Progress Report on the Global Data Processing System 2002

European Centre for Medium-Range Weather Forecasts

1. HIGHLIGHTS OF THE YEAR

22 January 2002: **New model cycle**: more data are activated (SeaWinds data from **QUIKSCAT**, less thinning of aircraft observations, more intelligent thinning and better scan correction of ATOVS radiances); pre-processing (bias correction) of SSMI data and redundancy checks for SYNOP, SHIP, DRIBU, AIREP, TEMP and PILOT observation are refined; **4D-var analysis algorithms are upgraded** (pre-conditioning; new radiative transfer code; observation time slots reduced to 30 minutes); **new vertical discretisation** (finite elements)

Additional EPS initial perturbations are computed in the tropics using diabatic singular vectors targetted over areas where tropical storms with category larger than 1 have been observed. The Caribbean (0°-25°N and 100°-60°W) is always target area;

February 2002: **New ECMWF web site**, with a wider range of documentation, news and products (Figure 1)

March 2002: The **new Seasonal Forecasting System** is given operational status, replacing the System 1 version.The main characteristics of the new system are higher-resolution ocean and atmosphere models (TL95L40, Cy23r4), and retuned ocean data assimilation (including corrections to salinity when temperature is assimilated, and to velocity when density is updated).The ensemble is now made of five different ocean analyses perturbed by wind anomalies. From each analysis, eight perturbations to sea surface temperature are made, creating an ensemble of 40 members, all starting from the same date (burst mode). Calibration has been done for this system using a five-member ensemble of hindcasts run from 1987 to 2001.

9 April 2002: **New model cycle**: revised shortwave radiation scheme with variable effective radius of liquid cloud water; retuning of the land surface (TESSEL) parametrization to reduce winter/spring warm biases in low-level temperatures; improved physics for the oceanic wave model; improved wind-gust post-processing; activation of new data streams: water-vapour radiances from Meteosat-7, SBUV and GOME ozone data, and European wind profilers;

24-28 June 2002: ECMWF hosts the WMO Expert Meeting on GDPS Solutions for Data Quality Monitoring

24 July 2002: **ECMWF gives NMHSs of WMO access to medium range forecasts** on its www.ecmwf.int website; charts are using products available on the GTS and EPS probabilities for rainfall and wind gusts in the extratropics are also available.

2. EQUIPMENT IN USE

The computer equipment in use at the end of 2002 summarised in Table 1 and Table 2 below:

Table 1: Computer equipment in use for operational activities (end of 2002)

Machine	Processors	Memory	Storage	Tape Drives
Fujitsu VPP5000	100	400 GB	5.3 TB	
3 x HP K580 machines	18	2.2 GB	0.4 GB	
5 x IBM Nighthawk nodes	18	22 GB	4 TB	44

Table 2: Computer equipment being readied for operational use

Machine	Processors	Memory	Storage	Tape Drives
2 IBM Cluster 1600	1820	2500 GB	9.6 TB	
3 x IBM p660 nodes	14	16 GB	7 TB	16

3. QUALITY CONTROL SYSTEM

The observational data used in the operational analysis (cf para. 5 below) undergo a quality control in near real-time, after having been decoded. Each observation is subject to a number of tests:

(i) The parameter values are compared with gross limits for the parameter. Limits depend on latitude and, for surface parameters, also on the season of the year.

(ii) Redundancy of information between the parameter values allows some internal consistency checks to be performed.

(iii) Temporal consistency checks on observations from the same source are done for the position of moving platforms.

The tests have, in general, been extracted from the publication "Guide on the Global Data Processing System", WMO-N305 1982 Chapter 6 - "Quality Control Procedures".

4. MONITORING OF THE OBSERVING SYSTEM

The operational monitoring of all data types continues to provide the basis for decisions on the operational use of the data. The quality of observations is monitored in non real-time, based on statistics of the departures between the data and the operational 3-15 hour forecasts and analyses. All data types used in the data assimilation system are monitored in that way.

Figure 1: New ECMWF web site home page (www.ecmwf.int).

