WORLD METEOROLOGICAL ORGANIZATION

COMMISSION FOR BASIC SYSTEMS

RA I – SWFDP – EASTERN AFRICA
NWP/WEB DEVELOPERS WORKSHOP

NAIROBI, KENYA, 14 – 16 MARCH 2012

FINAL REPORT

EXECUTIVE SUMMARY

The Severe Weather Forecasting Demonstration Project (SWFDP) for Eastern Africa NWP/Web Developers' Workshop was held in Nairobi, Kenya, from 14 to 16 March 2012.

The main focus of this event was to (a) evaluate progress in implementing the SWFDP in Eastern Africa, including the SWFDP – Eastern Africa websites and portal; and (b) identify gaps and develop a strategy to address them, including those related to NWP contributions by the participating centres. This workshop included actual work on the development of the RSMC Nairobi website and portal for the Eastern Africa project, and on the COSMO installation and display of products.

GENERAL SUMMARY OF THE WORK OF THE SESSION

1. OPENING

1.1 The Second Severe Weather Forecasting Demonstration Project (SWFDP) for Eastern Africa NWP/Web Developers Workshop was opened by Mr James G. Kongoti (Kenya) at 09.30 hours on Wednesday, 14 March 2012, at the Headquarters of Kenya Meteorological Department (KMD), in Nairobi, Kenya. Opening remarks were made by the WMO Secretariat, to provide the context for the workshop.

2. ORGANIZATION OF THE MEETING

2.1 Adoption of the agenda

2.1.1 The meeting adopted the provisional agenda, as provided in Annex I.

2.2 Working arrangements

2.2.1 The meeting was invited to nominate from among the participants a chairperson to conduct the business of the workshop. Mr James G. Kongoti (KMD) and Dr Hamza Kabelwa (Tanzania) were unanimously elected to act, respectively, as chairperson and vice-chairperson for this meeting.

2.2.2 All documents submitted for the workshop are referenced and hyperlinked in the Documentation Plan (INF. 1), which had been posted on the WMO web site at:

http://www.wmo.int/pages/prog/www/DPFS/Meetings/RAI-EA-NWP-WEB_Nairobi2012/DocPlan.html

2.2.3 The participants agreed its hours of work and other practical arrangements for the workshop, including the tentative work programme. Participants briefly introduced themselves, to facilitate interactions throughout the workshop. The list of participants in the workshop is provided in Annex II.

3. REVIEW THE PROJECT WEB SITES AND PORTAL

3.1 The meeting reviewed the content of the SWFDP – Eastern Africa Portal, which is managed and running at RSMC – Nairobi (Kenya), including the SWFDP – Eastern Africa Website for the Lake Victoria Basin, which is managed and running at the Tanzania Meteorological Agency (TMA). It noted that the SWFDP – Eastern Africa Portal is currently running in Windows environment and recommended the migration to Linux for managing and security purposes. The meeting agreed to further address this issue under agenda item 5.

3.2 The identified a number of aspects that needed improvement, including the design and content of the Project Portal homepage and associated links, the development of the Portal archive, and the visualization of the LAM (COSMO and WRF) products. The meeting agreed to break into small working groups to address the identified issues and reported under items 5 and 6.

4. REVIEW THE CONTRIBUTIONS BY CENTRES FOR LIMITED AREA MODELLING (LAM) OVER THE PROJECT FOOTPRINT AND LAKE VICTORIA REGION

4.1 Met Office UK

4.1.1 The meeting noted that the Met Office UK would be able to offer a range of products and training in support of the SWFDP for Eastern Africa. Met Office NWP encompasses high resolution, mesoscale, regional and global scale models together with an ensemble prediction system known as MOGREPS (Met Office Global regional Ensemble Prediction System) and the ATD Lightning detection system.

4.1.2 MOGREPS is a 24-member ensemble run by the UK Met Office. The global ensemble, run at horizontal resolution of 60km resolution and 70 levels in the vertical, is available in two modes; MOGREPS-G which runs to 3 days and MOGREPS-15 which runs to 15 days at ECMWF as part of the THORPEX TIGGE project. Model outputs will be provided which include: site specific EPS meteograms, known as EPSgrams; tailored regional precipitation threshold probability charts; wind speed threshold probability charts; spaghetti diagrams; and tropical cyclone track forecasts. Participating countries in an SWFDP for Eastern Africa have identified two different locations (preferably synoptic stations to allow for verification) for which the Met Office UK would provide EPSgrams.

4.1.3 The meeting noted that the Met Office UK is currently running a suite of deterministic models and associated products consistent with the requirements of the SWFDP Implementation plan. The Met Office Global NWP model products are provided via the GTS/EUMETCAST at a resolution of around 25km resolution. By the end of 2012 the Global model resolution will increase from 25km to either 16km or 20km.

4.1.4 The Met Office also runs a Limited Area Model for Africa (Africa-LAM), and as part of the VCP commitment, has supported enhancements to the model by bringing the resolution to 12km in March 2011. The model has daily outputs of a variety of parameters out to T+54. The model data is disseminated via EUMETCAST and images are made accessible via a password protected website (http://www.metoffice.gov.uk/weather/africa/lam/; Username: afr_nms, Password: uk_alam). The Met Office is planning to retire the 12km Africa LAM in late 2012, replacing it with the higher resolution global model which will have comparable performance and resolution. In addition, the Met Office is running a high resolution 4km model necessary to capture the convective processes that dominate weather in the Lake Victoria region. The 215 x 240 grid point model has daily outputs of a variety of parameters out to T+48 and is driven by the 25km global model. The 4km model is now assimilating the OSTIA database (Operational Sea surface Temperature and sea Ice Analysis) providing better representation of the Lake temperature in the model, which in turn provides more accurate wind and precipitation forecasts.

4.1.5 In the view of the need to improve the use of satellite imagery and observations, the Met Office UK is providing ATDNet (Arrival Time Difference Network) Lightning data over Africa overlaid with I.R imagery. The ATDnet primarily detects cloud-to-ground lightning due to the amount of electric current flowing through (but has also been shown to pick up cloud to cloud). The system can detect over 70 lightening strokes per second at ranges over 10,000 km, but needs at least 4 sensors to detect the same lightning stroke to determine position; so the number of sensors near an area of interest is an important aspect in determining the lightning detection efficiency. The lightning detection system could be a useful tool for forecasters to use to complement satellite systems and other observational data for nowcasting during severe rainfall events and is now available via EUMETCAST accessible and updated hourly via the password protected website.

4.1.6 The meeting noted that the Met Office would be able to continue to provide trainers and mentors to support the training component of the SWFDP. The Met Office can provide a trainer and mentor who is an expert in the interpretation of NWP products, and in particular ensemble and high resolution model products for severe weather forecasting. The Met Office could also supply a Public Weather Service Advisor, who is expert in interpreting forecast outputs for specific stakeholder groups and communicating forecast messages in a format that can be easily interpreted and acted upon.

4.2 DWD (Germany)

4.2.1 The meeting noted that the DWD has a longstanding tradition in supporting several (including African) countries (e.g., Kenya since 2001) with its regional model HRM (High resolution Regional Model) and more recently COSMO, at the same time enabling KMD to continuously run the model through provision of initial and boundary data from the global model GME and staff training concerning the COSMO. This should basically be the role of the DWD in the project. The necessary resources for support and custom-tailored data provision are already available at DWD, as such tasks have been and will be continuously fulfilled in the future also for several other countries.

4.2.2 The meeting reviewed the current status of HRM and COSMO (Consortium for Small Scale Modeling) installations on the new HPC Linux Cluster at KMD. It noted that, based on the collaboration between MFI and DWD, a new Linux cluster has been installed at KMD, in Nairobi. The numerical weather prediction models COSMO has been implemented as well as a scheduling system for handling the model queues (COSMO; WRF). COSMO-model (at 7 km) is working and producing weather forecasts for 00 and 12 UTC initial time plus 120h. The graphical outputs for COSMO have been produced and presented on the RSMC Nairobi website and portal. The meeting addressed additional output variable to be displayed on this portal under agenda item 6. Noting that due to the migration of GME to GRIB2 format, the official support for HRM will end in February 2013. From this point, only support and driving data for the COSMO model will be provided by DWD.

