

WORLD METEOROLOGICAL ORGANIZATION

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ANNUAL JOINT WMO TECHNICAL PROGRESS REPORT ON THE GLOBAL DATA- PROCESSING AND FORECASTING SYSTEM (GDPFS) INCLUDING NUMERICAL WEATHER PREDICTION (NWP) RESEARCH ACTIVITIES FOR 2017

Tanzania Meteorological Agency (TMA)

United Republic of Tanzania

1. Summary of highlights

TMA runs the non-hydrostatic WRF models at 15-km resolution. The 5Km horizontal resolution is from the nested domain from the 15 km resolution. TMA is also running COSMO Model (ICON) for 48 hours with the resolution of 7km and 2.9km. Furthermore, TMA has continued running Wave Watch III (WWIII) wave Model for the marine forecasts over Indian oceans and major Lakes (Victoria, Nyasa and Tanganyika). After successful, converting TAC messages to a single BUFR bulletin, TMA is now running WRF data assimilation (3-DVar and 4-DVar) whenever there is a need especially in case of severe events.

TMA as Regional Forecasting Support Center continued to provide Severe Weather Forecasting guidance for the Lake Victoria Basin. The center has the responsibility to interpret information received from global and regional NWP centres, prepare daily guidance products (up to two days) for forecasters in all countries (Rwanda, Uganda, Kenya and Tanzania) around Lake Victoria and share through video conferencing.

In terms of human resources, TMA has seven NWP experts - three PhD holders, two Master degrees and two BSc. Degrees in various areas such as surface physics, data assimilation using 3-DVar, 4-Dvar and borgus for tropical cyclones over south-west Indian Ocean

2. Equipment in use at the Centre

High performance computing platform - cluster computer with 16 computing nodes continued working well with the following configuration:

- 16 -computation nodes; each with 2-socket, 8-core Sand Bridge Intel e5530 2.6 GHz processors, 32GB DDR3-1333 Memory, (2) 146GB 10K RPM SAS, interconnected via Infiniband (Total 192 Cores)
- 1- Master cluster node /Head node (dual-socket, quad-core Intel E5-2609 2.4 GHz, 32GB DDR3-1333 memory, 2 x 146GB 15K RPM SAS HDD) to manage;
- 1-IBM DS3500 Storage subsystem with 25.2 TB of storage (Raw) using 42 x 600 GB SAS 10K RPM drives

3. Data and Products from GTS in use

Synoptic observations and upper air observation, including satellite are used on a daily basis for forecasting and verification. Pre-processing procedures such as data acquisition and decoding are not fully automated and this becomes a blocking mechanism for data assimilation in the daily operational runs.

- SYNOP
- SHIP
- BUOY

4. Forecasting system

4.1 System run schedule and forecast ranges

Short- and medium-range forecast

At TMA NWP system runs based on 00UTC and 1200UTC analyses for the forecast length of 48 to 78 hours depending on the type of the model. WRF (Weather and Research forecasting model) runs for 48 hours with the resolution of 15km for the (course domain) bigger domain and for 5km (for the nested one) for smaller one. WRF also runs for 168 hours forecast for medium range forecast for detecting atmospheric situation like tropical cyclone in south western Indian Ocean. WWIII (Wave Watch III model) for the forecasts of wave height, speed and direction for the marine forecasts over Indian ocean, Lake Victoria and Lake Nyasa, which runs for 72 hours, initialised at 00UTC. Initial boundaries conditions for WRF are generated from NCEP GFS at 0.25x 0.25 degree.

Model	Version	Resolution	Forecast length	Initial and boundary conditions	Comment
WRF	3.8.1	5-15km	48-168 hours	NCEP	Daily run
COSMO		2.9 – 7 Km	48 – 72 hours	DWD	Daily
WRF BOGUS	3.0 TC track	10 km	48-168 hours	NCEP	During TC
WWIII	3	15km	168 hours	NCEP/GFS	Daily run

Long-range forecast

TMA runs WRF-ARW for long range forecast include monthly and seasonal scales. The initial and boundary conditions are from global Climate Forecast Systems version 2 (CFSv2) model. The model outputs products are used in monthly and seasonal forecasting for the country.

4.2 Medium-range forecasting system (4-10 days)

WRF model runs for 168 hours forecast for medium range (4- 7days) and (1-3months) for seasonal

forecast .

