-surface temperature and two lead times. Because the BSS estimate is affected by the different ensemble sizes of the three forecasting systems (it has a negative bias for small ensemble sizes), an analytical expression that extrapolates the score to a hypothetical infinite ensemble size, *BSS*(∞), will be used in the following (*Ferro et al.*, 2008). As with the standard Brier Skill Scores, *BSS*(∞)=1 indicates perfect forecasts, *BSS*(∞)=0 for forecasts that have as much skill as the reference, and *BSS*(∞)<0 indicates forecasts that are less skilful than the reference. We use the climatological forecast from a reanalysis as the reference.

It can be seen that the MME has, on average, the highest skill, in particular in the tropics at shorter lead times (Figure 3a). The tropical Pacific is an area of very high skill for all three systems during the December, January and February season. While the pattern of positive skill in PPE for lead times of 2–4 months (Figure 3b) has a large-scale structure, the hindcasts based on SPE (Figure 3c) show regions of higher skill than PPE but over somewhat smaller areas. However, the skill estimates for MME, PPE and SPE are based on different hindcast periods (see the figure caption), which implies larger sampling uncertainty for SPE. The general drop of skill in the tropical Pacific at lead time 5–7 months during the boreal spring season of March, April and May (Figures 3d to 3f) cannot only be attributed to the

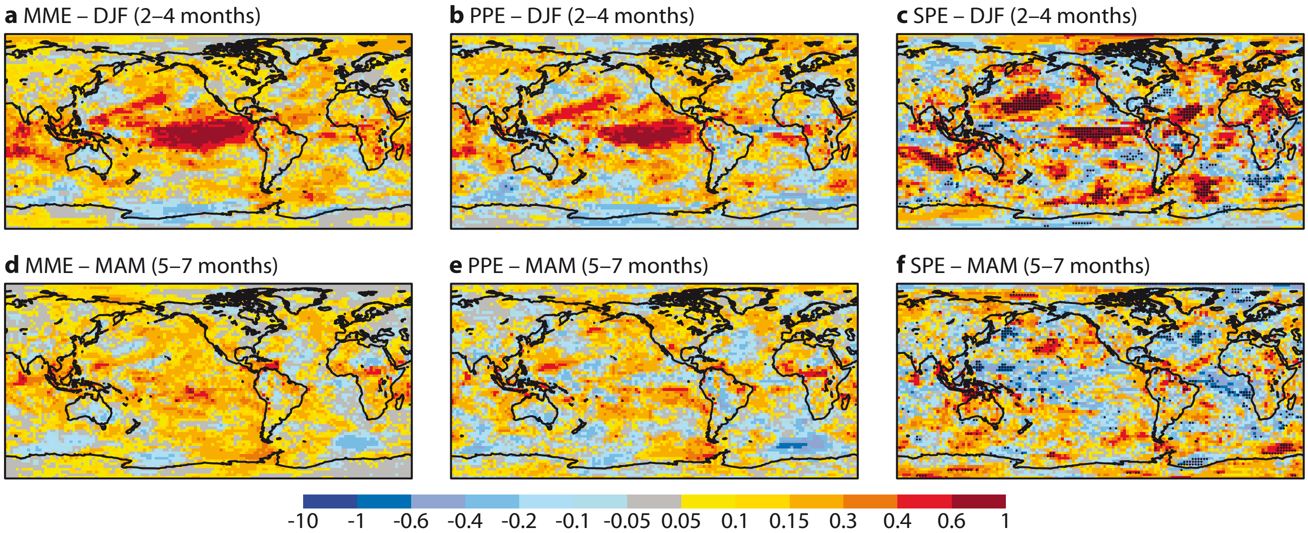


Figure 3 Brier Skill Score (BSS) for an infinite-sized ensemble of near-surface temperature anomalies falling in the upper tercile for (a) MME, (b) PPE and (c) SPE based on hindcasts initialised on 1 November for the December, January and February (DJF) season (lead time 2–4 months). (d), (e), (f). As (a), (b), (c) but for the March, April and May (MAM) season (lead time 5–7 months). As a reference forecast to compute the skill score the climatological forecast from a reanalysis (ERA-40) was used. Scores for MME and PPE have been estimated from the Stream 2 hindcast period 1960–2005 whereas for SPE the reduced period 1991–2005 was used.

generic loss of prediction skill at longer forecasting ranges, but is also related to the spring barrier, a seasonal dependence of ENSO forecast skill with substantially lower skill during and after the spring months.

A more detailed analysis of the skill in PPE versus SPE over their common hindcast period revealed that, while in general the performance of the two systems is comparable in absolute terms, forecasts based on SPE tend to be more reliable and have slightly better resolution than forecasts issued by PPE.

Forecast skill – European perspective

As Figure 3 gives a global perspective of the level of skill in the three systems, one might also be interested in the actual seasonal forecast skill for the region we live in, that is Europe. As an example of two standard European regions, Figure 4 has a comparison of the Brier Skill Scores for an infinite-sized ensemble for near-surface temperature and precipitation over Southern Europe. Here, only land points over the region 30° N to 48° N and 10° W to 40° E have been used.

Figure 4a show *BSS*(∞) for the lower tercile (left panel) and upper tercile (right panel) temperature events, while Figure 4b shows the corresponding scores for precipitation. As can be seen, temperature is, on the whole, more predictable than precipitation with more skill than a simple climatological forecast in summer. The significant skill in forecasting summer temperature in all three systems can be partially explained by the long-term warming trend in the observations that is well captured in the seasonal hindcasts (not shown). For the winter temperature forecasts, PPE has a lower skill relative to MME and SPE. The level of skill for predicting precipitation over Europe is similar to a climatological forecast for all three systems.

Northern Europe is a less predictable region than Southern Europe with skill scores that are often not much better than a climatological forecast (not shown). The lower skill in predicting temperature compared to Southern Europe is partly due to the fact that temperature in Northern Europe, in contrast to Southern Europe, does not show any obvious long-term trend over the hindcast period.

Annual-range forecasts

Hindcasts of the MME and PPE starting in November have been extended to 14 months to explore predictability on annual time scales. Corresponding runs with the SPE are not available as of now. Some positive skill has been found on these long lead-times for Niño3 SSTs. The anomaly correlation drops to 0.5 and 0.4 at month 9 for MME and PPE, respectively, and remains nearly constant thereafter. Remarkably, the above-mentioned good match between the RMSE and spread of the ensemble in the MME is further sustained over the extended forecast lead-time with an approximately linear error and spread growth. The PPE becomes under-dispersive after about month 6.

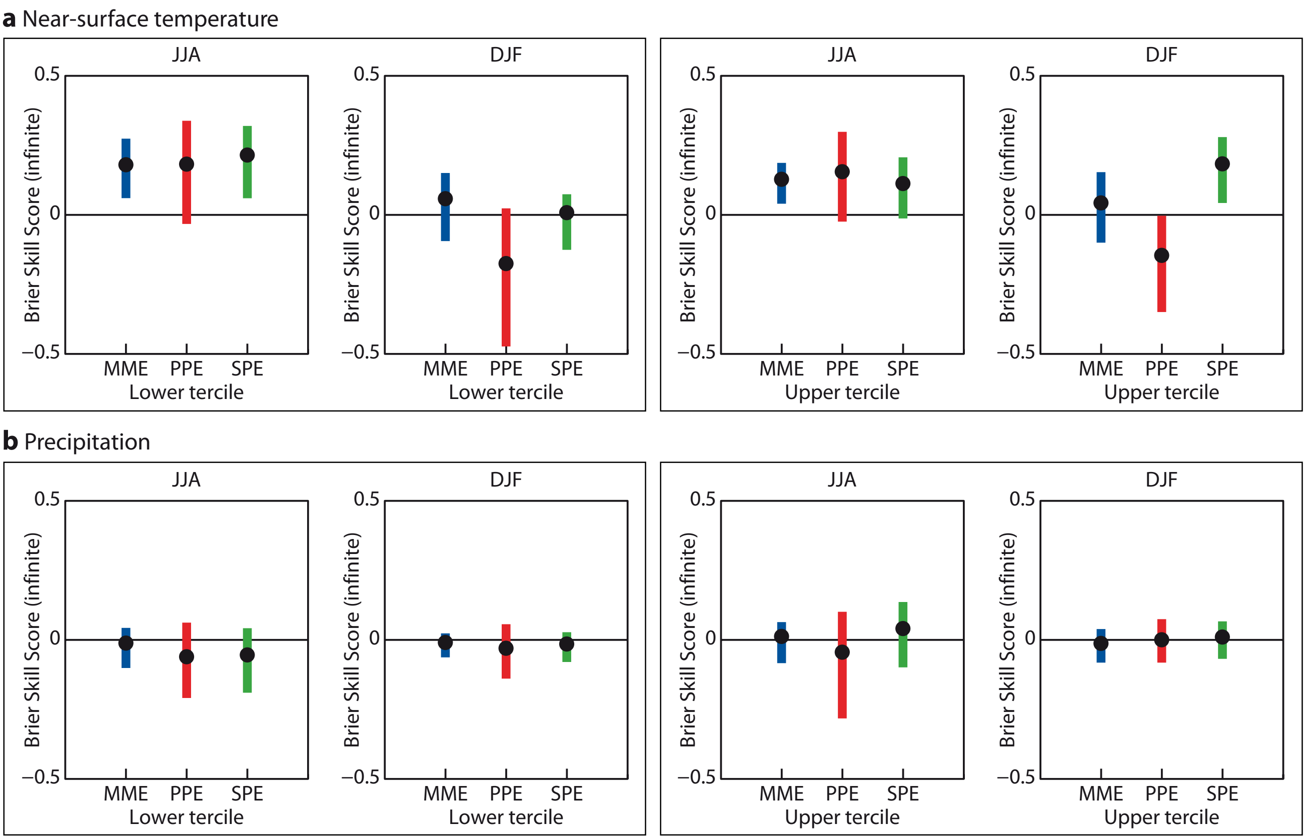


Figure 4 Brier Skill Score for an infinite-sized ensemble of (a) temperature and (b) precipitation over Southern Europe land points for MME (blue), PPE (red) and SPE (green). Scores for the event 'anomalies in the lower tercile' are in the left boxes and scores for 'anomalies in the upper tercile' are in the right boxes. Two start dates (May and November) and lead times of 2–4 months have been used over the common hindcast period 1991–2005. The error bars (95%) have been computed using a bootstrapping method with replacement. ERA-40/operational analysis has been used for the verification of temperature and GPCP for the verification of precipitation.

