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QWeCI

Quantifying Weather and Climate Impacts on Health in Developing Countries

Deliverable 3.1.c – Report on the skill of dynamical predictions for southern Africa

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Dissemination Level		
PU	Public	PU
PP	Restricted to other programme participants (including the Commission Services)	
RE	Restricted to a group specified by the consortium (including the Commission Services)	
CO	Confidential, only for members of the consortium (including the Commission Services)	

1. Implementing the WRF regional model

During 2010/2011 the Weather Research and Forecasting (WRF) model was implemented on a computer that was made available to the South African research team. The implementation was done by Mr Robert Maisha who also intent to use the model for his MSc research.

2. Finding the most suitable cumulus parameterization scheme

In 2011 the heavy rainfall events that appeared over southern Africa during December 2010 and January 2011 were used to find the most suitable cumulus parameterization scheme for use in WRF model. Simulations with WRF of the heavy rainfall events that occurred during the austral summer (December-January-February, DJF) of 2010/11 over southern Africa were therefor completed. Sensitivity simulations were performed with three different cumulus schemes, namely, the Kain-Fritsch (KF), Betts-Miller-Janjic (BMJ), and Grell-Devenyi ensemble (GDE) schemes. Two way interacting nested domains with a horizontal resolution of 27 and 9 km were used for the study. The model was initialized using data of 00 UTC on 5 November 2010 and was integrated up to 00 UTC on 28 February 2011. Data obtained from the National Centre for Environmental Prediction / National Center for Atmospheric Research (NCEP/NCAR) were used as original boundary forcing to the WRF model.

In all three cumulus parameterization schemes the WRF model could at least successfully capture the heavy rainfall observed over Namibia and South Africa during DJF2010/2011. However, differences were found in the spatial distribution of the rainfall between these schemes, with GDE being closest to observations. The KF scheme overestimated the rainfall, with a rainfall spread over the whole of southern Africa. Analysis of the observed and model simulated area averaged daily rainfall over central South Africa (24^{0}E-30^{0}E; 33^{0}S-25^{0}S) shows that the model could capture the intra-seasonal variability observed during DJF2010/11. The GDE scheme has a significant correlation of 0.55 (99% confidence level = 0.27) with the observed daily rainfall, which is higher than that of KF (0.44) and BMJ (0.49). The GDE and KF schemes captured the observed four heavy rainfall events during 11-15 December 2010, 1-3 January 2011, 20-23 January 2011 and 13 February 2011 but the BMJ simulated a total of 6 heavy rainfall events. The analysis of the spatial distribution of the number of rainy days within DJF2010/11 also shows that the GDE performed better than the KF and BMJ schemes. During the season, a total of 50-60 rainy days were observed over the domain. The GDE scheme simulated a total of 60-70 rainy days with BMJ and KJ showing rainy days throughout the season. The spatial distribution of the number of light, moderate and heavy rainfall days in the season are well captured by both the BMJ and GDE schemes, but the GDE scheme is comparatively better than the BMJ scheme. As the KF scheme simulated rainfall for almost every day and overestimated the rainfall for each category, it led to an overestimation of the seasonal total rainfall. This study demonstrates that the GDE scheme, in comparison with the other two schemes, does not only have the best skill in simulating the intra-seasonal oscillation of summer season rainfall, but could also capture the heavy rainfall events that occurred over southern Africa during DJF2010/11successfully.

Although results are representative of a case study for a single season, the results derived in this study are encouraging, and demonstrates that the WRF model might be suitable for use in seasonal prediction of summer rainfall over southern Africa which can make a significant contribution to outlooks for future Malaria occurrences.

3. WRF configuration over SA and Limpopo.

WRF has been configured to run as a regional model over SA, with a lot of effort and assistance from Scientists at JAMSTEC and UP IT personnel.
The domains has been set up as follows, an SA 9km domain (-20^0S to -36^0S; 16^0E to 36^0E) with (251*205) grid points and a Limpopo + Gauteng province 3km nest (-22^0S to -27^0S; 26^0E to 33^0E) with (220*184) grid points. Also a bigger domain covering Southern Africa is used in order to capture synoptic scale events like tropical cyclones and depressions.
The model has been set up to run with both non-hydrostatic and the hydrostatic option. The GDE is used as it was identified in earlier simulations to be the best parameterization scheme over the region.

The WRF model has been found to capture synoptic and mesoscale events*, i.e.* the tropical depression Dando that resulted flood over the North-Eastern region of South Africa (16-18 January 2012, Fig. 1), tropical Cyclone Funso (18-28 January 2012, Fig. 2) and heat waves over SA, including Limpopo province (25-28 October 2011) and heat waves over the Western Cape province (17 January 2012, Fig. 3).

