Current and anticipated conditions in the Pacific, Indian Ocean, the Atlantic Ocean and their impact on climate over Arab region

The 7th Arab Climate Outlook Forum (ArabCOF) Meeting &
The 4th Gulf Cooperation Council Climate Outlook Forum (GCC-COF) Meeting
Virtual, 1 & 3 June 2021

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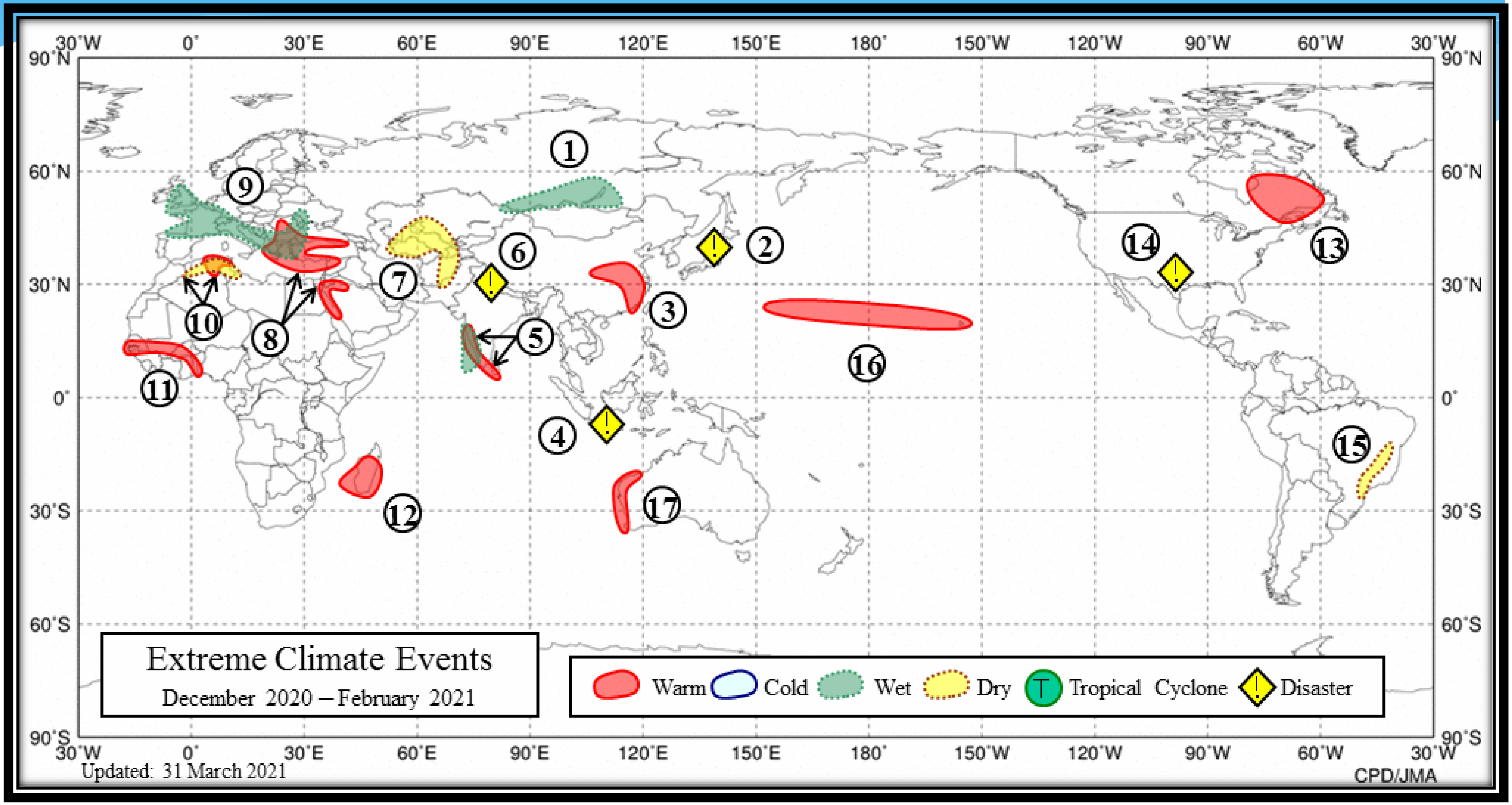
Meteorological Expert
Gulf Cooperation Council
Secretariat General

Outline

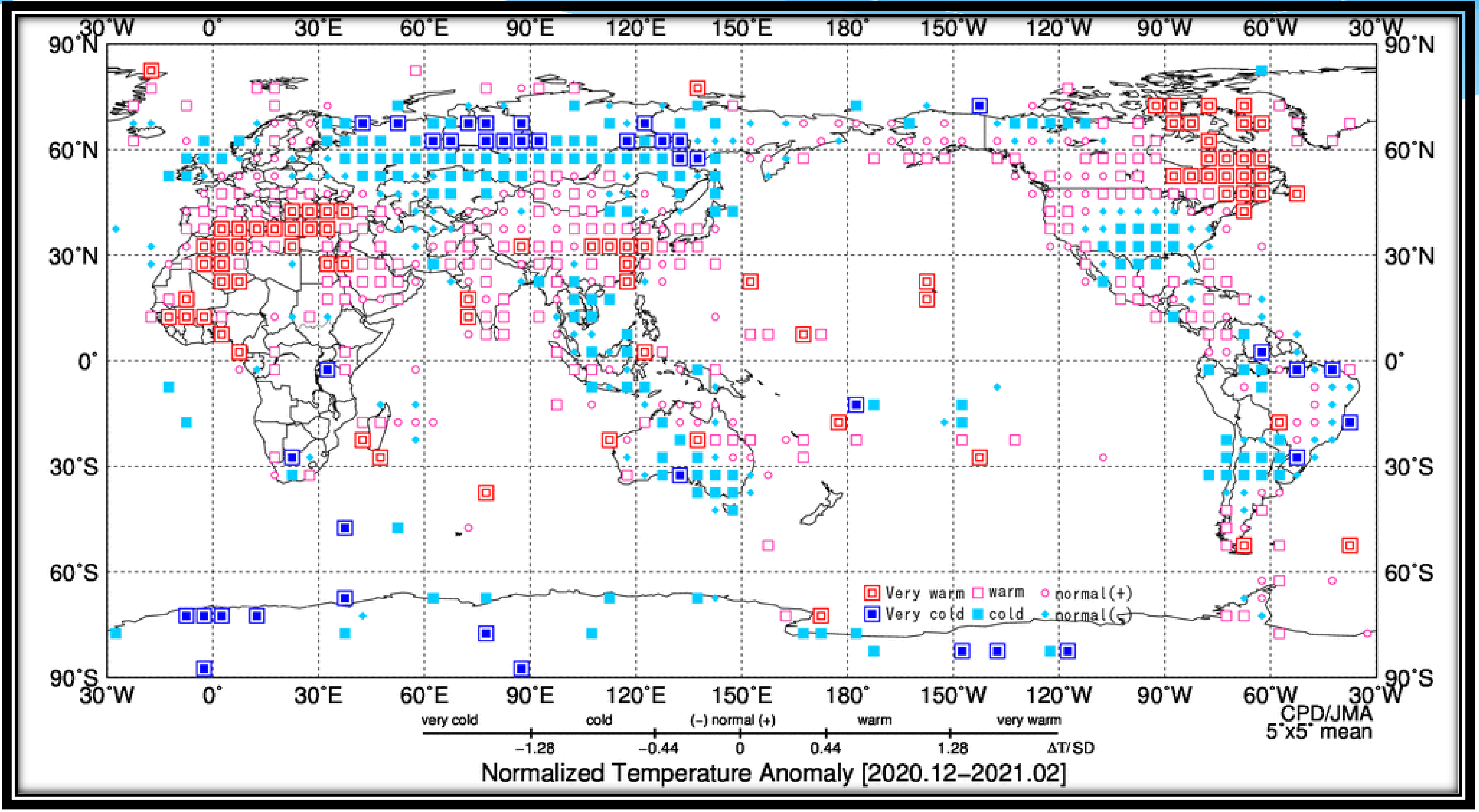
- Possible summer season drivers over the Arabian Peninsula.
- Drivers conditions.
- RAII RCCs and some WMO MME LR forecasts.

Outline

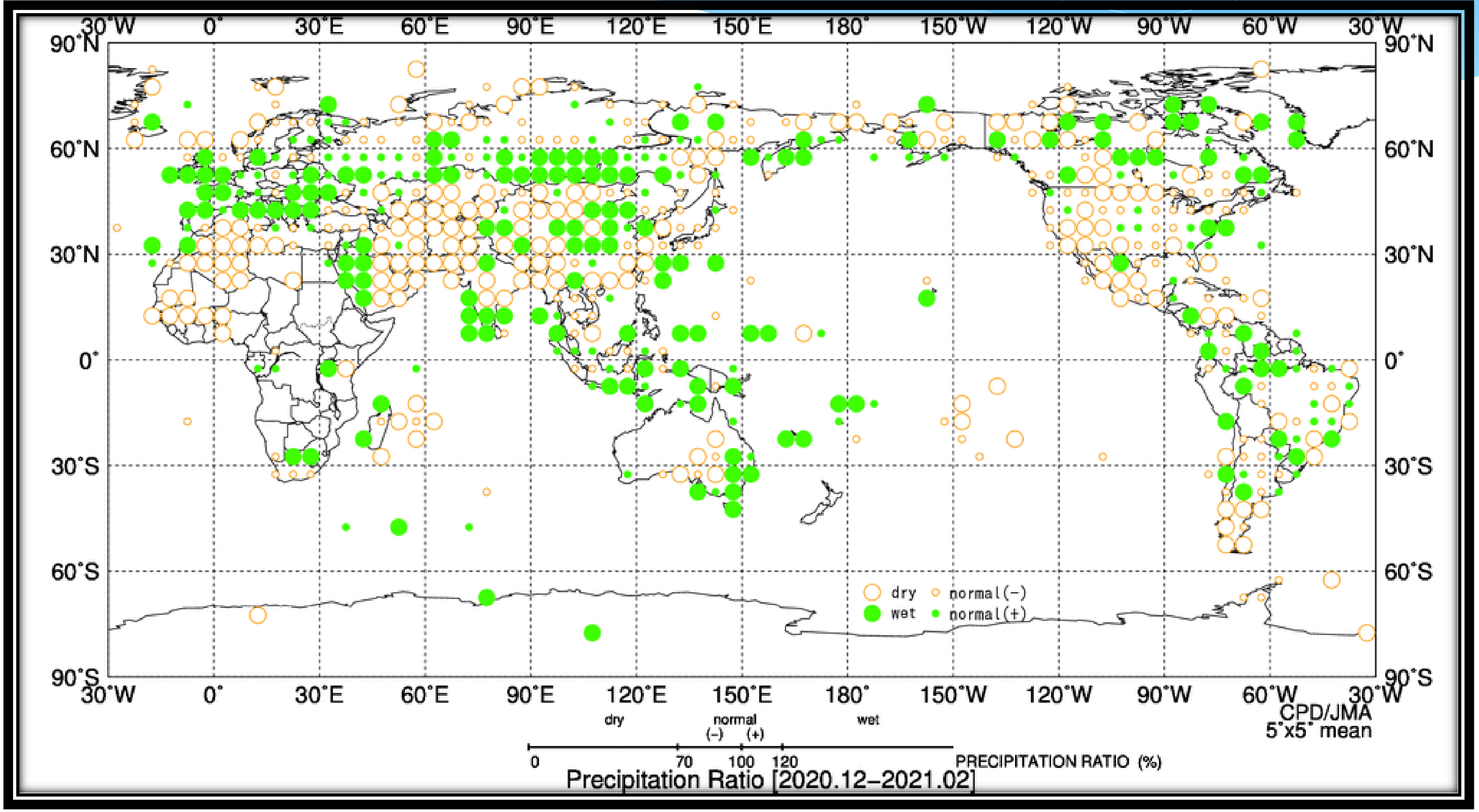
Possible summer season drivers over the Arabian Peninsula


Extreme Climate Events
December 2020 – February 2021
Warm
Cold
Wet
Dry
Tropical Cyclone
Disaster
Updated: 31 March 2021
CPD/JMA

Temp Dec 20 – Feb 21 Anomaly



Precip Dec 20 – Feb 21 Anomaly



Correlation coefficients with two periods 1990-2008 and 1970-2008 between some MJ standardized station temperature and precipitation extreme indices and both NCP and ENSO (coefficients significant at 0.05 level are in bold and to 0.1 level in italic).

