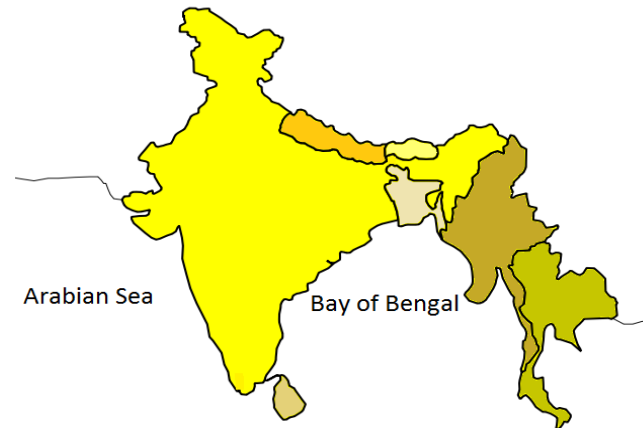




## **BIMSTEC Centre for Weather & Climate (BCWC): Activities and Plan**

Abhijit Sarkar

BIMSTEC Centre for Weather and Climate (BCWC), MoES



### **Background**

**Between 1997 and 2013: Ministerial Meetings and two Summits on different aspects of BIMSTEC were held**

**From beginning (1997) formation of BCWC in India was supported unanimously by BIMSTEC countries**



NCMRWF/BCWC is a Centre of Excellence in  
Numerical Modelling and Data Assimilation

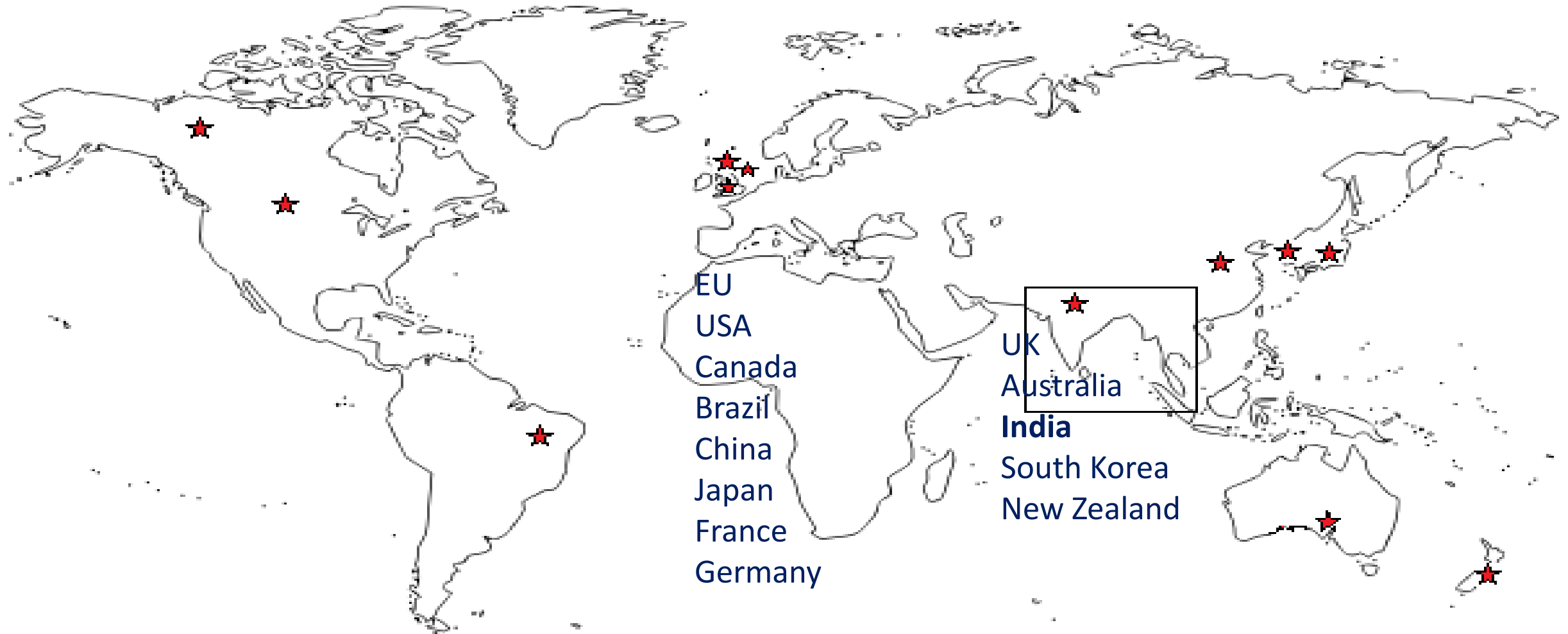


## Current Major Mandates

- **Development and improvement of Weather/Climate prediction models, Data Assimilation, to underpin the National Forecasting capability (Early Warning)**
- **Development & Maintenance of Data Assimilation (DA) systems for Global/Regional Models**
- **Development & Maintenance of a Seamless Prediction System (State-of-art )**
- **Full Establishment of BCWC ←  
(NCMRWF is doubling as BCWC)**

# Global Numerical Dynamical Weather/Climate Modeling & Data Assimilation Capability

[Early Warning is the Key to Disaster Management]





## Mihir HPCS (2.8 PF)



- 2.8 PF & 6 PetaByte Storage  
2320 Compute Nodes
- HPC Inaugurated January 2018  
by Honorable Minister Dr. Harshavardhan
- Dec 2022 new HPC 10 PF (Under Process)

