TECHNICAL PROGRESS REPORT ON THE GDPS: 1999

SOUTH AFRICA

1. SUMMARY OF HIGHLIGHTS

- Installation of a new Cray SV1 computer during November 1999.

-A new pre-processing system from NCEP was installed successfully and provides a much improved observational base for the Eta model.

-The Eta modelling system was upgraded to be Y2K compliant and to include a three-dimensional variational (rather than optimal interpolation) analysis system. The new system was installed on 30 November 1999.

2. EQUIPMENT IN USE

2.1 Mainframe Computer

CRAY J916	8 Processor 2 GB memory 30 GB disk storage 2 x 5 GB cartridge tape units
CRAY SV1	8 Processors 4 GB memory 60 GB disk space

2.2 UNIX Workstations

SGI Origin 200	Dual processors 256 MB memory	Model preprocessing
SGI Origin 200	128 MB memory	Development and research.

2.3 Climate Data Bank

SUN Enterprise 3000	256MB memory 24 GB disk storage

Database system: ACCEL UNIFY

2.4 Telecommunication System

Dual Weatherman system consisting of:

2 x communication nodes (DCP)
2 X SGI O2 UNIX computers
6 x local terminals

2.5 Satellite System

Tecnavia Skyceiver	Pentium II, 32 MB memory
Graphic display station	Pentium, 16 MB memory
File Server	Pentium, 32 MB memory

3. DATA AND PRODUCTS FROM GTS IN USE

Data	Type	Number of messages received in 24 hours
	SYNOP	4 500
	SHIP	1 000
	BUOY	700
	TEMP	580
	PILOT	95
	SATEM	1 060
	AMDAR	1 300

Products

GRID: ECMWF
EGRR

GRIB: ECMWF
EGRR
KWBC

4. DATA INPUT SYSTEM

Fully automated.

5. QUALITY CONTROL SYSTEM

All incoming and outgoing meteorological reports are scanned for gross errors by the communication system. Messages that do not pass this test are sent to an error queue

6. MONITORING OF THE OBSERVING SYSTEM

Only the national observing system is monitored in real time.

7. FORECASTING SYSTEM

7.1 System run schedule

There are two operational runs of the Eta system every day based on the 00:00 and 12:00 UT observations. Sets of NCEP global analyses and forecasts in GRIB format, based on 00:00 and 12:00 UT are captured from the GTS nine hours after their completion and are used as initial fields and boundary conditions for the Eta system.

The GSM is run twice a day at 00Z and 12Z for a 7-day forecast at a spectral truncation of T126. A 14-member ensemble of 14-day forecasts are run at a spectral truncation of T62 every day. COLA T30 GCM run from 00Z Friday to 00Z Sunday every six hours for 30-day forecasts and once a month from 12Z 08th to 12Z 12th for 8-month forecasts.

7.2 Medium-range forecasting system (4-10 days)

7.2.1 Data assimilation, objective analysis and initialization.
Analysis files obtained directly from NCEP in real-time.

7.2.2 Model
The T126/T62 versions of the GSM model are used operationally at NCEP for global medium-range forecasts (Sela, 1980). Prognostic variables are represented by spherical harmonics of legendre polynomials with triangular truncation at wave number 62. This corresponds to a horizontal grid of 192 by 94 points, about 200 km. The vertical coordinate is the sigma parameter which is the pressure at a level normalized by the surface pressure below that point. There are 28 unevenly spaced sigma levels. Physical processes included in the model are deep and shallow convection, large-scale precipitation, radiation, surface physics, vertical diffusion and gravity wave drag.

7.2.3 Numerical Weather Prediction products
Daily output of GRIB encoded global forecasts at 17 standard pressure levels of all model prognostic and diagnostic variables.

7.2.4 Operational techniques for application of NWP products
Clustering ensembles of daily 500Z and MSLP fields into three groups and using the largest cluster to determine average wind speed and direction and cloud cover. Temperatures at individual grid-points are clustered from time-evolving series of forecast data.