Results are published in a monthly Global Data Monitoring Report, provided to GDPS centres participating in data monitoring activities and to the WMO Secretariat (further copies can be obtained from ECMWF on request). Feedback is also provided directly to data producers. ECMWF hosted a WMO meeting on the GDPS Solutions for Data Quality Monitoring in June 2002; among its main recommendations this meeting agreed to start experimental exchange of monitoring data for radiosonde humidity measures and to refine the monitoring checks used for aircraft observations. More on this can be found in http://www.wmo.ch/web/www/DPS/ECMWF-GDPS-SOL-02/EM-QC-Final-report.doc

The Centre has continued to fulfil its rôle of lead centre for radiosonde and pilot data monitoring as requested by WMO, including co-ordination and liaison with other lead centres, and setting up the list of reference stations used for the exchange of verification scores for NWP products

5. FORECASTING SYSTEM - DECEMBER 2002

Model:

Smallest half-wavelength resolved:
40 km (triangular spectral truncation 511)

Vertical grid: 60 hybrid levels (top pressure: 10 Pa)

Time-step: 15 minutes

Numerical scheme:
Semi-Lagrangian, semi- implicit time-stepping formulation.

Number of grid points in model:
20,911,680 upper-air, 1,394,112 in land surface and sub- surface layers. The grid for computation of physical processes is a reduced, linear Gaussian grid, on which single-level parameters are available. The grid spacing is close to 40km.

Variables at each grid point (recalculated at each time-step):
Wind, temperature, humidity, cloud fraction and water/ ice content, ozone content (also pressure at surface grid-points)

Physics:
orography (terrain height and sub-grid-scale), drainage, precipitation, temperature, ground humidity, snow-fall, snow-cover & snow melt, radiation (incoming short-wave and out-going long-wave), friction (at surface and in free atmosphere), sub-grid-scale orographic drag - gravity waves and blocking **effects, evaporation, sensible & latent heat flux, oceanic waves.**

Data Assimilation:

Analysis:	**Mass & wind** (four-dimensional variational multi- variate analysis on 60 model levels) **Humidity** (four-dimensional variational analysis on model levels up to 250 hPa) **Surface parameters** (sea surface temperature from NCEP Washington analysis, sea ice from SSM/I satellite data), soil water content, snow depth, and screen level temperature and humidity
Data used:	**Global satellite data** (SATOB/AMV, (A)TOVS, Quikscat, SSM/I, SBUV, GOME, Meteosat7 WV radiance), **Global free-atmosphere data** (AIREP, AMDAR, TEMP, PILOT, TEMP/DROP, PROFILERS), **Oceanic data** (SYNOP/SHIP, PILOT/SHIP, TEMP/SHIP, DRIBU), **Land data** (SYNOP). Data checking and validation is applied to each

parameter used. Thinning procedures are applied when observations are redundant at the model scale.

Ensemble Prediction System: same model as used for data assimilation and deterministic forecast, except for :

Initial perturbations generated from singular vectors at T42 resolution. 10-days forecasts are perturbed through random perturbations of the physical tendencies (stochastic physics).

50 ensemble members at T_L255 resolution (linear grid), 40 levels, time step=45 minutes

Dissemination of analyses and forecasts to Member States:

via the RMDCN wide area network (mainly 64,000 bits per second) connecting the ECMWF system with the computer systems in the meteorological services of the 18 Member States and six co-operating States

dissemination requirements updated (and repeat transmissions requested) by individual Member States

Dissemination to non-Member States:

via the Global Telecommunications System, network (50 to 64,000 bits per second) operated under the World Weather Watch of the World Meteorological Organization, connecting the meteorological services of all countries of the world. The list of products available is listed in Table 3. The horizontal resolution is 5 x 5 degrees (dissemination in code GRID) and 2.5 x 2.5 degrees (dissemination in code GRIB).

Dissemination to the African Centre of Meteorological Applications for Development (ACMAD):

via METEOSAT MDD — *Specific products for the African region*

Dissemination to EUMETSAT:

A range of ECMWF products are sent daily to the Meteorological Product Extraction Facility at EUMETSAT to aid in retrieving cloud motion winds from METEOSAT. The ECMWF products are used for calculation of sea surface temperature and to assign cloud top heights to pressure levels.

