Third Pole RCC-Network and its role to TPCF

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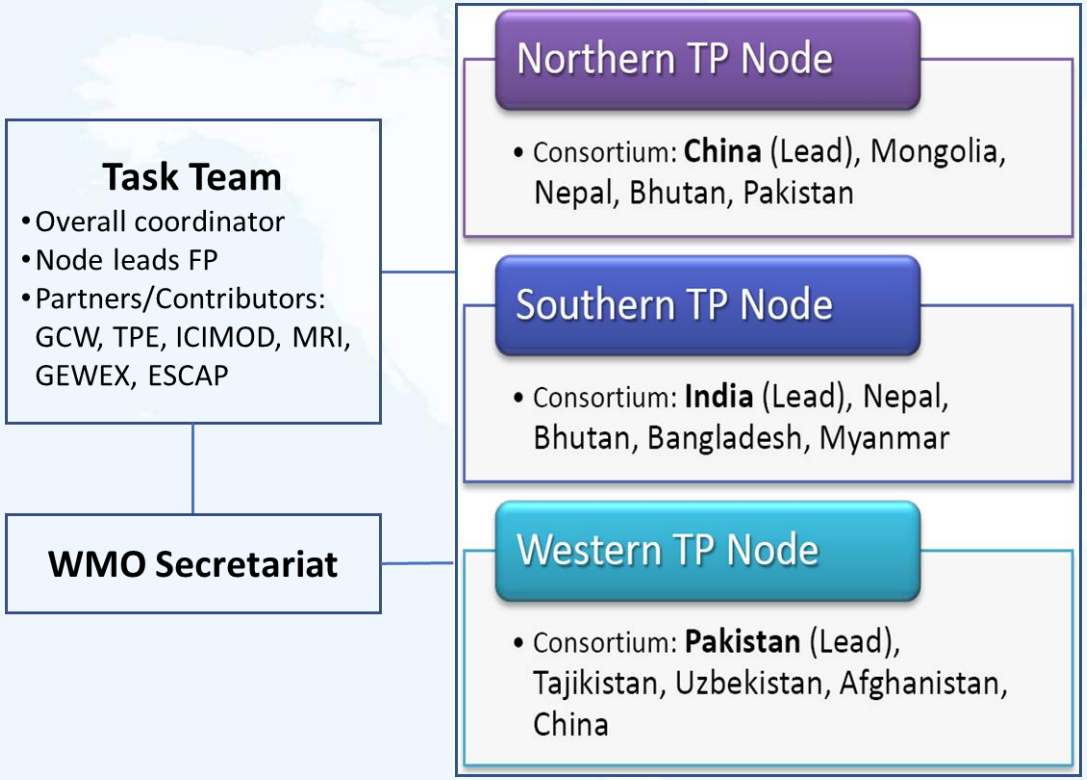
National Climate Center, CMA
Overall coordinator of TPRCC-Network

28 November 2024, @TPCF-2

1. Background

One of RCC Networks under the framework of WIPPS.

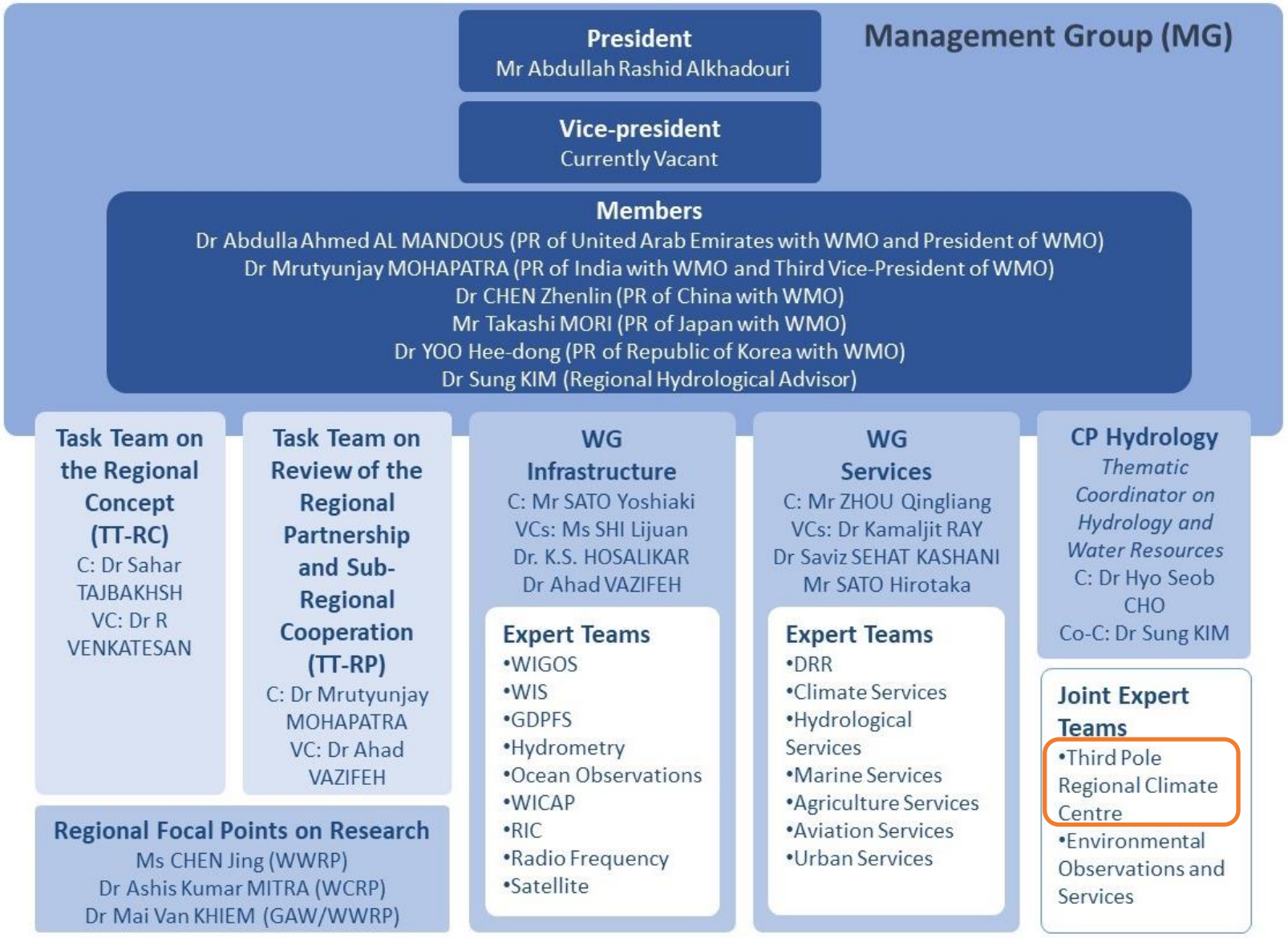


TPRCC-Network Structure endorsed by EC-70

The consortia member is extending to Kazakhstan and Kyrgyzstan.

