The use of medium range and seasonal forecast at CPTEC

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1 Introduction

The Centre for Weather Forecast and Climate Studies (CPTEC), one component of the Brazilian Institute for Space Research (INPE), is the most advanced centre of numerical weather prediction in Latin America. CPTEC delivers national and global weather, climate and weather forecasts, warnings and analyses mostly to brazilian users since 1994.

The main role of CPTEC in Brazil are: partnership with other institutions for research and development, to provide computer services for environmental modeling in general through the National System for High Performance Computing (SINAPAD), to provide model code, data and training for users.

The institutional structure of CPTEC é composed of the following divisions: Modeling and Development Division (DMD), Environmental Satellites Application Division (DSA), Operations Division (DOP), and Climate and Environment Division. DMD supports the development of research and implementation of numerical weather and climate models and also environmental atmospheric models. DSA focuses research and applications in satellite meteorology. Its mission involves receiving, processing, archiving and disseminating different types of weather satellite data and radar data. Operational runs of the CPTEC´s numerical weather prediction models are done at DOP; also daily weather bulletins are prepared and disseminated by forecaster in this division. DMA supports studies related to climate, global change and atmospheric environment.

2 Supercomputing Facilities

CPTEC delivered its first operational weather forecast in Brazil in 1994. It was produced using the NEC SX3/12R with a single processor computer with a memory of 0.5 Gbytes and a disk system totalling 60.0 Gbytes. After several years, the NEC SX3 was replaced in 2004 by the NEC SX-4 with 96 processors-16 GB storage, 768 Gbytes of memory and 1 Pbyte of disk and 768 Gigaflops peak. Recently CPTEC installed a cluster MPP NEC-SUN 1100 processors-72 TB storage.

3 Operational numerical weather prediction an climate prediction at CPTEC

Operationally, CPTEC runs a number of configurations of models. These ranges from the global model, down to a 20 km resolution ETA model; the main operational model configurations are shown in the next table:

	Global Spectral	Global Ensemble	Global Seasonal Prediction	Regional Eta	Regional Seasonal Eta
Resolution	63 km	100 km	200 km	20 km	40
Model levels	42	28	28	38	38
Run times	4 times daily	once a day	once a month	2 times daily	once a month
Forecast length	7 days	15 days	up to 6 months	7 days	up to 6 months

In addition to these model CPTEC is successfully running in operational mode the Coupled Aerosol and Tracer Transport to the Brazilian developments on the Regional Atmospheric Modeling System (CATT-BRAMS) since 2004. This system is a 3-D transport model to monitor atmospheric pollution, which is a core of a system to monitor the transport of biomass burning emissions and anthropogenic pollution in South America (see www.cptec.inpe.br/meio_ambiente/).

4 International Programs

CPTEC is involved in several international cooperation programs, the main ones are: PIRATA: Program of Moored Buoys in the Tropical Atlantic; LBA: Large Scale Biosphere Atmosphere Experiment in Amazonia; LPB/GEF: Climate Change and Variability in La Plata Basin – Global Environmental Facility; GPM-Brazil – National Space Program – Meteorological Mission;Thorpex/TIGGE: World Meteorological Organization; ECMWF: Ensemble forecasts with ocean atmosphere coupled models and EUROBRISA.

Among these cooperation programs stands out the EUROBRISA: An EURO-Brazilian Initiative for improving South American seasonal forecasts. The objectives of this initiative are to improve seasonal forecasts in South. America: a region where there is seasonal forecast skill and useful value, and to strengthen collaboration and promote exchange of expertise and information between European and S. American seasonal forecasters, and to produce improved well-calibrated real-time probabilistic seasonal forecasts for South America (i.e. combine and calibrate coupled [ECMWF, UKMO, Meteo-France] and empirical forecasts) an to develop real-time forecast products for non-profitable governmental use (e.g. reservoir management, hydropower production, agriculture and health). The EUROBRISA activities related to climate prediction research and development are:

