

Seasonal Climate Outlook for Winter 2023/2024 over China

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2023-November-7, Tokyo, Japan

Outline

1. EAWM System

2. Outlook for EAWM

2.1 Prediction by climate prediction system of CMA

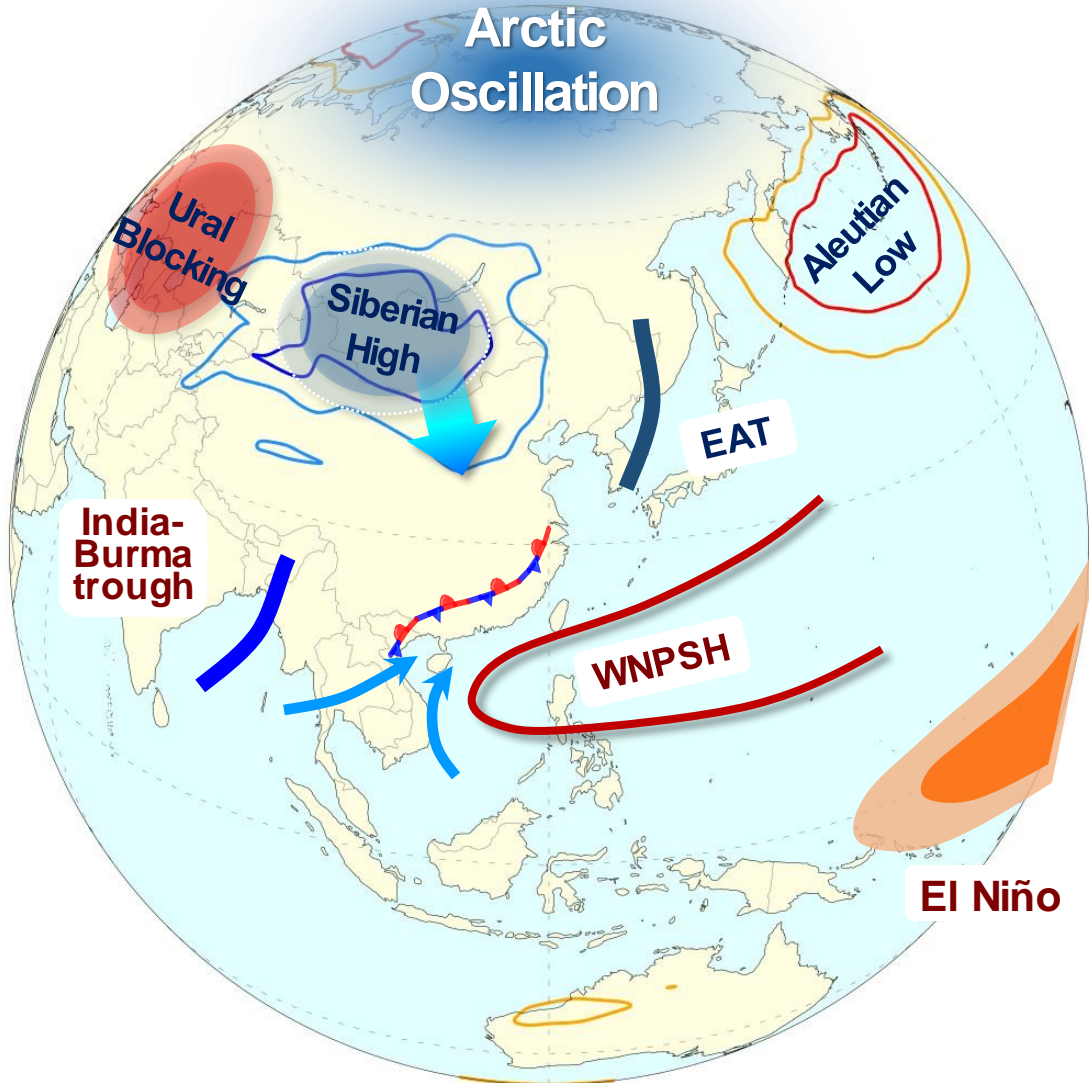
2.2 Statistic Analysis

3. Outlook for temperature and precipitation over China

EAWM system and potential boundary forcing



Major circulation systems affecting winter climate in China



■ East Asia Winter Monsoon (EAWM), including :

Arctic Oscillation (AO)

Ural blocking (UB)

Siberian high (SH)

East Asian trough (EAT)

Western North Pacific subtropical high (WNPSH)

India-Burma trough (IBT)

■ Potential Boundary Forcing:

SSTA

Arctic Sea Ice

Outline

1. EAWM System

2. Outlook for EAWM

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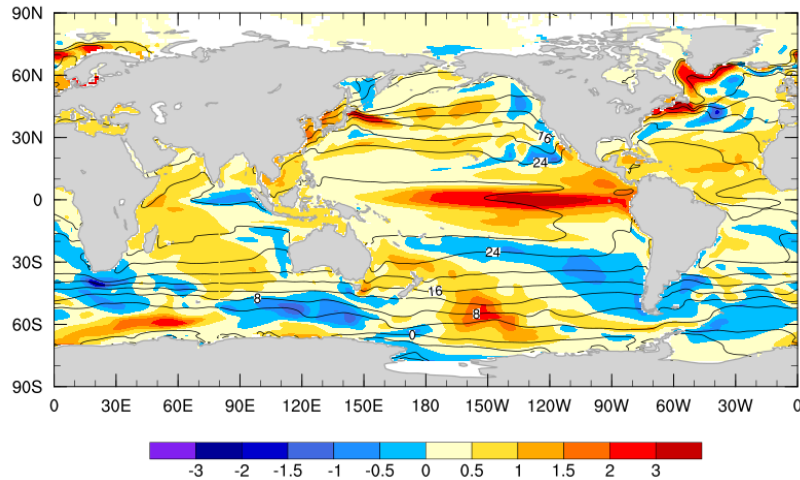
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ENSO

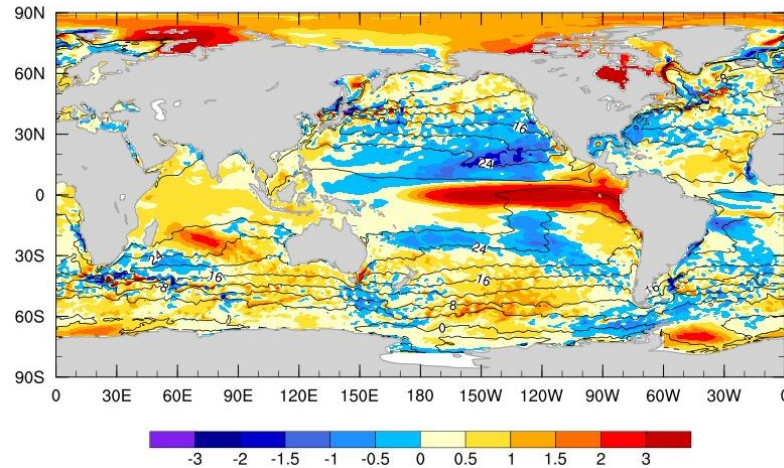
BCC_CSM1.1(m)

BCC Three-Month Forecast Started 20231001 Valid 202312 - 202402
 Sea Surface Temperature (line) and its Anomaly (shading) Units: C
 BCC_CSM1.1(m) Member Size = 24



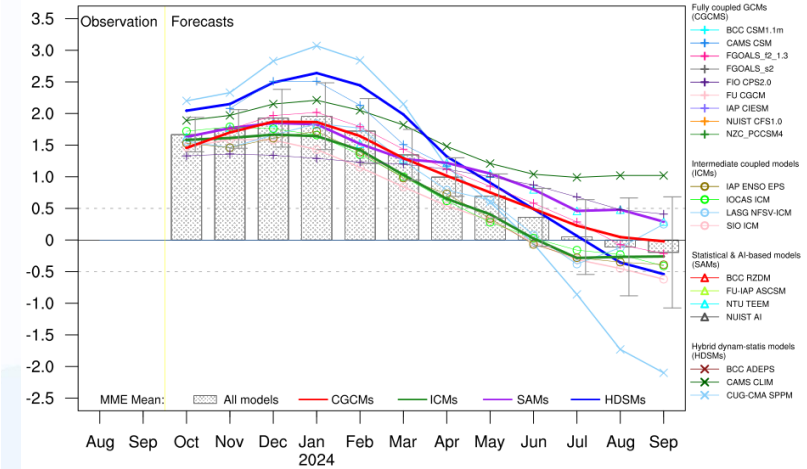
CMA-CPSv3

Sea Surface Temperature (line) and its Anomaly (shading) Dates: 202312 - 202402
 CMA-CPSv3 seasonal forecast Ensembler Size = 21
 Initial date: 20231001 Units: degC



China Multi-Model Ensemble

China Multi-Model Ensemble (CMME): ENSO Prediction
 Niño3.4 Index Forecasts 202310 - 202409 Issued on 20231025

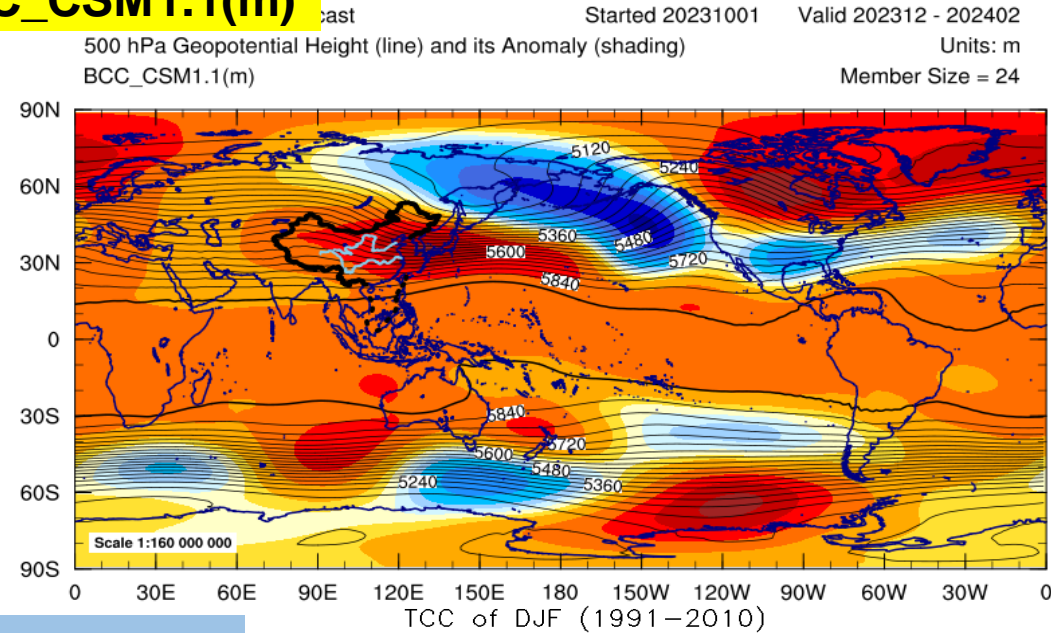


- In September 2023, the Niño 3.4 index was **1.58°C**.
- The latest model prediction indicate El Niño state is expected to develop in the central and eastern equatorial Pacific, and **possibly reach its peak phase during the coming winter**.

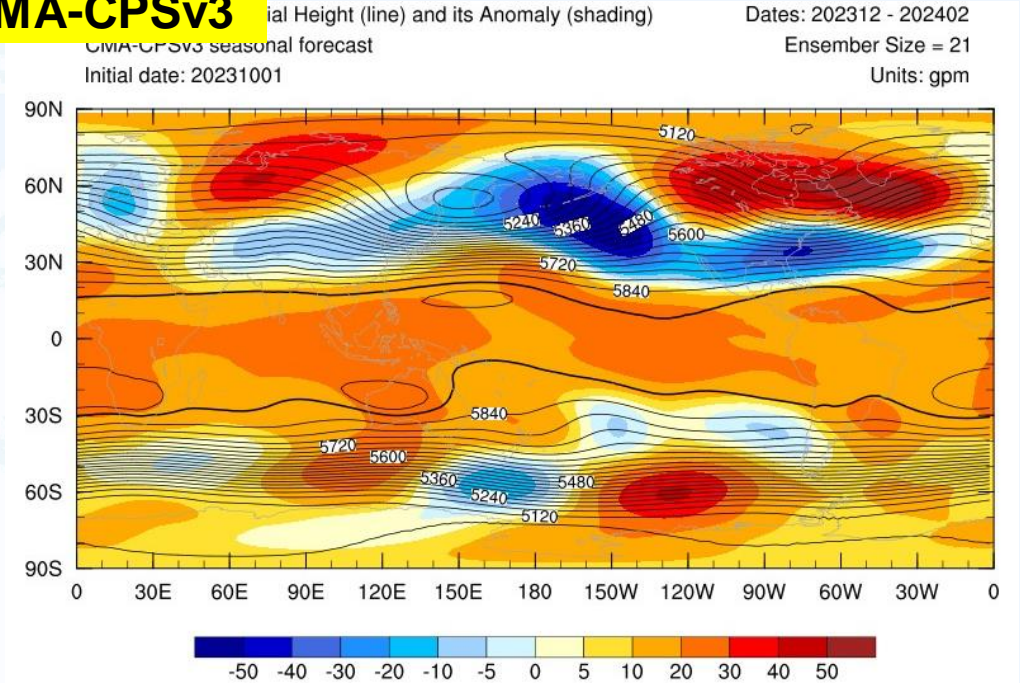
Geopotential height anomaly for DJF



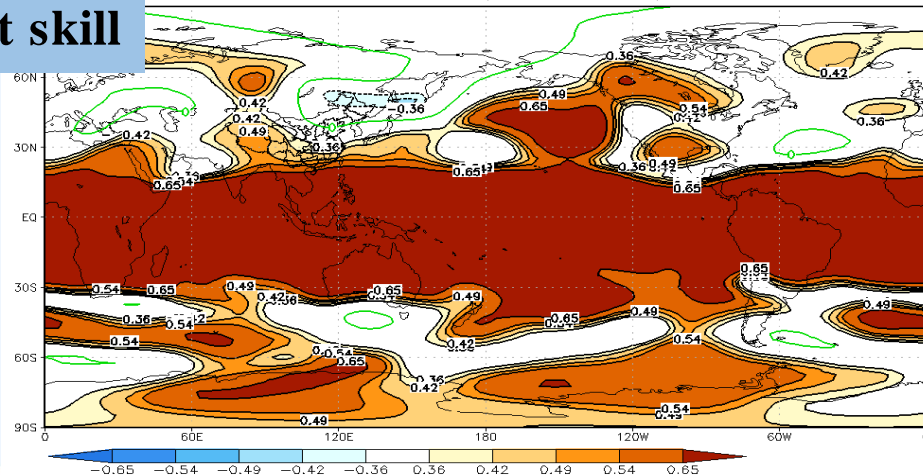
BCC_CSM1.1(m)



CMA-CPSv3



Hindcast skill



- Zonal circulation over East Asia
- Negative Ural blocking
- Normal-weak East Asia trough
- Positive height anomaly over Tibetan Plateau
- Strong western North Pacific subtropical high
- Strong India-Burma trough

