2003 WWW Technical Progress Report on the Global Data Processing and Forecasting System

BRAZIL

Centro de Previsão de Tempo e Estudos Climáticos - CPTEC (Centre for Weather Forecasting and Climate Studies)

1. Summary of highlights

The Brazilian Centre for Weather Forecasting and Climate Studies (CPTEC) of the National Institute for Space Research (INPE), located in Cachoeira Paulista, São Paulo, Brazil, develops, produces and disseminates real time weather forecasts, as well as seasonal climate forecasts since early 1995. This Centre is part of the research network of the Ministry of Science and Technology (MCT) of Brazil, and has two strong components on its structure: operational activities and research and development activities. There are four main divisions in the centre: Meteorological Operational, Modelling and Development, Satellite, and Climate and Environmental. The research and development activities comprise climate research, data assimilation, models development including coupled ocean-atmosphere model, hydrological model, and, since 2002, atmospheric chemistry and air quality. There is also a continuous development of the operational models to improve the forecasts. Operational activities include numerical weather forecasts, seasonal climate forecasts, satellite products and environmental forecasts for Brazil. Currently, the main users of CPTEC weather and climate products are research groups, universities, federal and state government agencies, civil defence, and private users.

2. Equipment in use at the Centre

Two supercomputers are currently in operation:
1. NEC-SX6/32M4 – 4 nodes, 8 processors per node, 32 Gbytes of memory per node, 4 Tbytes on disk, 64 Gflops peak performance per node (Total: 32 processors, 128 Gbytes of memory and 256 Gflops).

2. NEC-SX4/8A – 1 node, 8 processors, 8 Gbytes of memory, 270 Gbytes on disk, 16 Gflops peak performance.

The main data storage system comprises a DATABASE cluster (two Sun 280R, with OS Unix and RDBMS Oracle) and a HSM SERVER (one SunFire 6800, with 12 processors and OS Unix) with 40 Tbytes storage capacity.

GTS information is dealt with on the TELECOM cluster (two DEC 3000-500, operating with OS Unix) and on the INTERNET computer (one ALPHA SERVER DS20E, operating with OS Unix).

The management of the forecasting system (preprocessing, postprocessing, production of charts) is made on an ALPHA SERVER DS20E (2 processors, with OS Unix).

The GCM and Regional models are currently running on the NEC SX6.

3. Data and products from GTS in use

3.1 Observations

The global and regional data assimilation system makes use of the following observation types. The measures are averages received in June/2002, except for ATOVS data which refers to April/2003.

Observation Group	**Observation Sub-group**	**Items used**	**Daily extracted**
Land Surface	SYNOP	slp	20.000
Ocean surface	SHIP BUOY	slp, u, v, and q (processed from t and td)	3.500 10.000
Radiosondes	TEMP PILOT	h, u, v and q (processed from t and td) at mandatory levels	1.100 800
Aircraft	AIREP/AMDAR	u, v	19.000
Cloud tracks winds (satellite)	SATOB (GOES)	u, v, visible, IR	13.000
Vertical profiles (satellite)	ATOVS	h (processed from T and mixratio)	150.000

3.2 Gridded products

Several regional (South America) products are received from NCEP and ECMWF in 12 hours intervals up to T+72hours.

Format Field	**Daily extracted**
GRIB	132
GRID	980

4. Data input system

Fully automated, through network from INMET (Brasilia).

5. Quality control system

Quality control of data prior to the use in numerical weather prediction:
All conventional observations (aircraft, surface, radiosonde and also winds extracted from satellite) are controlled through the following steps:

1) Checks on the code format in preprocessing system. These include identification of unintelligible code, and checks to ensure that the identifier, latitude, longitude and observation time, all take possible values. If the failure is fatal, the report will not be used.
2) Checks for internal consistency within a report, and checks for validity within reasonable climatological limits. Preprocessing system assign a degree of confidence to each parameter value reported within an observation. The parameter values are compared with gross limits for the parameter. Limits depend on latitude and, for surface parameters, also on season. If the confidence flag is less than 50 %, the report will not be used.
3) Temporal consistency checks on observations from the same source are being introduced for the position of moving platforms.
4) Background check in data assimilation system. Simple check of the observations against a background field.
5) Adaptive Buddy check. Adjusts error bound according to the flow of the day. Check suspect observations against nearby observations (buddies) in data assimilation system.

