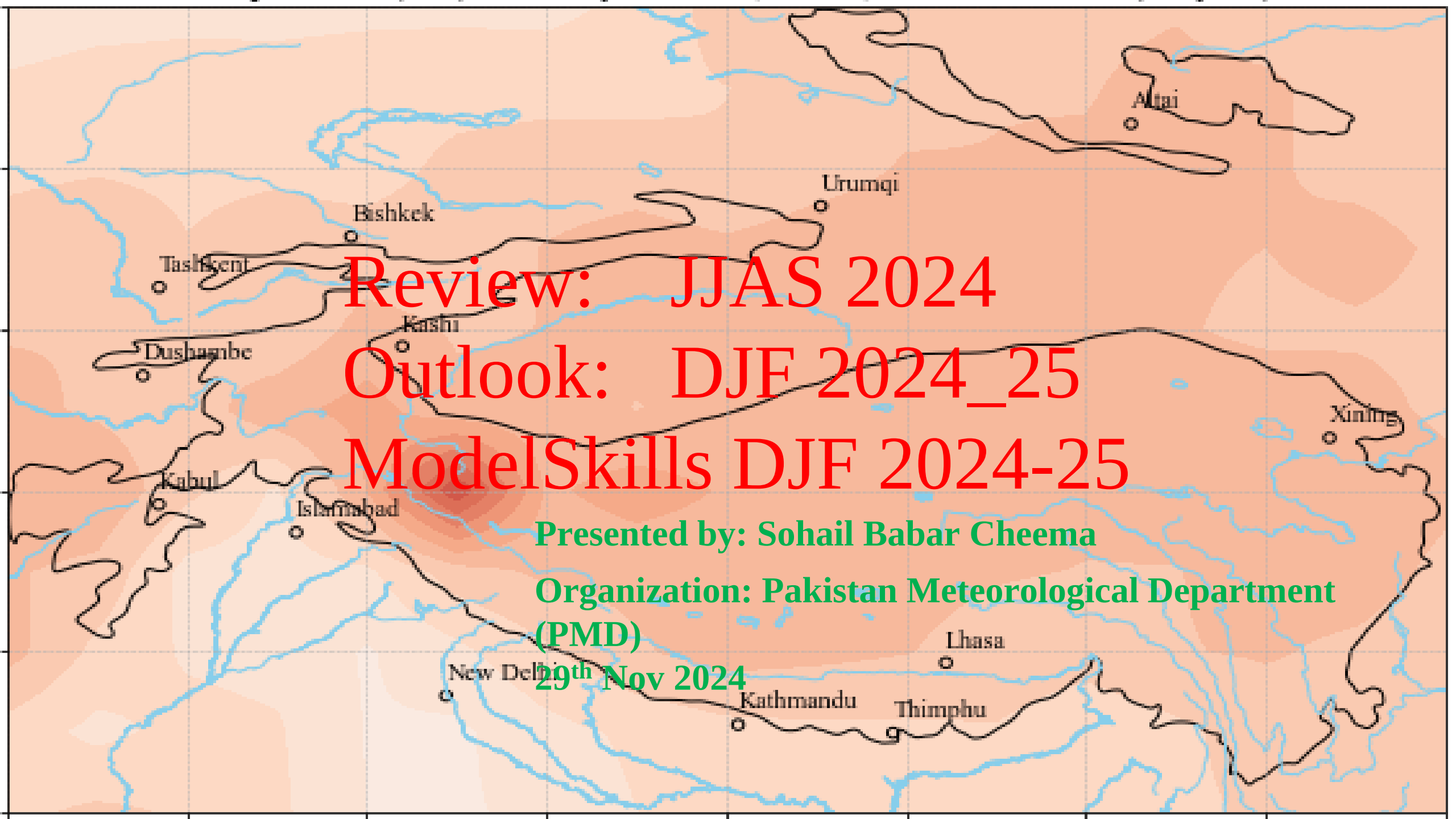


Review: JJAS 2024
Outlook: DJF 2024_25
ModelSkills DJF 2024-25

Presented by: Sohail Babar Cheema

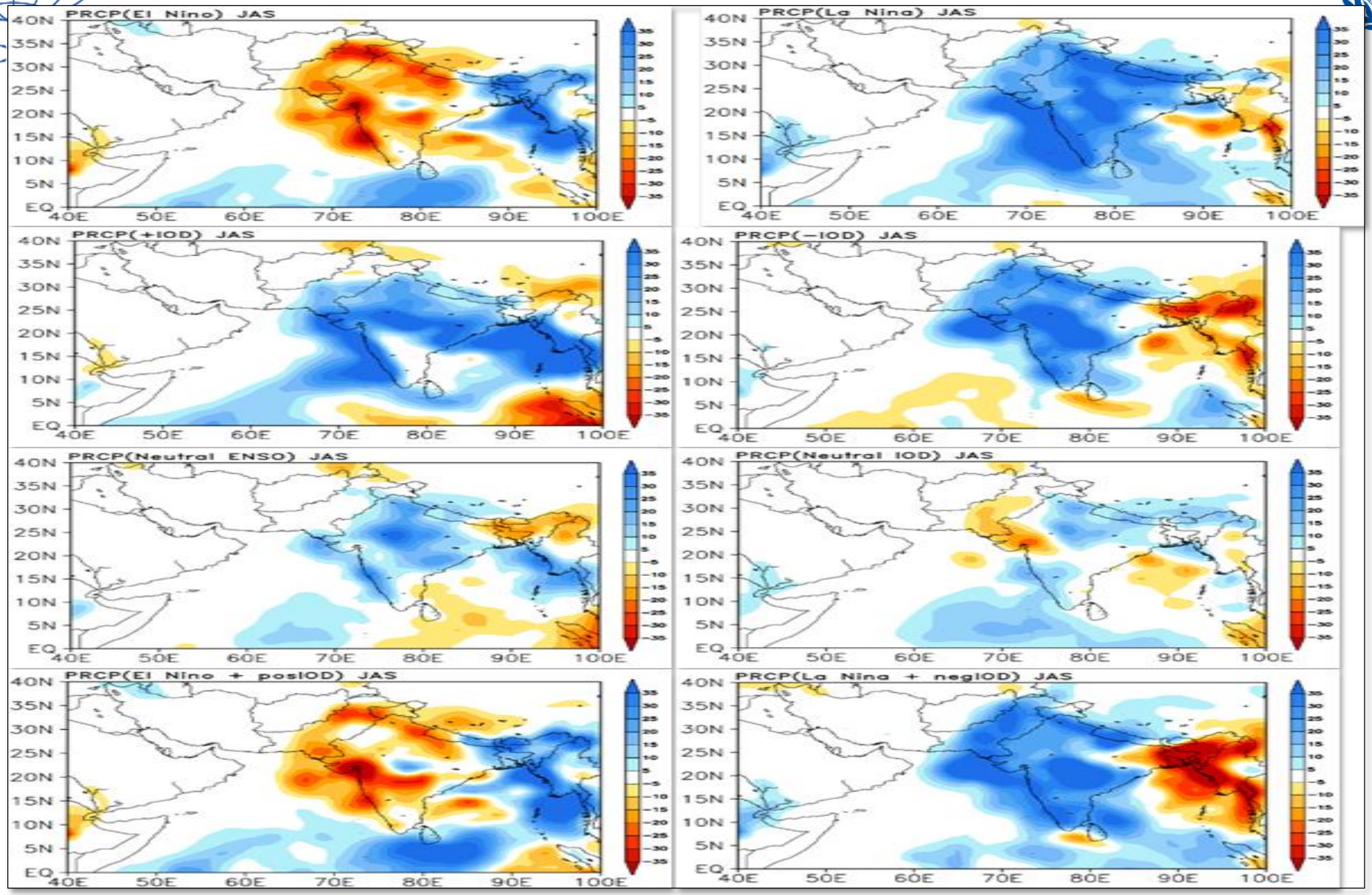
Organization: Pakistan Meteorological Department (PMD)