Index	1990-2008				1970-2008			
	NCP		ENSO		NCP		ENSO	
	station	cor	station	cor	station	cor	station	cor
PRCP_Mon	Tabuk	**-0.55**			.Al-Madinah	*-0.43*	Al-Taif	*0.40*
					Al-Taif	**-0.55**	Salalah	**0.47**
					Salalah	**-0.49**		
TMAXmean	Tabuk	**-0.55**	Kuwait	**-0.62**	Al-Taif	*0.41*		
	Doha	*0.39*	Riyadh	*-0.44*	Bisha	*0.46*		
	Sohar	**0.55**	Hail	**-0.46**				
	Sur	*0.47*	Tabuk	**-0.51**				
			Al-Madinah	**-0.47**				
			Al-Taif	**-0.55**				
			Bisha	*-0.41*				
TMINmean	Al-Madinah	*-0.44*	Kuwait	*-0.40*			Bahrain	**0.52**
	Doha	*0.44*	Dhahran	*-0.39*			Riyadh	*0.45*
	Masirah	**-0.62**	Hail	*-0.39*				
			Tabuk	**-0.60**				
			Doha	**-0.48**				
			Khasab	*-0.45*				
TX10p	Kuwait	**0.49**	Kuwait	**0.53**	Al-Taif	*-0.44*	Jeddah	*-0.40*
	Doha	**-0.50**	Riyadh	*0.43*	Bisha	*-0.41*		
	Sur	**-0.48**	Hail	*0.41*				
			Tabuk	**0.61**				
			Al-Madinah	**0.68**				
			Al-Taif	**0.58**				
			Saiq	*0.42*				
TN10p	Kuwait	*-0.41*	Hail	**0.60**	Bisha	**-0.48**	Bahrain	*-0.44*
			Tabuk	**0.64**			Hail	*-0.41*
			Al-Madinah	**0.57**				
			Khasab	**0.57**				

Same as table 4 but the correlation coefficients for Nino3.4 teleconnection during JAS season.

		1990-2008		1970-2008
	All	NMON	MON	extremes_11
PRCP_Mon	-0.25	-0.34	-0.11	-0.13
RX1day	-0.29	-0.28	-0.12	-0.03
TMAXmean	*-0.41*	**-0.51**	-0.14	0.08
TX10p	*0.39*	0.37	0.35	-0.18
TX90p	*-0.39*	**-0.49**	-0.06	-0.20
TXX	**-0.49**	**-0.56**	-0.20	-0.07
TMINmean	**-0.48**	**-0.51**	0.01	0.03
TN10p	0.24	0.32	-0.13	-0.13
TN90p	-0.61	-0.55	-0.14	-0.28
TNX	*-0.44*	-0.53	0.06	-0.20

North Sea-Caspian Pattern (NCP)

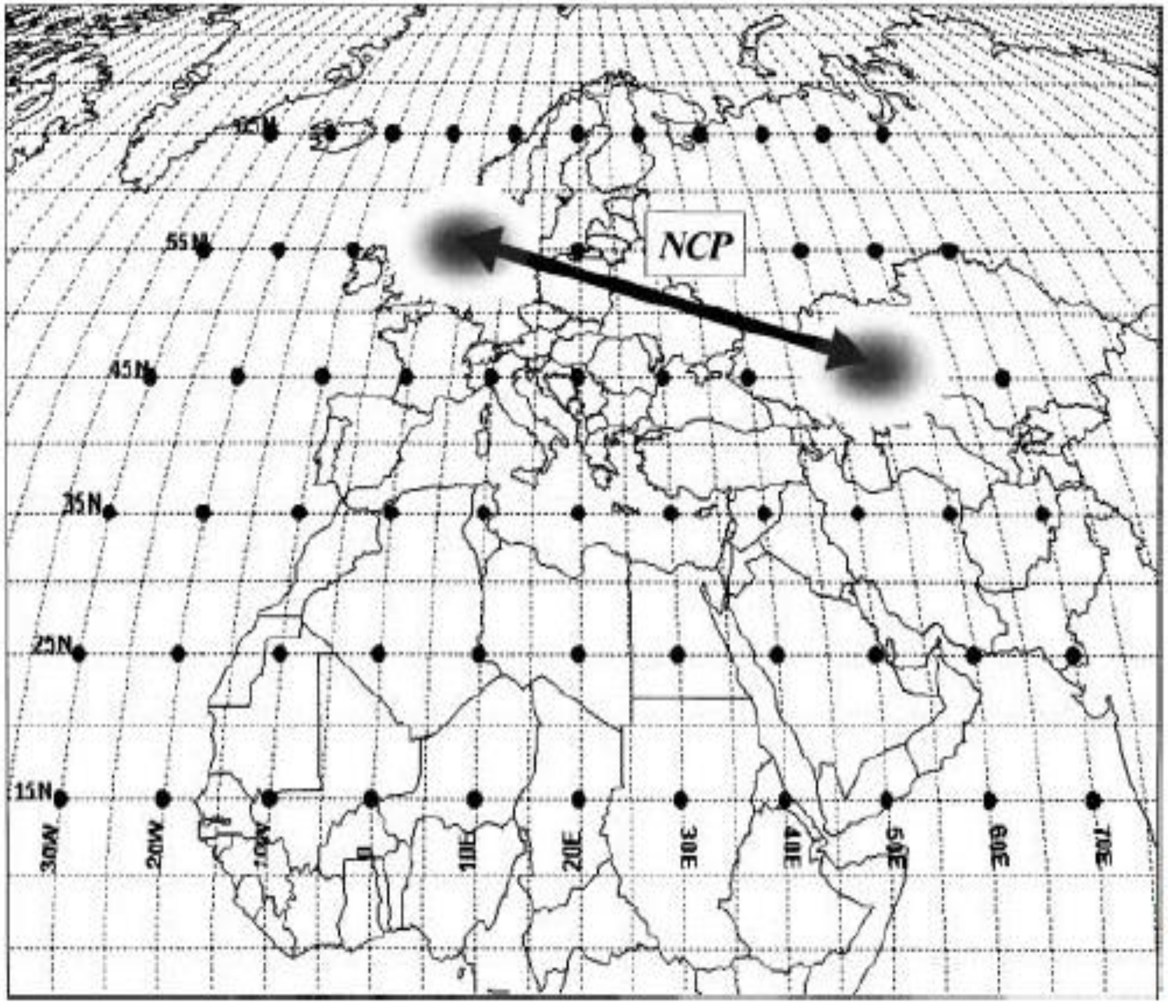


Fig. 1. Map showing the poles of the North Sea – Caspian Pattern (*NCP*), (after Kutiel and Benaroch, 2002)

Almazroui (2012)