4.2.3 The meeting noted that the initial and boundary fields from the global model GME switched from a 30km resolution to a 20km resolution on 29 February 2012. Since that change, troubles in receiving the GME data in an accurate time occurred. The problem seems to be caused by network communication errors. GME files are pushed in sequence by DWD, but received in random order by KMD. Solutions for this problem need to be addressed. In addition, the meeting noted that at the moment, there is no realistic surface temperature for Lake Victoria implemented in the COSMO installation at KMD, but the usual nearest ocean interpolation (which is about 5K too warm).

4.2.4 The meeting noted that a first case study was conducted at DWD with the proposed nested configuration GME – COSMO – 2.8 km (Lake Victoria domain). Results of this first case study were shown, which demonstrate that the COSMO model is generally able to run tropical cases. However, there was no attempt to conduct a proper verification of this experiment in comparison to data, except a qualitative comparison with satellite data. The latter showed that during daytime, convective precipitation was simulated qualitatively correct around the lake, and that precipitation amounts were considerably higher and spatially more confined in the 2.8 km model. Over Lake Victoria, a distinct see-breeze circulation was simulated in the 2.8 km model, which is an important precursor of convection over and around the lake. More systematic assessments of the forecast quality should be made in the future. The meeting noted that the COSMO model for this simple test initialize the Lake Victoria surface temperature with simple climatological values representatives of the dates of the simulation. Noting that this may impact on the model performance, the meeting recommended the use of in-situ or satellite-based surface temperature data. It also recommended DWD to work with the Met Office UK on the feasibility of using/assimilating the OSTIA database in the COSMO model (2.8 km).

4.2.5 Regarding verification aspects, the meeting noted that the Oman Met Service (OMS) has developed a verification package using COSMO data, and recommended that KMD requests this package to OMS for implementation at RSMC Nairobi. Prior to this request, the meeting recommended that an expert on verification to check the content of this package (e.g. Mr Lawrence Wilson, who has been involved on SWFDP verification aspects). In the same context, the meeting noted that NCAR has also a verification package that can be applied to different models.

4.3 NOAA/NCEP (USA)

4.3.1 The representative from the United States provides an overview of the various products of the U.S. National Center for Environmental Prediction (NCEP) that could contribute to the SWFDP. NCEP's Climate Prediction Center (CPC) operates through the African Desk several websites which provide specialized weather guidance products for Africa, South Asia and the Indian Ocean: http://www.cpc.ncep.noaa.gov/products/african_desk/cpc_intl/africa/africa.shtml;

http://www.cpc.ncep.noaa.gov/products/african_desk/cpc_intl/sasia/sasia.shtml;
http://www.cpc.ncep.noaa.gov/products/african_desk/cpc_intl/indian/indian.shtml.

4.3.2 More specialized products for East Africa can be found at this web address:
http://www.cpc.ncep.noaa.gov/products/african_desk/cpc_intl/eafrica/eafrica.shtml.

4.3.3 The representative noted that NOAA is already collaborating with the other countries in Africa, particularly the SWFDP for southern Africa to assess and improve the Global Forecast System (GFS) and the Climate Forecast System (CFS). The GFS and CFS offer the potential for applications useful to the SWFDP-East Africa. In addition, CPC produces daily high resolution satellite rainfall estimates also available on the African Desk's web site for use in both operational monitoring and in model evaluation studies. NOAA's National Environmental Satellite Information and Data Service (NESDIS) also operates at NCEP the Center for Satellite Applications and Research (STAR) which produces a number of proto-type products useful to the South Asia region. An example is the satellite-derived Hydro-Estimator for the Indian Ocean Basin: http://www.star.nesdis.noaa.gov/smcd/emb/ff/HE_World_Indian24Hr.php.

4.3.4 The NOAA representative noted that NCEP continues to operate a 4-month professional development training programme in both weather forecasting and climate predictions at the African Desk as part of the US contribution to the WMO VCP. Over a dozen meteorologists from East Africa have participated in this programme. Recently, NCEP introduced an *International Forecaster Training Desk* specific to *monsoon weather*. Invited participants generally spend four months at NCEP working on *advanced monsoon NWP* techniques to improve their understanding and forecasting weather associated with monsoon systems. This NCEP activity offers a synergistic opportunity for countries associated with the SWFDP-Eastern Africa.

4.3.5 The representative noted that NOAA has other activities in the Indian Ocean region which could benefit the SWFDP-Eastern Africa. These ongoing activities include NOAA processing Indian Ocean data related to the Research moored Array for African-Asian-Australia Monsoon Analysis (RAMA), a South Asian Regional Reanalysis (SARR) of atmosphere-land-ocean data, NWP-related activities to improve the region's understanding of the Indian monsoon and precipitation characteristics, and the development of a multi-grid wave model for wave/swell forecasting including coastal high wave alerts.

4.3.6 The meeting reviewed the WRF domains and configurations for the SWFDP – Eastern Africa, installed at KMD, and suggested a number of changes for improvement of the system under agenda item 6.

4.4 KMD (Kenya)

4.4.1 The meeting noted that the RSMC Nairobi (Kenya) has been acting as the lead regional centre for the SWFDP – Eastern Africa, including (among other activities) the responsibility for the development and management of a dedicated project website and portal. KMD makes available outputs from the COSMO and WRF models, and is responsible for synthesizing all available and relevant products and information, and making the best use of all these products for diagnosing the convective systems, in order to provide daily severe weather forecasting guidance for the entire project footprint to NMHSs in Eastern Africa region (day-1 to day-5).

4.4.2 The meeting noted that the operational COSMO - 7 km domain extends from latitudes (15^0 S, 16^0N) and longitudes (23^0E, 53^0E). WRF – 7 km covers a similar domain. Verification of the two models is ongoing. The model output products being considered in the verification exercise are the temperature, wind fields and moisture. Results have been included in the SWFDP Quarterly Reports.

4.4.3 The meeting noted that KMD is increasing its observational network, including 36 synoptic and agrometeorological stations, 3 upper air observing stations (radiosondes), 17 hydrometeorological AWSs, and 3 tide gauges along the Kenyan coast. Procurement process for the acquisition of three radar systems has started. Plans have been initiated to acquire and deploy Acoustic Doppler Current Profilers (ADCPs) in the Kenyan coastal areas of the western Indian Ocean, and 2 fixed buoys (with water and atmospheric sensors) in the Lake Victoria. The meeting encouraged KMD to share its observational data within the framework of the SWFDP, in particular considering its role as the lead regional centre for the project.

4.5 TMA (Tanzania)

4.5.1 The meeting noted that TMA (Tanzania) has been benefiting from participating in the SWFDP – Southern Africa and has been able to share its experience with participating countries in the proposed SWFDP – Eastern Africa. Therefore, TMA has been assisting RSMC Nairobi, as appropriate. The meeting also noted that TMA's major role and contribution to the project relates to the Lake Victoria component. TMA is responsible for synthesizing all available information and produce a daily severe weather guidance map for the Lake Victoria domain (day-1 and day-2). The meeting noted that with the support of NMHSs participating in the SWFDP – Eastern Africa, TMA will continue doing verification and evaluation of forecasted and non-forecasted severe weather events at selected sites.

4.5.2 The meeting noted that TMA runs the following limited-area models (LAM): WRF (horizontal resolution 5-15km; forecasting length: 48-54h); the WRF-BOGUS for TC track during the TC season (horizontal resolution 10km; forecasting length: 48-72h) for experimental purposes; and the COSMO (horizontal resolution 14km; forecasting length: 78h), which are also used for severe weather forecasting. The meeting also noted that to enhance the computing capacity, procurement procedures are going on to purchase a more powerful Computer Cluster with sixteen nodes, two CPU each with four high frequency processors.