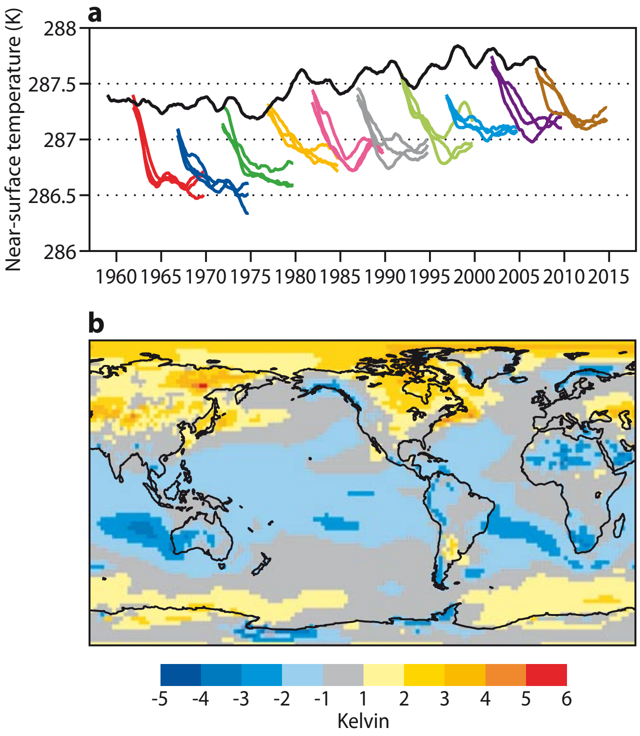


Figure 5 Decadal hindcasts in the coupled IFS/HOPE system. (a) The global mean of 2-metre temperature (filtered with a two-year running mean) in each of the ten-year long hindcast simulations with three ensemble members. The continuous black line shows the corresponding values from reanalyses (ERA-40/ERA-Interim). (b) 2-metre temperature bias (K) with respect to the reanalyses for the forecast range 2–5 years estimated from the 1960–2000 hindcasts.

Prospects for decadal predictions

As part of the ENSEMBLES activities to explore the potential of decadal predictions using coupled atmosphere-ocean model initialised from observed states, we have been, for the first time at ECMWF, testing the IFS/HOPE coupled model in ten-year long integrations. Our model does not use any techniques (e.g. anomaly initialisation, nudging or flux corrections) to avoid the coupled system drifting away from the observed state. It is based on the atmospheric IFS cycle 33r1 and also includes new monthly evolving two-dimensional climatologies for green house gases like carbone dioxide, ozone, methane, and for sulphate aerosols.

Figure 5a shows the global mean 2-metre temperature for the ten start dates of the Stream 2 hindcast period. During the first years of the simulations, the model develops a global mean cold bias of approximately 1° C. The spatial structure of the bias averaged over the forecast years 2–5 and estimated from all available start dates is displayed in Figure 5b. It can be seen that while the tropical and subtropical oceans undergo a strong cooling, the system builds up a substantial warm bias over the northern hemisphere extra-tropical continents.

In decadal forecasting, the forecast signals are often much smaller than the biases we currently have in our system. At this stage it is not clear how these relatively large biases can be accounted for. The approach used in seasonal forecasting, where *a posteriori* corrections to remove the bias are applied to the raw model output, relies on the assumption of a quasi-linear behaviour of the atmosphere and ocean anomalies. This is clearly not the case for our decadal forecasts. Reducing the model biases by testing the system in coupled long-term mode and continuing to improve the physics of the coupled model will have to be the ways forward in the future.

Public data dissemination

A common set of hindcast data provided by all ENSEMBLES partners has been archived and is available for public download without charge for use in research, education and commercial work. Both daily and monthly data are available for the atmospheric variables. The ocean output includes monthly means of ocean analyses and forecasts. Further details can be found in *Weisheimer et al.* (2009).

The ECMWF Meteorological Archival and Retrieval System (MARS) and a system based on the Open-source Project for a Network Data Access Protocol (OPeNDAP) provide users with access to the ENSEMBLES data in the most efficient way for their specific requirements, see http://www.ecmwf.int/research/EU_projects/ENSEMBLES/data/data_dissemination.html.

The ENSEMBLES data is also available through the KNMI Climate Explorer, an interactive tool to analyze climate data.

We hope that making the data publically available will enable the international community to explore the full scientific potential of the ENSEMBLES data.

FURTHER READING

Doblas-Reyes, F.J., A. Weisheimer, M. Déqué, N. Keenlyside, M. McVean, J.M. Murphy, P. Rogel, D. Smith & N. Palmer (2009): Addressing model uncertainty in seasonal and annual dynamical seasonal forecasts. *Q. J. R. Meteorol. Soc.*, **135**, 1538–1559.

Ferro, C.A.T., D.S. Richardson & P. Weigel (2008): On the effect of ensemble size on the discrete and continuous ranked probability scores. *Meteorol. Appl.*, **15**, 19–24.

Hagedorn, R., F. Doblas-Reyes & T.N. Palmer (2005): The rationale behind the success of multi-model ensembles in seasonal forecasting - I. Basic concept. *Tellus*, **57A**, 219–233.

Palmer, T.N., R. Buizza, F. Doblas-Reyes, T. Jung, M. Leutbecher, G.J. Shutts, M. Steinheimer & A. Weisheimer (2009): Stochastic parametrization and model uncertainty. *ECMWF Tech. Memo. No. 598.*

Weisheimer, A., F.J. Doblas-Reyes, T.N. Palmer, A. Alessandri, A. Arribas, M. Deque, N. Keenlyside, M. MacVean, A. Navarra & P. Rogel (2009): ENSEMBLES – a new multi-model ensemble for seasonal-to-annual predictions: Skill and progress beyond DEMETER in forecasting tropical Pacific SSTs. *Geophys. Res. Lett.*, **36**, L21711, doi:10.1029/2009GL040896.

Huber norm quality control in the IFS

CHRISTINA TAVOLATO, LARS ISAKSEN

QUALITY control (QC) of observations is a very important part of any data assimilation system. Observations contain measurement errors and sometimes gross errors due to technical errors, human errors or transmitting problems. The aim is to ensure that correct observations are used and erroneous observations are discarded from the analysis process. In this quality control process it is best to be cautious because accepted erroneous observations can lead to spurious features in the analysis.

Observations are compared against a short-range (6–12 hours) forecast from the previous analysis and they are discarded by automated QC procedures if they differ significantly from the forecast value. In the QC that was used operationally at ECMWF until recently, the threshold limits for exclusion of data was fairly tight to avoid the risk of using incorrect observations. This meant that, for example, surface pressure observations were rejected if they differed by more than about 6 hPa from the model field. In most cases this may be reasonable, but for extreme events it may well happen that the short-range forecast is wrong by more than 6 hPa near the centre of lows. To overcome this problem a new approach based on the Huber norm was implemented in cycle 35r3 of the Integrated Forecast System (IFS) on 8 September 2009.

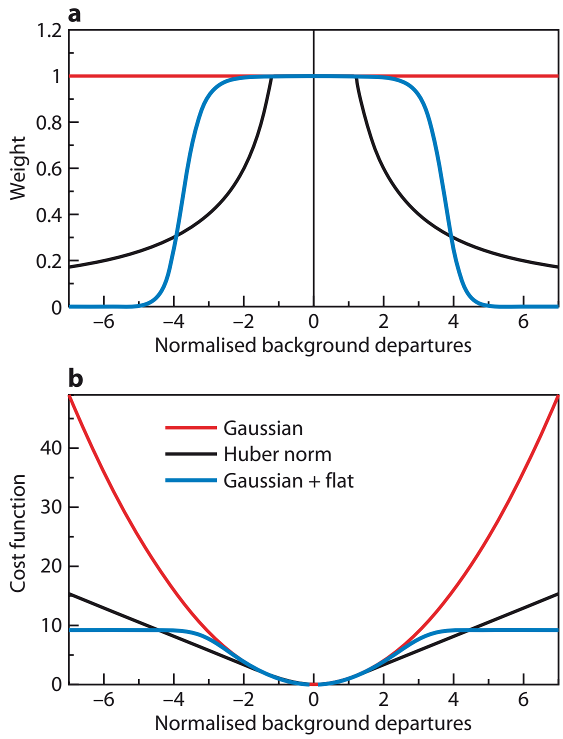


Figure 1 (a) Relative weight of an observation relative to a Gaussian distribution and (b) associated cost function values for the Gaussian 'normal' distribution (red line), Huber norm distribution (black line), and Gaussian plus flat distribution (blue line).

The Huber norm

The new Huber norm quality control (QC) is a robust method that allows the use of observations with larger departures with a low risk of ruining the analysis locally. It has been introduced for conventional data in the ECMWF variational data assimilation system. Figure 1 shows schematically how the quality control method has changed.

Figure 1a shows how the QC-weight assigned to observations with large departures from the model are reduced, compared to the full weight given by the Gaussian distribution. The QC-weight, a value between 0 and 1, defines how much the impact of a suspect observation is reduced in the analysis. The Huber method consists of a Gaussian distribution near the centre of the distribution (full weight of the data) combined with an exponential distribution towards the tails of the distribution which leads to gradually decreasing weights. The previously used QC method had a Gaussian distribution in the centre plus a flat distribution in the tails (see *Andersson & Järvinen*, 1999). It can be seen that the old method has a narrow transition zone of weights from one to zero, whereas the Huber norm has a broad transition zone. For medium-sized departures the Huber norm reduces the weight of the observations and for large departures the QC-weight is significantly higher.

Figure 1b shows the associated cost functions, where the Gaussian corresponds to a quadratic function and the Huber norm to a quadratic function for small departures and a linear function for large departures; the old QC cost function is flat for large departures.

The Huber norm is a so-called robust estimation method. The presence of a few incorrect outliers is less likely to ruin the analysis because their weights have been reduced compared to that of a purely Gaussian norm. On the other hand, if several outlier observations support each other, they will influence the analysis and their QC-weight will increase as the analysis manages to get closer to the observed values. For a purely Gaussian approach (with a QC-weight of 1) this would be potentially damaging, so for such an approach outliers have to be removed before the analysis. Consequently a major benefit for the Huber norm approach is that it enables a significant relaxation of the pre-analysis QC.

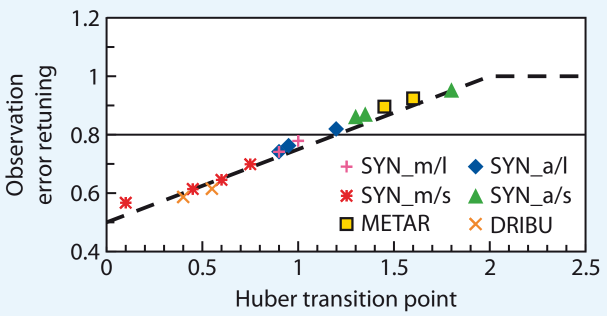
With the previous QC implementation, rather strict limits were applied for the first-guess (pre-analysis) QC, with rejection threshold values of the order of 5 standard deviations of the normalised departure value. For the implementation of the Huber norm this was typically relaxed to 15 standard deviations. This is beneficial for extreme events where the first-guess feature is more likely to be misplaced or too weak. The Huber norm also warranted a retuning of the observation error; this is discussed in Box A.