6. Monitoring of the observing system

Monitoring of the observing system is not implemented.

7. Forecasting system

7.1 System run schedule and forecast ranges

The CPTEC/COLA AGCM is run operationally with resolution of T126 L28 (forecast up to 12 days), twice a day (00 and 12 GMT). A version with resolution of T170 L42 is being run experimentally and higher resolution is being tested. Probabilistic forecast up to 7 days is also provided operationally, running the model in an ensemble mode of 15 members (once a day), using the T126 L28 version. The Eta regional model with resolution of 40 km is run twice a day for 7 days and has as lateral boundary conditions, the outputs of the AGCM.

7.2 Medium range forecasting system (4-10 days)

7.2.1 Global Model

Numerical Weather Prediction is carried out using the CPTEC/COLA Atmospheric Global Circulation Model (AGCM), which is a modified version of the spectral COLA (Center for Ocean-Land-Atmosphere Studies) AGCM, originally derived from the NCEP (National Center for Environmental Prediction, USA).

The current operational version is the Triangular 2.0 CPTEC/COLA (COLA Version 1.12 + CPTEC) in Fortran 90 syntax, with optimizations (vectorization and OpenMP parallelism), user defined horizontal and vertical resolutions, sigma coordinates in the vertical and spherical coordinates in the horizontal, full quadratic Gaussian grid. Global analyses from NCEP are used as initial conditions. The main resolutions are T042L18, T062L28, T126L28, T170L42 and T254L64; the current operational resolution for weather forecast is T126L28 and for seasonal prediction, T062L28. A full description of hydrodynamics is given in NMC (1988) and most of the physics is described in Kinter et al. (1997),

Boundary conditions: null vertical sigma velocity at top and at surface; smoothed and truncated spectral topography; climatological zonal mean ozone (each time step); fixed value for atmospheric CO_2; weekly mean sea surface temperature; initial climatological fields: soil moisture, snow and sea surface temperature.

Initialization: diabatic non-linear normal mode (Machenauer, 1977; Baer and Tribbia, 1977; NMC,1988).

Spectral dynamics (Bourke, 1972; Sela, 1980; NMC, 1988; Kinter et al. 1997): primitive equations (vorticity and divergence); spectral in the horizontal and finite differences in the vertical and in time; semi-implicit time integration (Eulerian) and Asselin filter.

Physical processes:
Land surface: SSiB (Xue, 1990).
Ocean: Bulk Aerodynamic Scheme (Sato et al., 1989).
Planetary Boundary Layer: Vertical Turbulent Diffusion 2.0 (Mellor and Yamada, 1982).
Gravity Wave Drag: (Alpert et al., 1988).
Radiation (GFDL): short wave every hour (Lacis and Hanson, 1974); long wave every three hours (Harshvardhan et al, 1987).
Cloud Radiation Interactions: (Slingo, 1987; Hou, 1990).
Deep convection: KUO (Kuo, 1965; Anthes, 1977; NMC, 1988) or RAS (Moorthi and Suarez, 1992; DeWitt, 1996).
Shallow convection: (Tiedke, 1983).
"Adjustments": Large Scale Condensation (NMC, 1988); Bi-Harmonical Horizontal Diffusion (NMC, 1988) or 2n-Harmonical Implicit Horizontal Diffusion (CPTEC implementation).

CFL Control: Local Diffusion (COLA/CPTEC implementation) or Enhanced Diffusion (CPTEC implementation based on an ECMWF scheme).

7.2.2 Ensemble Prediction System (Number or runs, initial state perturbation method, clustering)

The ensemble weather forecasting started operationally at the Center for Weather Forecast and Climate Studies (CPTEC) in October 2001. A set of 15 predictions is generated daily, one from the initial condition without perturbations (control forecast) and 14 from perturbed analysis based on the CPTEC/COLA AGCM with T126 resolution. The predictions are performed from 12Z initial conditions to 12 days.

