CPTEC GCM and Eta Model verifications against Rondônia Reference site in Brazil

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Abstract

Verification of CPTEC global and regional models forecasts against observation at the Rebio Jaru reference site is carried out for a dry period, between 1 July and 1 September 2001, within the EOP1. The Rebio Jaru is a forest site located in the Amazon region. Time series and mean diurnal cycle of precipitation and surface fluxes are shown for 24-h and 48-h forecasts. In the global model the incoming short wave radiation and net radiation were predicted closely to the observed values, however, this occurred with the large overestimate of deep clouds and precipitation. The partition of the available energy resulted in overestimate of the sensible heat fluxes and underestimate of the latent heat fluxes. The latent heat fluxes were large shortly after the rain, but decayed quickly. No clear improvement of the 48-h forecasts over the 24-h forecasts could be noticed. The Eta model forecasts of precipitation were very close to the observations; however, in the absence of deep clouds it largely overestimated the incoming short-wave radiation, which resulted in excessive net radiation. Consequently, the sensible heat fluxes and the latent heat fluxes were also overestimated. Small improvement of the 48-h forecasts over the 24-h forecasts could be noticed. Near surface temperature were overestimated by both models. Cloud treatment correction seems to be necessary in both models, whereas the global model also needs to correct the convective precipitation.

Objective

To identify the 24-h and 48-h forecast errors of the CPTEC Global Model and Eta regional Model using the surface variables and flux observations collected at the Forest Site of Rondônia, located in Brazil, at about 10ºS, 62ºW, for the period between 1 July and 1 September 2001. The models are used operationally at CPTEC and represent a contribution from CPTEC to CEOP.

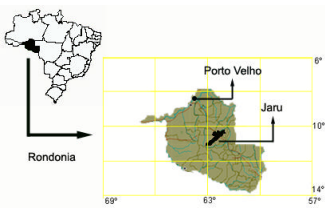

Figure 1 - REBIO JARU REFERENCE SITE

REBIO JARU Reference Site

The observations are taken from the tower located in the Jaru Biological Conservation Area (REBIO JARU) LBA Reference site in Rondonia at the location 10º 04' 42"S, 61º 56' 2"W. The vegetation cover is mainly evergreen tropical forest. The Ji-Paraná River flows next to the conservation area. The topography in the region varies from 0 to 800 m high to the southwest. Figure 1 shows the location of Rebio Jaru in Rondônia State (North Brazil).

Model Characteristics

CPTEC GCM	Eta Model
Spectral T126L28	grid-point 20 km, 38L
sigma vertical coordinate	eta vertical coordinate
Kuo convective scheme	Betts-Miller convective scheme
Lacis-Hansen Short-wave, 2/2 h,	GFDL package (Lacis-Hansen, Fels-
Hashvardan Long-wave, 3/3h	Schwarzkopf)
SSiB, Xue et al (1991)	NOAH (Chen et al, 1997)
Monthly climatology soil moisture	CPTEC GCM 12-h forecast soil moisture
1ºX1º degree daily updated weekly mean sea surface temperature	
seasonal climatological albedo	

Verifications

Global model grid-box value comparison against observation point value may not be completely fair, however, bearing in mind model limitations, the comparison can still provide some indication on the model processes that generate the errors. Time series of the variables measured at the site are shown for 48-hour forecasts. Comparisons with the Eta Model with 20 km resolution are carried out.

The Rebio Jaru reference site provided observations of precipitation, 2-m air temperature, latent and sensible heat fluxes, short wave incoming and outgoing, long wave incident and outgoing and net radiation on hourly frequency. Because the global model operationally outputs at 6 hour frequency, the predicted precipitation was accumulated at every 6 hours, whereas the energy fluxes were averaged every 6-hour.

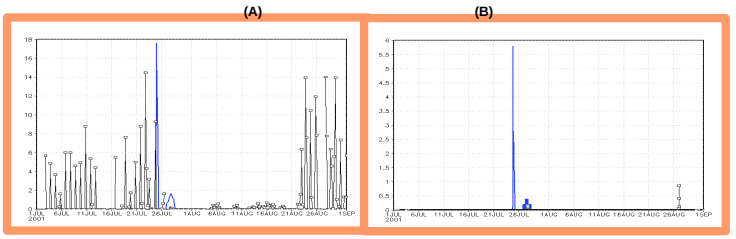

Figure 2 - PRECIPITATION: (A) 48-H CPTEC GCM FORECAST (mm/day) (black line), and (B) 48-h Eta FORECAST (mm/h) (solid line). OBSERVATIONS ARE SHOWN IN BLUE line.

