WEATHER CLIMATE WATER
TEMPS CLIMAT EAU

WMO OMM
World Meteorological Organization
Organisation météorologique mondiale
Organización Meteorológica Mundial
Всемирная метеорологическая организация
المنظمة العالمية للأرصاد الجوية
世界气象组织

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Notre réf.: 04467/2020/MS/ETR/FEL

4 mars 2020

Annexes: 2 (disponibles en anglais seulement)

Objet: Cours de formation en groupe sur la prévision numérique du temps (Centre régional de formation professionnelle du Service indonésien de météorologie, climatologie et géophysique (BMKG), Indonésie, 6 juillet–28 août 2020)

Suite à donner: Pour information et mesures à prendre, le cas échéant, avant le **15 mai 2020**

Madame, Monsieur,

Consciente du rôle que joue la prévision numérique du temps dans le bon déroulement des activités de prévision météorologique et de surveillance du climat, l'OMM organise le cours de formation susmentionné au Centre régional de formation professionnelle du BMKG, en Indonésie, du 6 juillet au 28 août 2020.

Cet atelier, qui se déroulera en anglais, est destiné à améliorer les connaissances pratiques et théoriques de participants provenant de Services météorologiques et hydrologiques nationaux. Une note d'information est jointe dans l'annexe I à toutes fins utiles.

Le centre de formation ne pouvant accueillir qu'un nombre limité de participants, il peut ne pas être possible d'accepter plus d'un candidat par pays, sauf circonstances particulières. Il convient de préciser que le cours proposé s'adresse aussi bien aux femmes qu'aux hommes.

Les personnes intéressées sont invitées à remplir le formulaire d'inscription disponible à l'adresse https://public.wmo.int/en/resources/training/fellowships. Il est nécessaire de renvoyer avant le **15 mai 2020** tant le formulaire de candidature de l'OMM que celui du BMKG (voir l'annexe II) à l'OMM et au BMKG, par courriel à fel@wmo.int et apply.rtcbmkg@bmkg.go.id. Une copie du passeport des candidats retenus sera exigée.

En vous remerciant de la coopération établie entre votre pays et l'OMM, je vous prie d'agréer, Madame, Monsieur, l'expression de ma considération distinguée.

(W. Zhang)
pour le Secrétaire général

Aux: Représentants permanents (ou directeurs des Services météorologiques ou hydrométéorologiques) des Membres du Conseil régional V

cc: Conseillers en hydrologie auprès des représentants permanents

04467/2020/ETR/FEL, ANNEX I

COURSE INFORMATION & SYLLABUS

TRAINING ON THE ENHANCEMENT OF NUMERICAL WEATHER PREDICTION

Course Location

Regional Training Centre Facilities in Citeko, West Java, State College of Meteorology, Climatology and Geophysics (STMKG), Tangerang and BMKG Headquarter in Jakarta.

Course Description

Located in prone areas, the WMO RA V Members affected by severe weather phenomena such as tropical cyclones, droughts, flood and prolonged heavy rain which adversely affect the economy and the society. Reliable numerical prediction is essential to improve weather early warning forecast.

The training program will be conducted in 3 phases to ensure learning outcomes achieved and its successful implementation to improve operational weather services in participant's respective Members particularly in NWP capacity improvement.

The 1st phase is the 8 weeks training course, with objectives is to improve participant's competency in NWP high resolution products using WRF model as well as to develop the action plan. The 2nd phase will be conducted after the participants are back to their home country in the form of online learning. During a month, participants will be mentored by BMKG experts in their action plan strategy implementation. The 3rd phase is the site visit program to participant's respective Members by BMKG experts to monitor the progress, evaluate the action plan implementation, discuss the impact, challenge and opportunity for the project improvement and sustainability.

Learning Outcomes

This is a hands-on course in NWP, focusing on mesoscale phenomena and dynamics, with an emphasis on the simulations of mesoscale weather systems, model verification techniques and model physical parameterizations utilizing Weather Research and Forecasting (WRF) model as principal tool. The goal of this course is to enable participant to develop their own NWP capacity to be implemented in their respective Members based on their needs. The participant is expected to enhance the capacity of NWP by applying NWP models for tropics region of WRF (operation, analysis and interpretation) in operational weather service with high resolutions.

