

**WMO OMM**

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

**Secrétariat**

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Ref.: 13959/2021-15 MS/ETR

Our ref.: 13959/2021/MS/ETFD/FEL

25 June 2021

Annexes: 4 (available in English only)

Subject: Blended Group Training Course on Numerical Weather Prediction at the Regional Training Centre of India Meteorological Department (IMD), Meteorological Training Institute, Pune, India from 4 October to 10 November 2021

Action required: For information and appropriate action, as necessary

Dear Sir/Madam,

I wish to refer to the World Meteorological Organization's (WMO) circular letter dated 28 January 2021 ref. 00597/2021/MS/ETFD about WMO Education and Training Opportunities (2021), which announced that in 2021 and 2022 WMO will organize blended group training on Numerical Weather Prediction (NWP) in different WMO Regions and official languages.

The course is aimed at personnel whose work relates to NWP as it will equip participants with knowledge and practical skills in this field. The blended course will be composed of the two parts, namely, the online phase and the follow-up on-campus phase in the Regional Training Centre (RTC) premises in 2022 when conditions permit. The online part will focus mainly on theory. The on-campus part will consolidate the theoretical knowledge and conduct the curricular practical training which can be difficult to deliver online.

I am pleased to inform you that after intensive discussions with the RTC, the first online part of the blended group training on NWP at RTC Pune hosted by the India Meteorological Department (IMD) will be held from 4 October to 10 November 2021. The course will be conducted in English and there is no tuition fee.

WMO Members of Regional Association II are invited to nominate candidates for the tailored courses to build the capacity of service delivery personnel. To ensure the teaching quality, Members are invited to kindly nominate up to three candidates. Applications from women and men are equally sought. The nomination will commit to guaranteeing that participants will be available to attend all live sessions, and have sufficient time allocated for the completion of all self-study modules. The time commitment for each participant is expected to be around 20 hours per week for attending live sessions and completing self-study modules and exercises. Each participant needs to have access to an individual computer or laptop, with a reliable internet connection, which allows streaming of video and sound, as well as a connection to remote servers to complete self-study modules.

Please note that the on-campus participants will only be selected from the online session participants. The on-campus session will be announced to the selected participants in due course.

Candidates should first apply to RTC Pune with the IMD Registration Form ([Annex IV](#)) and send the form to Dr Somenath Dutta ([dutta.dr.somenath@gmail.com](mailto:dutta.dr.somenath@gmail.com)) with a

To: Permanent Representatives of Members of Regional Association II (limited distribution)

cc: Hydrological Advisers

copy to Shri. R. K. Giri ([rk.giriccs@gmail.com](mailto:rk.giriccs@gmail.com)) no later than **4 August 2021** to acquire the admission letter, then send to WMO the [Fellowship Nomination Form](#) (FNF) and the admission letter to [fel@wmo.int](mailto:fel@wmo.int) no later than **3 September 2021**. A detailed course plan and related information are in [Annexes I, II](#) and [III](#). Please note that previous nominations for this particular course are still valid and there is no need to send them again.

I would like to express my appreciation for your continued support to the WMO activities.

Yours faithfully,



Prof. Petteri Taalas  
Secretary-General

### Meteorological Training Institute, India

	Host Member	India
1	Host institution(s)	Government of India, Ministry of Earth Sciences India Meteorological Department Meteorological Training Institute WMO RTC Pune component in India
2	Website	<a href="https://www.imdpune.gov.in/training/training.html">https://www.imdpune.gov.in/training/training.html</a>
3	Location(city) of Institution(s)	Pashan, Pune
4	Address of Institution	Meteorological Training Centre (MTI) IMD Colony Campus Dr Homi Bhaba Road Pashan, Pune, Pin 411008, Maharashtra State
5	Course type	Online and follow-up on-campus course
6	Main course content	<ul style="list-style-type: none"> <li>• History &amp; Hierarchy of NWP</li> <li>• Numerical methods</li> <li>• Spectral method</li> <li>• Data assimilation</li> <li>• Physical Parameterization</li> <li>• Operational forecast models</li> <li>• Interpretation and application of NWP output</li> </ul>
7	Duration of study	6 weeks. Follow-up on-campus course. Hands-on Practical: 2 weeks
8	Course start date	4 October – 10 November 2021 (online) TBD (on-campus course)
9	Target Region and Members	WMO Regional Association II Developing Members
10	Basic Requirements	Meteorologist with BSc degree or equivalent, with 2-year work experience
11	Language	English
12	Number of awards	30 Follow-up on-campus course: 15
13	Institution Online application	Optional
14	Admission from Institution	Mandatory
15	Application forms sent to WMO	1. WMO FNF 2. Pre-admission letter from host institution
16	Closing date for applications	RTC: 4 August 2021 WMO: 3 September 2021
17	Contact info	Dr Somenath Dutta Head, Meteorological Training Centre (MTI) India Meteorological Department, Pashan, Pune-411008, India Email: <a href="mailto:dutta.dr.somenath@gmail.com">dutta.dr.somenath@gmail.com</a> , and Dr R.K. Giri Head, Organization India Meteorological Department Mausam Bhavan, Lodi Road, New Delhi-110003 Email: <a href="mailto:rk.giriccs@gmail.com">rk.giriccs@gmail.com</a>

