

Application and verification of ECMWF products in Member and Co-operating States

Report 2007 - Summary

1. Introduction

In May 2007 Member States and Co-operating States were requested to contribute to the Report on Application and Verification of ECMWF Products for 2007. Contributions have been received from 25 States. These have been made available via the ECMWF web site as recommended by the 36th session of the TAC:

<http://www.ecmwf.int/products/greenbook/2007/>

This document presents a summary of the information and results given in the contributions - these were requested to be discussed under the following headings:

1. Summary of major highlights
2. Use and application of products
3. Verification of products (objective and subjective)
4. References to relevant publications

At the 36th session of the TAC, the committee requested Member States and Co-operating States to include information on the use of ECMWF products in each annual report. Verification was requested to focus on surface weather parameters, which complements the comprehensive upper-air verification carried out operationally at ECMWF. The recommendations to Member States for verification of local weather forecasts are given in ECMWF Technical Memorandum No 430 by P. Nurmi, available via the ECMWF website:

<http://www.ecmwf.int/publications/library/do/references/list/14>

This summary notes comments that have been made about verification results, when methods (e.g. subjective verification) differ from those used operationally at ECMWF. ECMWF objectively verifies a wide range of direct model output (DMO): upper air parameters verified against analyses and observations, weather elements verified against observations or 0-24h forecasts. Various statistics, such as area means, time averages, etc., are produced. The EPS verification is included in this system. These results are considered in a separate document on Verification statistics and evaluations of ECMWF forecasts (Document ECMWF/TAC/37(07)4).

The contributions from Member States and Co-operating States complement, in some detail, the presentations on applications and verification made at the ECMWF Product Users' Meeting, 13-15 June 2007. Some of the findings from this meeting are included in the following summary. The programme for the Users' Meeting, together with the presentations and the conclusions from the final discussion, can be found on the ECMWF website at:

http://www.ecmwf.int/newsevents/meetings/forecast_products_user/Presentations2007/index.html

2. Use and application of products

2.1. Post-processing of model output

- Most countries apply statistical procedures to post-process ECMWF products, especially to make forecasts of surface weather parameters for specific station locations. The main methods are MOS (reported this year by Austria, Croatia, France, Germany, Hungary, Norway, Romania, Slovenia) and Kalman filter (France, Germany, Greece, Iceland, Norway, Slovenia, Sweden, Turkey, UK). Perfect prognosis is also used (Austria, Germany, Italy). Iceland reported on statistical downscaling of ECMWF precipitation using high resolution precipitation climate to account for complex terrain.
- Equivalent statistical adaptations are also applied to EPS products, either the ensemble mean (France, Germany) or individual ensemble members (France, UK). In addition, calibration methods

for the ensemble distribution are being employed, including use of rank histograms (France, UK). Calibration of the EPS is an area of ongoing development in several countries (including Finland, France, Norway); Bayesian model averaging is one of the new methods under investigation.

- Austria reported on the statistical combination of ECMWF and limited area model ALADIN for short-range precipitation forecasts, which improves over both individual models. Germany reported improved results from using a combined MOS for ECMWF and DWD model output.
- Several countries do additional post-processing to provide tailored version of the more general products available from ECMWF. Estonia reported development of internal web displays to give regional focus and more temporal resolution than on ECMWF pages for forecasts to 5 days. Examples using EPS products include clustering for specific areas or variables (Hungary), EPSgrams and plumes for additional parameters such as wind direction and waves (France, Hungary), and probability maps for different thresholds and parameters, e.g. CAPE (Spain).
- ECMWF model output is post-processed to generate derived fields, often for use in severe weather warnings, such as freezing level, stability indices (Italy, Germany, Norway, Romania, Netherlands), sea state (Italy) and fronts (Portugal).
- ECMWF forecasts provide the boundary conditions for limited area models run in national weather services (Denmark, France, Greece, Serbia, Iceland, Ireland, Norway, Slovenia, Sweden, Turkey, Romania) and for limited area ensemble prediction systems (Italy, Norway, Spain).
- ECMWF model fields are used to drive a number of application models including trajectory and dispersion models (Austria, Czech Republic, France, Greece, Hungary, Portugal), ocean wave models (Portugal, Sweden, Turkey) and hydrology models (Czech Republic). The Czech Republic plans to also use EPS data as input to river discharge model