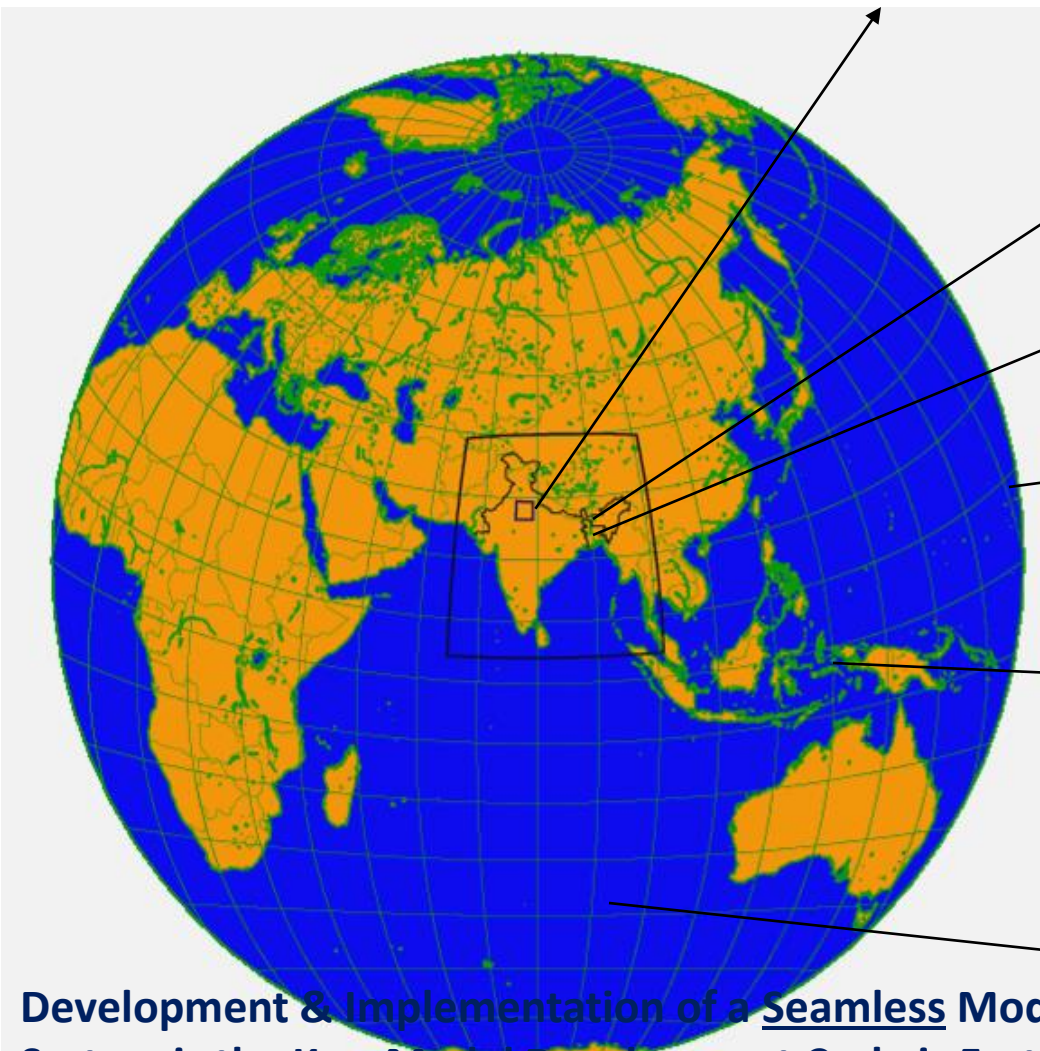




# Seamless Modelling System: Unified Model at NCMRWF Same Model for Global/Regional/Mesoscale/City/ Coupled



330 m Delhi Fog Model



1.5 km regional model  
up to 48 hr forecast

4 km regional model  
up to 72 hr forecast

12 km global model  
up to 10 Day forecast

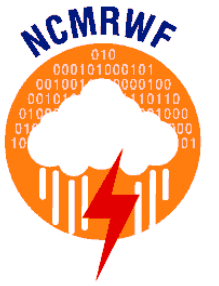
Global Ensemble Prediction  
System – 12 km with 21  
members up to 10 Days

Coupled Model N216  
(NCUM+JULES+NEMO+CICE)  
One Month Real-Time

Development & Implementation of a Seamless Modelling System is the Key. Model Development Cycle is Fast.

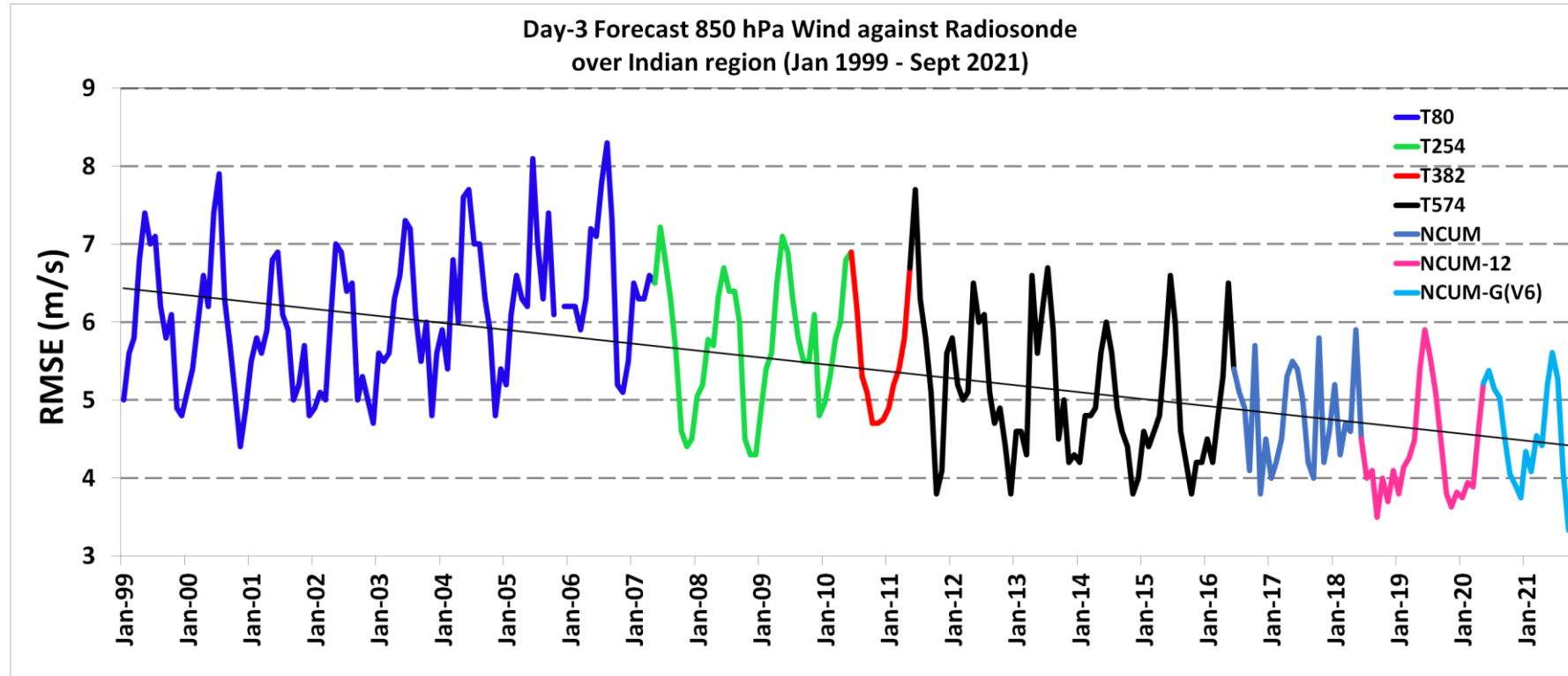


## Current Operational Models at BCWC/NCMRWF



- **Global (~12 km) NCMRWF Unified Model (NCUM)**
  - 10 day forecasts at 00 & 12 UTC
- **Global (~12 km) Ensemble Prediction System (NEPS)**
  - Control + 22 member 10 day Forecasts at 00 & 12 UTC
- **Regional (~4 km) NCUM at 00 UTC – 72 hour forecast at 00 UTC**
- **Regional NEPS (4 km/11 member) – 72 hour forecast at 00 UTC**
- **Coupled Model – Daily 2 weeks forecast (Coupled NWP)**
  - **Once a week 4 weeks forecast (ERP)**
    - **Atmosphere: NCUM (60 km)**
    - **Ocean: NEMO (0.25, L75)**

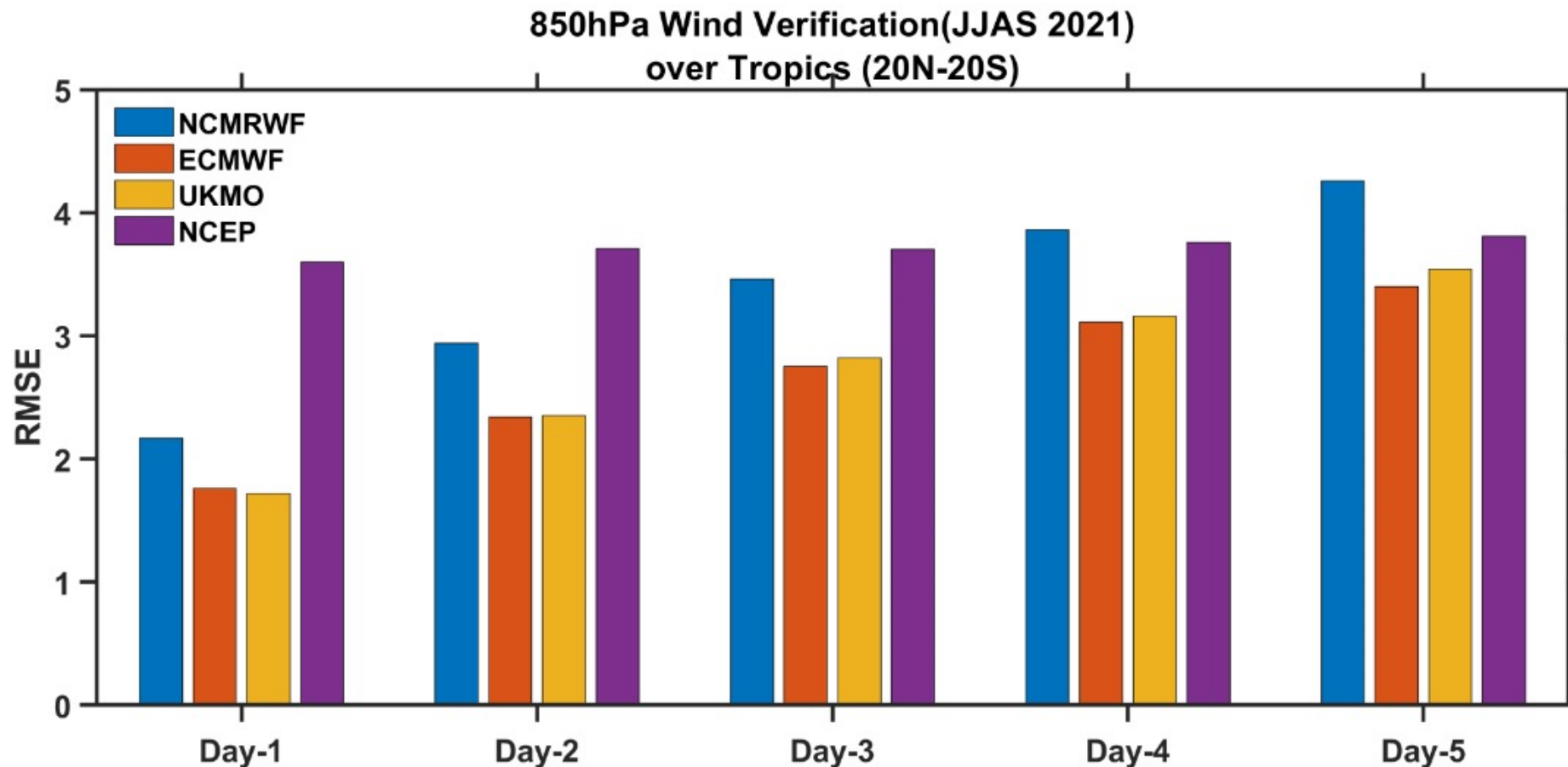
# Performance of models over Indian Region (January 1999 to September 2021)