7.2.5 Ensemble Prediction System
Daily 14 runs with perturbations created from the breeding of growing modes method. Four perturbations at 00Z and ten perturbations at 12Z combined using the lagged average forecasting method. Clustering done using the group average method.

7.3 Short-range forecasting

7.3.1 Data assimilation, objective analysis and initialization

Assimilation: After preparation of the initial first guess, four preliminary analysis-initialization-forecast cycles are run, from t-12h to t-9h, t-9h to t-6h, t-6h to t-3h and from t-3h to time t, followed by a final analysis at time t.

Analysis An NCEP optional interpolation system is used, including a complex quality control module that performs a multivariate optimal interpolation check of each observation against its neighbors. The analysis is performed on a 90x186, 0.75 by 0,75 degree latitude longitude grid, extending eastwards from 45W and northwards from 62.5S, and on the 38 levels of the Eta model. Parameters analysed are sea-level pressure, geopotential height, wind and specific humidity. Preliminary guess fields for the initial analysis at t-12h are provided by an NMC global analysis from the GTS; while guesses for the subsequent analysis are 3-hour forecasts from the Eta model itself. Observations are included from a 3-hour window around each analysis time.

7.3.2 Model

The prediction model in use is the regional eta co-ordinate model with step-like terrain representation.

Basic equations:	Primitive equations
Independent variables:	Longitude, latitude, eta, time.
Dependent variables:	Temperature, horizontal wind components, surface pressure specific humidity, turbulent kinetic energy, soil moisture, snow, dew point, surface potential temperature.
Diagnostic variables:	Precipitation, vertical velocity, turbulent exchange coefficients.
Integration domain:	Southern Africa and surrounding waters, transformed grid roughly contained in 52S to 1N, 28W to 68E.
Vertical co-ordinate:	Eta co-ordinate with step-like terrain representation, 38 levels, top at 25 hPa.
Grid:	Arakawa Egrid (106 x 157) on transformed latitude/longitude coordinate system centred at 20E,28S.
Resolution:	48 km.

Time integration:	Split explicit adjustment scheme, Euler backward advection scheme, basic time step 120s.
Orography:	Silhouette mountains.
Boundary values:	Time-dependent lateral boundary conditions from an NCEP global forecast, based on t-12h and sampled at 6-hourly intervals.
Physical parameterization	- Mellor-Yamada level 2.5 turbulence closure model for planetary layer, level 2 for surface layer. - Fourth order non-linear lateral diffusion. - Modified Betts-Miller scheme for deep and shallow convection. - GFDL radiation scheme. - Ground surface processes and surface hydrology. - Large-scale precipitation. - Model-predicted cloud cover - Two-layer soil model

7.3.3 Numerical weather prediction products

Products available operationally are:

- GRIB Eta Model Output:

  Window: 79 by 133 grid, 48S to 9S, 13W to 53E, half-degree resolution

  Fields: Temperature, horizontal wind components and relative humidity at 1000, 900, 850, 700, 600, 500, 300 and 250 hPa, except no relative humidity at 600 hPa. Geopotential height at 1000, 850, 700, 600, 500, 300 and 250 hPa. Surface lifted index, convective available potential energy, storm relative helicity, mean sea level pressure (Mesinger), surface pressure, 2-m temperature and relative humidity, 10-m wind components, total accumulated precipitation, and boundary layer temperature, specific humidity and horizontal wind components.

- For the South African Broadcasting Corporation:

  Surface (skin) and 850-hPa temperature, shelter and 850-hPa relative humidity, mean sea-level pressure, accumulated total precipitation, 850-hPa u and v winds

-For an oil refinery

  Window: 27-31 E, 25-29 S, at half-degree resolution

  Fields: Geopotential height, temperature, horizontal wind components and relative humidity on 19 pressure levels from 100 to 1000

hPa at 50 hPa intervals. Boundary layer winds at four levels, and total cloud fraction.