Retuning of observation error

A

The quality of each observing system is quantified by the observation error. As part of the quality control revisions we took the opportunity to check whether the specified observation error was reasonable, using the *Desroziers et al.* (2005) method and background departure statistics. This led to an increase in the specified observation error for radiosonde temperatures above 200 hPa, and retuning of the observation error for automatic and manual surface pressure measurements from ships. At the same time METAR surface pressure observation errors were adjusted to be similar to the observation error applied to automatic SYNOP data.

An overall retuning of the observation error was implemented for all data types for which a Huber norm was applied. This is justified because the standard deviation represents the good data in the central Gaussian part of the distribution, whereas it has to represent the whole active data set in the old method. The figure shows the tuning function and the ratio of standard deviations for a range of surface pressure observations as function of the Huber transition point. The different symbols signify different observation types over three different areas: northern hemisphere, tropics and southern hemisphere. This chosen function fits well for all observation types and areas. The retuning factor describes the ratio of those two standard deviations and has been estimated with the dashed curve shown in the figure. So the observation error is on average reduced to 80% of the previously used value.



Used observation error tuning function (dashed line). The symbols indicate the ratio between the Gaussian and the Huber standard deviation for different kinds of surface pressure observations. SYNOP observations are split in manual and automatic (m or a) as well as land or ship (l or s). Also shown are results for METAR and DRIBU (buoy data). Every observation type is evaluated in three regions: tropics, southern hemisphere and northern hemisphere.

The Huber norm describes the data well

It is important to assess whether the Huber norm is suitable for describing actual observation distributions. Background departure statistics (observed–background) are the only easily available measure to evaluate observation-related distributions. Their main weakness is that the background departure statistics contain both observation and background information. It is difficult to isolate the observation-related part, which is what we are really trying to estimate.

The QC affects only a small number of observations in the tails of the distributions. So, to get a sufficiently large sample of relevant statistics, 18 months worth of data (February 2006 to September 2007) was examined. This was done for a large number of observation types to determine the Huber distribution that best represented the departures. Figure 2 shows the distributions for a number of these observation types.

Figure 2a shows 'all temperature data' at 150–250 hPa for Vaisala RS92 radiosondes in the northern hemisphere. A similar plot for the 'used' data is shown in Figure 2b. Also shown are the corresponding statistics for 'not blacklisted' data for southern hemisphere land surface pressure (Figure 2c), northern hemisphere surface pressure (Figure 2d), tropical METAR surface pressure (Figure 2e) and northern hemisphere buoy wind (Figure 2f). The results are plotted on a semi-logarithmic scale, so a Gaussian distribution appears quadratic and an exponential appears linear. In this diagram, a Huber distribution appears quadratic near the centre and linear in the tails.

Figure 2 shows the best fit to the background departure statistics by the Huber norm distribution (black line) and the Gaussian distribution (red line). It is clear that actual background departure statistics are best described by a Huber norm distribution. Indeed, these results indicate that the Huber norm distribution is also much better than using Gaussian plus flat distribution that until recently has been used in operations. This is the case for all the variables shown in Figure 2 and for almost all other variables that have been investigated.

For the 'used data' (Figure 2b) in the old operational QC implementation it is clear that to a large extent the data is either assumed Gaussian or rejected. In Figure 2e 'all data' values (blue dots) have been included in addition to the 'not blacklisted data' (green stars). This shows the importance of removing blacklisted data from the data sample, for less reliable observing systems, because it may eliminate strange humps due to biases and gross errors.

Data types that use Huber norm quality control

We have concentrated on conventional data distributions because they are the most important for the analysis of extreme events. Small-scale, fast-developing weather systems are mainly analysed by conventional observations, whereas satellite data benefits the broader temperature and humidity analyses. The first operational implementation has introduced Huber norm for the majority of conventional observation types.

- Temperature and wind data from radiosondes, dropsondes, pilots, wind profilers, aircraft, SYNOP stations, ships, moored buoys and drifters.
- Surface pressure data from SYNOP stations, ships, aviation weather reports (METARs), moored buoys and drifters.

Humidity data is more difficult to represent and requires the use of a normalized variable. Satellite data is affected by cloud or surface contamination which makes the QC work more difficult. So both humidity and satellite data have been left out in the first Huber norm implementation.

Investigations showed that the Huber norm distributions tended to be distinct for three layers in the atmosphere: the stratosphere (observations above 100 hPa), the troposphere (observations between 100 hPa and 900 hPa) and the boundary

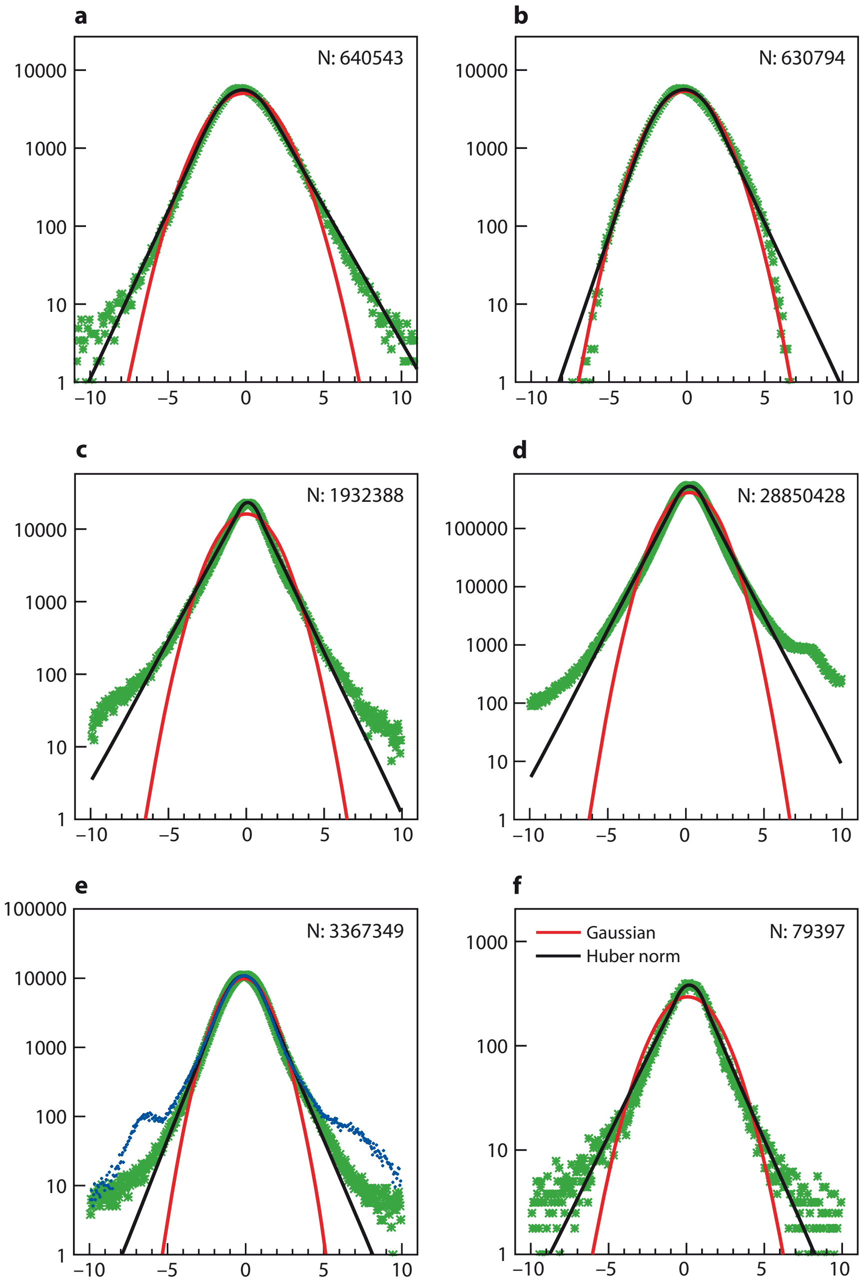


Figure 2 Best fit to background departure statistics by the Huber norm distribution (black line) and Gaussian distribution (red line) for a number of observing systems. (a) All Vaisala RS92 radiosonde temperature data at 150–250 hPa. (b) As (a) but for all used data. Results are also shown for (c) 'not blacklisted' southern hemisphere SYNOP surface pressure data, (d) As (c) but for northern hemisphere, (e) 'all' and 'not blacklisted' tropical METAR surface pressure data, and (f) 'not blacklisted' buoy wind speed data. The green stars are the 'not blacklisted data'. In (e) 'all data' values (blue dots) have been included. The number N each panel is the number of observations.

layer (observations below 900 hPa). So Huber norm distributions were computed and applied for these three layers for radiosonde, pilot, aircraft, and wind profiler data.

Some issues with surface pressure observations and satellite data

Investigating the background departure statistics for different observation types and parameters highlighted some unexpected behaviour. In cases where a Huber norm was difficult to fit to the data, it was usually due to erroneous data or gross errors. A few examples will be presented here.

Figure 2d shows the distribution of surface pressure departures for northern hemisphere SYNOPs. A hump is clearly identifiable on the positive side of the background departure distribution. This is related to the difference in model orography and station height for some observations. A high percentage of observations with positive background departures between 5 and 10 standard deviations are from stations located in alpine valleys. The height of these stations tends to be lower than the height according to the model orography as small valleys are not well resolved in the model. Specific QC ensures that those observations get rejected so this hump disappears in the distribution of the 'used' data.

Figure 2e shows the importance of not including blacklisted data in the estimation of the Huber norm distribution: without blacklisted data the Huber norm fits the distribution well. The blacklisted data add spurious humps for both positive and negative departures. This underlines the necessity of a good blacklisting procedure. It is also important to perform bias correction of surface pressure data to avoid spurious analyses for isolated stations when the first-guess quality control check is relaxed.

Satellite data has not been included in the Huber norm so far for three reasons. Firstly, most satellite data provides less detailed information than conventional data so the satellite data usually describes the broad features of small-scale weather events where the Huber norm is most beneficial. Secondly, satellite data seems to have a distribution more nearly Gaussian than conventional data. Thirdly, some satellite channels are contaminated by cloud and rain leading to distributions with large humps.

Extratropical storm impact studies

A number of impact studies and general investigations have been performed to evaluate the impact of the Huber norm quality control. Long runs over a period of three months in 2008 showed a small positive impact over Europe and the northern hemisphere in general, and neutral scores on the southern hemisphere.