The method used to generate the perturbed initial conditions was developed by Zhang and Krishnamurti (1999) for hurricane forecasting and was adapted for global weather forecasting at CPTEC by Coutinho (1999). Essentially, the method is based on:

a) Add random perturbations to traditional initial condition (control), integrate the model for 36 h starting from the control and from the perturbed initial conditions, and saving results at each 3 h;

b) Construct a time series formed by the successive differences between forecasts started from the control and the perturbed analysis;

c) Perform an empirical orthogonal function (EOF) analysis for the time series of difference fields over the interest region in order to obtain the fastest growing perturbation (considered as the eigenmode associated to the largest eigenvalue) and normalize the eigenmode to pre-fixed amplitudes for each variable;

d) The ensemble of initial conditions is generated by adding (subtracting) these EOF-based perturbations to (from) the control analysis.

Some characteristics of the method were modified in order to apply it for operational weather forecasting at CPTEC. In the original version, Zhang and Krishnamurti perturbed the hurricane initial position, however, in the version implemented at CPTEC, perturbations in relation to the position of meteorological systems are not considered. The perturbation region used by Zhang and Krishnamurti was the neighborhood of the hurricane and the CPTEC version uses the 45°S to 30°N and 0°E to 360°E region, to temperature and zonal and meridional wind components in all vertical levels of the model.

Several products are produced from the EPS in order to extract useful information and simplify the interpretation of the predictions. The ensemble mean, ensemble spread, spaghetti diagrams, probability forecast, probability plumes and cluster analysis are generated daily.

The cluster analysis at the CPTEC is based on the Ward's minimum variance method (Wilks, 1995). Essentially, for all possible ways of merging two of G + 1 groups to make G groups, that merger must minimizes the following expression

$$W = \sum_{g=1}^{G} \sum_{i=1}^{n_g} \sum_{k=1}^{K} \left(x_{i,k} - \bar{x}_{g,k} \right)^2 .$$

To select how many clusters there will be in a specific ensemble forecasting a kind of "climatological error" of the model (ERC) determined through the mean of the RMS errors from previous deterministic forecasts is considered. The procedure is that the members of each group are similar when the RMS difference between the mean of the group and each forecast of the group is less or equal to a half of the ERC. If a group has a member whose distance from the mean of the group is greater than ERC/2 then this member should not belong to that group. The process iterates while this condition is satisfied, when it fails the process is stopped and the number of cluster is selected. A maximum of 5 clusters is allowed in this process.

7.2.3 Regional Model

The CPTEC short range forecasting system uses the Eta model (Mesinger et al., 1988; Black, 1994). It is a grid-point, primitive equation, hydrostatic model, based on the eta vertical coordinate (Mesinger, 1984). The prognostic variables are temperature, specific humidity, meridional and zonal winds, surface pressure, turbulent kinetic energy and cloud liquid water. These variables are distributed on the Arakawa type E-grid. The integration applies the forward-backward scheme modified by Janjic (Janjic, 1979) for the adjustment terms and a modified Euler-Backward scheme for the advection terms. The tendencies are applied in a split-explicit fashion. The diffusion is second order non-linear. The domain covers most of South America, north of 50°S. The resolution is 40 km in the horizontal and 38 layers in the vertical.

The model uses Betts-Miller scheme (Janjic, 1994) to produce convective precipitation. Stable precipitation is produced explicitly through a cloud scheme (Zhao and Carr, 1997). The surface hydrology is solved by Chen scheme (Chen et al, 1997). This scheme distinguishes 12 types of vegetation and 7 types of soil texture. The radiation scheme package was developed by the Geophysical Fluid Dynamics Laboratory. The scheme includes short wave (Lacis and Hansen, 1974) and long-wave radiation (Fels and Schwartzkopf, 1975). The radiation tendencies are updated every 1 hour.

Sea surface temperatures are taken from the observed weekly mean at 1^{o}x1^{o} latitude-longitude resolution and interpolated to the Eta model grid. Soil moisture is derived from climatology and albedo is taken from a seasonal climatology. The initial conditions are taken from NCEP daily analyses. The lateral boundary conditions are input from the CPTEC global model forecasts. The latter conditions are updated every 6 hours at the boundaries. The tendencies at these boundaries are distributed linearly, within the 6-hour interval, along the single outermost line of the model domain.