The decrease in the Error can be attributed to:

- increase in the resolution of the model,
- increase in the amount of data being assimilated,
- improvements in data assimilation techniques,
- improvements in model physics/dynamics.

# 850 hPa Wind RMSE – Against analysis







## Operational NCUM Data Assimilation (DA) Systems

- **Hybrid 4D-Var DA for global NCUM (12-km) NWP system**
  - 22 Member global ensemble forecast is used in the Hybrid 4D-Var system to represent day-to-day varying forecast uncertainty**Initial condition perturbations for the NCMRWF Ensemble Prediction System (NEPS) are generated using Ensemble Transform Kalman Filter (ETKF) method.**
- **4D-Var DA for NCUM-Regional (4 km) NWP system**
- **Global & Regional Land Surface DA for NCUM (for Soil Moisture assimilation) (Extended Kalman Filter)**
- **Ocean and Sea-Ice Global Data Assimilation for Coupled NCUM NEMO-Var/CICE (0.25, L75)**

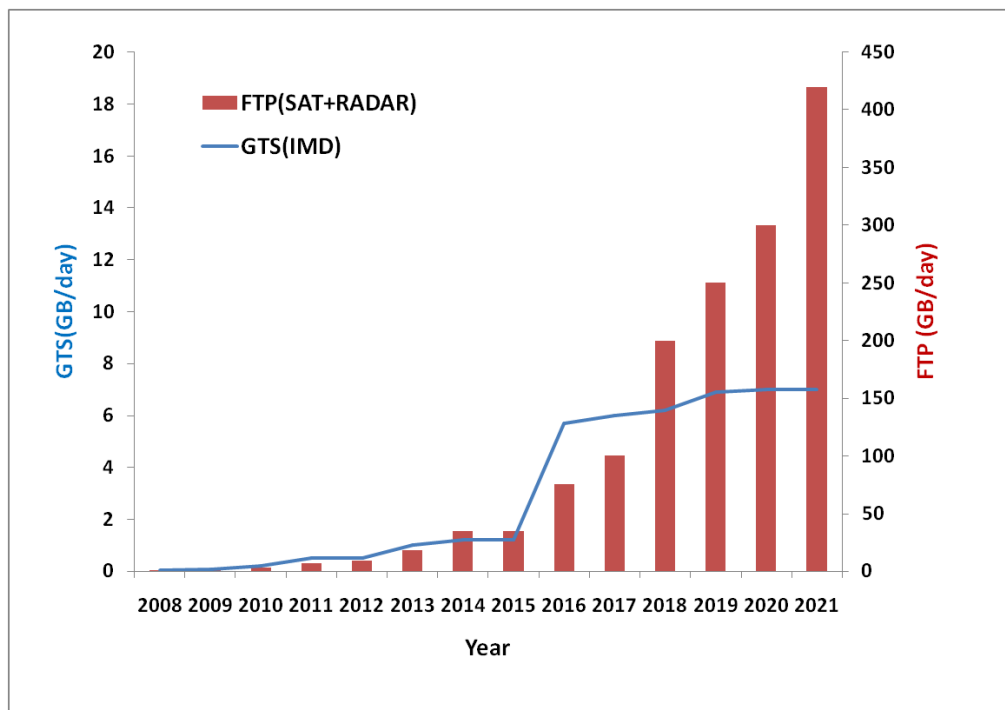


Data Assimilation for IITM/IMD GFS and WRF/HWRF Models

**Global 4D-ENS-Var & Regional GSI based Assimilation**



## Year-wise increase in the volume of NCMRWF data reception



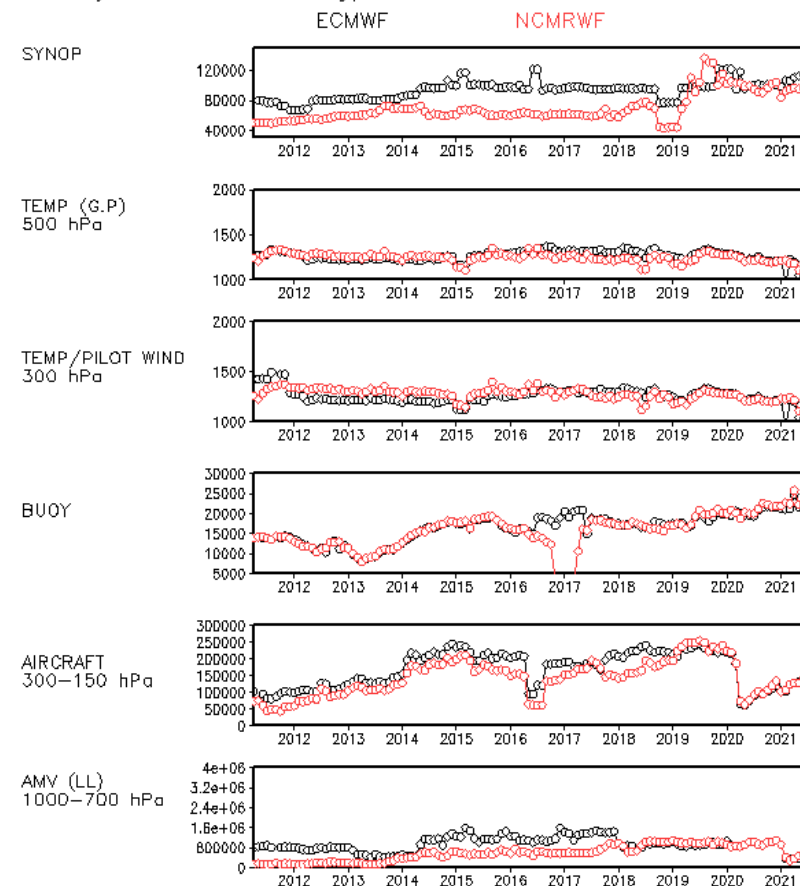
### Recent data addition

- Aeolus-HLOS , wind profilers**
- COSMIC-2/PAZ GPSRO**
- GPS-IPW (Global IGSS network)**
- OMPS(GOES)-OZONE,**
- METOP-Dual AMVs**
- ABI/AHI radiances**
- IMD-DWR**
- INSAT 3D-R**