4.5.3 The meeting noted that TMA has established a *Severe Weather and Medium Range Weather Forecast Desk* at Central Forecasting Office in the Forecasting Division. A five-day forecast is issued everyday in order to capture coming severe events in five day time in order to improve the daily severe weather forecasts. Some of the ToR of this Desk are:

(a) Prepare and issue Severe Weather Forecast for the Lake Victoria Basin and within the country;
(b) Prepare and issue medium range weather Forecast (5-day) with suitable format for the users;
(c) Conduct Case studies that will enhance Early Warning System in the country and Severe Weather Forecasting Demonstration Programme for Eastern Africa (SWFDP-EA);
(d) Prepare Alert, Advisory and Warnings for potential Severe Weather in the country coordination with H-ANI and H-PWS;
(e) Design and update Severe Weather template and appropriate symbols to be used for Alert, Advisory and Warnings;
(f) Daily update of Severe Weather website;
(g) Conduct monitoring, verification and prepare four-month report of Severe Weather event Forecasts.

Currently, at this Desk, there are seven personnel: two ICT, three forecasters, one Public Weather Services and one Agrometeorologist.

4.5.4 The meeting noted that TMA has a plan to increase the number of surface observation stations and developing a radar network. TMA has installed one Doppler weather RADAR with a range of 480 KM (with effective range of 200km) in the coastal zone (Dar-es-Salaam). However, due to power challenges at times is not working. The procurement process for the second radar is in place and a site for installation has already be identified in Mwanza, southern part of the Lake zone, with the coverage of the entire Lake Basin and countries within the Lake Victoria Basin. Tanzania is planning to install in total seven weather RADAR stations in the country in order to enhance the capability to monitor severe weather events not only in Tanzania but also the near bordering countries in project footprint. All these observational information are expected to be assimilated during the model run initialization and radar data imagery will likely be shared with the participating countries through the project.

5. STRATEGY FOR DEVELOPING THE SWFDP - EASTERN AFRICA WEBSITES AND PORTAL, INCLUDING CONTENT AND IT ASPECTS

5.1 Based on discussions under agenda items 3 and 4, the meeting agreed to break into small working groups to address the identified issues, including actual work on the development of the RSMC Nairobi website and portal for the Eastern Africa project, and on the COSMO installation and display of products. These include the harmonization of the website (i.e. headers, etc.), protection (security) of all webpages, the development of the archive (which includes the guidance products, discussion and risk tables), and the display of COSMO and WRF products. Annex III provides snapshots of:

(a) the revised version of the project webportal homepage;

(b) the webportal archive;

(c) the display of the LAM (COSMO/WRF 00 and 12 UTC – 7 km) products (further addressed in item 6).

5.2 The meeting noted that the project webportal has been developed in a Windows server. Recognizing that this is not a sustainable and secure approach, the meeting strongly recommended that KMD migrate the project webportal to a Linux server as soon as possible. In this context, the meeting requested the WMO Secretariat to assist KMD in this regard. This assistance would include financial and expert support.

6. STRATEGY FOR IMPLEMENTING AND SUSTAINING INSTALLATIONS OF LIMITED AREA MODELS (LAMs)

6.1 The meeting reviewed the current HRF, COSMO and WRF installations at KMD. It noted that HRF has been discontinued (see paragraph 4.2.2), while suggestions were made to keep COSMO 14 km for "testing purposes". As presented in item 5, actual work was carried out on the COSMO installation and display of products on the project webportal. Annex IV presents the COSMO and WRF list of parameters which are currently produced and displayed on the project webportal. Noting that this list also includes parameters that are possible to produce, the meeting suggested that KMD carry out this task and display these products on the webportal as they are beneficial for all participating countries in the SWFDP – Eastern Africa.

6.2 Regarding the WRF installations at KMD, the meeting proposed new WRF domains, reference configurations along with a very preliminary test, as presented in Annex V. In summary:

(a) three nested domains at 18, 6 and 2 km are proposed with the 6-km domain covers the region defined in the project implementation plan while the 2-km domain covering the Lake Victoria is an optional;

(b) a reference WRF configuration suitable for the tropics is suggested;

(c) NCEP real-time global SST analysis at 1/12 degree is suggested to initiate the WRF model.

6.3 The proposed WRF domains are for the project's regional centres to consider while national weather agencies may need smaller and specific domains to their own interest and to fit their computing resources. The meeting pointed out that, to have optimal model configuration, case studies for the region are necessary. The suggested WRF domains and configurations are helpful for KMD to start with, and scientific studies on typical severe weather regimes/events can be followed to guide model configuration for improvements. Verification against observations (surface parameters) at the RBSN stations has been strongly recommended (see paragraph 4.2.5).

6.4 The meeting stressed that any proposed changes should be implemented in a parallel run so that operational systems are not affected. Once the experiments have been tested/verified for the best configurations, they would be migrated to the operational environment.

6.5 The meeting noted with appreciation that similar reviews of LAM installations and configurations (as the one carried out at his meeting) are planned at TMA (Tanzania) and ENMS (Ethiopia).

6.6 Noting that the SWFDP – Eastern Africa addresses waves over the Lake Victoria and that TMA is willing to implement it and display the outputs on its SWFDP-EA website, the meeting requested the Met Office UK, DWD and NOAA/NCEP to explore the feasibility of implementing their wave models for the Lake Victoria.

7. STRATEGY FOR FORECASTING

7.1 The meeting noted that the RSMC daily forecasting guidance for Eastern Africa is being produced by KMD staff at the NWP Division, and issued every day before 14:00 (local time), so that participating NMHSs in the SWFDP-EA have access to it prior to their internal briefings. While noting that the NWP Division is part of the KMD Forecasting Office, the meeting suggested that the production of the RSMC daily forecasting guidance be part of the tasks of the forecasters in duty.

7.2 The meeting stressed the need for strengthening the operational linkage between the RSMC Nairobi and the Regional Forecasting Support Centre (RFSC) Dar for the Lake Victoria Basin, in order to ensure consistency between the information provided by the two centres. In addition, real time exchanges/communications with participating NMHSs in the SWFDP-EA should be improved in case of severe weather events.

7.3 The meeting recalled that the Regional Subproject Management Team (RSMT) of the SWFDP-EA has agreed that guidance should be provided for wind greater than 25kt. The meeting noted that RSMC Nairobi is providing guidance when wind is greater than 30kt and RFSC Dar for wind greater than 25kt. The meeting enquired either this is mean wind or wind gusts, and stressed the need for harmonization. It recommended that this issue be clarified at the next meeting of the RSMT, when the Regional Subproject Implementation Plan (RSIP) will be reviewed and criteria for issuing guidance be adjusted.

7.4 The meeting pointed out that the guidance products should be based on the use and interpretation of NWP/EPS outputs, as well as satellite-based products, so that severe convection/storms are identified. The meeting recommended the creation of a flow chart (check list) showing how to complete a guidance product (a job folder), which should be underpinned by training and a quality assurance programme. It noted that a “global guidance” may help to address this in the short term. The meeting requested the WMO Secretariat to follow up on this issue in collaboration with global and regional centres.

7.5 Noting that the main issues in the region are associated with convective-induced primary and secondary hazards (flash floods, lightning, strong winds, landslides, etc.), the meeting recommended that the SWFDP-EA put more attention and efforts on training forecasters to forecast convective storms.

8. ANY OTHER BUSINESS (AOB)

8.1 There were no other issues raised during the workshop.

9. CLOSING

9.1 The Severe Weather Forecasting Demonstration Project (SWFDP) for Eastern Africa NWP/Web Developers Workshop closed at 16:45 on Friday, 16 March 2012.