The overestimate of precipitation events in the global model may be caused by the size of the grid-boxes, of about 100 km X 100 km, which attempted to include the precipitation of neighboring sites. Nevertheless, the global model total accumulated precipitation amount of the month added to value much larger than observed values in either 24-h or 48-h forecasts (Fig 2A).

The Eta Model monthly total precipitation values are closer, but below observation in July. The no-rain events were generally well forecasted by the Eta Model (Fig.2B). The global model uses a very different convection scheme from the Eta Model, which results in very distinct model precipitation errors. July and August are the driest months for this region; the precipitation events caused by isolated showers during these months are difficult for the models to capture.

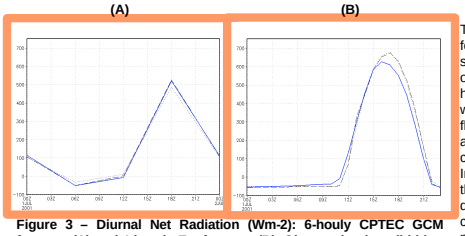

Figure 3 – Diurnal Net Radiation (Wm-2): 6-houly CPTEC GCM forecast (A) and 1-hourly Eta forecast (B). Observation in solid blue line, 24-h forecasts in dash and 48-h forecasts in dotted line.

The diurnal cycle of the global model 48-h forecasts of the 6-hourly net radiation showed also a good fit to the observations. The global model seems to have balances excessive incoming short wave and upward longwave radiation fluxes, but the partitioning between latent and sensible heat fluxes need some correction.

In the Eta Model, a clear one-hour delay of the peak of forecast occurred with a slow decay of these fluxes toward the sunset, causing an overall overestimate. The nighttime net radiation is well forecasted by both models. No clear difference between the quality of the 24-h and the 48-h forecasts can be noticed.

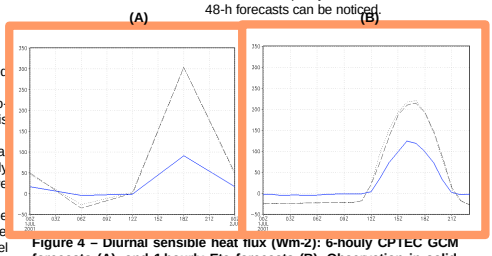

Figure 4 – Diurnal sensible heat flux (Wm-2): 6-houly CPTEC GCM forecasts (A), and 1-hourly Eta forecasts (B). Observation in solid blue line, 24-h forecasts in dash and 48-h forecasts in dotted.

The Global model largely overestimated the sensible heat fluxes, mainly during the no-rain predicted periods. The time 18Z is equivalent to 14:00 hour Local Time for Rondônia which is the time the deep clouds are fully developed and most of convective precipitation is observed.

The Eta model overestimated the sensible heat fluxes for the period, the errors were much smaller than the global model errors. During the daytime, these predicted fluxes overestimated the observations, but kept the peaks in phase.

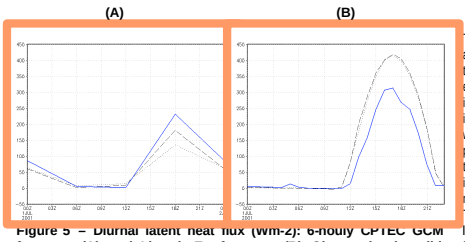

Figure 5 – Diurnal latent heat flux (Wm-2): 6-houly CPTEC GCM forecasts (A), and 1-hourly Eta forecasts (B). Observation in solid blue line, 24-h forecasts in dash and 48-h forecasts in dotted.

The observed 6-h mean value at 18 Z, of about 240 Wm^2, was underestimated by the global model at 24-h forecasts. The error increased at 48-h forecasts. This increase was caused by the forecast errors in the second half of the period, in August, when the global model largely reduced precipitation and the latent heat fluxes. As the global model did not produce much rain in August, the soil surface had less moisture available for evaporation.

The mean observed peak values was largely overestimated by the Eta model forecasts,. Differently from the global model, the Eta Model generally overestimated these fluxes. The 48-h Eta forecasts showed a small improvement relative to the 24-h forecasts, in an opposite error growth behavior compared to the global model.

Discussions and conclusions

The evaluation of CPTEC global model and Eta Model was carried out against surface observations at the Rebio Jaru CEOP Reference Site located in the LBA area in Brazil for the period 1 July 2001 and 1 September 2001, which is part of the EOP1 period.

Both models showed errors in the precipitation, however, the global model largely overestimated the quantity and the number of events. The global model tended to increase the precipitation errors with forecast time, whereas the Eta showed little change.

While the global model has the radiation scheme better solved and need adjustment of the surface fluxes, the Eta Model need to initially correct the excessive incoming short-wave radiation, although, an immediate correction could be the cloud representation in the model, the error is present in the absence of clouds.