Modelling activities at NCMRWF for weather and climate forecast in mountain region

THE 3rd SESSION OF THE THIRD POLE CLIMATE FORUM

&

MEETING OF THE THIRD POLE RCC-NETWORK TASK TEAM

3 – 5 June 2025 Mahika Hall

Ministry of Earth Sciences (MoES) Prithvi Bhawan, Lodi Road New Delhi, India

Centre of Excellence in Weather and Climate Modelling

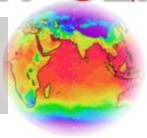
Modelling and Data Assimilation Centre

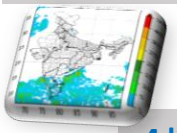
India's First Supercomputer for Weather Forecasting: 1989


WMO Secretary General Visiting
NCMRWF on 17th January 2025

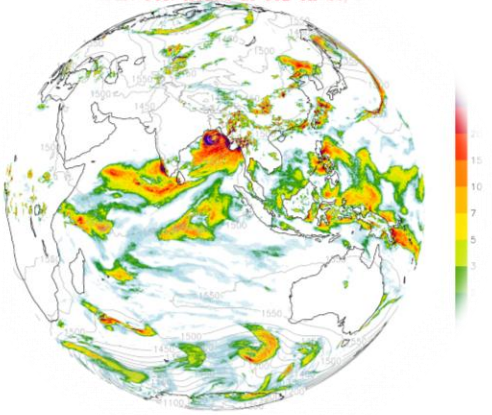
NCMRWF SEAMLESS MODELLING SYSTEM

12 km Global Model (NCUM-G)



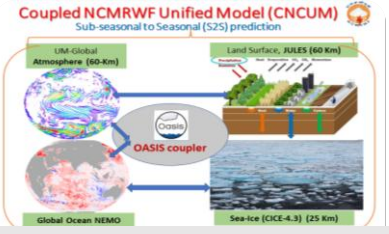


4 km Regional Model

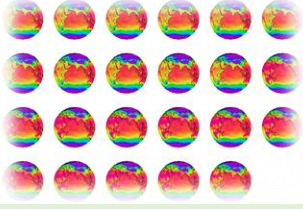


330 m Delhi Model

1.5 km Regional Model

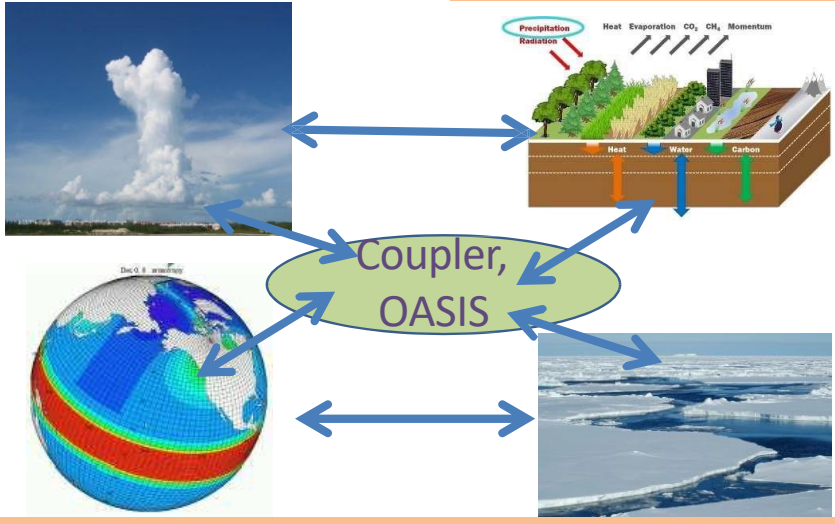


Coupled Model (CNCUM) for S2S



Ensemble Prediction System

Components of NCMRWF Global Coupled Modelling System



Ocean. NEMO 3.4 Sea Ice CICE 4.3

NCMRWF Coupled Modelling System

Ensemble Prediction System based on GloSea5 system of UK Met Office

- The NCMRWF Global Coupled Model Version 2.0 (GC2)
  - Global Atmosphere 6.0 (GA6.0)
  - Global Land 6.0 (GL6.0)
  - Global Ocean 5.0 (GO5.0)
  - Global Sea Ice 6.0 (GSI6.0)
- GloSea5/GC2 uses the N216 version (0.8 degrees in latitude and 0.5 degrees in longitude).
- Model has approx. **60 km horizontal** resolution for the atmosphere.
- Resolution is approximately **25 km/ORCA0.25 grid (0.25 degrees) for the ocean**.
- The vertical resolution **is 85 levels for the atmosphere and 75 levels for the ocean**.
- Started in 2019

Operational for Seasonal to Sub-seasonal (S2S) prediction

- Weekly extended range/Multi-week (4-week/1-month forecast): 16 ensemble members
- Issued every Thursday of the week.
- Monthly runs to issue Seasonal (3 to 9 months) forecast: 55 ensemble members,
- Issued on 23rd day of the month.
- Ensembles are created using time lag and Stochastic kinetic energy backscatter schemes (SKEBSs)

Users (Forecasts shared with) are :

- ✓ Renewable Energy companies
- ✓ IMD/NCPOR/Indian Navy/INCOIS/DRDO
- ✓ BIMSTEC countries

NCMRWF Coupled Model : (NCUM+JULES+NEMO+CICE)