29th Nov 2024

SST and Monsson Rainfall analysis

Third Pole C

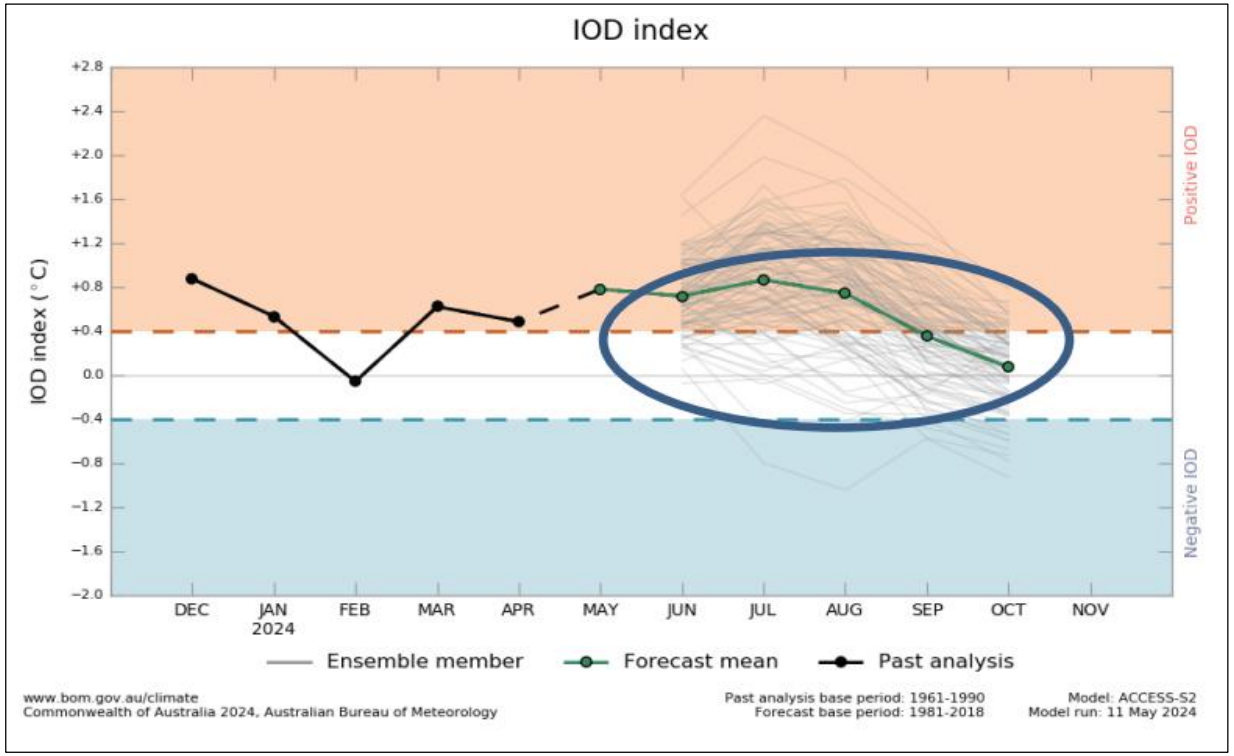
WMO Third Pole RCC Network

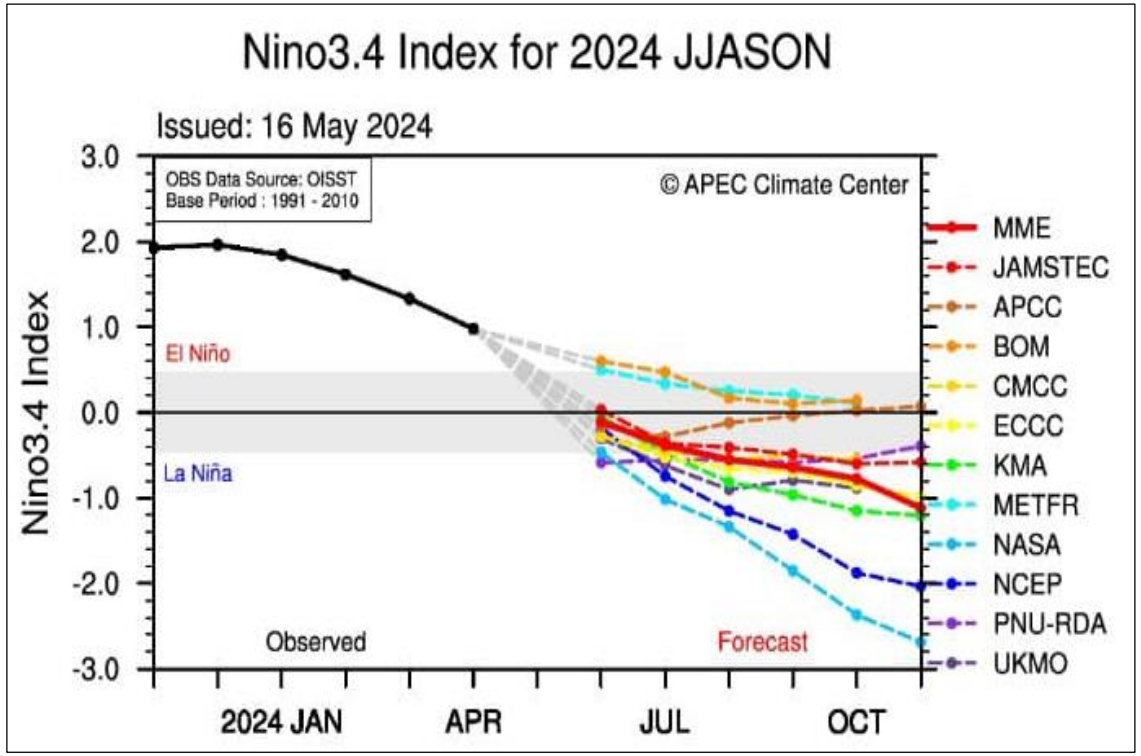


Third Pole Climate Forum

SST Outlook for JJAS

WMO Third Pole RCC Network





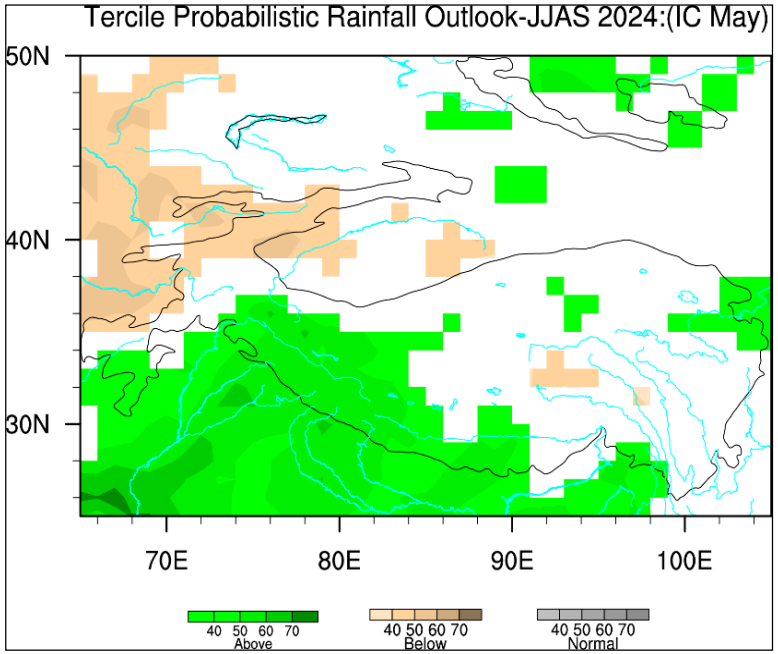
Third Pole Climate Forum

Probabilistic Precipitation Forecast

WMO Third Pole RCC Network

Relative to: 1991-2020

CMA



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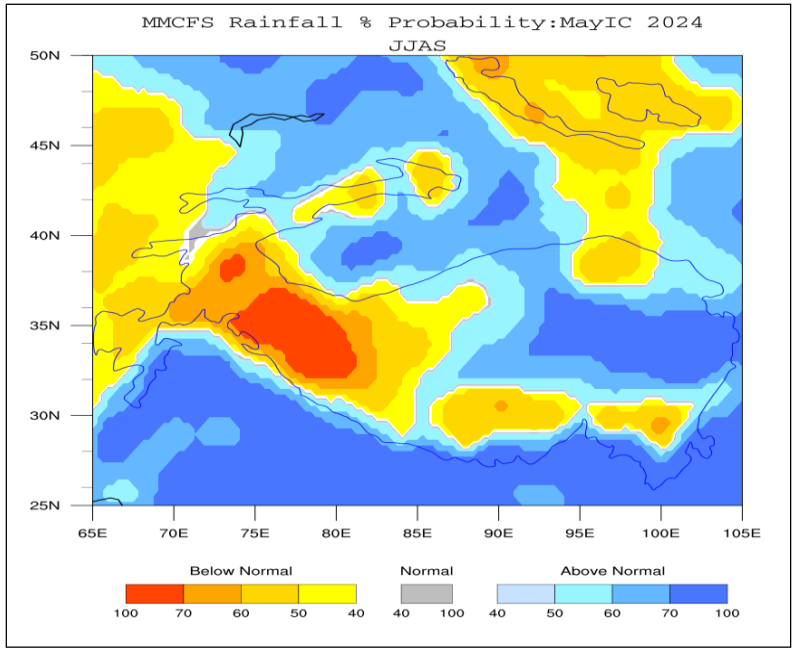

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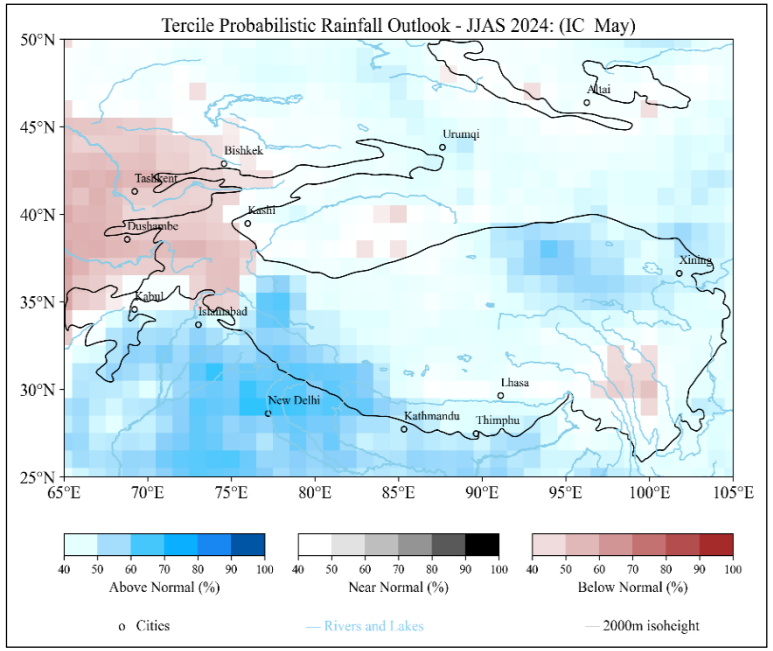
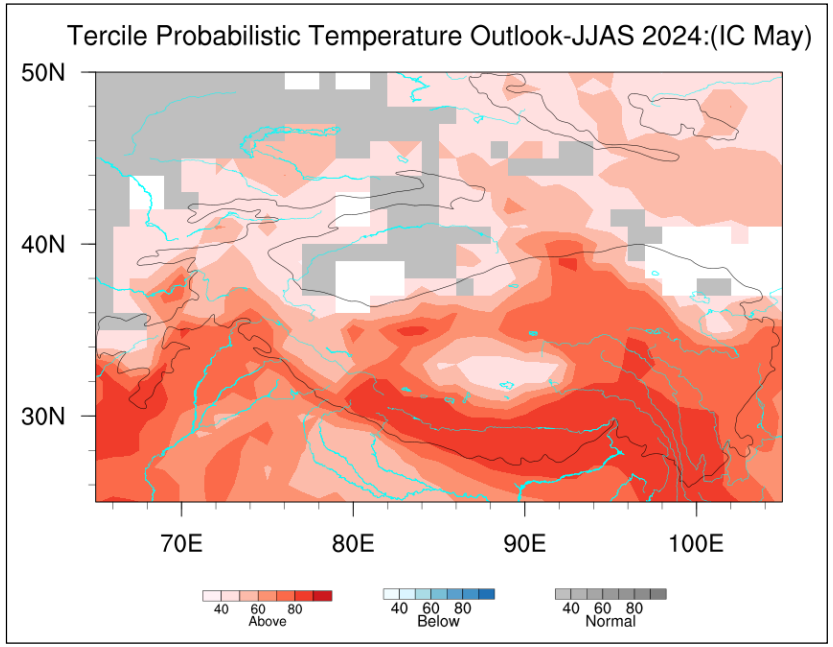


Third Pole Climate Forum

Probabilistic Temperature Forecast

WMO Third Pole RCC Network

CMA



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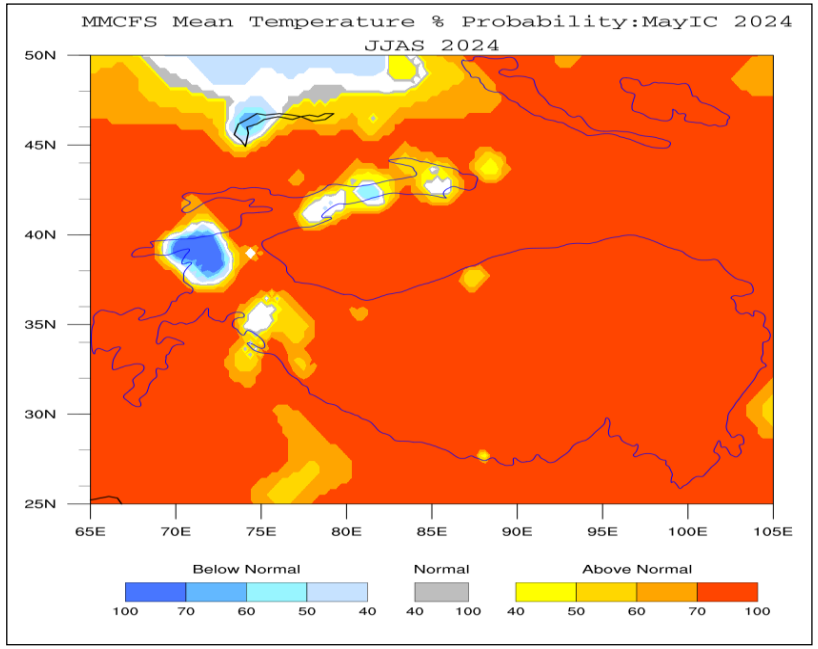