The Eta regional model with resolution of 40 km is run twice a day for 7 days and has as lateral boundary conditions, the outputs of the AGCM.

7.2.4 Regional data assimilation, objective analysis and initialization

The Regional Physical-space Statistical System (RPSAS), developed in collaboration with GMAO/NASA, is the assimilation system to the Regional Eta model.

The objective function is a combination of forecast and observation deviations from the desired analysis, weighted by the inverses of the corresponding forecast and observation error co-variances matrices. The analysis is made to the sea level pressure and to the following variables at 15 pressure levels: geopotential height, specific humidity, zonal and meridional wind components.

The RPSAS system assimilates data from GTS meteorological data and our local retrievals TOVS (NOAA 14) and ATOVS (NOAA 16) selected for the South America area and adjacent Pacific and Atlantic Oceans 4 times per day at the synoptic times of 00Z, 06Z, 12Z and 18Z. Using the initial conditions from the analysis, the system performs initialization running Lynch's digital filter running the Eta/CPTEC model for 12 hours to remove very short waves. At synoptic times of 00Z and 12Z the model uses the initialized fields to do forecasts for 5 days, with outputs at each 6 hours.

7.2.5 Numerical Weather prediction products

MEAN SEA LEVEL PRESSURE [hPa]
SURFACE PRESSURE [hPa]
TOPOGRAPHY [m]
LAND SEA MASK [0,1]
2 METRE TEMPERATURE [K]
2 METRE DEW POINT TEMPERATURE [K]
10 METRE U-WIND COMPONENT [m/s]
10 METRE V-WIND COMPONENT [m/s]
TOTAL PRECIPITATION [Kg/m2/day]
CONVECTIVE PRECIPITATION [Kg/m2/day]
LARGE SCALE PRECIPITATION [Kg/m2/day]
SNOWFALL [Kg/m2/day]
LATENT HEAT FLUX FROM SURFACE [W/m2]
SENSIBLE HEAT FLUX FROM SURFACE [W/m2]
TIME AVE GROUND HT FLX [W/m2]
SURFACE TEMPERATURE [K]
SURFACE SPEC HUMIDITY [kg/kg]
GROUND/SURFACE COVER TEMPERATURE [K]
SOIL TEMPERATURE OF ROOT ZONE [K]
SOIL WETNESS OF SURFACE [0-1]
SOIL WETNESS OF ROOT ZONE [0-1]
SOIL MOISTURE AVAILABILITY [0-1]
RUNOFF [kg/m2/s)]
ROUGHNESS LENGTH [m]
SURFACE ZONAL WIND STRESS [Pa]
SURFACE MERIDIONAL WIND STRESS [Pa]
LOW CLOUD COVER [0-1]
MEDIUM CLOUD COVER [0-1]
HIGH CLOUD COVER [0-1]
MEAN CLOUD COVER [0-1]
DOWNWARD SHORT WAVE AT GROUND [W/m2]

DOWNWARD LONG WAVE AT BOTTOM [W/m2]
UPWARD SHORT WAVE AT GROUND [W/m2]
UPWARD LONG WAVE AT BOTTOM [W/m2]
UPWARD SHORT WAVE AT TOP [W/m2]
OUTGOING LONG WAVE AT TOP [W/m2]
ALBEDO [%]
CONVECTIVE AVAIL. POT.ENERGY [m2/s2]
CONVECTIVE INHIB. ENERGY [m2/s2]
BEST LIFTED INDEX (TO 500 HPA) [K]
INST. PRECIPITABLE WATER [Kg/m2]
TROPOPAUSE PRESSURE [hPa]
FREEZING LEVEL HEIGHT [m]
FREEZING LEVEL RELATIVE HUMIDITY [%]
MAXIMUM WIND PRESS. LVL [hPa]
MAXIMUM U-WIND [m/s]
MAXIMUM V-WIND [m/s]
PRESSURE AT CLOUD BASE [hPa]
PRESSURE AT CLOUD TOP [hPa]
GEOPOTENTIAL HEIGHT [gpm]
ZONAL WIND (U) [m/s]
MERIDIONAL WIND (V) [m/s]
ABSOLUTE TEMPERATURE [K]
RELATIVE HUMIDITY [no Dim]
OMEGA [Pa/s]
SPECIFIC HUMIDITY [kg/kg]
PSEUDO-ADIABATIC POTENTIAL TEMPERATURE [K]
CLOUD WATER [kg/m2]