Prediction of GH with different initial date

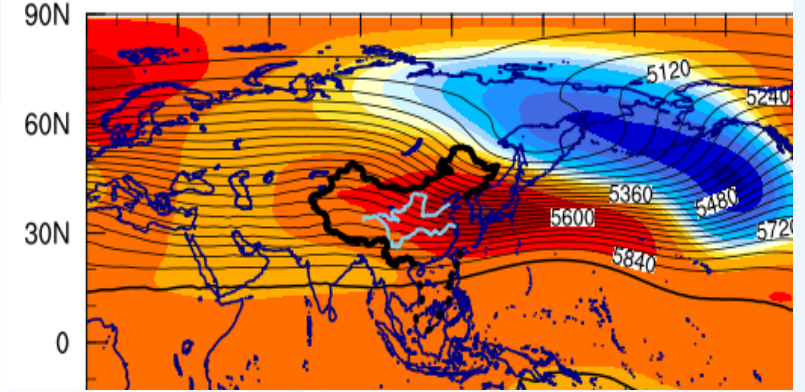
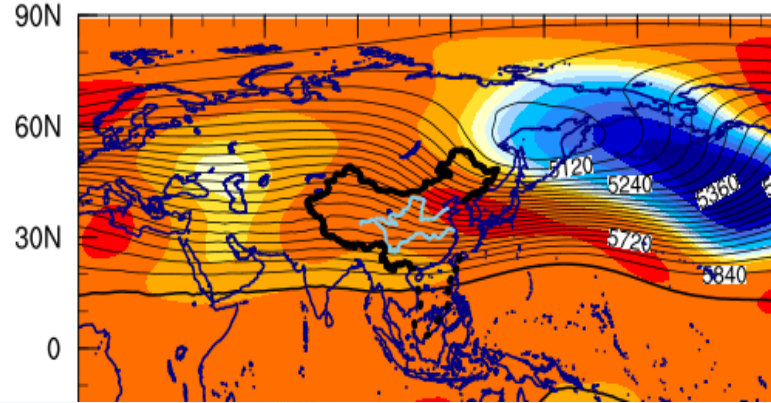
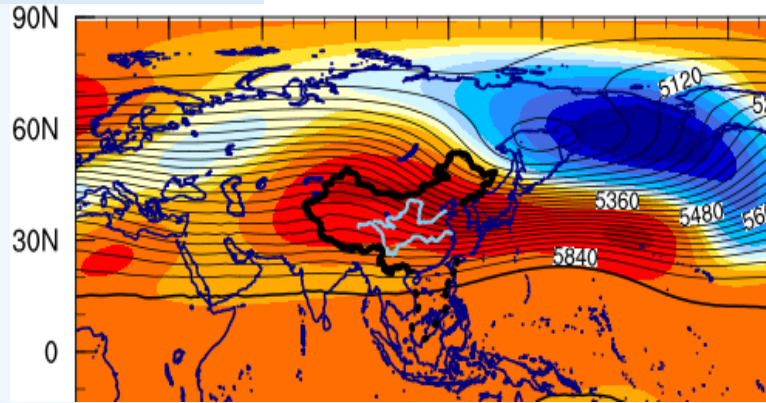


BCC-CSM1.1

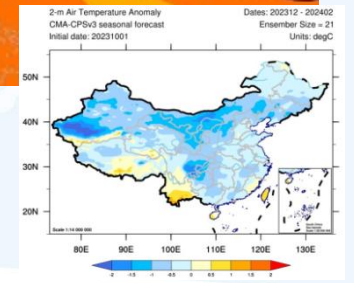
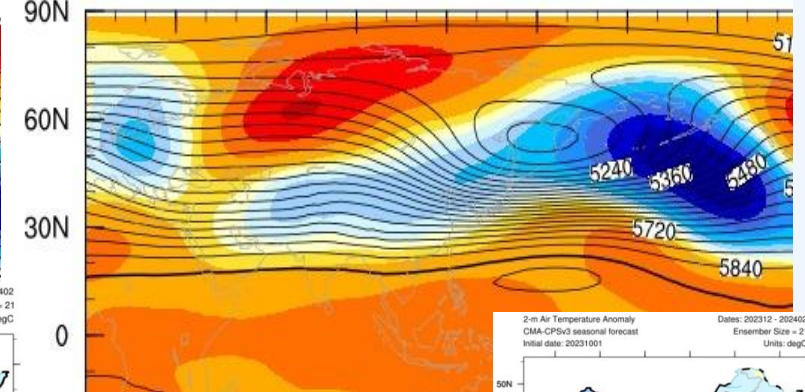
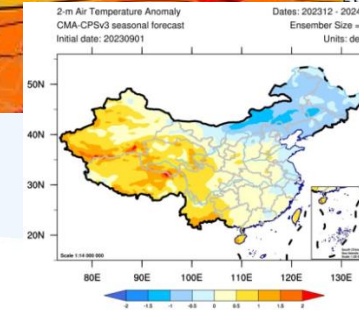
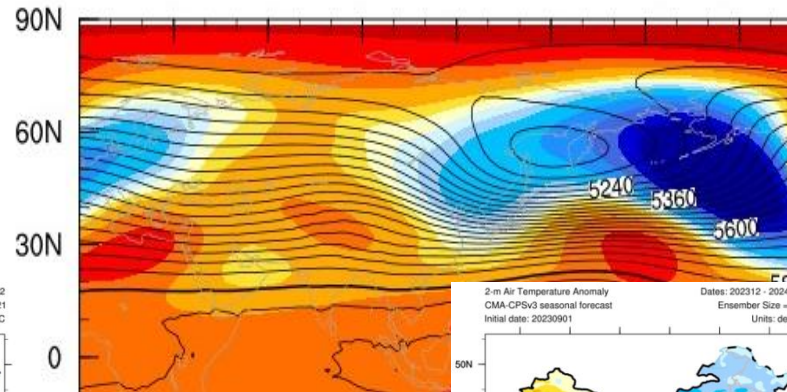
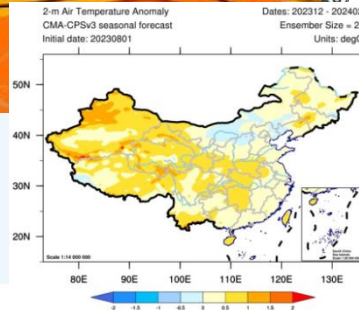
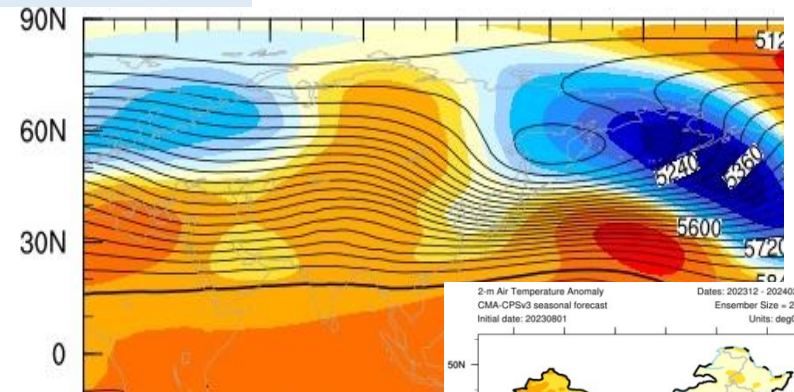
Initial date: Aug

Initial date: Sep

Initial date: Oct



CMA-CPSv3



Prediction of GH from world leading centers

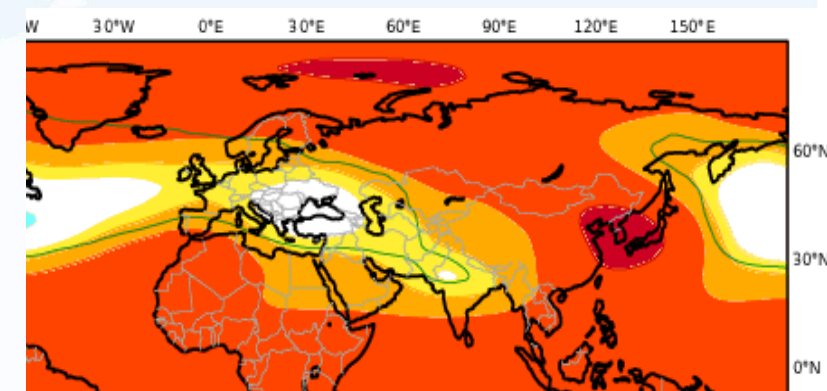
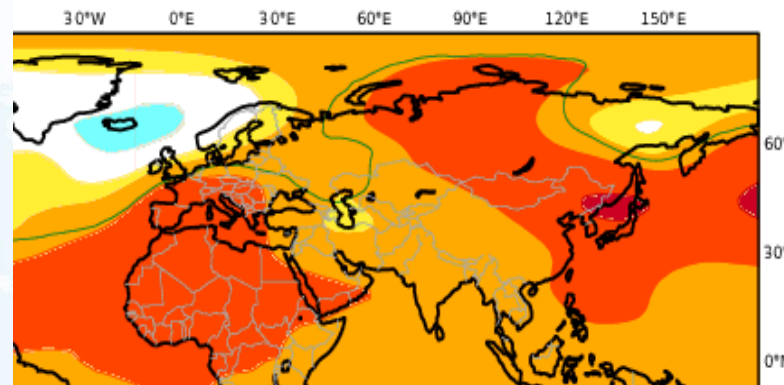
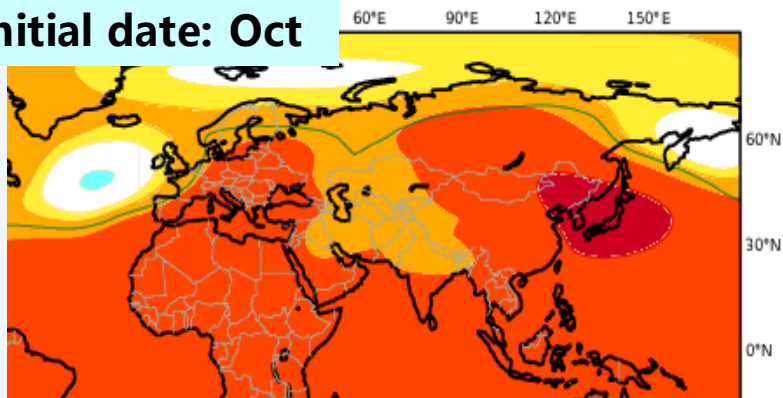


ECMWF

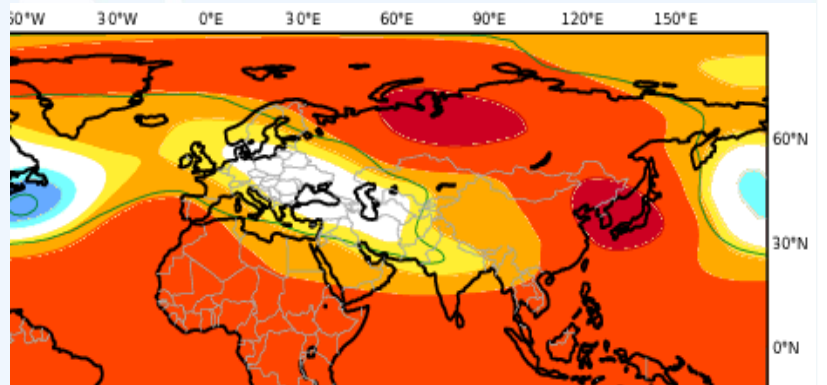
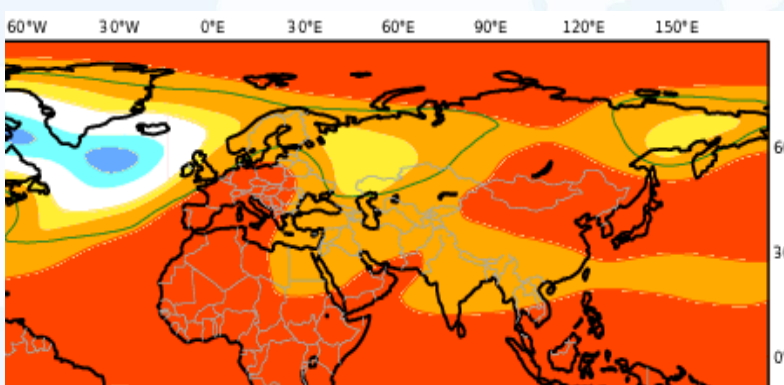
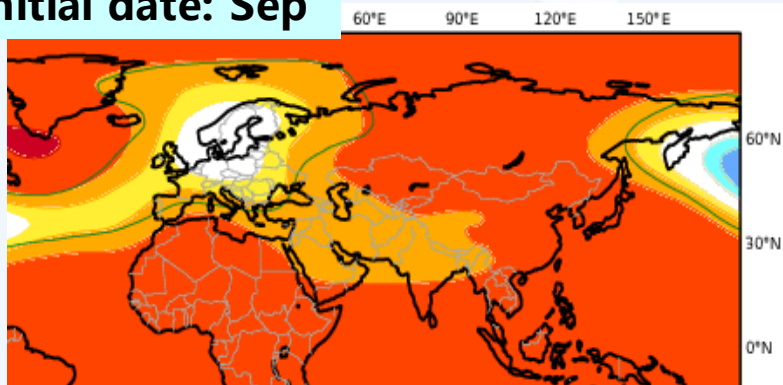
NCEP

JMA

Initial date: Oct



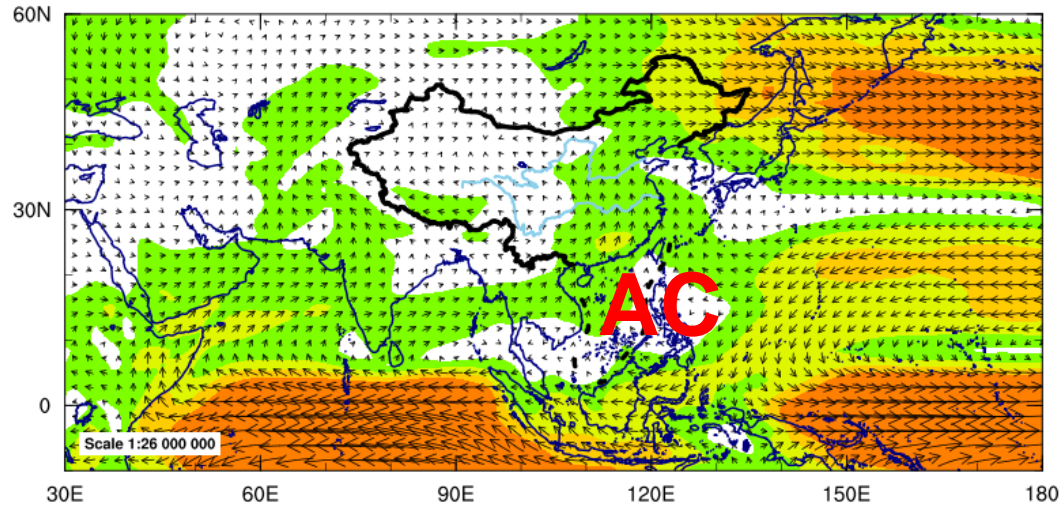
Initial date: Sep



850hPa wind

BCC_CSM1.1(m)