Annex I

AGENDA

1. **OPENING**

2. **ORGANIZATION OF THE MEETING**
   - 2.1 Adoption of the agenda
   - 2.2 Working arrangements

3. **REVIEW THE PROJECT WEB SITES AND PORTAL**

4. **REVIEW THE CONTRIBUTIONS BY CENTRES FOR LIMITED AREA MODELLING (LAM) OVER THE PROJECT FOOTPRINT AND LAKE VICTORIA REGION**

5. **STRATEGY FOR DEVELOPING THE SWFDP - EASTERN AFRICA WEB SITES AND PORTAL, INCLUDING CONTENT AND IT ASPECTS**

6. **STRATEGY FOR IMPLEMENTING AND SUSTAINING INSTALLATIONS OF LIMITED AREA MODELS (LAMs)**

7. **STRATEGY FOR FORECASTING**

8. **ANY OTHER BUSINESS (AOB)**

9. **CLOSING**

Annex II

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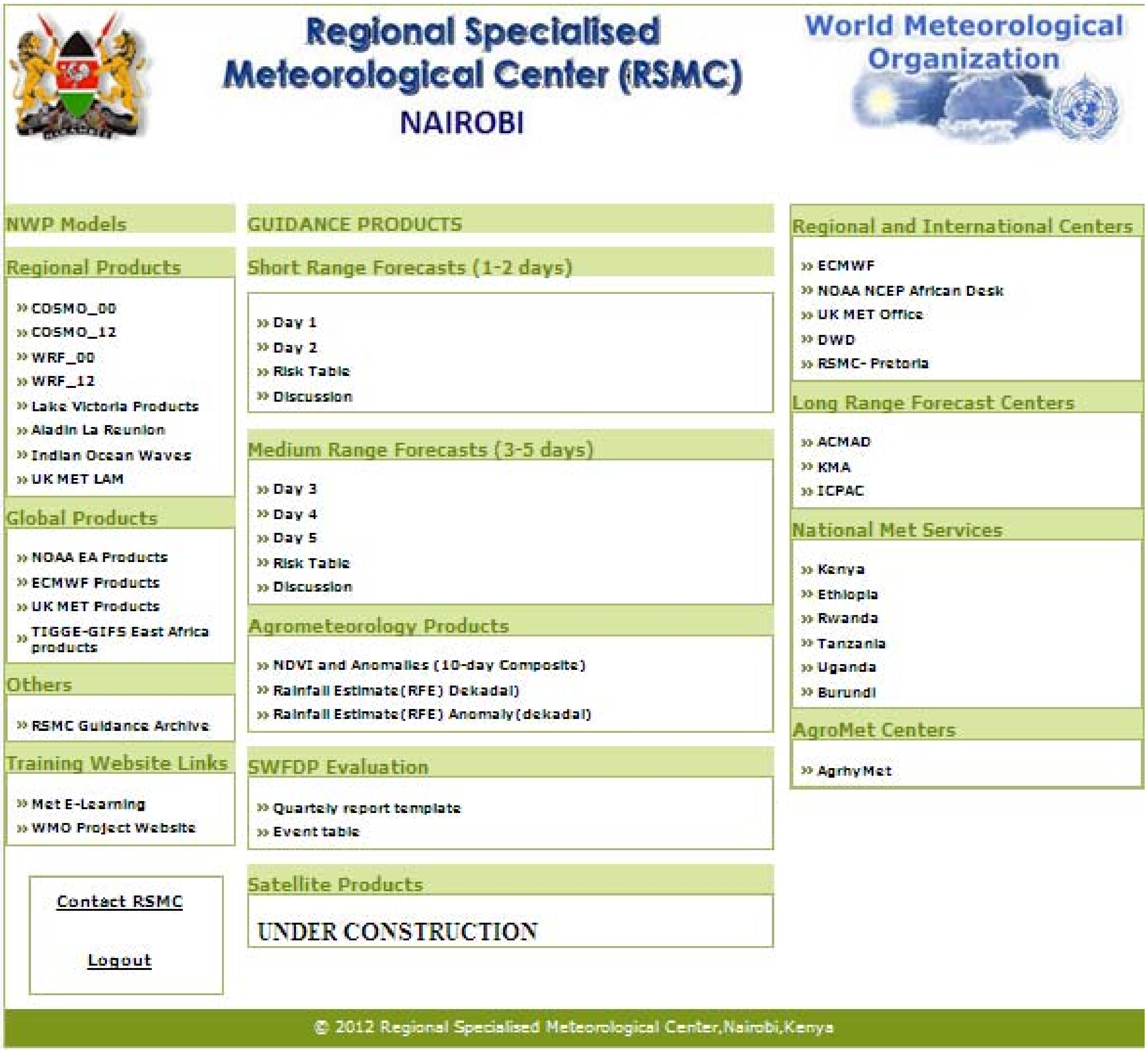
Annex III