7.3 Specialized forecasts (sea waves, sea ice, tropical cyclones, pollution transport and dispersion, solar ultraviolet (UV) radiation)

7.3.1 Analysis and Forecast of Fire Risk for the Vegetation

Fire is widely used in the vegetation of Brazil and of neighboring countries. Reasons include deforestation, pasture renewal, manual harvest of sugar-cane, control of weeds and insets, and suppression of vegetation growth in general. Weather satellites have been employed by INPE since the late 1980s to detect such fires, identifying hundreds of thousands every year; about 20% of the areas in use in the country typically burn in a dry year as a result of anthropic actions. The resulting environmental damage and atmospheric emissions are matters of local and global concern.

CPTEC has developed an empirical method to estimate the vegetation fire risk based on the relation of millions of fire occurrences and the corresponding weather variables. The following parameters are used in the equations: type of vegetation (e.g., savanna, tropical forest, agriculture) history of precipitation in the last 90 days, daily maximum air temperature and minimum relative humidity, and the presence of fires in the area. Precipitation has the highest weight and also determines the phenology phase of the vegetation. The forecasts are prepared up to four days in advance with the same empirical equations, but relying on the forecasts from the weather variables estimated by the “Eta Regional-40km” and “Global T-126L28-100km” models of CPTEC; forecasts of weekly composite products for one month in advance and seasonal outlooks are also produced. Final products and figures are made with the GRADS software package. The fire risk is used by many government and NGOs for fire control and use planning in the country; formal cooperation in this subject exists with Bolivia, Paraguay, Peru and Venezuela. For additional data and information, please see http://www.cptec.inpe.br/queimadas and http://www.cptec.inpe.br/queimadas/risco_eta.html.

7.3.2 Monitoring the transport of biomass burning emissions and anthropogenic pollution in South America.

The atmospheric transport of biomass burning and anthropogenic emissions in South America and Africa Continents has been monitored by CPTEC in collaboration with the University of São Paulo <www.cptec.inpe.br/meio_ambiente>. A real time operational monitoring transport system was implemented using the on-line 3-D transport model **CATT-BRAMS** (**C**oupled **A**erosol and **T**racer **T**ransport to the **B**razilian developments on the **R**egional **A**tmospheric **M**odelling **S**ystem) coupled to an emission model.

The BRAMS is a multipurpose, numerical prediction model designed to simulate atmospheric circulations spanning in scale from hemispheric scales down to large eddy simulations (LES) of the planetary boundary layer. The quasi-Boussinesq non-hydrostatic equations are used in the model. It is equipped with a multiple grid nesting scheme which allows the model equations to be solved simultaneously on any number of interacting computational meshes of differing spatial resolution. It has a complex set of packages to simulate processes such as: radiative transfer, surface-air water, heat and momentum exchanges, turbulent planetary boundary layer transport and cloud microphysics. The initial conditions can be defined from various observational data sets that can be combined and processed with a mesoscale isentropic data analysis package. For the boundary conditions, the 4DDA schemes allow the atmospheric fields to be nudged towards the large-scale data. From a computational point of view, BRAMS is a very efficient parallel code that can be run at several platforms. Recently, a new deep and shallow convective scheme based on the mass flux approach and with several types of closure were implemented. This cumulus scheme is suitable for mesoscale runs (horizontal grid spacing about 20 km) and so for regional transport studies.