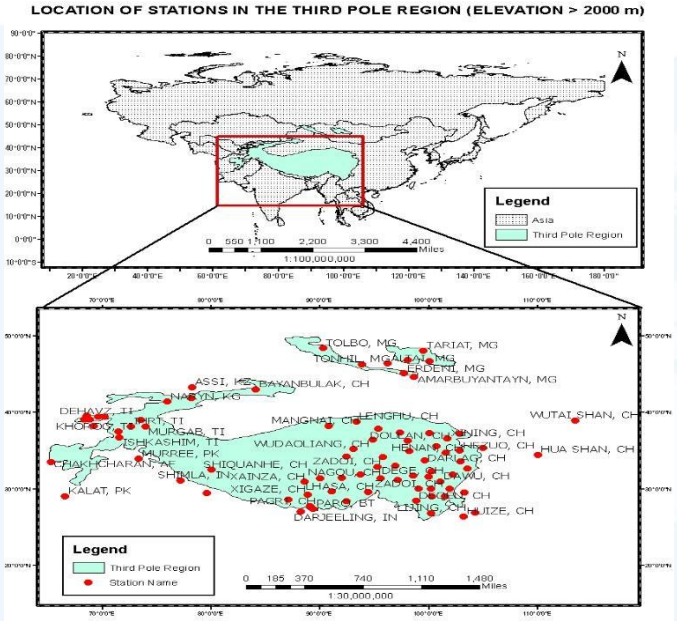
- To meet Members' needs in providing accurate and effective climate and cryosphere services in the Third Pole region.
- **Mandatory Function**
  - Long Range Forecast (Pakistan)
  - Climate Monitoring (China)
  - Operational Data Service (India)
  - Training (shared responsibility)
- **Highly Recommended Function** (mountain specific)
  - Cryosphere indicators that are indicative to regional climate change, esp. to water resources and potential cryo-hazards
  - Climate drivers of cryosphere changes, eps. those related to water resources and cryosphere hazards

Working Structure of Regional Association II



At regional level, to promote WMO polar and high mountain activities, RA II-17 approved TPRCC as a Joint Demonstration Program of RA II, and included it in its Operational Plan 2021-2024, and this will be a continued effort in the next financial period.

2. Progress made based on in-hand infrastructure



Countries	No. of Sta.
China	53
Tajikistan	11
Mongolia	8
India	3
Pakistan	2
Kyrgyzstan	2
Afghanistan	1
Kazakhstan	1
Bhutan	1

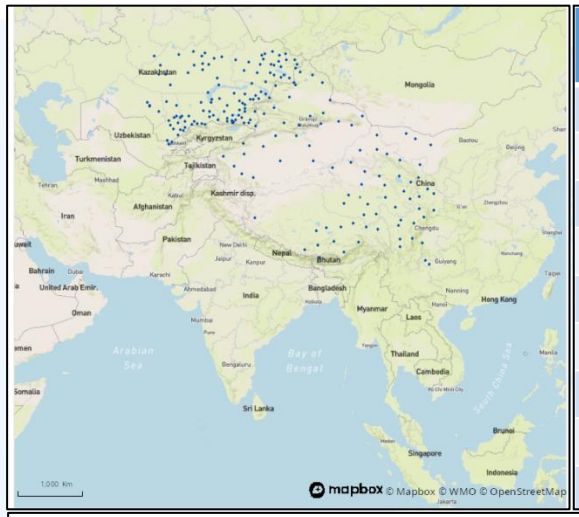
- On GTS: 698 stations totally in the rectangular area, ~80 of which locate above 2000 m;
- Vertical distribution: 12 sta.> 4000 m; 28 sta. 3000-4000 m; 42 sta. 2000-3000 m
- Monthly *Tair* and *P* in ~80 stations were delivered via TPRCC web portal, also was used to evaluate the performance of reanalysis data.

Data	Precipitation				
	CC	RMSE	MAE	Reanalysis Stdev.	Obs. Stdev.
CHIRPS	0.66	39.48	20.06	45.95	55.07
CMAP	0.64	43.68	23.36	40.86	55.07
CPC	0.72	35.77	16.20	44.67	55.07
CRU	0.64	47.91	27.32	47.13	55.07
ERA5	0.63	61.84	42.48	59.83	55.07
GPCP	0.64	48.16	28.42	48.85	55.07
JRA55	0.58	61.95	41.26	54.29	55.07
MERRA2	0.61	96.44	64.77	90.29	55.07
NCEP	0.53	73.90	46.70	70.14	55.07
	Temperature				
	CC	RMSE	MAE	Reanalysis Stdev.	Obs. Stdev.
ERA5	0.98	4.62	4.22	8.79	8.14
CPC	0.99	5.23	5.03	7.76	8.14
CRU	0.99	3.70	3.48	8.11	8.14
JRA55	0.83	6.64	5.63	8.15	8.14
NCEP	0.95	7.03	6.4	9.14	8.14

- JRA55, MERRA2, NCEP show relatively poor agreement with observations.
- CHIRPS, CMAP, CRU and CPC, ERA5, and GPCP data are **comparable** against observations, where CPC performs the best for precipitation.

- CPC, CRU and ERA-5 reanalysis data provide better performance over the Third Pole region.
- CRU and CPC have spatial resolution of 0.5° x 0.5°, while ERA-5 is in 0.25° x 0.25°.

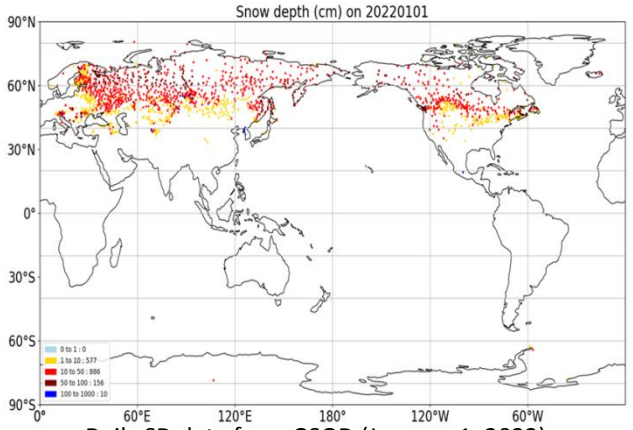
Region-specific key climate indicator – snow cover



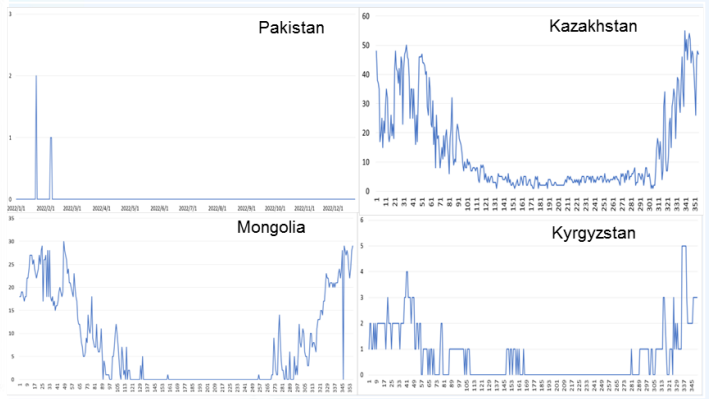
No.	Country	Num. of Reg. Sta.
1	China	23
2	India	13
3	Kazakhstan	3
4	Kyrgyzstan	3
5	Mongolia	6
6	Nepal	3
7	Pakistan	6
8	Uzbekistan	2
	total	59

- In TPRCC domain, **206** stations are registered with snow depth in OSCAR/Surface, **59** of which locate above 2000 m.
- With support of GCW and RWC-Beijing, metadata of stations from TPRCC concerned Members, e.g. China, India, Mongolia, Nepal, were maintained, and observations were newly added to OSCAR.

limit sources of in-situ snow depth observations – availability and accessibility

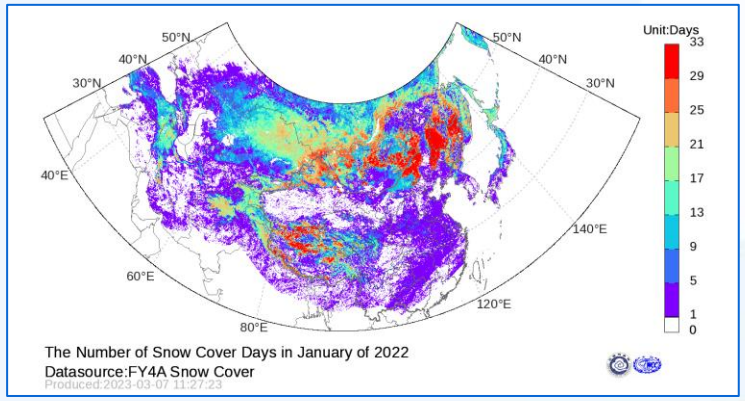


Daily SD data from GSOD (January 1, 2022)