Association to Standards

- Basic Instructional Package for Meteorological Technicians (BIP-MT) as described in WMO 1083 – Manual on the Implementation of Education and Training Standards in Meteorology and Hydrology;
- Technical Regulations Basic Documents No.2, Vol I – General Meteorological Standards and recommended Practices;
- Accredited by The Agency of Meteorology Climatology and Geophysics (BMKG).

Course Objectives

Job Competencies to be addressed by the training according to WMO Competency Framework for PWS Forecaster and Advisors are:

- Demonstrates a knowledge of NWP Basic;
- Demonstrates ability of displaying NWP products utilizing R Program and GrADS Software;
- Using Advance WRF techniques to data analysis and interpretation;
- Using NWP model to forecast hazardous weather phenomena and parameters.

Desired learning outcomes of the planned event, written as measurable learning objectives:

- Understand the use and benefit of NWP for operation;
- Applying Linux basic command;
- Able to operate Weather Research and Forecasting (WRF) model to simulating extreme weather;
- Able to display output of WRF model utilizing R Program;
- Able to process ensemble from WRF model output;
- Identify extreme weather parameter from the output of advance post processing.

Target Audience and Qualifications

The primary audience will be Meteorologist (15 persons) from WMO RA V Members. Participants have at least a bachelor degree or have an equivalent level of academic background. They are expected to have 2-year experiences as Meteorologist, have basic knowledge and skills of NWP modelling, preferably under the age of 35 years old and have sufficient command of spoken and written in English.

Program Overview

Title: Training on the Enhancement of Numerical Weather Prediction 2020

Duration: 6 July – 28 August 2020

Goal: The goal of this course is to enable participant to develop their own NWP capacity to be implemented in their respective Members based on their needs. The participant is expected to enhance the capacity of NWP high resolution model.

Language Used

This course will be conducted in English

Application and Selection Process

The applicant should be nominated by the Permanent Representative of WMO in the respect WMO Member;

The nominated candidates are requested to submit the completed WMO Fellowship Nomination Form (FNF) (https://www.wmo.int/pages/prog/dra/etrp/documents/Fellowship-Nomination-Form-en.pdf) to WMO and BMKG.

Accepted applicants who receive the Award Letter of WMO and Admission Notices of BMKG can participate in the training course.

Deadline for Application and contact

Application has to be sent to WMO and BMKG the WMO Fellowship Nomination Form and BMKG Application Form no later than 15 May 2020 to fel@wmo.int and apply.rtcbmkg@bmkg.go.id. A copy of the candidate's passport will be required if awarded.

Summary of Content

	Objectives	Activities	Output
1st Phase	Improve the capability of NWP high resolution products using WRF model for meteorological services Develop action plan (under mentor supervision of BMKG experts)	8 weeks training course with major learning activities of lectures, discussions, case studies, collaborative decision making, exercise, project report and action plan	Action Plan
2nd Phase	Develop the utilization of NWP (WRF Model) to improve operational weather services Develop action plan implementation strategy	Implement NWP (WRF Model) in operational weather services Long distance/online mentoring of action plan implementation	Short interim report on results of NWP (WRF Model) utilization for operational weather services
3rd Phase	Confirm action plan by identifying the problems and make adjustments to the implementation based on the respective country's capabilities. Conduct training evaluation level 3 to evaluate impact of the training to the performance improvement	Visit participant's respective country to monitor the progress, evaluate the action plan implementation, discuss the impact, challenge and opportunity for the project improvement and sustainability	Report on results of NWP (WRF Model) implementation for operational weather services in participant's respective Members

The training will have the following contents:

1. Introduction to NWP Application
2. Ubuntu Linux System Operation
3. NWP Basic
    1. The Principles and Concepts of NWP
    2. Unreliability of NWP
    3. NWP Equation
    4. Types of NWP Models
4. Consortium for Small-scale Modelling (COSMO)
5. Ubuntu Linux System Operation
6. Weather Research and Forecasting (WRF) Model
    a. WRF Model Introduction and Application
    b. WRF model parametrization
    c. WRF Installation
    d. WRF Simulation Procedure
    e. WRF Simulation of Extreme Weather Events
7. Post-Processing Application and Visualization
    a. Application of Post-Processing WRF Model using Grads, VAPOR and R Programme
    b. Displaying WRF Model
    c. Interpreting WRF Products to identify weather parameter
8. Verification Techniques
9. WRF Simulation in High Performance Computing (HPC)
10. Advance WRF Model
    a. WRF Data Assimilation
    b. WRF Ensemble
    c. WRF Tropical Cyclone
11. Ocean Model
    a. Introduction to Ocean Wave Model
    b. Ocean Wave Model Application
12. Climate Model
    a. Introduction to Climate Model
    b. Regional Climate Model (RegCM) Application
13. Application on NWP products in BMKG Daily Weather Forecast (Practical Session)

Course Content

- **Introduction to NWP Application**
    a. Describe the NWP application for analysis and interpretation of tropical cyclone and extreme weather
        - Tropical cyclone trajectory, stage and location
        - NWP products for tropical cyclone and extreme weather: ECMWF, GFS, WRF, ACCESS and WRF TC
        - Weather Physical Parameterization: Cloud Cover, Sea Surface Temperature, Wind Speed and Direction, Mean Sea Level Pressure, Rainfall Distribution, Rainfall Accumulation (hourly, daily), Rain Rate, Cloud Type and Horizontal Wind Speed and Direction

- Stability Index: Convective Available Potential Energy (CAPE), Lifting Index (LI), K-Index, Showalter Index
- Convergence and divergence area and value
- Vorticity, Vertical Velocity and Mixing Ratio Value

b. Describe the NWP application for analysis and interpretation of Volcanic Ash and Forest Fire
   - NWP products for volcanic ash and forest fire detection: WRF-Fire and WRF-Chem
   - Types of Aerosol: SO2, NO2, Ice Particle and Ash
   - Volcanic ash and Fire Event Location
   - Ash and smoke dispersion

- **Ubuntu Linux System Operation**

  Understand Ubuntu Linux System Operation

  - Basic operating system concepts: features and benefit of Ubuntu
  - Ubuntu-Linux installation procedure
  - Ubuntu-Linux file system: Understand Ubuntu Menus, managing Files & Folders, Location (Path) of files and folders
  - Ubuntu-Linux Basic Command

- **NWP Basic**
  1. Recall the Principles and Concepts of NWP
  2. Recall Unreliability of NWP
     Factors behind potential NWP Unreliability: Errors in initial conditions, differences between model atmosphere and actual conditions, computing limitations, chaos in non-linear terms in NWP modelling and Butterfly Effects
  3. Recall the NWP Equation
  4. Describe the Types of NWP Models
     a. Grid point models
     b. Spectral models
     c. Hydrostatic models
     d. Non-hydrostatic models

- **Consortium for Small-scale Modelling (COSMO)**
  1. Describe COSMO model introduction
  2. Describe COSMO model application

- **Weather Research and Forecasting (WRF) Model Introduction and Application**

  Describe WRF modelling system

  - Two Dynamical cores of WRF: Advanced Research WRF (ARW) for research and Non-Hydrostatic Mesoscale Model (NMM) for operational
  - Benefit of using WRF

- WRF Parametrizations: Radiation transferred through the atmosphere, Planetary Boundary Layer and Surface Layer, Cumulus Convection, Microphysics of clouds and precipitation, and interaction with earth surface
- WRF Applications: Parametrization research, case studies, short-range forecast, data assimilation etc.
- WRF Types and Versions
- WRF Standard Initialization: Inputs (Grids location/levels, terrain/land-use, Gridded Fields (GRIB)
- WRF Global Model Data: Global Forecast System (GFS), Final Analysis (FNL) Global Data Assimilation System (GDAS) and ECMWF Models
- WRF Modelling System Components
- WRF Application Function (WPS, WRF RUN, ARW POST)