(60 km Atmosphere & 25 km Ocean/Sea-Ice)

Medium Range (Course Resolution NWP)	Extended Range (Multi-Week Prediction)	Long Range (Seasonal Prediction)
Forecast Freq.= Daily once Length of forecast: 15 days	Forecast Freq.= Weekly once Length of forecast: 4 weeks	Forecast Freq.= Monthly once Length of forecast: 3-6 months
• Single model deterministic forecast • Issued daily at 00Z • Ocean State Forecasting (OSF), Tropical Cyclone Heat Potential (TCHP) and IOP's	• 16-member ensemble prediction system • Issued every Thursday • Week-by-week anomalies and full fields and monthly mean anomalies are used	• 55-member ensemble prediction system • Issued on 23rd Day of the month • Seasonal and month by month full field and anomalies

separately carried out, which generated **23 Years (1993-2015)** model runs for calculating model climatology and study the seasonality and annual cycle.

Model Products (Forecasts/Hindcast)

- ✓Hindcast: 1993-2015
- ✓Forecast 2019 onwards
- ✓Regular Ocean products: NEMO/ORCA25
- ✓Regular Atmospheric Products: UM-> rain, snow, winds etc…
- ✓Sea-Ice Forecasts from C-ICE

For More Please see the report:
https://nwp.ncmrwf.gov.in/publication/NCUM_S2S_TR_May2019.pdf

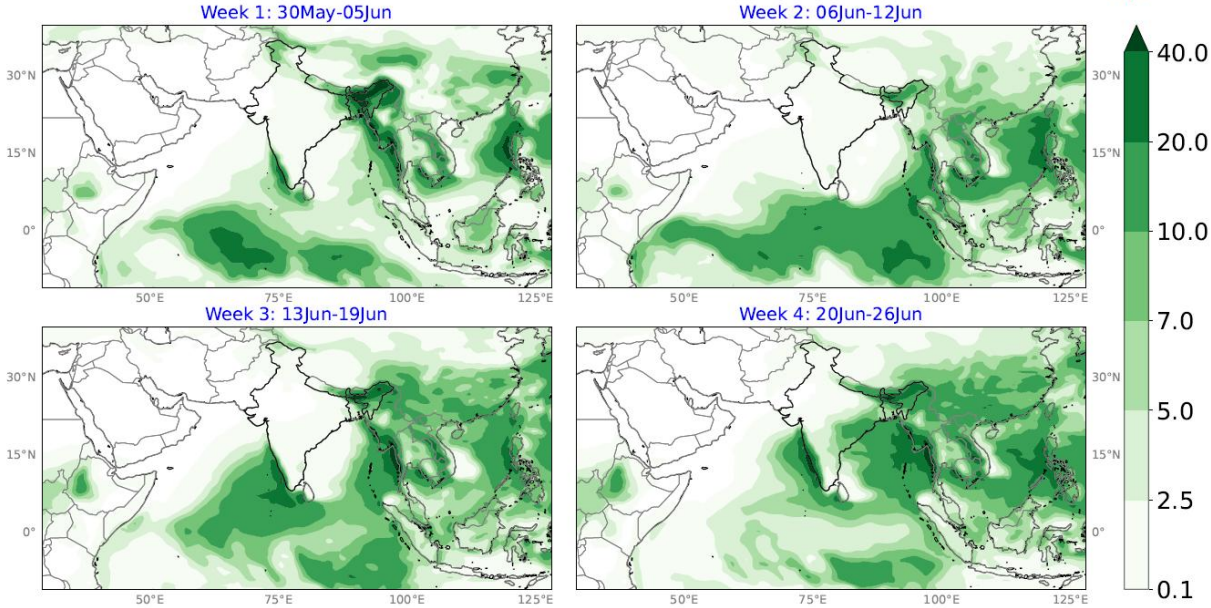
Extended Range Forecasts
NCMRWF Coupled Model Runs

Issued on 29 May 2025

- NCMRWF Coupled Model Runs with 60 km NCUM and 25 km NEMO
- Weekly Anomalies during 30 May 2025-26 Jun 2025
- Model Climatology 23 years. Hindcast data used (1993-2015) from 6 members
- This Forecast is from 16 ensemble members with IC: 25 May 2025-28 May 2025
- Plots show week-by-week anomalies and full fields