**Joint IMD-WMO group fellowship training course on  
Numerical Weather Prediction  
through distance learning**

**Managed by the Meteorological Training Institute,  
India Meteorological Department (IMD), Pune**

**4 October–10 November 2021**

### **Course Description**

Predicting weather phenomenon with reasonable accuracy crucially depends on numerical weather prediction (NWP) with all of its components, such as data assimilation, physical parameterization, numerical integration, post processing, etc. The recent phenomenally accurate prediction of extreme weather events like the Super Cyclonic Storm *AMPHAN* in India has again proved this. Hence meteorological personnel engaged in weather forecasting should have reasonable a knowledge and skill on different aspects of NWP. They must be capable of understanding, interpreting and applying different NWP products more appropriately with full confidence. They must be able to appreciate the scientific reason for the change in accuracy in an NWP forecast, due to certain tuning in the NWP model. This can only be achieved by systematically designing, conducting and participating in training in NWP. This training course has been designed with forecasting personnel in mind and efforts have been made to maintain the standards of the Basic Instruction Package for Meteorologists (BIP-M).

### **Expected Learning Outcomes**

Participants who successfully complete this training course:

- Will understand the concept of an initial and boundary value problem and appreciate that the problem of weather forecasting is so;
- Will learn about the history and hierarchy of NWP models;
- Will know and understand different numerical methods and the spectral method for solving the governing equations, along with their difficulties, like linear and nonlinear instability;
- Will understand different data assimilation methods;
- Will understand different schemes for parameterizing important physical processes;
- Will understand different NWP models along with some knowledge of the basics of developing an NWP model;
- Will understand the uncertainty in an NWP forecast and know how to interpret ensemble predictions;
- Will be able to understand, interpret and apply different NWP products appropriately.

## Target Audience and Qualifications

Forecasters from RA II Members who have successfully completed a BIP-MT course and have a Bachelor of Science degree (BSc) — with Physics and Mathematics as main subjects.

## Course Content

The event shall consist of online lectures/presentations on certain broad themes and online practical exercises. Each participant shall prepare a review for presentation of a research paper of their choice, on any aspect of NWP. The broad themes to be discussed are given below:

- History and hierarchy of NWP
- Numerical Methods,
- Spectral method,
- Data assimilation,
- Physical Parameterization,
- Operational forecast models,
- Interpretation and application of NWP output and a practical exercise.

At the end of the course trainees will be examined by an MCQ-type test and their participation will be certified based on the results of that text.

## Course Format

Online lectures/presentations on certain broad themes, hands-on exercises.

## Last date for receipt of nominations

Nominations from the PR must reach:

- Dr. Somenath Dutta (email: [dutta.dr.somenath@gmail.com](mailto:dutta.dr.somenath@gmail.com)), with a copy to Dr R.K. Giri (email: [rkgiriccs@gmail.com](mailto:rkgiriccs@gmail.com))

**no later than 21 August 2021** along with the REGISTRATION FORM duly completed by the nominated participants.

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**Joint IMD-WMO group fellowship Training Course  
on Numerical Weather Prediction**

**Meteorological Training Institute, India Meteorological Department (IMD), Pune**

**4 October to 10 November 2021**

**Mode: Online (Synchronous & Asynchronous)**

**Tentative Agenda**

(Time Zone : UTC+5:30)