The CATT-BRAMS explores the BRAMS tracer transport capability of using slots for scalars. The mass conservation equation is solved for carbon monoxide (CO) and particulate material PM2.5. Source emissions of gases and particles associated with biomass burning activities in tropical forest, savanna and pasture are parameterized and introduced in the model. The sources are spatially and temporally distributed and daily assimilated according to the biomass burning spots obtained by remote sensing. Anthropogenic climatological sources of CO are also included following the EDGAR 3.0 database. This capability has been improved by including a sub-grid transport associated with deep and shallow convective transport coupled to the Grell cumulus scheme and wet and dry deposition for aerosols and trace gases. Also, an additional radiation parameterization, which takes the interaction between aerosol particles and short and long wave radiation using the rapid two-stream approximation and the aerosol scattering and absorption calculated with the Mie code for stratified spheres was implemented. The coupling with the chemical mechanism of the MOZART model (Model of Ozone And Related Tracers) is on development.

The model is set up with 2 grids at horizontal resolution of 160 and 40 km, respectively. The vertical resolution starts at 150 m near the surface, stretching at a rate of 1.15 to a final resolution of 850 m, with the model top at about 21 km. The coarse grid, covering the South American and African continents, is intended to generate the tracer inflow from Africa to South America. The atmospheric model is initialized and nudged with CPTEC global model (6 hours 1.875 degrees) analysis/forecast data. The 3D tracer concentration fields of the previous run are used as the tracer initial condition for the next, and the constant inflow condition is used to the tracer boundary condition in the coarse grid. The simulation is performed for 48 hours, beginning at 00 UTC of the previous day. The soil moisture is initialized based on the antecedent precipitation index method. Analysis and forecast of carbon monoxide and aerosol particles mass concentration, aerosol optical thickness, and aerosol particle mass wet deposited fields are provided daily at www.cptec.inpe.br/meio_ambiente. Comparison of the model results with remote sensing aerosol and trace gases products and direct measurements has been demonstrating the good predictability skills of the method.

7.4 Long-range forecasts (Models, Methodology and Products)

7.4.1 Global Model

Long-range forecasts (LRF) are being issued by CPTEC since 1995 and made available for the public. Forecasts for specific regions may differ substantially at times, due to the inherent limited skill of long-range forecast systems. This LRF can be monthly or three-month (90-day) outlook (Seasonal outlook). CPTEC issues deterministic long-range forecasts presented as maps of anomalies and probabilistic categorical forecasts (equiprobable terciles). Deterministic LRF is produced from the ensemble mean from all the members of an Ensemble Prediction System (EPS) with the CPTEC AGCM. The seasonal forecast issued one month before the beginning of the validity period is said to be of one-month lead. In that sense, CPTEC has been recognized by the WMO as one of the Global Producer Data Centres (GPDC) for seasonal to interannual climate forecast products.

The Centre has a state-of-the-art seasonal forecasting system which uses e the CPTEC/COLA AGCM with resolution T62L28 in an ensemble mode. Two ensembles are constructed with 15 different initial conditions each and two fields of boundary forcing conditions. One set uses the persisted Sea Surface Temperature (SST) anomaly, and other uses the predicted SST in the tropical Pacific and Atlantic Oceans. Predicted Pacific SST are obtained from NCEP and the predicted Atlantic Ocean SST is obtained from a statistical model, SIMOC. Although the model is global, focus is given to South America and specific areas which requires climate attention, as Northeast and Southern Brazil due to droughts and floods. The predictability of several regions using the CPTEC/COLA AGCM was established through many statistical analysis, studies of simulations, and through the experience of 8 years applying this model in climate prediction at CPTEC. The main global climatological features and the seasonal variability of several atmospheric variables were reasonably well represented in a simulation with the CPTEC/COLA AGCM (Cavalcanti et al, 2002). Regional South America features and statistical analyses were demonstrated in Marengo et al (2003). Interannual variability of precipitation anomalies in several regions of South America showed high convergence among members of the ensemble for the Northeast region and higher dispersion among members in Amazonia and in the South America monsoon region. There was also good comparison of the ensemble mean with the observed precipitation anomaly for Northeast of Brazil. ROC diagrams which measures the rate of hits and failures showed also the highest scores in the Northeast region.

The numerical prediction results are presented in maps of precipitation anomalies and precipitation probabilities. A mask is applied to the anomaly field, to remove values in places where there is not statistical significance. The probability map and the mask are constructed based on 10 integrations of 50 years simulation. The probability maps show rainfall categories above normal, near normal and below normal, as well as a "rebuilt" forecast for South America.