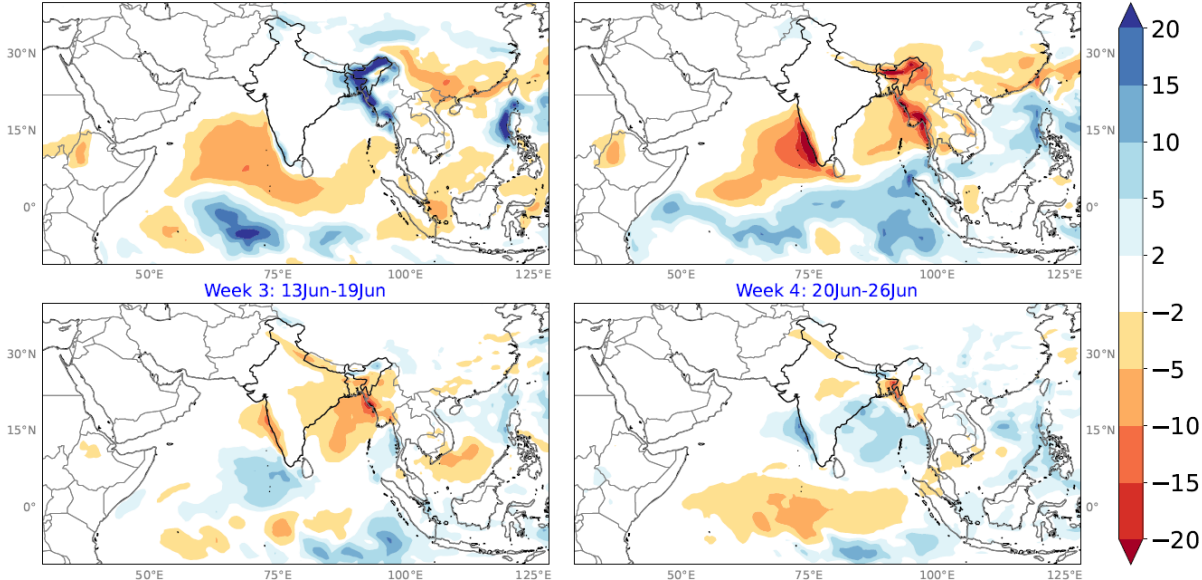
NCMRWF Extended Range Forecasts: 20250529

Precipitation (mm/day)



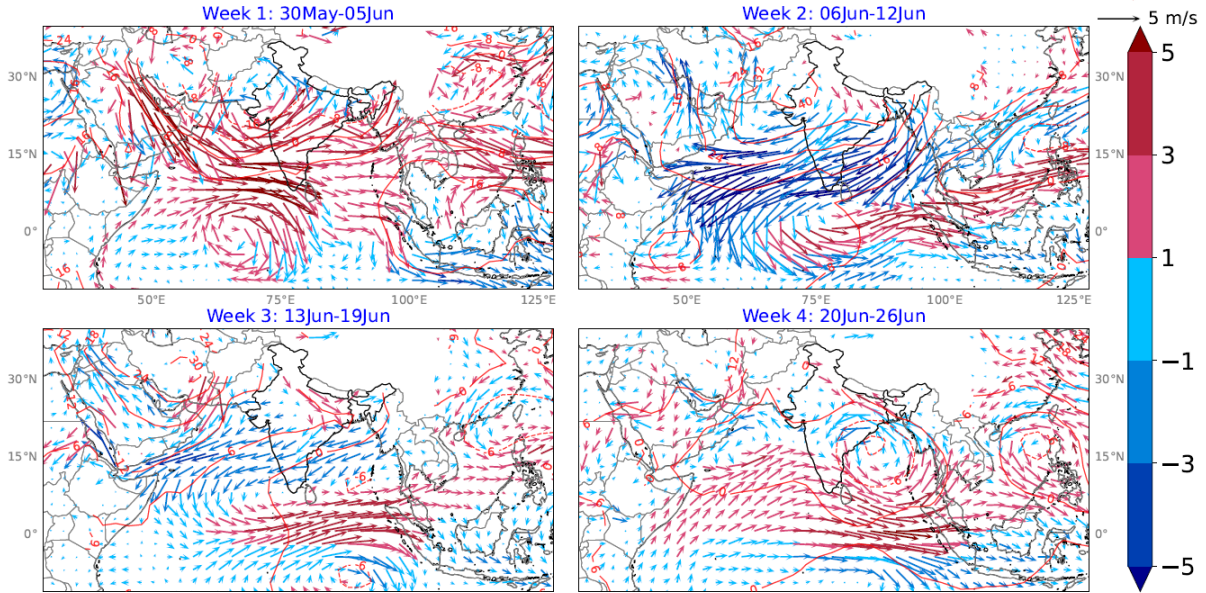
NCMRWF Extended Range Forecasts: 20250529

Precipitation Anomaly (mm/day)

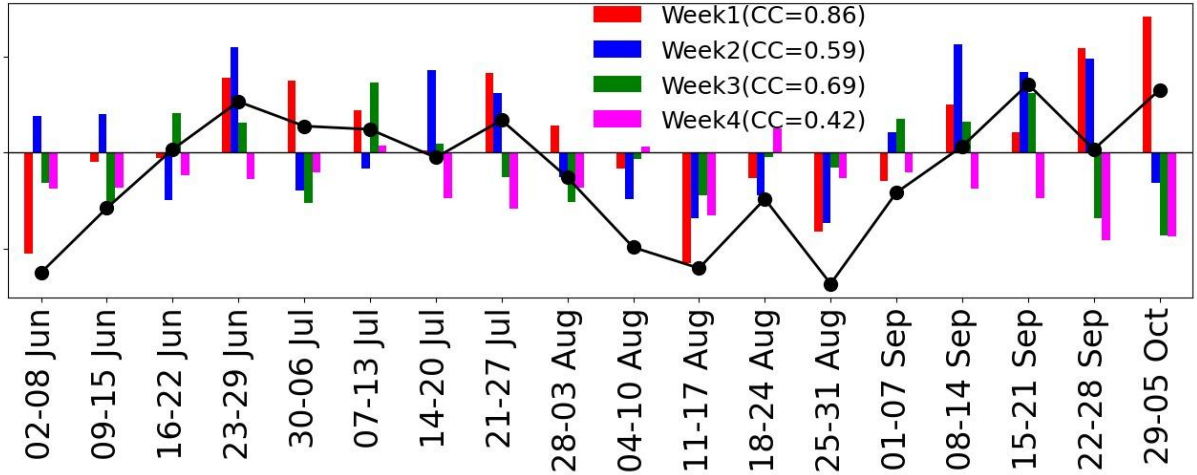


NCMRWF Extended Range Forecasts: 20250529

850hPa GH(m) & Winds Anomaly(m/s)