## ECMWF/NCMRWF data comparison

Monthly count of different types of observation: ECMWF Vs NCMRWF





## Observation Assimilated in the NCUM-G data assimilation system

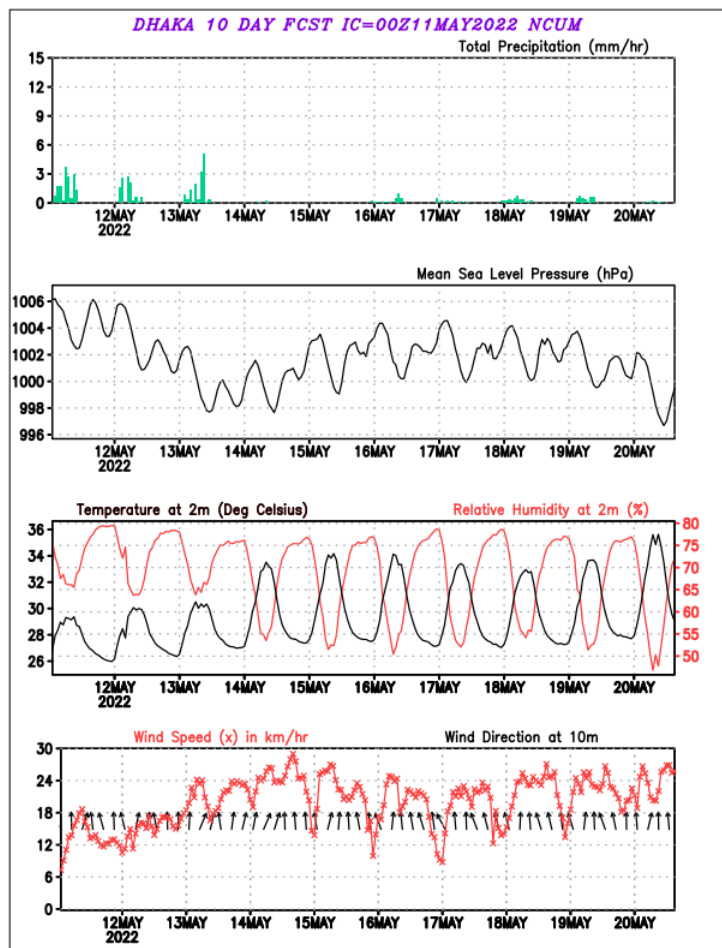
Observation Type	Observation Description	Assimilated Variables
Surface	Surface observations over Land and Ocean (TAC & BUFR), TC bogus	Wind, Temperature, Humidity, Surface Pressure
Sonde	Radiosonde (TAC & BUFR), Pilot balloons, Wind profiles & Radar VAD winds	Wind, Temperature, Humidity
Aircraft	Upper-air wind and temperature from aircraft (AMDAR & AIREP)	Wind, Temperature
Ground GPS	Ground based GPS observations	Zenith Total Delay
Satellite: GPSRO	Global Positioning System Radio Occultation observations from various satellites (Terra-Sar X, COSMIC (E1 to E6), FY3D, KOMPSAT, MetOp (A, B & C))	Bending Angle
Satellite: Satwind	Atmospheric Motion Vectors from geostationary and polar orbiting satellites (MSG, JMA, GOES, MetOp, INSAT-3D & INSAT-3DR, MODIS, NOAA)	Wind
Satellite: Scatwind	Advanced Scatterometer in MetOp-A & B, ScatSat-1, WindSat	Wind
Satellite: MicroWave Sounder/Imager	Microwave sounders / imagers ATMS, AMSU, GMI, MWHS, AMSR2, SAPHIR, SSMIS	Brightness Temperature
Satellite: Hyperspectral IR	Hyperspectral infrared sounders IASI, CrIS, AIRS	Brightness Temperature
Satellite: Geostationary Sounder/Imager	Sounder/Imagers from MSG, GOES, Himawari, INSAT	Brightness Temperature
Satellite: HLOS Wind	Mie-scattering and Rayleigh-scattering Horizontal Line-Of-Sight (HLOS) winds from AEOLUS satellite	HLOS wind

## Products for the Member Countries.

Metegograms and EPSgrams are produced for the Capital Cities (Bangkok, Colombo, Dhaka, Kathmandu, Nay Pyi Taw and Thimpu) in real-time.

The skill of the model products are being evaluated for each country.

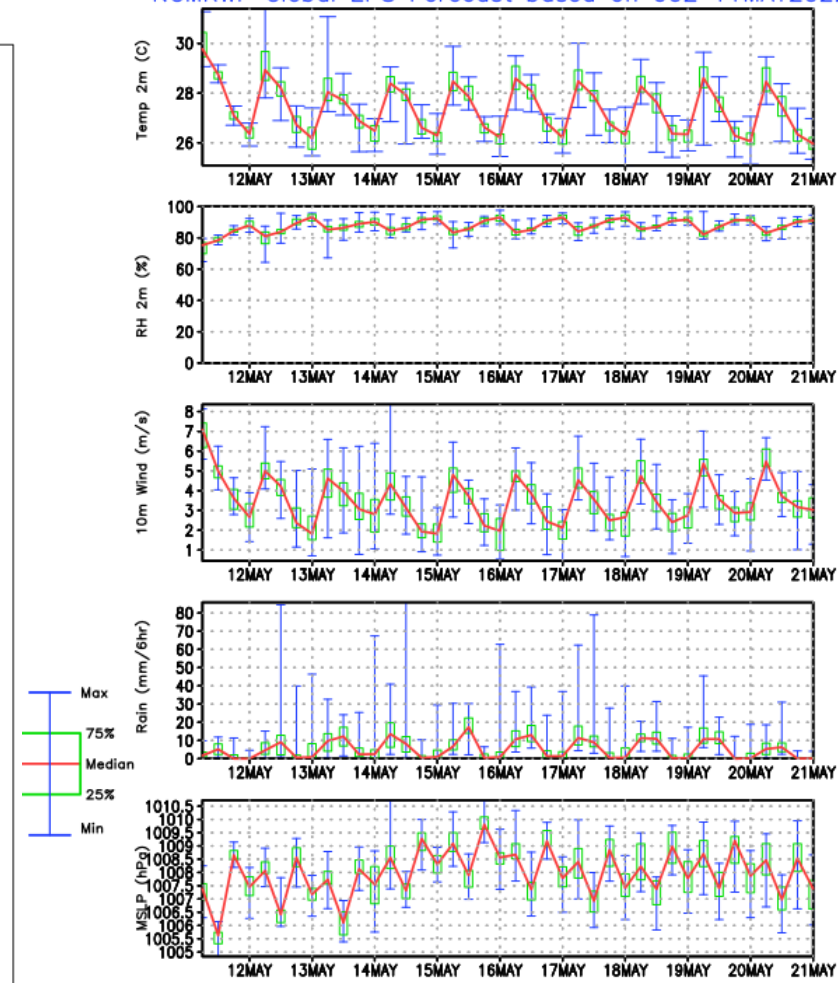
Value added and improved products shall be provided to the member countries.