WRF also simulated successfully floods over the interior of South Africa (6-9 June 2011, Fig 4) and heat waves over northern parts of South Africa and Botswana on 25-26 October 2011 (Fig 5). All these events were verified with the ground truth from Daily weather bulletins provided by the South African weather Service and Satellite images from Eumetsat.

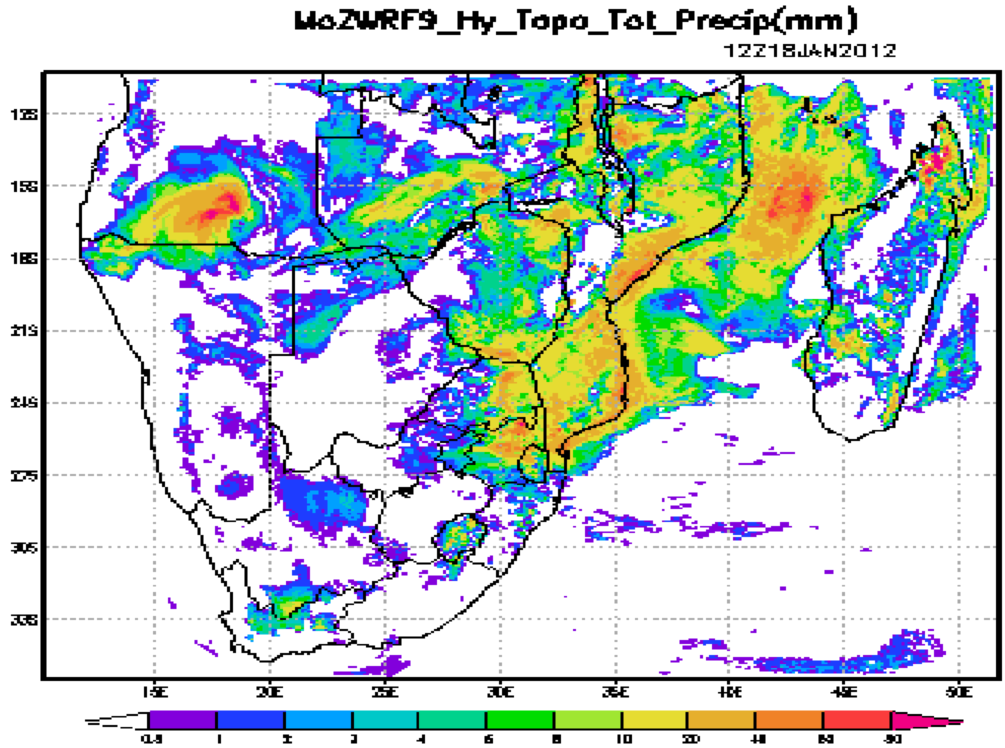

Figure1: WRF simulation of flooding (tropical Depression Dando) over the North-Eastern region of South Africa on 18 January 2012.