2024 Monsoon Season Rainfall Skills

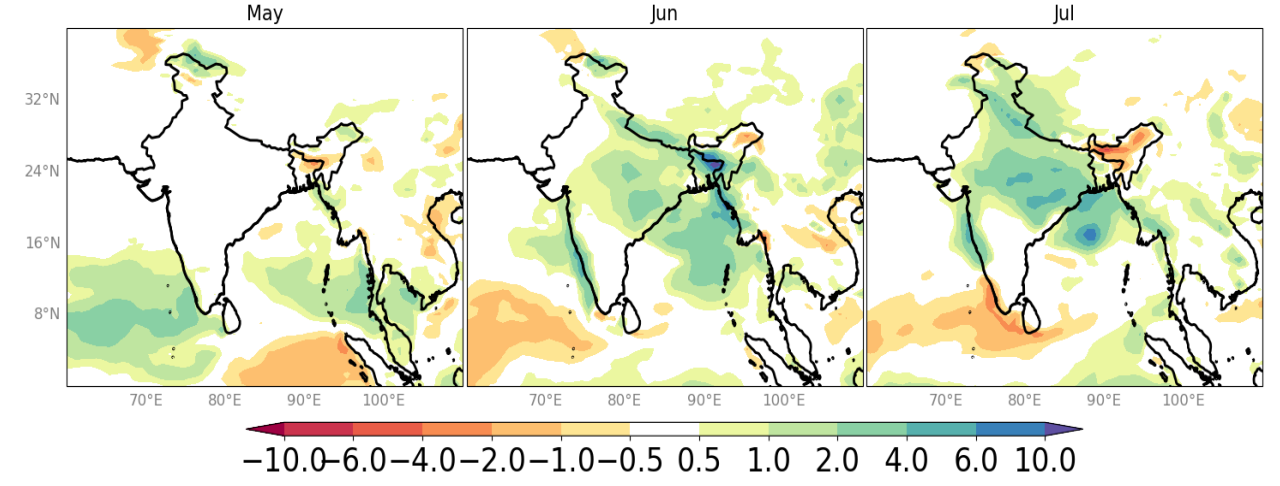


Forecast Issued: 23rd April 2025
April 2025 Initial condition (IC)

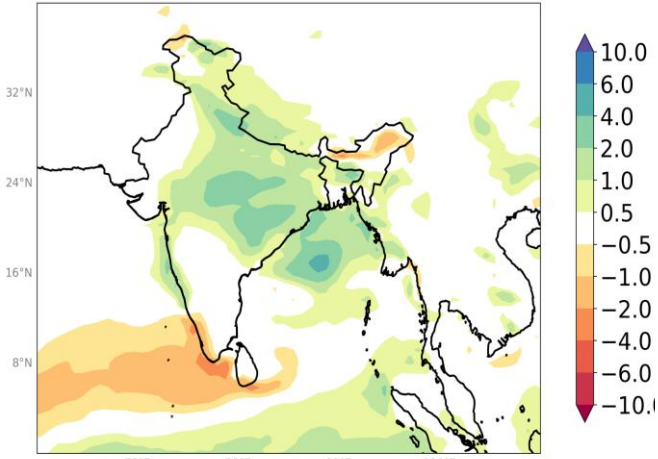
- **Coupled model: 60 km Atmosphere (NCUM), 25 km Ocean (NEMO)**
- **55 members ensemble forecast.**
- **Start dates: 12th to 22nd of the month. 5 members per start date**
- **Number of hindcast members: 6 member**
- **Period of hindcast: 23 Years (1993-2015)**
- **Hindcasts are used to compute climatology and to define terciles used in probabilistic forecasts**

Monthly Mean Precipitation Anomaly Forecast (mm/day)

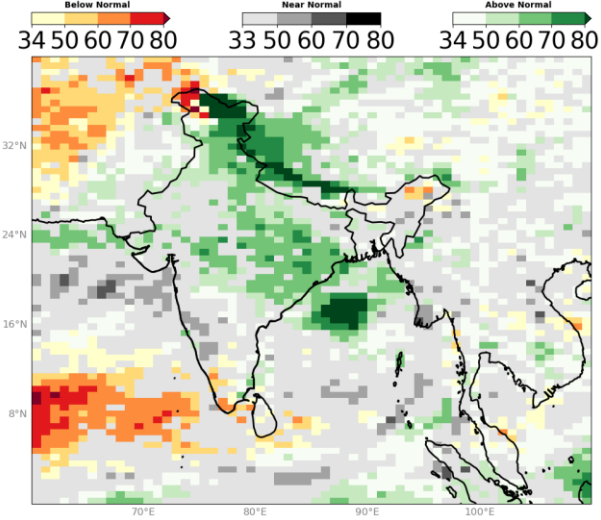
Forecast Issued: 23rd April 2025 (April Initial Condition)