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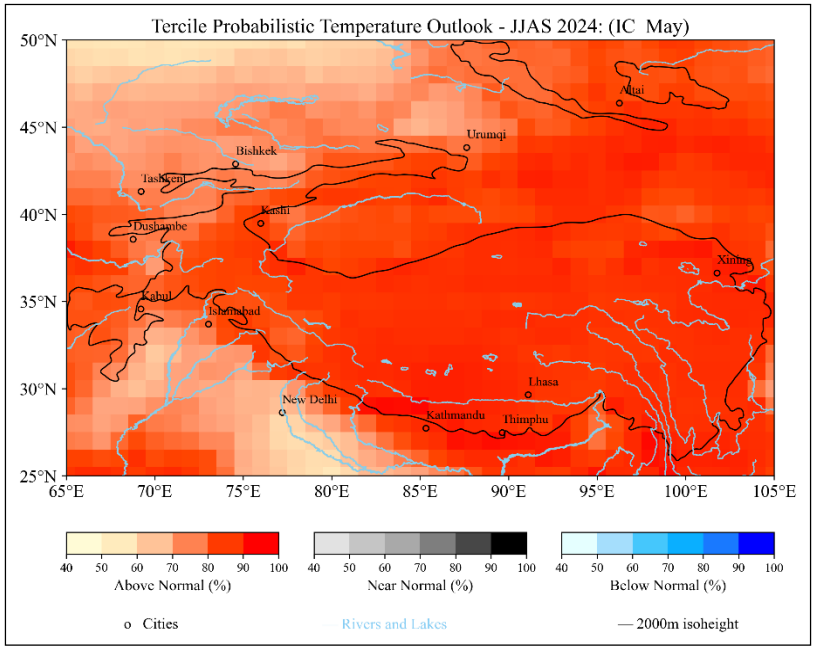
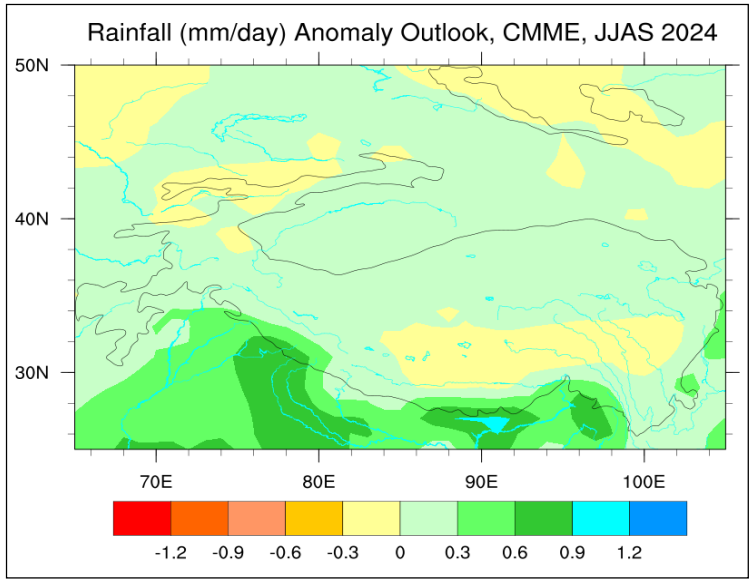


Third Pole Climate Forum

Anomalies/Deterministic Forecast Precipitation

WMO Third Pole RCC Network

CMA



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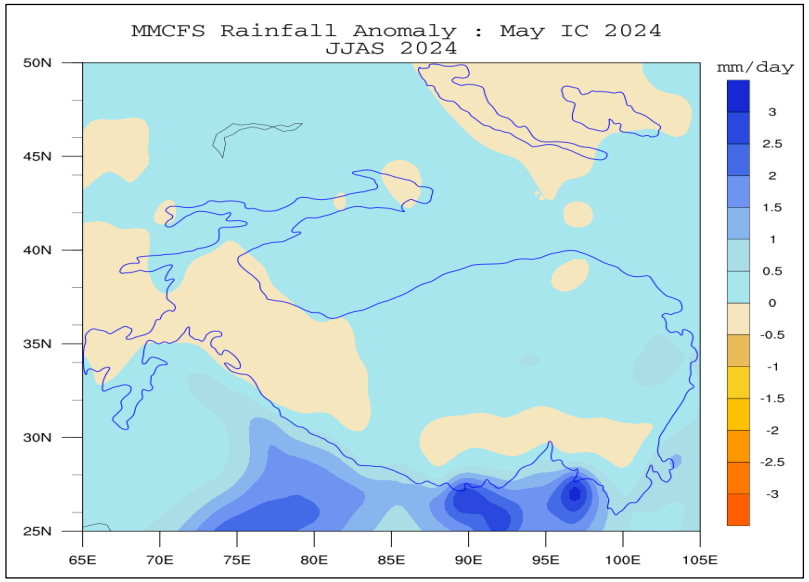

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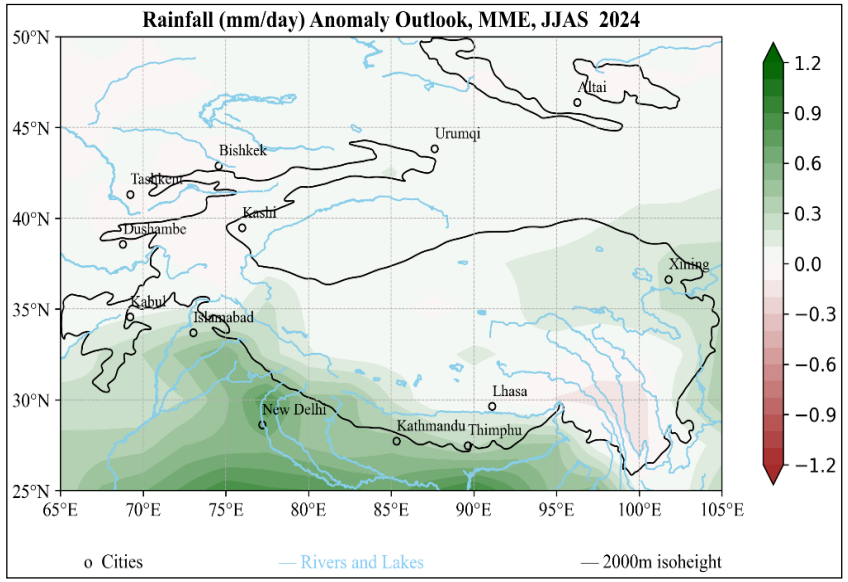
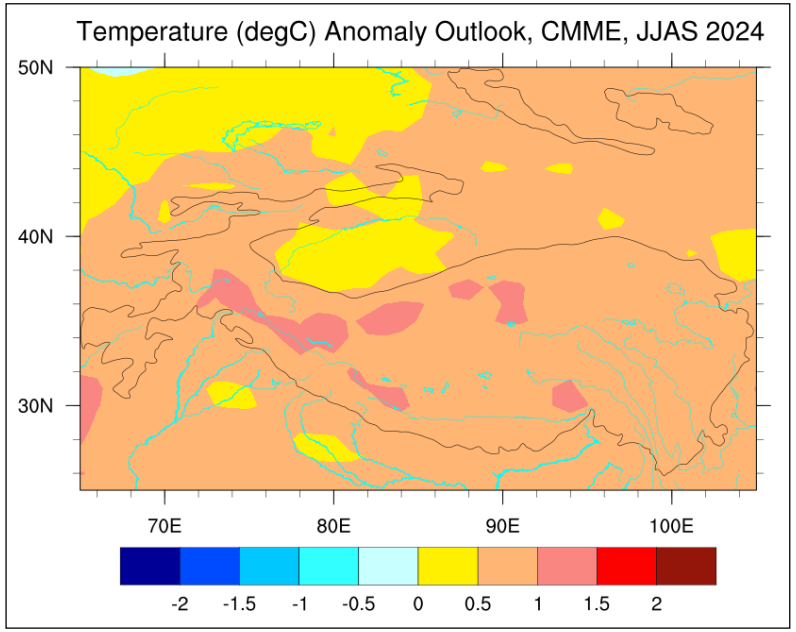


Third Pole Climate Forum

Anomalies/Deterministic Forecast Temperature

WMO Third Pole RCC Network

CMA



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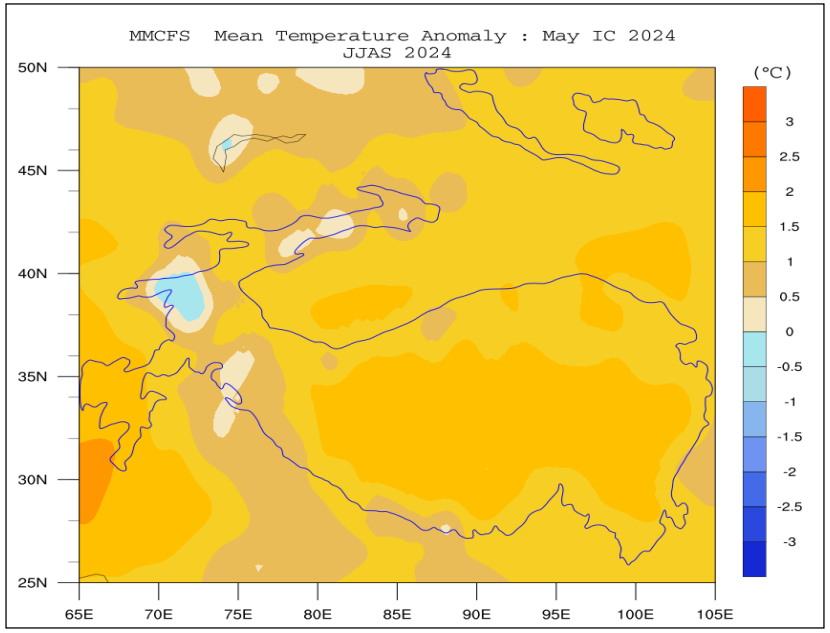

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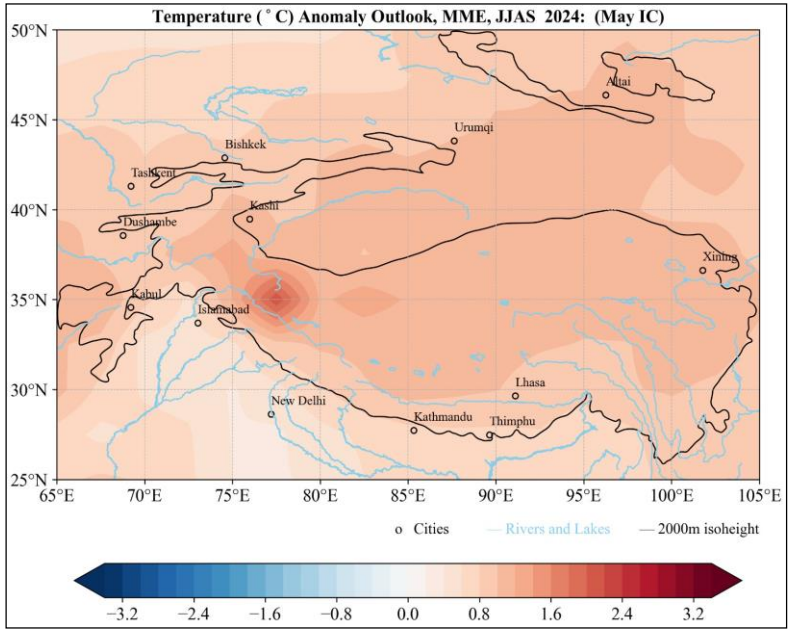

Third Pole Climate Forum

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PMD OUTLOOK FOR JJAS 2024

Data and Mechanism

- 14 GCMs data is utilized for MME calculation (subject to data availability).