Metegogram for Dhaka

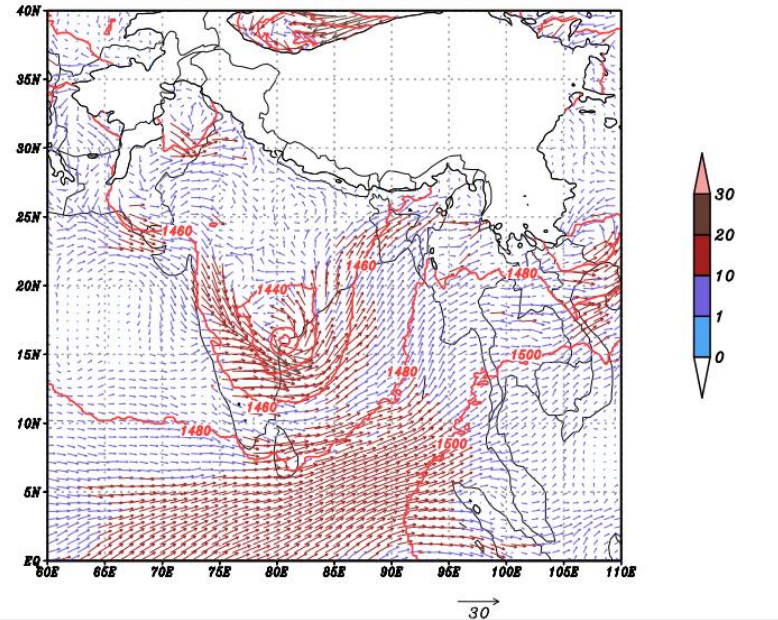
## Colombo

NCMRWF Global EPS Forecast based on 00Z 11MAY2022

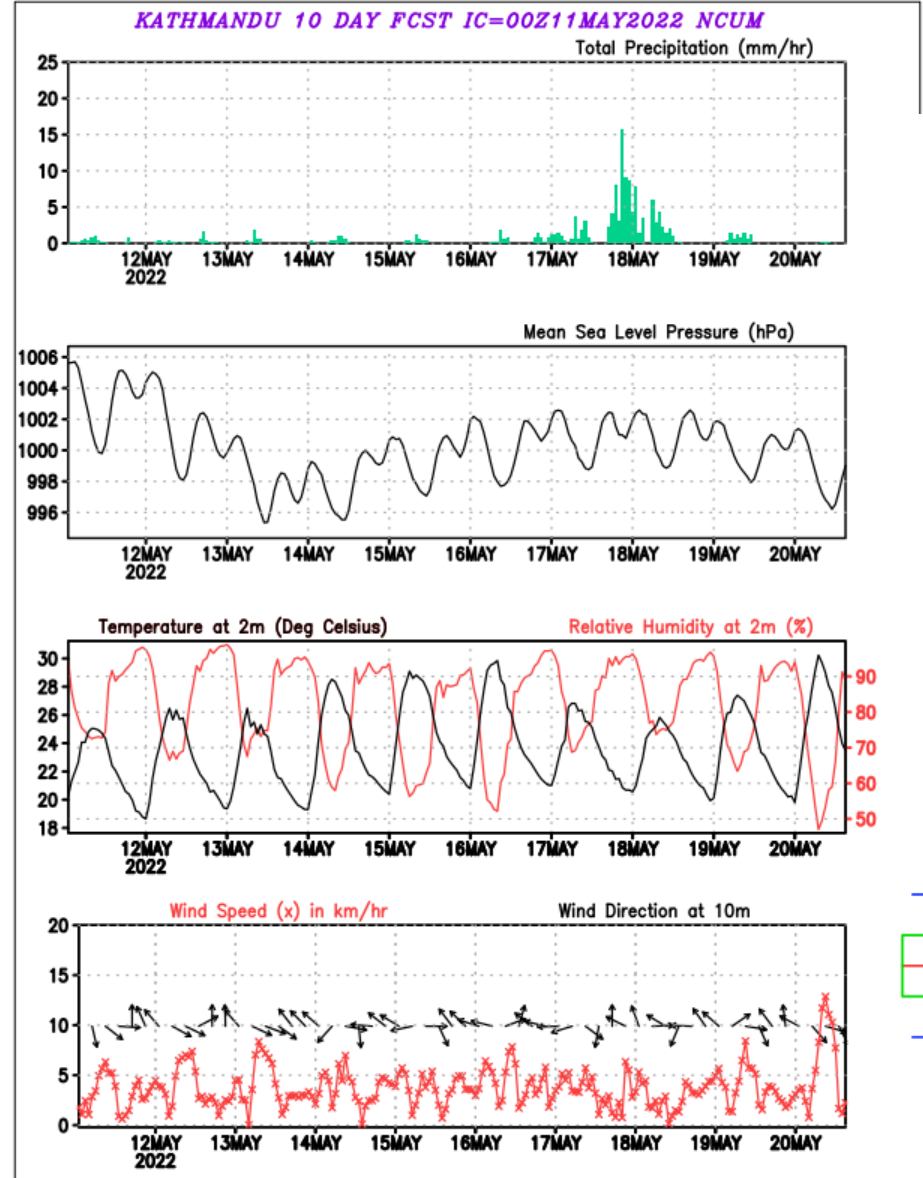
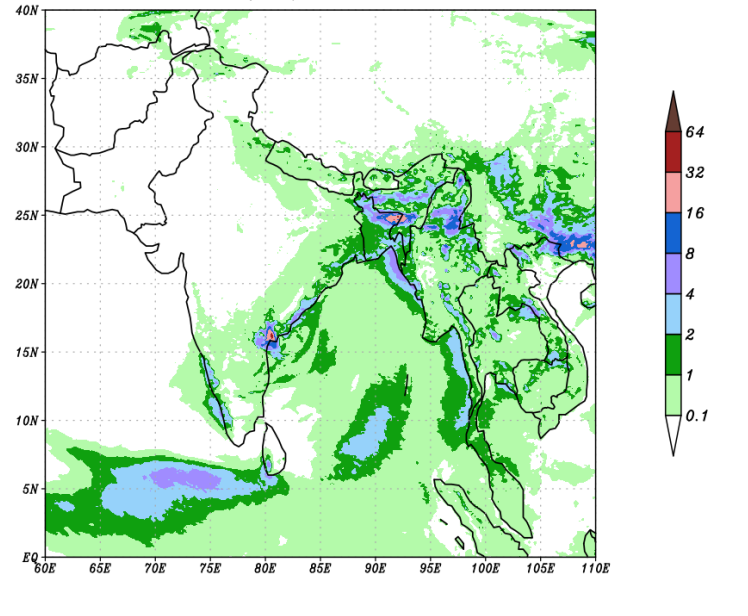


EPSgram for Colombo

NCUM 24 HR FORECAST VALID ON 00Z12MAY2022  
850 hPa GEOP(m) & WINDS(m/s)



NCUM 24 HR FORECAST VALID ON 00Z12MAY2022  
RAINFALL(cm) CI=0.1,1,2,4,8,...

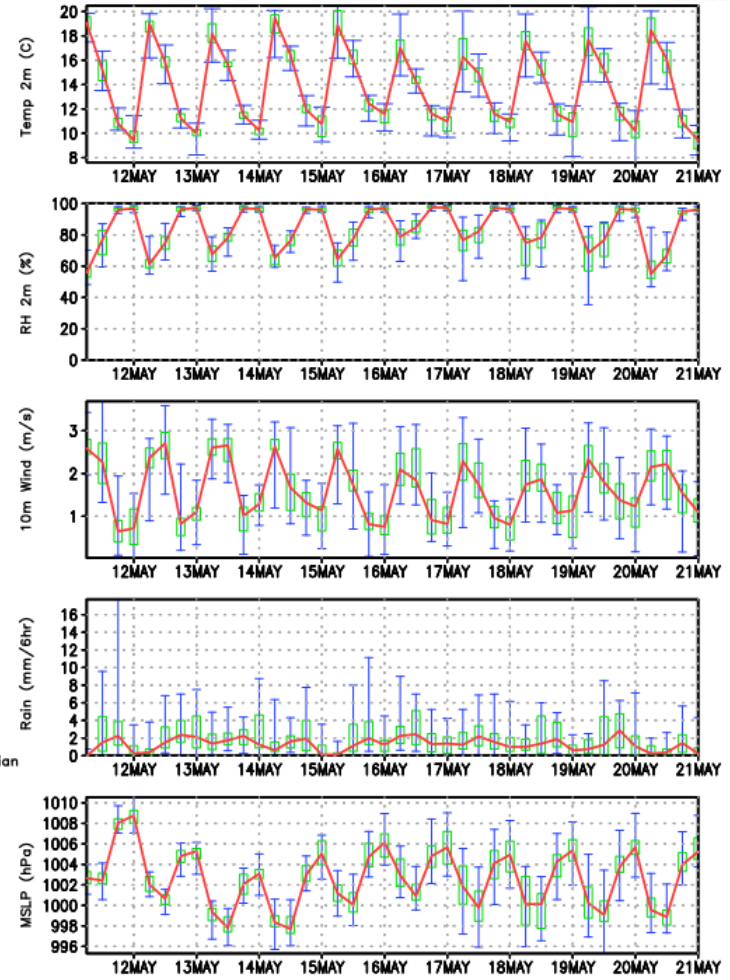


Meteogram for Kathmandu



Thimphu

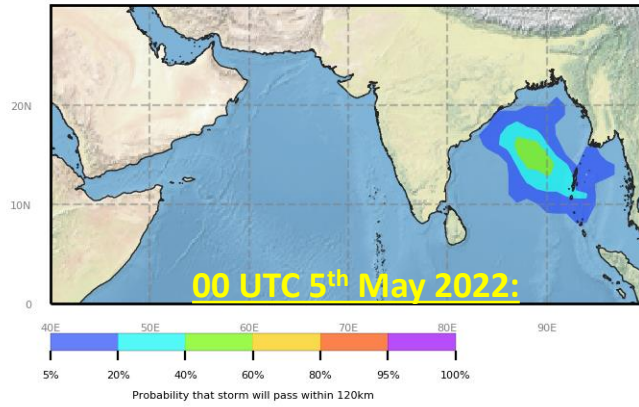
NCMRWF Global EPS Forecast based on 00Z 11MAY2022