During the last week of December 1999 two small-scale lows affected Europe with intense gusts and storm damage. These storms are ideal case studies due to the high-density, high-quality SYNOP station network over France and Germany. These surface pressure observations captured the intensity and location of the storms, and neighbouring stations consistently support each other. However, the strength of these storms is poorly represented in both the operational analysis and the ECMWF climate reanalyses runs (ERA) that all used the old quality control method.

Two case studies investigated the difference in data rejection of the Huber norm assimilation experiment and the most recent ECMWF reanalysis, ERA-Interim (http://www.ecmwf.int/research/era/do/get/era-interim). The Huber norm experiment is run at the same resolution and with the same model version as ERA-Interim.

Storm Lothar

The first storm that hit Europe on the 26 December 1999 is known as Lothar. It followed a path from the Atlantic to France, moving eastwards into Germany. The position of this storm was well predicted in both analyses (ERA-Interim as well as the Huber norm experiment) but the intensity is not captured well in ERA-Interim. Indeed, the SYNOP observations reporting the lowest surface pressure were first-guess rejected in the ERA-Interim analysis. The Huber norm experiment showed a reduced central pressure because many more observations were assimilated. However, the analysis was still significantly above the lowest observed surface pressure. One of the reasons is that the analysis is not able to capture the small scale of this event well enough at the reanalysis resolution.

Storm Martin

The second storm was the very intense Martin that reached the French coast on 27 December 1999. It was poorly predicted being too weak and misplaced in the operational analysis; the ERA-Interim reanalysis produced similar results. Most surface pressure observations near the cyclone centre were rejected by the first-guess quality control (shown as filled triangles on Figure 3a) even though a hand analysis showed that all the observations from France were correct. This led to an analysis with the storm centre further to the east than surface pressure observations would suggest. The lowest surface pressure observation at 1800 UTC on 27 December 1999 reported 963.5 hPa and was first-guess rejected in ERA-Interim.

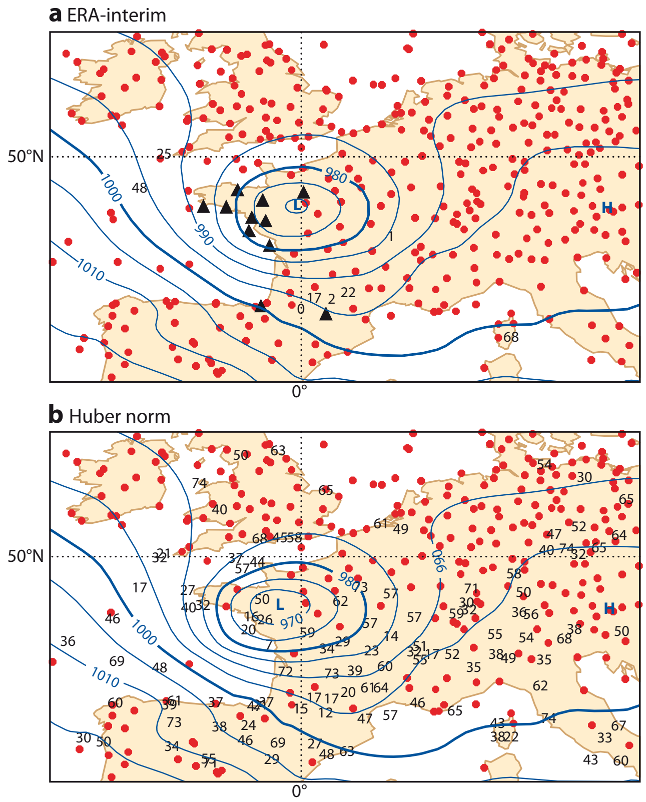


Figure 3 Mean sea level pressure chart (5 hPa contour level) valid at 1800 UTC on 27 December 1999 for (a) ERA-Interim and (b) Huber norm experiment showing the location and usage of surface pressure observations. The contours show the analysed surface pressure field for each experiment. Black triangles indicate first-guess rejected observations. The numbers indicate the effective percentage weight for observations with a partial weight, as defined by the quality control. Red dots indicate observations with weights higher than 75%.

Figure 3b shows rejections and observation weights from the Huber norm assimilation experiment. The numbers show the effective percentage QC-weight associated with each surface pressure observation: they are 16% or higher for all stations. More observations get higher QC-weights than in the reanalysis due to the Huber norm. The centre of the low has correctly moved further to the west in good agreement with the observations. Furthermore, the minimum surface pressure is reduced significantly.

The analysis and the observation rejections for the December 1999 storm cases have also been discussed by *Dee et al.* (2001). They use an adaptive buddy check QC approach with the same effect as the Huber norm method to analyse this case. However, the Huber norm method is simpler to implement in the IFS.

Tropical cyclones

Another benefit from the use of the Huber norm method is that it provides the opportunity to relax the parameters defining rejection limits even further for special observation types. This is done for dropsonde wind and temperature observations.

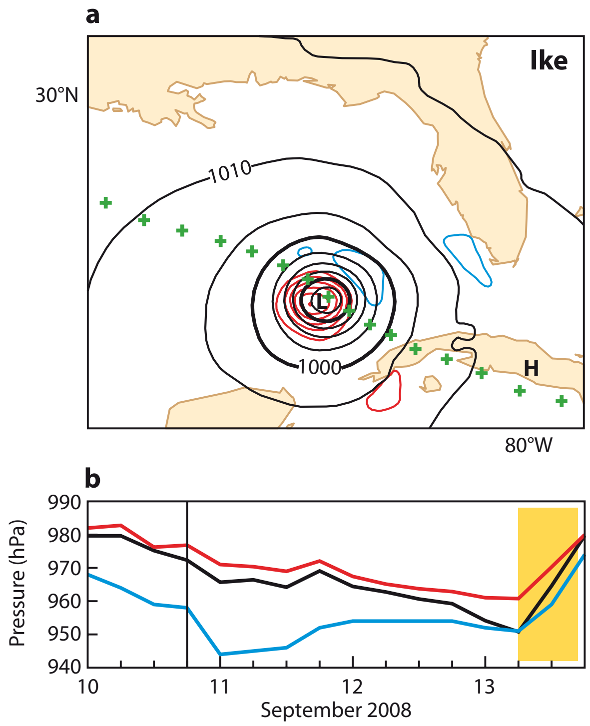


Figure 4 Impact of the Huber norm quality control impact on the analysis of tropical cyclone Ike2008 in the Gulf of Mexico approaching Texas. (a) Surface pressure analysis of the Huber norm assimilation experiments at 1800 UTC on 10 September (black line, pressure interval 5 hPa). The red (blue) contours indicate how the surface pressure analysis has intensified (weakened) compared to the control analysis that used the Gaussian plus flat distribution in the quality control. The green crosses show the observed cyclone track. (b) Time series of core surface pressure (in hPa) from the Huber norm assimilation experiment (black line) and the control experiment (red line), along with the observed surface pressure (blue line). The shaded area indicates the time after the land fall of the cyclone and the grey line marks the date and time used in (a).

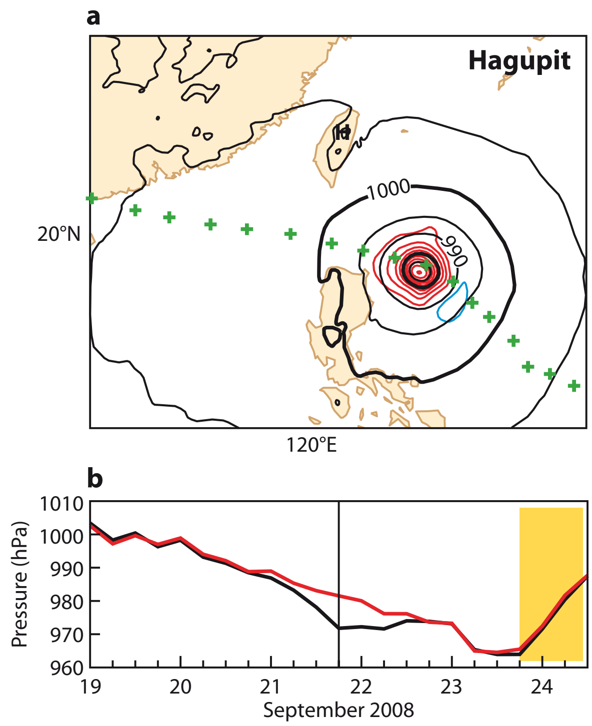


Figure 5 As Figure 4 but for Typhoon Hagupit in the Pacific approaching the Chinese coast. Note that (a) shows results for 1800 UTC on 21 September 2008 and in (b) there are no surface pressure measurements as usually none are available for tropical cyclones in the West Pacific.

Dropsondes provide highly accurate measurements of tropical cyclones. With our relaxation of dropsonde QC thresholds the analysed surface pressure of tropical cyclones is typically deeper and the centres are more correctly positioned.

We will now consider results for Hurricane Ike and Typhoon Hagupit that occurred during September 2008. Both tropical cyclones were observed by dropsondes. Usage statistics for this period showed that more dropsonde wind and temperature data from low levels was used in the Huber norm experiment compared to the operational system.

Significantly deeper and more accurate analyses (not shown) were also obtained for Hurricane Bill in August 2009 when the Huber norm quality control was applied.

Figure 4 shows (a) the analysis of surface pressure at a specific time and (b) the time series of core surface pressure for Hurricane Ike. These results indicate that use of the Huber norm intensified the core pressure compared with the analysis that used the Gaussian plus flat distribution in the quality control. Also comparison with observations shows that it improved for the surface pressure analysis.

The results for Typhoon Hagupit shown in Figure 5 are similar to those for Hurricane Ike, but in this case there are no surface observations against which the analysis can be assessed.

Concluding remarks

The introduction of the Huber norm quality control has allowed the use of more observations with large departures in the analysis. This has resulted in more correct analyses of extreme events such as extratropical storms and tropical cyclones. If several observations deviate significantly and consistently from the model background the Huber norm method ensures that they influence the analysis. The previously used quality control method would reject the observations.

The Huber norm quality control has been implemented successfully for wind, temperature and surface pressure measurements for most conventional data. In the future this will be extended to humidity and some satellite data.

This work has shown that refined quality control and observation error tuning can be an important method to help extract more information from observations.

FURTHER READING

Andersson, E. & H. Järvinen, 1999: Variational quality control. *Q.J.R. Meteorol. Soc.*, **125**, 697–722.

Dee, D.P., L. Rukhovets, R. Todling, A.M. da Silva & J.W. Larson, 2001: An adaptive buddy check for observational quality control. *Q.J.R. Meteorol. Soc.*, **127**, 2451–2471.