4.2.1 Data assimilation, objective analysis and initialization

4.2.1.1 In operation

TMA is currently doing data assimilation in operational mode. The models under data assimilation are WRFDA (3DVARs and 4DVARs).

4.2 Medium range forecasting system (4-10 days)

4.2.1 Data assimilation, objective analysis and initialization

4.2.1.1 In operation

Operational runs

4.2.1.2 Research performed in this field

In progress

4.2.2 Model

4.2.2.1 In operation

It is in operational runs at 168 hours forecast range.

4.2.2.2 Research performed in this field

In progress

4.2.3 Operationally available Numerical Weather Prediction (NWP) Products

In operational

4.2.4 Operational techniques for application of NWP products (MOS, PPM, KF, Expert Systems, etc.)

4.2.4.1 In operation

No operational runs

4.2.4.2 Research performed in this field

In progress

4.2.5 Ensemble Prediction System (EPS) (Number of members, initial state, perturbation method, model(s) and number of models used, number of levels, main physics used, perturbation of physics, post-processing: calculation of indices, clustering)

4.2.5.1 In operation

No operational runs

4.2.5.2 Research performed in this field

No research performed

4.2.5.3 Operationally available EPS Products

No

4.3 Short-range forecasting system (0-72 hrs)

4.3.1 Data assimilation, objective analysis and initialization

4.3.2.1 In operation

Now it is in operational runs.

4.3.2.2 Research performed in this field

In progress

4.3.2 Model

4.3.2.1 In operation

No operational runs

4.3.2.2 Research performed in this field

No

4.3.3 Operationally available NWP products

4.3.4 Operational techniques for application of NWP products (MOS, PPM, KF, Expert Systems, etc.)

4.3.4.1 In operation

No operational runs

4.3.4.2 Research performed in this field

No

4.3.5 Ensemble Prediction System (Number of members, initial state, perturbation method, model(s) and number of models used, perturbation of physics, post-processing: calculation of indices, clustering)

4.3.5.1 In operation

No operational runs

4.3.5.2 Research performed in this field

No

4.3.5.3 Operationally available EPS products

No

4.4 Nowcasting and Very Short-range Forecasting Systems (0-12 hrs)

4.4.1 Nowcasting system

4.4.1.1 In operation

Current TMA is using products available on Synergie system

4.4.1.2 Research performed in this field

No

4.4.2 Models for Very Short-range Forecasting Systems

4.4.2.1 In operation

No operational runs

4.4.2.2 Research performed in this field

No

4.5 Specialized numerical predictions (on sea waves, storm surge, sea ice, marine pollution transport and weathering, tropical cyclones, air pollution transport and dispersion, solar ultraviolet (UV) radiation, air quality forecasting, smoke, sand and dust, etc.)

4.5.1 Assimilation of specific data, analysis and initialization (where applicable)

4.5.1.1 In operation

TMA runs 168 hours of Wave Watch III operationally over South Western Indian Ocean and Lake Victoria for marine weathering and sea waves. The model is initiated by surface winds and temperature from Global Forecasting System model from NCEP.

4.5.1.2 Research performed in this field

TMA conducted research on marine weather especially the validation of a wave model WW III against satellite altimetry data over the South Western Indian Ocean domain. The results show that the model is relatively good in forecasting the significant wave height despite of lack of actual observations

4.5.2 Specific models (as appropriate related to 4.5)

4.5.2.1 In operation

No operational runs

4.5.2.2 Research performed in this field

No

4.5.3 Specific products operationally available

No

4.5.4 Operational techniques for application of specialized numerical prediction products (MOS, PPM, KF, Expert Systems, etc.) (as appropriate related to 4.5)

4.2.4.1 In operation

No operational runs

4.2.4.2 Research performed in this field

No

4.5.5 Probabilistic predictions (where applicable)

4.5.5.1 In operation

No operational runs. Uses available product on SWFDP Portal

4.5.5.2 Research performed in this field

No

4.5.5.3 Operationally available probabilistic prediction products

Heavy rainfall, strong winds and large waves

4.6 Extended range forecasts (10 days to 30 days) (Models, Ensemble, and Methodology)

4.6.1 In operation

TMA is operationally issuing the 10 days (Dekad) outlook on every 10, 20 and 31 or 30 of every month and 28 or 29 of February for the following 10 days

TMA is operationally issuing the 30 days (Monthly) outlook on every 31 or 30 of every month and 28 or 29 of February for the following month

Methods used in preparation of the extended forecasts are prepared by using statistical tools and downscaling of Global Circulation Models. Tools used: CPT tool, GeoCOF tool, SYSTAT tool, etc
Models used: Dynamical models from NCEP, ECMWF, UK-met, etc.