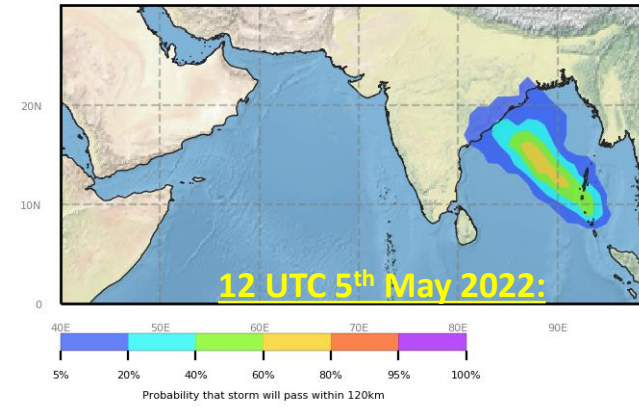
EPSgram for Thimphu



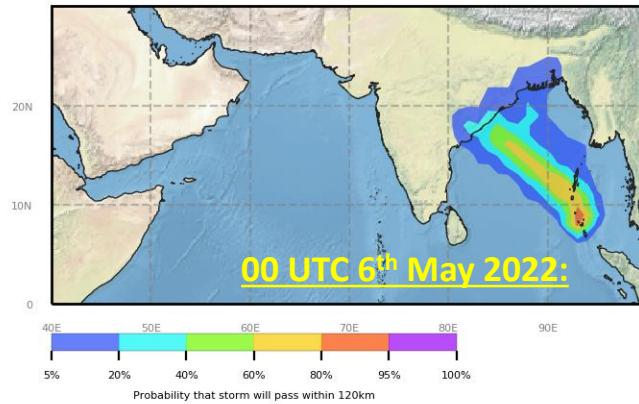
NEPS-G\_12km\_22mem: Forecast tropical storm activity (existing and forming storms) in North Indian basin from 00UTC 05/05/2022 Composite over the next 5.0 days



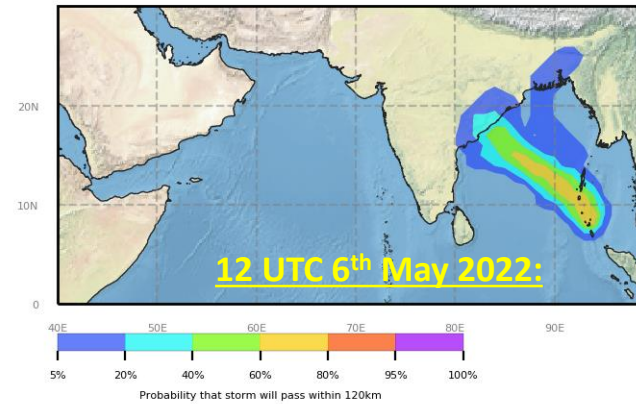
NEPS-G\_12km\_22mem: Forecast tropical storm activity (existing and forming storms) in North Indian basin from 12UTC 05/05/2022 Composite over the next 5.0 days



NEPS-G\_12km\_22mem: Forecast tropical storm activity (existing and forming storms) in North Indian basin from 00UTC 06/05/2022 Composite over the next 5.0 days



NEPS-G\_12km\_22mem: Forecast tropical storm activity (existing and forming storms) in North Indian basin from 12UTC 06/05/2022 Composite over the next 5.0 days



## Early indications

**Cumulated Strike Probability indicated : Cyclone tracking towards Andhra Pradesh-  
Odisha coast**



## High Resolution Global Ens. Fcst Developing Applications for various sectors

Centers	Model	Grid/Scale & Forecast Length
NCEP	GEFS, 21 Members each cycle	T574L64 (~22 km) for 0-8 days and T382L64 (~38 km) for 8-16 days
ECMWF	IFS-ENS, 51 Members (Coupled)	O640 (~18 km), 91 levels for 15 days
UKMO	MOGREPS-G, 17 Members each cycle 12 UTC20190428	N640L70 (~20 km) for 7 days
<b>IMD- IITM- NCMRWF</b>	<b>GEFS, 21Members</b>	<b>T1534L64 (~12 km) for 10 days</b>
<b>NCMRWF</b>	<b>NEPS, 23 Members</b>	<b>N1024L70 (~12 km) for 10 days</b>



# 12-km NCMRWF-EPS in TIGGE Portal



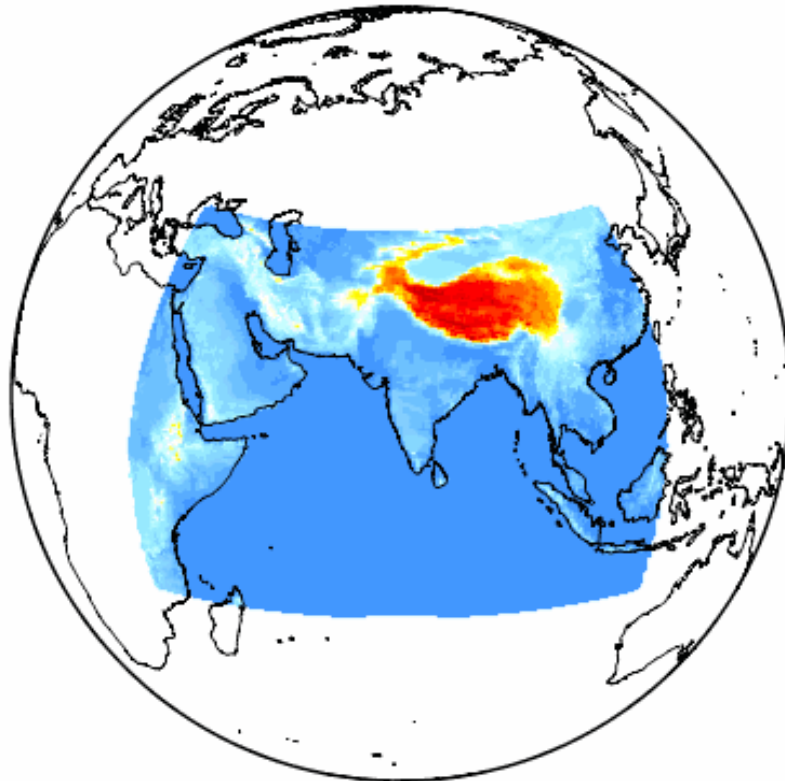
The screenshot shows a web browser window displaying the TIGGE portal news page. The browser address bar shows 'confluence.ecmwf.int'. The page header includes the ECMWF logo and navigation options like 'Spaces', 'Search', and 'Log in'. The main content area is titled 'News' and lists several news items:

- 24-07-2018 NCMRWF forecast system change**  
Update of NCMRWF forecast system. A new version of NCMRWF model was introduced. The first archived updated model runs are from the 1<sup>st</sup> of July. The main changes are:
  - reduced number of the ensemble size from 45 to 12
  - two model runs 00 and 12 UTC at very high resolution (0.12x0.18 degree)Click [here](#) for more details.
- 18-06-2018 Usage statistics**  
A new page with [TIGGE data usage statistics](#) was added.
- 20-12-2017 New model (NCMRWF, India) added to TIGGE archive**  
New model outputs (NCMRWF, India) were added to TIGGE archive. The first starting date available thanks to the back-archiving is the 1st of August 2017. Click [here](#) for more details.
- 11-07-2017 ECMWF forecast system change**  
Update of ECMWF forecast system. A new version of ECMWF model (IFS cycle 43r3) was introduced. Click [here](#) for more details.