1 Probabilistic seasonal forecasts with empirical and dynamical coupled models;

2 Production of objectively combined (dynamical + empirical) well-calibrated integrated forecasts;

3 Skill assessment of empirical, dynamical and combined forecasts using deterministic and probabilistic measures;

4 Dynamical and statistical downscaling and

5 Seasonal predictability studies.

The EUROBRISA impact (collaborative work with users) includes the areas of Hydrology: Downscaling of seasonal forecasts for river flow predictions and use in hydrological models and Agriculture: Research on the use of seasonal forecasts in agricultural activities; Downscaling of seasonal forecasts for use in crop models. Users may access EUROBRISA products (see example Fig. 1) at: http://www6.cptec.inpe.br/eurobrisa/

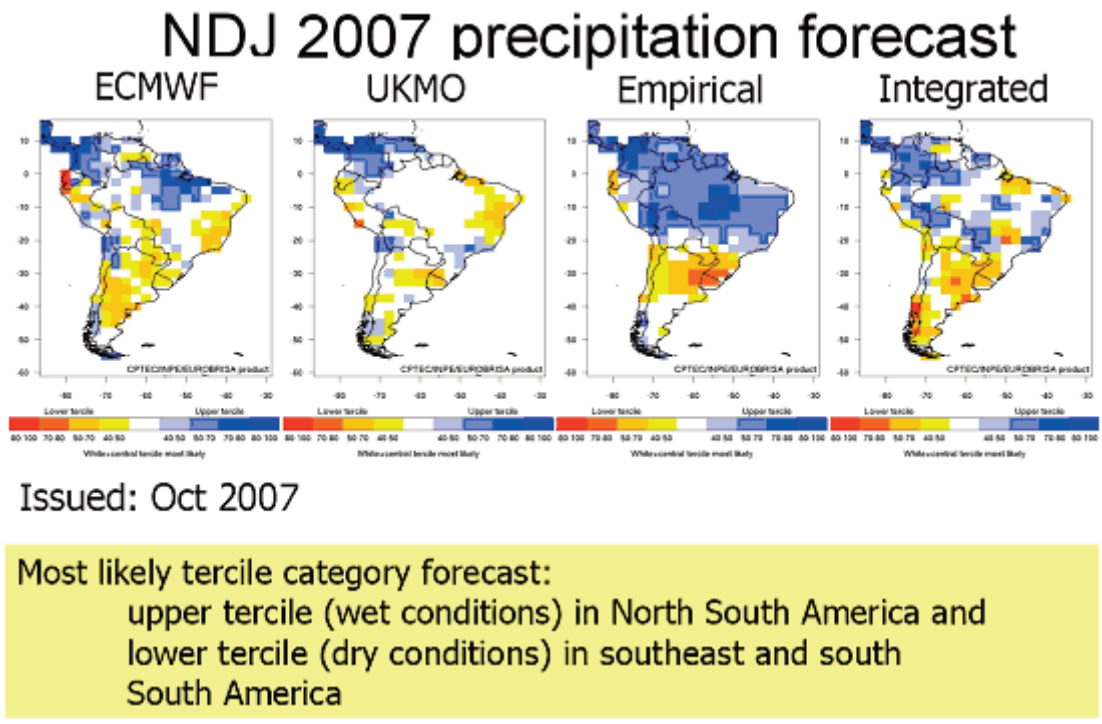

Fig. 1 Example of EUROBRISA product available at http://www6.cptec.inpe.br/eurobrisa/

5 Ensemble Weather Prediction Model at CPTEC - EWPC

The EWPC started operationally in October 2001; two runs are performed starting from 00 and 12 UTC analysis. Each run represents a set of 15 forecasts (1 control plus 14 perturbed) up to 15 days; its domain is global (perturbed region ranges from 45S-30N and 0-360E) with a resolution of T126L28, and the perturbed fields are temperature and horizontal winds. The EWPC forecasts model is based on the perturbation method, following Zhang and Krishnamurti (1999) and modified by Coutinho (1999). According to this approach a set of perturbed initial conditions is generated using the "EOF-Based Perturbation" method; then the model is integrated starting from each perturbed initial condition to produce an ensemble forecasting. This EOF-based perturbation follows the procedures:

a) Random perturbations are added to control initial condition to generate a random perturbed initial condition; b) The full model is integrated for 36 h starting from the control and from the perturbed initial conditions saving results each 3 h; c) A time series is constructed for the successive differences between forecasts started from the control and perturbed initial conditions; d) An EOF analysis is performed for the time series of difference fields in order to obtain the fastest growing perturbation; e) The eigenmode associated to the largest eigenvalue is considered as the fastest growing mode; f) The fastest growing mode is normalized to pre-fixed amplitudes; g) The "optimum" ensemble of initial conditions is generated by adding (subtracting) this fastest eigenmode to (from) the control analysis.

