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Resilient nations.*



**Training
on
Mesoscale Weather Forecasting System
5-9th August 2019**

**Demonstration of
Weather Research and Forecasting (WRF)
Installation, Operation, and Maintenance**

For
Department of Meteorology, Cambodia
2019

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ABREVIATIONS

NWP: Numerical Weather Prediction

WRF: Weather Research and Forecasting

NCEP: National Center for Environmental Prediction

RIMES: Regional Integrated Multi-Hazard Early Warning System for Africa and Asia

NCAR: National Centre for Atmospheric Research

WRF DA: Weather Research and Forecast Data Assimilation

1. Training Objective and Scope

RIMES capacity building program on numerical weather prediction (NWP) aims to enhance capacity of operational forecasters from national meteorological and hydrological services (NMHSs) to produce short-range weather forecast products for their respective countries. This training shall introduce participants on the basic concepts of weather forecasting, and practice them on tools, techniques, and models used for generating forecast products.

RIMES has been using the Weather Research and Forecast (WRF) model for weather forecasting, an open source package, developed at the U.S. National Center for Atmospheric Research (NCAR). The training shall cover basic aspects of working on Linux operating system, WRF modelling environment, and weather forecasting. Training modules and delivery shall be customized based on the requirement of the meteorological service and on level of expertise of its staff.

2. Expected Outcomes

At the end of the one-week training program, participants are expected to have:

- Knowledge and familiarity on using Linux environment for numerical modeling
- Skill on installation, customization, and simulation of WRF model for their domain of interest
- Ability to generate experimental short-range forecast for their domain of interest

3. Participant Selection Criteria

Participants are desired, although not strictly required, to have the following knowledge and skills:

- a) Very novice skills on Linux operating system
- b) Knowledge on weather forecasting concept
- c) Knowledge about global forecast models
- d) Observation data analysis skills, using Excel or any other tools

Key requirements from participants are:

- a) Clear understanding of the climate of the country
- b) Involvement in daily forecast operations, to ensure that the model will be used beyond the training period

4. Training Components

The training is scheduled for one week, which should provide ample time to cover the components described below, along with hands-on exercises for most of the sessions.

4.1 Introduction to Linux Operating System

The training is designed with the assumption that most participants do not have much knowledge about Linux operating system environment. Thus, the first few sessions will be spent on explaining the very basics of the operating system and in working in Linux environment.

The users can use individual notebooks or remote access shall be provided, enabling each participant to gain server access for performing tasks during practical sessions. Practical sessions shall focus on working in a multi-user environment, familiarization on the Linux platform, and practice on basic commands.

4.2 Basics of Mesoscale Weather Prediction

This will provide a brief on the theoretical aspects of atmospheric science, and the different forecasting techniques. This would include basics of weather dynamics, to understand how atmospheric parameters are observed and measured, as well as mesoscale weather system formation. This shall include:

- Dynamics of weather systems and concept
- Mesoscale numerical weather prediction modeling
- Understanding WRF model dynamics and physics

4.3 NWP Model Customization (WRF version 4.1.2)

The WRF model will be accessed and all other relevant packages will be collected from the UCAR web links (http://www2.mmm.ucar.edu/wrf/users/download/get_sources.html) and other supporting packages from various other web sources. For this training, the latest version of the model will be used. The packages include:

a. Getting model source codes

- WRF model (WRF v4.1.2)
- WRF preprocessor (WPS v4.1.2)
- Post-processing utilities, (ARWpost version 3.1)
- Visualization (GrADS v 2.1)
- Other model dependencies will be installed during the course of demonstration and hands-on

b. Identifying data sources and access

WRF model requires a number of data for initialization, including geostatic land use, land cover, and topography data from USGS. This also includes access to global model outputs, to force the customized WRF model. Data collection methodologies shall be demonstrated.

4.4 WRF Modeling and Real-Time Simulation

Once the model setup is complete, participants could customize the model by changing the parameters to their region of interest, undertake experimental simulation for weather in real-time, visualize outputs, and interpret images.

4.5 Forecast Verification Techniques

Verification of the modeled forecast products is an essential part of the operational forecasting unit. This provides a knowledge of the performance of the model over the region and for any season. This also gives an opportunity to improve the model performance through experiments. Verification processes with indicators include the RMSE, Pearson Correlation, POD, HR and other standard verification methods prescribed by the World Meteorological Organization.

5. Training Evaluation

At the end of the training program, participants shall provide feedback on:

- Structure and content of the training program
- Usability of training materials provided
- Facilitators' inputs
- Method of delivery
- Knowledge, skills, and abilities gained
- Relevance of training to their work and personal development
- Overall effectiveness of the training

An evaluation form shall be distributed to get responses from participants. Results shall be used to refine the training program.

Name of Instructor	Position	Expertise in
Mr. Itesh Dash	Lead, Systems Research	Linux, WRF Model, verification, data assimilation

Draft Program
Training at Department of Meteorology, Cambodia
5-9 August 2019

Day 1	Training Component (Linux, Weather Dynamics, WRF)	Facilitator
Introduction to Linux OS and operating environment	<ul style="list-style-type: none"> • Basics of operating systems • Working with Linux environment • Mastering the command line environment (CLE) • Linux file editor environment (vi/gedit) 	Mr. Itesh Dash
Installation of OS and starting with CLI	<ul style="list-style-type: none"> • Hands-on exercise throughout the session (working with Linux) • User space creation in the server for practice 	Mr. Itesh Dash
Day 2 – Model installation and running		
Basics of mesoscale modelling & theory of weather systems	<ul style="list-style-type: none"> • Dynamics of weather systems and concept • Mesoscale numerical weather prediction modeling • Understanding the WRF Model dynamics and physics 	Mr. Itesh Dash
Introduction to WRF modeling environment	<ul style="list-style-type: none"> • Overview and applications of WRF • Introduction to RIMES WRF • WRF Modeling Systems 	Mr. Itesh Dash
Day 3 – Model installation and running - continue		
WRF Model compilation and installation	<ul style="list-style-type: none"> • Understanding the structure of WRF modeling environment • Accessing source codes • Dependent Libraries Installation and environment variable setup • Building WRF model from source code • WRF modeling with customized domain setup • Access to static terrain datasets • Pre-processing, model interpolation • WRF Model Experimental Simulation setup • Access to the forcing data and model run 	Mr. Itesh Dash
Day 4 – Visualization and Verifications		
Post process tools	<ul style="list-style-type: none"> • Post-processing and visualization • Interpretation of model outputs • Troubleshooting and intricacies of WRF model simulation 	Mr. Itesh Dash
Model verification techniques	<ul style="list-style-type: none"> • Model verification process • Introduction to CDO and standard verification methods • Data processing and preparation and result interpretation 	Mr. Itesh Dash
Day 5	<ul style="list-style-type: none"> • Final Presentations 	