SNAPSHOT OF THE REVISED VERSION OF THE PROJECT PORTAL HOMEPAGE

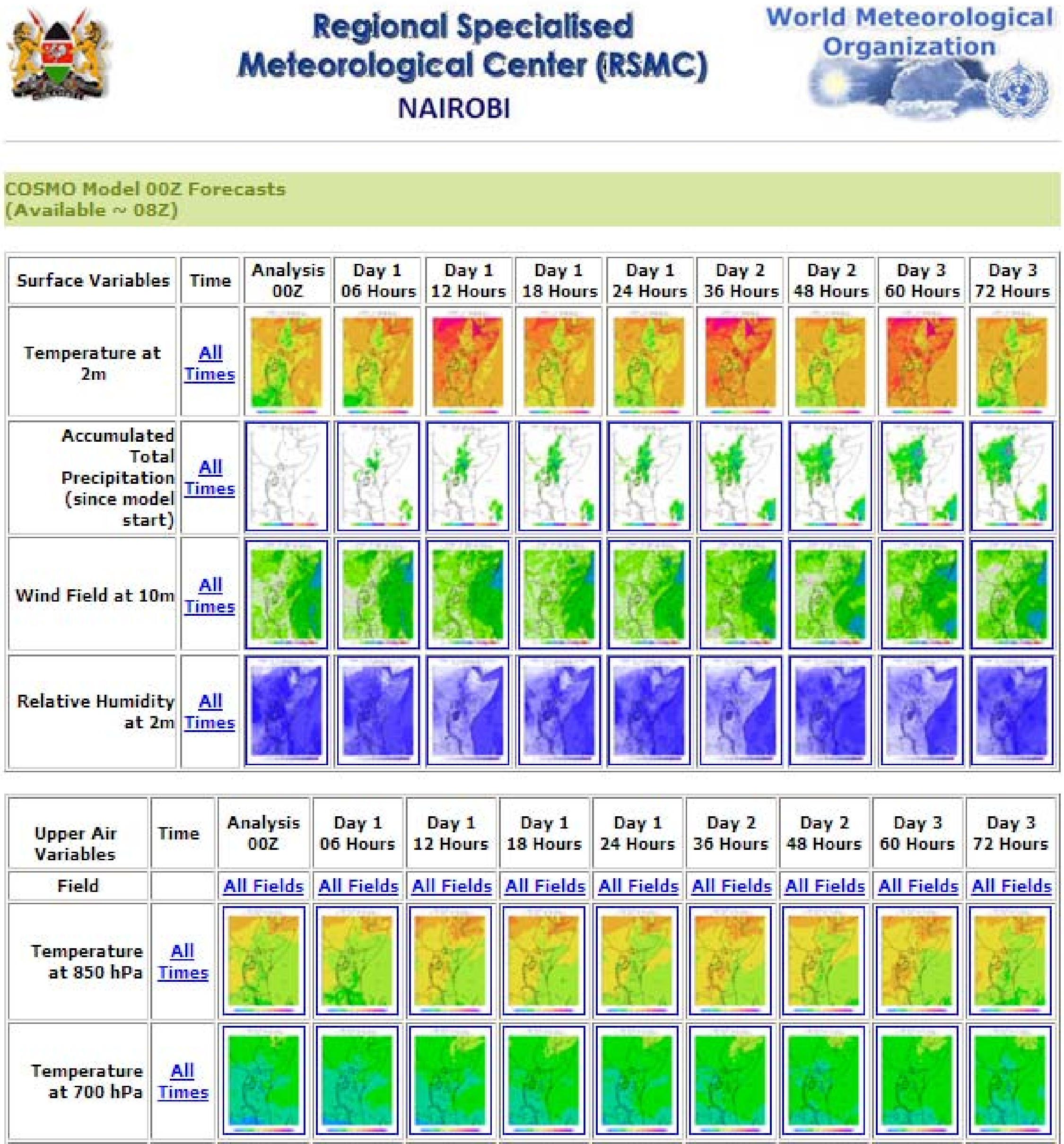


SNAPSHOT OF THE PORTAL ARCHIVE

Index of /rsmc/products/guidance_archive

- Parent Directory
- RSMC01_20120315.jpg
- RSMC01_20120316.jpg
- RSMC01_20120317.jpg
- RSMC01_20120318.jpg
- RSMC01_20120319.jpg
- RSMC01_20120320.jpg
- RSMC01_20120321.jpg
- RSMC01_20120322.jpg
- RSMC01_20120323.jpg
- RSMC01_20120324.jpg
- RSMC01_20120325.jpg
- RSMC01_20120326.jpg
- RSMC01_20120327.jpg
- RSMC01_20120328.jpg
- RSMC01_20120329.jpg
- RSMC01_20120330.jpg
- RSMC01_20120331.jpg
- RSMC01_20120401.jpg
- RSMC01_20120402.jpg
- RSMC01_20120403.jpg
- RSMC01_20120404.jpg
- RSMC01_20120405.jpg
- RSMC01_20120406.jpg
- RSMC01_20120407.jpg
- RSMC01_20120408.jpg
- RSMC01_20120409.jpg
- RSMC01_20120410.jpg
- RSMC01_20120411.jpg
- RSMC01_20120412.jpg
- RSMC01_20120413.jpg
- RSMC01_20120414.jpg
- RSMC01_20120415.jpg
- RSMC01_20120416.jpg
- RSMC01_20120417.jpg
- RSMC01_20120418.jpg
- RSMC01_20120419.jpg
- RSMC01_20120420.jpg
- RSMC01_20120421.jpg
- RSMC01_20120422.jpg
- RSMC01_20120423.jpg

SNAPSHOT OF THE LAM (COSMO OR WRF) PRODUCTS



Annex IV

COSMO AND WRF LIST OF PARAMETERS

Model	Parameter	Level Type	Level	Outputable	Output	Plotted	On Website	Model	Parameter	Level Type	Level	Outputable	Output	Plotted	On Website	Notes
COSMO	**wind**	**surface**	**10m**	**yes**	**yes**	**yes**	**yes**	**WRF**	**wind**	**surface**	**10m**	**yes**	**yes**	**yes**	**yes**	
COSMO	wind	pressure	925	yes	yes	no	no	WRF	wind	pressure	925	yes	yes	no	no	
COSMO	wind	pressure	850	yes	yes	yes	yes	WRF	wind	pressure	850	yes	yes	yes	yes	
COSMO	wind	pressure	700	yes	yes	yes	yes	WRF	wind	pressure	700	yes	yes	yes	yes	
COSMO	wind	pressure	500	yes	yes	yes	yes	WRF	wind	pressure	500	yes	yes	yes	yes	
COSMO	wind	pressure	300	yes	yes	yes	yes	WRF	wind	pressure	300	yes	yes	yes	yes	
COSMO	wind	pressure	200	yes	yes	no	no	WRF	wind	pressure	200	yes	yes	no	no	
COSMO	**temperature**	**surface**	**2m**	**yes**	**yes**	**yes**	**yes**	**WRF**	**temperature**	**surface**	**2m**	**yes**	**yes**	**yes**	**yes**	
COSMO	temperature	pressure	925	yes	yes	no	no	WRF	temperature	pressure	925	yes	yes	no	no	
COSMO	temperature	pressure	850	yes	yes	yes	yes	WRF	temperature	pressure	850	yes	yes	yes	yes	
COSMO	temperature	pressure	700	yes	yes	yes	yes	WRF	temperature	pressure	700	yes	yes	yes	yes	
COSMO	temperature	pressure	500	yes	yes	yes	yes	WRF	temperature	pressure	500	yes	yes	yes	yes	
COSMO	temperature	pressure	300	yes	yes	yes	yes	WRF	temperature	pressure	300	yes	yes	yes	yes	
COSMO	temperature	pressure	200	yes	yes	no	no	WRF	temperature	pressure	200	yes	yes	no	no	
COSMO	**rel. Humidity**	**surface**	**2m**	**yes**	**yes**	**yes**	**yes**	**WRF**	**rel. Humidity**	**surface**	**2m**	**yes**	**yes**	**yes**	**yes**	
COSMO	rel. Humidity	pressure	925	yes	yes	no	no	WRF	rel. Humidity	pressure	925	yes	yes	no	no	
COSMO	rel. Humidity	pressure	850	yes	yes	yes	yes	WRF	rel. Humidity	pressure	850	yes	yes	yes	yes	
COSMO	rel. Humidity	pressure	700	yes	yes	yes	yes	WRF	rel. Humidity	pressure	700	yes	yes	yes	yes	
COSMO	rel. Humidity	pressure	500	yes	yes	yes	yes	WRF	rel. Humidity	pressure	500	yes	yes	yes	yes	
COSMO	rel. Humidity	pressure	300	yes	yes	yes	yes	WRF	rel. Humidity	pressure	300	yes	yes	yes	yes	
COSMO	rel. Humidity	pressure	200	yes	yes	no	no	WRF	rel. Humidity	pressure	200	yes	yes	no	no	
COSMO	**Geopotential Height**	**surface**						**WRF**	**Geopotential Height**	**surface**						**Does not make sense**
COSMO	Geopotential Height	pressure	925	yes	yes	no	no	WRF	Geopotential Height	pressure	925	yes	yes	no	no	
COSMO	Geopotential Height	pressure	850	yes	yes	no	no	WRF	Geopotential Height	pressure	850	yes	yes	no	no	
COSMO	Geopotential Height	pressure	700	yes	yes	no	no	WRF	Geopotential Height	pressure	700	yes	yes	no	no	
COSMO	Geopotential Height	pressure	500	yes	yes	no	no	WRF	Geopotential Height	pressure	500	yes	yes	no	no	
COSMO	Geopotential Height	pressure	300	yes	yes	no	no	WRF	Geopotential Height	pressure	300	yes	yes	no	no	
COSMO	Geopotential Height	pressure	200	yes	yes	no	no	WRF	Geopotential Height	pressure	200	yes	yes	no	no	
COSMO	**Rel. Vorticity**	**pressure**	**500**	**Pot. Vort. only**	**no**	**no**	**no**	**WRF**	**Rel. Vorticity**	**pressure**	**500**	**??**	**no**	**no**	**no**	
COSMO	Rel. Vorticity	pressure	300	**Pot. Vort. only**	no	no	no	WRF	Rel. Vorticity	pressure	300	??	no	no	no	
COSMO	**Vertical Velocity**	**pressure**	**850**	**yes**	**no**	**no**	**no**	WRF	**Vertical Velocity**	**pressure**	**850**	**yes**	**yes**	**no**	**no**	
COSMO	Vertical Velocity	pressure	700	yes	no	no	no	WRF	Vertical Velocity	pressure	700	yes	yes	no	no	
COSMO	Vertical Velocity	pressure	300	yes	no	no	no	WRF	Vertical Velocity	pressure	300	yes	yes	no	no	
COSMO	**Accumulated rain**	**surface**	**sfc**	**yes**	**yes**	**yes**	**yes**	WRF	**Accumulated rain**	**surface**	**sfc**	**yes**	**yes**	**yes**	**yes**	
COSMO	Instantaneous rain rate	surface	sfc	yes	no	no	no	WRF	Instantaneous rain rate	surface	sfc	yes	no	no	no	through namelist option
COSMO	Tmin	surface	sfc	**yes T2m**	no	no	no	WRF	Tmin	surface	sfc	yes	no	no	no	
COSMO	Tmax	surface	sfc	**yes T2m**	no	no	no	WRF	Tmax	surface	sfc	yes	no	no	no	
COSMO	SLP	surface	sfc	yes	no	no	no	WRF	SLP	surface	sfc	yes	no	no	no	
COSMO	Total Precipitable Water	surface	atm.column	yes	no	no	no	WRF	Total Precipitable Water	surface	atm.column	yes	no	no	no	
COSMO	CAPE_ML	surface	sfc	yes	no	no	no	WRF	CAPE_ML	surface	sfc	postprocessable	no	no	no	
COSMO	CIN_ML	surface	sfc	yes	no	no	no	WRF	CIN_ML	surface	sfc	postprocessable	no	no	no	
COSMO	Lifted Index	surface	sfc	**no**	no	no	no	WRF	Lifted Index	surface	sfc	postprocessable	no	no	no	
COSMO	K Index	surface	sfc	**no**	no	no	no	WRF	K Index	surface	sfc	postprocessable	no	no	no	
COSMO	total totals index	surface	sfc	**no**	no	no	no	WRF	total totals index	surface	sfc	postprocessable	no	no	no	
COSMO	Theta-e	surface	sfc	**no**	no	no	no	WRF	Theta-e	surface	sfc	??	no	no	no	
COSMO	Wet bulb potential temp.	pressure	850	**no**	no	no	no	WRF	Wet bulb potential temp.	pressure	850	postprocessable	no	no	no	
COSMO	1000-500 thickness	layer		postprocessable	no	no	no	WRF	1000-500 thickness	layer		postprocessable	no	no	no	

