Seasonal Prediction at the Regional Scale: An Analysis of Regional Climate Model Performance Over the Tropical Americas.

Etienne TOURIGNY, Colin JONES

Université du Québec à Montréal – CRCMD Network, Canada
tourigny@sca.uqam.ca

1. Introduction

The main goals of seasonal prediction are to forecast climatic variables of societal interest over 3 to 9 month lead times in order to alleviate the potential consequences of climatic extremes and to assist in resource planning in fields such as agriculture. The drawback of current global scale seasonal forecasting is their low resolution. Regional models can be used to produce more useful forecasts through their higher resolution response to global phenomena. In tropical regions, large-scale atmospheric circulations are linked to the more slowly evolving Sea Surface Temperatures (SST). Anomalous SST forcing such as ENSO drives large scale atmospheric anomalies which have consequences on the regional scale.

In order to assess the added value of regional scale models in seasonal forecasting, the output of hindcasts using these models must be evaluated and compared to observations. Using prescribed SST and analysed lateral boundary conditions, the Rossby Center Regional Climate Atmospheric Model RCA3 (Jones 2004), has been used to make high resolution simulations. Emphasis is put on El Niño and La Niña composites and the comparison of the model to observations. This will determine if RCMs, when given accurate large-scale forcing, are able to reproduce the main regional scale climatic features over the tropical Americas and the detailed response in this region to the phase of ENSO. The study looks at interanual variability associated with ENSO at two time scales: seasonal and sub-seasonal (using pentad values).

2. Numerical Experiment

The Rossby Center Regional Atmospheric Model RCA3 was run over Central America with a resolution of 0.33° (~37km) and grid size of 276x168 using observed SST and ECMWF ERA40 reanalyses for initial and boundary conditions. The simulations were of 13 months each (1 month discarded for spinup) from 1970-2005. Figure 1 shows the model domain (the outer 15 points are removed in this figure and are not included in any analysis) and the regions chosen for analysis. We present here only results for the CAM (Central America) region.

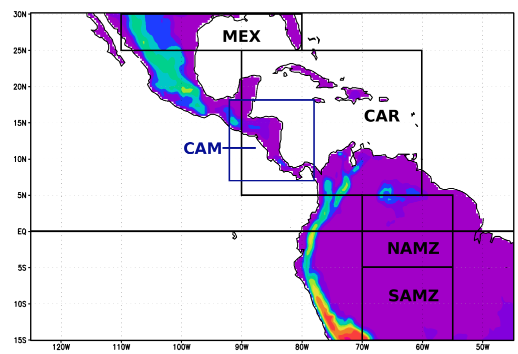

Fig. 1 Domain of the study and chosen regions

3. Results for seasonal timescale

Figure 2 shows the climatological average of monthly means of precipitation for years 1979-2001. for the CAM region. The model (RCA) is compared to GPCP (GPCPv2, satellite), CRU (land-based) and ERA40. The model values are comparable to GPCP but lower than CRU. ERA40 data is much too wet to be used as an observation over this region.

The technique used to evaluate the ability of the RCM to simulate inter-annual variability due to ENSO is to compute the differences of El Niño and La Niña composites normalized by climatology. This is done to ensure that any bias in the model's climatology is removed from the ENSO results. Composites span two years (0 and +1) representing mean conditions in the two years of ENSO events. Figure 3 shows the result of ENSO difference over CAM region. The model follows the general tendencies in the observations, but shows excessive drying from APR-SEP of year(0). The most documented period of dryness in El Niño years is JUL-OCT of year(0) (Ropelewski 1987), and in this period the model is in accordance with the observations although of greater magnitude.

4. Results for sub-seasonal timescale

The sub-seasonal distribution of precipitation (and its anomalous distribution in ENSO years) is at least as important as the seasonal mean (and anomaly) for decision makers. Sub-seasonal timescale statistics can also indicate if the model is producing precipitation in the right way. We examine the frequency distribution of precipitation during the rainy season divided into intensity bins. The model is compared to GPGP pentad (GPCP), over the 1979-2003 period.

Figure 4 shows the climatological distribution for the CAM region. The way this is done is to compute the distribution or each grid point for each rainy season, followed by a spatial average over the area and temporal average over the analysis period. The model follows rather closely the observations (with small differences) and the maxima are in the same category (5-10 mm/day). Figure 5 shows the average difference between El Niño and La Niña years. Both in observations and model, El Niño years have more frequent dryer days and less frequent wetter days than La Niña years. This is both true in the extreme (0-1, 20+) and in moderate categories. Again the differences between model and observations are quite small, with similar phase shifts in the distribution.