Ref.: 13959/2021-15 MS/ETR

<b>4 October 2021: 1430-1530 - Inauguration</b>		
<b>Week I</b>		
<b>Day 1: 4 October 2021</b>		
<b>Theme - Introduction</b>		
<b>Time</b>	<b>Session</b>	<b>Speaker</b>
1545-1645	1. Basic concept of an initial value problem. Well posed and ill posed initial value problems. 2. Limitation in traditional synoptic method, demand for a location and time-specific forecast system, giving rise to the concept NWP.	Dr S. Dutta, IMD
1700-1800	3. Potential of NWP system to give location and time-specific forecast. 4. A generic structure of an NWP system. 5. History and Hierarchy of NWP	Dr S. Dutta, IMD
<b>Day 2: 5 October 2021</b>		
<b>Theme - Numerical method</b>		
<b>Time</b>	<b>Session</b>	<b>Speaker</b>
1430-1530	1. Discussions on different types of differential equations and how governing equations are non-linear partial differential equations.	Dr S. Dutta, IMD
1545-1645	2. Difficulties in getting analytical or exact solutions of such equations. Alternative approaches — Numerical methods and Spectral method.	Dr S. Dutta, IMD
1700-1800	3. Different finite difference schemes (FDS), viz., forward, backward and leapfrog schemes.	Dr S. Dutta, IMD

<b>Week I (cont'd)</b>		
<b>Day 3: 6 October 2021</b>		
<b>Theme - Numerical method</b>		
<b>Time</b>	<b>Session</b>	<b>Speaker</b>
1430-1530	1. Compatibility of FDS. 2. Explicit and implicit or semi implicit time differencing schemes.	Dr S. Dutta, IMD
1545-1645	3. Lax equivalence theorem. 4. Numerical approximation of Jacobian and Laplacian. Concept of Arakawa's 9 point Jacobian.	Dr S. Dutta, IMD
1700-1800	5. Stability analysis of numerical solution using linear advection equation for explicit and implicit time differencing schemes. 6. CFL criteria and its physical interpretation. Numerical solution of linear advection equation using leapfrog scheme.	Dr S. Dutta, IMD
<b>Day 4: 7 October 2021</b>		
<b>Theme - Spectral method</b>		
1430-1530	1. Basic concepts of orthogonal function, Spherical harmonics and orthogonal polynomial. Basic properties of Legendre polynomial.	Dr R. Krishnan, Scientist G, IITM
1545-1645	2. Spectral representation of Meteorological field variable. Spectral coefficient, spectral transform. Basic concepts of spectral method.	Dr R. Krishnan, Scientist G, IITM
1700-1800	3. Triangular and Rhomboidal truncation.	Dr R. Krishnan, Scientist G, IITM
<b>Day 5: 8 October 2021</b>		
<b>Theme - Data assimilation</b>		
1430-1530	Definition of objective analysis, its importance and its different types, Viz., Cressman method, Optimum interpolation method, BLUE, Maximum likelihood estimate. To show that BLUE is same as maximum likelihood estimate and is the best estimate.	Dr S. Dutta, IMD
1545-1645		
1700-1800		

<b>Week II</b>		
<b>Day 1: 11 October 2021</b>		
<b>Theme - Data assimilation</b>		
<b>Time</b>	<b>Session</b>	<b>Speaker</b>
1430-1530	Different formats of data and their interchangeability. Decoding and quality control of GTS conventional/non-conventional observations, processing of non-GTS (satellite radiance) observations, Grid Statistical Interpolation (GSI) scheme, Concept of observation operator.	Scientists from NCMRWF
1545-1645		
1700-1800		
<b>Day 2: 12 October 2021</b>		
<b>Theme - Data assimilation</b>		
1430-1530	Basic concept of a general data assimilation cycle, Variational data assimilation (3D-Var and 4D-Var). Introduction to cost function for 3D-VAR as well as for 4D-VAR data assimilation and its minimization, giving rise to analysed field. Concept of Kalman filtering.	Scientists from NCMRWF
1545-1645		
1700-1800		
<b>Day 3: 13 October 2021</b>		
<b>Theme - Data assimilation</b>		
1430-1530	1. Basic concept of a general data assimilation cycle, Variational data assimilation (3D-Var and 4D-Var). Introduction to cost function for 3D-VAR as well as for 4D-VAR data assimilation and its minimization, giving rise to analysed field. Concept of Kalman filtering.	Scientists from NCMRWF
1545-1645	2. Processing Doppler Radar Data for quality control and mesoscale data assimilation. Oceanic data assimilation: data assimilation at mesoscale, assimilation of altimetry data.	
1700-1800	3. Ensemble data assimilation technique, Hybrid data assimilation technique.	
<b>Day 4: 14 October 2021</b>		
<b>Theme - Data assimilation</b>		
1430-1530	Definition of initialization, its importance and its different types, viz., Static Dynamic, Normal mode, Dynamic normal mode and Physical, Nudging, Synthetic data generation/vortex initialization.	Scientists from NCMRWF
1545-1645		
1700-1800		
<b>Day 5: 15 October 2021</b>		
<b>Theme - Parameterization of physical processes</b>		
1430-1530	1. Definition with example of subgrid scale physical processes and their influence on grid scale variable. Definition of parameterization of subgrid scale physical processes and explain its importance. 2. Different subgrid scale physical processes, viz., SWR, LWR, Cumulus/convective parameterization, Orographic drag, eddy transport in PBL.	Scientists from IITM, Pune
1545-1645		
1700-1800		