Desroziers, G., L. Berre, B. Chapnik & P. Poli, 2005: Diagnosis of observation, background and analysis error statistics in observation space. *Q.J.R. Meteorol. Soc.*, **131**, 3385–3396.

Magics++ 2.8 – New developments in ECMWF's meteorological graphics library

STEPHAN SIEMEN, SYLVIE LAMY-THÉPAUT

Magics++ is the successor of Magics 6, ECMWF's meteorological graphics library that has been used successfully at the Centre and in the Member States for more than 25 years. Magics++ has been written in C++, and takes advantage of the experience gained with its predecessor. More general information can be found in the article about Magics++ in *ECMWF Newsletter No. 110*, 36–41.

The newly released version 2.8 brings many new features and improvements to users. In the past year the library underwent much development for its integration into Metview 4, Web Re-Engineering Project (WREP) and the observation monitoring project. The aim in all these developments was to reach same look and feel for the visualisation between these services. Version 2.8 includes these changes along with many improvements and wishes from users outside the Centre. New features of version 2.8 include:

- Support of rotated grids (e.g. for HIRLAM models, see Figure 2)
- Introduction of Mercator projection
- Improvements in shading missing data
- Advanced symbol table mode for the support of ODB2
- Taylor diagrams (see Figure 3)
- Generalisation of the use of netCDF
- Improvement in the handling of satellites images

The new version also handles more complex layouts as used for the extreme forecast index (EFI) support plots, as shown in Figure 4. The Magics++ documentation has been updated and now includes more examples and information. The installation guide is also integrated within the main documentation, as are descriptions of how to set up an environment to develop and run Magics programs.

To meet the challenge of the high-resolution data, Magics++ offers a wide variety of options for contouring from simple grid-shading to complex polygon shading, and also some tuning mechanisms to find the best compromise between high-quality output and processing time.

Magics 6 has always been able to produce high quality output, and Magics++ maintains this tradition. It does not only produce high-quality PS, EPS or PDF but also with version 2.8 more modern web-oriented formats such as PNG, SVG and KML/KMZ (for Google Earth®) as shown in Figure 1. To take full advantage of the latter format, Magics++ gathers some metadata about time or elevation from the data header, and integrates it in the KML output.

The family of user interfaces has been extended to offer a Python interface. This first interface is similar to the procedural Fortran and C interfaces. First user feedback is very positive and a more object-oriented interface in conjunction with Metview is currently under consideration.

Magics++, which has been used operationally for the last four years to produce EPSgrams and EFI plots, has also been chosen to be the graphics engine for the Web Re-Engineering Project (WREP). This project provides services with features

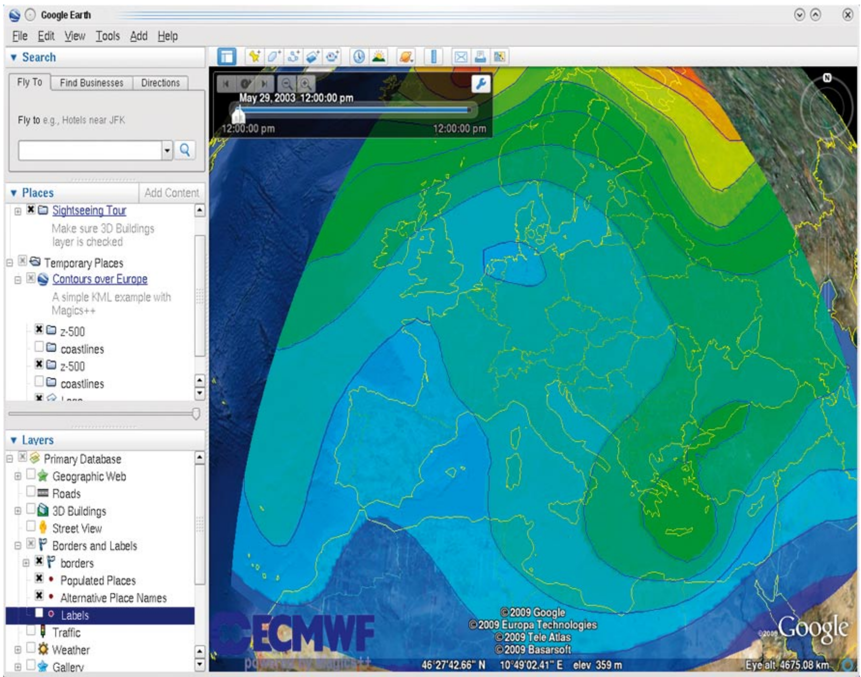


Figure 1 Magics++ also now supports KML output which can be visualised within Google Earth®. The KML output supports layers and animations.

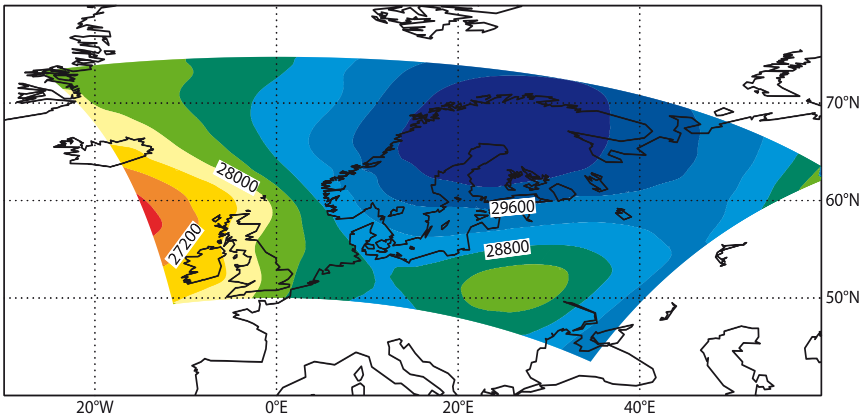


Figure 2 Example of data on a rotated grid (Hirlam) plotted by Magics++.

such as zooming or on-demand production of customised plots. In this context, a JavaScript library has been developed to allow the navigation of the maps and the possibility of clickable maps. An experimental OGC WMS (Web Map Service) as part of WREP is also using Magics++. Efforts have also been put into the creation of a library of meteorological styles for specific parameters that combine efficiency and readability with a new modern look.

The similarity between a MagML Style Description and a Metview Visual Definition will allow a user to easily prepare a plot using Metview 4 and push it to the new Web catalogue.

The consolidation period of Magics++ will continue into 2010. In the coming months major software packages at ECMWF, such as Metview, obstat and the verification package, will be updated to use Magics++ instead of Magics 6.

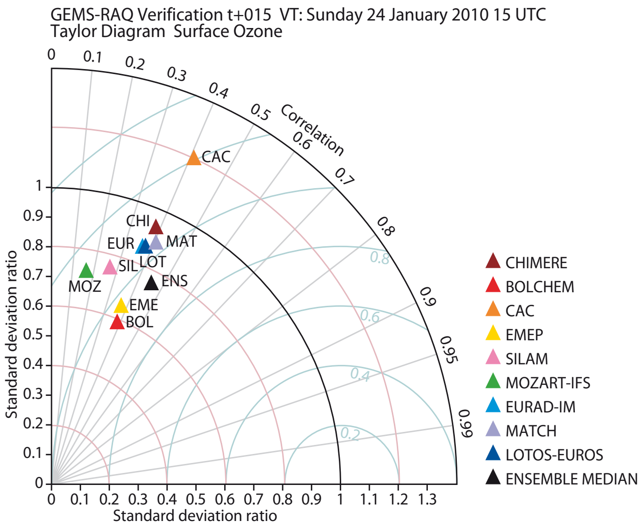


Figure 3 A Taylor diagram produced by Magics++.

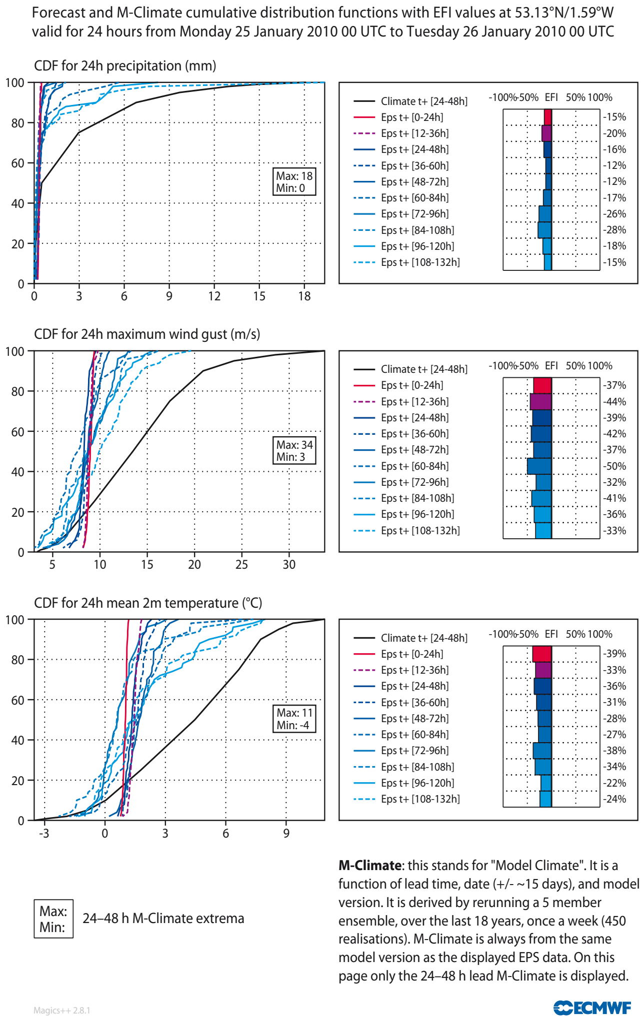


Figure 4 Example of Magics++'s ability to lay out and generate graphs. The plot shows more detailed information to support the extreme forecast index (EFI).

Special Project computer allocations for 2010–2011

The allocations for 2010 have been approved. The figures for 2011 indicate what has been requested.