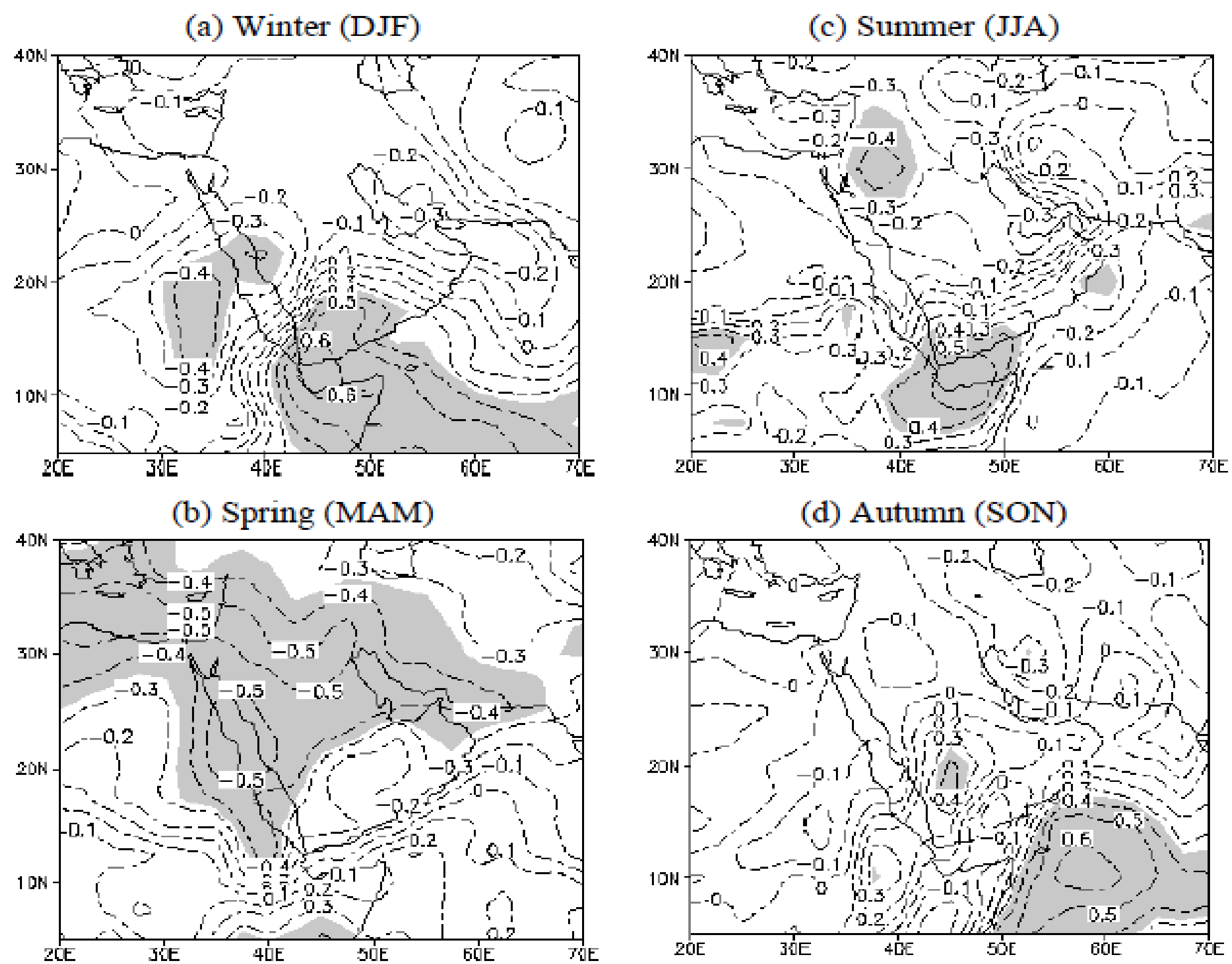
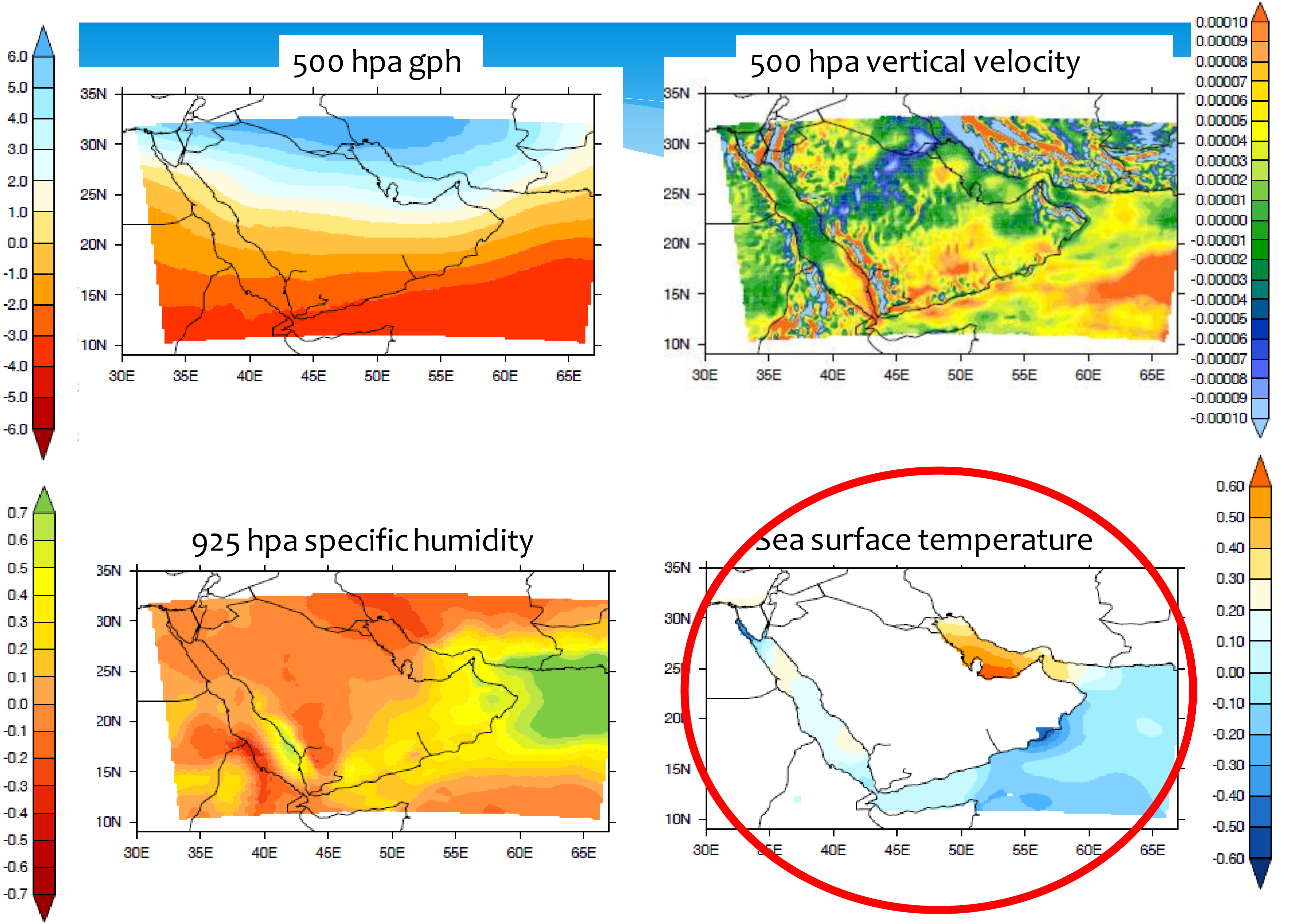
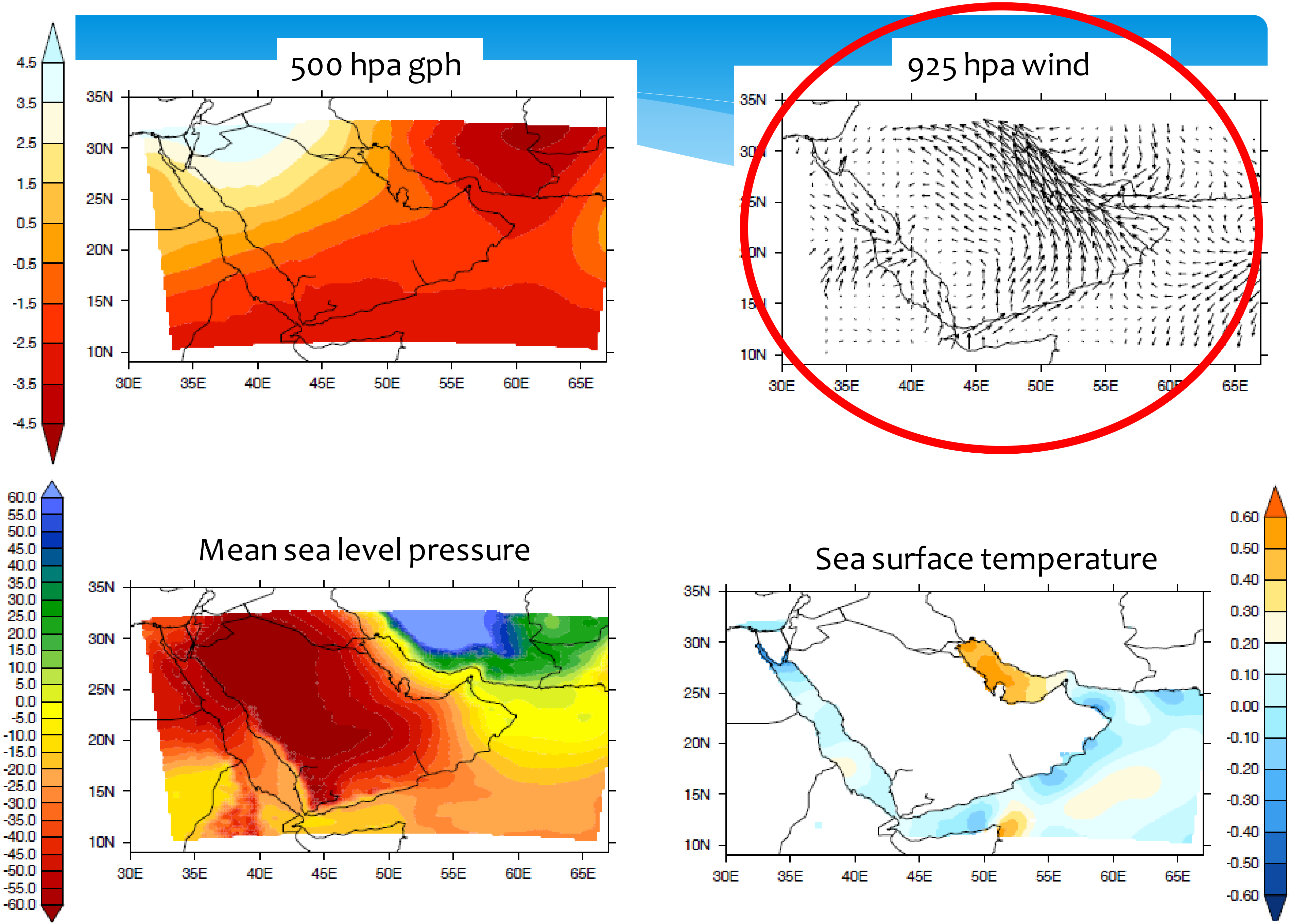


Fig. 8. The correlation of Niño 3.4 index and the mean temperature obtained from the NCEP data for the (a) Winter, (b) Spring, (c) Summer, and (d) Autumn seasons averaged over 1978-2010.


500 hpa gph
500 hpa vertical velocity
925 hpa specific humidity
Sea surface temperature
35N
30N
25N
20N
15N
10N
30E
35E
40E
45E
50E
55E
60E
65E
6.0
5.0
4.0
3.0
2.0
1.0
0.0
-1.0
-2.0
-3.0
-4.0
-5.0
-6.0
0.00010
0.00009
0.00008
0.00007
0.00006
0.00005
0.00004
0.00003
0.00002
0.00001
0.00000
-0.00001
-0.00002
-0.00003
-0.00004
-0.00005
-0.00006
-0.00007
-0.00008
-0.00009
-0.00010
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
-0.1
-0.2
-0.3
-0.4
-0.5
-0.6
-0.7
0.60
0.50
0.40
0.30
0.20
0.10
0.00
-0.10
-0.20
-0.30
-0.40
-0.50
-0.60


500 hpa gph
925 hpa wind
Mean sea level pressure
Sea surface temperature
4.5
3.5
2.5
1.5
0.5
-0.5
-1.5
-2.5
-3.5
-4.5
60.0
55.0
50.0
45.0
40.0
35.0
30.0
25.0
20.0
15.0
10.0
5.0
0.0
-5.0
-10.0
-15.0
-20.0
-25.0
-30.0
-35.0
-40.0
-45.0
-50.0
-55.0
-60.0
0.60
0.50
0.40
0.30
0.20
0.10
0.00
-0.10
-0.20
-0.30
-0.40
-0.50
-0.60
35N
30N
25N
20N
15N
10N
30E
35E
40E
45E
50E
55E
60E
65E

Almazroui (2012)