5. Discussion and conclusion

The Regional Climate Model RCA3 has been used to assess the ability of regional climate models to simulate seasonal and sub-seasonal anomalies associated with ENSO. In the area presented here (CAM) the model has shown to reproduce the (monthly averaged) dry conditions associated with El Niño, although the signal is more intense than in observations. When looking at the sub-seasonal distribution the model agrees quite well in simulating more dry days and less wet days in El Niño years. We believe that these positive results indicate that Regional Climate Models can be used to provide locally enhanced detail, with respect to ENSO forced seasonal variability, when run forced by global seasonal forecasts.

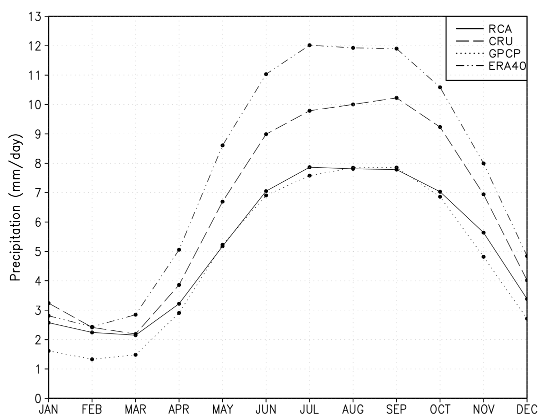

Fig. 2 Climatology over CAM region.

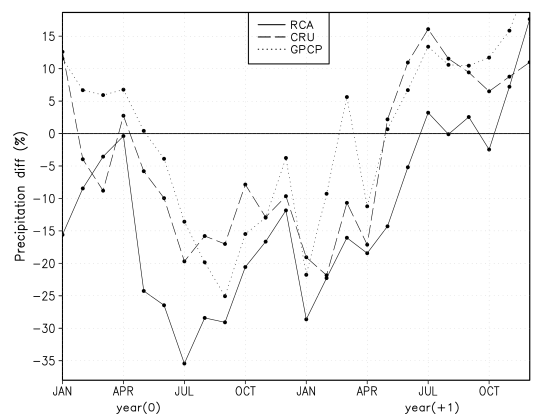

Fig. 3 ENSO differences over CAM region.

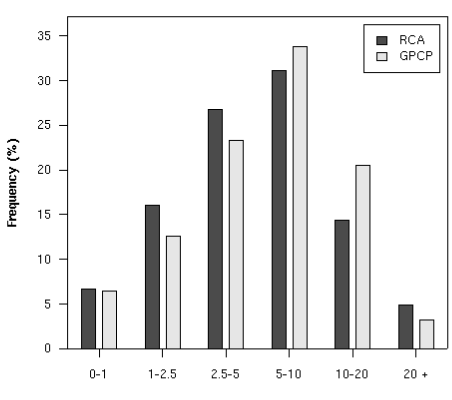

Fig. 4 Frequency distribution over CAM region.

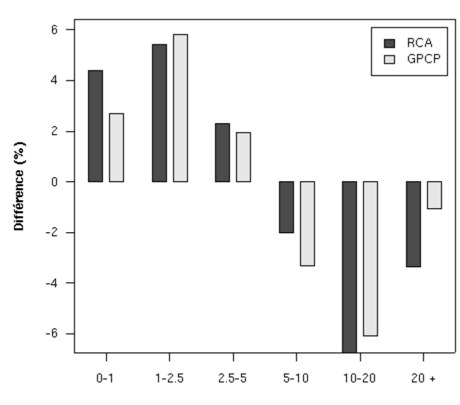

Fig. 5 ENSO differences of frequency distribution over CAM region.

References

Jones, C.G., A. Ullerstig, U. Willen and U. Hansson, 2004: The Rossby Centre regional atmospheric climate model (RCA). Part I: Model climatology and performance characteristics for present climate over Europe. *Ambio*, **33**, 199-210.

Ropelewski, C.F., and M. S. Halpert, 1987: Global and Regional Scale Precipitation Patterns Associated with the El Niño/Southern Oscillation. *Monthly Weather Review*, **115**, 1606-1626.