Seasonal (JJAS) Mean Precipitation Anomaly Forecast (mm/day)



Seasonal (JJAS) Precipitation Categorical probabilistic



JJAS: Jun, Jul, Aug, Sep 2025

Forecast Issued: 23rd April 2025, (IC=APR2025)

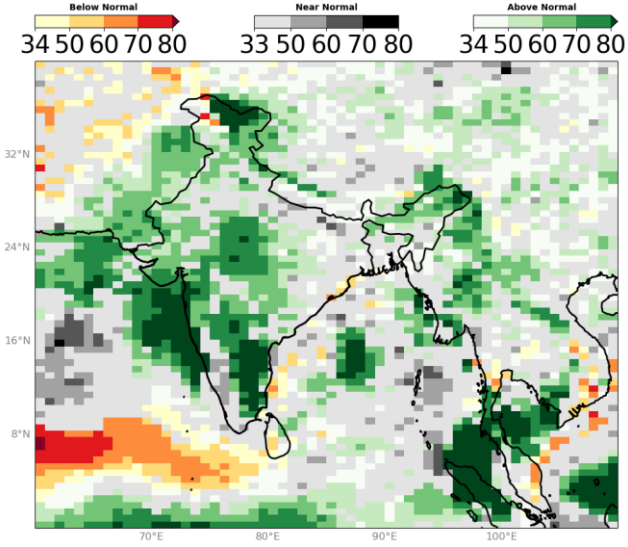
Seasonal Verification 2024 Monsoon for May IC

Coupled model: 60 km Atmosphere (NCUM), 25 km Ocean (NEMO)

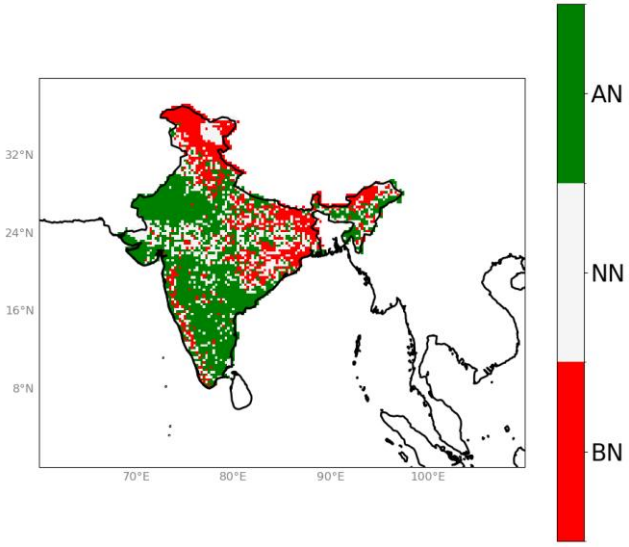
Start dates: 12th to 21st of May

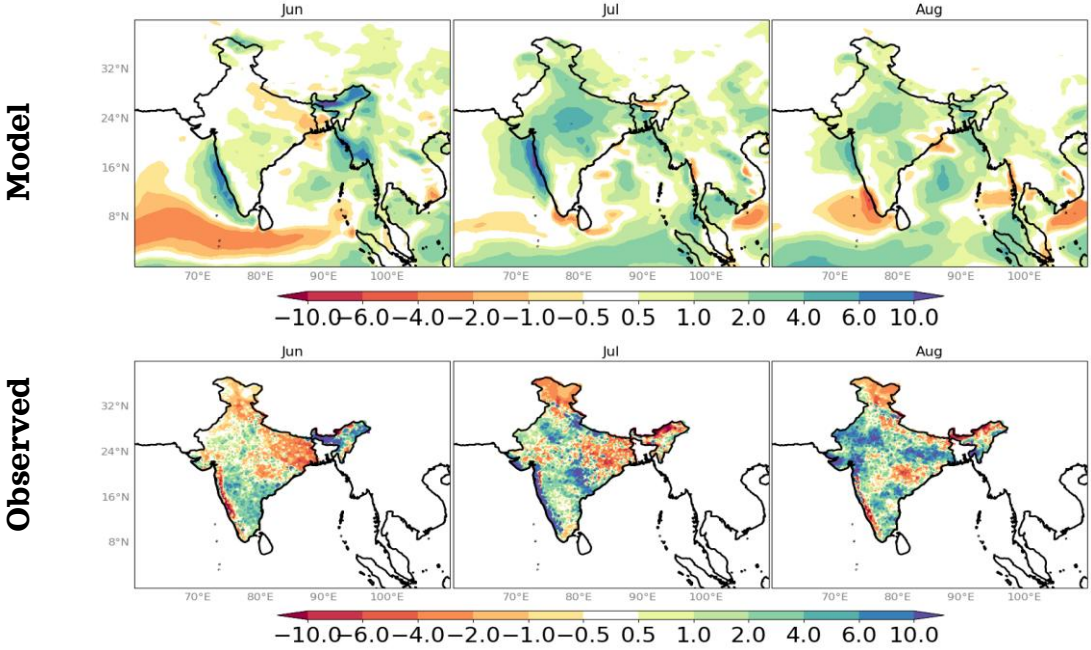
5 members per start date

CNCUM Model



Observed




Model
Observed
Jun
Jul
Aug
32°N
24°N
16°N
8°N
70°E
80°E
90°E
100°E
−10.0 −6.0 −4.0 −2.0 −1.0 −0.5 0.5 1.0 2.0 4.0 6.0 10.0