- **WRF Installation Procedure**
  a. Understand the required components for WRF-ARW Version 4.0 Software Installation
  b. Pre-installation
     - Compiling the module and creating libraries
     - Building the WRF Code
     - Building the WPS Code
  c. Demonstrate the steps of WRF-ARW Version 4.0 Software Installation
     - Checking the required libraries
     - WPS installation steps (configure-compile)
     - Setting the name list (domain, geogrid, data initial, etc)
     - Running the WPS
     - WPS Outputs
  d. Demonstrate the WRF-ARW Running Process
     - Checking the required libraries
     - WRF Installation (configure-compile)
     - Setting the name list (time step, parametrizations, nesting, etc.)
     - WRF Outputs
  e. Demonstrate ARW Post Installation and identify the errors
     - Checking the required libraries
     - ARW Post installation steps (configure-compile)
     - Setting the name list (input, output, plot etc)
  f. Identify and solving error issues

- **WRF Simulation Procedure**
  a. Able to configure and prepare the WRF-ARW Version 4.0 (before running simulations)
  b. Demonstrate the simulation steps
     - - Data Initial Downloads
     - - Setting the domain and name list
     - - Running procedure
     - - Plotting the output
  c. Identify weather parameters through extreme weather simulation (a case study)

- **Post-Processing Application and Visualization**
  a. Demonstrate application of Post-Processing WRF Model using Grads, VAPOR and R Programme function and language
     - Introduction to Grads, VAPOR and R Programme
     - Software Installation, Basic Command, General Scripts (.gs), Visualizations, Saving Files, Troubleshooting
  b. Interpreting WRF Products to identify the weather parameter: Rainfall Distributions, Clouds (type, height and radius), Temperatures, and Wind Speed and Direction

- **Verification Techniques**
  a. Using Eyeball and Contingency Table verification techniques to evaluate the WRF output for exp. rainfall accumulation
  b. Using statistics verifications techniques to evaluate WRF output: Root Mean Squared Error (RMSE), Mean Absolute Error (MAE) and Scatter Plot

- **WRF Simulation in High Performance Computing (HPC)**
  a. Understand about High Performance Computing Unit
     - Benefits of uses HPC
     - HPC Components (Hardware and Software)
     - HPC Architecture
     - Parallel Computing: OPEN Message Passing Interface (MPI) and MPICH)
  b. Able to install and run WRF in HPC

- **Advance WRF Model**
  a. Understand technique (3Dvar and 4Dvar), type of observation data assimilation and utilization of the WRF Data Assimilation (WRFDA) system
     - WRFDA Principles, Concepts and Technique
     - Background of Error Concept
     - Preparation of Observation Data (Synoptic and Weather Radar)
     - WRFDA Running Procedure
  b. Understand principles, technique, type and utilization of Ensemble Forecast System
  c. Able to process ensemble from WRF model output
  d. Understand principles, technique and utilization of WRF Tropical Cyclone (WRF TC) system technique
  e. Able to run simulation on WRF (DA or TC)
  f. Identify extreme weather parameter from the output of advance post processing
  g. Verify WRF output with observation data

- **Ocean Model**
  a. Explain the Ocean Wave Model products for operational forecasting
     - Wave Model products: Significant Wave Height, Swell Height
     - Hydrodynamics Model: Sea Temperature, Sea Salinity, Sea Current
  b. Demonstrate Ocean Wave Model Application: Wave Model (Wavewatch III), Wave Model Nearshore (SWAN)
     - Installation

- Configuration and preparation input
- Simulation
- Visualization

c. Interpret Ocean Model products from Wavewatch III, SWAN and Hydrodynamics Model

- **Climate Model**
  a. Understand the role of atmosphere, ocean, cryosphere and land surface inside the climate system and their interaction
  b. Understand the mechanism of how earth's energy is energizing the climate system and affecting hydrological and carbon cycle
  c. Understand state of the art of climate model, its historical development, the utilization the numerical resolution of the equations and how the scientist testing the validity of models

- **Application on NWP products in Daily Weather Forecast (Practical Session)**
  a. Recognize BMKG weather forecast operation services
     - Weather Prediction Operation
     - Early Warning Operation
     - Weather Radar and Satellite Operation
     - Weather Information and Dissemination Operation
  b. Recall Multi-Model Analysis used in BMKG
  c. Recognize BMKG Daily Weather Forecast Operation
     - Daily Model Evaluation
     - Observational Data
     - Weather Global and Regional Model
  d. Recognize Nowcasting Techniques used in BMKG
  e. Understand Impact Based Forecast Implementation in BMKG

Pre-course Content, Activities or Assessment

Participant will have to prepare a short presentation about the current status of NWP products and models in their operational weather services.