Annex V

Proposed WRF Domains and Configurations for SWFDP-Eastern Africa

1. Redesign WRF Domains:

As discussed during the workshop, the current domains (see Figure 1) for operational WRF-NMM on KMD Linux Cluster may experience computational inefficiency because inappropriate grid ratio of West-East to South-North (~0.49, which is far less than 1) may cause over decomposition in parallel environment.

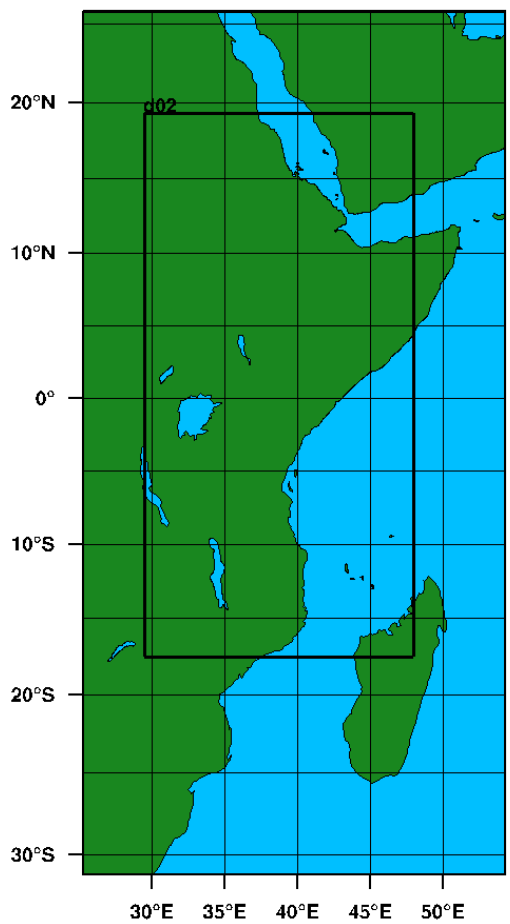


Figure 1 – Two nested WRF domains (at ~21 and 7 km grid spacing) used in current KMD operational WRF-NMM.

In addition, a strong west-east moving weather system may pass through the domain too fast for the model to develop necessary mesoscale processes. Therefore it is proposed to redesign the domains. Figure 2 shows the redesigned domains with the ratios of west-east to south-north at 0.96 and 0.81 at grid spacing of 18 and 6 km, which will be computationally more efficient though overall computing time may be increased because of increased model grids (~1.7 times). In comparison to the current domains in Figure 1, the new interior domain is also relatively far from its mother domain boundaries in the west and east sides while it still has reasonable space in the south and north sides to the boundaries.

The Lake Victoria is one of interesting areas to this project. Thus an additional domain was nested (Figure 3). This third domain is optional, and can be tuned on when enough computing power is available to interested parties.

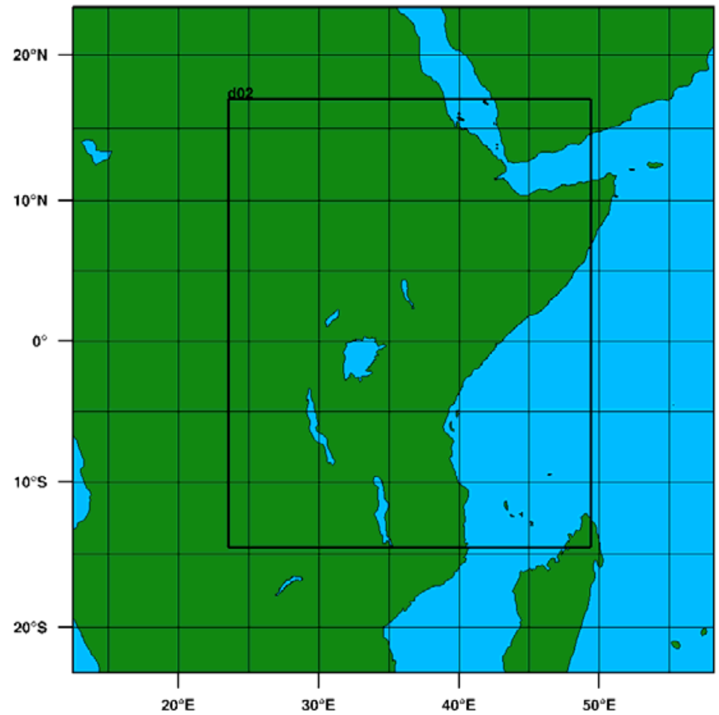


Figure 2 – Redesigned WRF domains (at 18 and 6 km horizontal resolution)

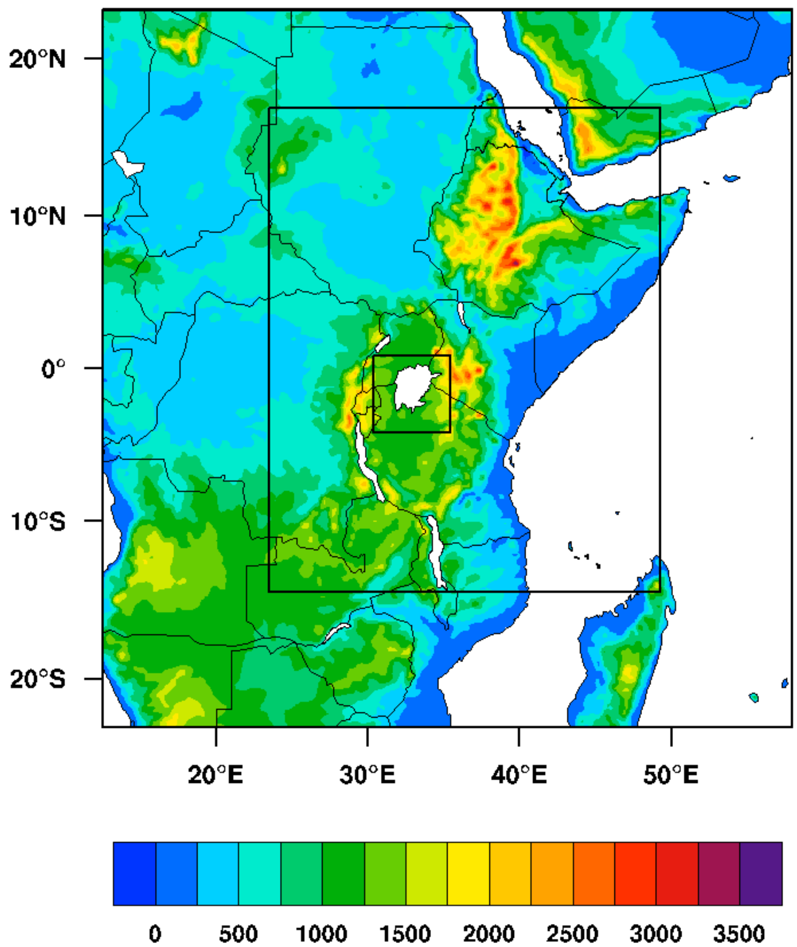


Figure 3 – Topography in newly designed three nested domains (at 18, 6, and 2 km grid spacing). The intermediate domain covers the area proposed by WMO SWFDP-Eastern Africa while the most interior domain is optional.