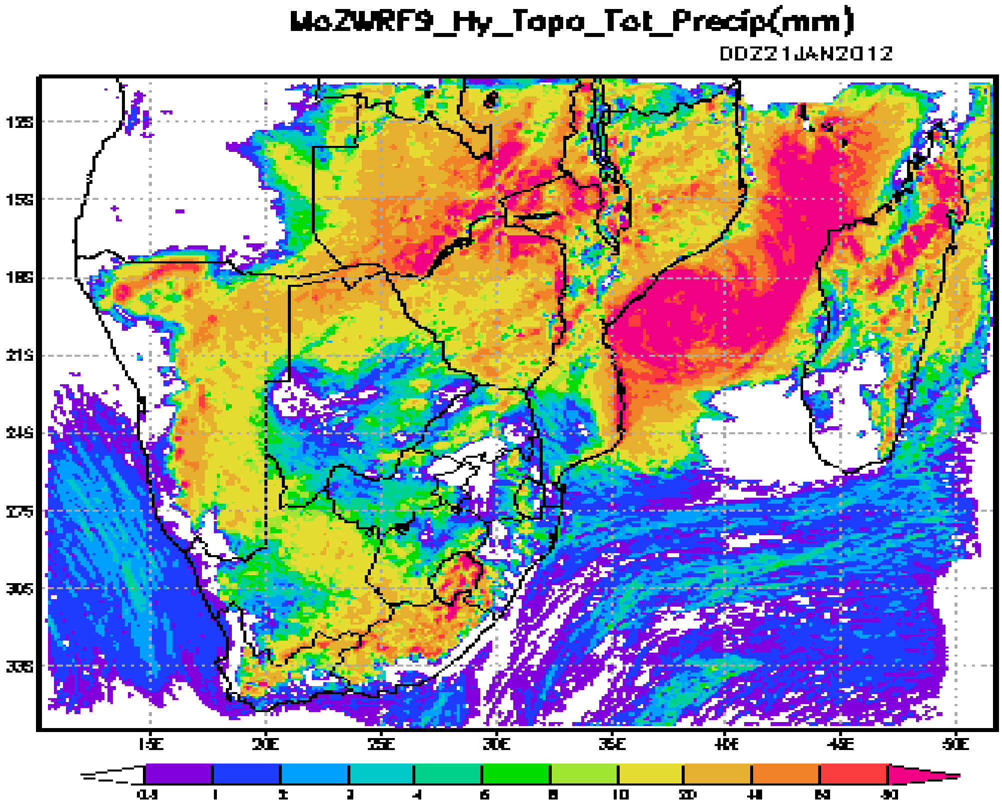

Figure 2: WRF simulation of tropical cyclone Funso over the Mozambique Channel on 21 January 2012.

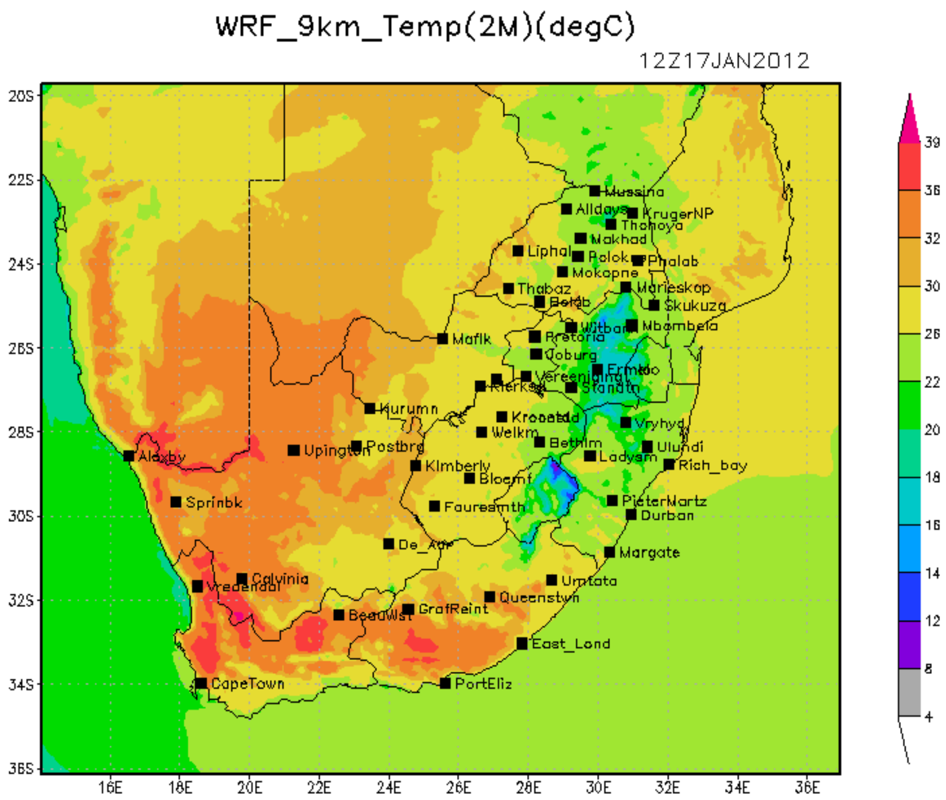

Figure 3: WRF simulation of heat waves over Western Cape region of South Africa on 17 January 2012.