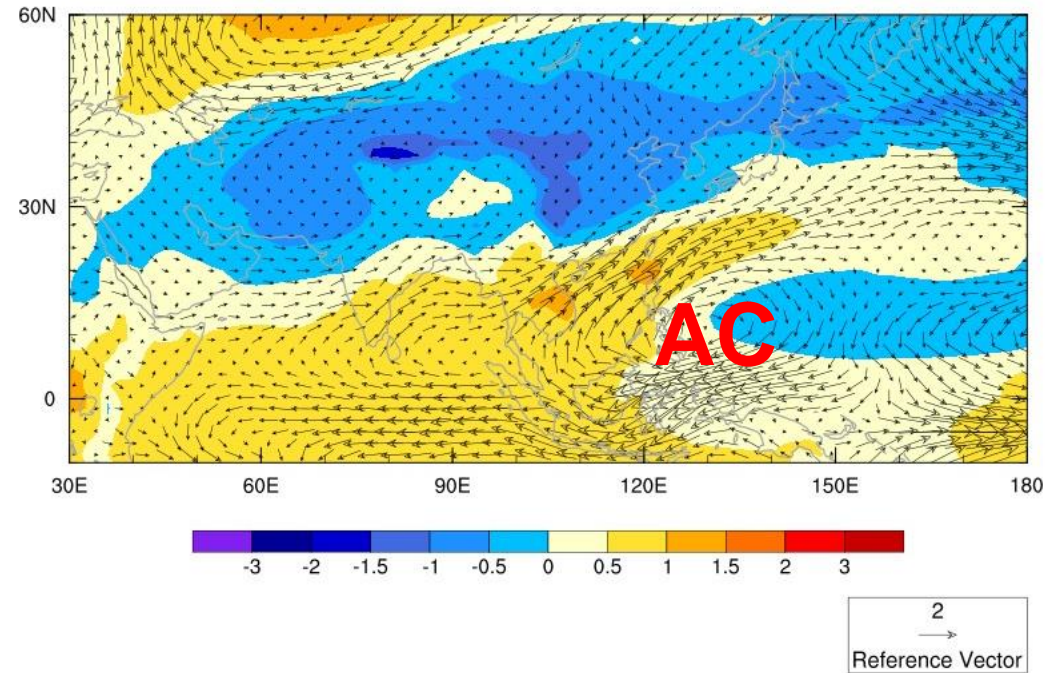
Started 20231001 Valid 202312 - 202402
Units: m/s
Member Size = 24



850hPa Air Temperature Anomaly(shading) and Wind Anomaly

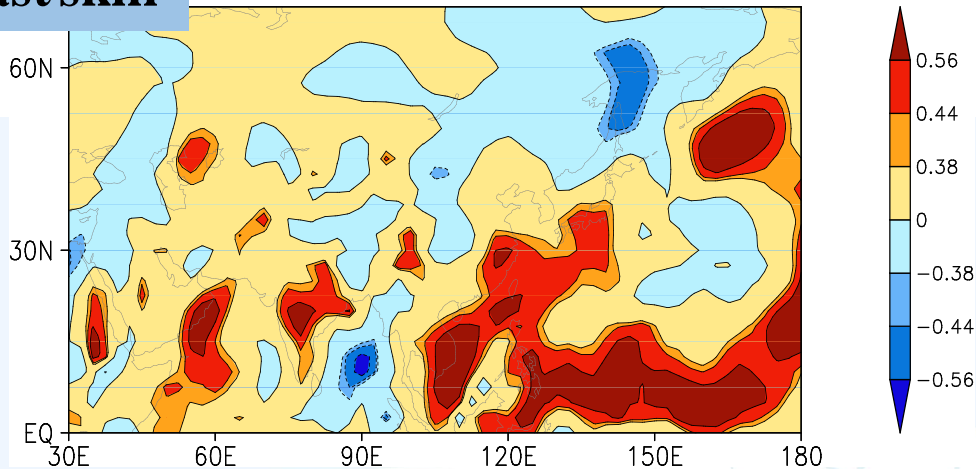
Dates: 202312 - 202402
Ensemble Size = 21
Units: K

CMA-CPSv3



Hindcast skill

ACC of V850(DJF)



- Southerly prevails over central and eastern part of China.
- Anti-cyclone anomaly above the Philippines.

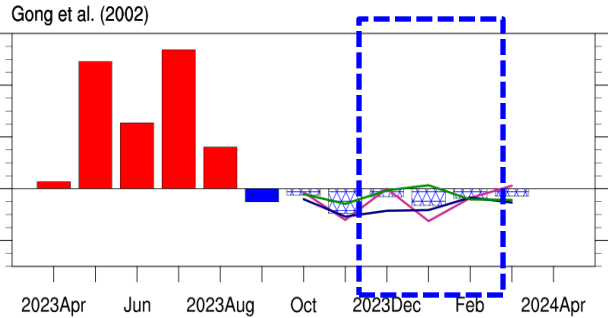
Circulation index predicted by CMME



Siberian High

Siberian High (SH) index: MODES forecast

Monitor (NCEP I): 202304-202309; Forecast: 202310-202404

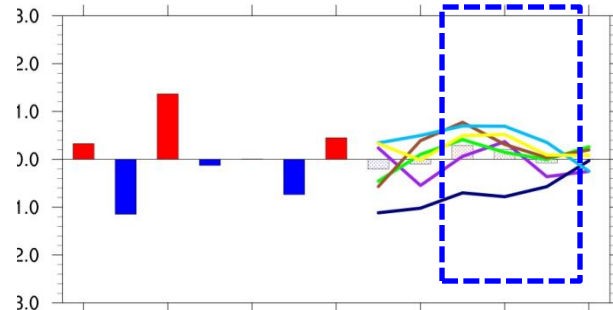


■ >0 ■ <0 Monitor ■ >0 ■ <0 Ensemble mean
— BCC_CSM1.1(m) — NCEP_CFSv2 — ECMWF_SYSTEM5

Arctic Oscillation

Arctic Oscillation (AO) index: CMME 20230920 Forecast

Monitor (CRA): 202304-202309; Forecast: 202310-202403

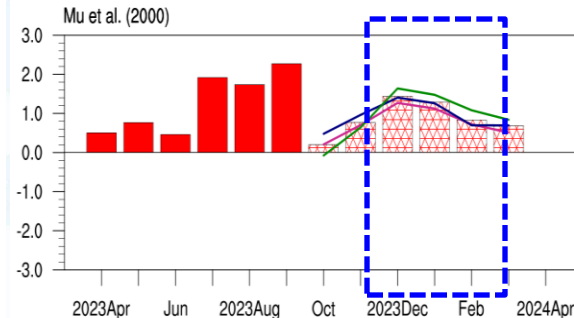


■ >0 ■ <0 Monitor ■ >0 ■ <0 Ensemble mean
— BCC_CSM1.1m — NZC-PCCSM4 — FGOALS-f2
— FGOALS-s2 — ECMWF-S5 — NCEP_CFS
■ >0 ■ <0 CMME Ensemble mean

East Asia Trough

East Asia Trough (EAT) index: MODES forecast

Monitor (NCEP I): 202304-202309; Forecast: 202310-202404

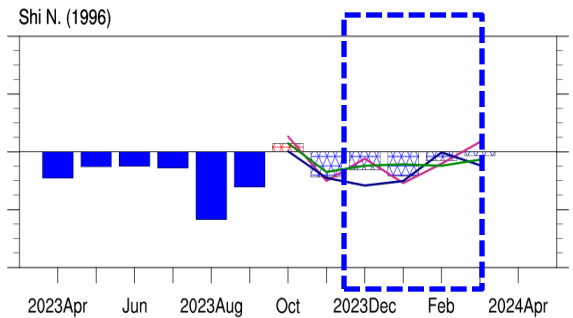


■ >0 ■ <0 Monitor ■ >0 ■ <0 Ensemble mean
— BCC_CSM1.1(m) — NCEP_CFSv2 — ECMWF_SYSTEM5

EAWM index

East Asian Winter Monsoon (EAWM) index: MODES forecast

Monitor (NCEP I): 202304-202309; Forecast: 202310-202404

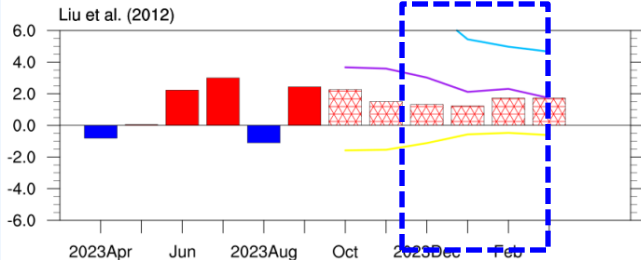


■ >0 ■ <0 Monitor ■ >0 ■ <0 Ensemble mean
— BCC_CSM1.1(m) — NCEP_CFSv2 — ECMWF_SYSTEM5

WNPSH-Intensity

WPSH Intensity: CMME 20230920 Forecast

Monitor (CRA40): 202304-202309; Forecast: 202310-202403

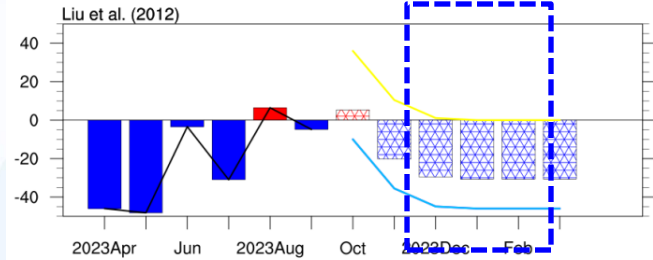


■ >0 ■ <0 Monitor ■ >0 ■ <0 Ensemble mean
— BCC_CSM1.1m — NZC-PCCSM4 — FGOALS-f2 — FGOALS-s2
— ECMWF — NCEP_CFSv2 — JMA — CAMS

WNPSH-West point

WPSH Ridge Point Anomaly(°E): CMME 20230920 Forecast

Monitor (CRA40): 202304-202309; Forecast: 202310-202403

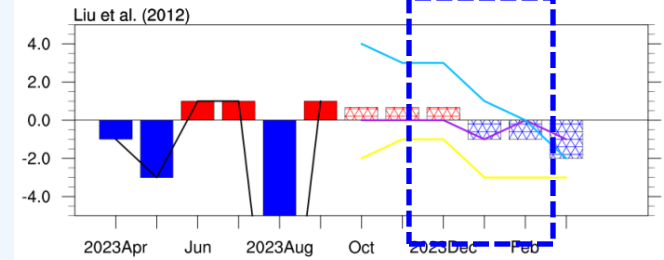


■ - East ■ - West Monitor ■ - East ■ - West Ensemble mean
— BCC_CSM1.1m — NZC-PCCSM4 — FGOALS-f2 — FGOALS-s2
— ECMWF — NCEP_CFSv2 — JMA — CAMS

WNPSH-Ridge line

WPSH Ridge Line Anomaly(°N): CMME 20230920 Forecast

Monitor (CRA40): 202304-202309; Forecast: 202310-202403



■ - North ■ - South Monitor ■ - North ■ - South Ensemble mean
— BCC_CSM1.1m — NZC-PCCSM4 — FGOALS-f2 — FGOALS-s2
— ECMWF — NCEP_CFSv2 — JMA — CAMS



From CMA-CPS output

- Moderate El Niño event
- Weak EAWM/Siberian High
- Zonal circulation over East Asia
- Positive Arctic Oscillation
- Weak East Asia Trough
- Positive Tibetan Plateau height anomaly
- Strong West Pacific Subtropical High
- Strong India-Burma trough
- Southerly wind anomaly over East Asia
- Anticyclone anomaly around the Philippines

Outline

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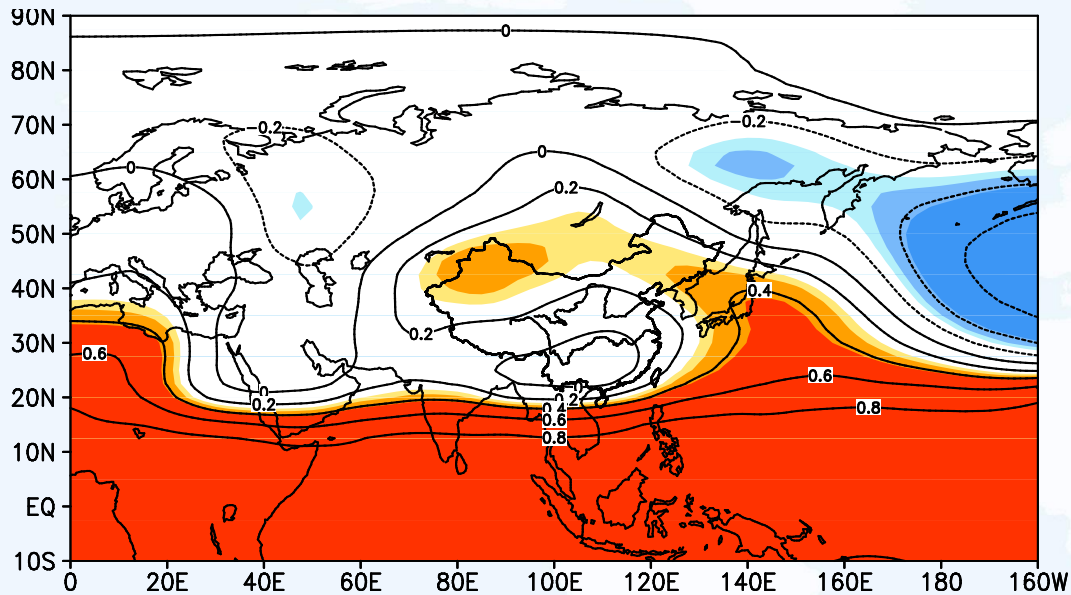
2.2 **Statistic Analysis**

3. Outlook for temperature and precipitation over China

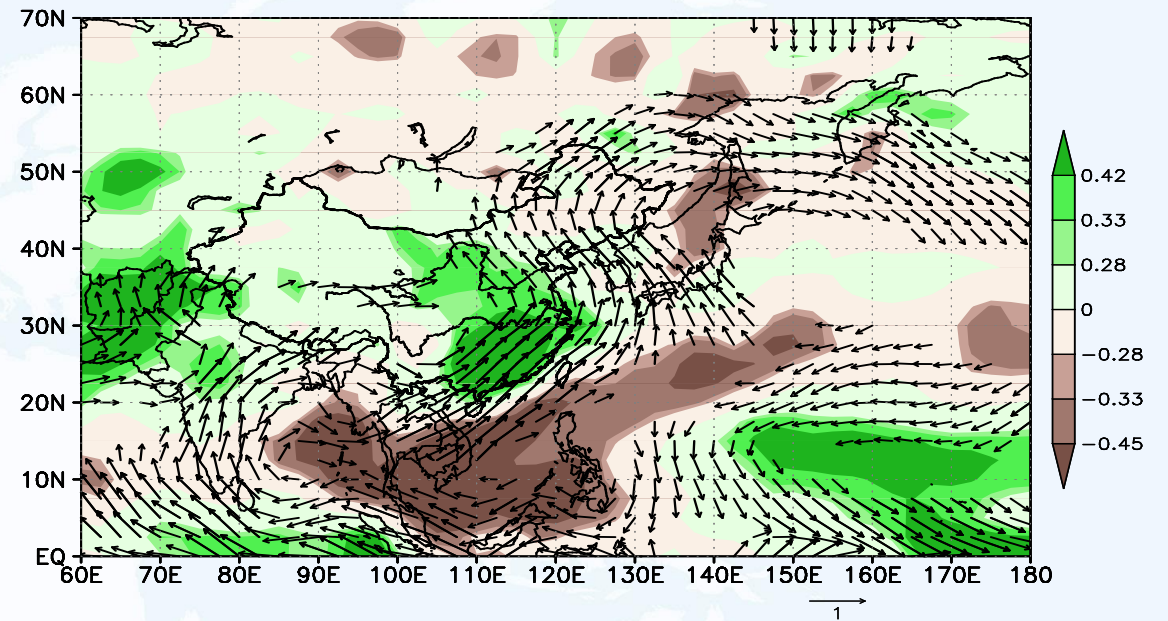
Impact of El Niño mature phase



H500



UV850



Weak East Asian trough. Weak Ural blocking high. Low-level anomalous southerlies over East Asia. WPSH extending more westward and southward. Anomalous anticyclone around the Philippines.