CPTEC disseminates various products from its operational ensemble models (Figs. 2), the main ones are: ensemble mean, ensemble spread, spaghetti diagrams, probability forecast, probability plumes, cluster analysis, week mean precipitation anomaly, evolution of high level potential velocity and probability forecast of 5 days accumulated precipitation higher than 10 mm. CPTEC also performs ensemble cluster analysis to reduce the number of possible future atmospheric scenarios merging similar ensemble members using the Ward Minimum Variance method. In this case it is allowed a maximum of 5 clusters, the key variable is geopotential height at 500 hPa, and the domain extends from 600S to 150N and 101.250W to11.250W.

The EWPC is evaluated from daily statistical indexes estimation off the following fields: anomaly correlation of ensemble mean, root mean square error of ensemble mean, mean error (bias) of ensemble mean, ensemble spread. Also deterministic and reliability tables are prepared for exchange ensemble prediction system (EPS) verification results following the instructions of WMO for EPS producers. CPTEC is sending these data in test mode and is preparing the operational suite for production mode.

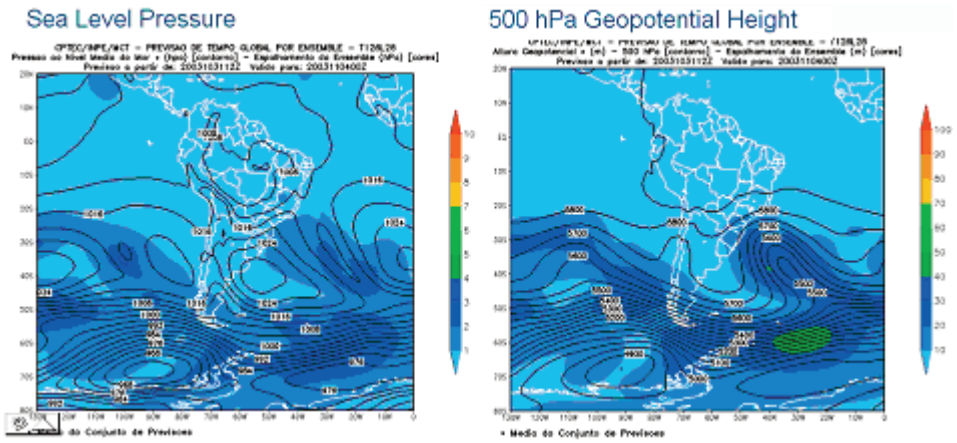

Fig. 2 Example of ensemble product available at CPTEC. Ensemble mean (contours) + spread(shaded).

6 Future Developments

In the near future CPTEC will use the last 12-hours lagged forecasts to increase the number of ensemble members (from 15 to 30 members) and will derive operationally the Extreme Forecast Index (EFI) based on Lalaurette (2003). Also others expected improvements are the development of the Local Ensemble Kalman Filter to Data Assimilation and Ensemble Forecasting (Ott et al, 2002; Szunyogh et al, 2005; Sauer et al 2004) and to consider the uncertainty on model formulation through perturbation in physics.

7 Concluding Remarks

CPTEC runs in operational mode its ensemble medium range forecasts model (T126L28, 15 members) to support weather forecasts in Brazil. The ensemble seasonal forecast model with resolution of T62L28, 5 members is also operational since 1997. The medium range weather forecasts are disseminated to users in several formats like meteograms, rainfall charts and diagram of dispersion. The ensemble medium range forecasts are used by CPTEC´s forecasters in their daily routine for issuing weather forecasts for the general public. Regarding special applications of medium range weather forecasts, CPTEC provides probability maps of rainfall and bulletins for users interested in agricultural activities. For climatic forecasts CPTEC is running its ensemble global model in a monthly basis to issue seasonal forecasts for the several Brazilian regions.

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8 References

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