2.2. Use of ECMWF products including for severe weather prediction

- ECMWF products form the basis of medium-range forecasts in most countries. In the short range, ECMWF products are often used in combination with other sources, especially limited area models (Austria, Czech Republic, France, Germany, Greece, Iceland, Portugal, Romania, Sweden).
- Use of the ECMWF web site is becoming a widespread part of day-to-day activities in the forecast offices. General comments included “more and more use” (Ireland); “widely used by forecasters” (France). It was also reported at the Users Meeting that the web pages are often an integral part of the forecasters’ daily routine and that it becomes a problem if the web products are unavailable (Germany, Portugal, Romania).
- The usefulness of the EFI for alerting for severe weather events was particularly mentioned (Czech Republic, Germany, Greece, Italy, Lithuania, Romania, Serbia, Slovenia). The EPS probability products are often used to provide additional information. EPSgrams are widely used, and clusters and tubes are also used by forecasters looking at alternative scenarios. The EPS is used to provide confidence indices (Germany, France). Ireland reported increasing use of the EPS by its forecasters. The UK has integrated internally produced graphics from the EPS and the Met Office short-range EPS to develop “seamless” products for short to medium range (extended to 15 days with VarEPS). Use of the 15-day EPS was also noted by France, Germany, Hungary, Netherlands, Romania, Serbia, Sweden, including for some commercial customers (France).
- Specific uses of ECMWF forecasts include road maintenance, heating, agriculture (Ireland, Serbia), wind power company (Estonia, Sweden), ship routing (Denmark), aviation (Greece).

- ECMWF products are also used in the tropics. France reported development of a new genesis index for tropical cyclones and use of EPS-based wave products for swell forecasts.
- It was also noted that ECMWF data are used for research (e.g. chemical transport model in Sweden) and verification (France).

3. Verification of products

- Most countries include results of verification of ECMWF forecasts, generally by comparison to observations in the local area of interest.
- Several countries regularly compare the performance of their limited area models (LAMs) with the ECMWF forecasts in the short range (Austria, Denmark, Greece, Hungary, Italy, Norway, Portugal, Sweden, Turkey). In general the higher resolution LAMs provide more accurate short-range wind forecasts, but ECMWF gives better temperature forecasts. Skill of precipitation forecasts is similar in most comparison.
- Countries that include post-processing of direct model output noted that this considerably improves verification results when comparison is made with station observations. Kalman Filters can be efficient at removing systematic differences (biases) between model and station (Iceland, Sweden), but is less useful where biases are not present. Post-processing of precipitation forecasts can lead to very reliable PoP forecasts (Germany). It was also noted that MOS can reduce forecast variability which can limit usefulness for severe weather prediction; the EPS distribution can provide important additional guidance in such situations (Germany).
- Subjective verification is also reported. Improved quality and reliability of weather parameters was noted by forecasters (Portugal), and better diurnal cycle for convective rain (Germany, Romania). Some problems with cloud cover in particular situations were reported (Luxembourg, Slovenia, Sweden). Romania noted some problems with cut-off lows over the Balkans.
- UK reported continued improvements in ECMWF tropical cyclone track forecasts 72 hours and beyond; Met Office tracks are better in the analysis and in short-range forecasts.

4. Monthly and seasonal forecasts

- Use of the monthly and seasonal forecast products continues to increase. Applications include civil protection briefings (Italy, Portugal), public and media (Norway, Sweden), input to crop models using soil moisture (Switzerland, Romania), and research or consultancy (Greece). The ECMWF website is often used to view the monthly and seasonal forecasts. Some countries are now developing their own products for internal use (Austria, Italy, Switzerland). ECMWF fields are used for initial conditions for seasonal forecast modelling (France). The 15-day EPS forecasts are used in some countries as additional input to preparation of monthly forecast products (Italy, Serbia).
- Some verification of monthly forecasts has begun (Austria, France, Switzerland). Temperature forecasts can be useful out to week 3; the level of skill varies with season and region.