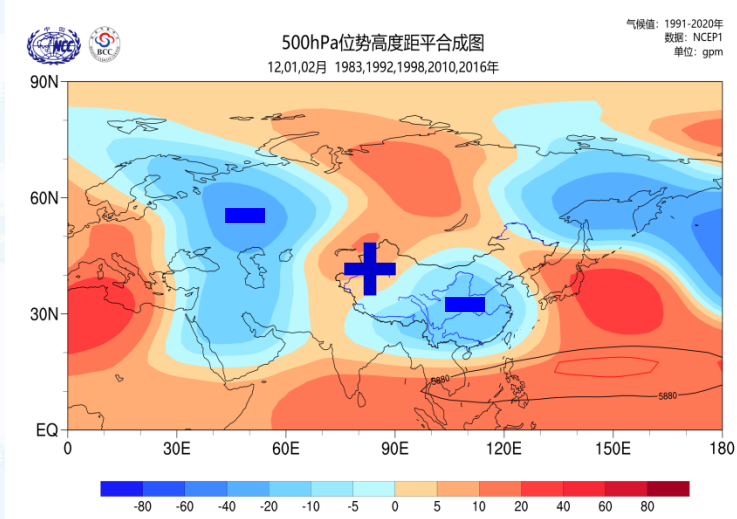
Impact of El Niño with different intensity



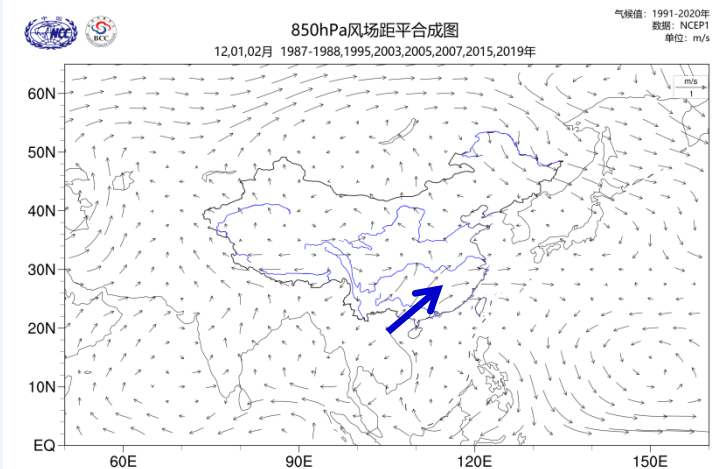
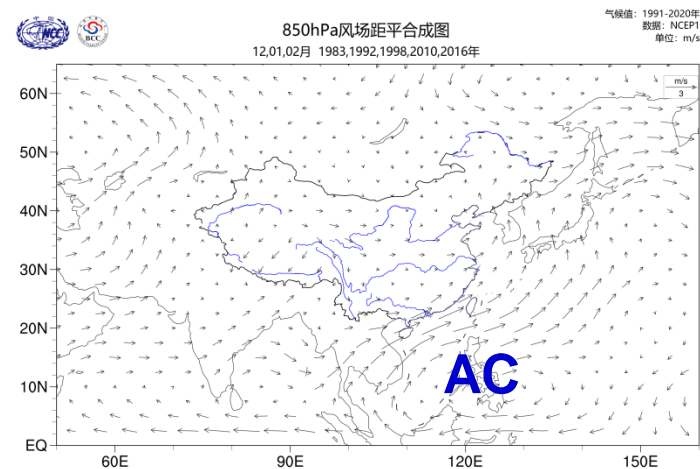
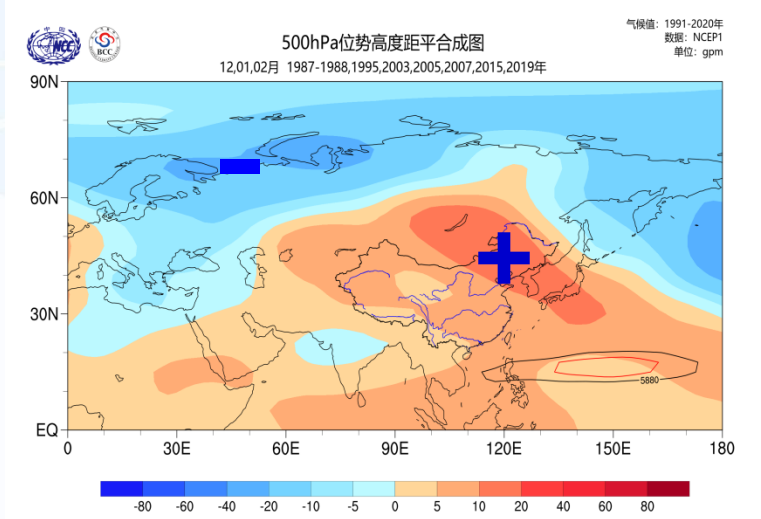
Geopotential height anomaly at 850hPa in DJF

Horizontal wind anomaly at 850hPa in DJF

Moderate/Strong El Niño



Weak El Niño

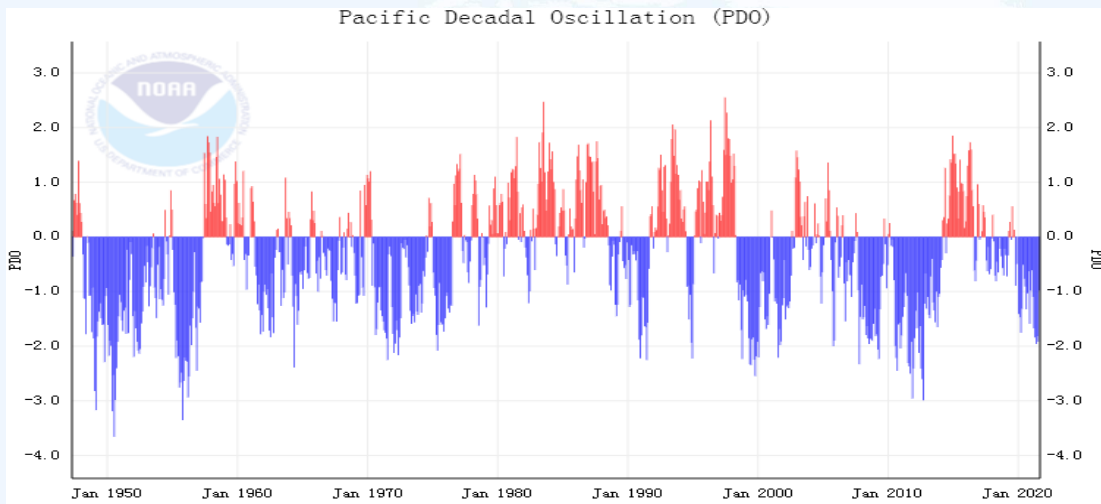


➤ Weak Ural blocking high, anti-cyclonic circulation prevails over WNP

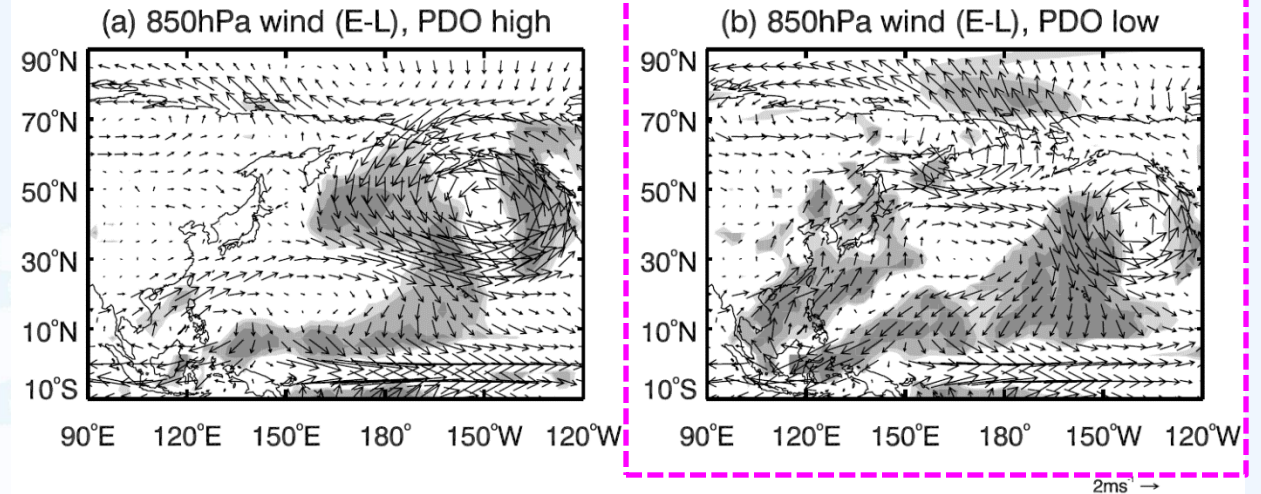
Modulation of cold PDO phase



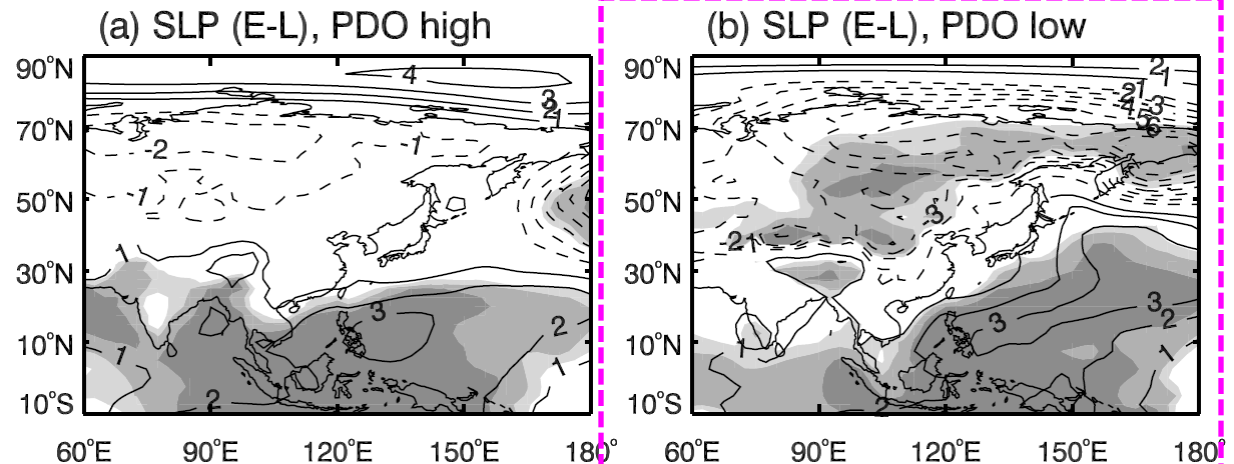
Pacific Decadal Oscillation (PDO)



UV850 El Niño minus La Niña



UV850 El Niño minus La Niña

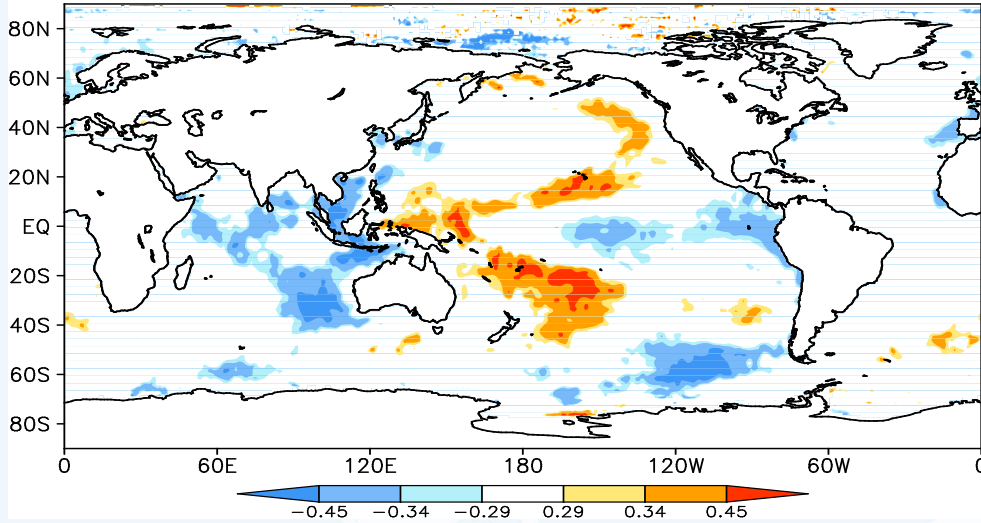


➤ The influence of ENSO on East Asian winter monsoon (EAWM) would be more significant under the background of cold PDO phase, especially for WNP anticyclone and Siberian high.

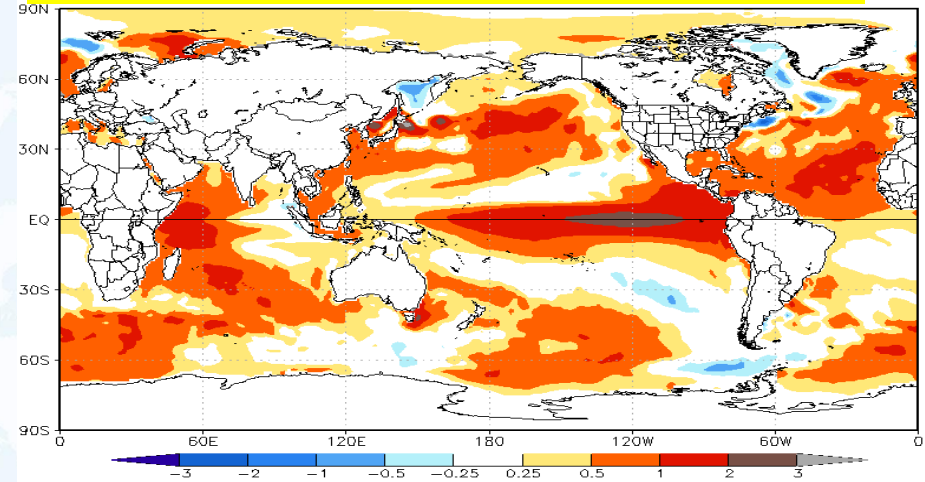
Impact of Indian Ocean – India Burma trough