Snow Initialization for NCMRWF S2S Prediction System

Fields read from input dump (Analysis) in forecast model

Sl. No.	Field Name
1	Snow Amount Over Land Aft Tstp Kg/M2

Fields read from ancillary files (Climatology)

Sl. No.	Field Name
$ANCILDIR_N216/orca025/general_land/GlobAlbedo/v2/qrclim.land	
1	Observed/Climatology Snow-Free Surf Sw Albedo

Following Fields set to 0

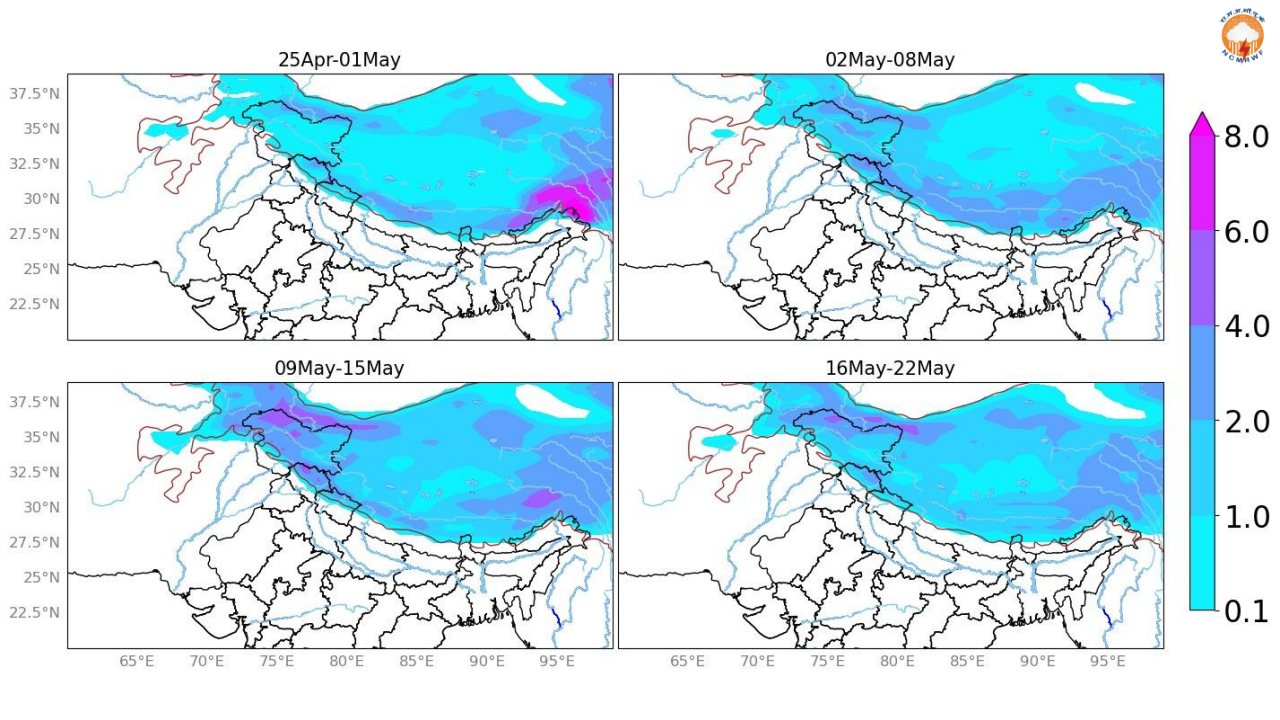
Sl No.	Field Name
1	Snow Amount Over Sea-ice Aft Ts Kg/M2
2	Large Scale Snow Rate: Cpl Kg/M2/S
3	Convective Snow Rate: Cpl Kg/M2/S
4	Snow Beneath Canopy Kg/M2
5	Sea Ice Snow Depth By Categories