Member State		Institution	Project title	2010 HPCF (units)	2010 Data storage (Gbytes)	2011 HPCF (units)	2011 Data storage (Gbytes)
Continuation Projects							
Austria	1	Univ. Vienna (Haimberger)	Bias estimation of historic in-situ upper air data	5,000	300	10,000	500
	2	Univ. Graz (Kirchengast)	Climate Monitoring by Advanced Spaceborne Sounding and Atmospheric Modelling	30,000	300	30,000	300
	3	Univ. of Natural Resources and Applied Life Sciences, Vienna (Seibert)	Modelling of Tracer Transport (MoTT)	30,000	100	30,000	100
Denmark	4	DMI (May)	Numerical experimentation with the EC-Earth system with special focus on the Mediterranean region	800,000	10,000	800,000	10,000
	5	DMI (Yang)	Decadal climate change experiments of EC-Earth at high resolution and with top atmosphere	200,000	2,000	400,000	4,000
France	6	CNRM/GMAP, Météo-France (Fischer)	Investigation of coupling the ALADIN and AROME models to boundary conditions from ECMWF and ERA model data	30,000	800	30,000	800
	7	CERFACS (Rogel)	Seasonal to interannual predictability of a coupled ocean-atmosphere model	10,000	150	10,000	150
	8	CERFACS (Weaver)	Variational data assimilation with the OPA OGCM	250,000	2,000	250,000	2,000
Germany	9	FU Berlin (Cubasch, Kirchner)	Investigation of systematic tendency changes and their influence on the general circulation simulated with climate models	20,000	2,000	20,000	2,000
	10	DLR (Dörnbrack)	Influence of non-hydrostatic gravity waves on the stratospheric flow field above Scandinavia	150,000	80	150,000	80
	11	DLR (Dörnbrack)	Support tool for HALO missions	50,000	80	50,000	80
	12	Univ. Munich (Egger)	Landsurface - Atmosphere interaction	150	10	150	10
	13	Univ. Cologne (Elbern)	GEMS: work package WP_RAQ_2	2,200,000	15,000	2,200,000	15,000
	14	DLR / MPI Chemistry, Mainz (Eyring, Steil)	Impact of anthropogenic emissions on tropospheric chemistry with a special focus on ship emissions	400,000	4,000	400,000	4,000
	15	Univ. Köln (Fink)	Interpretation and calculation of energy budgets	120	30	120	30
	16	DLR (Gierens)	Ice-supersaturation and cirrus clouds	200,000	100	200,000	100
	17	MPI, Hamburg (Hagemann)	Regional downscaling of ERA-40 data and validation of the hydrological cycle	640,000	5,200	700,000	5,800
	18	DLR (Hoinka)	Climatology of the global tropopause	500	10	500	10
	19	MPI, Hamburg (Jacob)	Regional Ensemble Prediction	92,000	7,500	104,000	8,500
	20	Univ. Karlsruhe (Jones)	The impact of tropical cyclones on extra-tropical predictability	350,000	2,000	350,000	2,000
	21	MPI, Hamburg (Jungclaus)	Community Simulations of the last Millennium (COMSIMM)	600,000	3,000	–	–

Member State		Institution	Project title	2010		2011	
				HPCF (units)	Data storage (Gbytes)	HPCF (units)	Data storage (Gbytes)
Germany	22	DLR (Keil, Craig)	Ensemble Modelling for the Improvement of Short-Range Quantitative Precipitation Forecasts	120,000	150	120,000	150
	23	Univ. Karlsruhe (Kottmeier)	Mesoscale Modelling using the DWD Lokal-Modell	120,000	500	180,000	800
	24	FU Berlin (Langematz)	Chemistry-climate model simulations for WMO ozone assessment	400,000	4,000	10,000	1,000
	25	Leibniz-Institut, Univ. Kiel (Latif)	Seasonal to decadal forecasting with coupled ocean-atmosphere general circulation models	1,080,000	5,000	1,000,000	5,000
	26	IMK-IFU (Laux)	Statistical Analysis of the onset of the Rainy Season in the Volta Basin (West Africa)	0	10	0	10
	27	DLR (Mayer)	Remote Sensing of Water and Ice Clouds with Meteosat Second Generation	20,000	20	20,000	20
	28	MPI, Hamburg (Niemeier)	Climate Impact of Clouds and Aerosols	1,000	200	1,000	200
	29	Ruhr-University Bochum (Pahlow)	Optimisation of Water Management by using Ensemble Forecasts	25,000	3	25,000	3
	30	Alfred Wegener Institute, Potsdam (Rex)	Ozone and water vapour transport with the residual circulation	200	200	200	200
	31	Alfred Wegener Institute, Potsdam (Rinke)	Sensitivity of HIRLAM	100	10	100	10
	32	FZ Jülich (Schultz)	Global Atmospheric Chemistry Modelling	600,000	10,000	600,000	11,000
	33	FU Berlin (Ulbrich, Leckebusch)	Investigations of storms in forecasts, hind-casts and climate model simulations on daily to seasonal and climatological timescales	5,000	2,000	5,000	2,000
	34	Univ. Bremen (Weber)	Chemical and dynamical influences on Decadal Ozone Change (CANDIDOZ)	20	20	20	20
	35	Univ. Mainz (Wirth)	Water vapour in the upper troposphere	1,000	20	1,000	20
	36	Univ. Hohenheim (Wulfmeyer, Bauer)	Real-Time Assimilation of Observations of Key Prognostic Variables and the Development of Aerosol Operators (RAPTOR)	300,000	2,500	300,000	2,500
Italy	37	ISMAR-CNR (Cavaleri)	Evaluation of the performance of the ECMWF meteorological model at high resolution	250,000	200	–	–
	38	ARPA-SIM (Di Giuseppe, Marsigli)	Flow dependent Error statistic for Satellite data Assimilation in Regional model (FEAR)	1,000,000	150	–	–
	39	ISAC-CNR (Maurizi)	GEMS: BOLCHEM	30,000	1,000	30,000	1,000
	40	ARPA-SMR, Emilia Romagna UK MetOffice (Montani, Mylne)	Limited-area ensemble forecasts of windstorms over Northern Europe	490,000	100	500,000	100
	41	ARPA-SMR, Emilia Romagna MeteoSwiss (Montani, Walser)	Improvements of COSMO limited-area ensemble forecasts	800,000	500	850,000	550
	42	ARPA-SMR, Emilia Romagna Italian Met. Service (Paccagnella, Montani, Ferri)	Limited area model targeted ensemble prediction system (LAM-TEPS)	490,000	800	500,000	800
	43	Univ. Genova (Parodi)	High-resolution numerical modelling of intense convective rain cells	50,000	200	50,000	200
	44	ARPA-SMR, Emilia Romagna & UCEA (Pavan, Esposito)	Seasonal Prediction for Italian Agriculture (SPIA)	10	100	10	100
	45	CNMCA (Torrisi, Marcucci)	Limited Area Ensemble Kalman Filter	1,500,000	700	2,000,000	700
	46	CNMCA (Zauli, Torrisi)	Tuning COSMO-ME to H-SAF requirements	1,800,000	700	2,000,000	800

Member State		Institution	Project title	2010		2011	
				HPCF (units)	Data storage (Gbytes)	HPCF (units)	Data storage (Gbytes)
Italy	46	CNMCA (Zauli, Torrisi)	Tuning COSMO-ME to H-SAF requirements	1,800,000	700	2,000,000	800
Netherlands	47	KNMI (Haarsma)	Storm Tracks in a Warmer Climate	80,000	500	100,000	500
	48	KNMI (Hazeleger)	EC-Earth: developing a European Earth System model based on ECMWF modelling systems	5,000,000	15,000	5,000,000	20,000
	49	KNMI (Huijnen)	Global reactive gas modelling in GEMS and MACC: Towards an operational assimilation and forecasting system for tropospheric reactive gases	100,000	250	100,000	250
	50	KNMI (Onvlee)	The Hirlam-A project	2,000,000	8,500	2,500,000	8,500
	51	KNMI (Selten)	Climate change studies using the IFS system	225,000	500	225,000	500
	52	KNMI (Siebesma)	Rain in cumulus	300,000	500	350,000	500
	53	KNMI (van den Hurk)	Participation in GLACE-2	100,000	580	50,000	580
	54	KNMI (van Meijgaard)	Multi-annual integrations with the KNMI regional climate model RACMO2	500,000	5,000	500,000	5,000
	55	KNMI (van Meijgaard)	Regional modelling of the Greenland surface mass balance for key episodes in the past and the future	500,000	3,000	500,000	3,000
	56	KNMI (van Noije)	Global Atmospheric Chemistry Modelling with EC-Earth: Understanding past and predicting future tropospheric ozone in a changing climate	300,000	500	300,000	500
	57	KNMI (van Oldenborgh)	Patterns of climate change: coupled modelling activities	400,000	500	1,000,000	500
	58	KNMI (van Weele)	Global Chemistry-Transport Modelling of Natural Reactive Greenhouse Gases	100,000	100	100,000	100
	59	KNMI (Weber)	Modelling past greenhouse worlds with EC-Earth: Understanding past and predicting future response to high greenhouse gas levels	400,000	200	400,000	200
Norway	60	DNMI (Benestad)	Seasonal Predictability over the Arctic Region – exploring the role of boundary conditions	215,000	1,000	–	–
	61	NILU (Eckhardt)	FLEXPART transport simulations for the International Polar Year and further model development	150,000	150	150,000	150
	62	DNMI (Frogner)	TEPS – Targeted EPS for Europe	500,000	500	500,000	500
	63	Univ. Oslo (Isaksen)	Ozone as a climate gas	50,000	5	50,000	5
	64	DNMI (Iversen)	GLAMEPS – Grand Limited Area Model Ensemble Prediction System	4,000,000	10,000	5,000,000	10,000
	65	DNMI (Iversen, Kristiansen)	REGCLIM: optimal forcing perturbations for the atmosphere	600,000	1,000	600,000	1,000
	66	DNMI (Randriamampianina)	Tuning of HARMONIE assimilation and forecast systems	500,000	2,000	500,000	2,000
Portugal	67	Univ. Lisbon (Soares)	HIPOCAS-SPEC	0	10	0	10
Spain	68	Univ. Illes Balears (Cuxart)	Study of the Stably stratified Atmospheric Boundary Layer through Large-Eddy simulations and high-resolution mesoscale modelling	96,000	200	96,000	200
	69	Univ. de Castilla-La Mancha (Gärtner)	Analysis of land surface-atmosphere interactions through mesoscale simulations	700,000	1,000	700,000	1,000
	70	Univ. Basque Country (Saenz)	Mesoscale meteorological reanalysis over the Iberian Peninsula	50,000	1,000	50,000	1,000