Correlation between IBT and SSTA



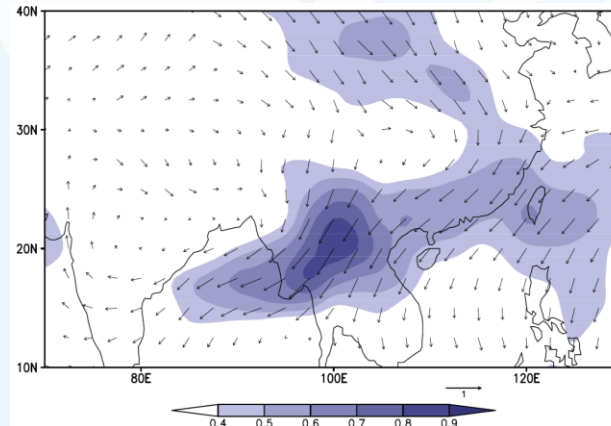
Prediction of SSTA in DJF 2023/2024



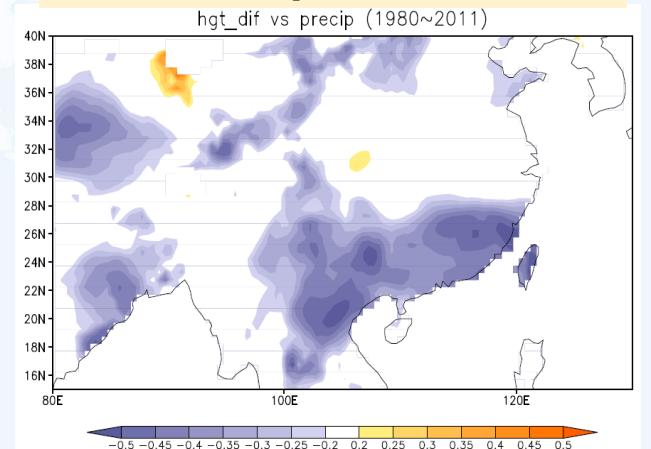
Correlation between IBT and SST modes

TCC	IBT-Nino3.4	IBT-IOBW	IBT-IOD
1951-2013	-0.24 (>95%)	-0.47 (>99.9%)	-0.46 (>99.9%)
1980-2013	-0.32 (>90%)	-0.35 (>95%)	-0.54 (>99.9%)

Corr. water vapor vs. IBT



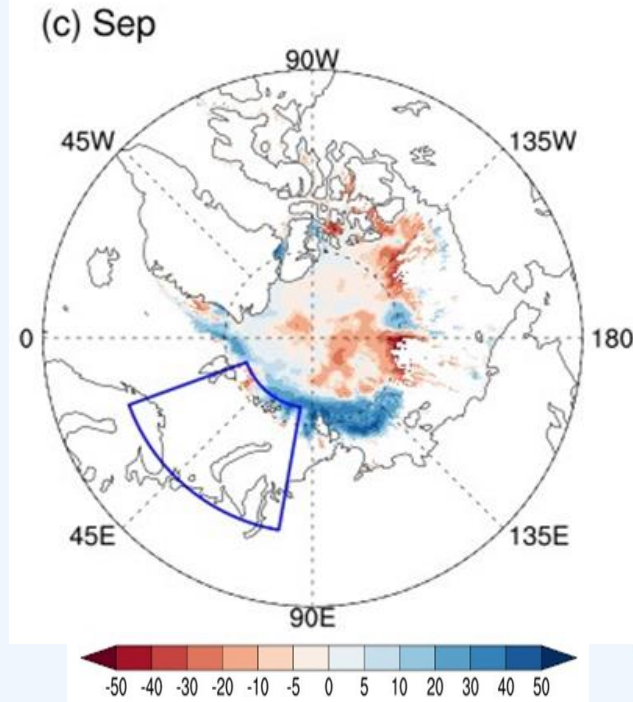
Corr. Precip vs. IBT (DJF)



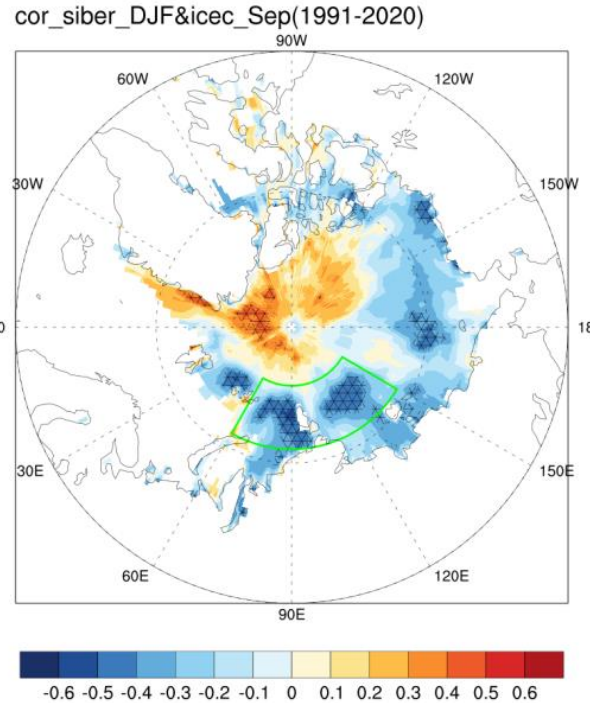
➤ Warmer tropical Indian Ocean and El Niño favor strong IBT in boreal winter;

Possible impact of SIC in Arctic

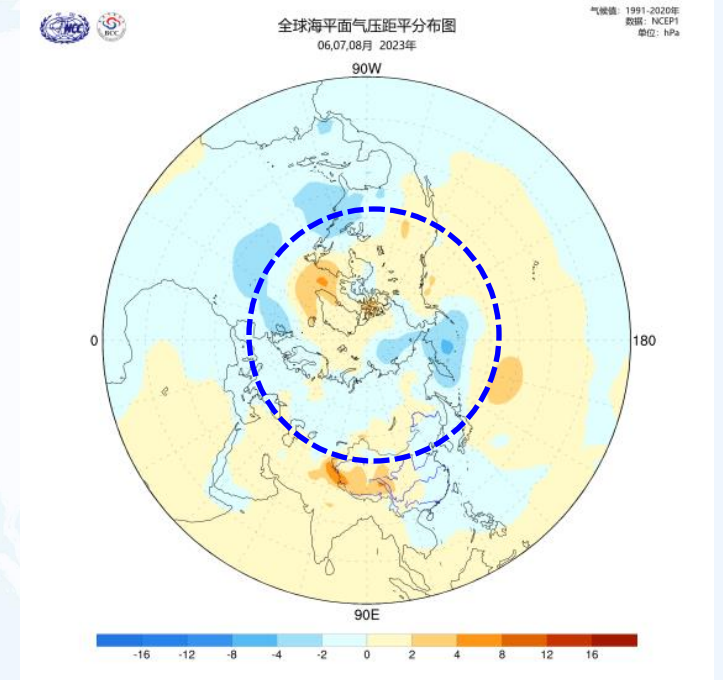
SIC anomaly in Sep 2023



Corr. Siberian High (DJF) vs. SIC(Sep)

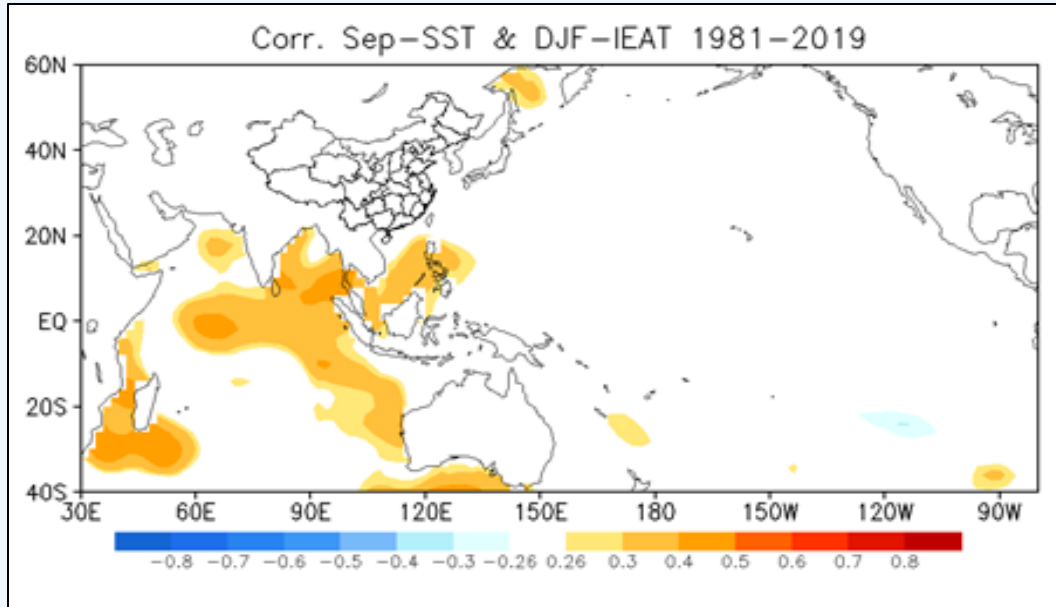


SLP in JJA of 2023



- ❑ Studies have shown that **Arctic sea ice concentration** provides a potential signals for winter Siberian High(Wu et al., 2011, 2012, 2016, 2021). There is a significant **negative correlation** between sea ice anomalies over Barents-Kara Sea in Sep and the SH in winter.
- ❑ **SIC in Sep 2023 is favorable to a weak Siberian high in the upcoming winter.**

Impact of Indian Ocean-- EAT

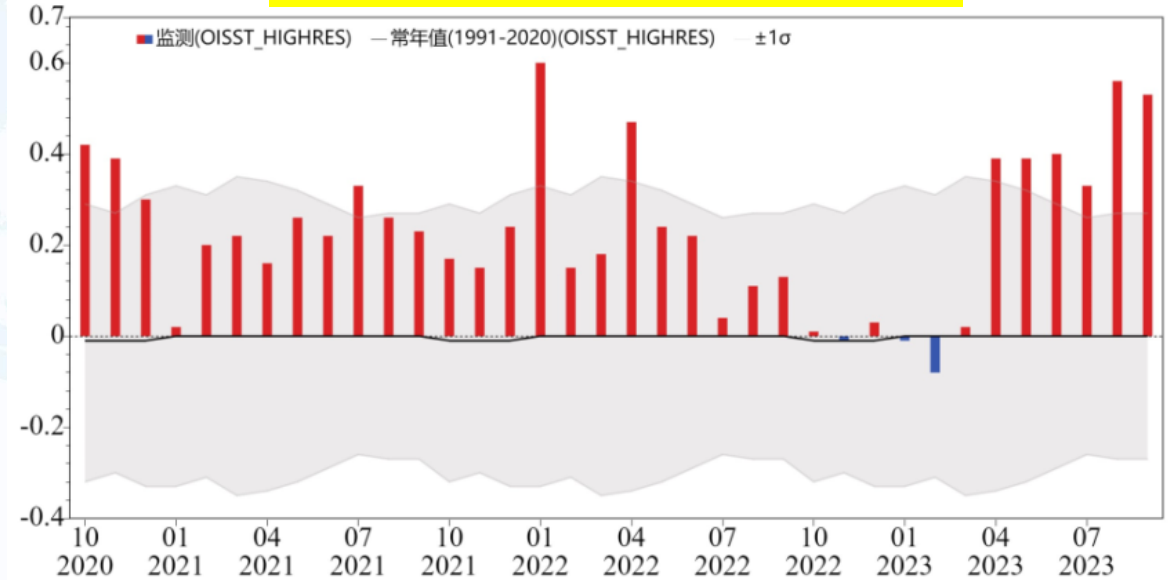


Correlation coefficients between the EAT index and SST in the preceding Sep.

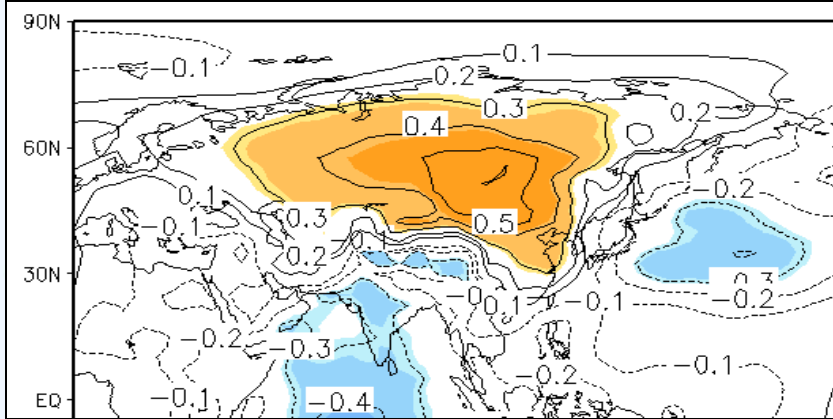
- Positive SSTA over tropical Indian Ocean during the preceding September indicates weak EAT in the coming winter.
- IOBW index in Sep 2023 is above normal, and that favorable to a **weak EAT** in the coming winter.



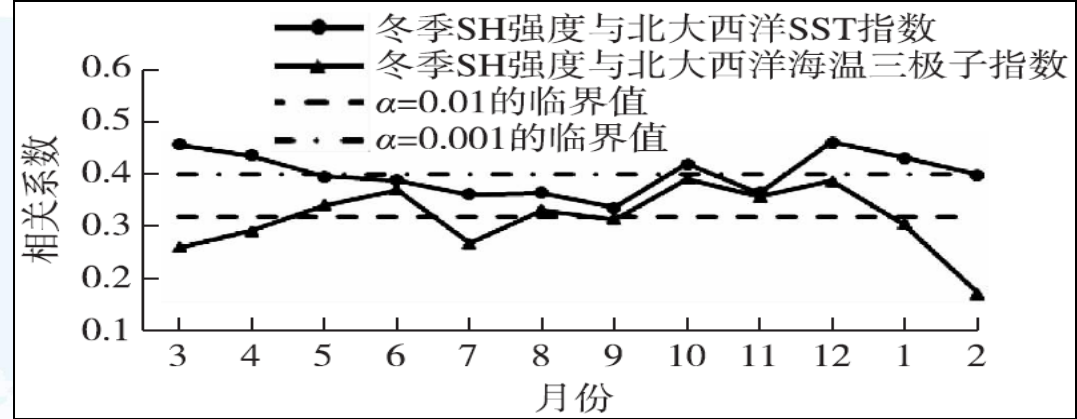
IOBW : warm phase



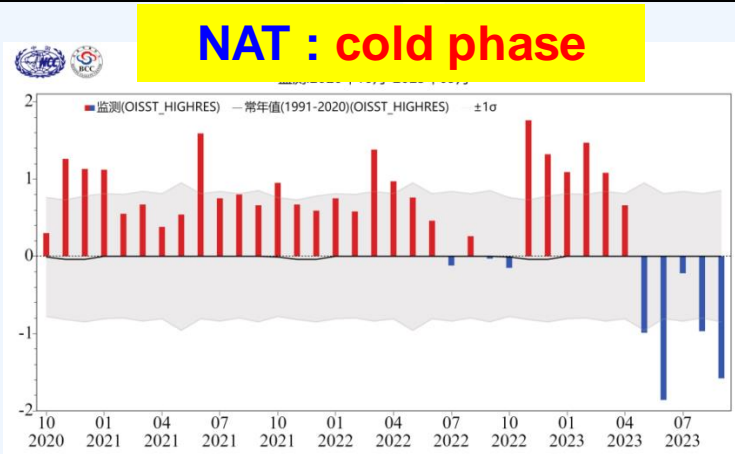
Impact of North Atlantic-- SH



Regression map of SLP in the corresponding winter against the winter NAT index.



Monthly correlations of the NAT index from March in the current year to February in the next year with the winter SH index



➤ **Anomalous low NAT index in December is favorable for weak Siberian High (SH)**

(Li Dongliang and Lan Liuru, 2017)

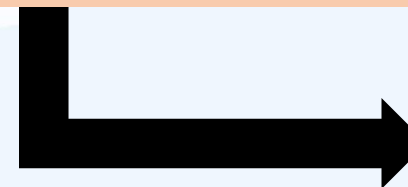
Summary of Outlook for Winter Circulation in 2023/2024

- EAWM: **weak**
- Siberian High: **weak**
- East Asian Trough: **weak**
- AO: **positive**



Warmer than normal (clim: 1991-2020) over most of China

- Western Pacific Subtropical High: **strong**
- India-Burma Trough: **strong**
- UV850: **anticyclone** anomaly around the Philippines.