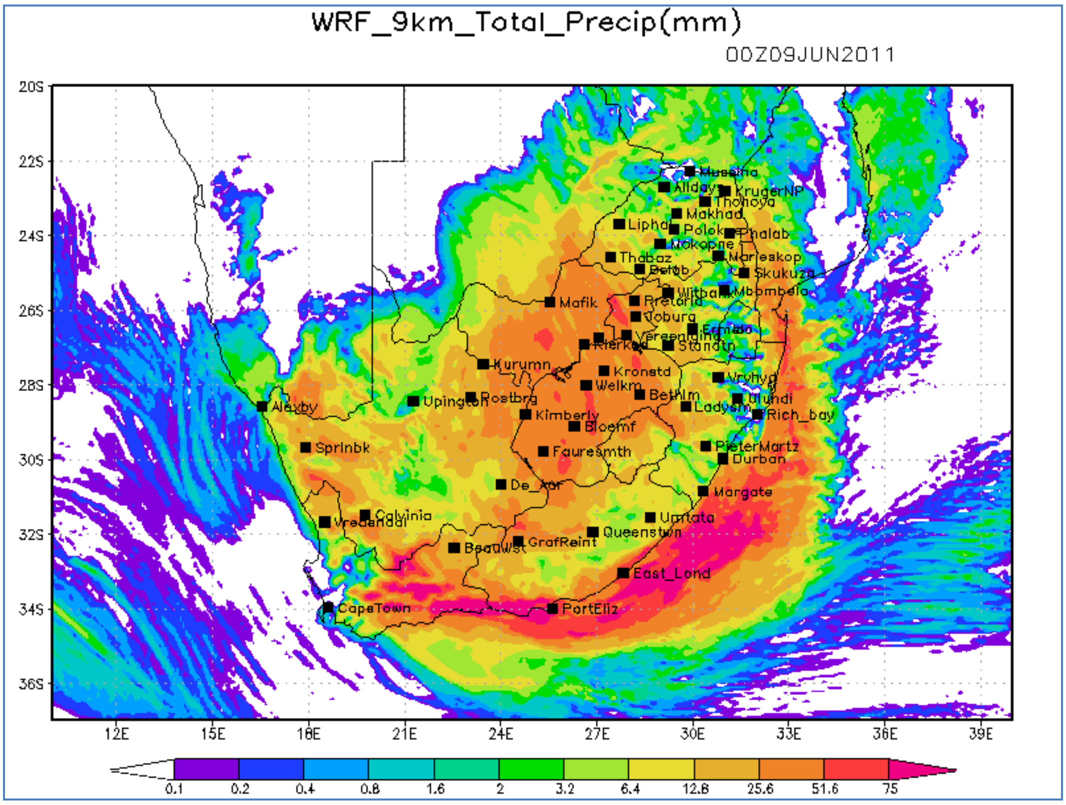

Figure 4: WRF simulation of floods over the interior of South Africa from 6-9 June 2011

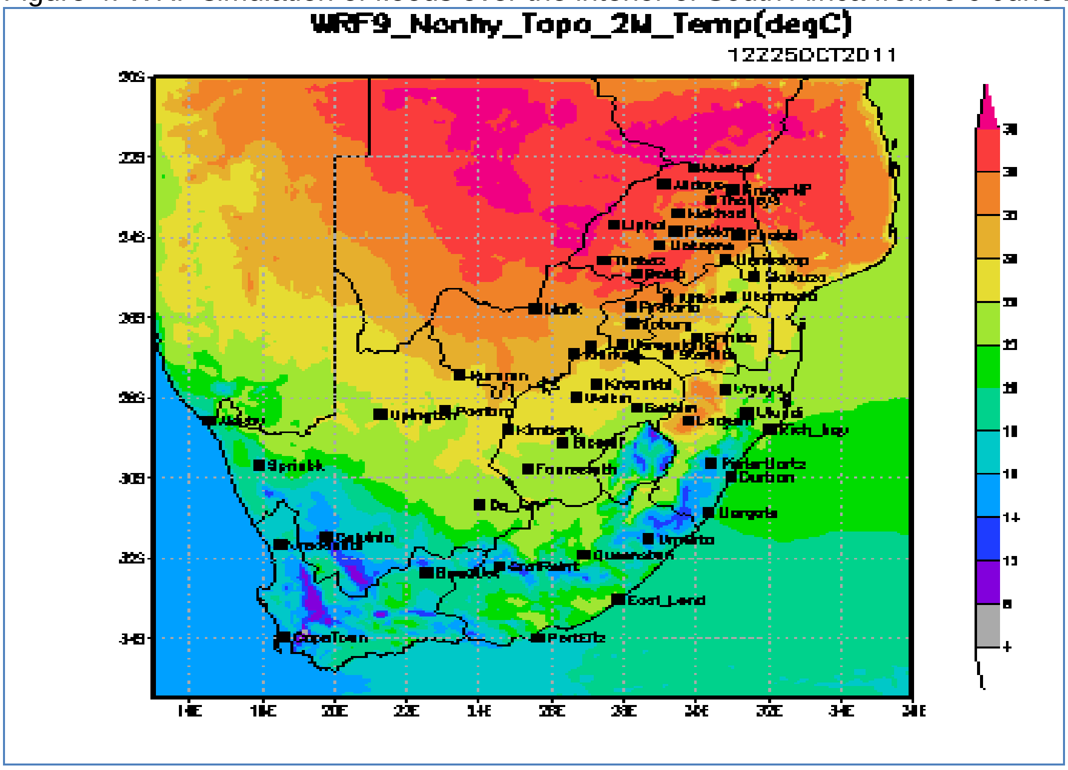

Figure 5: WRF simulation of heat waves heat waves over northern parts of South Africa and Botswana on 24-26 October 2011

The model is applied daily as a research tool by Mr Robert Maisha to support his MSc dissertations to investigate the atmospheric flow patterns over SA and Limpopo region.

The North-Eastern region is prone to extreme weather events, *i.e.* very high temperatures and rainfall. This usually results in droughts, flooding and malaria cases over the area. The model will also be used by undergraduate students to do research on their case studies on numerical weather predictions.