Member State		Institution	Project title	2010		2011	
				HPCF (units)	Data storage (Gbytes)	HPCF (units)	Data storage (Gbytes)
Sweden	71	SMHI (Robertson)	GEMS/MACC – Global and regional earth-system monitor using satellite and in-situ data	145,000	6	145,000	6
Switzerland	72	Institute for Atmospheric and Climate Science, ETH Zurich (Lohmann)	Cloud Aerosol Interactions	300,000	200	300,000	200
	73	Institute for Atmospheric and Climate Science, ETH Zurich (Storelvmo)	Aerosol influence on clouds, precipitation and climate in EC-Earth	250,000	200	250,000	200
United Kingdom	74	ESSC, Univ. Reading (Bengtsson)	Predictability studies with emphasis on extra-tropical and tropical storm tracks and their dependence on the global observing systems	300,000	300	300,000	300
	75	Univ. Reading (Haines)	Using data assimilation in a high-resolution ocean model to determine the thermohaline circulation	1,000,000	7,000	1,000,000	7,000
	76	Univ. Reading (Hoskins)	Moist Singular Vectors and African Easterly Waves	10,000	150	–	–
	77	Manchester Metropolitan Univ. (Lee)	Determining the relative roles of NO_x and CO_2 emissions from aviation in climate change	200,000	800	200,000	800
	78	Keele University (Shrira)	Direct numerical simulations of 2-D freak waves	100,000	100	–	–
	79	BAS, Cambridge (Turner)	Assessment of ECMWF forecasts over the high-latitude areas of the Southern Hemisphere	0	1	0	1
ICTP	80	ICTP (Kucharski)	Dynamical downscaling of seasonal predictions with a regional climate model	500,000	2,000	500,000	2,000
JRC	81	JRC-IES (Bergamaschi)	Inverse Modelling of Atmospheric CH_4 and N_2O	450,000	340	600,000	450
	82	JRC-IES (Dentener)	The linkage of climate and air pollution: simulations with the global 2-way nested model TM5	150,000	160	200,000	180
	83	JRC-IES (Dosio)	Coupling a regional climate model to a biogeochemical land-surface model in the study of climate change impacts on the European ecosystem	200,000	100	–	–
New Projects							
Austria	1	Univ. Innsbruck (Mayr)	Advanced investigation methods for Foehn	180,000	800	130,000	1,000
Spain	2	Institut Catala de Ciencies (Doblas-Reyes)	Assessment of the limit of initial-condition useful skill in interannual climate prediction	3,135,000	5,225	1,461,000	2,435
United Kingdom	3	Univ. Reading (Kaiser-Weiss)	Assimilation of trace gas retrievals using quasi-optimal assimilation	150,000	1,000	150,000	1,000
ICTP	4	ICTP (Kucharski)	Interactions between the Atlantic Ocean, African monsoon, the Indian and Pacific Oceans using the EC-Earth and IFS modelling systems	500,000	1,000	500,000	1,000
	5	ICTP (Tompkins)	Use and value of ECMWF short-range and seasonal forecast products for developing countries in terms of end-user impact variables	100,000	100	100,000	100
Total requested				**39,676,100**	**155,220**	**38,534,100**	**155,310**

Special Projects that finished in 2009

Member State		Institution	Project title
Austria	1	Univ. Vienna (Steinacker)	MESOCLIM - Mesoscale Alpine Climatology
Belgium	2	MUMM (Ponsar)	Data assimilation in high resolution hydrodynamic and ecological forecasts of the North Sea
Denmark	3	DMI (Amstrup)	Data Impact Studies in HIRLAM
Germany	4	MPI, Mainz (Baumgaertner)	Solar effects in an Earth-System-Model simulation for 1960-2006
	5	MPI, Hamburg (Bengtsson)	Numerical experimentation with a coupled ocean/atmosphere model
	6	Univ. Frankfurt (Casanova, Ahrens)	Combination of Seasonal Forecasts by BMA
	7	ISET (Czisch)	Evaluation of the Global Potential of Energy Towers
Ireland	8	Met Éireann (Wang)	Changes in the North Atlantic Climate and Impacts for Ireland
Italy	9	CNMCA (Bonavita, Torrisi, Marcucci)	EUCOS Observing System Experiment (EUCOS-OSE)
	10	Osservatorio Astrofisico di Arcetri, Firenze (Masciadri)	Forecasting of the optical turbulence for Astronomy applications with the MesoNH mesoscale model coupled with ECMWF products
Netherlands	11	KNMI (John de Vries)	Data Assimilation over the North Atlantic (DANA)
Sweden	12	Stockholm Univ. (Magnusson)	New methods for an ensemble prediction system
United Kingdom	13	Univ. Reading (Ehrendorfer)	The TIGGE Data Base: atmospheric predictability and Bayesian decision making
	14	Univ. Oxford (Hanlon)	Attribution of changes in extreme weather risk using large ensembles of climate model simulations
	15	DARC, Univ. Reading (Migliorini)	Assimilation of geostationary ozone measurements for global ozone monitoring
	16	DARC, Univ. Reading (Migliorini)	GlobModel
	17	Univ. Reading (O'Neill)	Assimilation of retrieved products from EOS MLS
	18	DARC, Univ. Reading (O'Neill)	How good are simulated water vapour distributions in the UTLS region?
ICTP	19	ICTP (Kucharski)	Decadal interactions between the tropical Indo-Pacific Ocean and extratropical modes of variability in an intermediate coupled model

Member State computer allocations for 2010

Member State	HPCF (kunits)	Data Storage (Gbytes)
Belgium	22,891	103,137
Denmark	19,523	87,962
Germany	93,135	419,625
Spain	43,940	197,977
France	74,090	333,818
Greece	18,991	85,566
Ireland	16,938	76,315
Italy	62,867	283,250
Luxembourg	12,923	58,227
Netherlands	30,524	137,527
Norway	20,576	92,707

Member State	HPCF (kunits)	Data Storage (Gbytes)
Austria	20,695	93,242
Portugal	17,208	77,530
Switzerland	23,626	106,449
Finland	17,716	79,819
Sweden	22,691	102,236
Turkey	21,582	97,238
United Kingdom	77,987	351,375
Allocated to Special Projects	39,676	155,220
Reserved for Special Projects	13,421	60,780
Total	**671,000**	**3,000,000**

TAC Representatives, Computing Representatives and Meteorological Contact Points

Member States	TAC Representatives	Computer Representatives	Meteorological Contact Points
Belgium	Dr D. Gellens	Mrs L. Frappez	Dr J. Nemeghaire
Denmark	Mr L. Laursen	Mr T. Lorenzen	Mr G. Larsen
Germany	Dr D. Schroeder	Dr E. Krenzien	Mr T. Schumann
Greece	Lt Col A. Anthis	Mr A. Emmanouil	Mr D. Ziakopoulos Mr M. Manoussakis Mr P. Fragkouli
Spain	Mr E. Monreal	Mr R. Corredor	Mr A. Alcazar
France	Mr B. Strauss	Mr D. Birman	Ms N. Girardot
Ireland	Mr P. Halton	Mr P. Halton	Mr G. Fleming
Italy	Dr S. Pasquini	Dr C. Gambuzza	Dr T. La Rocca
Luxembourg	Mr C. Alesch	Mr C. Alesch	Mr C. Alesch
Netherlands	Mr T. Moene	Mr H. de Vries	Mr J. Diepeveen
Norway	Mr J. Sunde	Ms R. Rudsar	Mr P. Evensen
Austria	Dr G. Kaindl	Mr M. Langer	Dr H. Gmoser
Portugal	Mrs T. Abrantes	Mr L. Cardoso	Mr N. M. Moreira
Switzerland	Dr S. Sandmeier	Mr P. Roth	Mr E. Müller
Finland	Dr J. Damski	Mr K. Niemelä	Mr P. Nurmi
Sweden	Mr M. Hellgren	Mr R. Urrutia	Mr M. Hellgren
Turkey	Mr M. Fatih Büyükkasabbaşi	Mr F. Kocaman	Mr M. Kayhan
United Kingdom	Dr A. Dickinson	Mr R. Sharp	Mr A. Radford
Co-operating States			
Croatia	Mr I. Čačić	Mr V. Malović	Mr Č. Branković
Czech Republic	Ms A. Trojakova	Mr K. Ostatnický	Mr F. Sopko
Estonia	Mr T. Kaldma	Mr T. Kaldma	Mrs M. Merilain Mrs T. Paljak
Hungary	Dr L. Bozó	Mr I. Ihász	Mr I. Ihász
Iceland	Mr H. Björnsson	Mr V. Gislason	Mrs S. Karlsdottir
Latvia	Mr A. Bukšs	Mr A. Bukšs	Mr A. Bukšs
Lithuania	Mrs V. Auguliene	Mr M. Kazlauskas	Mrs. V. Raliene
Montenegro	Mr A. Berber	Mr A. Marčev	Ms M. Ivanov
Morocco	Mr H. Haddouch	Mr M. Jidane	Mr K. Lahlal
Romania	Dr I. Pescaru	Mr R. Cotariu	Mrs T. Cumpanasu
Serbia	Ms L. Dekic	Mr V. Dimitrijević	Mr B. Bijelic
Slovakia	Mr J. Vivoda	Mr O. Španiel	Dr M. Benko
Slovenia	Mr J. Jerman	Mr P. Hitij	Mr B. Gregorčič
Observers			
EUMETSAT	Mr M. Rattenborg	Dr S. Elliott	
WMO	Mr M. Jarraud		

ECMWF Newsletter No. 122 – Winter 2009/10

ECMWF Council and its committees

The following provides some information about the responsibilities of the ECMWF Council and its committees. More detail can be found at:

http://www.ecmwf.int/about/committees

Council

The Council adopts measures to implement the ECMWF Convention; the responsibilities include admission of new members, authorising the Director to negotiate and conclude co-operation agreements, and adopting the annual budget, the scale of financial contributions of the Member States, the Financial Regulations and the Staff Regulations, the long-term strategy and the programme of activities of the Centre.

President: Mr Wolfgang Kusch (*Germany*)

Vice President: Mr Daniel Keuerleber-Burk (*Switzerland*)

Policy Advisory Committee (PAC)

The PAC provides the Council with opinions and recommendations on any matters concerning ECMWF policy submitted to it by the Council, especially those arising out of the Four-Year Programme of Activities and the Long-term Strategy.

Chair: Mr Alain Ratier (*France*)

Vice Chair: Prof Petteri Taalas (*Finland*)

Finance Committee (FC)

The FC provides the Council with opinions and recommendations on all administrative and financial matters submitted to the Council and shall exercise the financial powers delegated to it by the Council.

Chair: Ms Monika Köhler (*Austria*)

Vice Chair: Mr Sergio Pasquini (*Italy*)

Scientific Advisory Committee (SAC)

The SAC provides the Council with opinions and recommendations on the draft programme of activities of the Centre drawn up by the Director and on any other matters submitted to it by the Council. The 12 members of the SAC are appointed in their personal capacity and are selected from among the scientists of the Member States.

Chair: Dr Heikki Järvinen (*Finnish Meteorological Institute*)

Vice Chair: Dr François Bouttier (*CNRM/GMAP Météo-France*)

Technical Advisory Committee (TAC)

The TAC provides the Council with advice on the technical and operational aspects of the Centre including the communications network, computer system, operational activities directly affecting Member States, and technical aspects of the four-year programme of activities.