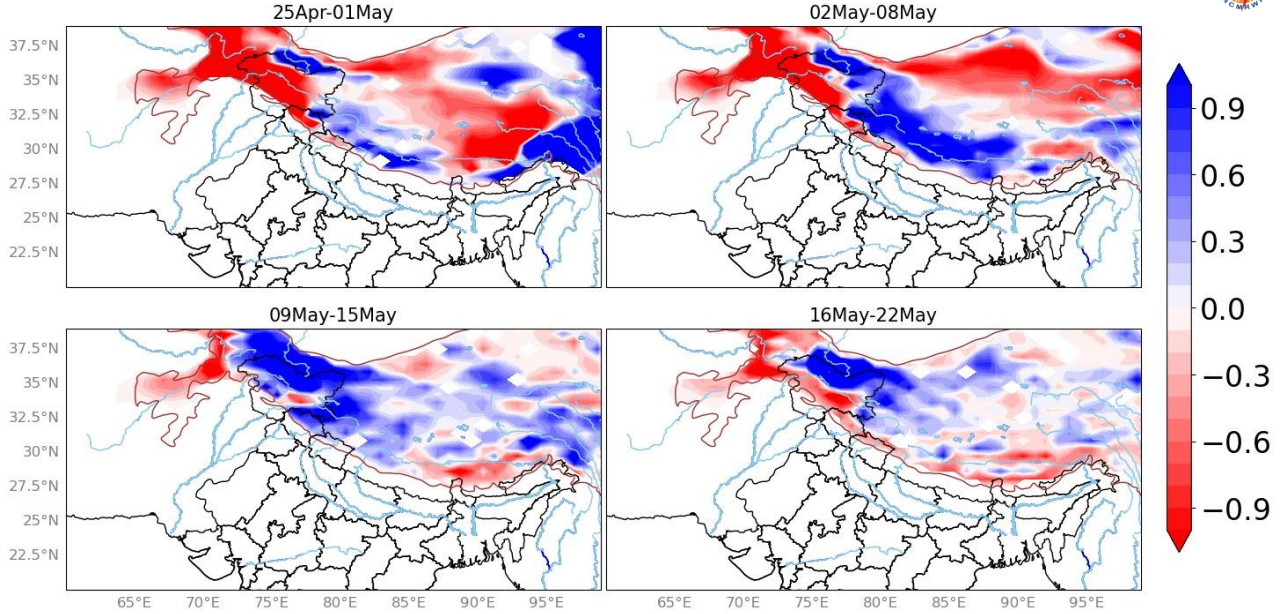
Snow output/forecast from Model

S.N.	Field Name	Frequency
1	Snow Amount Over Land Aft Tstp Kg/M2 from Atmospheric Model	Daily
2	Total Snowfall Rate: Ls+Conv Kg/M2/S from Atmospheric Model	Daily
3	Convective Snowfall Rate Kg/M2/S from Atmospheric Model	Daily
4	Large Scale Snowfall Rate	Daily
6	Snow Mass After Hydrology Kg/M2 from Atmospheric Model	Monthly
7	Snow Thickness in m (Cell Average) from Ocean Model	12 hr.
8	Grid Cell Mean Snow Thickness from CICE Model	Daily
9	Snow-Ice Formation from CICE Model	Daily

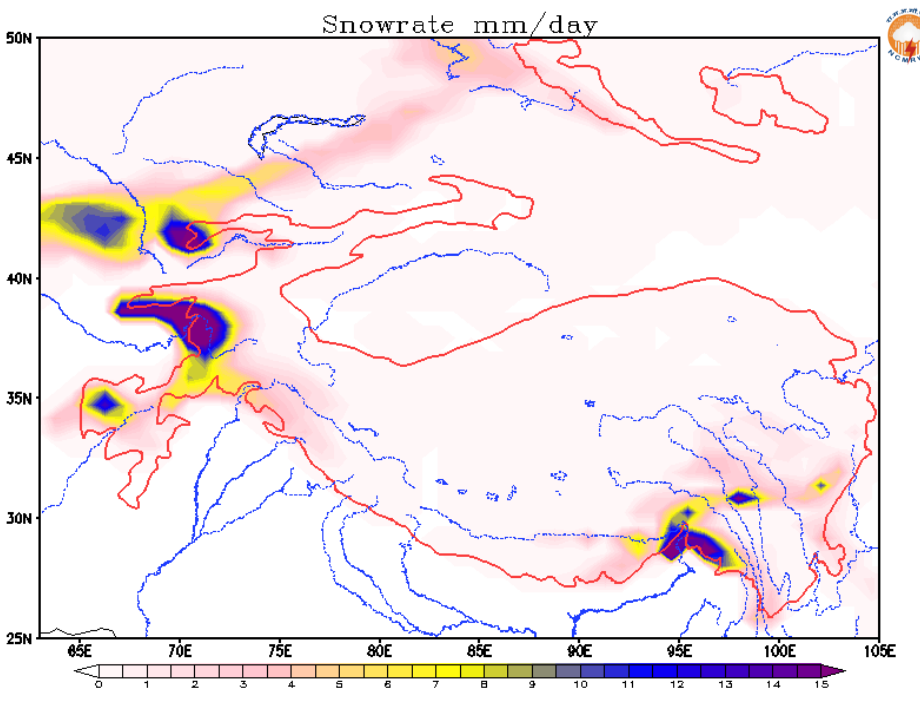
S.N.	Field Name	Frequency
11	Top Snow Melt (cm/day) From CICE model	Daily
12	Total Snowfall Rate: Ls+Conv Kg/M2/S from Atmospheric Model	Daily
13	Convective Snowfall Rate Kg/M2/S from Atmospheric Model	Daily
14	Large Scale Snowfall Rate Kg/M2/S from Atmospheric Model	Daily
15	Snow Mass After Hydrology	Daily