Table 1 – WRF model grid points in current and proposed domains

	Domain 1	Domain 2	Domain 3 (optional)
Current setting	134x274	256x518	NONE
Proposed setting	245x255	415x515	244x244

Table 1 lists the model grid points in current and proposed domains. The new domains are about 1.7 of the current setting in terms of area. Considering the power of the KMD Linux Cluster and current idle time, and increased time step (from 60 seconds to 90 seconds, see Section 2 for details), I think the new model domains should be feasible at least running first two domains. Domain 3 (Lake Victoria) is optional, but can be tested if KMD or other party has interest.

Since concerned weather systems in Eastern Africa can be affected by the Indian Ocean, forecasts from NWP models are therefore sensitive to the regional sea surface temperature (SST). One of the best SST products available is NCEP real-time, global, sea surface temperature (RTG_SST_HR) analysis at 1/12-degree (http://polar.ncep.noaa.gov/sst/ophi/Welcome.html). Thus daily 1/12-degree SST analysis is suggested to initialize WRF model instead of the default SST in GFS forecasts.

2. WRF Configurations & Test

Based on the knowledge and experience on tropical modelling, a set of model configuration is proposed as reference to start with. As we discussed and realized during the workshop, *necessary scientific studies on typical weather events/regimes are required to have optimal configuration*. The key options in the reference configuration are (numbers are used in WRF parameter files, see Appendix 1):

Microphysics: WRF Single-Moment 6-class scheme: A scheme with ice, snow and graupel processes suitable for high-resolution simulations (6).

Radiation (long and short-wave): New Goddard scheme: Efficient, multiple bands, ozone from climatology (5).

Frequency for radiation computation: every 60, 30 and 15 minutes for Domains 1, 2 and 3.

Surface Layer Physics: Eta similarity: Based on Monin-Obukhov with Zilitinkevich thermal roughness length and standard similarity functions from look-up table (2).

Boundary Layer Physics: Mellor-Yamada-Janjic scheme: One-dimensional prognostic turbulent kinetic energy scheme with local vertical mixing (2).

Land Surface Physics: Noah Land Surface Model: Unified NCEP/NCAR/AFWA scheme with soil temperature and moisture in four layers, fractional snow cover and frozen soil physics (2).

Cumulus Cloud Physics: Grell 3D is an improved version of the GD scheme that may also be used on high resolution (in addition to coarser resolutions) if subsidence spreading (option cugd_avedx) is turned on (5).

Frequency for Cumulus Physics: Every four timesteps for domain 1

Appendix 2 is the file (namelist.input) with the above necessary parameters.

With the proposed domains and reference configurations, I tested WRF-ARW (V3.3.1) with the windstorm event occurred at the beginning of March 2012.

Here is the test design, and the WRF model run successfully:
Initial and Boundary conditions: NCEP GFS ½-degree three-hourly forecasts.

All three WRF domains were **initiated at Feb. 29 2012 12:00UTC**, and were ended at March 03 2012 00:00UTC. **A 60-hour forecast with hourly model output.**
Timestep: 90, 30, 10 seconds for Domain 1, 2 and 3, respectively.

As an example, here are two snapshots from the test model run. Figure 4 is the surface wind (at 10 meter high above the ground) and 24-hour accumulated precipitation (valid at March 02 14:00UTC) from the 6-km intermediate domain (D2). Note only the Lake Victoria area in the domain 2 was plotted in the figure. It was apparent that there was strong precipitation around the Lake, and relatively strong wind in the north and northeast of the Lake (up to 26 knots), and strong wind shear on the Lake. While Figure 5 is as the Figure 4, but is from the 2-km domain (D3) forecast (the two figures do not cover exact area). As expected the higher resolution forecast shows quite similar patterns as the 6-km one in both precipitation and wind fields, but the 2-km one in Figure 5 does exhibit stronger wind (up to 28 knots) and more heavy precipitation.

Without observation and verification, it is hard to know how good or bad this test run is in terms of capturing the windstorm features (timing, strength, potential damage). As discussed during the workshop, it looked all the models (global and limited-area models) somewhat missed the windstorm. Thus observational data are critical for verification and further investigation.

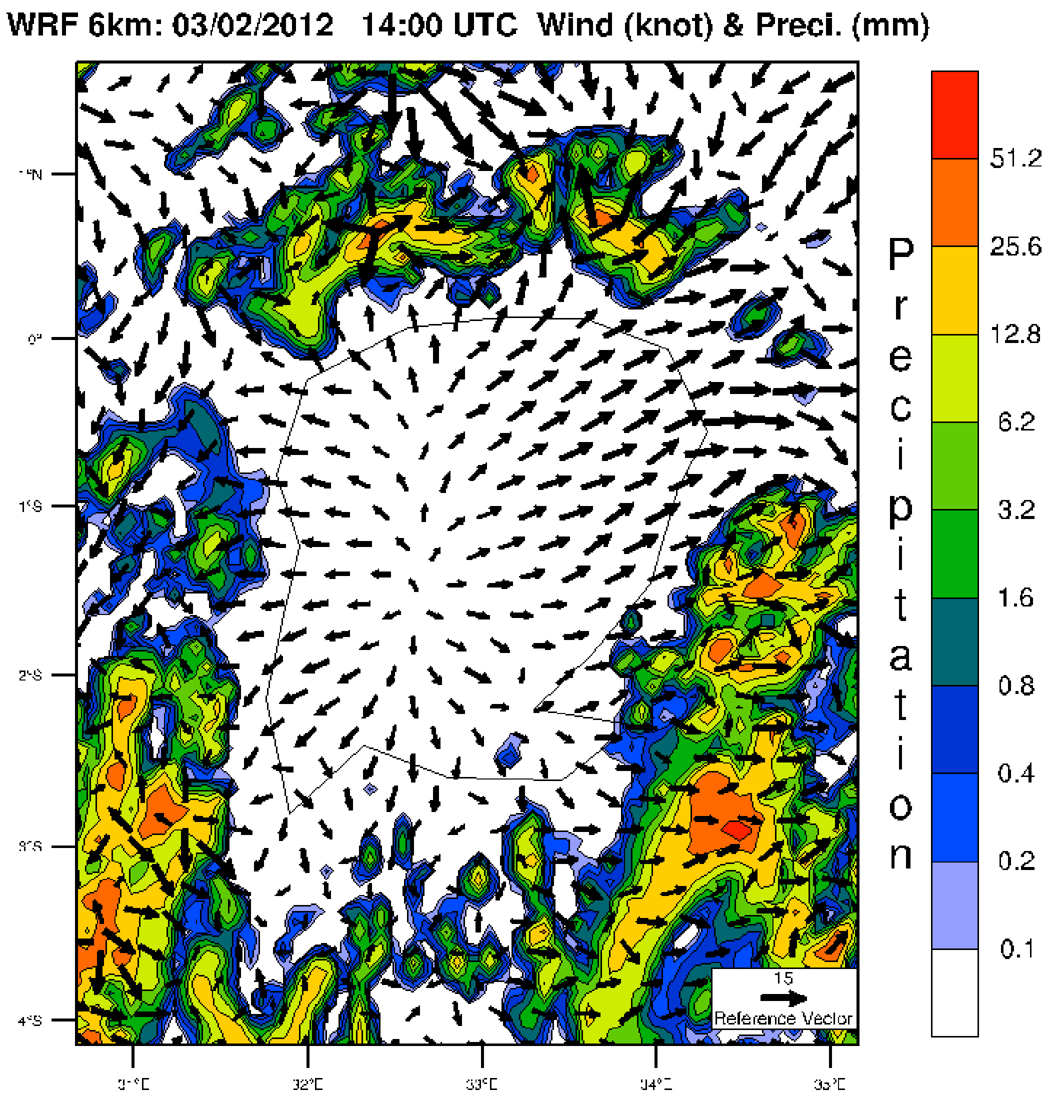


Figure 4 – **10-m Wind (knots)** and **24-hour accumulated precipitation** valid at March 02 14UTC at the Lake Victoria predicted by **WRF-ARW (3.3.1)** at 6 km resolution.