Institution/Model		Ensembles	Data Availability
1.	APCC-SCOPS	10	1982-2013
2.	BCC-CSM1.1M	24	1991-2015
3.	BOM-ACCESS-S1	11	1990-2012
4.	CMCC- SPS3.5	50	1992-2017
5.	CWB-TCWB1Tv1.1	30	1982-2019
6.	HMC-SL-AV	20	1985-2010
7.	KMA-GLOSEA5GC2	42	1991-2016
8.	METFR-SYS8	51	1991-2016
9.	MGO-MGOAM-2	10	1979-2004
10.	NASA-GEOS-S2S-2.1	10	1981-2016
11.	NCEP-CFSv2	20	1982-2010
12.	PNU-CGCMv2	35	1980-2020
13.	UKMO-GLOSEA5	42	1991-2016
14.	ECCC-CANSIPSv2.1	20	1980-2020

- Data Sources:
  - https://cliks.apcc21.org
  - https://cds.climate.copernicus.eu

- The ensemble mean of the individual models is calculated by simple composite method (SCM).
- $F_t = \frac{1}{N}\sum_{i=1}^{N}(F_{i,t} - \bar{F_i})$
- The same weights of 1/N are assigned to each of the N participating models at all the grid points, regardless of the model relative performance.

Forecast Evaluation Methods

- **The metrics used include:**
  - Accuracy ($\boldsymbol{ACC} = \frac{\boldsymbol{a+d}}{\boldsymbol{a+b+c+d}}$)
    - $\boldsymbol{a}$ = The number of events predicted by the model and actually observed (hit)
    - $\boldsymbol{b}$ = The number of events predicted but didn't occur (false alarm)
    - $\boldsymbol{c}$ = The number of events not predicted by the model but actually occurred (missed events)
    - $\boldsymbol{d}$ = The number of no-predicted events and they actually did not occur (true negative)
- **The analysis is done for all grid-points inside Pakistan map contour**
- Mean Absolute Error
- Root Mean Square Error
- Correlation coefficient
- Index of Agreement

1)

$$d = 1 - \frac{\sum_{i=1}^{n}(Y_i - X_i)^2}{\sum_{i=1}^{n}\left[\left(|Y_i - \overline{X}|\right) + \left(|X_i - \overline{X}|\right)\right]^2}$$

- Data Sources:
  - CPC _Rainfall https://psl.noaa.gov/data/gridded/data.cpc.globalprecip.html
  - ERA5 Temp https://cds.climate.copernicus.eu/datasets/reanalysis-era5-single-levels-monthly-means?tab=download

Model Skills for data averaged over the TP domain

Precipitation			
Models	**Correlation**	**IA**	**RMSE**
APCC	-0.03	0.18	1.27
BCC	0.40	0.44	0.36
BOM	0.48	0.23	1.01
CMCC	0.64	0.18	1.33
CWA	-0.21	0.24	0.85
ECCC	0.71	0.31	0.70
KMA	0.48	0.26	0.86
METFR	0.59	0.20	1.17
NCEP	0.29	0.35	0.52
PNU	0.64	0.20	1.27
UKMO	0.55	0.25	0.95
MME	0.53	0.24	0.93

Temperature			
Models	**Correlation**	**IA**	**RMSE**
APCC	0.63	0.12	3.96
BCC	0.75	0.39	1.04
BOM	0.75	0.53	0.59
CMCC	0.67	0.45	0.69
CWA	0.63	0.45	0.78
ECCC	0.75	0.48	0.68
KMA	0.75	0.45	0.78
METFR	0.82	0.32	1.25
NCEP	0.64	0.51	0.59
PNU	0.64	0.21	2.20
UKMO	0.81	0.59	0.50
MME	0.78	0.71	0.35

Correlation in RED indicates statistical significance at 95% confidence level

Accuracy and Bias of Rainfall Forecast

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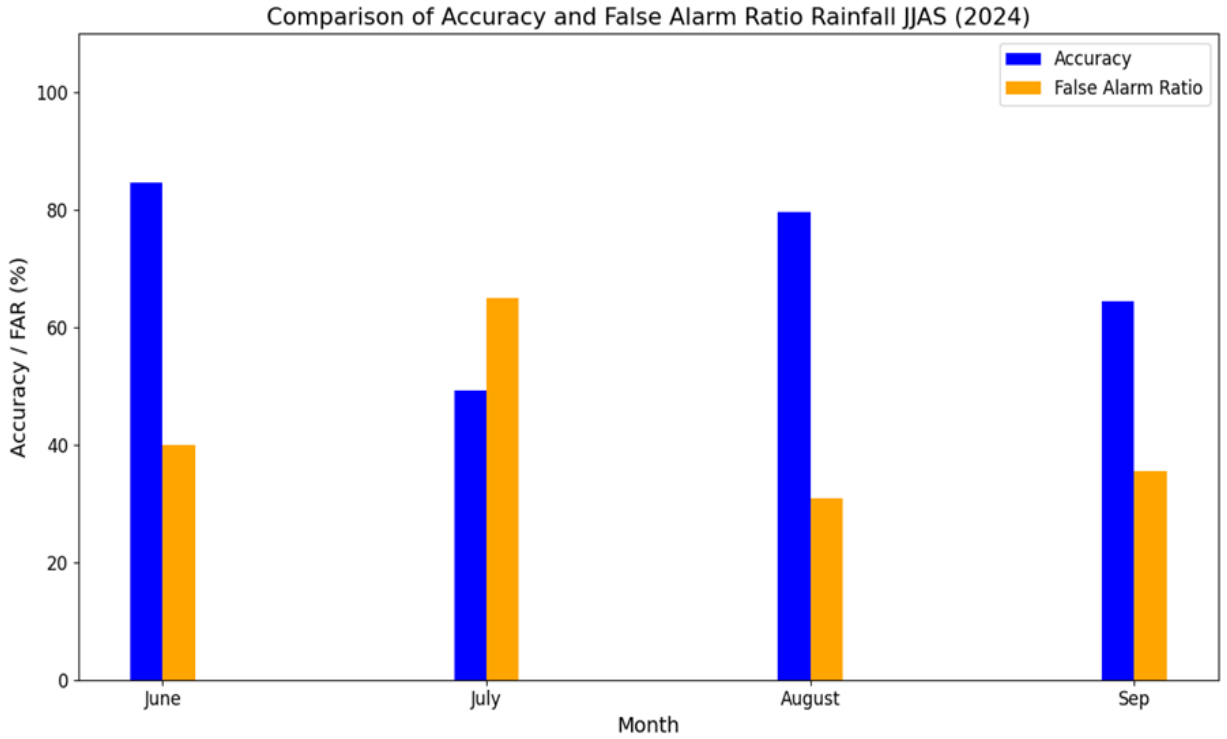
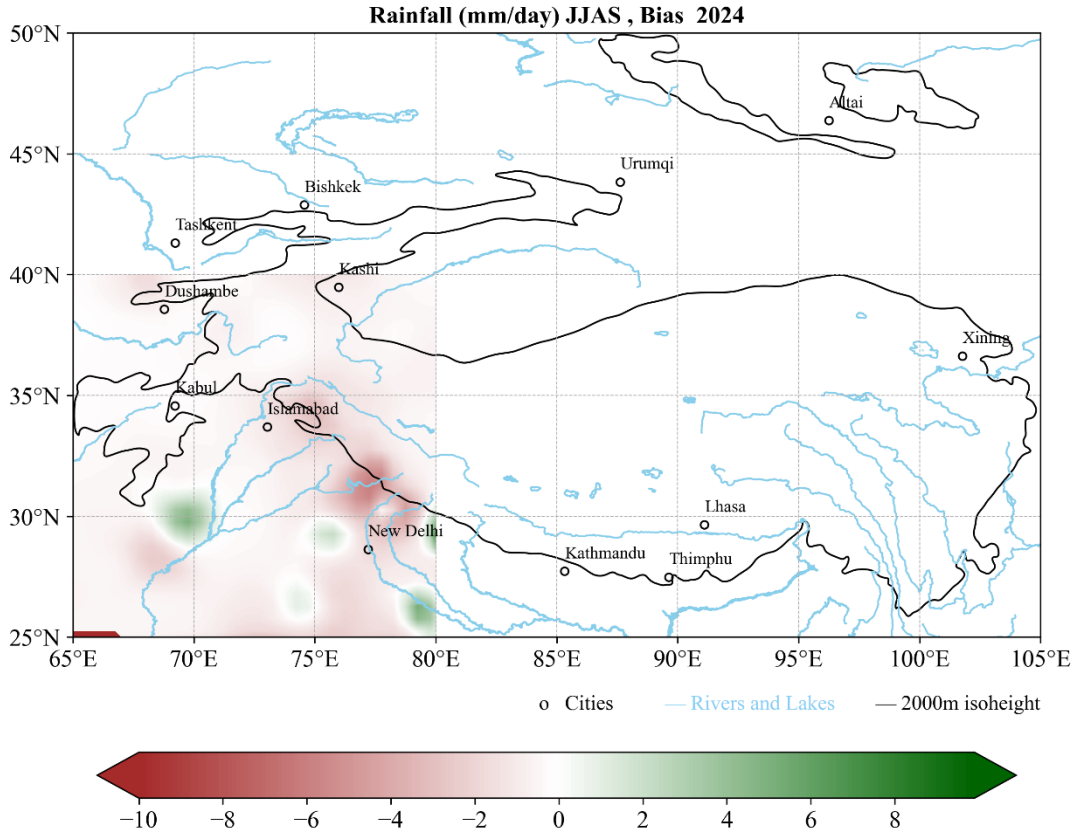
Third