<b>Week III</b>		
<b>Day 1: 18 October 2021</b>		
<b>Theme - Parameterization of physical processes</b>		
<b>Time</b>	<b>Session</b>	<b>Speaker</b>
1430-1530	Dry and moist adiabatic adjustment process. Different cumulus parameterization schemes, Viz., Kuo, Arakawa, BM, KF schemes, etc., their broad aspects, benefits and limitations and intercomparison.	Scientists from IITM, Pune
1545-1645		
1700-1800		
<b>Day 2: 19 October 2021</b>		
<b>Theme - Parameterization of physical processes</b>		
1430-1530	1. Principle of radiative transfer. Gravity wave drag and its parameterization Biosphere and Land surface processes.	Scientists from IITM, Pune
1545-1645	Parameterizations of air-sea interaction processes.	
1700-1800	2. PBL parameterization under different stratification. Concept of mixing length, Von Kerman constant, roughness length, Monin Obukov length, etc.	
<b>Day 3: 20 October 2021</b>		
<b>Theme - Parameterization of physical processes</b>		
1430-1530	PBL parameterization under different stratification. Concept of mixing length, Von Kerman constant, roughness length, Monin Obukov length, etc.	Scientists from IITM, Pune
<b>Day 4: 21 October 2021</b>		
<b>Theme - Types of Dynamical models</b>		
1545-1645	1. Primitive equation model with different vertical coordinates, viz., p, sigma, terrain following, eta, etc. Representation of orography in a model.	Dr S. Dutta, IMD
1700-1800	2. Derived model, viz., barotropic model, equivalent barotropic model, two-layer baroclinic model and quasi geostrophic model.	Dr S. Dutta, IMD
<b>Day 5: 22 October 2021</b>		
<b>Theme - Operational forecasting models</b>		
1430-1530	Global Forecast System model and Global ensemble forecast system model.	Dr Durai, IMD and Dr P.S. Mukhopadhyay, IITM, Pune
1545-1645		
1700-1800		

<b>Week IV</b>		
<b>Day 1: 25 October 2021</b>		
<b>Theme - Operational forecasting models</b>		
<b>Time</b>	<b>Session</b>	<b>Speaker</b>
1430-1530	1. Global Forecast System model and Global ensemble forecast system model.	Dr Durai, IMD and Dr P.S. Mukhopadhyay, IITM, Pune
1545-1645	2. Couple Model (Climate Forecast system), Ensemble prediction system, multimodel ensemble technique, Extended range forecasting.	Scientists from IITM, Pune
1700-1800		
<b>Day 2: 26 October 2021</b>		
<b>Theme - Operational forecasting models</b>		
1430-1530	1. Couple Model (Climate Forecast system), Ensemble prediction system, multimodel ensemble technique, Extended range forecasting.	Dr D.R. Pattanaik, IMD
1545-1645		
1700-1800	2. Regional and mesoscale forecast system models (WRF, ARPS), Nowcast model	Dr Soma Sen Roy and Dr A.K. Das, IMD
<b>Day 3: 27 October 2021</b>		
<b>Theme - Operational forecasting models</b>		
1430-1530	Regional and mesoscale forecast system models (WRF, ARPS), Nowcast model	Dr Soma Sen Roy and Dr A.K. Das, IMD
1545-1645		
1700-1800		
<b>Day 4: 28 October 2021</b>		
<b>Theme - Operational forecasting models</b>		
1430-1530	Antarctica model Polar WRF, Air quality model WRF (Chem)	Dr V.K. Soni and Dr A.K. Das, IMD
1545-1645		
1700-1800		
<b>Day 5: 29 October 2021</b>		
<b>Theme - Operational forecasting models</b>		
1430-1530	1. Antarctica model Polar WRF, Air quality model WRF (Chem)	Dr V.K. Soni and Dr A.K. Das, IMD
1545-1645	2. Cyclone model Hurricane WRF, vortex relocation and initialization	Scientists from NWP division IMD
1700-1800		

