Progress Report on the Global Data Processing System 2000

European Centre for Medium-Range Weather Forecasts

1. HIGHLIGHTS OF THE YEAR

15 March 2000: The Initial Deployment of the Regional Meteorological Data Communication Network (RMDCN) is accepted. 32 countries from WMO RA VI plus ECMWF are now using the RMDCN for their operational communication and the majority of the old Leased Lines and GTS links have been cancelled. ECMWF has been designated in 1997 to lead and co-ordinate the procurement, implementation and operational monitoring of this network for all RA VI Members.

11 April 2000: Revised use of SSM/I radiance including new bias correction and preventing the assimilation where precipitation occurs; quality control procedure changes for dropsonde data; modification of the assimilation of humidity in the stratosphere that was moistening unrealistically; bug fixed in the gravity wave drag formulation in the stratosphere; technical changes to the wave model and changes in the assimilation of altimeter wave height, and implementation of a new post-processing software developed in collaboration with Météo-France (Full-Pos);

9 May 2000: **Operational model moved on to the Fujitsu VPP5000 machine**;

27 June 2000: New parameterisation schemes for the land surface, lying snow and sea-ice (tiles); revised snow analysis; new (RRTM) long-wave radiation scheme; improved ozone model; improved treatment of precipitation processes in the first time step; use of more TOVS/ATOVS data (HIRS-12, AMSU-14; less constraint on AMSU-8; more off-nadir data); use of actual buoy heights; revised observation and background error variances in 4D-Var; use of a digital filter for the gravity-wave constraint Jc in 4D-Var

12 September 2000: **Change of cycling period of the assimilation from 6 to 12 hours**. 4D-Var now processes the observations in 12-hour sets, spanning 03 UTC - 15 UTC for the 12 UTC analysis, and 15 UTC - 03 UTC for the 00 UTC analysis; use of more accurate background trajectory in 4D-Var; new quality control step that prevents the use of observations which the incremental formulation of 4D-Var cannot handle ; resetting of the stratospheric ozone and switching off of the multivariate coupling between ozone and vorticity.

21 November 2000: **Change of horizontal resolution**. The deterministic model and the outer loops of 4D-Var are run at TL511 (40 km) resolution instead of TL319 (60 km) before. The 12h inner loops (increments) of 4D-Var are now run at TL159 (120 km) resolution (T63 before) using new Semi-Lagrangian tangent linear and adjoint codes. The Ensemble Prediction System (EPS) now has at TL255 (80 km) resolution (TL159 before).

1-3 December 2000: **ECMWF celebrates its first 25 years** (1975-2000)

19 December 2000: Correction of a bug affecting the computation of EPS stochastic physics tendencies.

2. EQUIPMENT IN USE

The computer equipment in use at the end of 2000 summarised in Table 1.

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".

Figure 1: New (top) and old (bottom) model orography. Units are dam.