S.NO	Index	Score
1	MAE	1.64
2	RMS	4.9
3	BIAS	-0.57
4	Corr	0.73

Monsoon (Rain, Temp) Normal and Predicted(JAS) 2024

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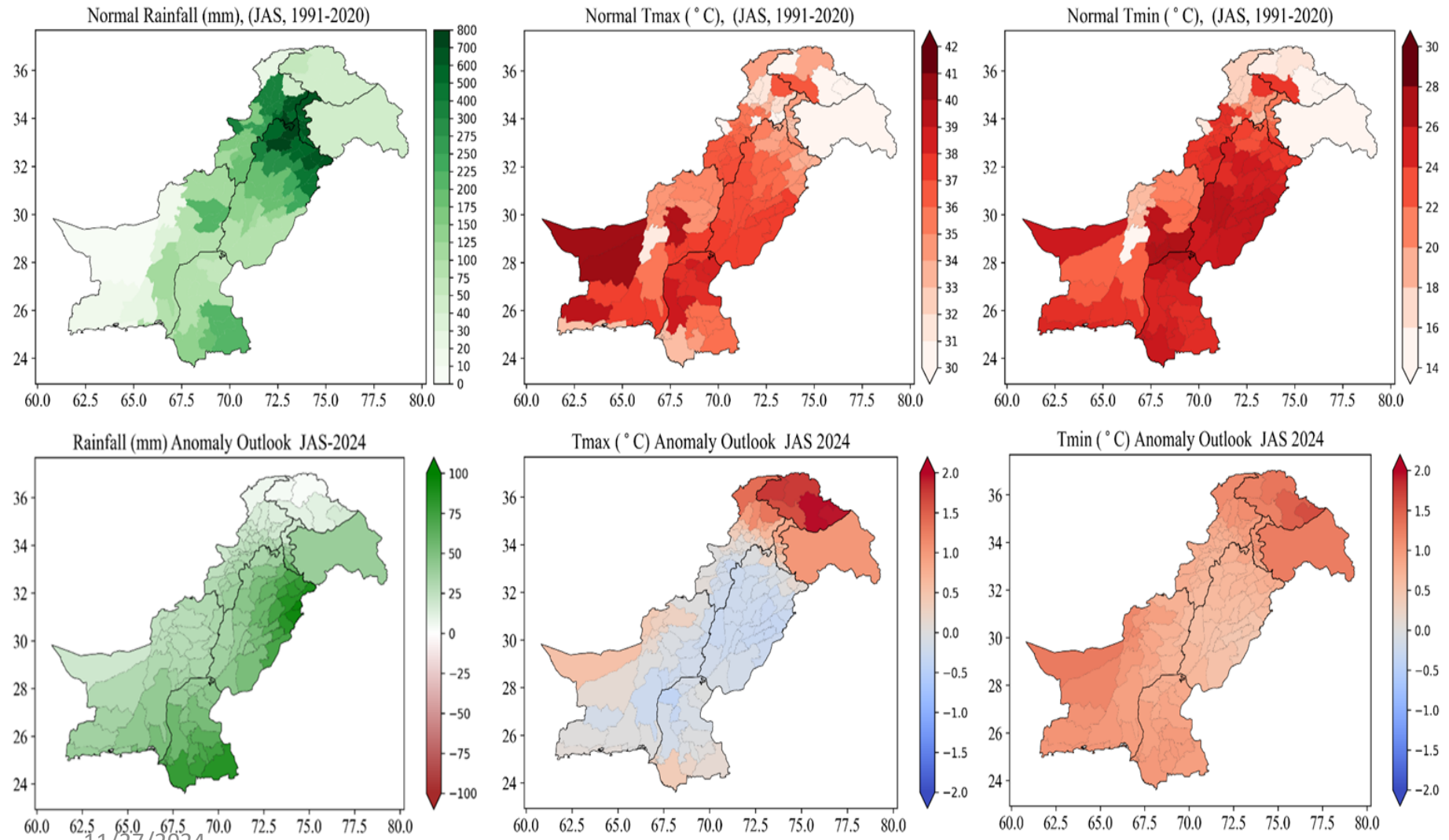

- **Normal* to above normal rainfall** is expected in most parts of the country, with maximum departure over upper Punjab and lower Sindh.
- Northern Khyber Pakhtunkhwa and Gilgit Baltistan may get nearly normal rainfall.
- Most parts of Balochistan may receive **slightly above normal rainfall** during the season.

Observed JAS Departure and Recorded Rainfall 2024

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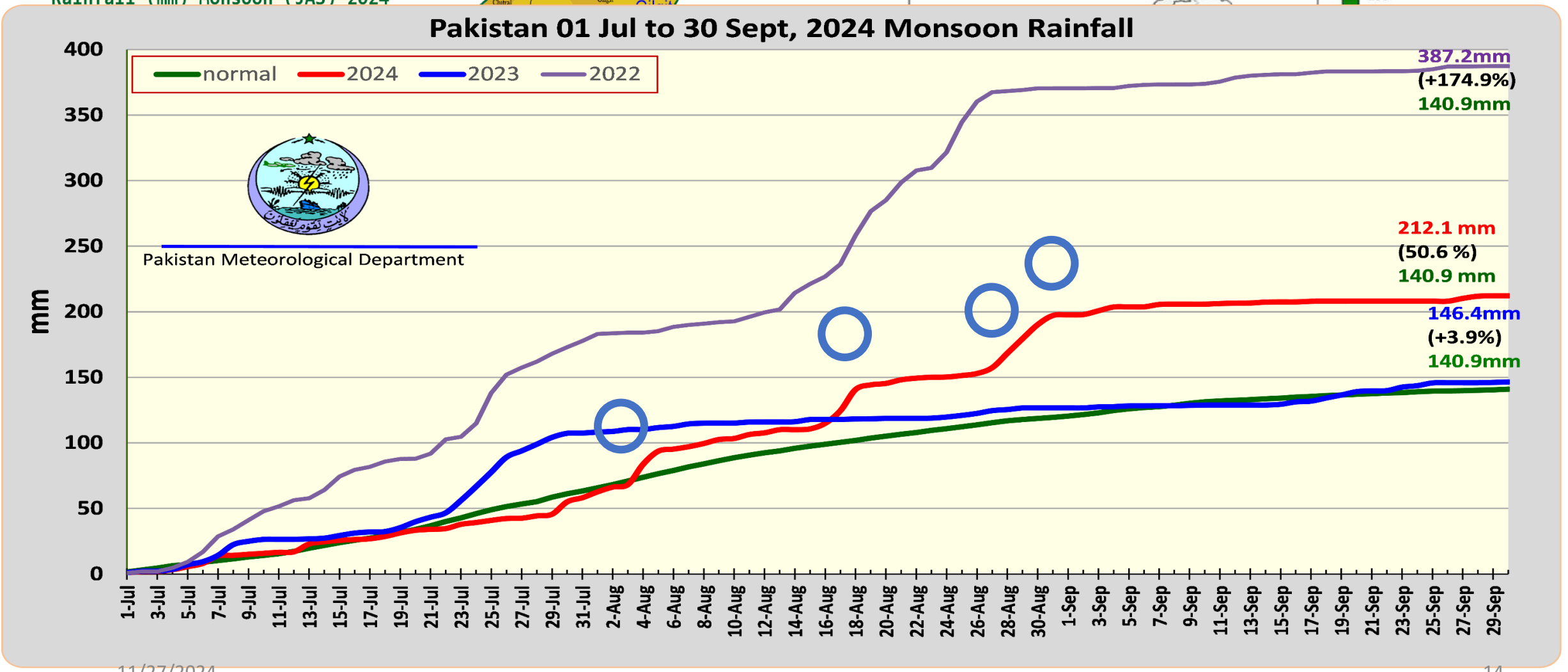
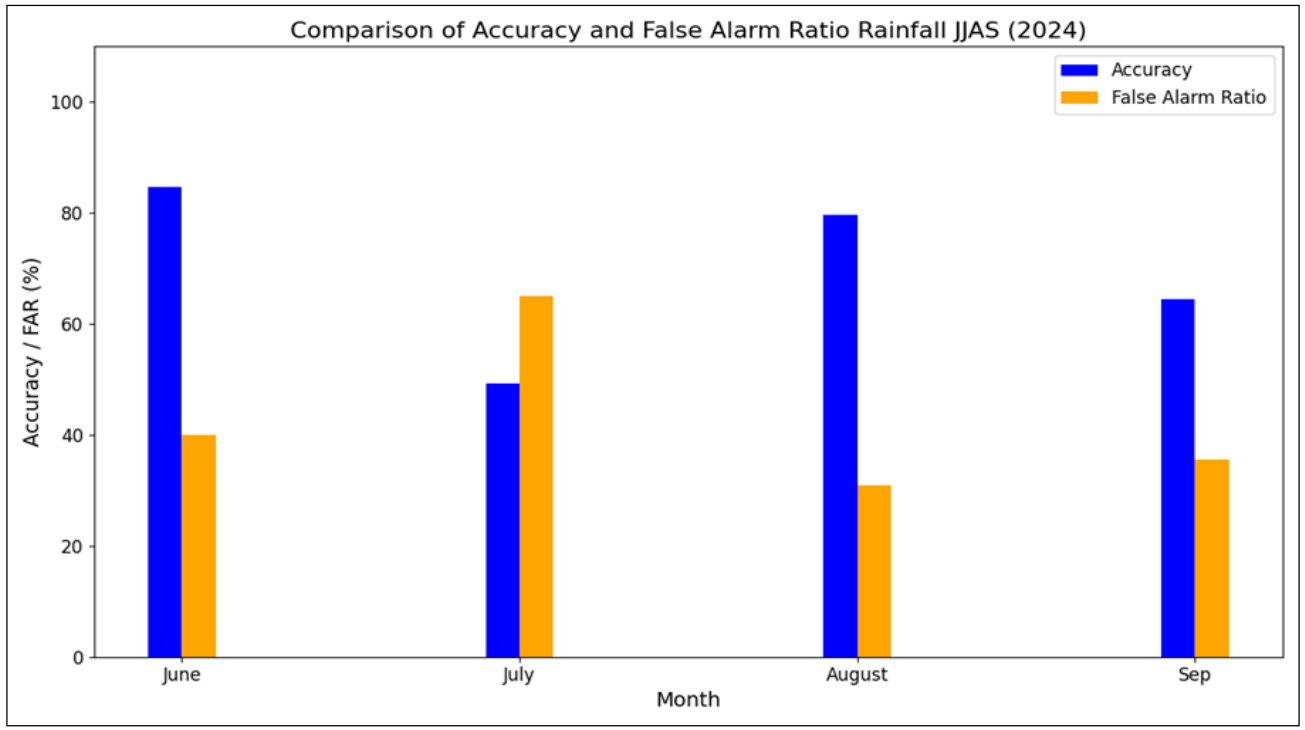
Rainfall (mm) Monsoon (JAS) 2024

Rainfall (mm) Anomaly Outlook JAS-2024



JAS Accuracy of Rainfall Forecast



S.NO	Index	Score
1	MAE	1.64
2	RMS	4.9
3	BIAS	-0.57
4	Corr	0.73

JJAS 2024 Precipitation Highlights

➢ **Above-Normal SAT in Most of the Region (JJAS 2024)**:

•The Third Pole region experienced above-normal SAT (compared to 1991-2020) during June to September 2024.

•Exceptions included parts of the southwestern and northwestern regions.

➢ **Positive SAT Anomalies in TPCR**:

•The TPCR was 1-4°C warmer than normal.

•Parts of the western TPCR exhibited positive SAT anomalies of 2-4°C.

➢ **October SAT Anomaly Pattern**:

•The spatial SAT anomaly pattern in October aligned with that of JJAS.

•An overall above-normal SAT pattern prevailed.

•Western and central TPCR experienced significantly higher-than-normal SAT.

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JJAS 2024 Precipitation Highlights

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- **Above-Normal Precipitation**:
  - •Most of the Third Pole region experienced above-normal precipitation.
  - •Southwestern and northeastern areas saw significantly wetter conditions, with precipitation
  - •exceeding normal levels by 100%-200%.
  - •In some localized areas, precipitation surpassed 200%.
- **Below-Normal Precipitation**:
  - •Northwestern edge, parts of central to northern areas, and some southeastern regions
  - •experienced below-normal precipitation.
  - •Negative anomalies ranged from 20% to 50%, with some areas exceeding a 50% deficit.
- **October Precipitation Anomaly Pattern**:
- **Opposite Trend to JJAS**:
  - •Central and southwestern regions recorded the most significant negative anomalies,
  - •with reductions exceeding 80% in some areas.
- **Positive Anomalies in Other Regions**:
  - •Parts of the western and northeastern Third Pole region experienced above-normal precipitation.
  - •Increases in these areas surpassed 200%.