Above normal (clim: 1991-2020) precipitation over southern China

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Temperature – CMA-CPS

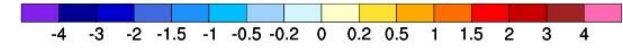
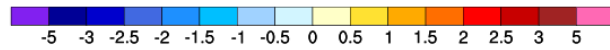
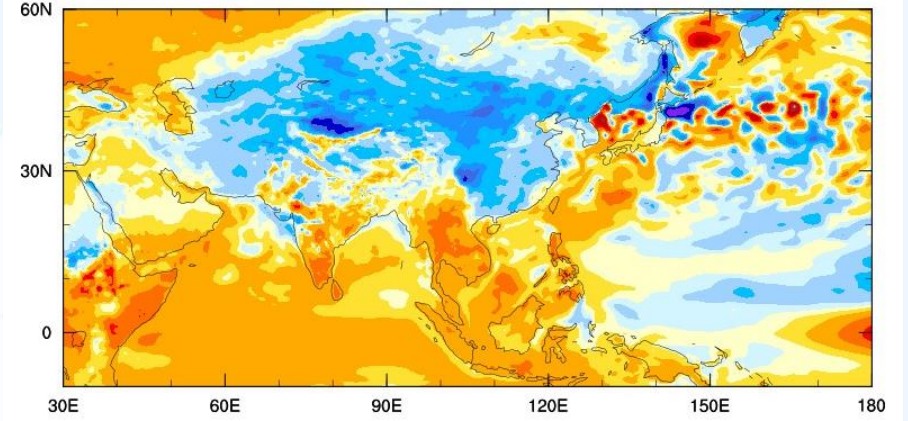
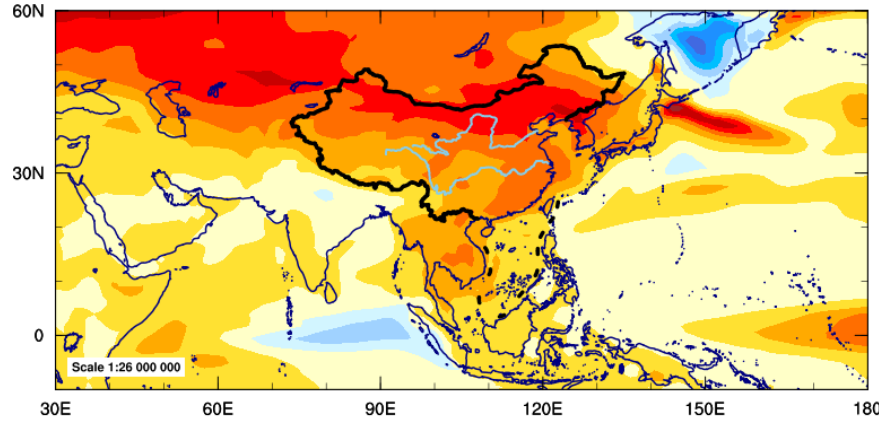


BCC_CSM1.1(m)

CMA-CPSv3

BCC Three-Month Forecast
2-m Air Temperature Anomaly
BCC_CSM1.1(m)
Started 20231001 Valid 202312 - 202402
Units: degC
Member Size = 24

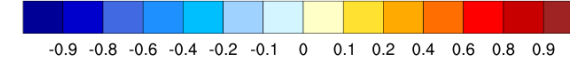
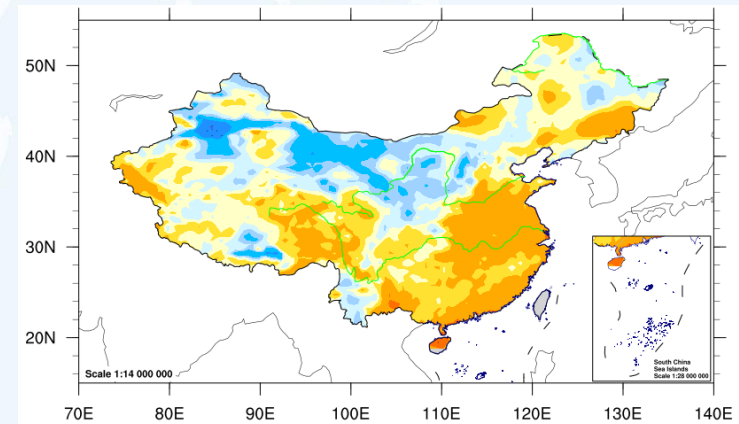
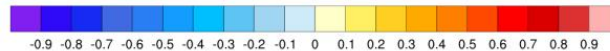
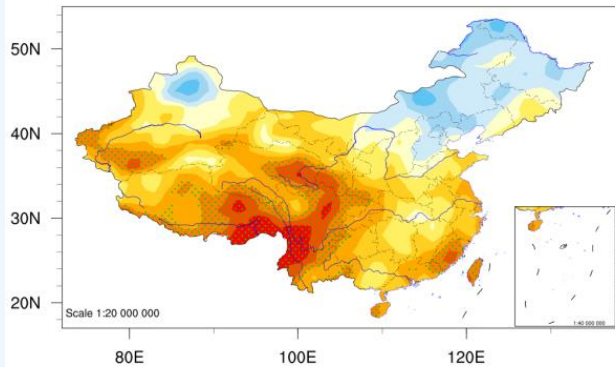
2-m Air Temperature Anomaly
CMA-CPSv3 seasonal forecast
Initial date: 20231001
Dates: 202312 - 202402
Ensemble Size = 21
Units: degC



Prediction

Hindcast skill

TCC of season T2m: 1991-2020
Monitor: CRA-40 Forecast: BCCSM1.1m
FCS ini OCT Target for DJF (Lead 2 month)



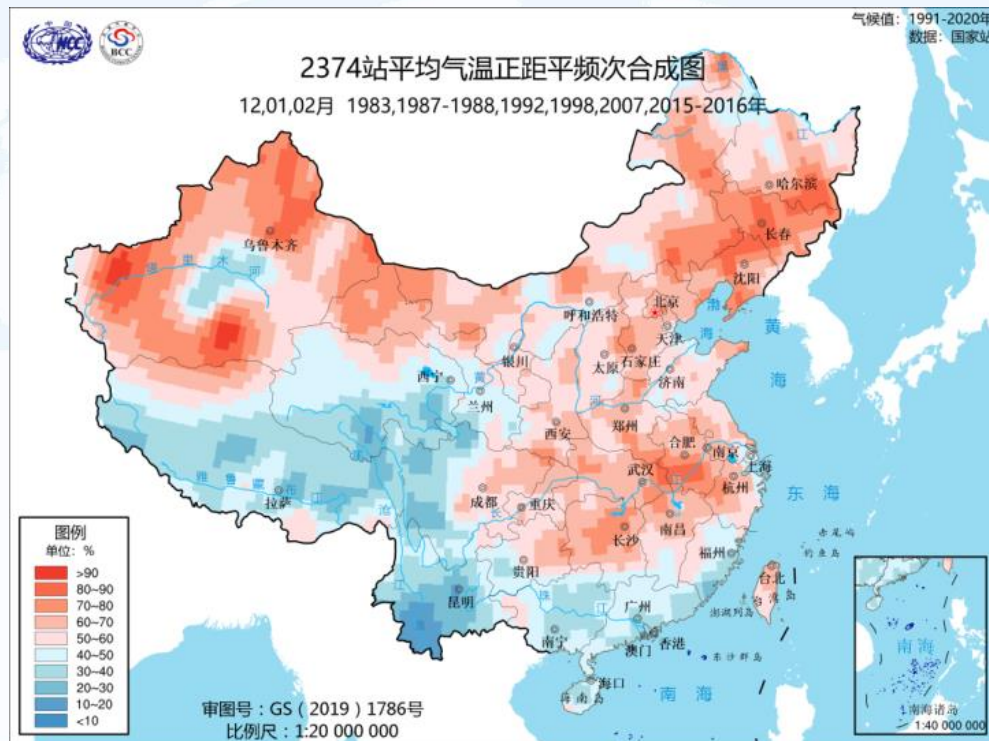
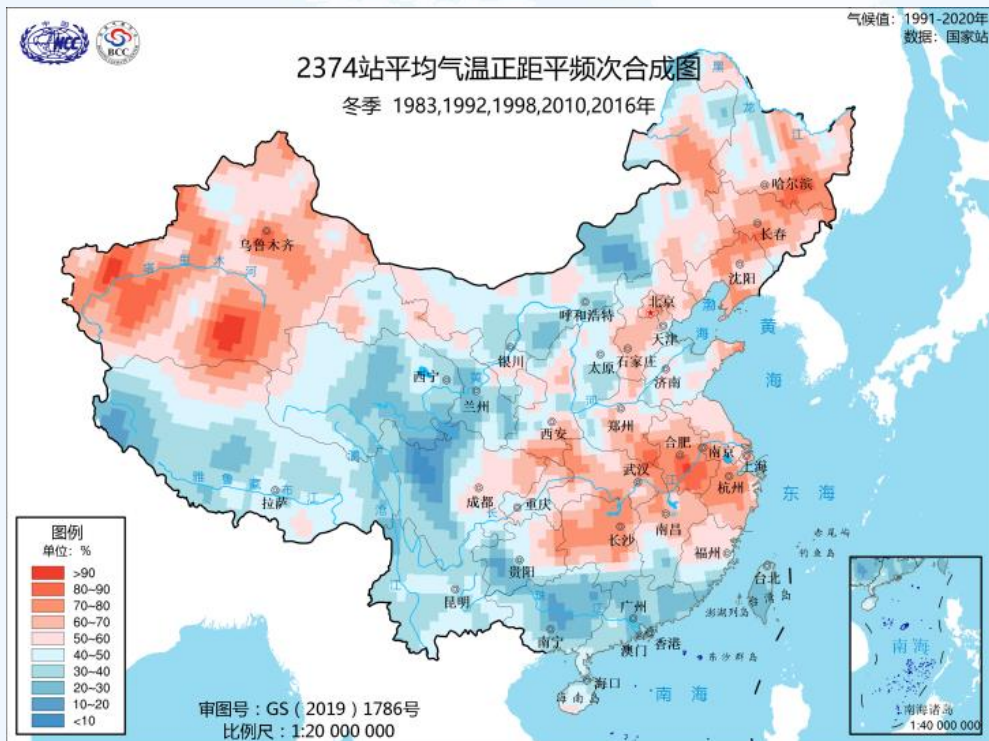


Impact of El Niño



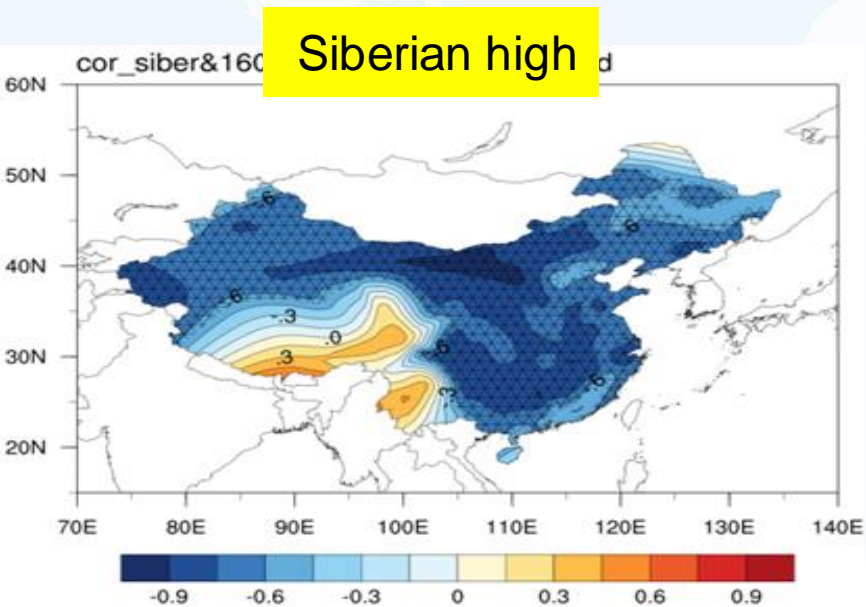
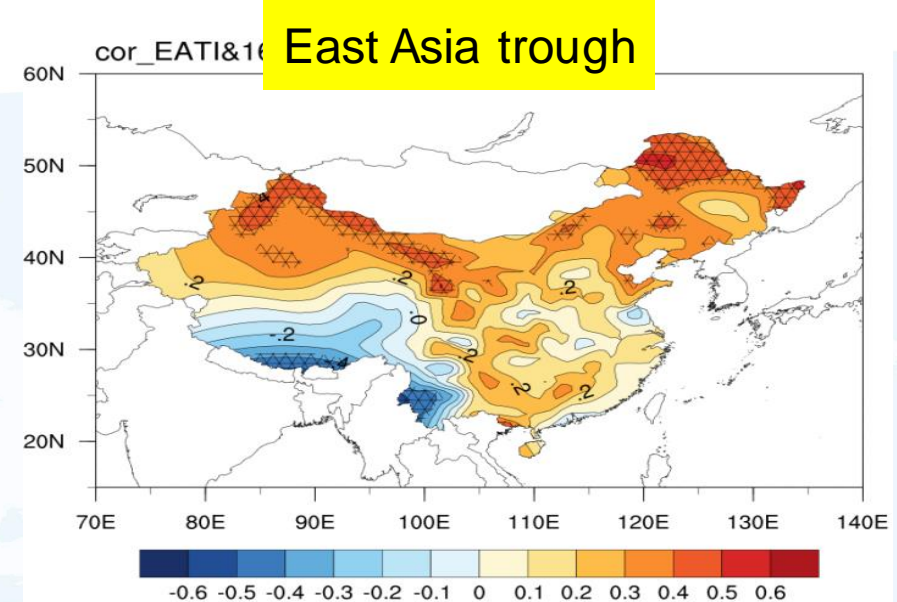
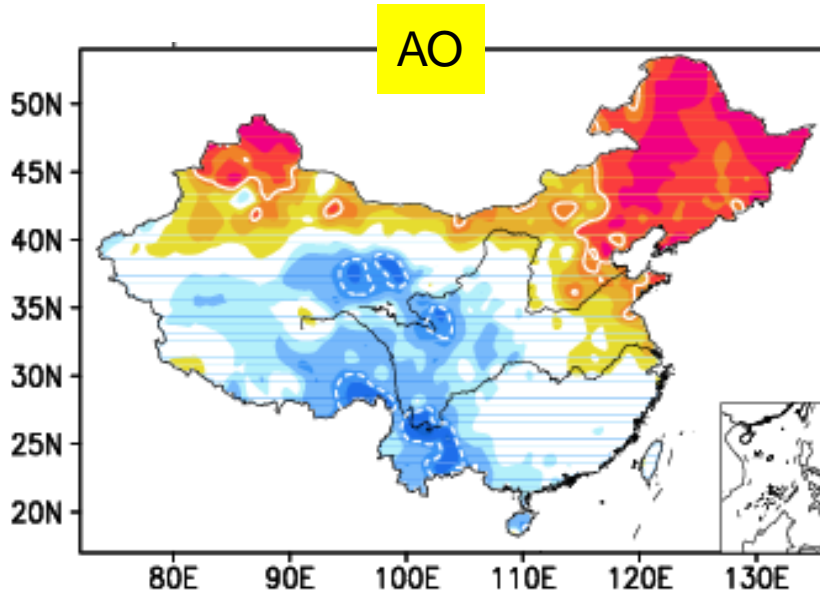
Moderate or strong El Niño