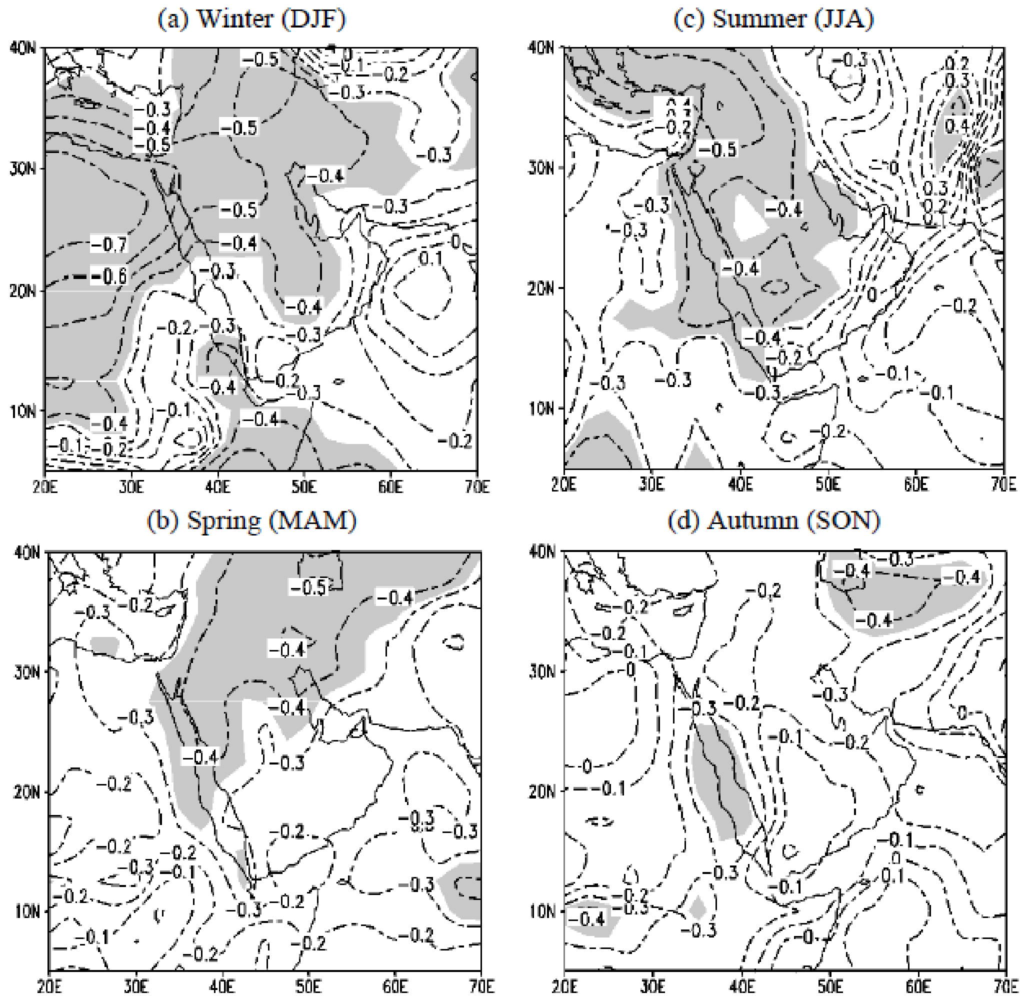


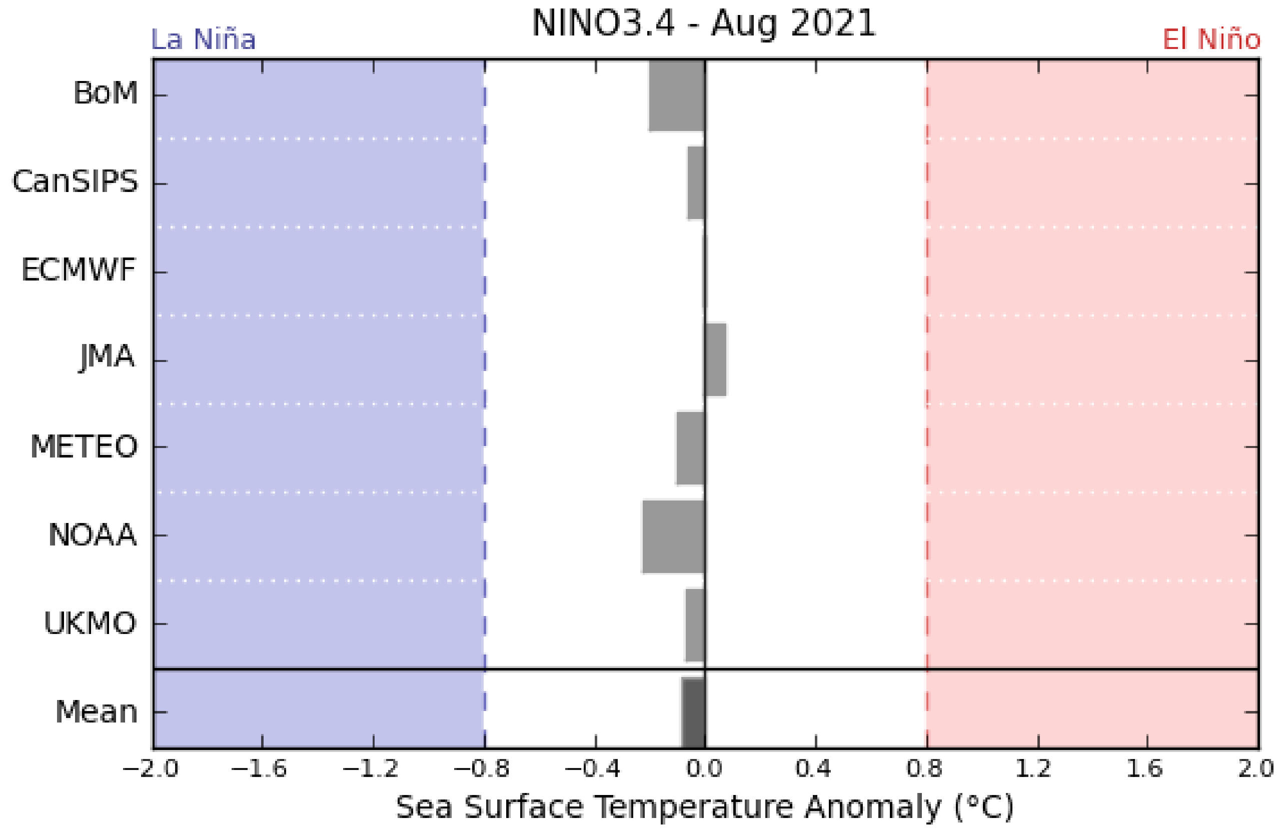
Fig. 12. The correlation of the NAO index and the mean temperature obtained from the NCEP data for (a) Winter, (b) Spring, (c) Summer, and (d) Autumn seasons averaged over 1978-2010.

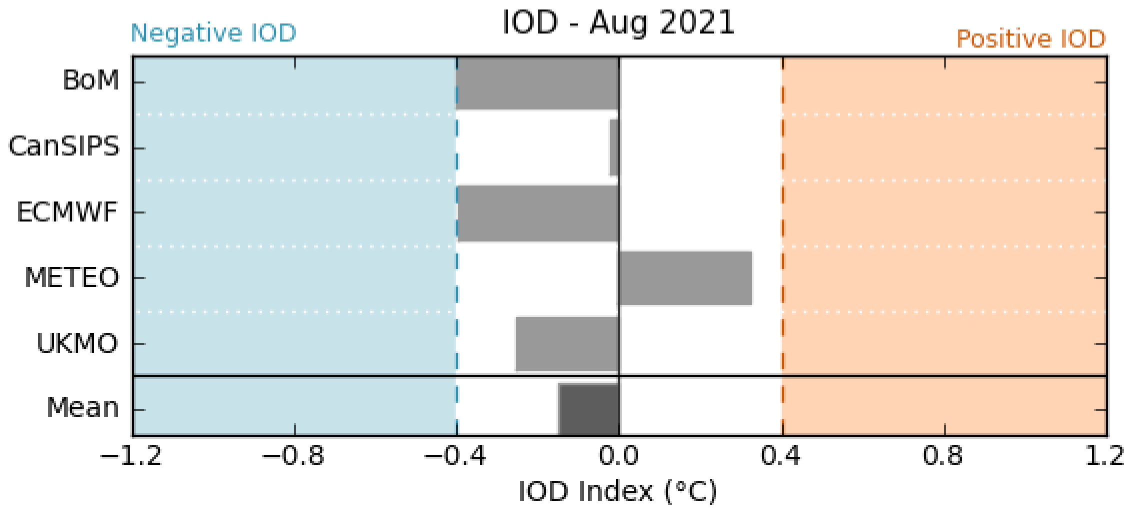
* Atif et al (2020) reported that the Extreme Precipitation Events over Saudi Arabia are associated with El Niño Southern Oscillation (ENSO), which shows that during the positive (negative) ENSO phase the frequency of EPEs increases (decreases) over the country.
* AlMazroui et al(2019) found that during summer above normal Surface Air Temperature anomalies reported over the northern parts of the Peninsula during the cold phase of ENSO and below normal temperature during the warm phase.
* Abid et al (2018) reported that the warm phase of ENSO during summer there is upper-level convergence over the southern Arabian Peninsula leads to sinking motion, low-level divergence and consequently to reduced rainfall, while reverse happens in the cold phase.

Outline

Drivers conditions.