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WMO Third Pole RCC Network

Models Skills

Third Pole Climate Forum

Contributing institutions

WMO Third Pole RCC Network

Institution/Model		Ensembles	Data Availability
1.	APCC-SCOPS	10	1982-2013
2.	BCC-CSM1.1M	24	1991-2015
3.	BOM-ACCESS-S1	11	1990-2012
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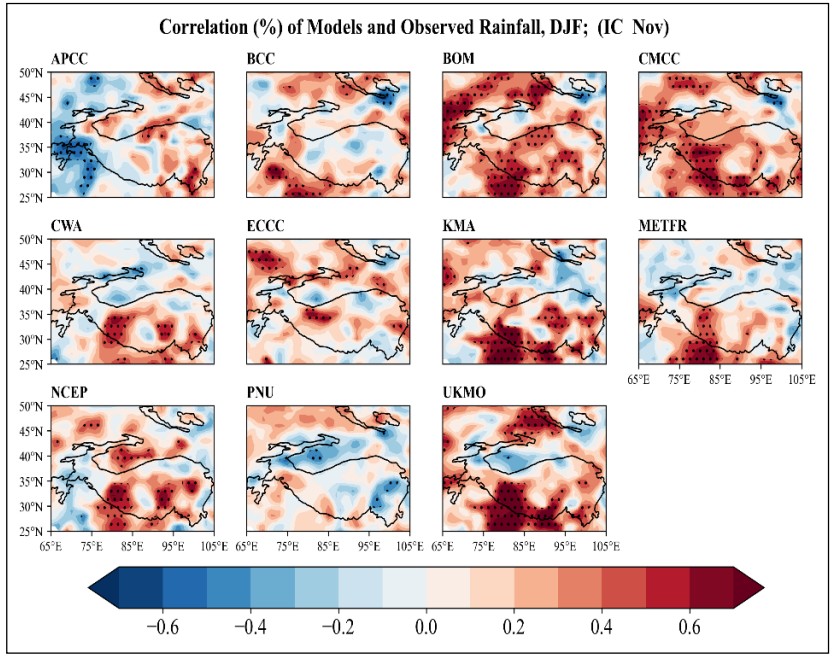
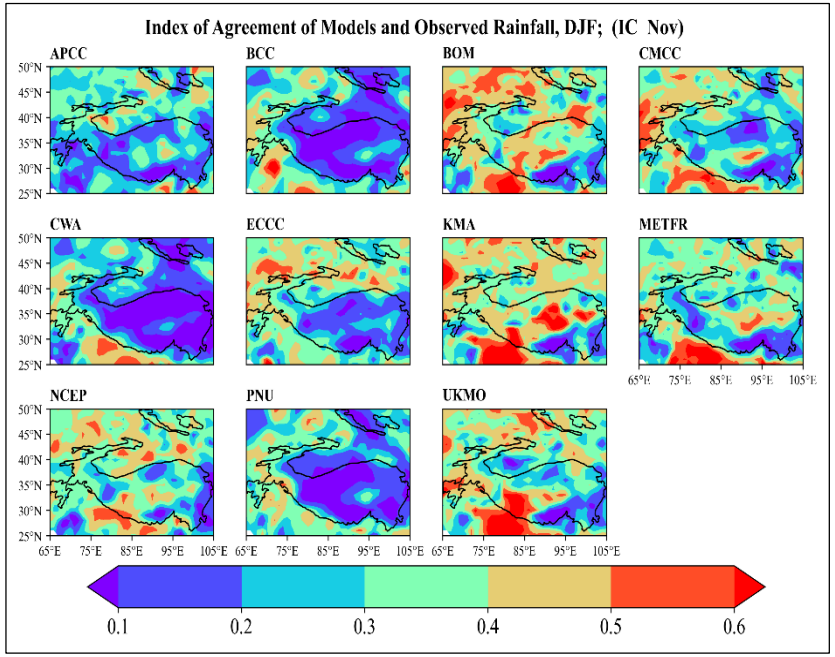
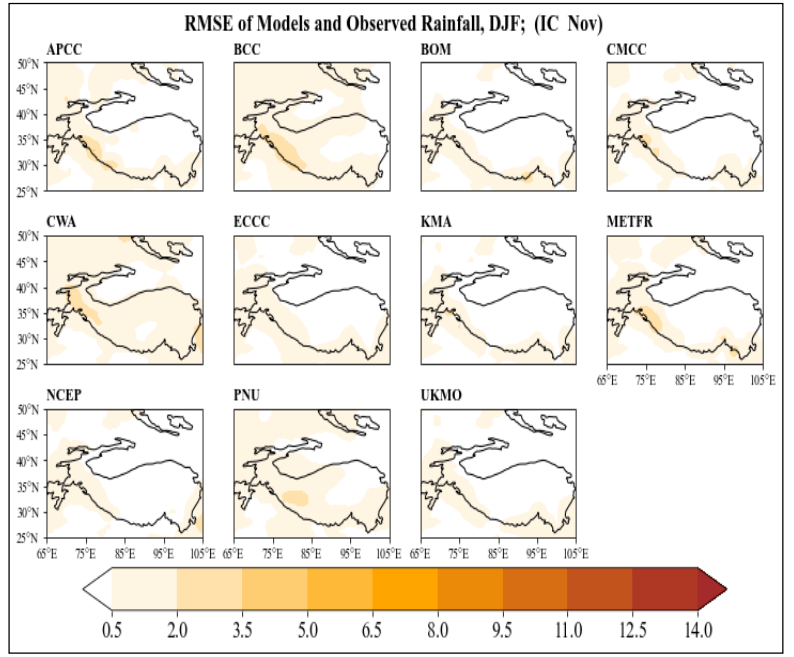
Model Skills for Rainfall averaged over the TP domain

WMO Third Pole RCC Network



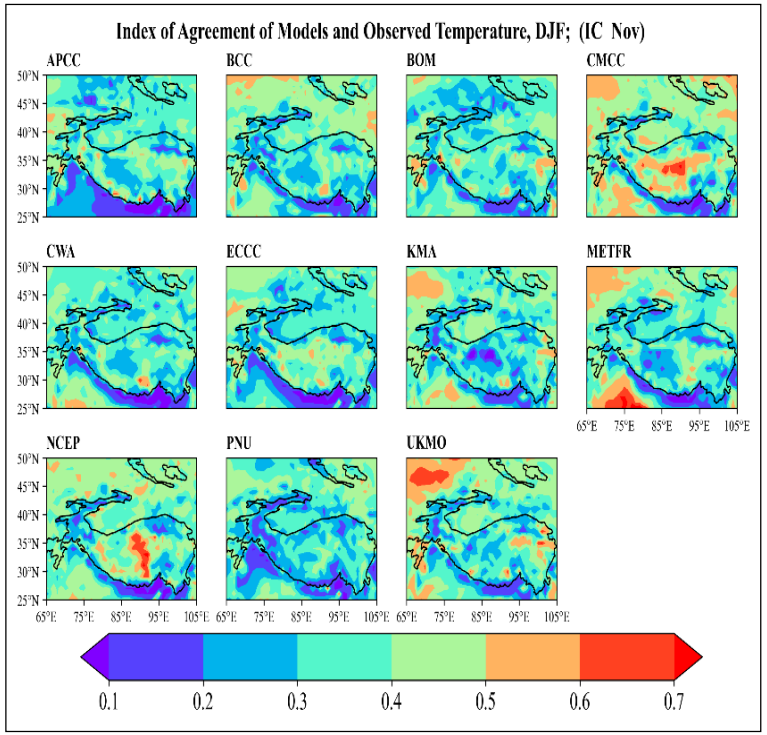


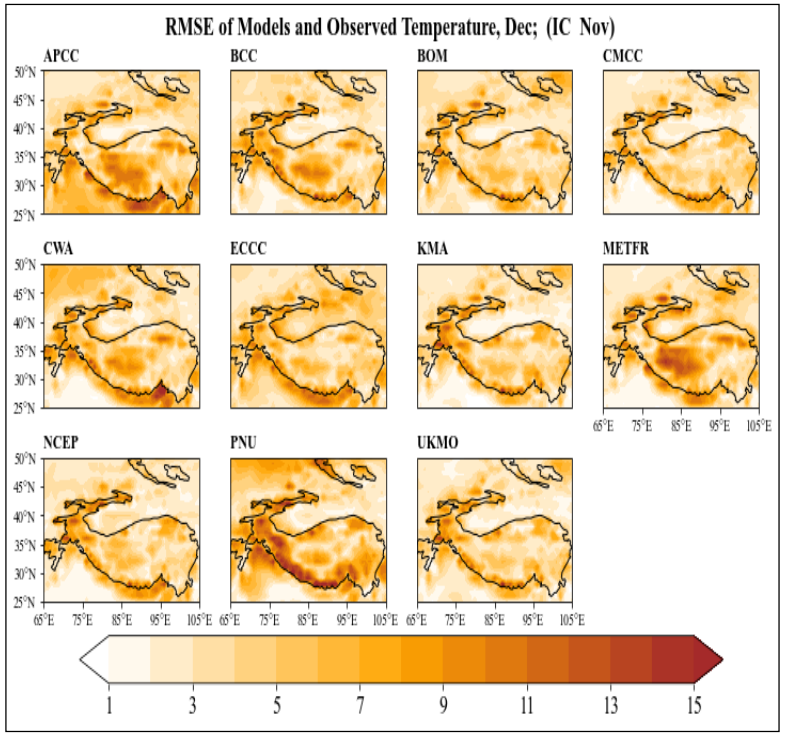


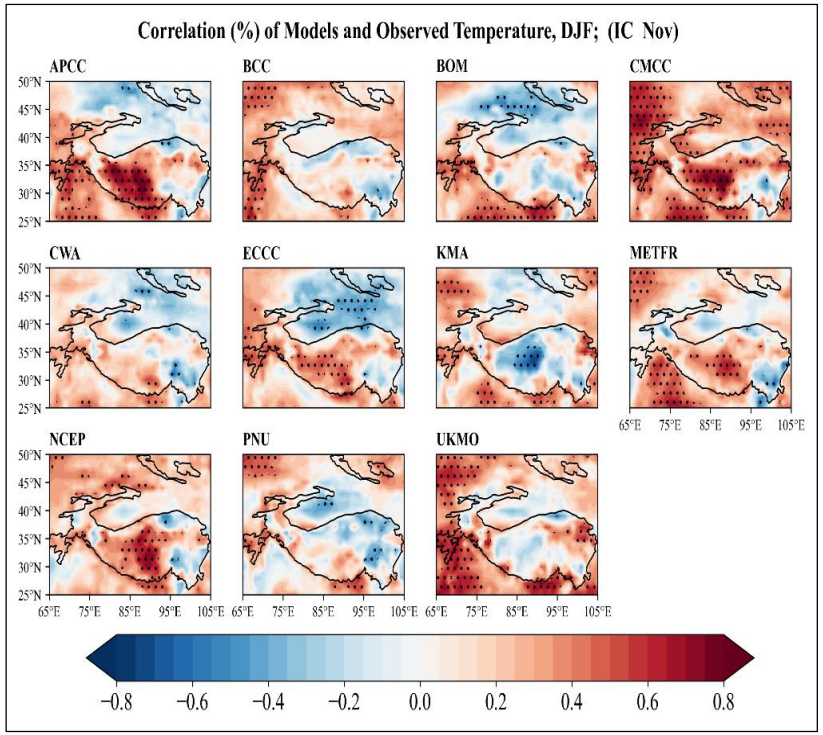
Third Pole Climate Forum

Model Skills for Temp averaged over the TP domain

WMO Third Pole RCC Network







Model Skills for DJF over the TP domain

Third Pole Climate Forum

WMO Third Pole RCC Network

Temperature Score						
Sr No	Models	Correlation	P-value	T-score	IA	RMSE
1	APCC	0.1348	0.5938	0.5441	0.3184	2.8444
2	BCC	0.1259	0.6187	0.5075	0.4284	0.8544
3	BOM	0.0718	0.7772	0.2878	0.4486	1.2169
4	CMCC	0.4708	0.0486	2.1348	0.633	0.7022
5	CWA	0.0451	0.8591	0.1804	0.3699	0.9016
6	ECCC	-0.0635	0.8022	-0.2547	0.4201	1.5372
7	KMA	0.2186	0.3835	0.896	0.4691	0.8121
8	METFR	0.1168	0.6445	0.4703	0.3714	2.1789
9	NCEP	0.2197	0.381	0.9009	0.4913	1.0214
10	PNU	0.097	0.7018	0.3898	0.4115	1.8336
11	UKMO	0.3126	0.2066	1.3162	0.5776	0.7898
12	MME	0.2018	0.4219	0.8243	0.4831	0.8837