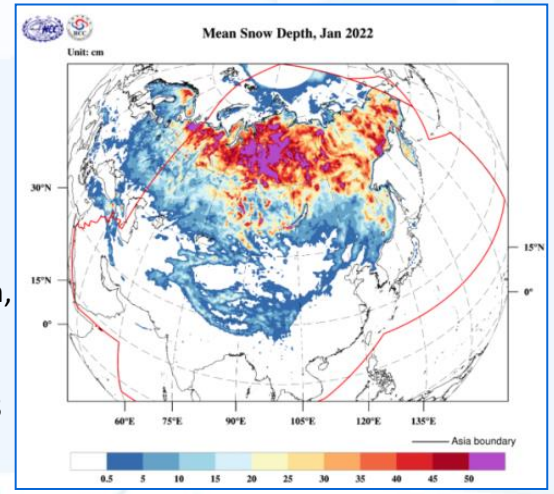
Number of stations that report daily SD by GSOD in 2022

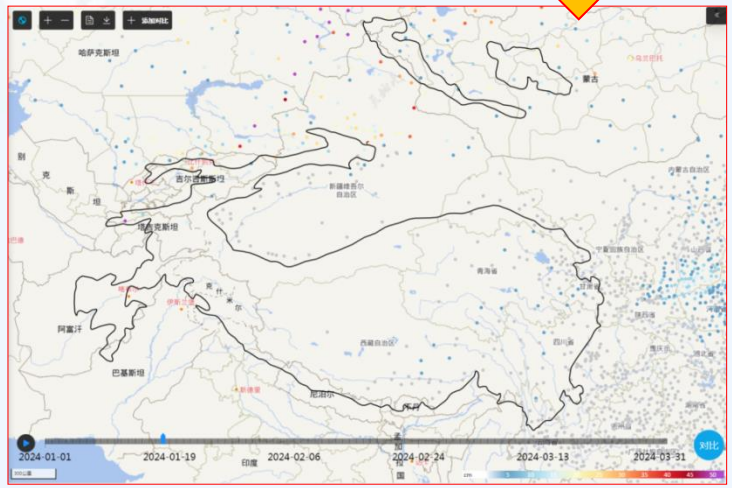
- Inconsistence in num. of stations (~280 obs. over TPRCC domain on 20230101)
- Compliance: not implement 0 cm snow depth report, lots of missing data
- No quality control



FY-3C since 2014.9

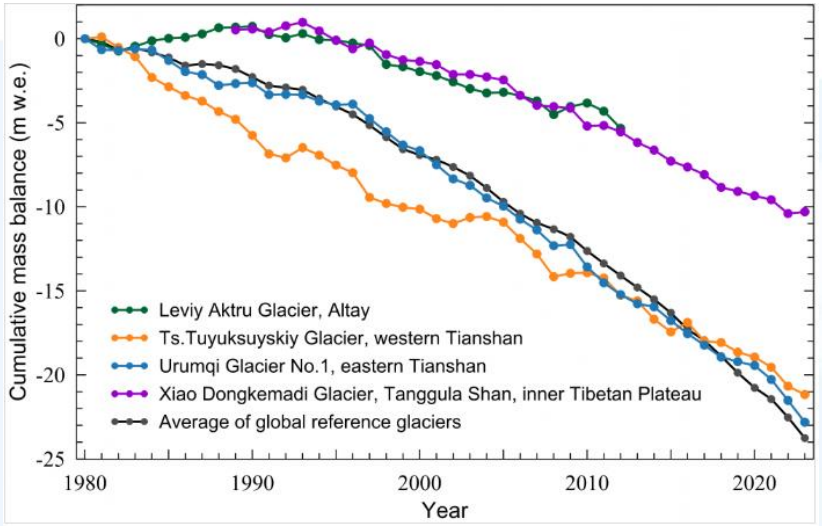
- Extend MWRI (FY) backwards through combining SSM/I, SSMI/S
- false snow detection, cross-calibration,
- Spatial resolution ~25 km since 1987.8

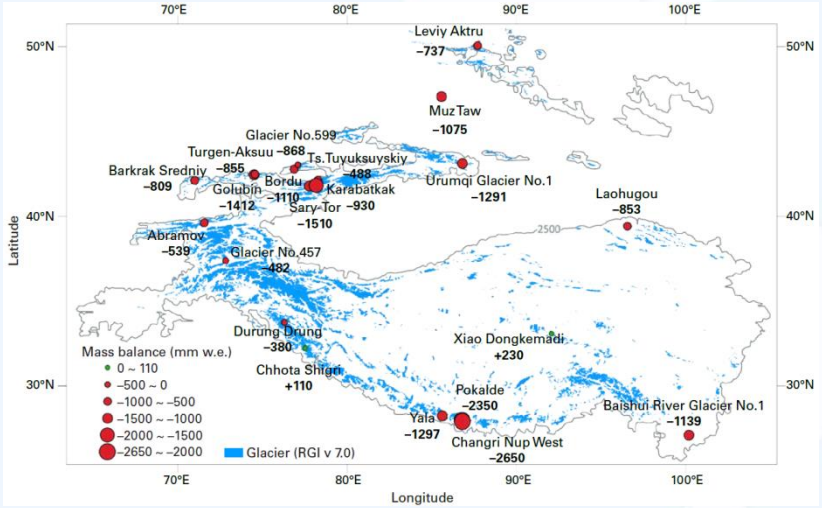




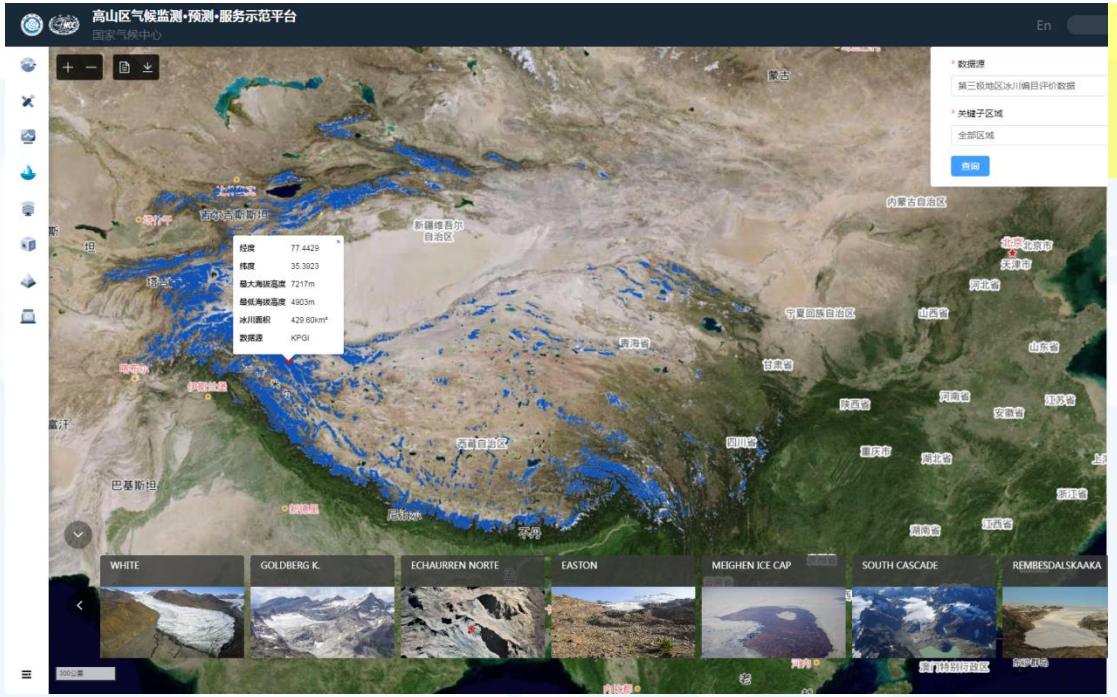
GTS, GSOD and CMA observations-combined daily snow depth data by NMIC, CMA