Eastern Pacific El Niño



Composite of temperature in DJF

Correlation between circulation indices and temperature

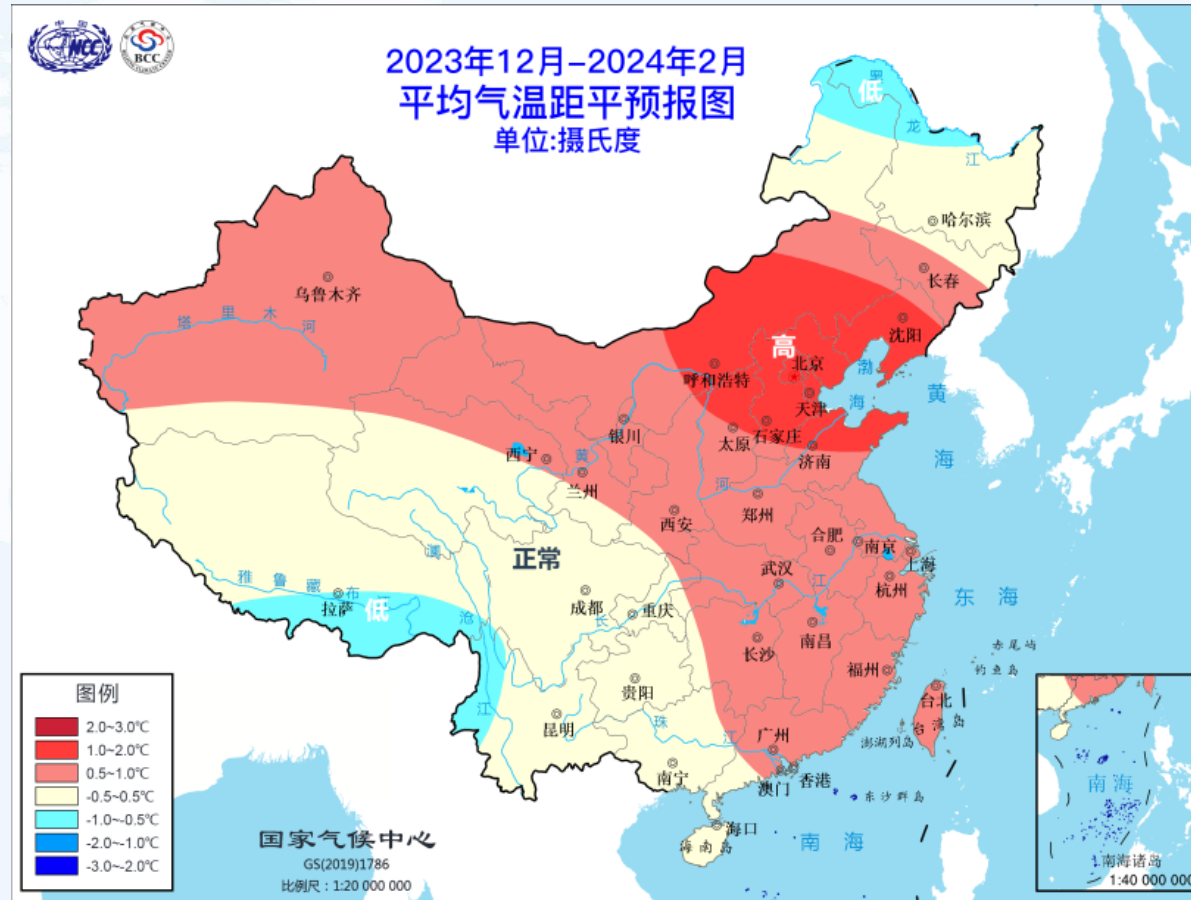


Positive AO (positive index) ->
Above-normal temperature over northern China

Weak EAT (positive index) ->
Above-normal temperature over eastern China

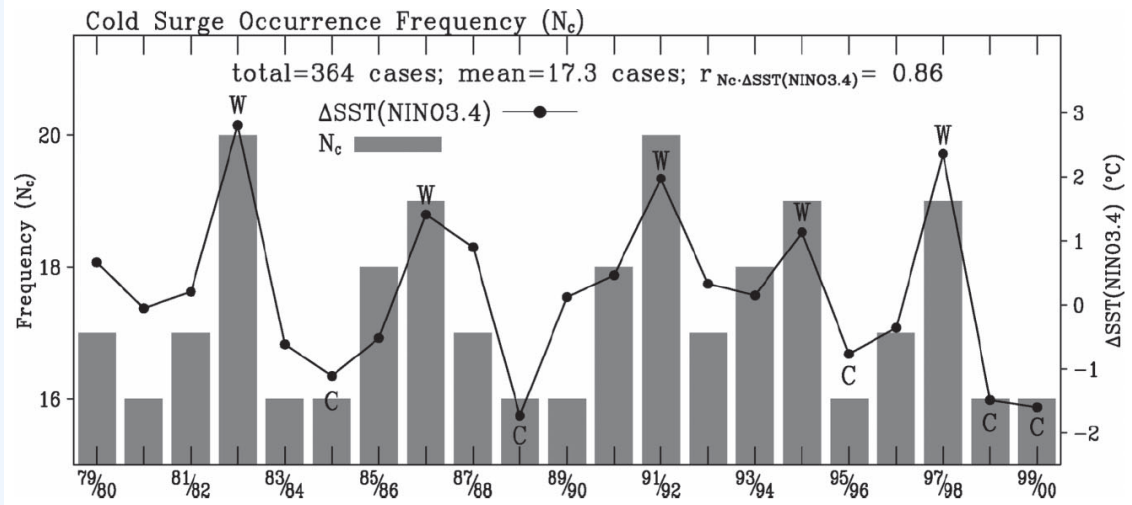
Weak SH (negative index) ->
Above-normal temperature over most of China

Temperature forecast



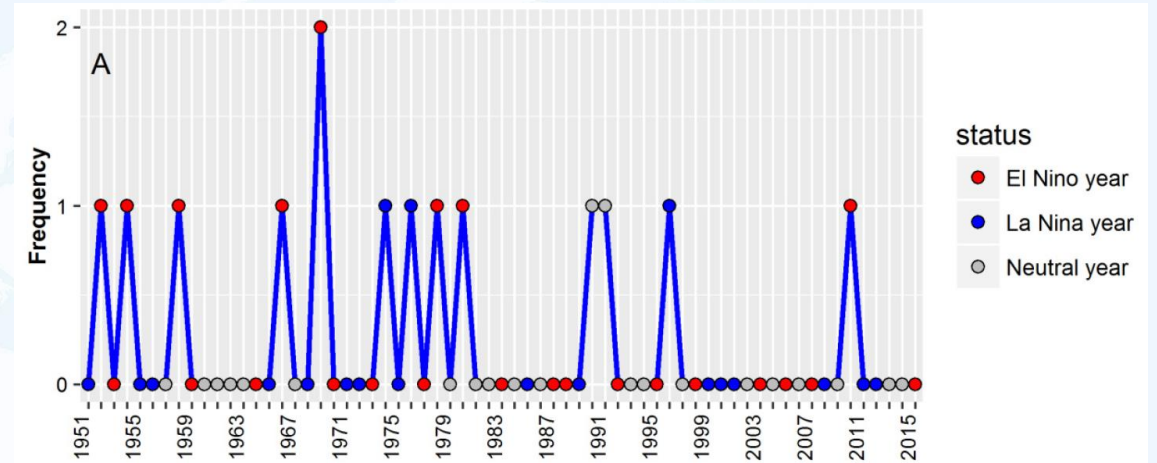
Climatology:1991-2020

Impact of El Niño on cold air frequency



Higher cold surface occurrence frequency under the background of El Niño

——Chen et al., 2004



In South China, the ratio of cold air frequency in winter for El Niño/La Niña and neutral phase is 8:3:2

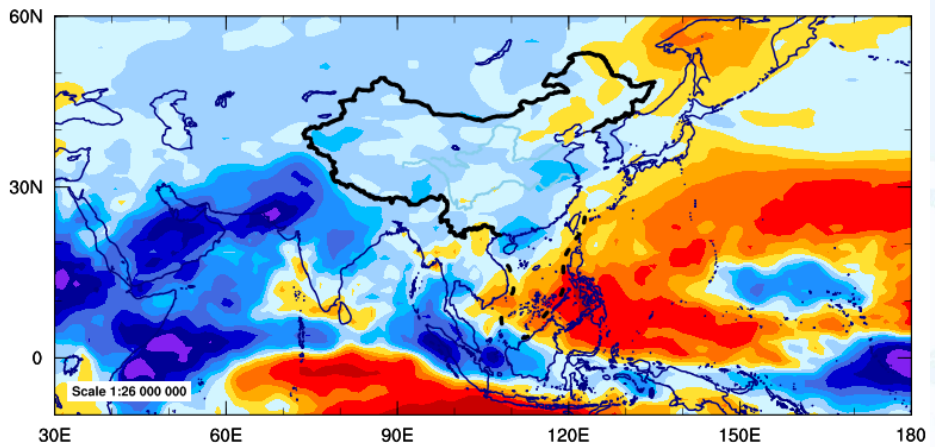
——Zhang et al., 2017

Precipitation – CMA-CPS



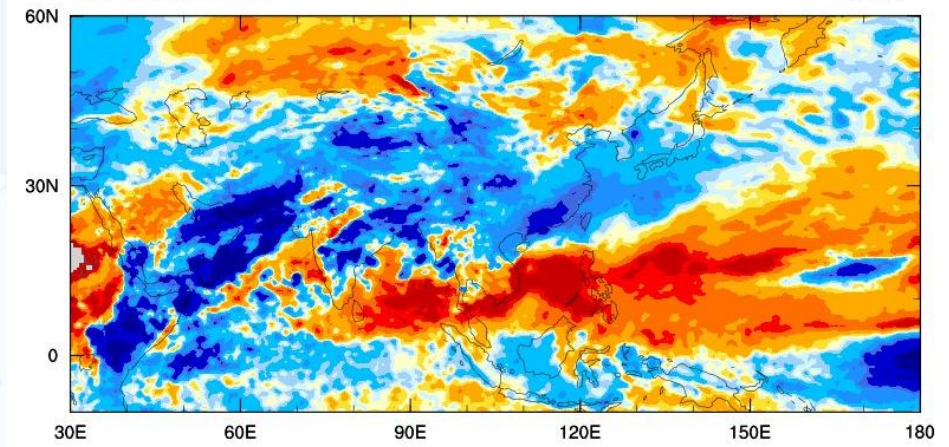
BCC_CSM1.1(m)

BCC Three-Month Forecast
 Departure Percentage of Precipitation Rate
 BCC_CSM1.1(m)
 Valid 202312 - 202402
 Units: %
 Member Size = 24

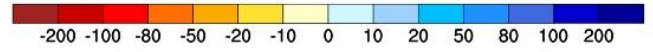
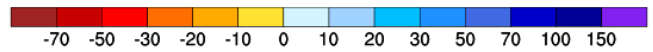


CMA-CPSv3

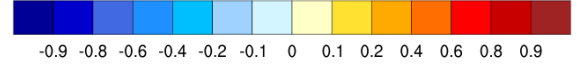
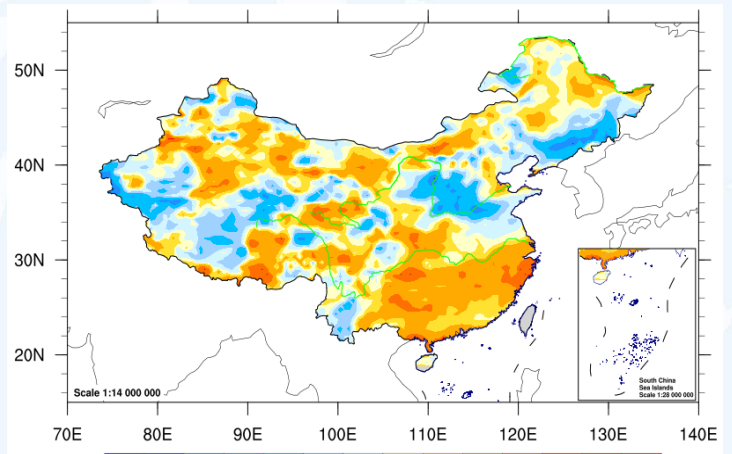
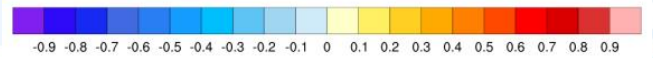
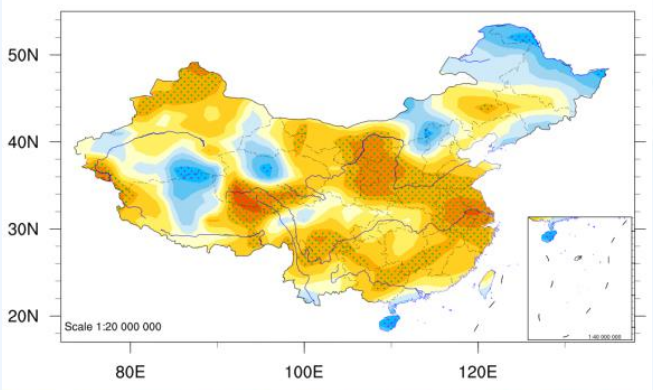
Departure Percentage of Precipitation
 CMA-CPSv3 seasonal forecast
 Initial date: 20231001
 Dates: 202312 - 202402
 Ensemble Size = 21
 Units: %



Prediction



TCC of season PREC: 1991-2020
 Monitor: CMAP Forecast: BCCSM1.1m
 FCS ini OCT Target for DJF (Lead 2 month)



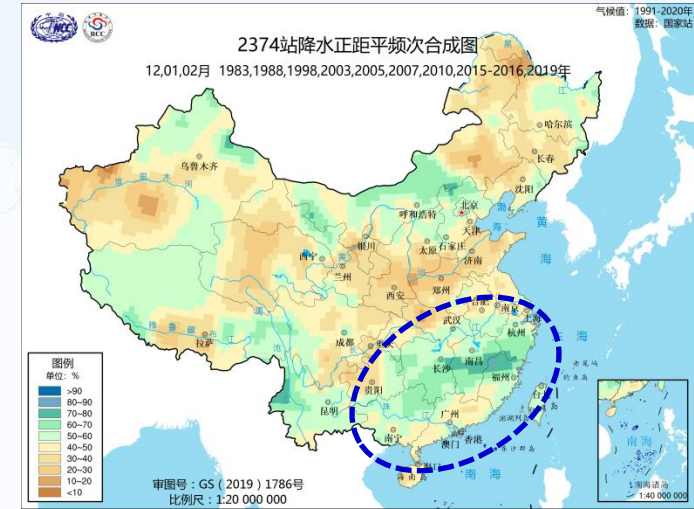
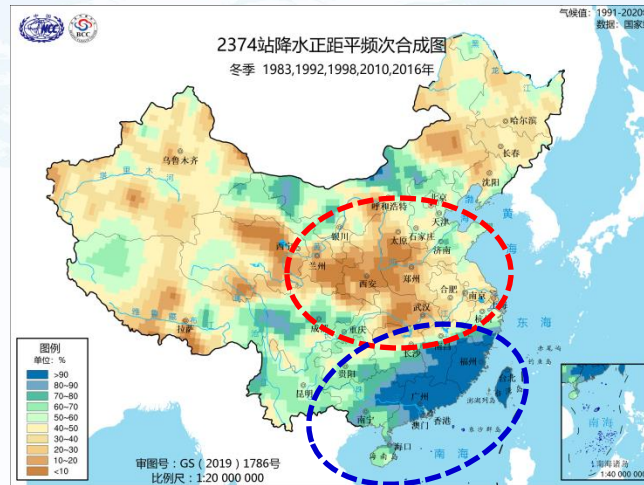
Hindcast skill