Table 3: List of products agreed by ECMWF's Council 53 for dissemination on the GTS

Parameter	Level	Domain	Steps
Based on deterministic model			
Z	500	G	H+00,24,48,***72,96,120,144,168***
T	850	G	H+00,24,48,72,96,120,144,168
u,v	850	G	H+00,24,48,***72,96,120,144,168***
u,v	700	G	H+00,24,48,72,96,120,144,168
u,v	500	G	H+00,24,48,72,96,120,144,168
u,v	200	G	H+00,24,48,72,96,120,144,168
Rel Humidity	850	G	H+00,24,48,72,96,120,144,168
Rel Humidity	700	G	H+00,24,48,72,96,120,144,168
MSL pressure	surface	G	H+00,24,48,***72,96,120,144,168***
Divergence	700	T	H+00,24,48,72,96,120,144
Vorticity	700	T	H+00,24,48,72,96,120,144
Based on EPS(*)			
Prob Precip	>10mm	NH,SH	H+72,96,120,144
Prob Precip	>20mm	NH,SH	H+72,96,120,144
Wind gusts	>15m/s	NH,SH	H+72,96,120,144
Wind gusts	>25m/s	NH,SH	H+72,96,120,144

G = Global
T = Tropics between 35S and 35N
NH = Northern Hemisphere north of 20 deg
SH = Southern Hemisphere south of 20 deg
<<Essential>> products are underlined above
(*) EPS products are not yet available on the GTS; corresponding charts can however be retrieved from www.ecmwf.int by WMO members.

Dissemination to the European Space Agency:

A range of ECMWF products are sent daily to ESA to aid in processing data from the ERS satellites.

Management of the operational suite

The processes forming the operational suite and the research experiments are managed and controlled by a Supervisor - Monitor - Scheduler (SMS) system. Many suites can be controlled under one SMS; alternatively, several versions of SMS may run simultaneously.

Data archives and services

Demand for data from the Centre's archives of grid products, provided for research by ECMWF data services, continued to grow. Available data and services for external users are described at the following address: http://www.ecmwf.int/products/data/

6. VERIFICATION OF PROGNOSTIC PRODUCTS IN 2002

Average of the monthly WMO/CBS standard scores for **2002** (*2001)*are summarised in Table 4 and Table 5 below; the evolution of scores over the last 8 years is also shown in graphical format in Figure 2.

Table 4: Annual scores against Analyses

VERIFICATION AGAINST ANALYSIS in **2002** (*2001*)								
		24 hr		72hr		120hr		
North. Hemisphere	500-hPa height RMS (m)	**8.68**	*8.84*	**26.19**	*26.53*	**50.87**	*51.22*	
	Wind RMSVE 250 hPa (ms^{-1})	**4.47**	*4.52*	**9.38**	*9.43*	**14.48**	*14.57*	
South. Hemisphere	500-hPa height RMS (m)	**10.24**	*10.5*	**32.28**	*33.19*	**61.69**	*61.98*	
	Wind RMSVE 250 hPa (ms-1)	**4.38**	*4.44*	**9.96**	*10.23*	**15.63**	*15.82*	
Tropics	Wind RMSVE 850 hPa (ms^{-1})	**2.21**	*2.17*	**3.28**	*3.33*	**3.93**	*4*	
	Wind RMSVE 250 hPa (ms^{-1})	**3.96**	*3.95*	**6.82**	*6.95*	**8.49**	*8.57*	