# IMDAA Regional Reanalysis : Salient Features

IMDAA Domain



Period	1979 – 2020 (40 + 2 years)
Domain	30 - 120° E, 15° S to 45° N
Lateral Boundary Condition (LBC)	ERA-Interim
Data Assimilation Method	4D-Var (Atmosphere) Simplified Extended Kalman Filter method for Soil Moisture
Atmospheric Model	Unified Model
Horizontal Resolution	12 km (~0.11°)
Vertical Resolution	63 model levels (upto ~ 40 km altitude)
Observation Source	ECMWF, NCMRWF, UK Met Office, IMD
Surface	<u>Soil Moisture Analysis</u> <u>Sea Surface Temperature: HadSST2, OSTIA analysis</u>

Register / Download Free from NCMRWF

<https://rds.ncmrwf.gov.in>

18,000 users



## Secretary General BIMSTEC visit to BCWC, Feb 2020

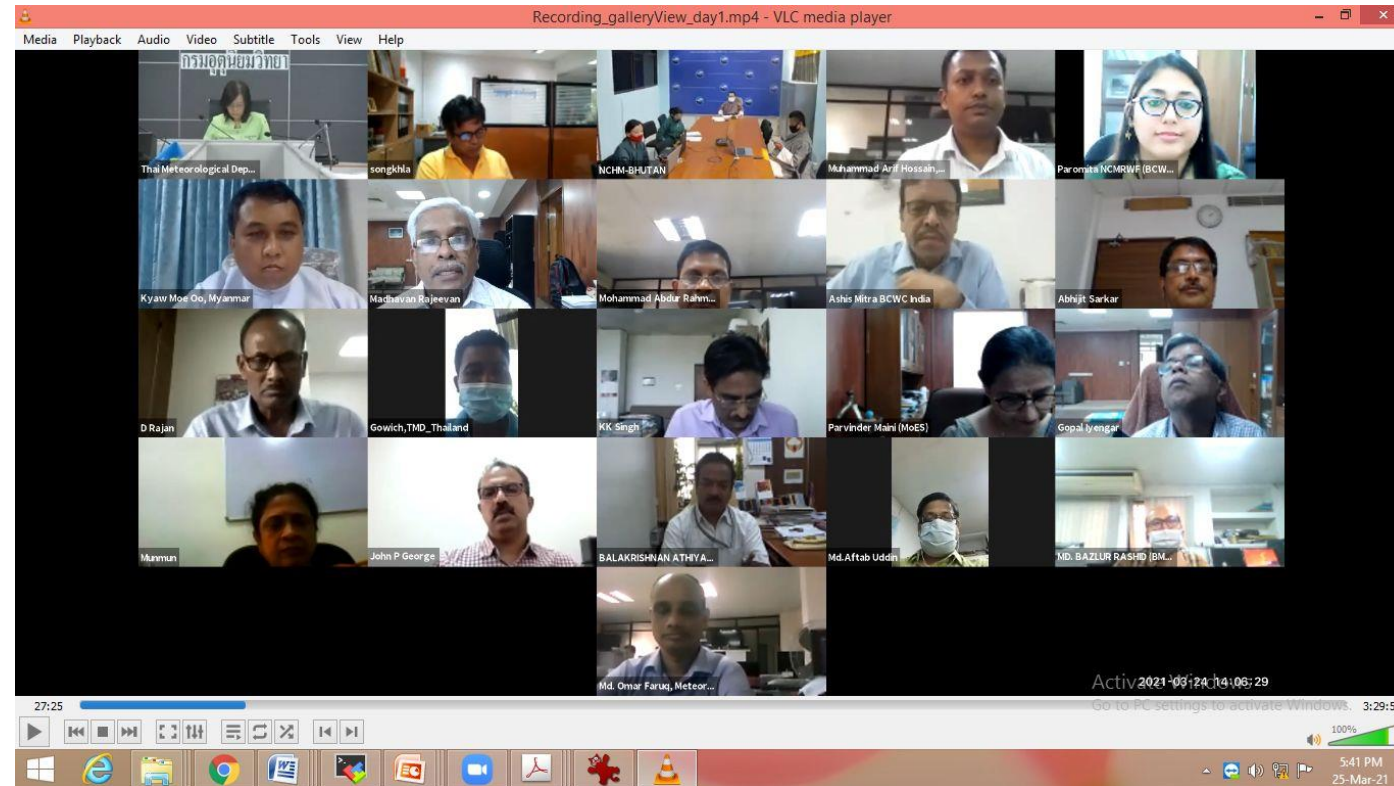
His Highness M. Shahidul Islam



organized

## Online Workshop cum Training on 'Use of Ensemble Model Forecast Products for Weather/Climate' during 24-26 March 2021

- About 70 participants from National Hydromet Departments of all the BIMSTEC countries
- Senior Scientists from BCWC (NCMRWF), IITM, NDMA and NHMs of all BIMSTEC countries were the resource persons

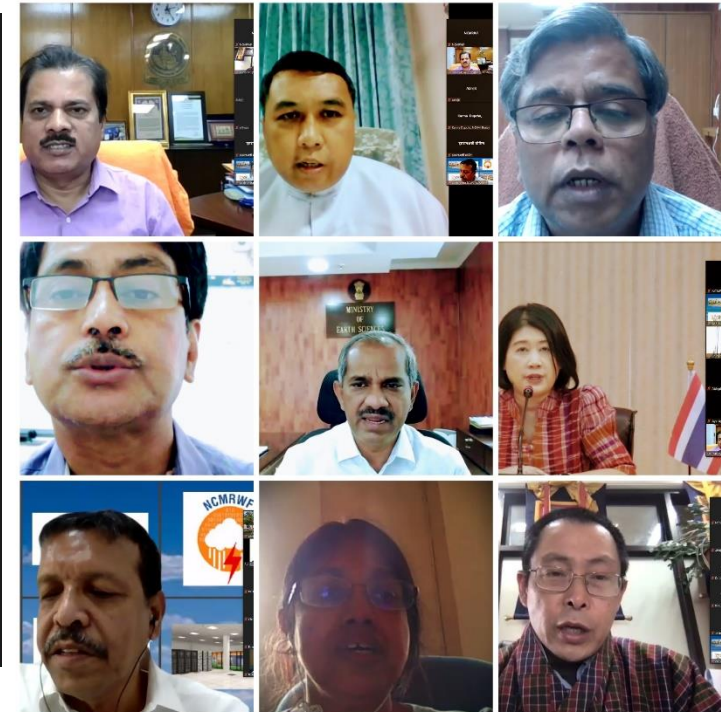
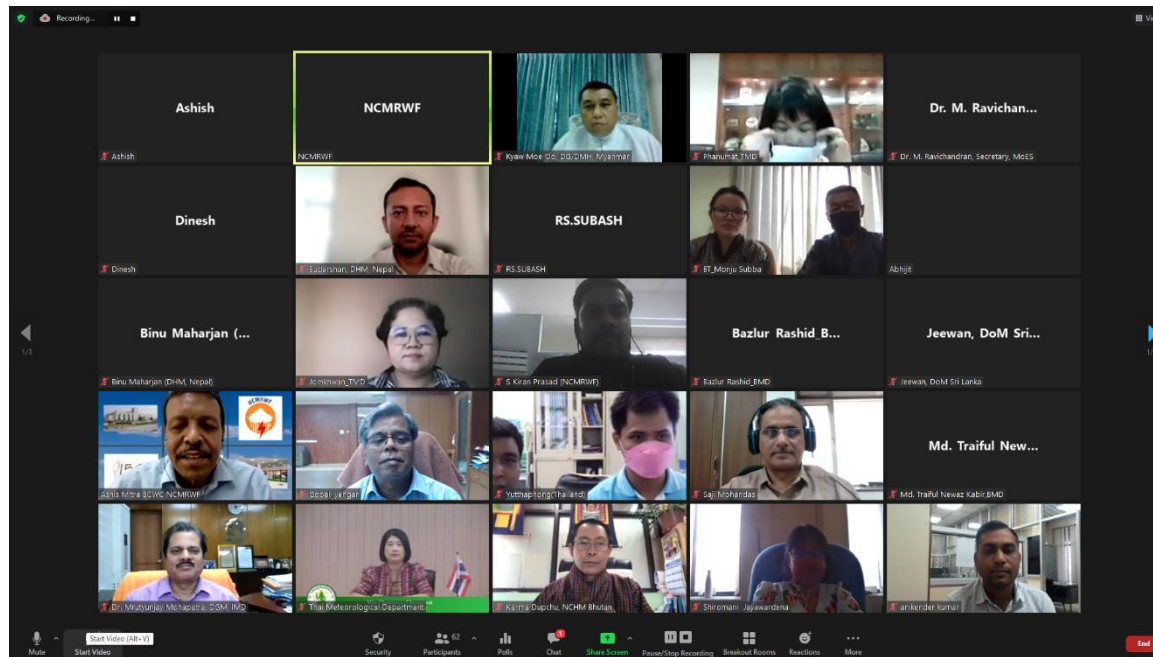


The BCWC, NCMRWF scientists shared the state of the art scientific and technical information on ensemble method of weather and climate modelling and the model products with the national Hydromet divisions of the member countries.