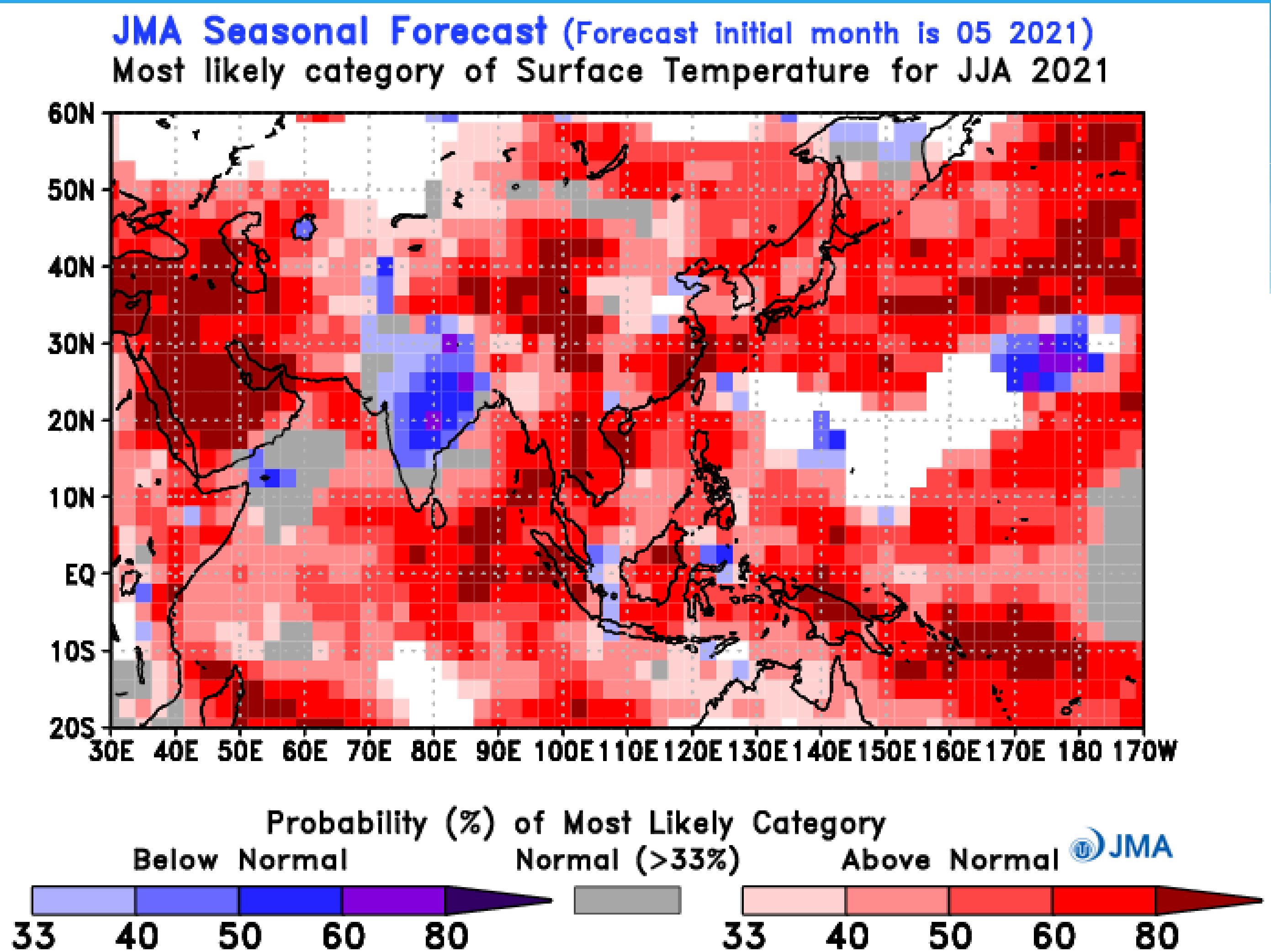
International climate model outlooks

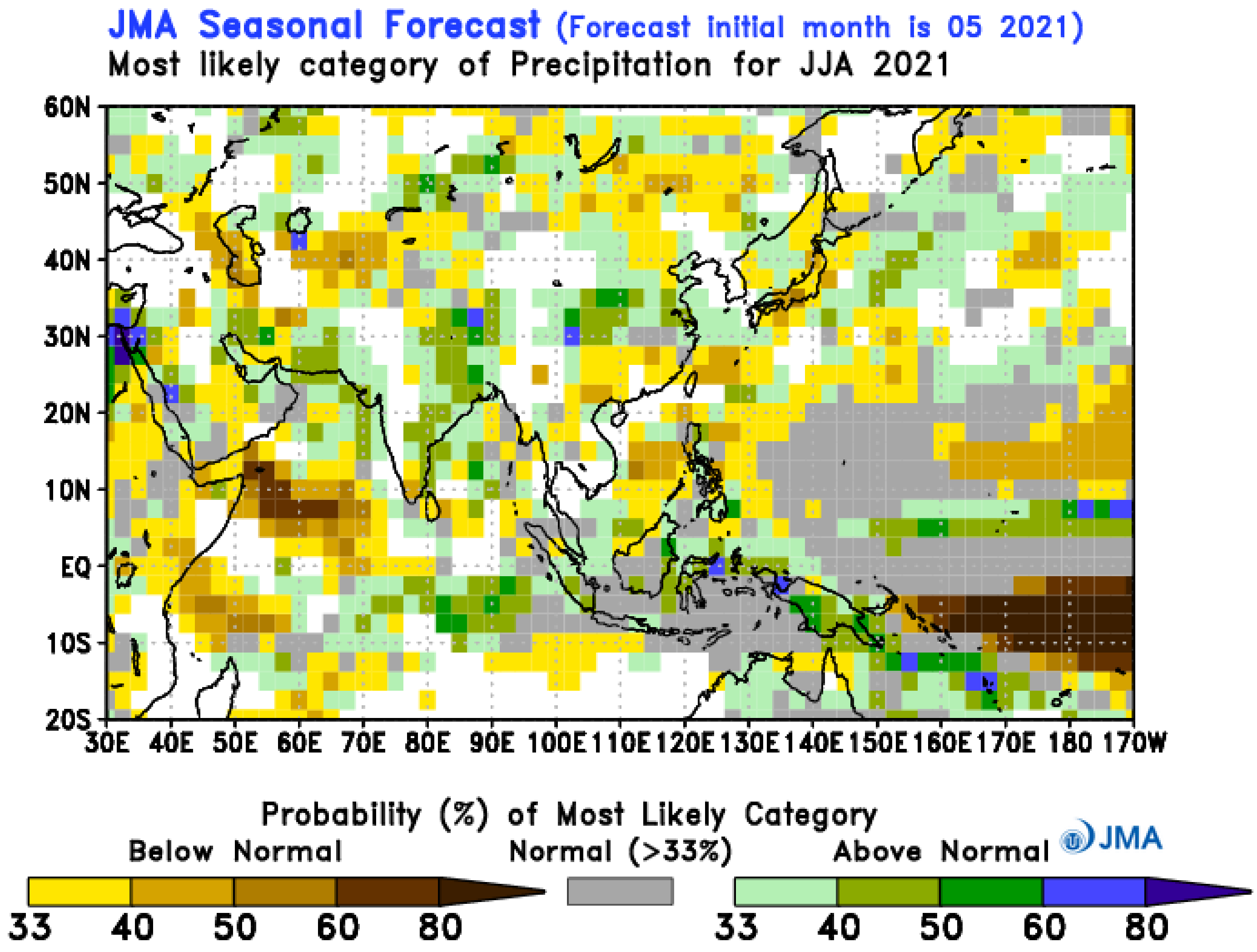


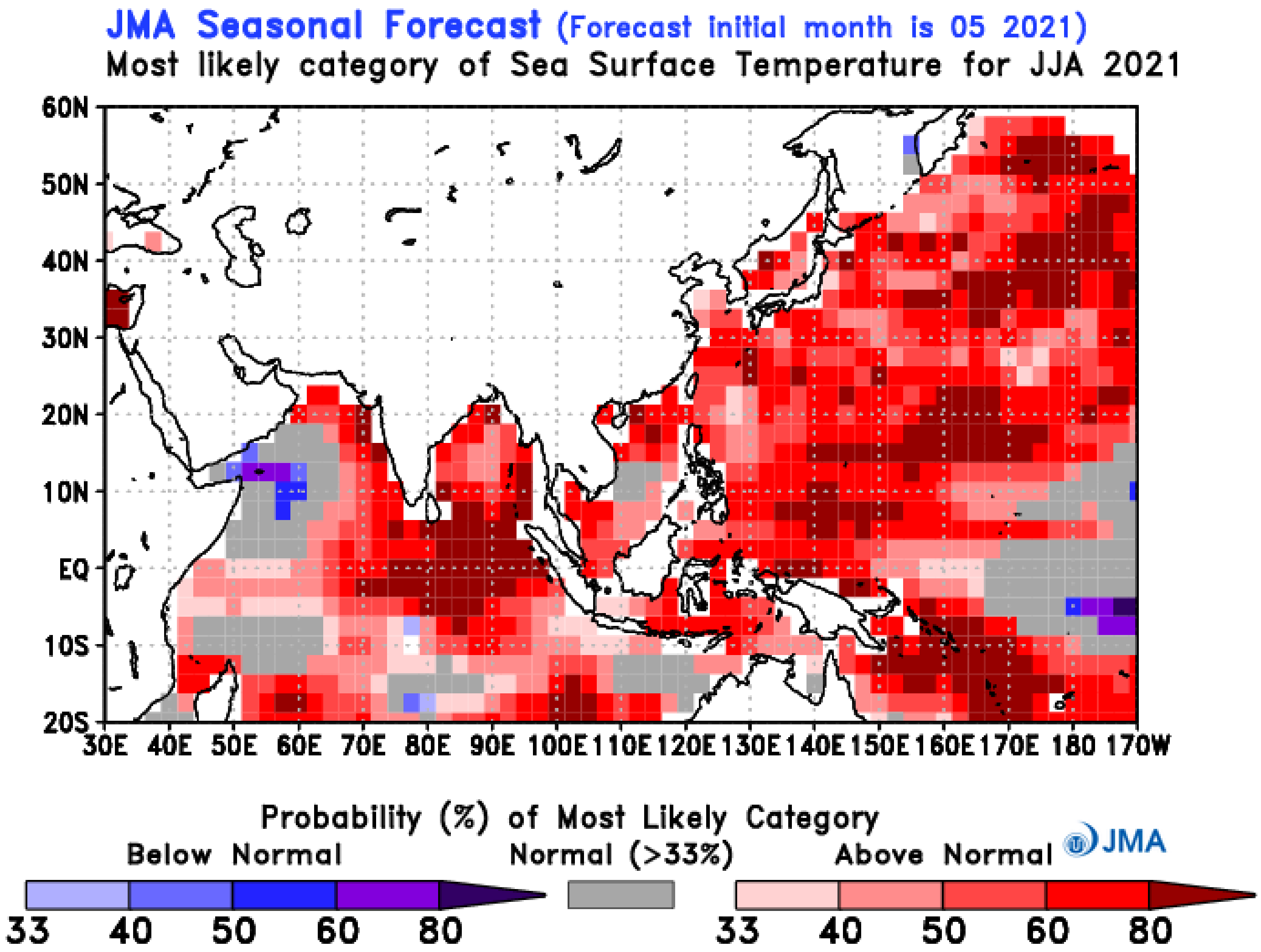

IOD - Aug 2021
Negative IOD
Positive IOD
BoM
CanSIPS
ECMWF
METEO
UKMO
Mean
−1.2
−0.8
−0.4
0.0
0.4
0.8
1.2
IOD Index (°C)

Outline

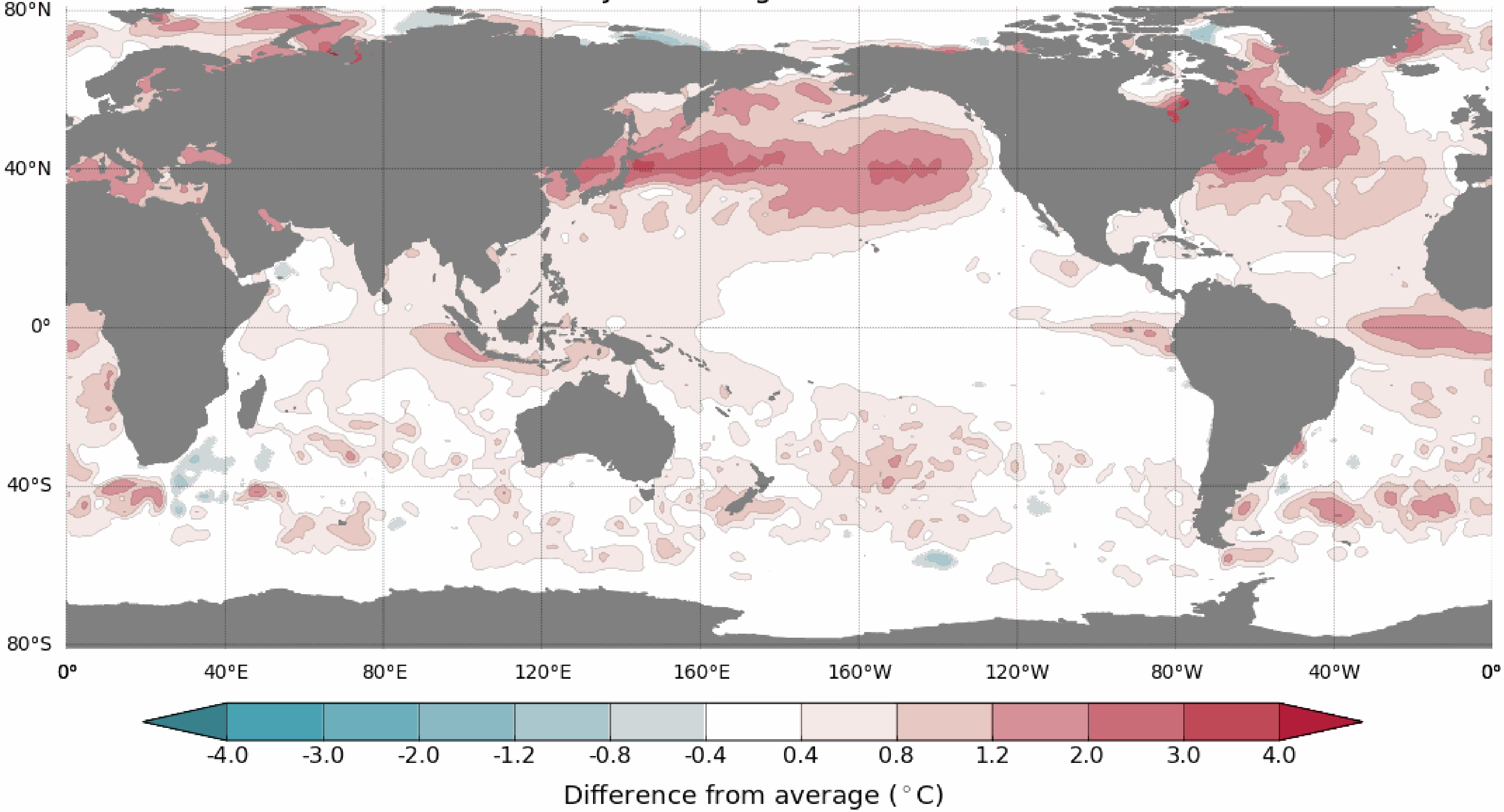
- RAII RCCs and some WMO MME LR forecasts.


JMA Seasonal Forecast (Forecast initial month is 05 2021)
Most likely category of Surface Temperature for JJA 2021
60N
50N
40N
30N
20N
10N
EQ
10S
20S
30E 40E 50E 60E 70E 80E 90E 100E 110E 120E 130E 140E 150E 160E 170E 180 170W
Probability (%) of Most Likely Category
Below Normal
Normal (>33%)
Above Normal
JMA
33 40 50 60 80
33 40 50 60 80


JMA Seasonal Forecast (Forecast initial month is 05 2021)
Most likely category of Precipitation for JJA 2021
60N
50N
40N
30N
20N
10N
EQ
10S
20S
30E 40E 50E 60E 70E 80E 90E 100E 110E 120E 130E 140E 150E 160E 170E 180 170W
Probability (%) of Most Likely Category
Below Normal
Normal (>33%)
Above Normal
JMA
33 40 50 60 80
33 40 50 60 80


JMA Seasonal Forecast (Forecast initial month is 05 2021)
Most likely category of Sea Surface Temperature for JJA 2021
60N
50N
40N
30N
20N
10N
EQ
10S
20S
30E 40E 50E 60E 70E 80E 90E 100E 110E 120E 130E 140E 150E 160E 170E 180 170W
Probability (%) of Most Likely Category
Below Normal
Normal (>33%)
Above Normal
JMA
33 40 50 60 80
33 40 50 60 80