Chair: Dr Alan Dickinson (*United Kingdom*)

Vice Chair: Mr Bernard Strauss (*France*)

Advisory Committee for Data Policy (ACDP)

The ACDP provides the Council with opinions and recommendations on matters concerning ECMWF Data Policy and its implementation.

Chair: Mr Colin Cuthbert (*United Kingdom*)

Vice Chair: Mr Klaus Haderlein (*Germany*)

Advisory Committee of Co-operating States (ACCS)

The ACCS provides the Council with opinions and recommendations on the programme of activities of the Centre, and on any matter submitted to it by the Council.

Chair: Mr Ivan Čaćić (*Croatia*)

Vice Chair: Dr Laszlo Bozo (*Hungary*)

ECMWF Calendar 2010

January 11–15	First General Assembly of the MACC Project
February 1–5	Training Course – Use and interpretation of ECMWF products
February 5	TAC Subgroup on the BC Project
February 8–12	Training Course – Use and interpretation of ECMWF products
February 17–18	Working Group on the Building Programme
Feb. 23–March 24	Training Course – Use of computing facilities
February 23–26	*GRIB API: library and tools*
March 1–5	*Introduction for new users/MARS*
March 8–9	*MAGICS*
March 10–12	*METVIEW*
March 15–19	*Use of supercomputing resources*
March 22–24	*Introduction to SMS/XCDP*
March 2–4	GEO User Interface Committee (*14th Session*)
April 12–May 27	Training Course – Numerical Weather Prediction
April 12–16	*Numerical methods, adiabatic formulation of models and ocean wave forecasting*
April 19–28	*Predictability, diagnostics and extended-range forecasting*
May 5–14	*Data assimilation and use of satellite data*
May 17–27	*Parametrization of subgrid physical processes*
April 15–16	TAC Subgroup on Verification Measures (*3rd Session*)
April 20–21	Advisory Committee for Data Policy (*11th Session*)
April 27–28	Finance Committee (*84th Session*)
April 28–29	Policy Advisory Committee (*29th Session*)
May 25	Security Representatives' Meeting
May 26–28	Computer Representatives' Meeting
June 9–11	Forecast Products – Users' Meeting
June 15–17	Workshop on 'Assimilating satellite observations of clouds and precipitation into NWP models'
June 24–25	Council (*73rd Session*)
September 6–9	Seminar on 'Predictability in the European and Atlantic regions from days to years'
October 4–6	Scientific Advisory Committee (*39th Session*)
October 7–8	Technical Advisory Committee (*42nd Session*)
October 11–15	Training Course – Use and interpretation of ECMWF products for WMO Members
October 11–12	Finance Committee (*85th Session*)
October 12–13	Policy Advisory Committee (*30th Session*)
October 19	Advisory Committee of Co-operating States (*16th Session*)
November 1–5	14th Workshop on 'Use of High Performance Computing in Meteorology'
November 8–10	Workshop on 'Non-hydrostatic modelling'
December 7–8	Council (*74th Session*)

ECMWF publications

(see http://www.ecmwf.int/publications/)

Technical Memoranda

614 **Buizza, R.**: Impact of truncation on variable resolution forecasts. *January 2010*

613 **Flemming, J., A. Inness, L. Jones, H.J. Eskes, V. Huijnen, D. Kinnison, M.G. Schultz, O. Stein, D. Cariolle & G. Brasseur**: Forecasts and assimilation experiments of the Antarctic Ozone Hole 2008. *January 2010*

612 **Agustí-Panareda, A., A. Beljaars, M. Ahlgrimm, G. Balsamo, O. Bock, R. Forbes, A. Ghelli, F. Guichard, M. Köhler, R. Meynadier & J.-J. Morcrette**: The ECMWF re-analysis for the AMMA observational campaign. *December 2009*

611 **Agustí-Panareda, A., G. Balsamo & A. Beljaars**: Impact of improved soil moisture on the ECMWF precipitation forecasts in West Africa. *December 2009*

610 **Abdalla, S., P.A.E.M. Janssen & J.-R. Bidlot**: Jason-2 OGDR wind and wave products: Monitoring, validation and assimilation. *December 2009*

609 **Balsamo, G., E. Dutra, V.M. Stepanenko, P. Viterbo, P.M. Miranda & D. Mironov**: Deriving an effective lake depth from satellite lake surface temperature data: A feasibility study with MODIS data. *December 2009*

608 **Dutra, E., V.M. Stepanenko, G. Balsamo, P. Viterbo, P.M. Miranda, D. Mironov & C. Schär**: Impact of lakes on the ECMWF surface scheme. *December 2009*

606 **Richardson, D.S., J. Bidlot, L. Ferranti, A. Ghelli, C. Gibert, T. Hewson, M. Janousek, F. Prates & F. Vitart**: Verification statistics and evaluations of ECMWF forecasts in 2008-2009. *October 2009*

605 **Buizza, R.**: The value of a variable resolution approach to numerical weather prediction. October 2009

604 **Jung, T., T.N. Palmer, M.J. Rodwell & S. Serrar**: Understanding the anomalously cold European winter of 2005/06 using relaxation experiments. *October 2009*

603 **Jung, T., M.J. Miller & T.N. Palmer**: Diagnosing the origin of extended-range forecast error. *October 2009*

602 **Wedi, N. & P.K. Smolarkiewicz**: A nonlinear perspective on the dynamics of the MJO: idealized large-eddy simulations. *October 2009*

601 **Agustí-Panareda, A., A. Beljaars, C. Cardinali, I. Genkova & C. Thorncroft**: Impact of assimilating AMMA soundings on ECMWF analyses and forecasts. *October 2009*

600 **Bormann, N., A. Collard & P. Bauer**: Estimates of spatial and inter-channel observation error characteristics for current sounder radiances for NWP. *October 2009*

599 **Cardinali, C.**: Forecast sensitivity to observation (FSO) as a diagnostic tool. *October 2009*

598 **Palmer, T.N., R. Buizza, F. Doblas-Reyes, T. Jung, M. Leutbecher, G.J. Shutts, M. Steinheimer & A. Weisheimer**: Stochastic parametrization and model uncertainty. *October 2009*

594 **Wedi, N.P., K. Yessad & A. Untch**: The non-hydrostatic global IFS/ARPEGE model: model formulation and testing. *October 2009*

EUMETSAT/ECMWF Fellowship Programme Research Report

19 **Krzeminski, B., N. Bormann, G. Kelly, T. McNally & P. Bauer**: Revision of the HIRS cloud detection at ECMWF. *October 2009*

18 **Geer, A.J., R.M. Forbes & P. Bauer**: Cloud and precipitation overlap in simplified scattering microwave radiative transfer. *September 2009*

Contract Report to the European Space Agency

de Rosnay, P., M. Drusch & J. Muñoz Sabater: Milestone 1 Tech Note – Part 1: SMOS Global Surface Emission Model. *November 2009*

Muñoz Sabater, J., P. de Rosnay, A. Fouilloux, M. Dragosavac & A. Hofstadler: Milestone 1 Tech Note - Part 2: IFS Interface. *November 2009*

ARM Report Series

4 **Ahlgrimm, M. & M. Köhler**: Evaluation of trade cumulus and the DualM parametrization in the ECMWF model. *December 2009*

Index of past newsletter articles

This is a selection of articles published in the *ECMWF Newsletter* series during the last five years. Articles are arranged in date order within each subject category. Articles can be accessed on the ECMWF public website – www.ecmwf.int/publications/newsletter/index.html

Ensemble prediction and Seasonal Forecasting

Ocean and wave modelling

Environmental monitoring

Meteorological applications and studies

Useful names and telephone numbers within ECMWF

Telephone

Telephone number of an individual at the Centre is:

International: +44 118 949 9 + three digit extension
UK: (0118) 949 9 + three digit extension
Internal: 2 + three digit extension

e.g. the Director's number is:
+44 118 949 9001 (international),
(0118) 949 9001 (UK) and 2001 (internal).

E-mail

The e-mail address of an individual at the Centre is:
firstinitial.lastname@ecmwf.int

e.g. the Director's address is: D.Marbouty@ecmwf.int

For double-barrelled names use a hyphen
e.g. J-N.Name-Name@ecmwf.int

Internet web site

ECMWF's public web site is: http://www.ecmwf.int

	Ext
Director	
Dominique Marbouty	001
Deputy Director & Head of Operations Department	
Walter Zwieflhofer	003
Head of Research Department	
Erland Källén	005
Head of Administration Department	
Ute Dahremöller	007

Switchboard	
ECMWF switchboard	000
Advisory	
Internet mail addressed to Advisory@ecmwf.int	
Telefax (+44 118 986 9450, marked User Support)	
Computer Division	
Division Head	
Isabella Weger	050
Computer Operations Section Head	
Sylvia Baylis	301
Networking and Computer Security Section Head	
Rémy Giraud	356
Servers and Desktops Section Head	
Richard Fisker	355
Systems Software Section Head	
Neil Storer	353
User Support Section Head	
Umberto Modigliani	382
User Support Staff	
Paul Dando	381
Dominique Lucas	386
Carsten Maaß	389
Pam Prior	384
Christian Weihrauch	380
Computer Operations	
Call Desk	303
Call Desk email: calldesk@ecmwf.int	
Console – Shift Leaders	803
Console fax number +44 118 949 9840	
Console email: newops@ecmwf.int	
Fault reporting – Call Desk	303
Registration – Call Desk	303
Service queries – Call Desk	303
Tape Requests – Tape Librarian	315

	Ext
Meteorological Division	
Division Head	
Erik Andersson	060
Meteorological Applications Section Head	
Alfred Hofstadler	400
Data and Services Section Head	
Baudouin Raoult	404
Graphics Section Head	
Stephan Siemen	375
Meteorological Operations Section Head	
David Richardson	420
Meteorological Analysts	
Antonio Garcia-Mendez	424
Anna Ghelli	425
Martin Janousek	460
Fernando Prates	421
Meteorological Operations Room	426
Data Division	
Division Head	
Jean-Noël Thépaut	030
Data Assimilation Section Head	
Lars Isaksen	852
Satellite Data Section Head	
Peter Bauer	080
Re-Analysis Section Head	
Dick Dee	352
Probabilistic Forecasting & Diagnostics Division	
Division Head	
Tim Palmer	600
Seasonal Forecasting Section Head	
Franco Molteni	108
Model Division	
Division Head	
Martin Miller	070
Numerical Aspects Section Head	
Agathe Untch	704
Physical Aspects Section Head	
Anton Beljaars	035
Ocean Waves Section Head	
Peter Janssen	116
GMES / MACC Coordinator	
Adrian Simmons	700
Education & Training	
Renate Hagedorn	257
ECMWF library & documentation distribution	
Els Kooij-Connally	751