# BCWC Online Training

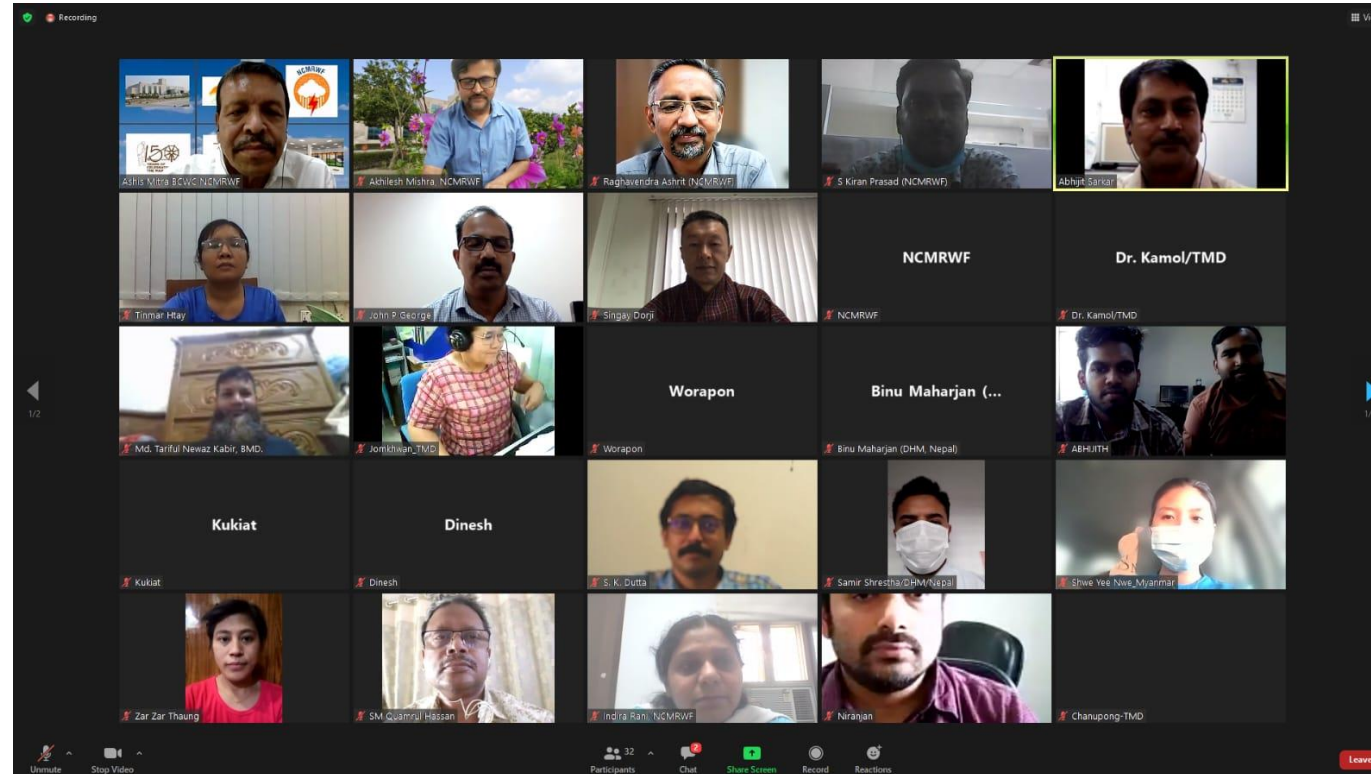
## ‘Recent Development in Weather/Climate Modelling and Data Assimilation’

### 24, 25 and 28 March 2022



BCWC, NCMRWF Scientists shared the state of the art scientific and technical information on weather/climate modelling and data assimilation with the trainees

# BCWC online Science Workshop on ‘Outstanding Challenges in Forecasting with Models’ Tuesday, 29 March 2022



The challenges faced by operational forecasters of the Hydromet Departments of different BIMSTEC member countries in providing forecasts to the user community based on the model predictions were discussed.



## Fifth Summit March 2022 by Heads of State



Our Region has always been prone to natural disasters. The **BIMSTEC Center for Weather and Climate** is an important Organization for cooperation on disaster management, especially on disaster risk reduction, and I would like your cooperation to Make this more active. India is ready to contribute **three million dollars** to restart the work of this Centre again.

Sh. Narendra Modi Ji  
Honorable Prime Minister of India



## Plans

- (1) Engaging with BIMSTEC countries to develop more weather, climate and disaster related products using model and data assimilation products. Enhancing observations for the BIMSTEC region to improve the model skill and better model validation is also important. Validation of satellite products is also a key aspect.**
- (2) Implementing region/country specific high resolution meso-scale models for BIMSTEC countries/regions. Study the impact of inclusion of more local data from BIMSTEC countries.**
- (3) Use dynamical and statistical downscaling methods to improve the regional and location specific forecasts for BIMSTEC countries.**
- (4) A seamless forecasting system from days-to-season to be developed for BIMSTEC countries/region using various model products from different institutes of MoES. This will include customized forecasts for various sectors like agriculture, water, health, energy and disaster management.**
- (5) Study to be undertaken to understand the climate variability and change for the BIMSTEC countries/region. This also has to be undertaken along with involvement of MoES institutes.**
- (6) NCMRWF will work with INCOIS, NCAOR, NIOT and ICMAM to make customized ocean parameter products and for various applications. The study of coastal processes will also be included.**



## Plans .....

**(7) Under capacity building for BIMSTEC countries various training programmes and workshops on specific topics will be undertaken. Fellowship programme for young scientists of BIMSTEC countries will be undertaken. Various positions like Research Associates, Research Fellows and visiting scientist position will be opened. Annual international conference will be organized to showcase the developments in Weather/Climate information for the region.**

**(8) The computational and infrastructure facilities at BCWC/NCMRWF will be enhanced with high-end data servers and advanced software for further developing, improving and communicating products for BIMSTEC region.**

**(9) Undertake special field campaign in partnership with BIMSTEC member countries to understand various physical processes like PBL, Convection and land-surface. The mountain regions field data will have an important role.**

**(10) To develop and implement a regional coupled model for severe weather for BIMSTEC region with emphasis on tropical cyclone intensity forecast.**

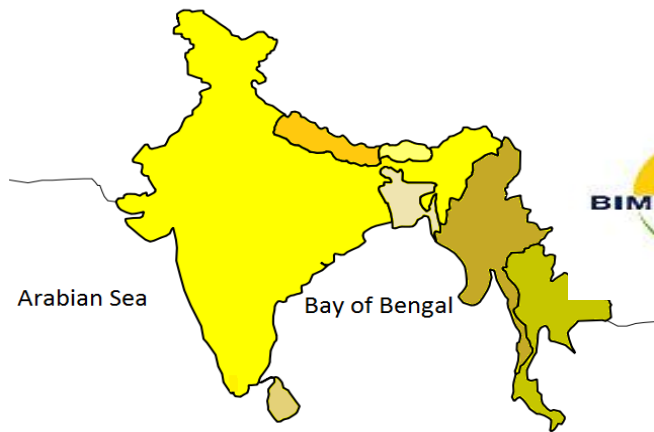
**(11) Set up enhanced observing systems (Radiosonde, Radars and AWS) in BIMSTEC member countries**

**(12) Launch BIMSTEC Fellowship program, Recruitment of Staff**





# Thank You



**BANGLADESH**

**BHUTAN**

**INDIA**

**MYANMAR**

**NEPAL**

**SRI LANKA**

**THAILAND**