7.3.4 Operational techniques for application of NWP products:
Extensive, and growing use is made of the PCGRIDDS graphical system in both the Central Forecasting office and regional offices.

7.4 Specialized Forecasts

None

7.5 Extended range forecasts (10 to 30 days)

Two GCMs are used at the SAWB for monthly forecasting. The T30 version of the Center for Ocean-Land-Atmosphere Studies (COLA) GCM (COLA T30) is used for 30-day forecasts and the T62 version of the National Centers for Environmental Prediction (NCEP) GCM, implemented locally as the Global Spectral Model (GSM T62), is used for daily 14-day forecasts.

The GSM T62 model is used operationally at NCEP for global medium-range forecasts. Prognostic variables are represented by spherical harmonics of legendre polynomials with triangular truncation at wave number 62. This corresponds to a horizontal grid of 192 by 94 points, about 200 km. The vertical coordinate consists of 28 unevenly spaced sigma levels. Physical processes included in the model are deep and shallow convection, large-scale precipitation, radiation, surface physics, vertical diffusion and gravity wave drag.

The COLA T30 model is a spectral model with triangular truncation at wave number 30. This corresponds to a horizontal Gaussian grid of 96 by 48 points, roughly 400 km resolution. Physical processes included in this GCM are similar to those of the GSM T62 GCM. A simple biosphere model is also included to enable the model to be used for climatological studies. Data processed in this part of the model are deep soil temperature, ground temperature, canopy temperature, soil moisture, liquid water storage, latest computed precipitation, roughness, maximum mixing length and sea-ice temperature. This model is used mainly to study ocean-atmosphere processes.

Real-time initial conditions for GCM runs are available from the operational GDAS at the SAWB. Boundary condition data for the GCMs, including SSTs, snow and ice cover, are collected in re al-time from NCEP via the Internet and prepared for each model.

7.6 Long-range forecasts (seasonal)

Statistically-based techniques are used to study the variability and predictability of South African summer rainfall and temperature. These include Canonical Correlation Analysis (CCA) and Optimal Climate Normals (OCN). In the case of CCA, the country is divided into homogeneous regions on the basis of the inter-annual rainfall variability. Canonical variants are then used to make 3-month aggregate precipitation forecasts for South Africa from global-scale sea-surface temperatures. Four

consecutive 3-month mean periods of sea-surface temperatures are used to incorporate evolutionary features as well as steady-state conditions in the global oceans.

The Optimal Climate Normal (OCN) technique is an empirical method that forecasts a continuation of the long-term trends already in progress. The OCN technique has been used as one of the prediction method in operational seasonal rainfall forecasts at the South African Weather Bureau. Further, sensitivity tests were done to investigate the seasonal temperature predictability over South Africa.

Furthermore, a multi-tiered method is introduced where the COLA GCM was forced by predicted monthly sea-surface temperatures from a CCA model. Using CCA again, GCM predicted atmospheric fields are down scaled to rainfall over South Africa.

8. VERIFICATION

8.1 Verification against analysis of the Eta model - 1998 annual averages

	Z500 (gpm)		MSLP (hPa)	
	24h	48h	24h	48h
RMSE	16.88	24.91	1.80	2.54
CORR COEFF	0.96	0.94	0.93	0.91

Comparison of the average statistics for the periods October 1994 to September 1995 (v1), October 1996 to September 1997 (v2) and October 1998 to September 1999 (v3)

RMSE	24-h		48-h	
	MSLP hPa	Z500 gpdam	MSLP hPa	Z500 gpdam
94/95 (v1)	2.50787	2.07873	3.72091	3.63140
96/97 (v2)	2.04181	1.95881	3.43353	3.43671
98/99 (v3)	1.81285	1.75485	2.57631	2.54989

9. PLANS FOR THE FUTURE

- Increases in horizontal and vertical resolution of the Eta model.