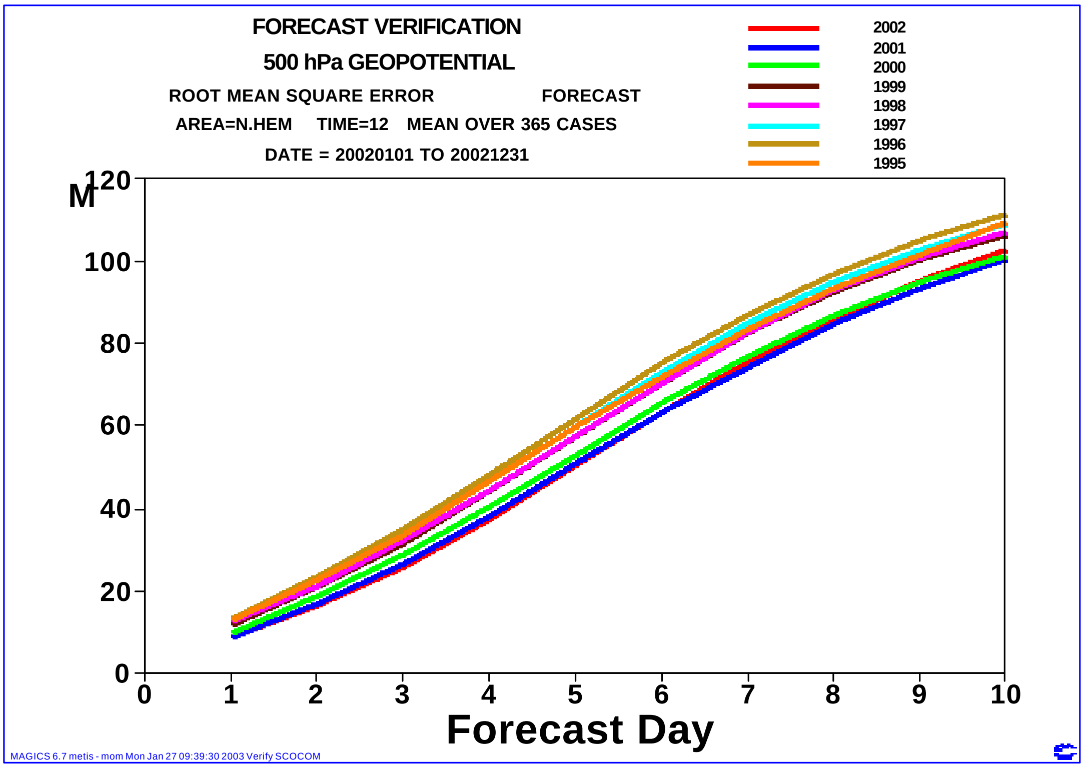
Table 5: Annual scores agains Radiosondes measurements

VERIFICATION AGAINST RADIOSONDES in **2002** (*2001*)		24 hr		72hr		120hr	
North America	500-hPa height RMS (m)	**11.97**	*13.13*	**28.91**	*30.00*	**51.22**	*53.68*
	Wind 850 hPa (ms^{-1})	**4.25**	*4.29*	**5.90**	*5.97*	**7.97**	*8.11*
	Wind 250 hPa (ms^{-1})	**6.50**	*6.53*	**10.93**	*11.15*	**15.93**	*16.48*
Europe	500-hPa height RMS (m)	**11.23**	*11.79*	**27.84**	*26.61*	**55.75**	*54.61*
	Wind 850 hPa (ms^{-1})	**3.93**	*3.99*	**5.47**	*5.51*	**7.71**	*7.67*
	Wind 250 hPa (ms^{-1})	**5.83**	*5.70*	**10.55**	*9.89*	**17.19**	*16.16*
Asia	500-hPa height RMS (m)	**12.88**	*12.98*	**24.20**	*23.87*	**41.78**	*42.24*
	Wind 850 hPa (ms^{-1})	**4.05**	*4.22*	**5.48**	*5.48*	**7.11**	*7.04*
	Wind 250 hPa (ms^{-1})	**6.07**	*6.34*	**9.88**	*9.63*	**13.73**	*13.32*
Australia/NZ	500-hPa height RMS (m)	**10.79**	*10.48*	**20.18**	*19.91*	**36.95**	*36.89*
	Wind 850 hPa (ms^{-1})	**4.00**	*4.05*	**4.96**	*5.06*	**6.34**	*6.65*
	Wind 250 hPa (ms^{-1})	**6.06**	*6.17*	**8.98**	*9.11*	**12.87**	*13.21*
Tropics	Wind 850 hPa (ms^{-1})	**3.92**	*4.03*	**4.42**	*4.59*	**4.95**	*5.09*
	Wind 250 hPa (ms^{-1})	**5.71**	*5.87*	**7.53**	*7.60*	**9.07**	*8.97*
North Hemisphere	500-hPa height RMS (m)	**12.53**	*13.05*	**28.98**	*29.14*	**54.68**	*55.34*
	Wind 850 hPa (ms^{-1})	**4.13**	*4.20*	**5.72**	*5.78*	**7.82**	*7.87*
	Wind 250 hPa (ms^{-1})	**5.98**	*6.08*	**10.37**	*10.25*	**15.77**	*15.57*
South Hemisphere	500-hPa height RMS (m)	**13.13**	*12.91*	**27.10**	*27.58*	**49.75**	*49.63*
	Wind 850 hPa (ms-1)	**4.38**	*4.42*	**5.58**	*5.76*	**7.34**	*7.60*
	Wind 250 hPa (ms^{-1})	**6.38**	*6.56*	**9.88**	*10.19*	**14.67**	*14.89*