Impact of El Niño and Indian Ocean

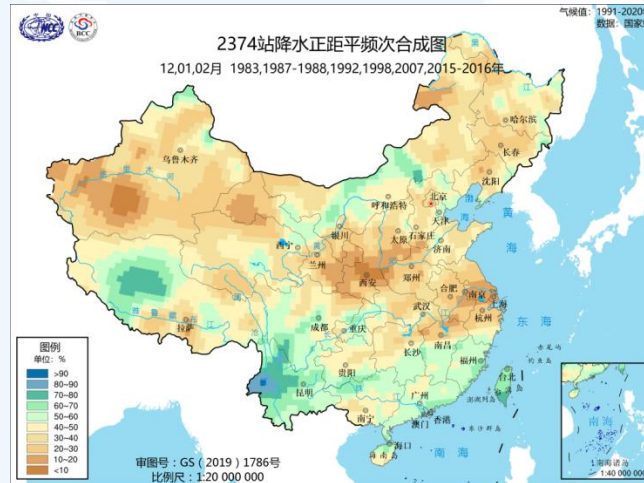
Composite of precipitation in DJF

El Niño + IOBW positive phase

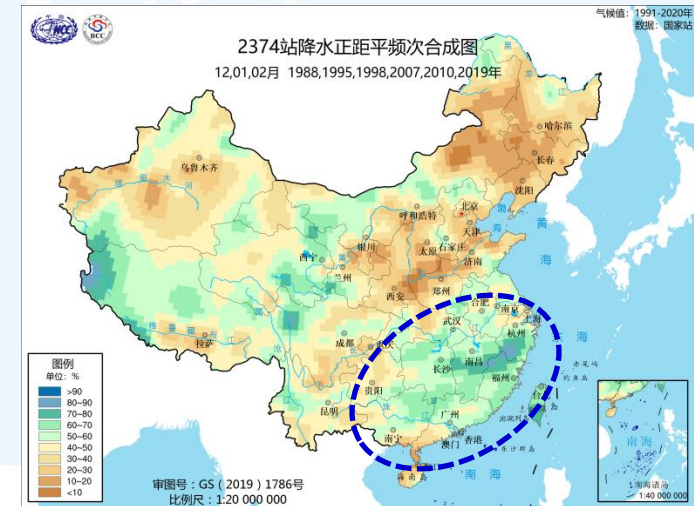
Moderate or strong El Niño



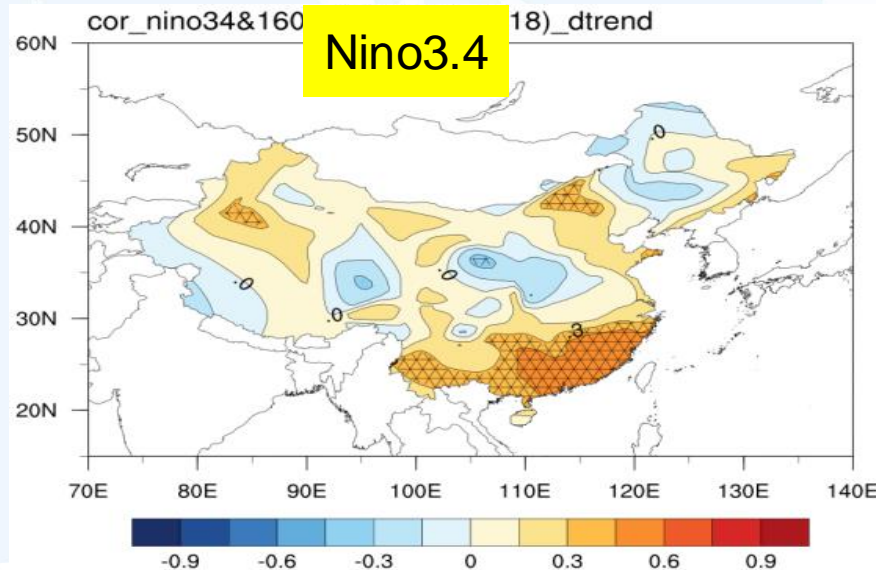
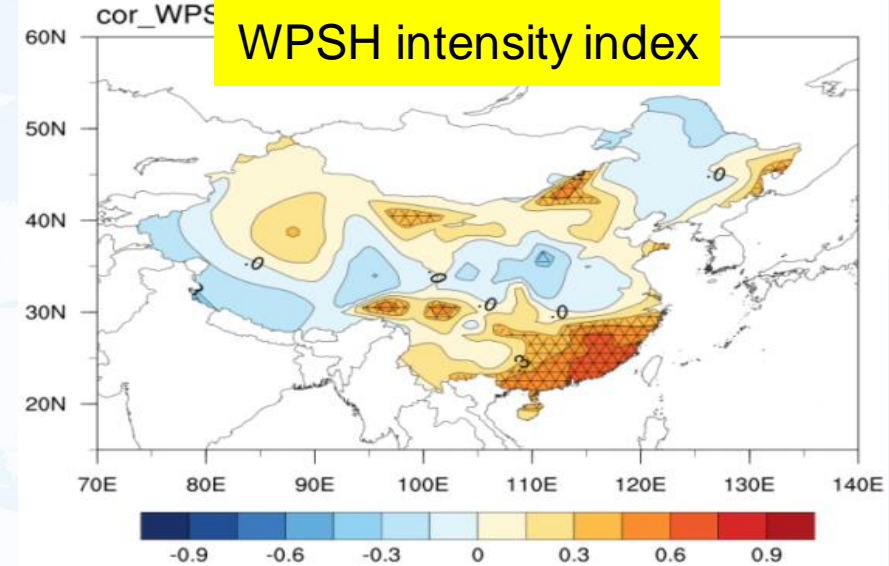
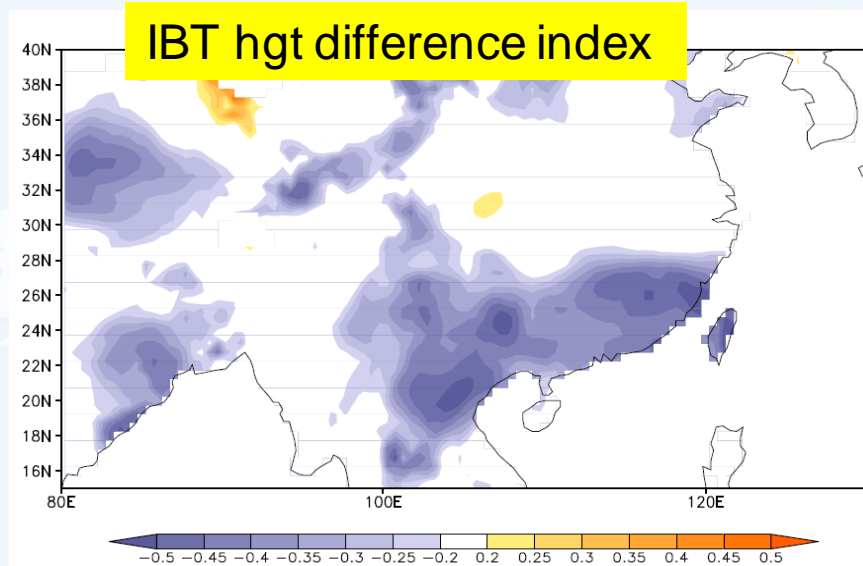
Eastern Pacific El Niño



TIOD positive phase



Correlation between circulation/SST indices and precipitation

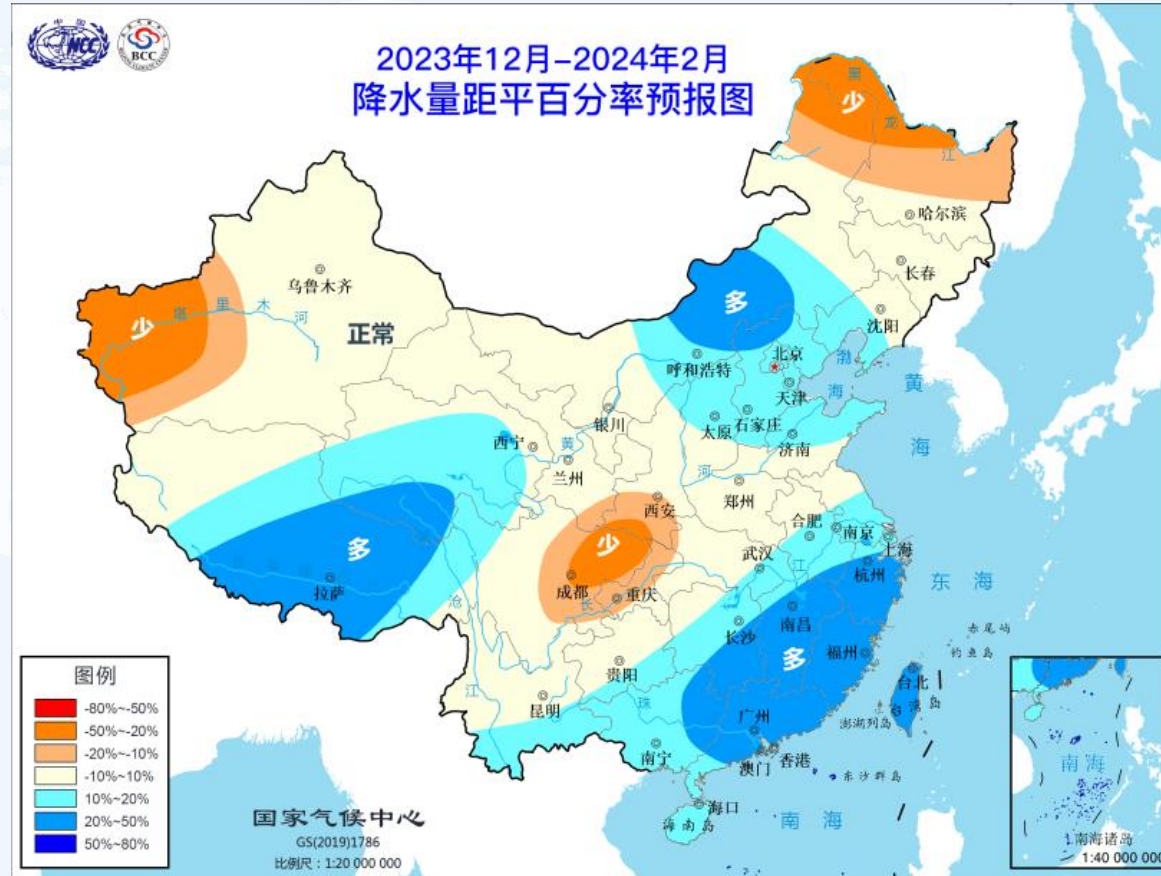


Strong IBT (negative index) ->
Above-normal precipitation over Southern China

Strong WPSH (negative index) ->
Above-normal precipitation over Southern China

Positive Nino3.4 index ->
Above-normal precipitation over Southern China

Precipitation forecast



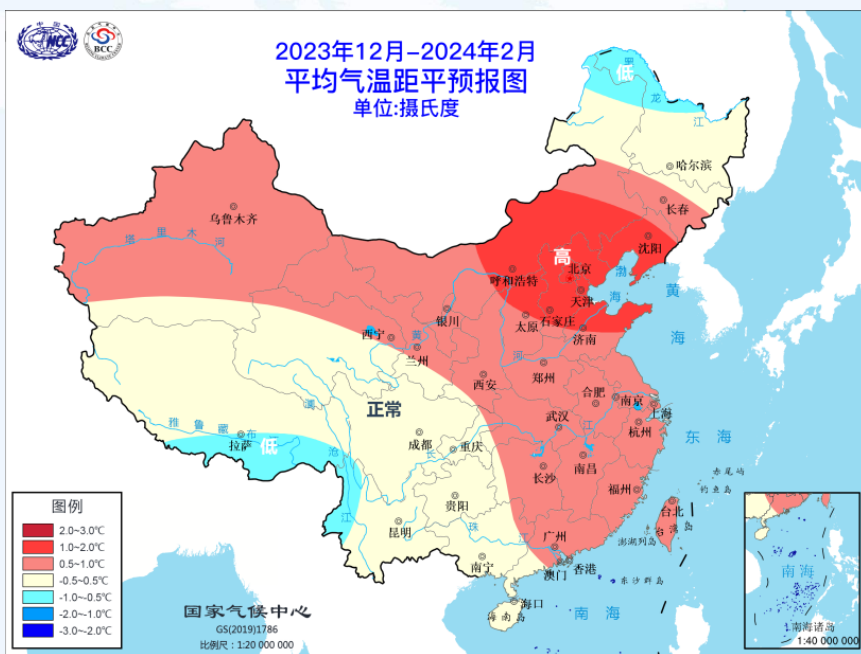
Climatology:1991-2020

Outlook for 2023/2024 winter

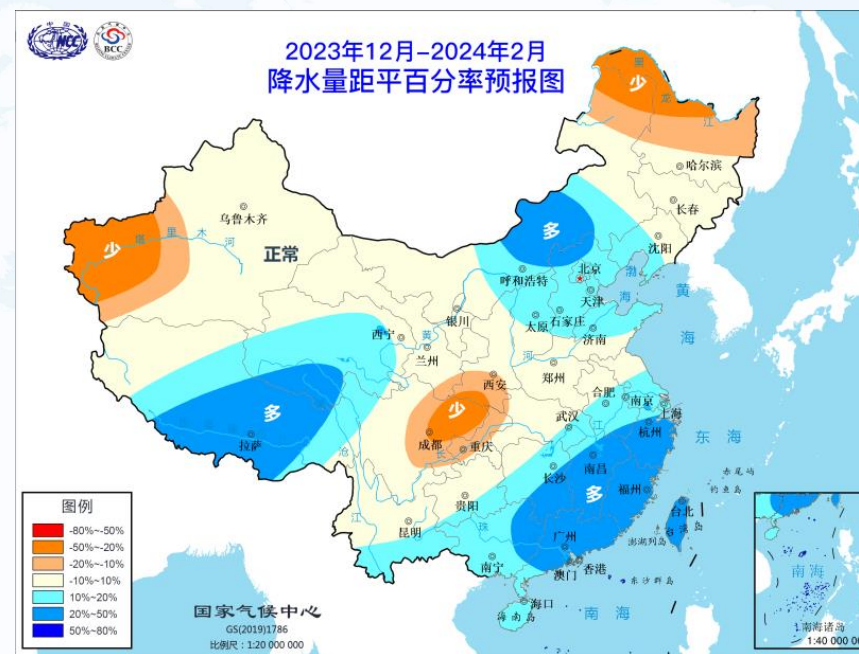


Weak East Asia winter monsoon

Temperature



Precipitation



- The **temperature** of most central and eastern parts of China will be warmer than normal.
- The **precipitation** will be above normal over southern China, but near or below normal over northern Northeast and Southwest China.



THANK YOU!





Figure 1 Deterministic forecast of **Precipitation**



Figure 2 Deterministic forecast of **Temperature**