Pre-course Content, Activities or Assessment

BMKG experts will assist the participant with the course implementation in their country. This assistance could be applied in form of mentoring and site visit.

Course Format

Participant will attend 8 weeks classroom training course that will be conducted in BMKG InaRTC Training Facility in Citeko Bogor, BMKG Headquarter Jakarta and State College of Meteorology, Climatology and Geophysics (STMKG) Tangerang. There will be another 2 weeks for the project assignments in BMKG Headquarter Jakarta. Asynchronous online platform will be available for distributing reading materials, quizzes, assignments and forum discussions.

The major learning activities that will be included but not limited to:

- Lectures
- Discussions
- Case studies
- Collaborative decision making
- Exercise
- Project Report and Action Plan

Learning Assessment and Evaluation

Initial assessment will be done through each participant country report presentation to assess the NMHS's capacity in NWP operation. For formative evaluation, case studies and discussions will be used during classroom sessions and some quizzes will be delivered in online sessions. At the end of the course, participants will have to write a project report and action plan about how he/she will implement the enhancement of NWP modelling in their NMHSs.

Instructor and Qualifications

Instructors are experienced Meteorologist, Lecturers and Researchers from BMKG, Bandung Institute of Technology (ITB) and State College of Meteorology, Climatology and Geophysics (STMKG) which hold a Master or Doctorate degree.

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The Training Course on Numerical Weather Prediction
Jakarta and Citeko, Indonesia
6 July to 28 August 2020

APPLICATION FORM

Note: Please complete the form in **typed capital letters** and get it scanned in PDF version. Send to **BMKG** by email as soon as possible.

I. Personal Data

Photo
3 x 4

1. Family name _____
   Given Name _____
2. Gender _____
3. Date of Birth _____
4. Place of Birth _____
5. Passport Number_____
6. Nationality_____
7. Marital Status _____
8. Health Condition _____
9. History of infectious disease: □ No □ Yes
   _____
   _____ (Please specify if yes)
10. Special Needs (e.g. dietary requirements, disability facilities, etc) if any:_____
    _____
11. Address: _____
    Mobile phone: _____
    Telephone: _____ Fax:_____
    E-mail Address: _____@_____
12. Permanent Address: _____
13. Contact person in emergency
    Name: _____
    Address: _____
    Mobile phone:
    Telephone _____ Fax _____

E-mail Address: _____@_____

14. Statement of present work

Name of institution

_____

_____

Position held_____

Brief description of duties _____

_____

_____

15. Previous employment history

Date Institution Position and Duties

_____

_____

_____

_____

16. Educational and/or professional qualification

Date Major and University Degree/Diploma

_____

_____

_____

_____

17. Training Course and Certification

Date Title

_____

_____

_____

_____

18. Language Proficiency
    Mother Tongue _____

    English Proficiency (Please tick):

    Reading : a. excellent b. good c. fair d. poor

    Listening : a. excellent b. good c. fair d. poor

    Speaking : a. excellent b. good c. fair d. poor

    Writing : a. excellent b. good c. fair d. poor

19. State why you wish to attend the course and indicate the practical use of the course to your work in the future.

    _____
    _____
    _____
    _____
    _____

20. For any further information please contact the Local Organizing Committee at the following address:

    Ms. Ratih Prasetya
    The Agency for Meteorology, Climatology and Geophysics of the Republic of Indonesia (BMKG)
    Jl. Kemayoran I No 2, Jakarta Pusat, 10720 INDONESIA
    Telephone : (6221) 4246321 ext. 1071
    Mobile : +62 896 9810 4529
    Fax : +62 21 4244710
    E-mail : apply.rtcbmkg@bmkg.go.id ; ratih.prasetya@bmkg.go.id

II. Personal Statement

I hereby declare that the information given above is true, correct and complete. I shall bear the responsibility for the above information.

I pledge to observe all the Indonesia laws and will respect the local customs and follow the course regulations during my stay in Indonesia for the training course.

Signature of Permanent Representative **(.....)**	Date…….. Participant **(.....)**