Installation of the Unified Model for NWP in South Africa

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Introduction

The South African Weather Service (SAWS) installed the Met Office Unified Model in 2006. This modelling system was selected to become the SAWS operational in-house numerical weather prediction (NWP) model for forecast guidance up to two days ahead from December 2006.

The SAWS has maintained an operational NWP system with data assimilation (DA) since 1993. This first system was based on the National Centers for Environmental Prediction (NCEP) regional Eta model. Table 1 shows the model resolution and forecast statistics for this period. Performance of this system improved steadily in sync with increasing computer capacity and improved model skill, roughly equivalent to a doubling of forecast lead-time for the same level of skill over the decade. The UM forecasts (last line) show a greatly improved skill using these same metrics but results are as yet only available for a relatively short period.

Table 1: Average statistics for 12-month periods for SAWS Eta forecasts

RMS Error		24-h		48-h	
Model version	**Dates**	**MSLP (hPa)**	**500Z (dam)**	**MSLP (hPa)**	**500Z (dam)**
Eta80km17L	1994-1995	2.508	2.079	3.721	3.631
Eta80km38L	1996-1997	2.042	1.959	3.434	3.437
Eta48km38L	1998-1999	1.813	1.755	2.576	2.550
Eta48km38L	2000-2001	1.810	1.548	2.467	2.432
Eta48km38L	2001-2002	1.755	1.489	2.474	2.415
Eta32km45L	2002-2003	1.519	1.387	2.181	2.182
UMSA12km38L	Nov06-Feb07*	0.995	0.714	1.454	1.080

* UM verification is only available for a short period during the austral summer, but the Eta32km45L and UMSA12km38 domains are very similar in size and location

Operational UM Configuration at the SAWS

The South African domain of the UM was chosen to be similar in size to the Met Office NAE12km, and covers all of southern Africa south of the equator to 45°S, and 10°W to 60°E. The horizontal resolution was set at 12km with the standard set of 38 levels in the vertical, as used at the Met Office. This domain is intended to form the basis for the provision of initial dumps and lateral boundary conditions (LBCs) to other centres in the region who wish to run limited area versions of the UM in this domain, thus lifting the pressure on the Met Office to fulfil this role.

The UM system at the SAWS runs a full 3D-VAR data assimilation system, but tests on a 4D-VAR upgrade are also being done. The Met Office provides an intermediate observation file every six hours on the SAWS SA12 domain that is transferred to the SAWS in real time, thus eliminating the need to interface the Observation Processing System (OPS) with a local observation database. Historically this has been a weak point in the SAWS NWP system. Justification for running a data assimilation cycle at the SAWS is based on the findings of an earlier study with the Eta 32km45L model where a clear degradation in the forecast skill at 24 and 48 hours was apparent when data assimilation was switched off. Furthermore, the finer resolution SA12 model can exploit more of the high-density satellite data than the relatively coarser UM global model.

Research Applications using the UM

Preliminary research work started at the SAWS includes case studies to investigate the model simulation of rainfall over the summer rainfall region of South Africa at 15km resolution plus successive nests within that domain of 5km and 1.7km respectively. The aim of this experiment was to determine whether the UM can improve upon the spatial distribution of convective-type rainfall as horizontal resolution increases. Convective parametrization is switched off for the 1.7km run based on the assumption that convective processes are resolved at this horizontal resolution. Five case studies were chosen between March and August 2006 to cover varying synoptic situations and seasons. Results for the case of 22 April 2006 is shown in figure 1. The plotted areas roughly depict the model domains. It becomes clear that the 5km and 1.7km resolutions capture the RADAR observed streak pattern in rainfall, while the 15km does not. The topographical influence on rainfall is best captured at the 1.7km resolution, as seen toward the upper part of the figure where mountain ranges are present. These early results indicate that resolutions less than 5km ought to be quite successful in capturing the spatial structure convective rainfall at least in a qualitative sense. Clearly it would be short-sighted to expect the model to place these events correctly unless topography plays the only dominant role in convective development during a particular event.

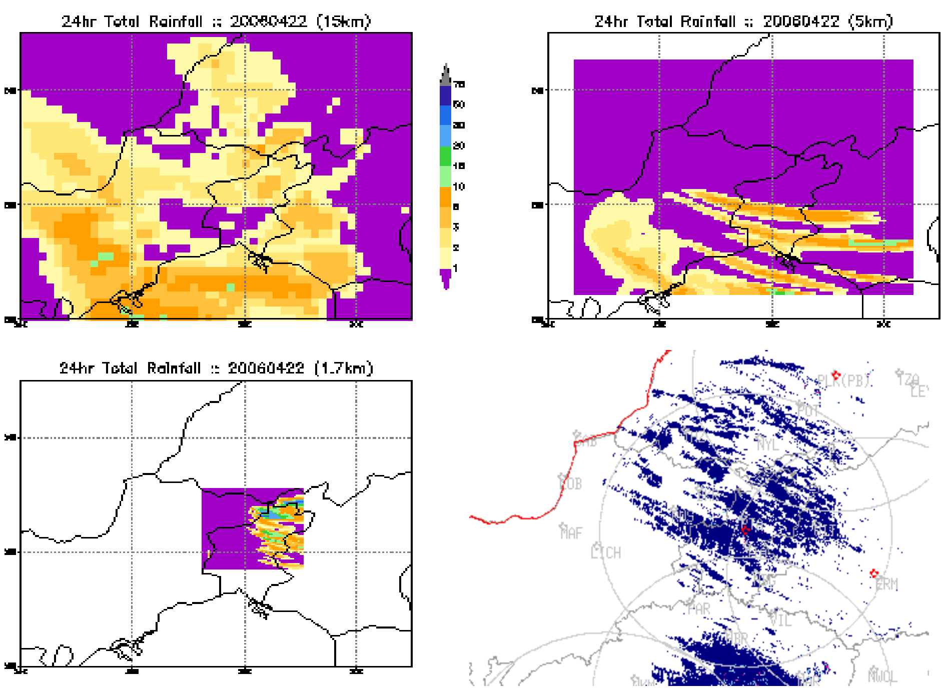

Fig. 1: Total 24-hour forecast precipitation for 22 April 2006 (0-hour lead time) simulated by the UM at 15km (top left), 5km (top right) and 1.7km (bottom left), and radar rainfall estimates (bottom right).