Following recent recommendations from CBS, a preliminary set of annual verifications statistics for the Ensemble Prediction System follows in Table 6 below:

Table 6: Annual scores against analyses of the Ensemble Prediction System

EPS VERIFICATION AGAINST ANALYSES (2002)			72 hr	120hr	192hr
North Hemisphere	500-hPa height	Ensemble Mean RMS (m)	**27.08**	**47.66**	**72.13**
		Ensemble Spread/Ensemble Mean Error	*1.12*	*0.97*	*0.90*
	850-hPa Temperature	Ensemble Mean RMS (K)	**1.72**	**2.50**	**3.42**
South Hemisphere	500-hPa height	Ensemble Mean RMS (m)	**33.15**	**57.28**	**82.80**
	850-hPa Temperature	Ensemble Mean RMS (K)	**1.73**	**2.44**	**3.15**



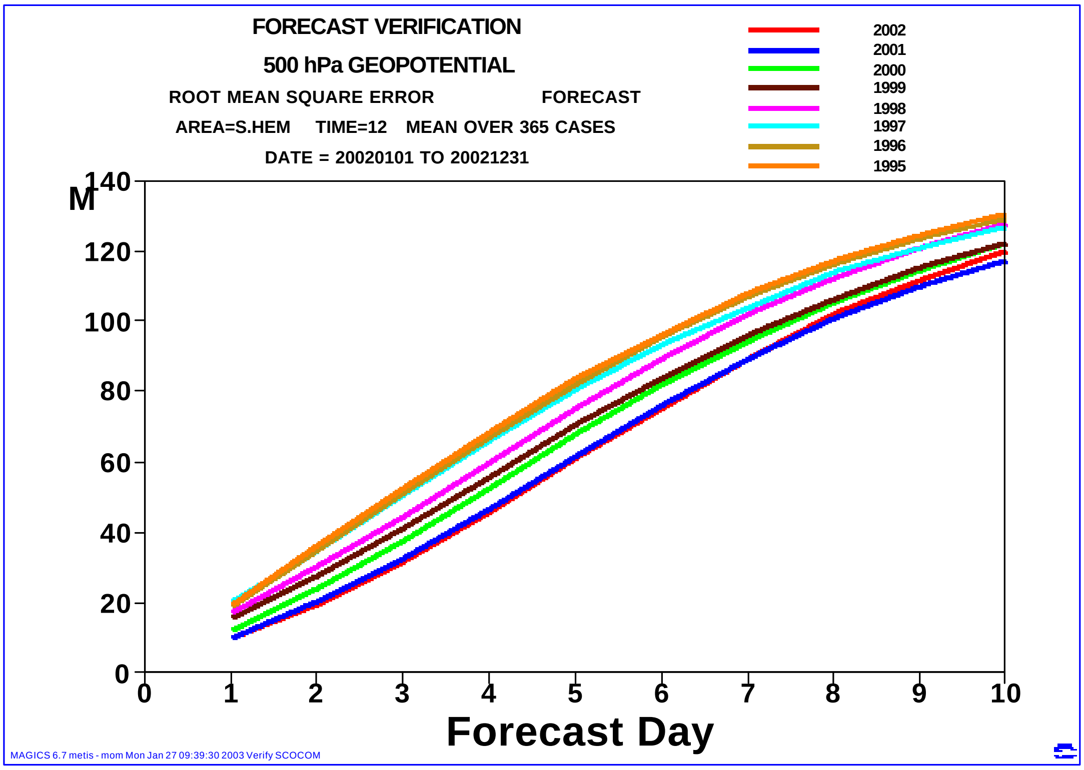


Figure 2: Z500 RMSE over N. Hem. (upper) and S.Hem. (lower) extratropics over the last 8 years.