Global forecasts are produced routinely, but the analyses focus mostly on South America, and, based on numerical model predictions, predictability of several regions of South America, intensity of the SST forcing, and verifying the consistence with other GCMs, a consensus map of probabilities is constructed. This map is shown for Brazil only, as indicated on the CPTEC web site (www.cptec.inpe.br).

CPTEC has also developed a statistical model SIMOC (from *Sistema de Modelagem Estatística dos Oceanos* or Statistical Modelling System of the Oceans). It is based on canonical correlations using Pacific and Atlantic SST's as predictors of seasonal rainfall anomalies for many areas of South America (Northeast Brazil, Southeastern South America, etc). Another module of the SIMOC model also produces forecasts of SST anomalies over the tropical Atlantic. These predicted anomalies are input to the CPTEC AGCM as lower boundary conditions. The SIMOC model outputs are available to any centre in the world. CPTEC is currently developing hydrological seasonal forecasts, using seasonal climate forecasts from regional and global models for agriculture and hydroelectric generation purposes.

7.4.2 Regional Model:

CPTEC runs on a monthly basis the Regional Eta model for seasonal forecasts over South America. The horizontal resolution is 40 km and vertical resolution is 38 layers. The model has the same characteristics of the short-range forecasts, except the daily update of sea surface temperature that is replaced by persisted anomalies.

The model is run for continuously for 4.5 months and the initial 15 days are excluded from the analyses. The anomalies are calculated from a 5-year model climatology generated from monthly integrations of 4.5 month length.

8. Verification of prognostic products

CPTEC has used the following “observational” data sets for the validation of the CPTEC AGCM, regional model and for the assessments of seasonal climate forecasts:

1. NCEP/NCAR reanalyses for circulation, humidity and air temperatures.
2. Xie-Arkin – CMAP and CRU for Precipitation anomaly.
3. Precipitation and temperature from different Brazilian institutions (INMET, regional meteorological centres, private electric companies, etc).
4. OLR data sets from NOAA.

Measurements of model skill used at CPTEC include (so far, for rainfall only):

(a) Anomaly correlation,
(b) Relative Operating Characteristics ROC,
(c) Brier skill score,
(d) Bias score,
(e) Root Mean Square Error (RMSE),
(f) Equitable Treat score,

In addition, evaluations are performed from

(g) Radiosonde profiles versus model,
(h) Subjective evaluation of cold fronts position,
(i) Evaluation of SLP – data versus model

These diagnostics allow for a direct inter-comparison of results across different geographical regions, forecast ranges, etc. For these verifications, we have used the observed precipitation over Brazil, in addition to the global CMAP-Xie/Arkin rainfall data sets.

9. Plans for the future

Current computer capability makes possible to carry out a large number of integrations of global and regional models using the ensemble technique for weather and climate forecasts. The SX6 cluster (currently with 32 processors, 128 Gbytes of memory, peak performance of 256 Gflops and disk capacity of 4 Tbytes) will grow to 96 processors, 768 Gbytes of memory, peak performance of 768 Gflops and 16 Tbytes on disk during the first half of 2004.
One of the near future implementation is the ensemble seasonal prediction and ensemble weather forecasts using the regional Eta model. Changes in parameterisations of the AGCM and Regional Eta will be considered. Several experiments are been conducted to test different convection and radiation parameterisation schemes. A new vegetation field will be incorporated as well as a more realistic soil humidity field. Updated values of CO_2 will be applied. A higher resolution (T254 L64) is expected to be implemented for weather forecasts. Aplication of a semi-Lagrangian scheme in the AGCM is in development, as well as code optimization.

A Coupled Ocean- Atmosphere Global Circulation Model CPTEC/COLA is being tested and calibrations are in development. The oceanic model is MOM 3 (GFDL) with 20 levels and resolution of 1.5 lat X 3.0 long. The atmospheric model is CPTEC/COLA T62L28. Before the coupled model can be used in the operational system, several experiments, skill and statistical analyses will be performed.

10. References

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