Difference from average sea surface temperature forecast for June to August 2021

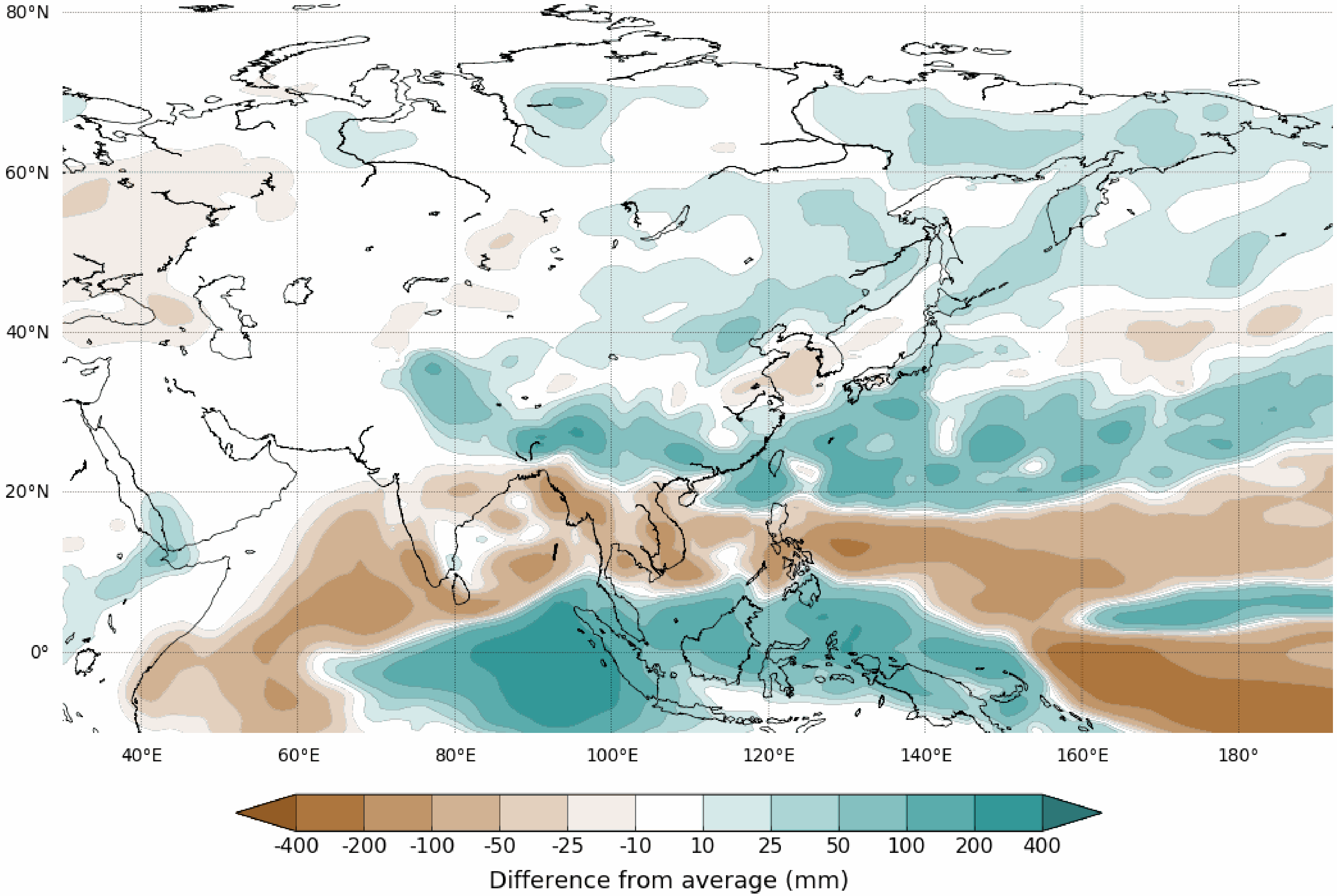


www.bom.gov.au/climate

Model: ACCESS-S1
Base period: 1990-2012

Model run: 22/05/2021
Issued: 24/05/2021

Difference from average rainfall forecast for June to August 2021

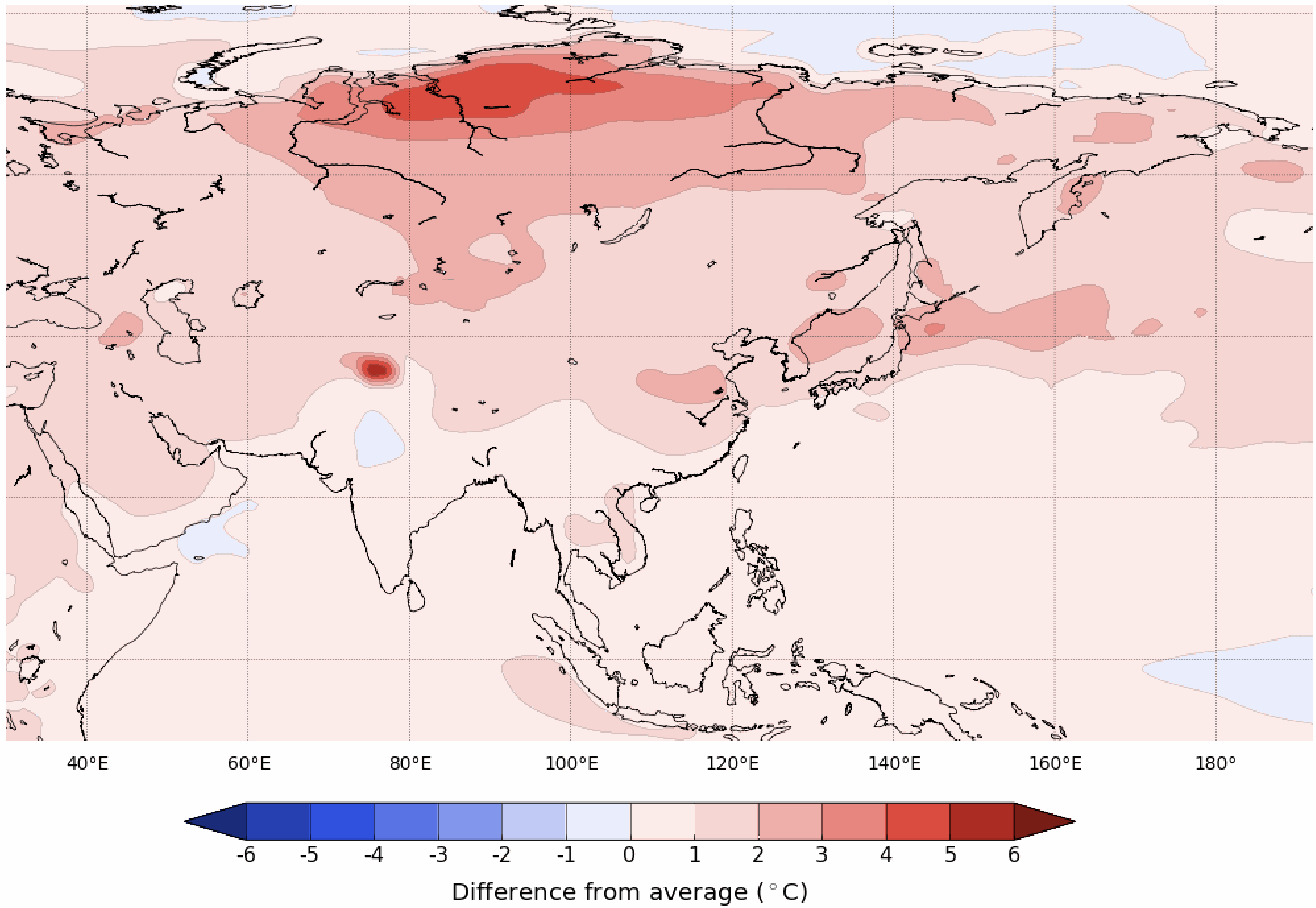


www.bom.gov.au/climate

Model: ACCESS-S1
Base period: 1990-2012

Model run: 24/05/2021
Issued: 27/05/2021

Difference from average mean maximum temperature forecast for June to August 2021