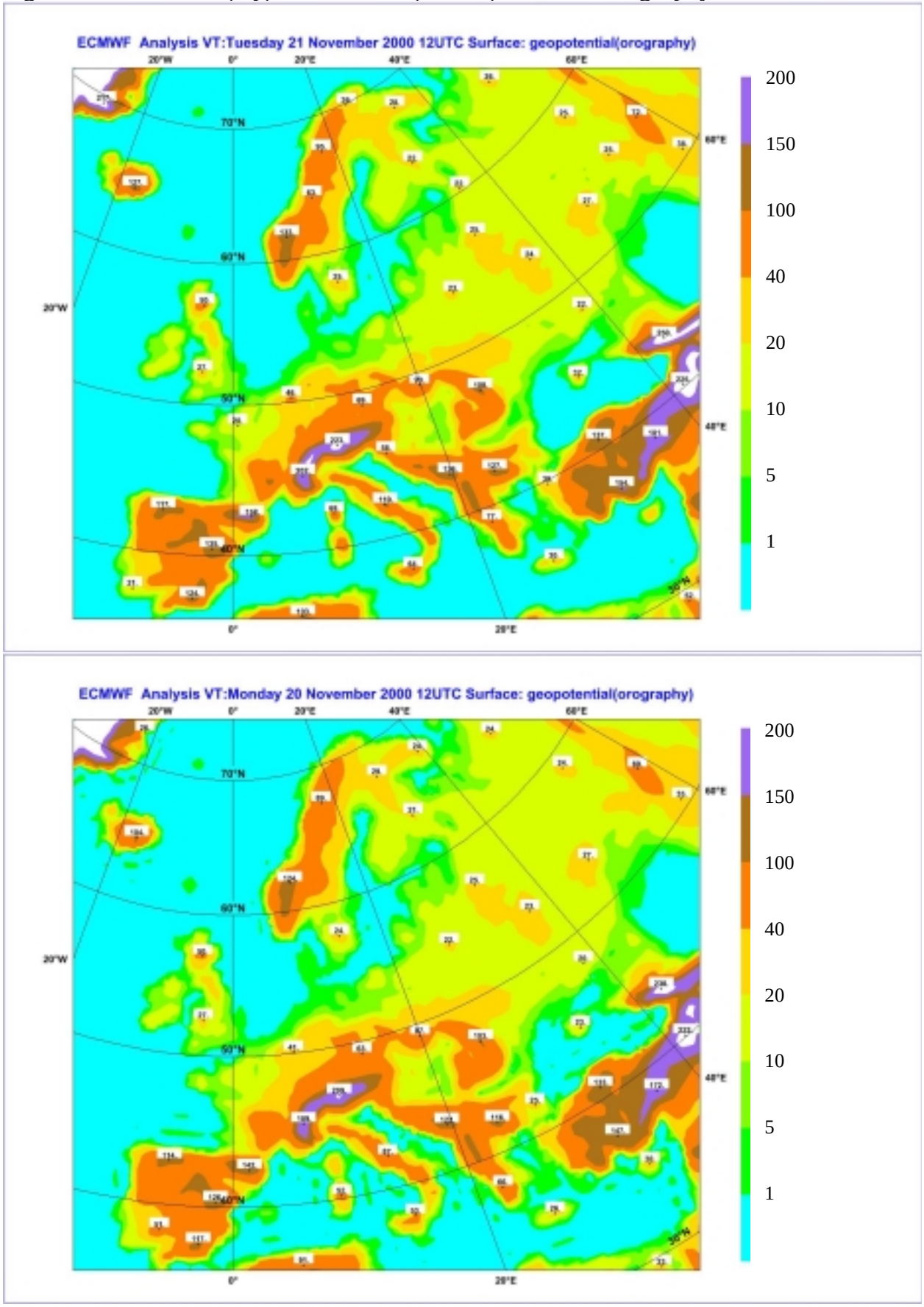

Table 1: Computer equipment in use for operational ECMWF activities (end of 2000)

Computer	Memory	Disk, Tape or Cartridge storage
Fujitsu VPP5000 (100 processors)	4Gbytes per processor	Disk 5.3 Tbytes
3 HP K series 2 Origin 2000	768 Mbytes each 12 Gbytes each	Disk 400 Gbytes Disk 612 Gbytes
IBM SP (5 Nighthawk I-nodes + 1 Silverwide node)	22 GBytes	Disk 4 Tbytes 48 IBM3590 tape drives

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 6-hour forecasts and analyses. All data types used in the data assimilation system are monitored in that way.

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.

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.

5. FORECASTING SYSTEM - DECEMBER 2000

Model:

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

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, carbon dioxide, 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

Data Assimilation:

Analysis:

Mass & wind (four-dimensional variational multi- variate analysis on 31 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, (A)TOVS, ERS2, SSM/I), **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:

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

Dissemination of analyses and forecasts to Member States:

via a dedicated telecommunications network (mainly 64,000 bits per second) connecting the ECMWF system with the computer systems in the meteorological services of the 17 Member States and four 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

Parameters:

Free atmosphere:

A	Geopotential height at 500 hPa
B	Temperature at 850 hPa
C	Wind at 850 & 200 hPa

Surface:

D	Mean-sea-level pressure

Time-steps:

A, B, C, D:	one analysis time-step (12 UTC current day)
A, B, D (NH,SH):	seven forecast time-steps (24 to 168 hours at 24-hour intervals)
C (tropics):	five forecast time-steps (24 to 120 hours at 24-hour intervals)

Horizontal resolution:

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 parameters 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.

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. A brochure describing available services can be obtained from ECMWF on request.

6. VERIFICATION OF PROGNOSTIC PRODUCTS IN 2000

Average of the monthly WMO/CBS standard scores for 2000

VERIFICATION AGAINST ANALYSIS				
		24 hr	72hr	120hr
North. Hemisphere	500-hPa height RMS (m)	10.2	29.0	53.9
South. Hemisphere		12.8	38.3	68.0
North. Hemisphere	Wind RMSVE 250 hPa (ms^{-1})	4.9	10.0	14.9
South. Hemisphere		4.9	11.0	16.5
Tropics	Wind RMSVE 850 hPa (ms^{-1})	2.4	3.5	4.1
Tropics	Wind RMSVE 250 hPa (ms^{-1})	4.3	7.1	8.7

VERIFICATION AGAINST RADIOSONDES				
		24 hr	72hr	120hr
North America	500-hPa height RMS (m)	13.3	33.2	58.3
	Wind 250 hPa (ms^{-1})	6.9	11.9	17.3
Europe	500-hPa height RMS (m)	12.6	30.0	58.6
	Wind 250 hPa (ms^{-1})	6.0	10.9	17.0
Asia	500-hPa height RMS (m)	13.8	24.3	38.8
	Wind 250 hPa (ms^{-1})	6.7	10.0	13.2
Australia/NZ	500-hPa height RMS (m)	11.1	22.7	39.4
	Wind 250 hPa (ms^{-1})	6.4	9.7	13.7
Tropics	Wind 850 hPa (ms^{-1})	2.4	3.5	4.1
	Wind 250 hPa (ms^{-1})	5.9	7.6	8.9
North Hemisphere	500-hPa height RMS (m)	13.7	32.3	58.4
	Wind 250 hPa (ms^{-1})	6.4	11.0	16.3
South Hemisphere	500-hPa height RMS (m)	14.0	30.6	54.0
	Wind 250 hPa (ms^{-1})	6.9	10.9	15.7