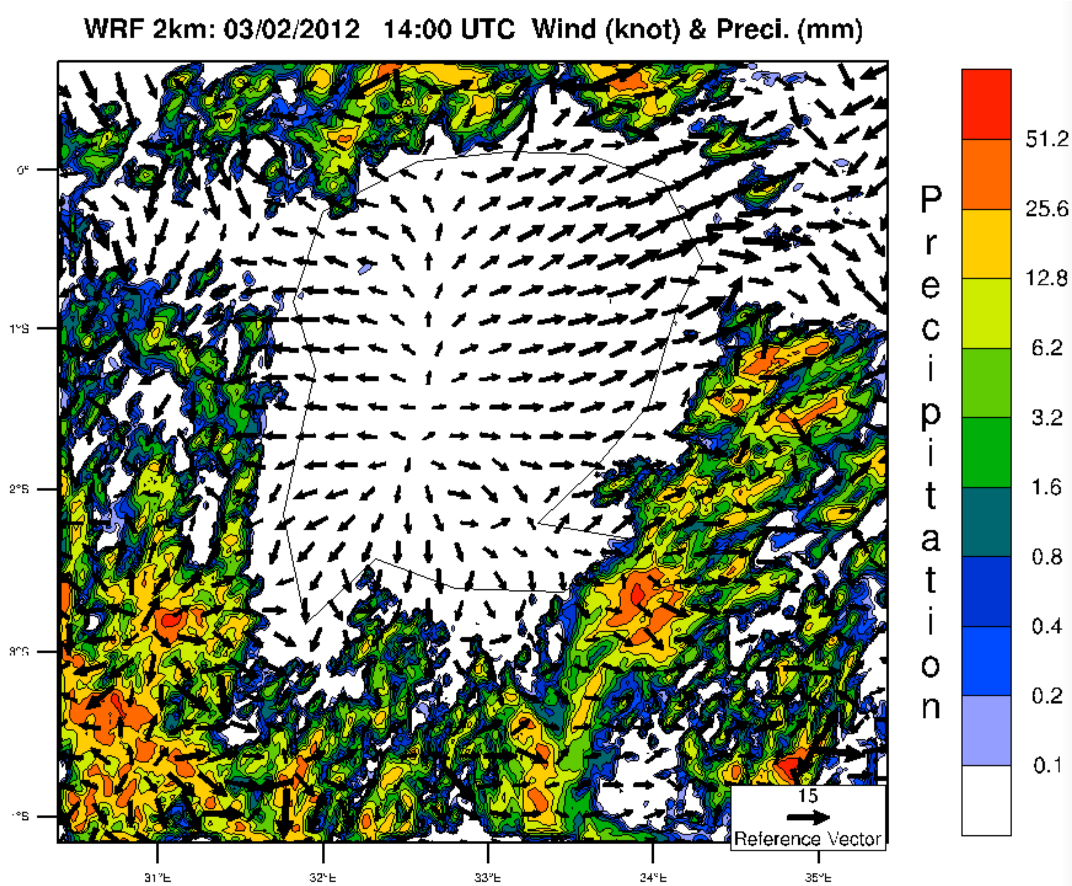


Figure 5 – **10-m Wind (knots)** and **24-hour accumulated precipitation** valid at March 02 14UTC at the Lake Victoria predicted by **WRF-ARW (3.3.1)** at 2 km resolution.

3. Appendices

3.1 File for Domain Creation: namelist.wps

(Note: this file can be applied to WRF-NMM after changing wrf_core ='ARW' to wrf_core='NMM')

```
&share
 wrf_core = 'ARW',
 max_dom = 3,
 start_date = '2012-02-29_12:00:00','2012-02-29_12:00:00',
 end_date   = '2012-03-03_00:00:00','2012-03-03_00:00:00',
 interval_seconds = 10800
 io_form_geogrid = 2,
 opt_output_from_geogrid_path = './KMDARW/',
/
&geogrid
 e_we                  =245,   415,   244,
 e_sn                  =255,   514,   244,
 parent_id             = 0,    1,     2,     3,     4,
 parent_grid_ratio     = 1,    3,     3,     3,     3,
 i_parent_start        = 1,    60,    112,
 j_parent_start        = 1,    49,    171,
 dx                    = 18000,
 dy                    = 18000,
 geog_data_res         = '30s',  '30s', '30s', '30s', '30s','30s',
```

```
 map_proj                 = 'mercator',
 ref_lat                   = 0.0,
 ref_lon                   = 35.25,
 stand_lon                 = 35.25
 truelat1                  = 30.0,
 truelat2                  = 60.0,
 opt_geogrid_tbl_path  = './'
 geog_data_path            = '/glade/user/wanliwu/WRF331/GEOG'
/
&ungrib
 out_format          = 'WPS',
 prefix               = 'FILE',
/
prefix                = 'SST',

&metgrid
 fg_name              = 'FILE', 'SST',
 io_form_metgrid = 2,
/
```

3.2 File for running WRF-ARW: namelist.input

```
&domains
 time_step                  = 90,
 time_step_fract_num       = 0,
 time_step_fract_den       = 1,
 max_dom                     = 3,
 e_we                          = 245,   415,   244,    88,   46,
 e_sn                          = 255,   514,   244,    88,    46,
 e_vert                        = 38,    38,    38,
 p_top_requested            = 5000,
 num_metgrid_levels         = 27,
 num_metgrid_soil_leve      = 4,
 dx                              = 18000,  6000, 2000.,
 dy                              = 18000,  6000, 2000.,
 grid_id                        = 1,     2,     3,
 parent_id                     = 0,     1,     2,
 i_parent_start              = 1,    60,    112,    56,    46,
 j_parent_start              = 1,    49,    171,    83,    46,
 parent_grid_ratio          = 1,     3,     3,
 parent_time_step_rati      = 1,     3,     3,
 feedback                       = 0,
 smooth_option                = 0
 /
&physics
 mp_physics                   = 6,     6,     6,
 ra_lw_physics               = 5,     5,     5,
 ra_sw_physics               = 5,     5,     5,
 radt                            = 60,    30,    15,
 sf_sfclay_physi             = 1,     1,     1,
 sf_surface_phys            = 2,     2,     2,
 bl_pbl_physics              = 1,     1,     1,
 bldt                             = 0,     0,     0,
 cu_physics                    = 5,     0,     0,
 cudt                             = 4,     5,     5,
cugd_avedx                    =  1,  3, 3
 isfflx                           = 1,
```

```
 ifsnow                        = 0,
 icloud                        = 1,
 surface_input_source        = 1,
 num_soil_layers              = 4,
 sf_urban_physics             = 0,     0,     0,
 num_land_cat                 = 24,
 prec_acc_dt                   = 60, 60, 60,
/
```

3.3 Physical options to run WRF-NMM

```
mp_physics            = 85,       85,   Modified Ferrier scheme for tropics
ra_lw_physics         = 98,       98,   Modified GFDL schemes
ra_sw_physics         = 98,       98,   Modified GFDL schemes
nrads                  =  60,       90, Number timesteps between Rad. Computed
nradl                  =  60,       90, Number timesteps between Rad. Computed
sf_sfclay_physics    = 2,         2,     Surface layer physics (Janjic scheme)
sf_surface_physics  = 2,        2,      Land surface model
bl_pbl_physics       = 3,        3,     GFS PBL scheme for tropics
nphs                   = 5,        15,     frequency of PBL  and Microphysics called
cu_physics            = 4,        4,      Arakawa-Schubert scheme for tropics
ncnvc                  = 5,        15,    Frequency of CU called
```