Precipitation Score						
Sr No	Models	Correlation	P-value	T-score	IA	RMSE
1	APCC	-0.2468	0.3235	-1.0187	0.2267	0.4586
2	BCC	0.6026	0.0081	3.02	0.1833	0.7233
3	BOM	0.7215	0.0007	4.1678	0.4056	0.2676
4	CMCC	0.7548	0.0003	4.6031	0.3612	0.3292
5	CWA	0.5435	0.0197	2.5898	0.1683	0.7881
6	ECCC	0.7399	0.0004	4.3993	0.311	0.3699
7	KMA	0.5667	0.0142	2.7512	0.4552	0.2232
8	METFR	0.4754	0.0461	2.1616	0.2965	0.3931
9	NCEP	0.4569	0.0566	2.0545	0.3612	0.2789
10	PNU	0.5251	0.0252	2.4682	0.2162	0.5973
11	UKMO	0.6144	0.0067	3.1147	0.3969	0.271
12	MME	0.6631	0.0027	3.5434	0.2818	0.4235

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Key Findings

WMO Third Pole RCC Network

- CMCC, BOM, and BCC consistently demonstrated high skill in predicting precipitation.
- Across most regions, especially in Western and southern Third Pole areas.
- BCC,CMCC, CWA, and UKMO showed reasonable performance in select regions but struggled in high-altitude and arid areas.
- APCC, NCEP, and PNU exhibited poor agreement and weak correlation in most parts of the Third Pole, indicating limited skill in.
- All the models have limited skill in temperature forecasting.

Third Pole Climate Forum

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Seasonal outlook for DJF 2024-25

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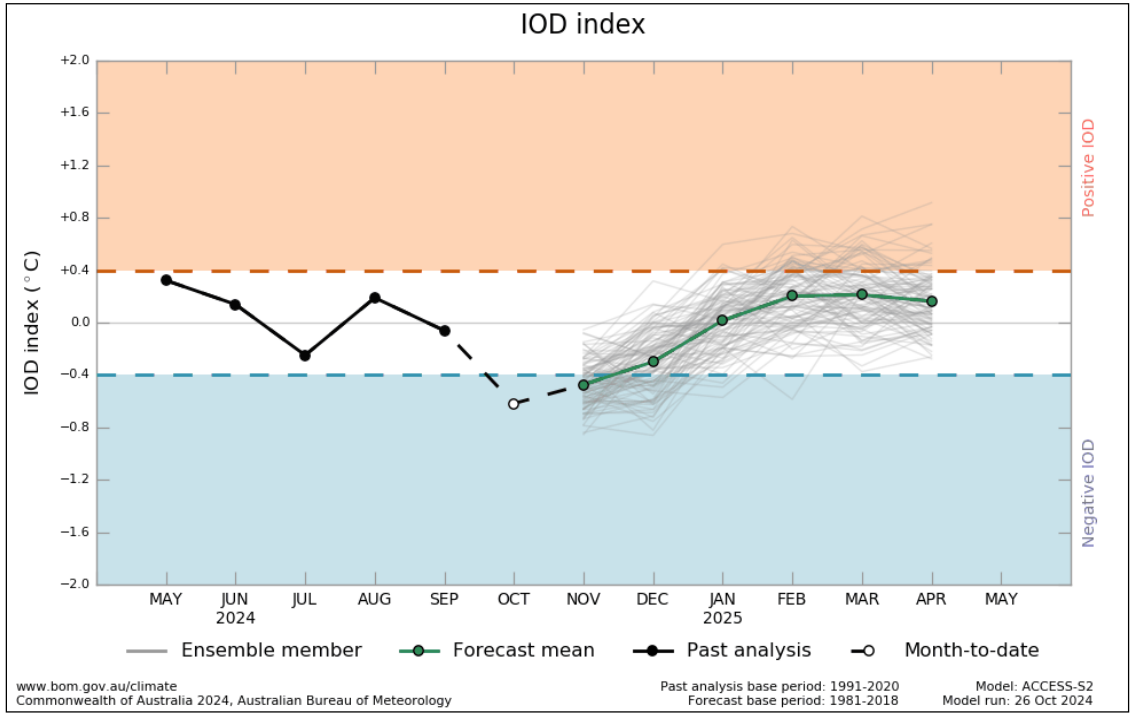
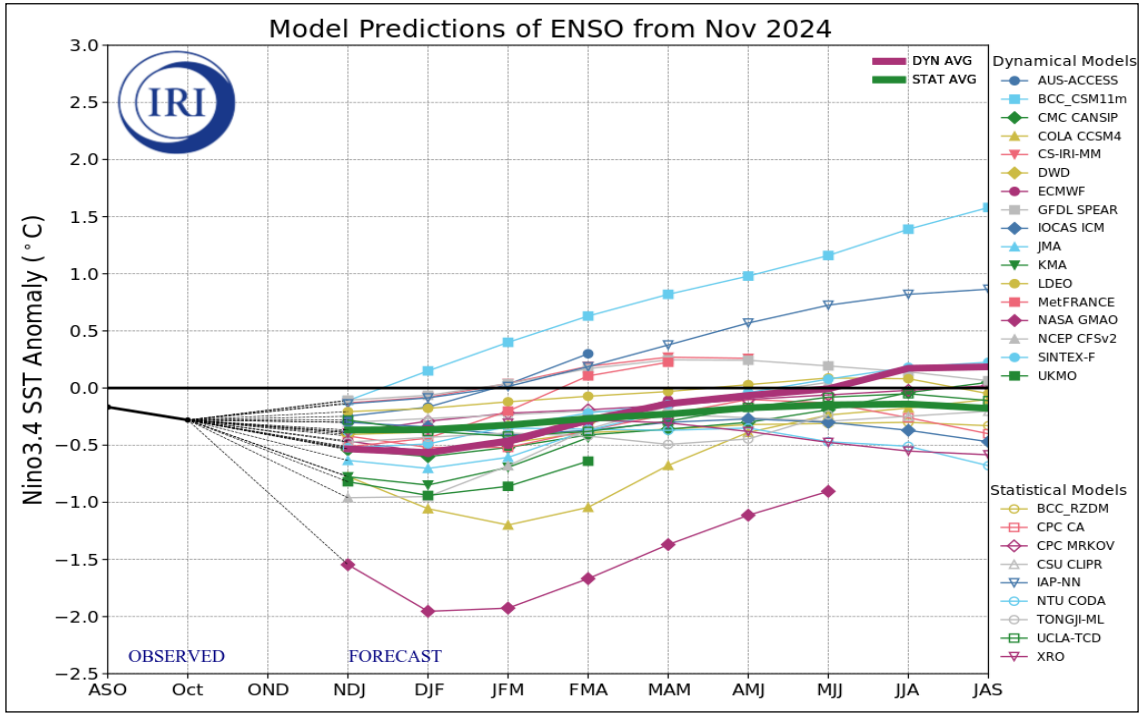
Climate Drivers Out look