Region-specific key climate indicator – Glacier





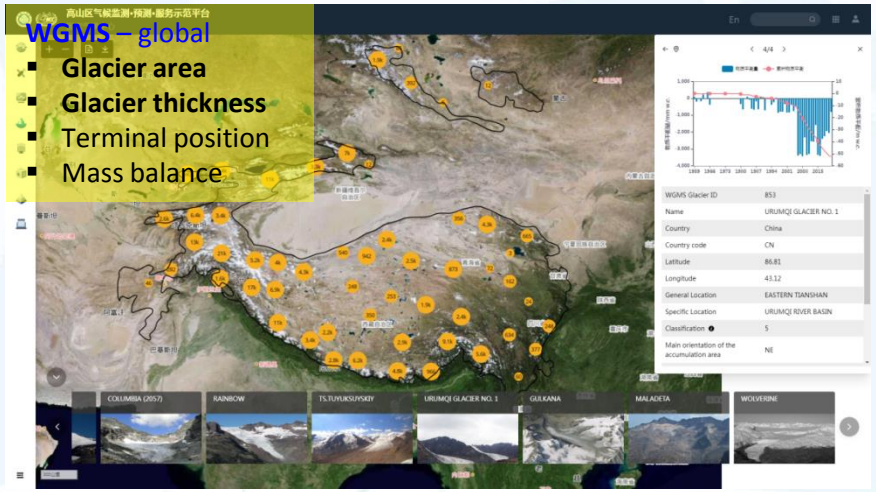
Cooperated with WGMS and NIEER/CAS, products of the Glacier Mass Balance for global reference glaciers and regionally representative glaciers were produced.



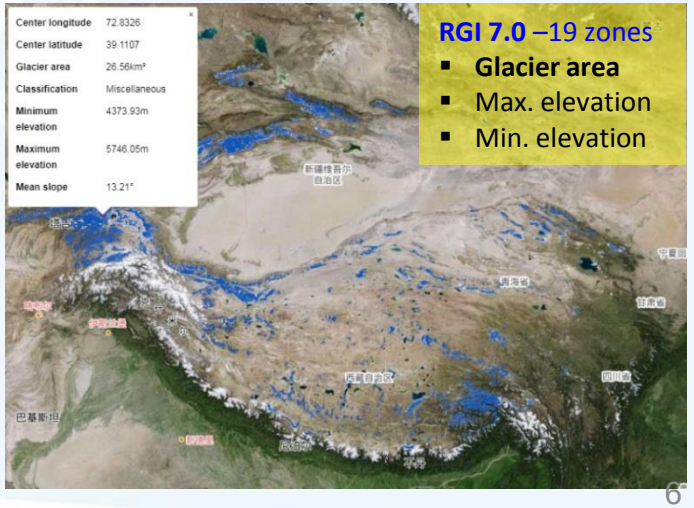
TPDC – third pole
- **Glacier area**
- Max. elevation
- Min. elevation

- RGI;
- GGI18;
- CGI-2 by China;
- HKHGI by ICIMOD;
- WHGI by GlobGlacier Project;
- KPGI;
- PGI-2 by Pakistan;
- SETPGI by SETP;
- mergy_product

He and Zhou (2022)



WGMS – global
- **Glacier area**
- **Glacier thickness**
- Terminal position
- Mass balance



RGI 7.0 –19 zones
- **Glacier area**
- Max. elevation
- Min. elevation

Contribution to WMO reports

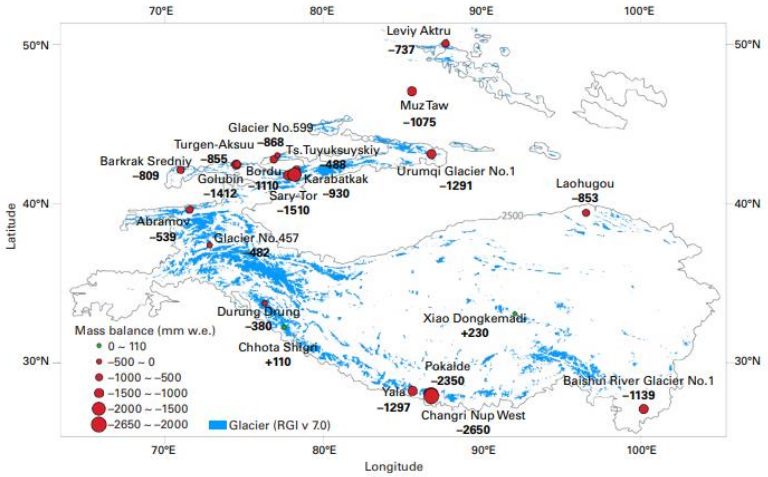


Figure 8. Preliminary estimations of the 2022–2023 mass balance of glaciers in the High Mountain Asia region. The area indicated by grey contours is 2500 metres above sea level.

Source: WMO Third Pole Regional Climate Centre Network (TPRCC-Network) and WGMS; the original observations upon which this figure is based are from China, India, Kazakhstan, Kyrgyzstan, Nepal, the Russian Federation, Tajikistan and Uzbekistan.

Summary of the Working Group I contribution to IPCC AR6, glaciers over South Asia have thinned, retreated, and lost mass since the 1970s (high confidence), although partial Karakoram glaciers have either slightly gained mass or are in an approximately balanced state (medium confidence).

For the glaciological year 2022/2023, 20 out of 22 glaciers observed in the HMA region show continued negative mass changes. Record-breaking high temperature and dry conditions in the East Himalaya and most of the Tien Shan exacerbated mass loss for most glaciers. During the period 2022–2023, Urumqi Glacier No. 1, in Eastern Tien Shan, recorded its second most negative mass balance (1.29 m w.e.) since measurements began in 1959 (Figure 8).

Climate Service:

- WMO State of the Climate in Asia (2020-2023)
- GCW/WMO Snow Assessment Report (2023)

SNOW COVER

Snow cover plays an important role in the feedback mechanisms in the climate system (such as albedo,[16] run-off, soil moisture and vegetation). Hence, it is a crucial variable for monitoring climate change. In the past 27 years, the northern hemisphere's spring (March to May) snow cover extent (SCE)[17] over Asia exhibited a decreasing trend of 250000 km² per decade, with negative anomalies with respect to the 1998–2020 long-term average dominating since the mid-2000s. In the spring of 2023, the SCE in Asia was about 14.57 million km², slightly less than the 1998–2020 average. Spatially, lower-than-average snow extent appeared especially in the northern part of Central Asia and North-Eastern East Asia. On the contrary, positive SCE anomalies dominated from northern East Asia to central North Asia (Figure 10). In the HMA region, SCE was above normal in its western, mid-eastern region, and along the southern edge. However, the south-east area of HMA was dominated by negative anomalies.

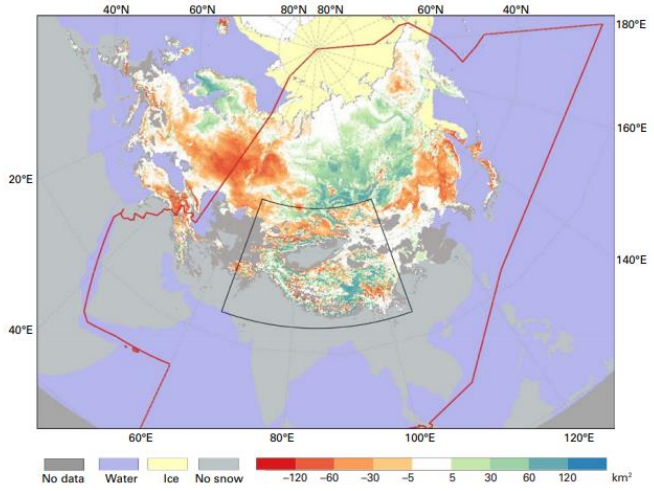


Figure 10. Anomalies of mean snow cover extent in the spring of 2023 (from March to May), relative to the 1998–2020 average.
To derive the monthly snow cover extent anomalies for each grid, the number of monthly snow cover days was divided by the