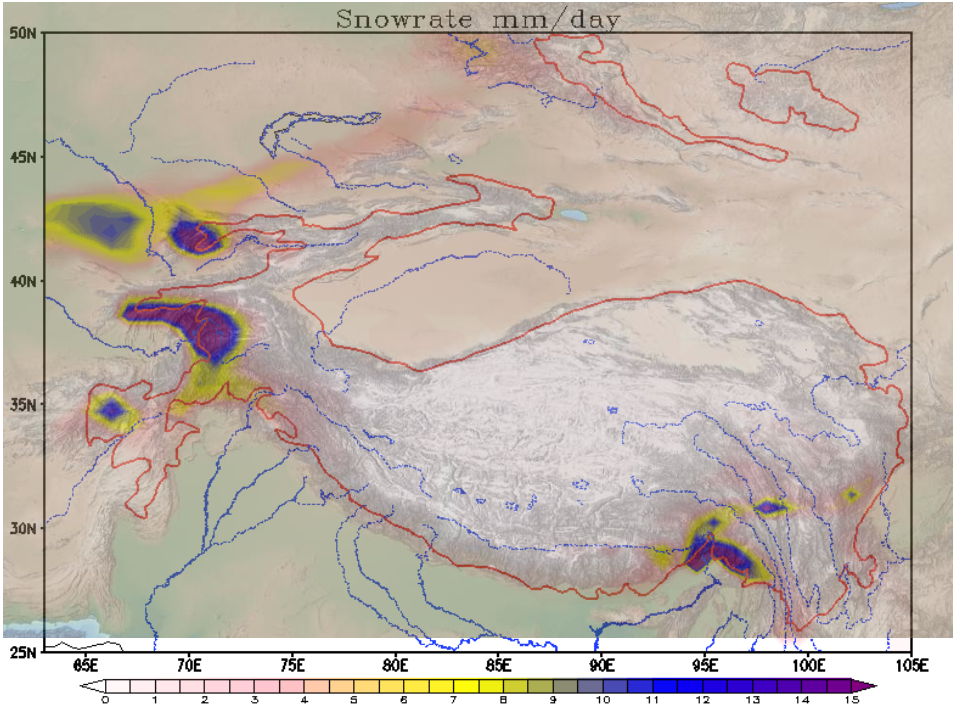
11	Top Snow Melt (cm/day) From CICE model	Daily
12	Total Snowfall Rate: Ls+Conv Kg/M2/S from Atmospheric Model	Daily
13	Convective Snowfall Rate Kg/M2/S from Atmospheric Model	Daily
14	Large Scale Snowfall Rate Kg/M2/S from Atmospheric Model	Daily
15	Snow Mass After Hydrology	Daily


25Apr-01May
02May-08May
09May-15May
16May-22May
37.5°N
35°N
32.5°N
30°N
27.5°N
25°N
22.5°N
65°E
70°E
75°E
80°E
85°E
90°E
95°E
8.0
6.0
4.0
2.0
1.0
0.1


25Apr-01May
02May-08May
09May-15May
16May-22May
37.5°N
35°N
32.5°N
30°N
27.5°N
25°N
22.5°N
65°E
70°E
75°E
80°E
85°E
90°E
95°E
0.9
0.6
0.3
0.0
−0.3
−0.6
−0.9

Sample Forecast from 1-member of NCMRWF-ERPS




Snowrate mm/day
50N
45N
40N
35N
30N
25N
65E
70E
75E
80E
85E
90E
95E
100E
105E
0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15

Summary

1. NCMRWF can provide model guidance over the Third Pole region from Days to Season.

2. Seamless Modelling System operational at NCMRWF provides Model Guidance to India Met. Department using its regional, global and coupled (Global) Prediction system.

3. 23-member Global Ensemble Prediction System (NEPS) is operational at 12km resolution on Medium range time scale.

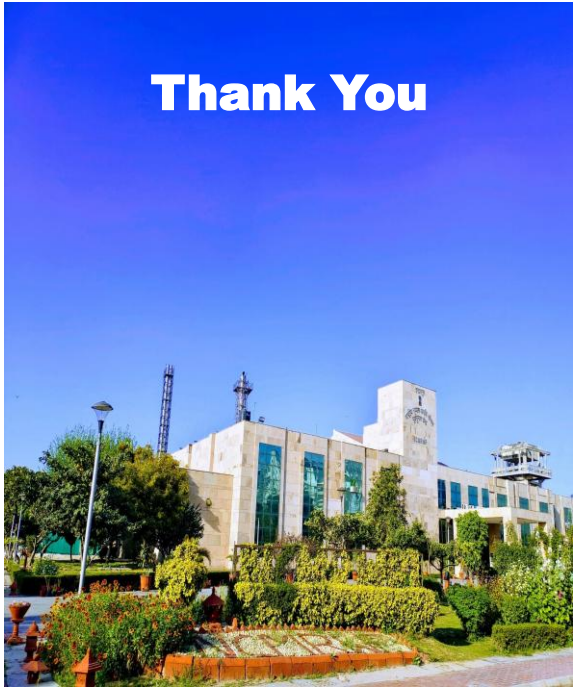
4. 16-member Global Extended Range Prediction System (ERPS) can facilitate ocean and sea-ice products at 25 km resolution and Atmospheric products at 60 km grid resolution.

5. Experimental Seasonal scale forecast every month is started from 2019 onwards. This system is using 55-member ensemble seasonal prediction system.

Way Forward

- **Coupled Global NWP (10 km) Regional Coupled system 1.5 km (Include details of Regional Seas, LS interactions, waves) Improving Northern Bay Coupled Process Improve Real-Time Observations**

- **Global Coupled Data Assimilation**
- **Higher Resolution Global Coupled system for S2S (with more ensemble numbers)**
- **Development of applications based on S2S probabilistic prediction**



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Lead: Coupled Modelling Team

The National Centre for Medium Range Weather Forecasting (NCMRWF)

Ministry of Earth Sciences, Government of India