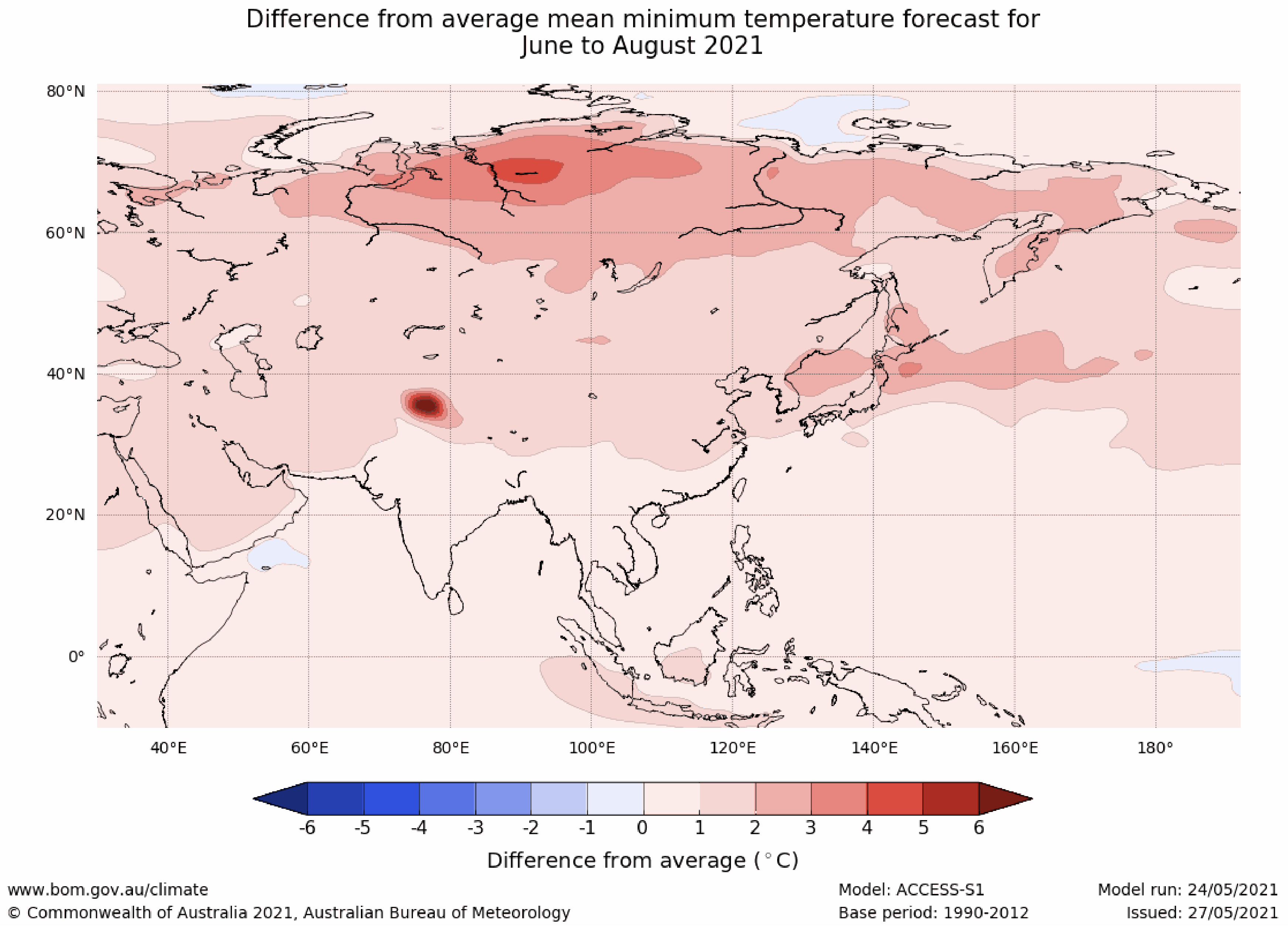
www.bom.gov.au/climate

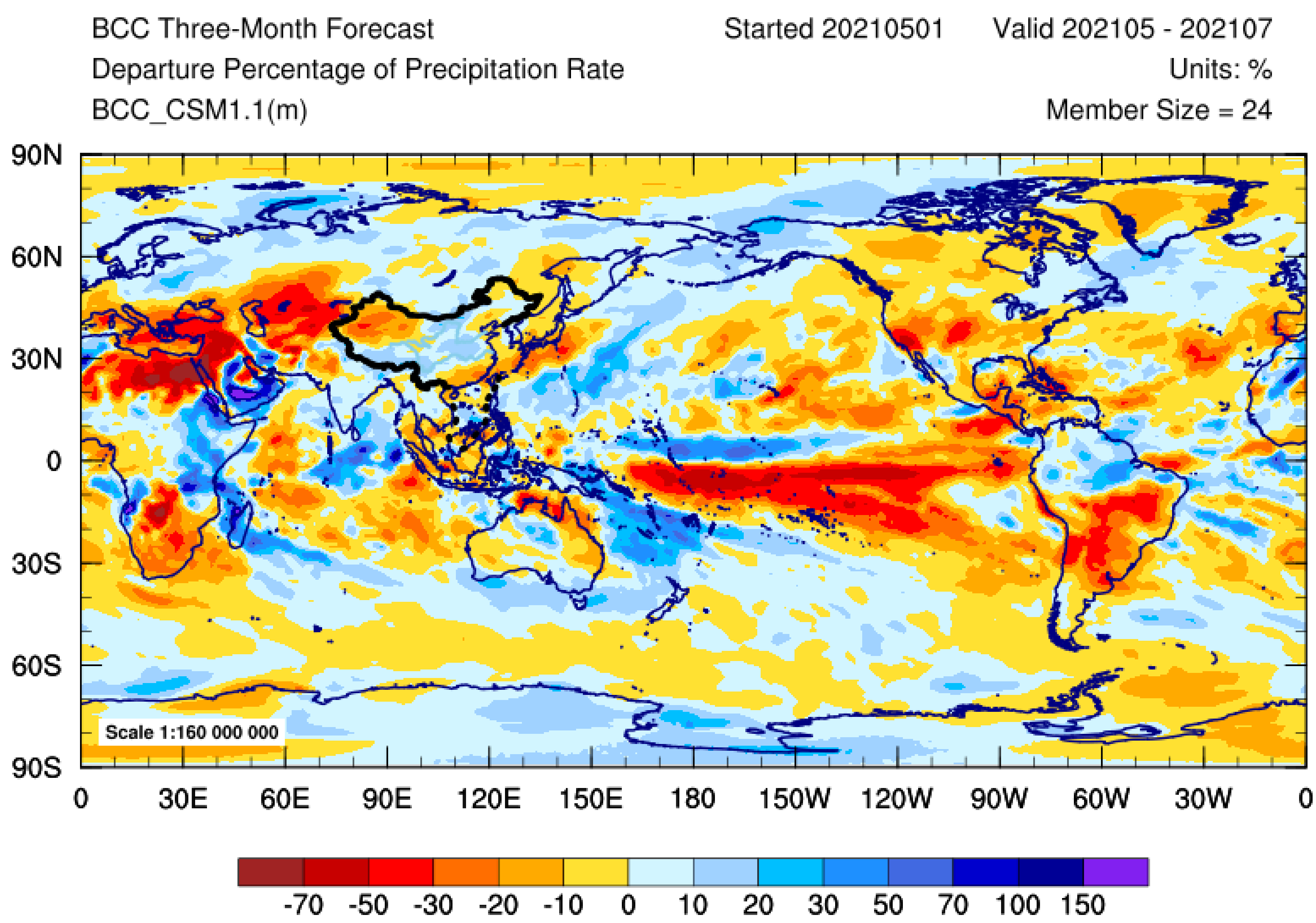
Model: ACCESS-S1

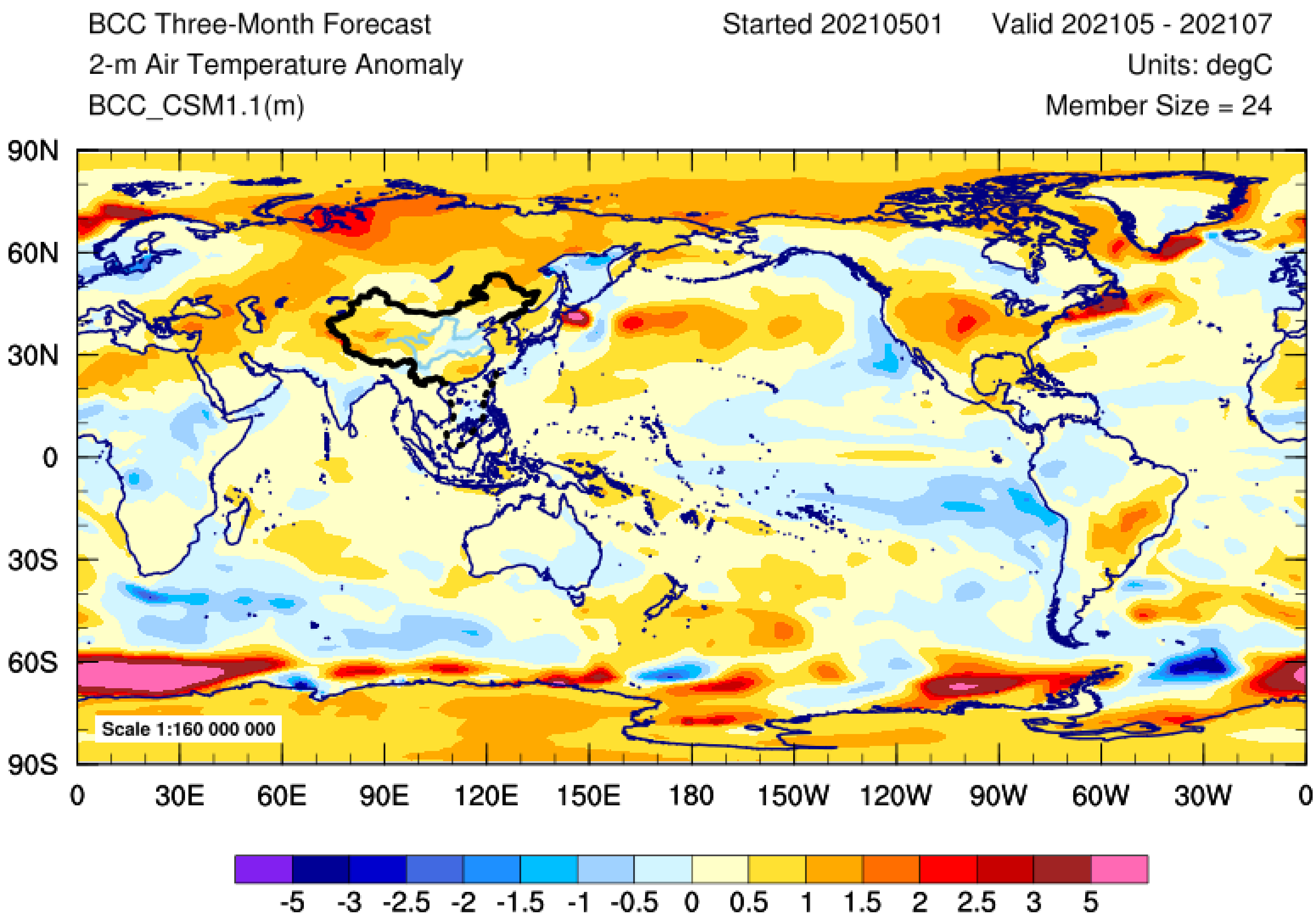
Base period: 1990-2012

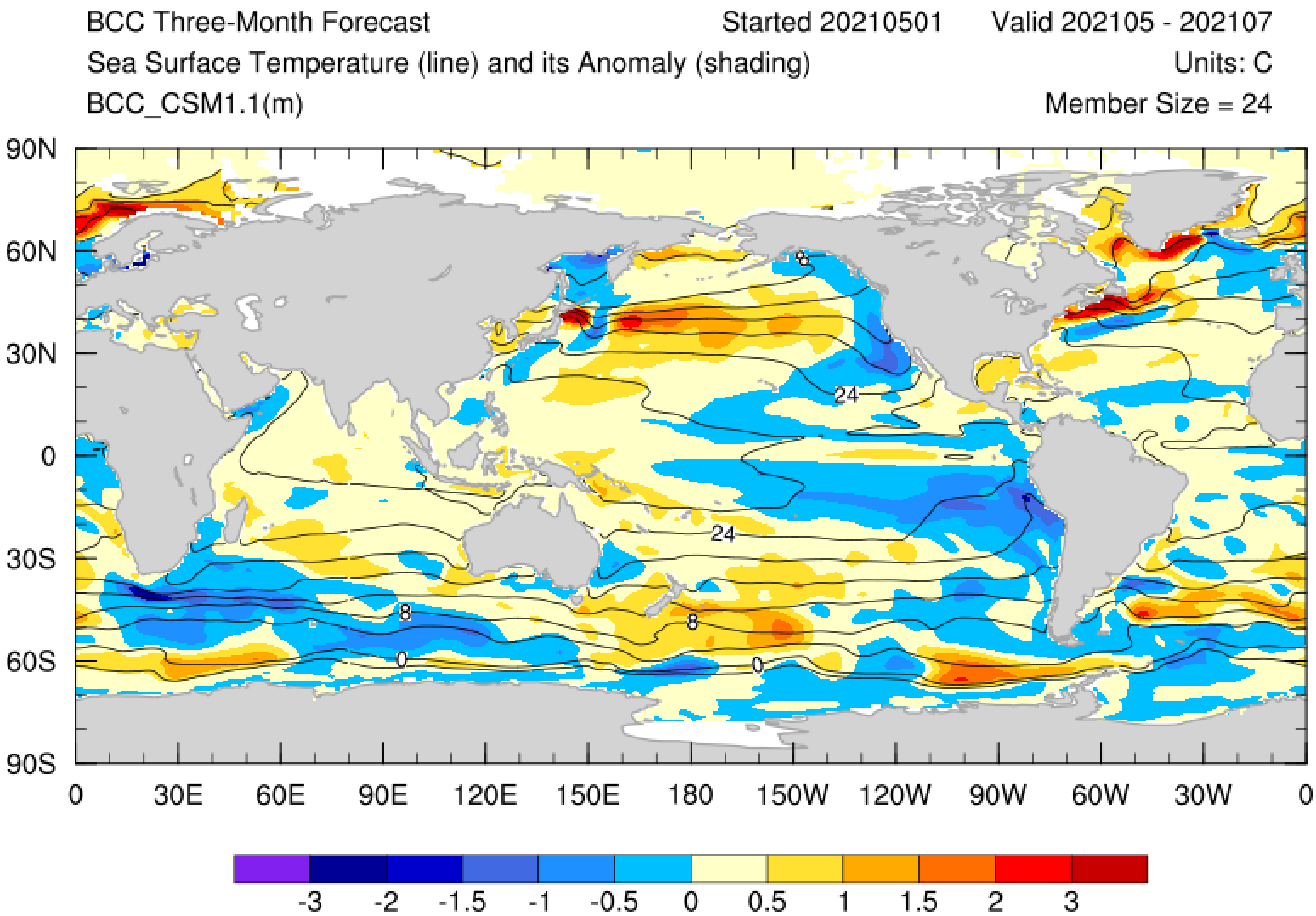
Model run: 24/05/2021

Issued: 27/05/2021

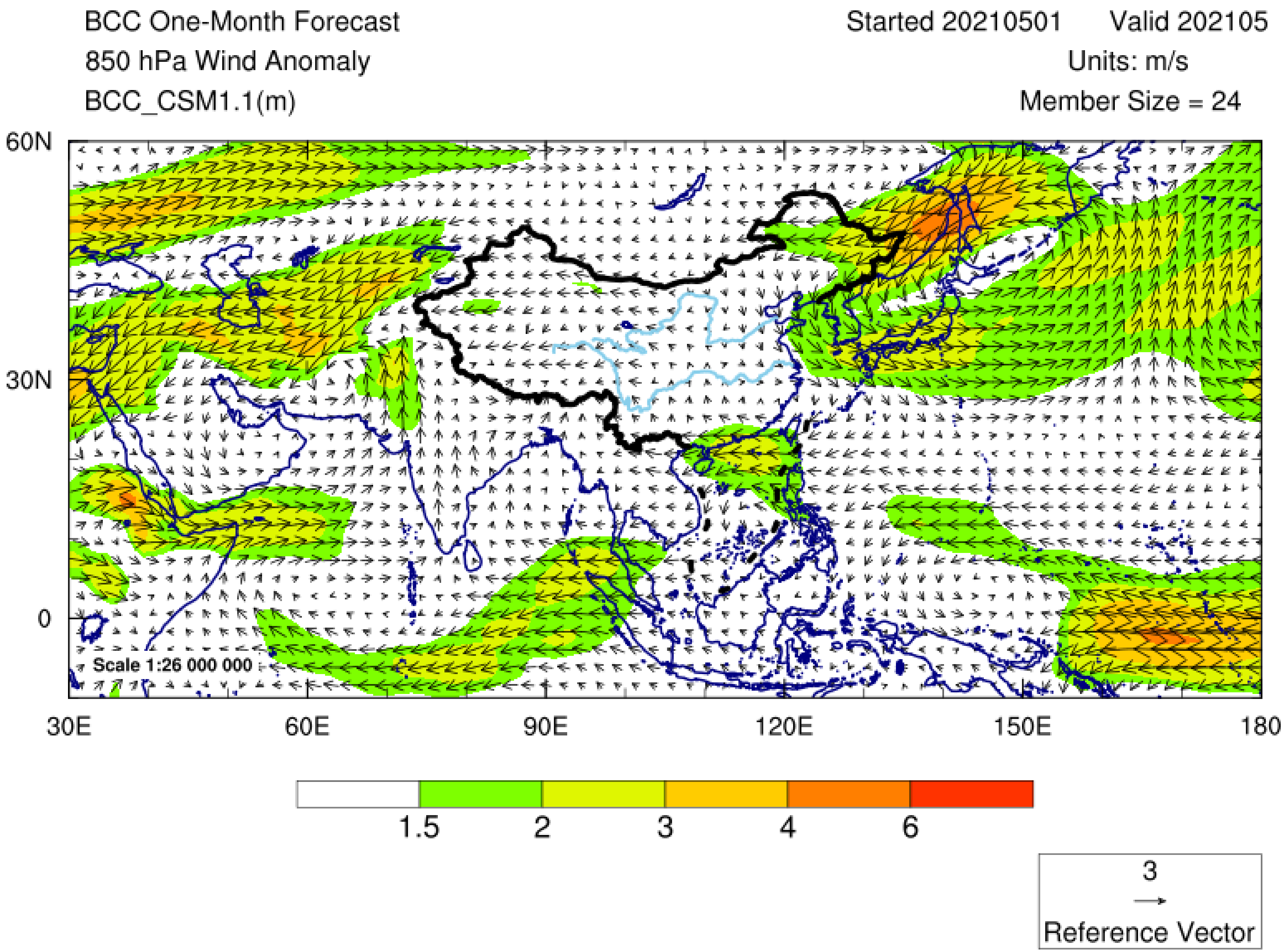

Difference from average mean minimum temperature forecast for
June to August 2021
80°N
60°N
40°N
20°N
0°
40°E
60°E
80°E
100°E
120°E
140°E
160°E
180°
-6
-5
-4
-3
-2
-1
0
1
2
3
4
5
6
Difference from average (°C)
www.bom.gov.au/climate
© Commonwealth of Australia 2021, Australian Bureau of Meteorology
Model: ACCESS-S1
Base period: 1990-2012
Model run: 24/05/2021