<b>Week V</b> <b>Day 1: 1 November 2021</b> <b>Theme - NWP Products (Understanding, interpretation and application)</b>		
Time	Session	Speaker
1430-1530	Direct (basic field variables) and Derived (vorticity/its tendency, divergence, vertical velocity, wind shear/its tendency, differential vorticity advection, thermal advection, moisture advection, vertically integrated moisture flux, total precipitable water, etc.) products, their interpretation and application.	Scientists from NWP division, IMD, New Delhi
1545-1645		
1700-1800		
<b>Day 2: 2 November 2021</b> <b>Theme - NWP Products (Understanding, interpretation and application)</b>		
1430-1530	1. Direct (basic field variables) and Derived (vorticity/its tendency, divergence, vertical velocity, wind shear/its tendency, differential vorticity advection, thermal advection, moisture advection, vertically integrated moisture flux, total precipitable water, etc.) products, their interpretation and application.	Scientists from NWP division, IMD, New Delhi
1545-1645	2. NWP products for aviation services, hydrological services, NWP products for localized severe weather, monsoon rainfall prediction, prediction of Western disturbances. NWP-based objective cyclone forecast system, NWP-based location specific forecast, GIS application for NWP.	Scientists from NWFC, IMD, New Delhi
1700-1800		
<b>Day 3: 3 November 2021</b> <b>Theme - NWP Products (Understanding, interpretation and application)</b>		
1430-1530	1. NWP products for aviation services, hydrological services, NWP products for localized severe weather, monsoon rainfall prediction, prediction of Western disturbances. NWP-based objective cyclone forecast system, NWP-based location specific forecast, GIS application for NWP.	Scientists from NWFC, IMD, New Delhi
1545-1645		
1700-1800	2. Post processing of model output: Model output verification: Forecast skills, Forecast errors, Systematic errors. 3. Down scale of NWP model like location-specific forecast, Statistical interpretation.	Scientists from NCMRWF, Delhi
<b>Day 4: 4 November 2021</b> <b>Theme - NWP Products (Understanding, interpretation and application)</b>		
1430-1530	1. Post processing of model output: Model output verification: Forecast skills, Forecast errors, Systematic errors. 2. Down scale of NWP model like location-specific forecast, Statistical interpretation.	Scientists from NCMRWF, Delhi
1545-1645		
1700-1800		
<b>Day 5: 5 November 2021</b> <b>Theme - Review presentation by participants</b>		
1430-1530	Presentation of review of a research paper (Duration 10 minutes)	By the participants of each country
1545-1645		
1700-1800		

<b>Week VI</b> <b>Day 1: 8 November 2021</b> <b>Theme - Review presentation by participants</b>		
<b>Time</b>	<b>Session</b>	
1430-1530	Presentation of review of a research paper (Duration 10 minutes)	By the participants of each country
1545-1645		
1700-1800		
<b>Day 2: 9 November 2021</b> <b>Theme - Review presentation by participants</b>		
1430-1530	Presentation of review of a research paper (Duration 10 minutes)	By the participants of each country
1545-1645		
1700-1800		
<b>Day 3: 10 November 2021</b> <b>Theme – Evaluation of Training</b>		
1430-1530	MCQ type test of 30 marks	By the participants of each country
1545-1645	Feedback session	By the participants of each country
1700-1800	Valedictory programme	

Joint IMD-WMO group fellowship Training Course  
on Numerical Weather Prediction (online)

Meteorological Training Institute, India Meteorological Department (IMD), Pune  
4 October to 10 November 2021

REGISTRATION FORM

1.	Full name (expanding the initials)	:	
2.	Nationality	:	
3.	Date of birth	:	
4.	Male/Female	:	
5.	Parents name and nationality	:	
6.	Present Address	:	
7.	Email Id and WhatsApp mobile number	:	
8.	Educational qualification	:	
9.	Details of Meteorological training, if any.	:	
10.	Whether previously trained in India? If so, give detail of same	:	
11.	Current post held	:	
12.	Name and full address of Employer including country ZIP	:	
13.	Area of specialization and field of study	:	
14.	Working Experience in terms of years.	:	
15.	Signature of the candidate	:	
16.	Signature of the PR of the country with WMO, along with recommendation	:	

Please return this form to Dr Somenath Dutta, India Meteorological Department, by email ([dutta.dr.somenath@gmail.com](mailto:dutta.dr.somenath@gmail.com)) with a copy to Dr Shri. R. K. Giri ([rkgiriccs@gmail.com](mailto:rkgiriccs@gmail.com)) **no later than 21 August 2021.**