WMO Third Pole RCC Network

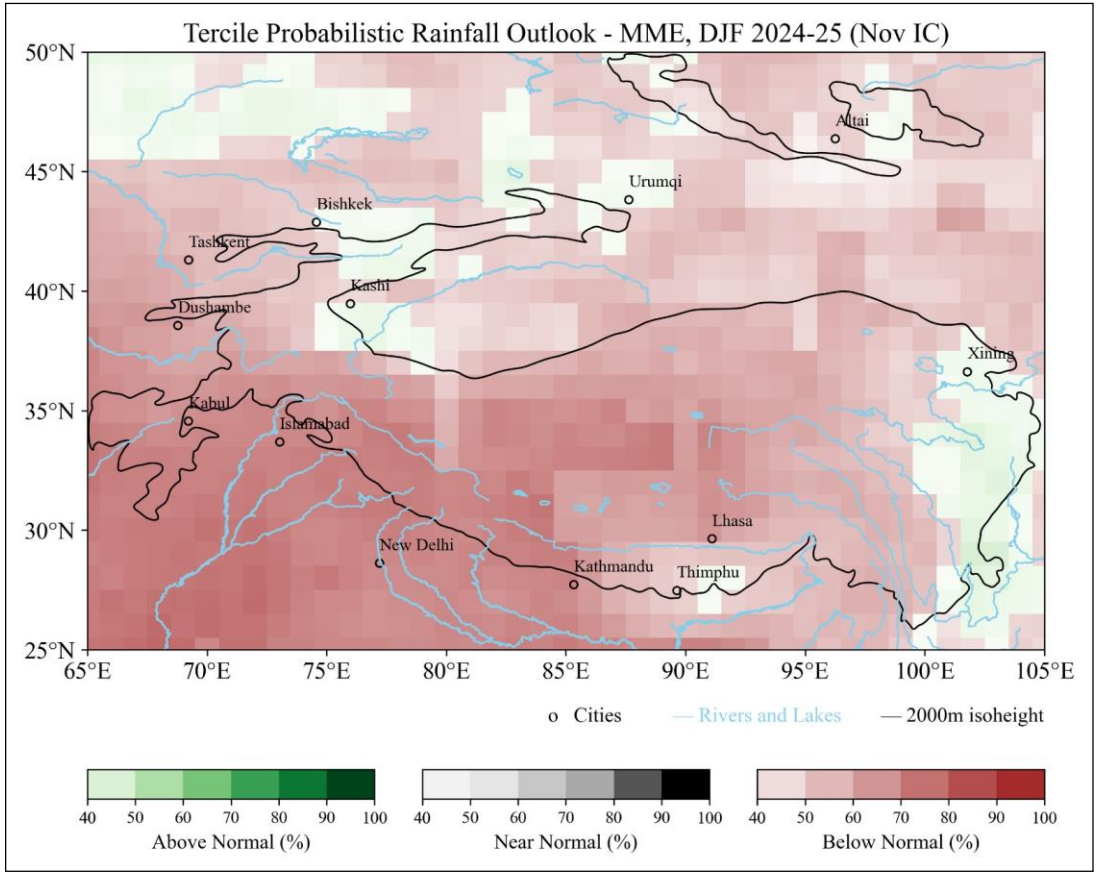


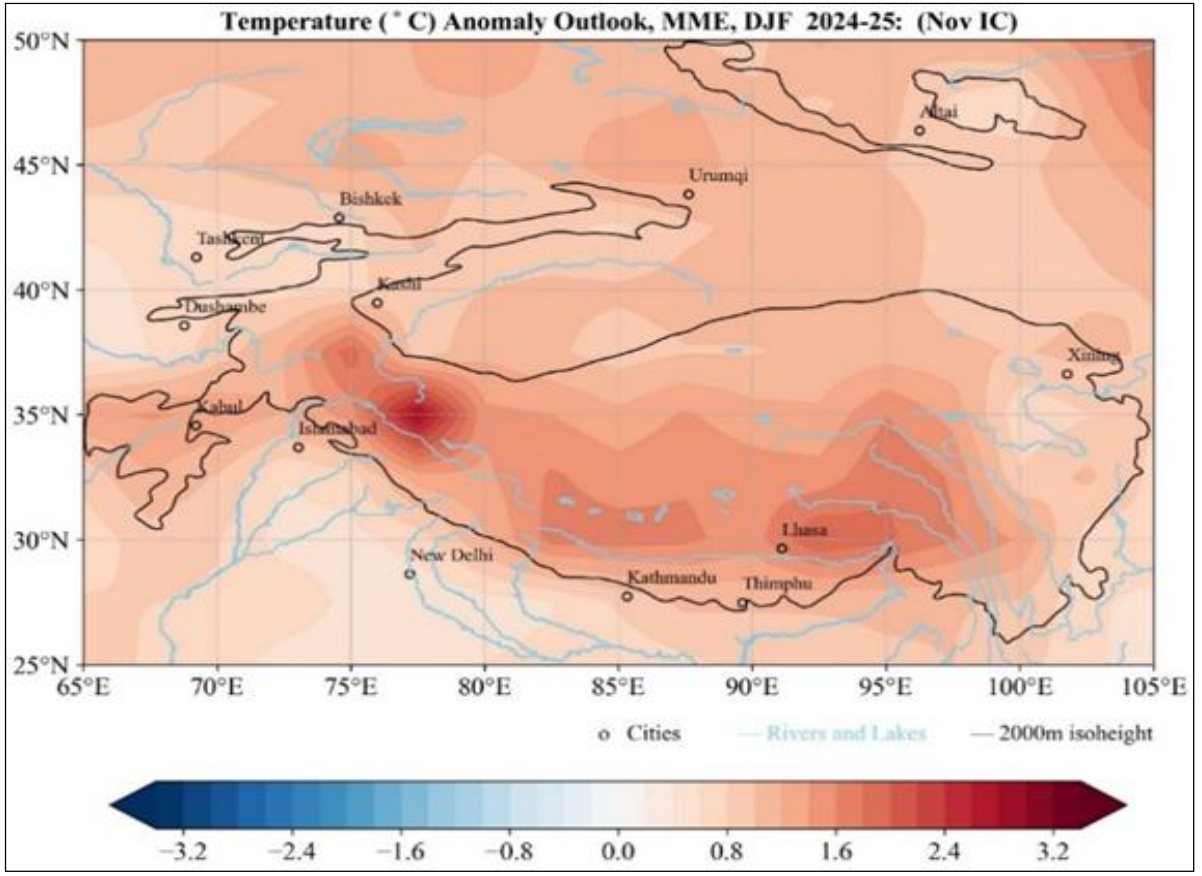


Third Pole Climate Forum

Temp and Rainfall outlook DJF

WMO Third Pole RCC Network





Precipitation Outlook DJF 2024-25

➢ **Below-Normal Precipitation**:

•Expected over the southwestern and southern parts of the TP region, including the Karakoram and adjacent areas.

•Both probabilistic and tercile forecasts highlight drier-than-normal conditions in these areas.

•The southwestern TP region and parts of the Himalayas exhibit a clear signal of below-normal precipitation.

➢ **Normal to Above-Normal Precipitation**:

•Predicted in the northern and northeastern parts of the TP region.

•These areas, extending towards Central Asia, align with the probabilistic forecast indicating slightly wetter conditions.

➢ **Near-Normal Precipitation**:

•Likely in the central parts of the TP region.

•This area reflects a transitional zone between wetter conditions in the north and drier conditions to the south of the Karakoram Ranges.

Temperature Outlook DJF 2024-25

- Strong Warming Tendency:

Forecast indicates a strong warming trend across the Third Pole region during DJF 2024-25.Above-normal temperatures are likely to dominate most parts of the region. Southern and eastern areas, including the Himalayas and Tibetan Plateau, are particularly prone to significant warming.

- Western and Northern Third Pole Region: Above-normal temperatures are expected in the Karakoram and parts of Central Asia.

- Localized Near-Normal Temperatures:

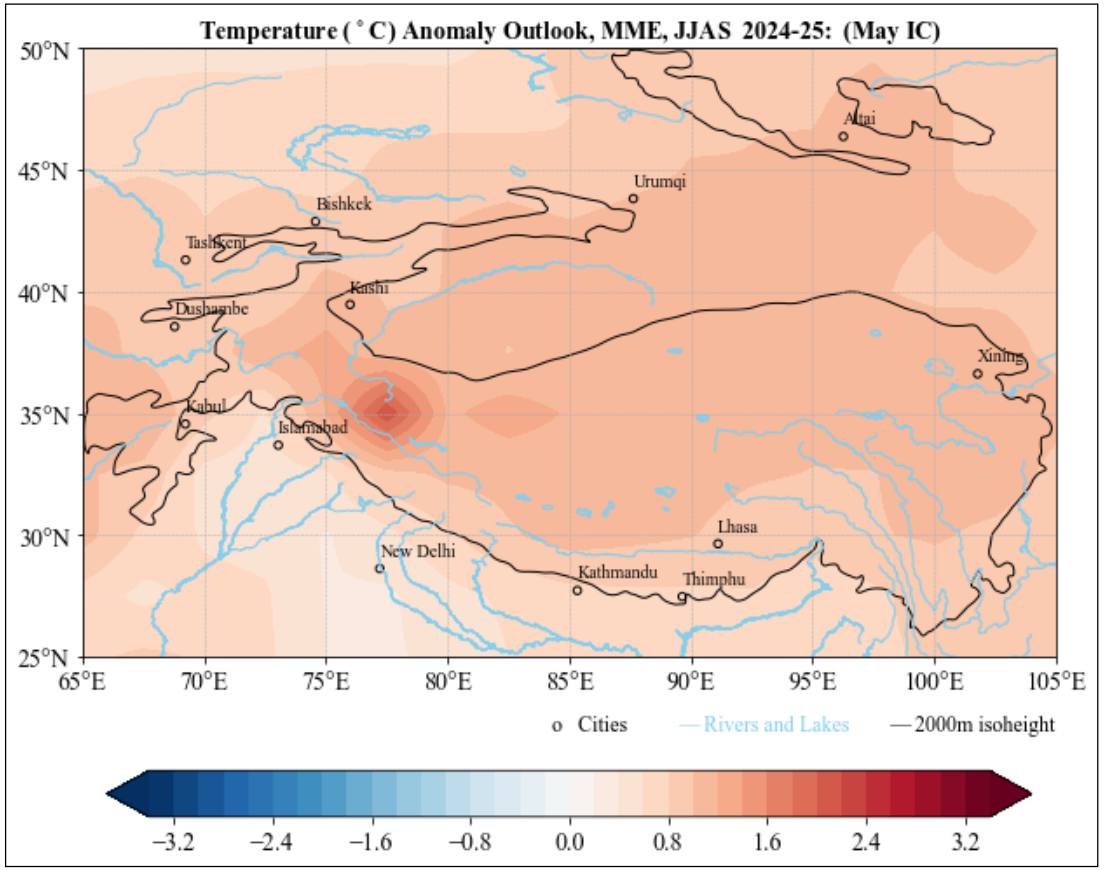
Some localized areas in the far northern region show a near-normal temperature signal. This suggests a potential moderation of the warming trend in these areas.

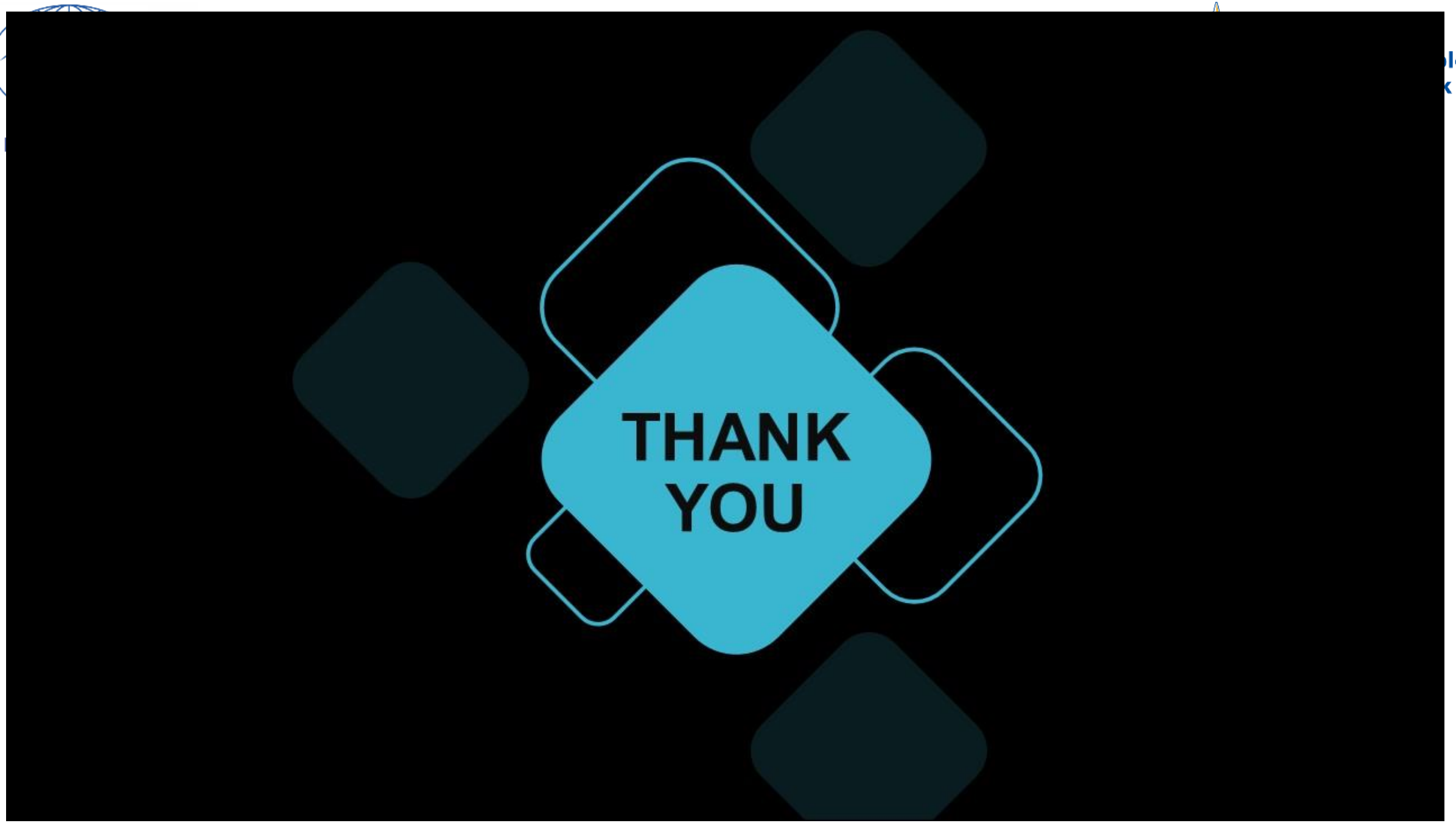
Third Pole Climate Forum

Statistical Index Score

WMO Third Pole RCC Network

S.NO	Index	Score
1	MAE	1.64
2	RMS	4.9
3	BIAS	-0.57
4	Corr	0.73




THANK
YOU