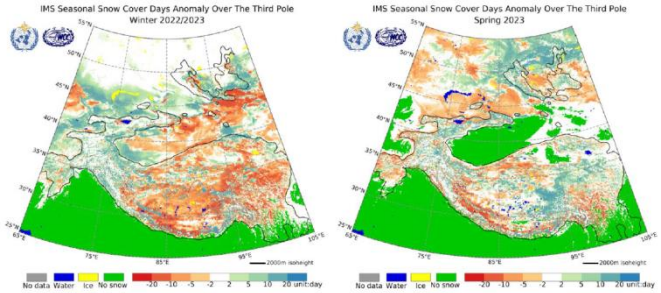


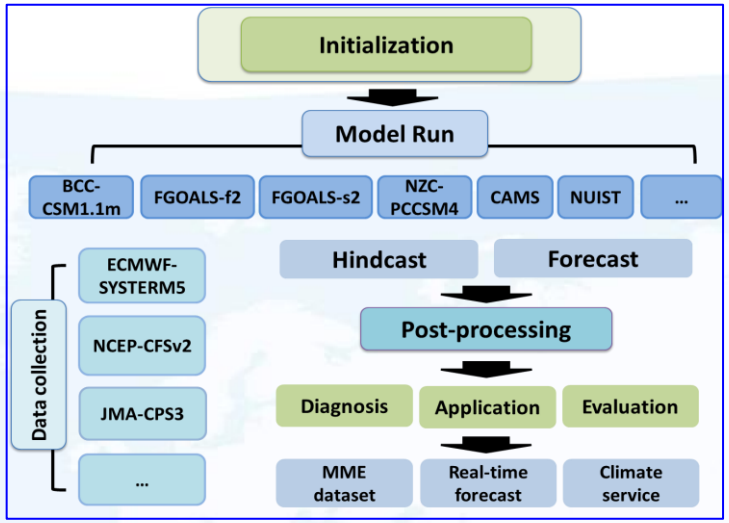
Figure 9. *Anomalies of the number of snow cover days in winter of 2022/2023 (left, DJF) and spring of 2023 (right, MAM), relative to the 2005–2020 average.*

WMO survey for RA II Members on the status and planning of terrestrial cryosphere observations and data (in situ and remote sensing), and 'International Training Course on Cryosphere Obs., Monitoring and Research along B&R'

Member	Organization	Category	Snow		Glacier		Permafrost or seasonally frozen ground		Lake ice		River ice	
			Observation	Data collection and archival	Observation	Data collection and archival	Observation	Data collection and archival	Observation	Data collection and archival	Observation	Data collection and archival
China	CMA, TPDC, CAS	Both	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
India	IMD	NMHS	Yes	Yes	Yes	No	No	No	No	No	No	No
Iran	IRIMO	NMHS	Yes	Yes	No	No	No	No	No	No	No	No
Japan	NIPR	Non-NMHS	Yes	Yes	No	No	No	No	No	No	No	No
Kazakhstan	CARGC	Non-NMHS	Yes	Yes	Yes	Yes	Yes	Yes	No	No	No	No
Kyrgyzstan	CAIAG	Non-NMHS	No	No	Yes	Yes	Yes	No	No	No	No	No
Mongolia	IRINHE	NMHS	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes
Nepal	DHM	NMHS	Yes	Yes	Yes	No	No	No	No	No	No	No
Pakistan	PMD	NMHS	Yes	Yes	No	Yes	No	No	No	No	No	No
Republic of Korea	KMA	NMHS	Yes	Yes	No	No	No	No	No	No	No	No
Russian Federation	AARI	Non-MMHS	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Tajikistan	Center for Glacier Studies of NAST	Non-NMHS	Yes	Yes	Yes	Yes	Yes	No	No	Yes	No	No

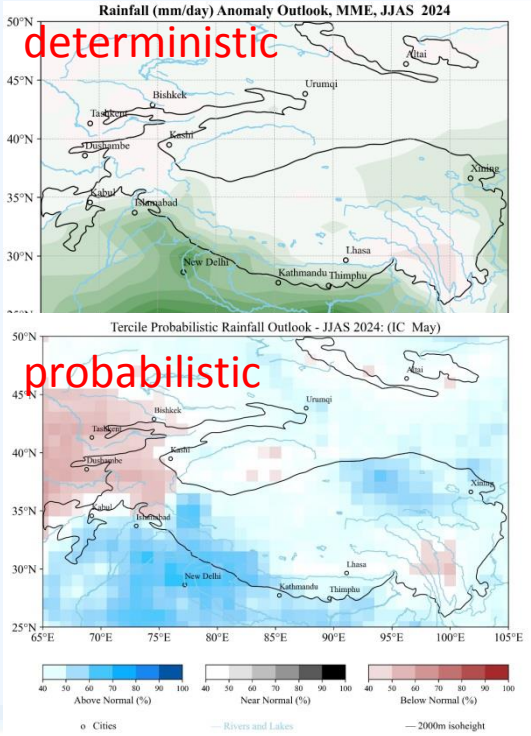
Procedure of producing Long-Range Forecast

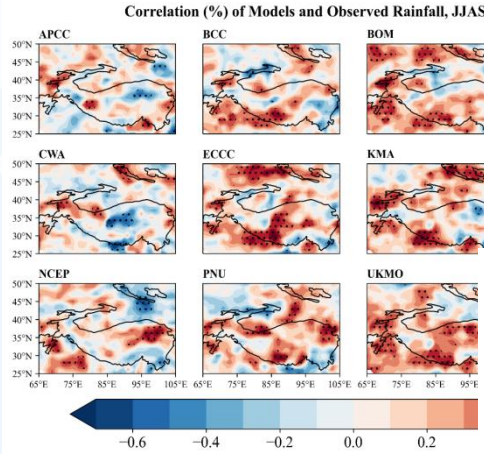
	Institution/Model	Ensembles	Data Availability
1.	APCC-SCOPS	10	1982-2013
2.	BCC-CSM1.1M	24	1991-2015
3.	BOM-ACCESS-S1	11	1990-2012
4.	CMCC- SPS3.5	50	1992-2017
5.	CWB-TCWB1Tv1.1	30	1982-2019
6.	HMC-SL-AV	20	1985-2010
7.	KMA-GLOSEA5GC2	42	1991-2016
8.	METFR-SYS8	51	1991-2016
9.	MGO-MGOAM-2	10	1979-2004
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



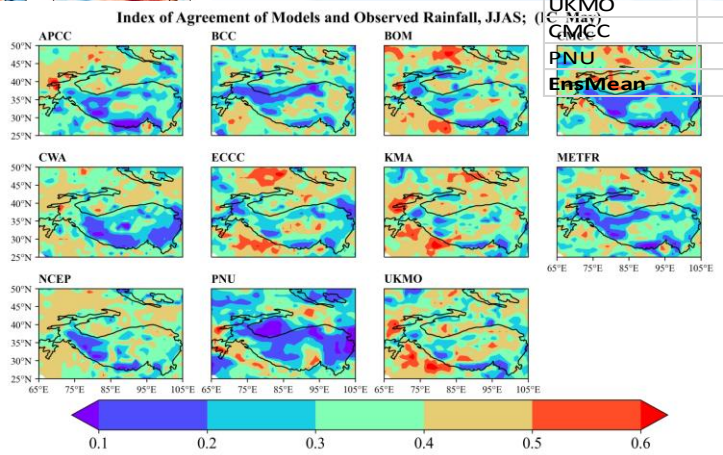
IMD—MMCFS Model Details

- Atmospheric Component: Global Forecast System (GFS) with spectral resolution of T382 and 64 hybrid vertical levels
- Ocean Component: Geophysical Fluid Dynamics Laboratory (GFDL) Flexible Modeling System (FMS) & Modular Ocean Model version 4 (MOM4; Griffies et al. 2004). The horizontal resolution of the ocean component (MOM4) is 0.25° between 10°S to 10°N latitude band and 0.5° elsewhere.
- In addition to the atmosphere and ocean component, the CFSv2 also employs a four-layer NOAH land surface model [*Ek et al.*, 2003] with dynamic vegetation as well as a three-layer (one layer of snow and two layers of sea ice) interactive sea ice model [*Winton*, 2000].
- The ocean and atmosphere are coupled without flux correction.

