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WEATHER PREDICTION SIMULATIONS FOR EAST AFRICA

Julianne Sansa-Otim
Mary Nsabagwa

IoT-ra lab
Makerere University
Makerere Hill Road
Kampala, UGANDA

Isaac Mugume

Uganda National Meteorological Authority
Luzira Portbell Road
Kampala, UGANDA

ABSTRACT

Numerical weather prediction (NWP) simulations contributes significantly in the production of appropriate weather forecasts. These critical capabilities were still largely lacking in East Africa in the early 2010s and were recently established under the auspices of the WIMEA-ICT Project. The project introduced the use of the Weather Research and Forecasting (WRF) model in the region. This model was adopted by the National Hydro-meteorological Agencies and is largely being used as guidance in the operations. However, due to advances in technology, there is a need to build capacity in integrating the available weather data in NWP simulations; as well as using Machine Learning to further improve the accuracy of weather and climatic predictions. Additional crop weather modelling studies will further inform agricultural productivity enhancement in the region.

1 INTRODUCTION

The National Meteorology Services (NMSs) in the East African region face several challenges while executing their mandate of managing weather, hydrologic and climate information. This information is vital for decision making in various sectors. Inadequate and inappropriately packaged weather information has particularly resulted into problems such as low agricultural productivity, deaths due to weather related diseases, delayed delivery times in the construction and energy industry and weather-related accidents on the lakes especially Lake Victoria where about 3000 people die every year (Semazzi, F.). In addition, this region has experienced droughts, mudslides and floods leading to loss of lives, property, infrastructure, and displacement of hundreds of thousands of people.

A feasibility study before the implementation of the WIMEA-ICT Project (Sansa-Otim, J.) highlighted critical challenges pointing to the need for capacity building in numerical weather prediction for the region. These were: i) Manual data processing due to lack of computers, software (plotting, modelling, forecasting, format conversions) and expertise resulting into delayed analysis; ii) The available weather information was neither properly packaged nor readily accessible to the various stakeholders; and iii) Lack of continuous professional development (in ICT skills e.g. programming, data management, modelling and forecasting, hardware maintenance and network management) to cope with emerging trends in weather prediction and analysis.

To address these challenges the WIMEA-ICT project set out to establish operational NWP models for the three East African countries (Uganda, Tanzania, and South Sudan) and for the East African region. This involved building NWP expertise through training as well as setting up server clusters on which the NWP models ran. Thereafter model enhancement studies for increased accuracy in weather forecasting were

conducted. The WRF modelling system was the starting point because some of the partners had prior experience with it and it is open and freely available.

2 NUMERICAL WEATHER PREDICTION STUDIES

Traditionally, meteorologists carried out weather prediction by analyzing the drivers of weather and atmospheric systems. This was supplemented with the guidance obtained from the global numerical weather and climate prediction centers, e.g., UK's Unified Model; the European Center for Medium Range Weather Forecast Model, etc. The running of locally customized operational weather prediction models was limited over Uganda, Tanzania, and South Sudan. Efforts to build capacities in NWP started with the e-WRF (Mesquita, M.D.S), a virtual tutorial that introduced participants to the WRF model.

The WRF model became an NWP of choice in the region; and, indeed the IGAD Climate Prediction and Applications Center (ICPAC) furthered and conducted a series of training on WRF for the IGAD region; including Uganda. Eastern Africa now has fully developed capacity in NWP. NWP, especially the WRF model, is the main model input into daily and seasonal weather predictions.

In a study to compare the parametric and non-parametric methods while simulating surface air temperature (Mugume, et al. 2016), the results showed that the WRF model reasonably predicted the trends and signals of surface air temperature over Uganda. A related study (Opio et al. 2020) observed that the WRF model can be used to simulate extreme rainfall over Lake Victoria Basin.

There is less documentation regarding the use of data assimilation in improving weather and climatic prediction, except over Tanzania. Additionally, the use of Machine Learning in improving and conducting simulations in weather and climatic prediction over the Eastern African region is less documented.

3 CROP WEATHER PREDICTION STUDIES

The WIMEA-ICT project has supported a couple of crop weather modelling studies. In these simulations, the WOrld FOod STudies model (WOFOST) was used to address the key question "given a seasonal weather forecast, what crop production level should be expected?" (Nsabagwa, et al. 2021). The WOFOST model is indeed a helpful guidance tool for agro meteorological services as it accurately predicted crop yield.

4 CONCLUSIONS AND FURTHER WORK

The use of NWP as a guidance in simulating weather and climate over East Africa is now developed. To further improve and promote using NWP, there is a need to build capacities in data assimilation and Machine Learning. More crop modelling studies for different crops and regions will also be valuable.

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