SENSITIVITY OF RegCM3 SIMULATIONS TO HORIZONTAL RESOLUTION

Mary-Jane M Bopape
Centre for High Performance Computing, Meraka Institute, Building 43, CSIR Site, Meiring Naude, Brummeria, 0001, South Africa

1. INTRODUCTION

Dynamical downscaling for climate studies utilises a regional climate model that is nested within a global climate model (GCM) or global reanalyses. The GCM or reanalyses data are interpolated to the RCM's grid and used to drive the RCM as initial and time-dependent lateral boundary conditions (Giorgi.,1990). The basic idea behind regional climate modelling is that a GCM can provide correct large scale circulation in response to global climatic forcing and the RCM can represent sub-GCM grid scale forcings due to complex topography adequately (Giorgi, 1990).

Most regional climate modelling studies used a 60 km resolution following the initial RCM studies such as those of Giorgi and Bates (1989) and Giorgi (1990). Regional climate modelling studies over South Africa that have been conducted have used resolutions of 100 km (Joubert, 1999) and 60 km (e.g. Engelbrecht et al, 2002, Landman et al, 2005 and Kgatuke et al. 2008). The aim of this study is to investigate the influence of resolution on the RegCM3 simulations over southern Africa. This study is important for determining the best resolution to use with this model for studies over the area of interest with the parameterisation scheme used for this study nested within 2.5^0 resolution reanalyses.

2. DATA AND METHOD

In this study the Regional Climate Model version 3 (RegCM3) developed by the Abdus Salam International Centre for Theoretical Physics (ICTP) (Pal et. al., 2007) is nested within the ERA40 reanalyses which provide initial conditions (ICs) and time-dependent lateral boundary conditions (LBCs). The Optimum Interpolation Sea Surface Temperatures (OISSTs) are used as surface boundary conditions. For the ICs and LBCs quantities from the ERA40 renalyses are interpolated to the grid of the RegCM3 and the first set of interpolated fields is used as ICs for the RegCM3 simulation. The parameterization scheme used is Grell with the Fritsh and Chappell closure scheme.

The RegCM3 was run with four different resolutions, 40, 60, 80 and 100 km for a period of 20 years from 1982 to 2001 on the Centre for High Performance Computing (CHPC)'s e1350 cluster. The number of grid points for each resolution was chosen such that the domain remains almost the same for the different resolutions. The domain is from -7 to 59 degrees in the east-west direction and from -43 to 18 degrees in the north-south direction. The number of grid points in the x and y direction was made the same to simplify the choice of the number of processors to use. The 40 km resolution utilized 180X180 grid points, the 60 km one had 120X120 gridpoints, the 80 km resolution had 90X90 grid points while the 100 km used 72X72 grid points.

3. RESULTS

The detail of the topography increases with the increase in resolution, with the highest resolution simulations showing the most realistic topography. The influence of topography is visible on surface temperature simulations where the highest resolution shows the lowest temperatures at the maximum altitude. The influence of topography is less visible for temperature in the upper atmosphere. The simulated features of all the variables that were investigated looked very much similar and this includes rainfall (Figure 1 and Figure 2).

Model simulations are sensitive to cumulus parameterisations which are sensitive to model resolution and may sometimes be tested and tuned for specific resolutions (Giorgi and Marinucci, 1996). When running a model at different spatial resolutions, it is possible for the physical and dynamical forcing to be masked by the direct sensitivity of a scheme to resolution. For this reason, without specific tuning of the parameterization for different resolutions, an increase in model resolution does not necessarily result in an improvement in the simulation of some aspects of precipitation. In this study it is

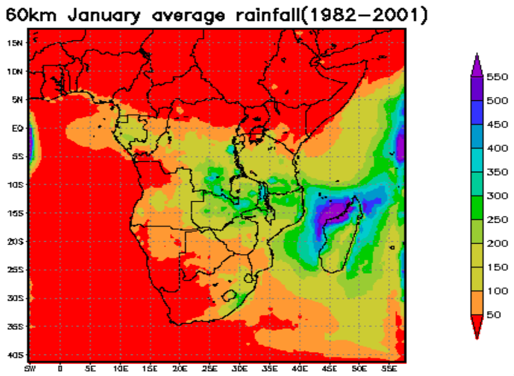

Figure 1: RegCM3 simulated January average rainfall for the period 1982 to 2001 for 60 km resolution

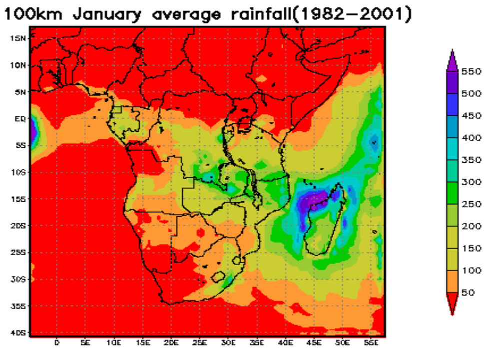

Figure 2: RegCM3 simulated January average rainfall for the period 1982 to 2001 for 100 km resolution

not clear if increasing the resolution results improved precipitation simulations however simulations look very similar (Figure 1).

4. REFERENCES

Engelbrecht F.A., C.J. de W. Rautenbach, J.L. Mcgregor and J.J. Katzfey, 2002: January and July climate simulations over the SADC region using the limited area model DARLAM. *Water SA*, **28,** 361-373.

Joubert A. M., J.J. Katzfey, J.L. Mcgregor and K.C. Ngunyen, 1999: Simulating midsummer climate over southern Africa using a nested regional climate model. *Journal of Geophysical research*, **104**, 19015-19025.

Giorgi F. and GT Bates, 1989: The Climatological Skill of a Regional Model over Complex Terrain. Monthly Weather Review, 117, 2325-2347.

Giorgi, F.and M.R. Marinucci, 1996: An Investigation of the Sensitivity of Simulated Precipitation to Model Resolution and Its Implications for Climate Studies. *Monthly Weather Review*, **124**,148–166.

Giorgi, F., 1990: Simulation of Regional Climate Using a Limited Area Model Nested in a General Circulation Model. *Journal of Climate*, **3**, 941–964.

Kgatuke, M.M., Landman, W.A., Beraki, A. & Mbedzi, M.P., 2008: The internal variability of the Regcm3 over South Africa, *International Journal of Climatology*, **28**, 505-520.

Landman W.A., A. Seth and S.J. Camargo, 2005: The effect of regional climate model domain choice on the simulation of tropical cyclone-like vortices in the south-western Indian Ocean. *Journal of Climate*, **10**, 1263-1274.

Pal J.S., F. Giorgi, X. BI, N. Elguindi, F. Solmon, X, Gao, R. Francisco, A. Zakey, J. Winter, M. Ashfaq, F.S. Syed, J.L. Bell, N.S. Diffenbaugh, J. Karmacharya, A. Konare, D. Martinez, R.P. da Rocha, L.C. Sloan and A. Steiner, 2007: Regional Climate Modelling for the Developing World: The ICTP RegCM3 and RegCNET.Bulletin of the American Meteorological Society, 88, 1395-1409.