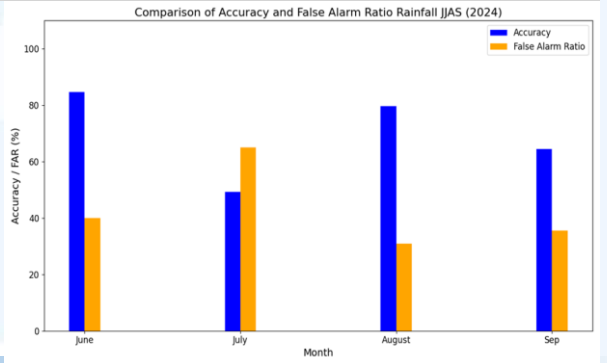




ACC
Mean Absolute Error
Root Mean Square Error
Correlation coefficient
Index of Agreement

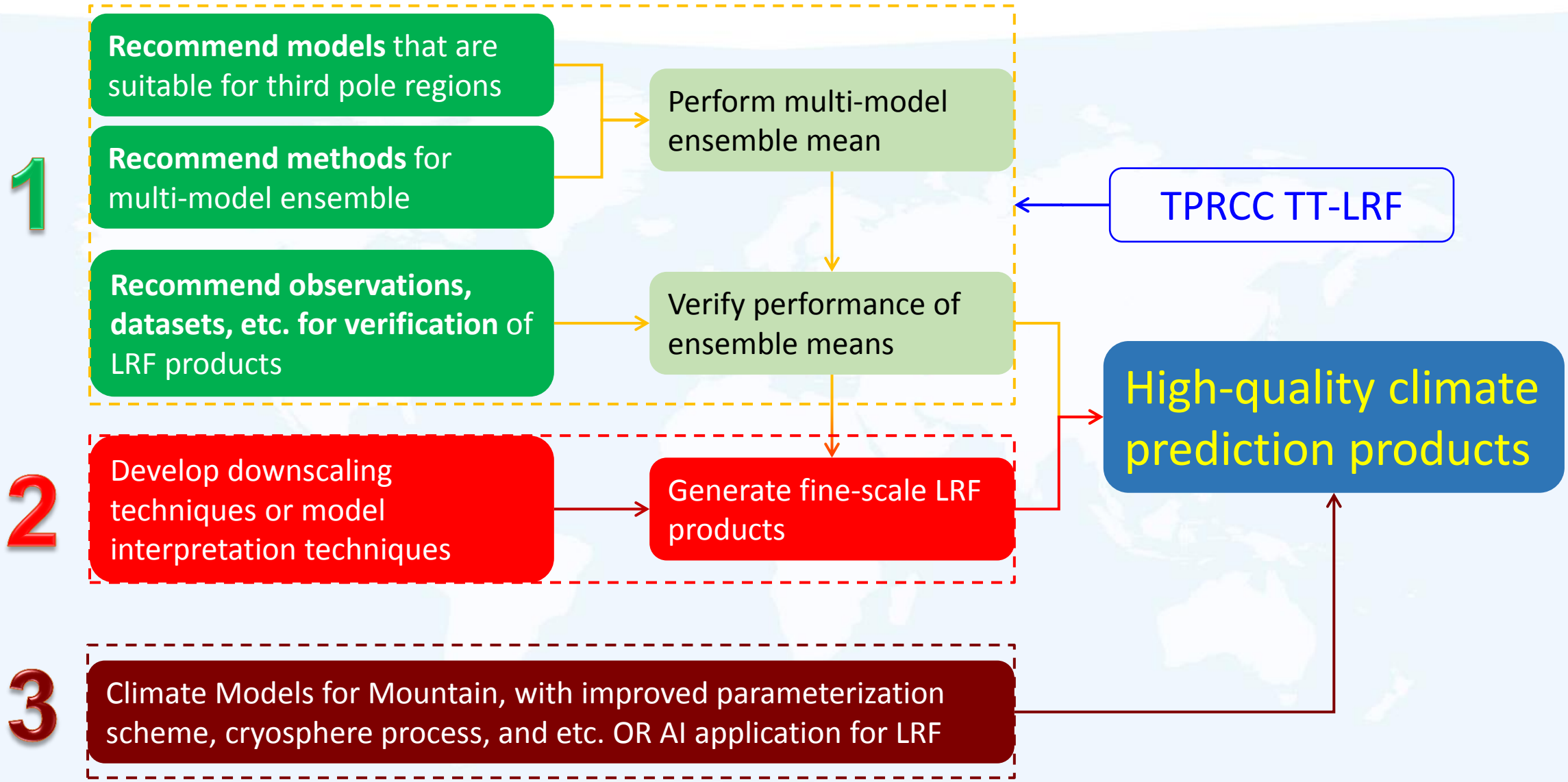


Model_List	Correlation	P-value	T-score	IA	RMSE
APCC	-0.0266	0.9165	-0.1065	0.1796	1.2678
BCC	0.3963	0.1035	1.7268	0.4378	0.3563
BOM	0.4752	0.0463	2.1603	0.228	1.0066
CWA	-0.0066	0.9794	-0.0263	0.1767	1.2949
ECC	0.713	0.0009	4.0677	0.3077	0.904
KMA	0.4756	0.0461	2.1625	0.2601	0.8637
MeteoFrance	0.5874	0.0104	2.903	0.2047	1.1725
NCEP	0.292	0.2397	1.2212	0.35	715
UKMO	0.5998	0.0085	2.9982	0.2454	0.9512
CMCC	0.6393	0.0043	3.3258	0.1841	1.3294
PNU	0.6395	0.0043	3.3277	0.1955	1.2728
EnsMean	**0.7547**	**0.0169**	**2.6669**	**0.2341**	**0.5719**

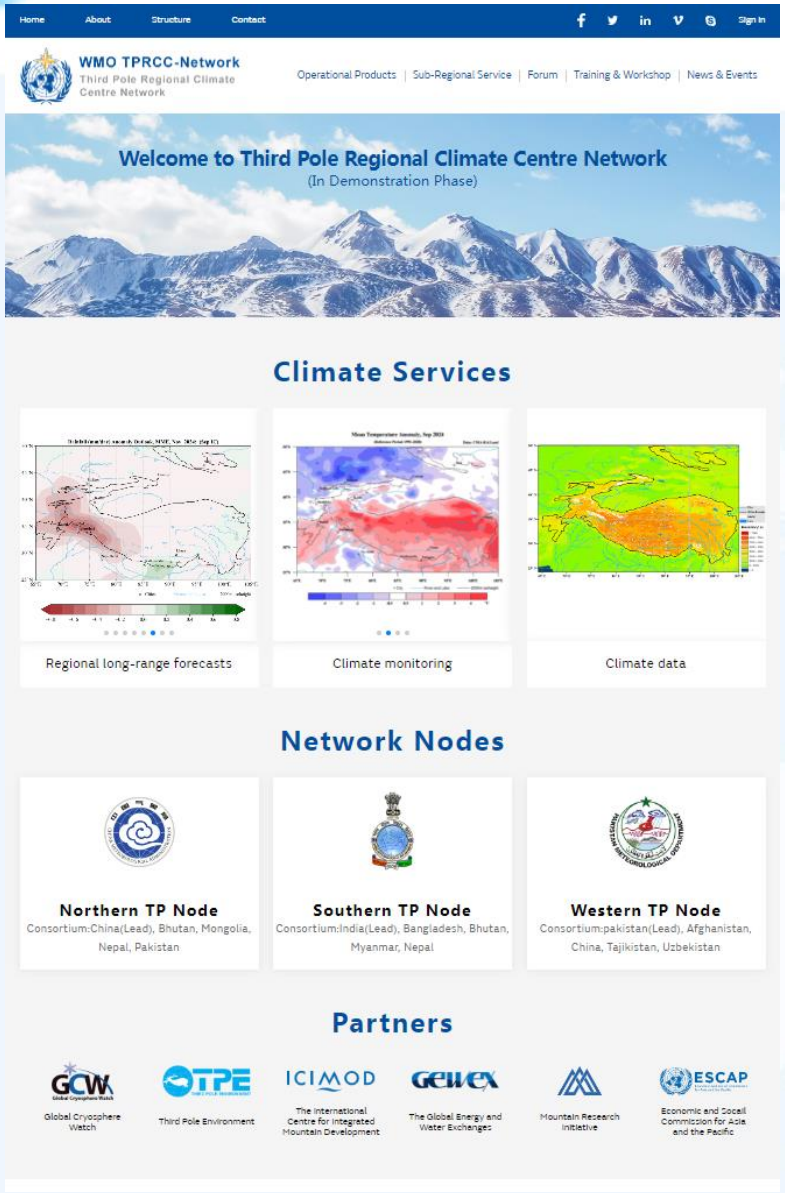


Method of evaluating model performance and verifying seasonal outlook was developed.