4.6.2 Research performed in this field

No research already completed.

4.6.3 Operationally available EPS products

Precipitation, Wind speed, Temperature and Waves

4.7 Long range forecasts (30 days up to two years) (Models, Ensemble, and Methodology)

4.7.1 In operation

- TMA is operationally issuing seasonal weather forecasts (3 months outlook)

- Methods used in preparation of the extended forecasts are prepared by using statistical tools and downscaling of Global Climate outlook.

-Tools used: CPT tool, GeoCOF tool, etc.

- TMA operationally run WRF for 3-months outlook

-Model products used: Dynamical models from NCEP, ECMWF, UK-met, Global leading centres, etc.

4.7.2 Research performed in this field

- Climate variability
- Determination of homogeneous zones

4.7.3 Operationally available products

- Precipitation
- Temperature during JJA

5. Verification of prognostic products

5.1 Annual verification summary

-TMA performs verification of daily and seasonal weather forecasts. The daily forecast is about 76.4% (POD) on average correct while the seasonal forecast is 83.8% on average correct.

-TMA is planning to install various verification packages include METv4 (Meteorological Evaluation Tool version 4) so that can be used for WRF model daily forecasting verifications.

5.2 Research performed in this field

There is no research already done.

6. Plans for the future (next 4 years)

6.1 Development of the GDPFS

6.1.1 Major changes in the operational DPFS which are expected in the next year

Additional capacity of available CLUSTER COMPUTER

6.1.2 Major changes in the operational DPFS which are envisaged within the next 4 years

Generation of Ensemble Prediction System products and data assimilation using radar data.

6.2 Planned Research Activities in NWP, Nowcasting, Long-range Forecasting and Specialized Numerical Predictions

6.2.1 Planned Research Activities in NWP

6.2.2 Planned Research Activities in Nowcasting

-TMA is finalizing to establishing a network of seven radars. As of now TMA have one radar in Dar ES Salaam and the second one is installed in Mwanza region. Thus the presence of a network of seven radars, TMA is planning to use COSMO and WRF models to do research on nowcasting.

-Severe convective storm formation in the country

- determination of models' accuracy and different season of the year

-Storm surge evolution and forecasting

-area of forecast for marine and coastal inundation (i.e. waves and storm surges). This research will be done using the WAVE WATCH III wave model.

6.2.3 Planned Research Activities in Long-range Forecasting

-Determination of intra-seasonal dry and wet spells

-Determination of onset and cessation of rainfall season

- Determination of new rainfall predictors

6.2.4 Planned Research Activities in Specialized Numerical Predictions

7. Consortium (*if appropriate*)

7.1 System and/or Model

7.1.1 In operation

No operational model

7.1.2 Research performed in this field

No

7.2 System run schedule and forecast ranges**7.3 List of countries participating in the Consortium****7.4 Data assimilation, objective analysis and initialization****7.4.1 In operation**

No

7.4.2 Research performed in this field

No

7.5 Operationally available Numerical Weather Prediction (NWP) Products

Mean Sea Level Pressure, 10 Meter winds, SkewT, precipitation, Relative Humidity

7.6 Verification of prognostic products**7.7 Plans for the future (next 4 years)****7.7.1 Major changes in operations**

TMA intends to start giving climate projection in collaboration with UK Met office. First by using WRF-ARW and PRECIS models, we will reconstruct climate conditions since 1851 to 2011 and then after that we will run PRECIS model based on different scenario, from 2011 to 2100.

TMA will start using MET (Meteorological Evaluation Tools) to verify our WRF output against observed so as to find out the performance of the WRF model, in daily and medium range forecasting.

7.7.2 Planned Research Activities

-TMA by using the mention models above (WRF-ARW and PRECIS model), do research on the climate change over Tanzania

- TMA intends to carry out research into the level of air quality in some cities such as Dar Es Salaam to evaluate the quality of air. This exercise will be done by putting some measuring equipment of air quality first. And the data acquired will be the initial input (Initial condition) to the WRF model and make simulation of the air quality using WRF (Chemistry) model later. This simulation will help as guidance relating to air pollutions over Tanzania.

- TMA intends to carry research on land use and change using WRF-ARW model and analyze the impact land use in prediction of temperature and rainfall over Lake Victoria Basin