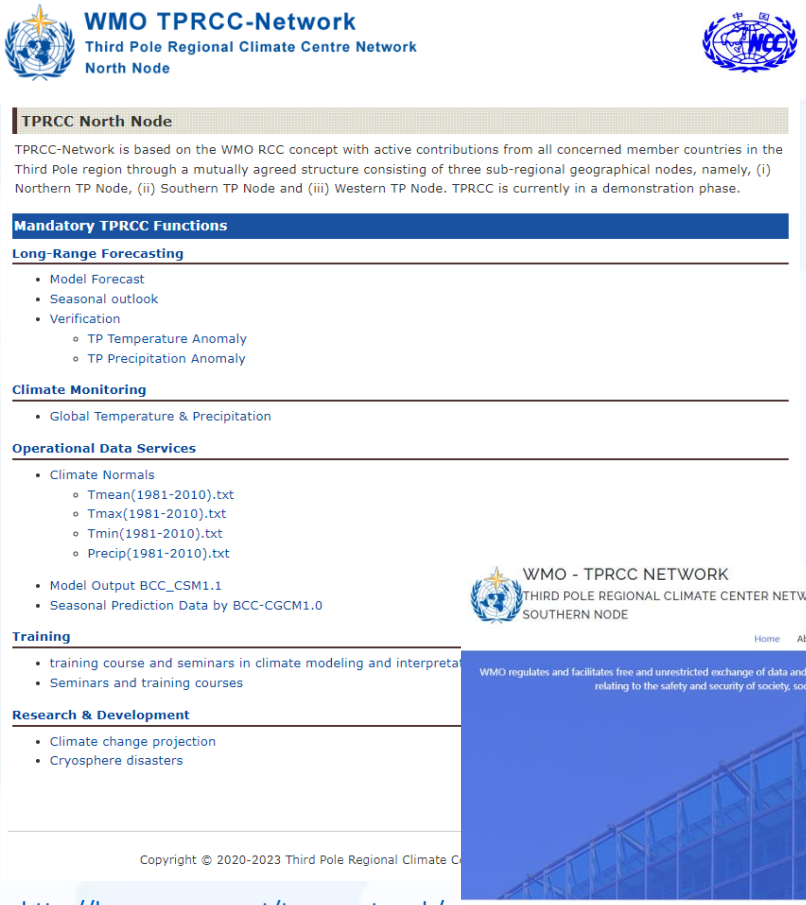
Roadmap of developing objective LRF



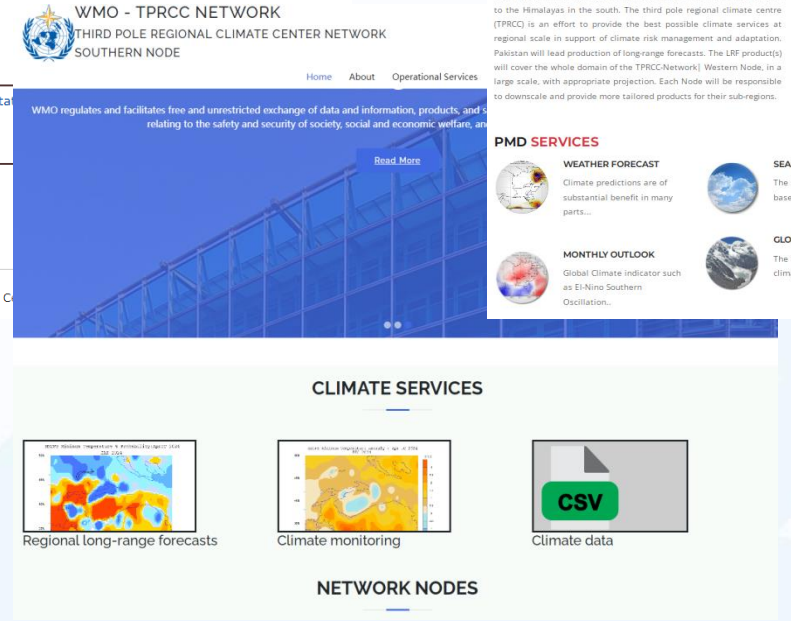
TPRCC Web Portal and Nodes' websites



http://www.rccra2.org/tp-rcc/



http://bcc.ncc-cma.net/tprcc-network/

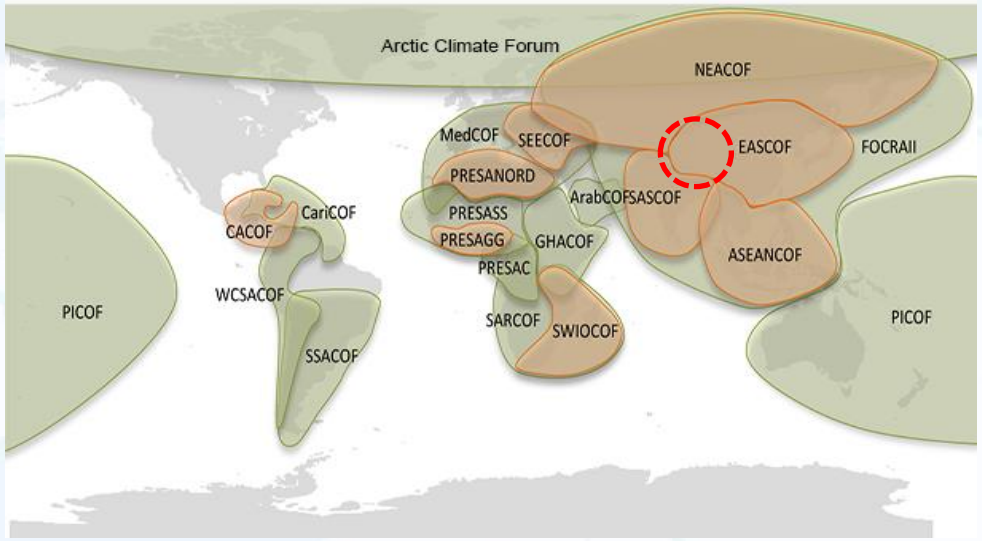


https://mausam.imd.gov.in/tprcc/

https://ffd.pmd.gov.pk/cp/tprcc-network/tprccn-new.html

3. TPCF Concept and TPCF-1


TPCF Scoping Workshop in Bangkok on 7-9 November 2023

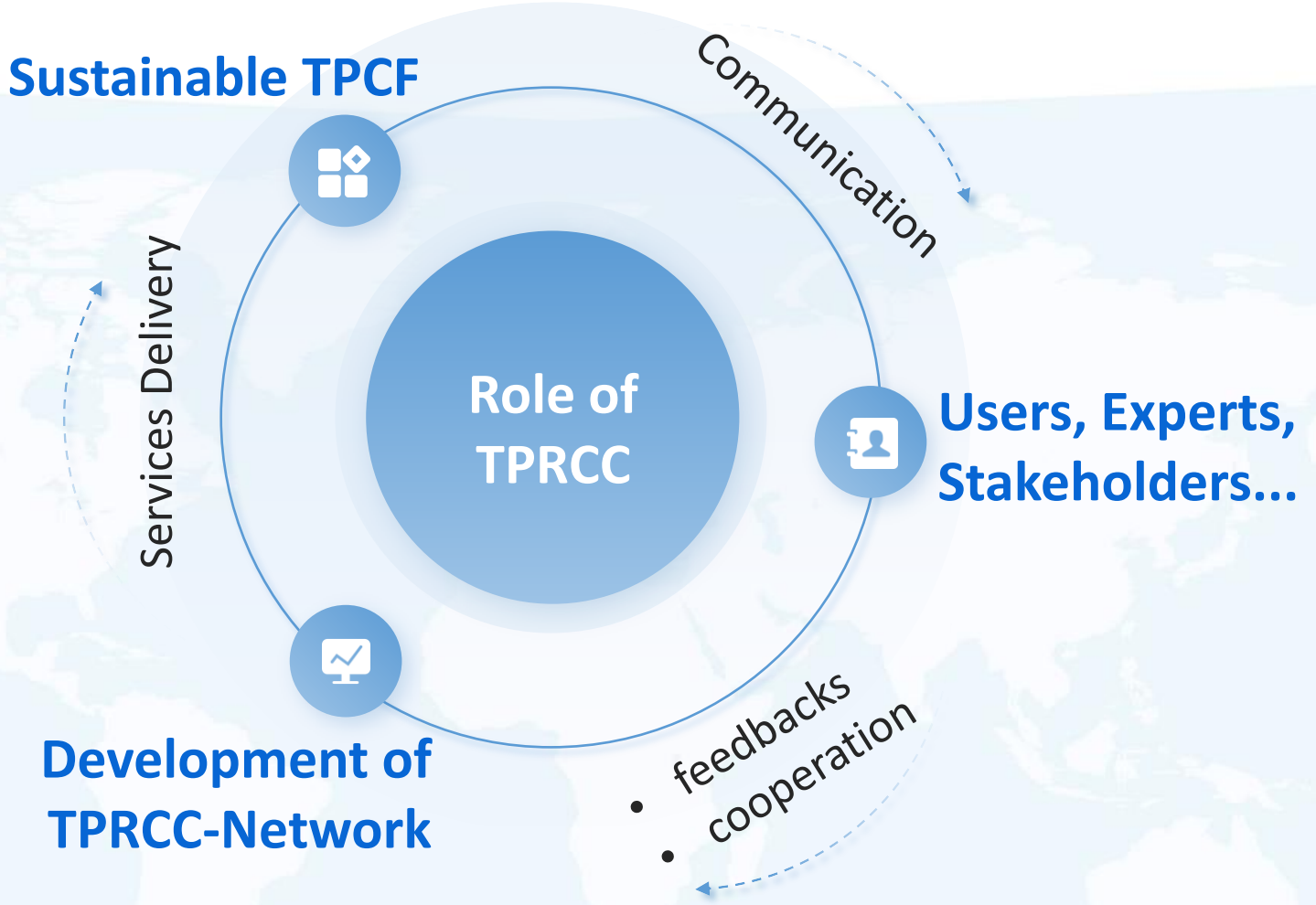


To provide value-added climate services to the third pole users, to address the needs of Members in this region with a rapidly changing and remote high-mountain environment.

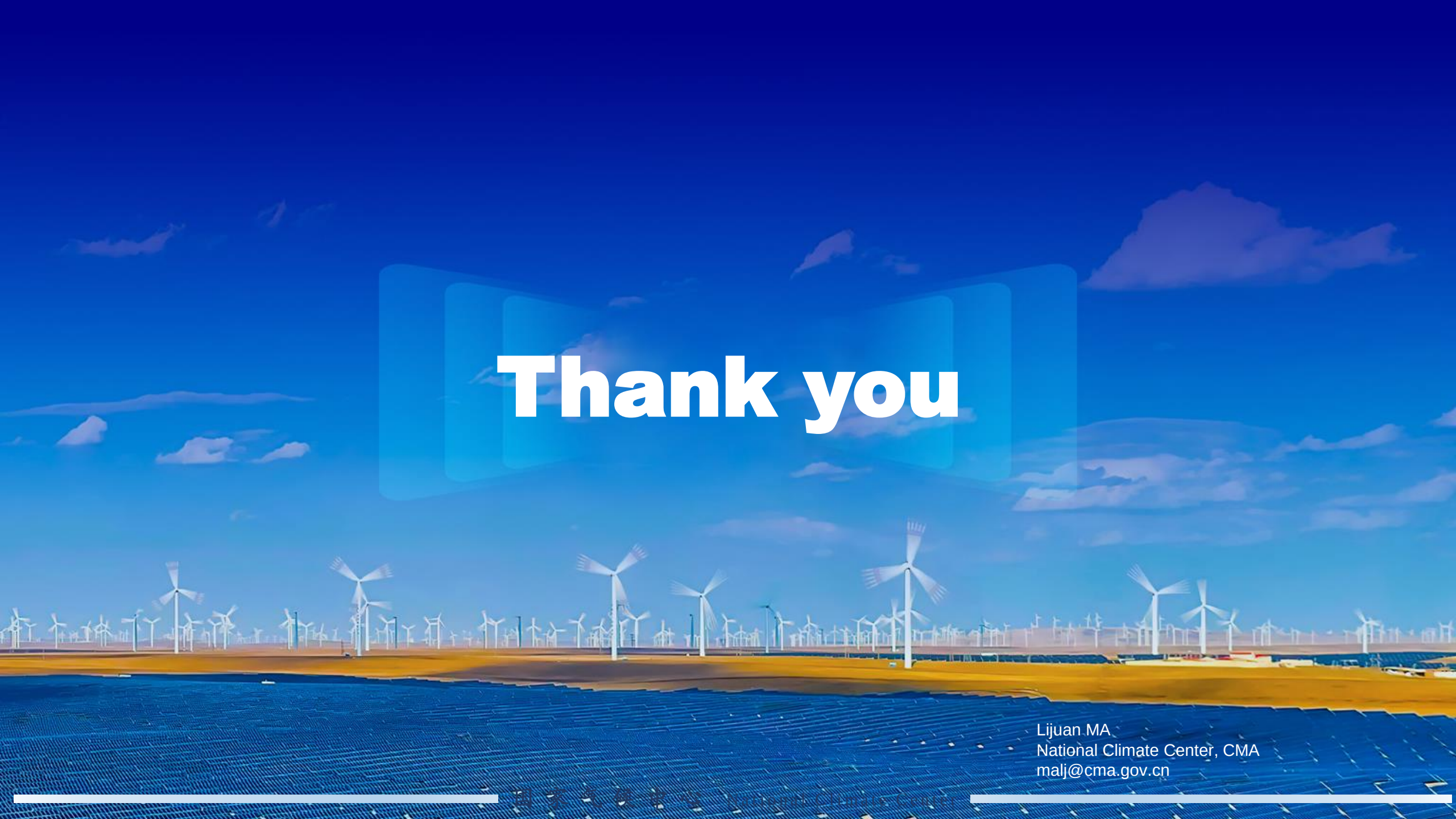
- To establish a **sustainable regional collaborative platform** that brings together national, regional, and international **climate experts, users and stakeholders,** to **produce seasonal outlook** based on input from WMO GPCsLRF, LC-LRFMME, RCCs and NMHSs, and to **discuss how the climate information can be effectively integrated into decision making processes**.
- To convene TPCF twice a year, in May and November, targeted at JJAS and DJF, respectively.


Inaugural session of Third Pole Climate Forum, Lijiang, China, 4-6 June 2024

Commencement of the Demonstration Phase of TPRCC-Network



TPCF is one of the flagship activities of TPRCC-Network and the main user engagement mechanism at regional level to implement WMO high mountain priority.



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