Issued: 27/05/2021

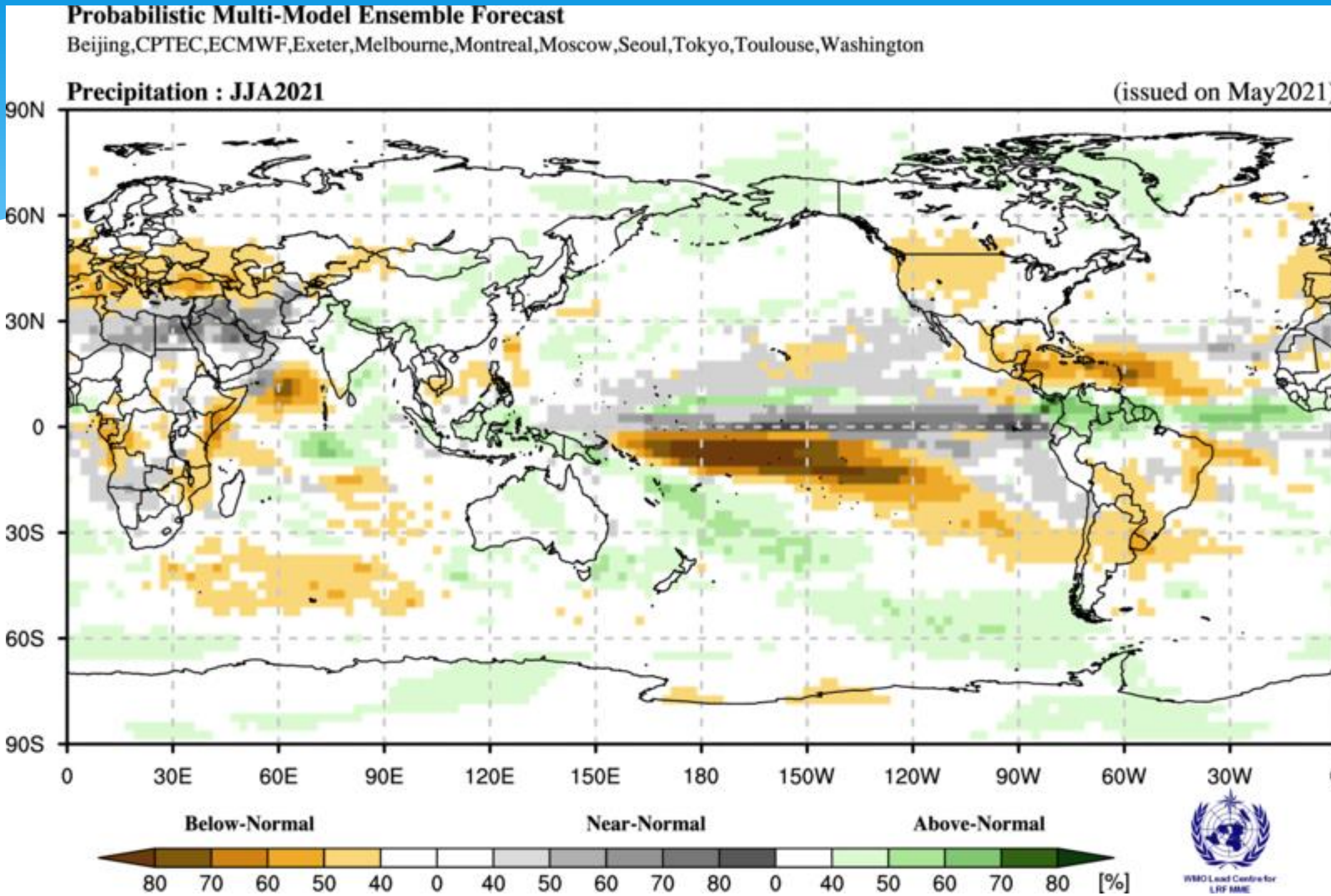

BCC Three-Month Forecast
Started 20210501
Valid 202105 - 202107
Departure Percentage of Precipitation Rate
Units: %
BCC_CSM1.1(m)
Member Size = 24
90N
60N
30N
0
30S
60S
90S
Scale 1:160 000 000
0
30E
60E
90E
120E
150E
180
150W
120W
90W
60W
30W
0
-70
-50
-30
-20
-10
0
10
20
30
50
70
100
150

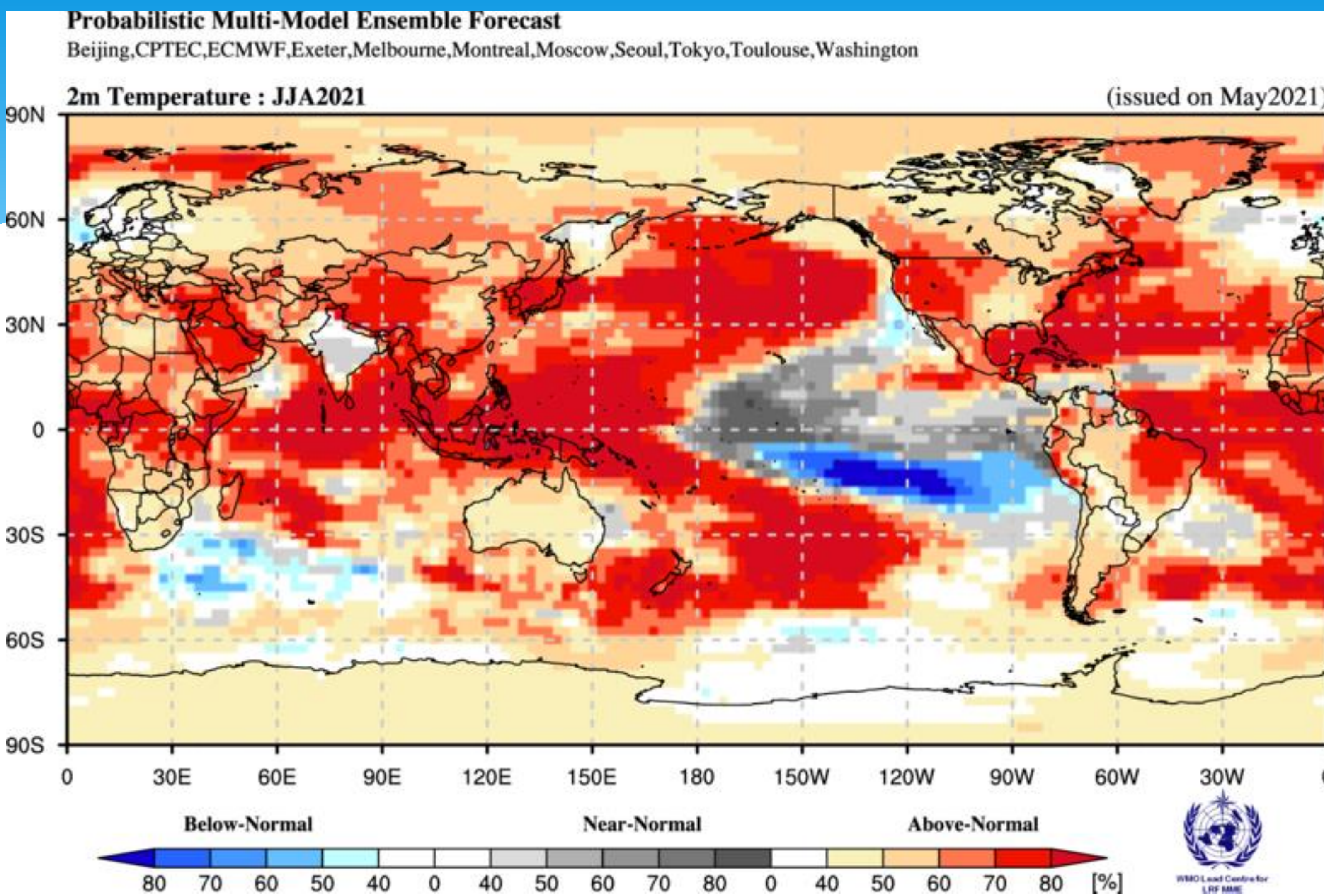

BCC Three-Month Forecast
2-m Air Temperature Anomaly
BCC_CSM1.1(m)
Started 20210501
Valid 202105 - 202107
Units: degC
Member Size = 24
90N
60N
30N
0
30S
60S
90S
Scale 1:160 000 000
0
30E
60E
90E
120E
150E
180
150W
120W
90W
60W
30W
0
-5
-3
-2.5
-2
-1.5
-1
-0.5
0
0.5
1
1.5
2
2.5
3
5



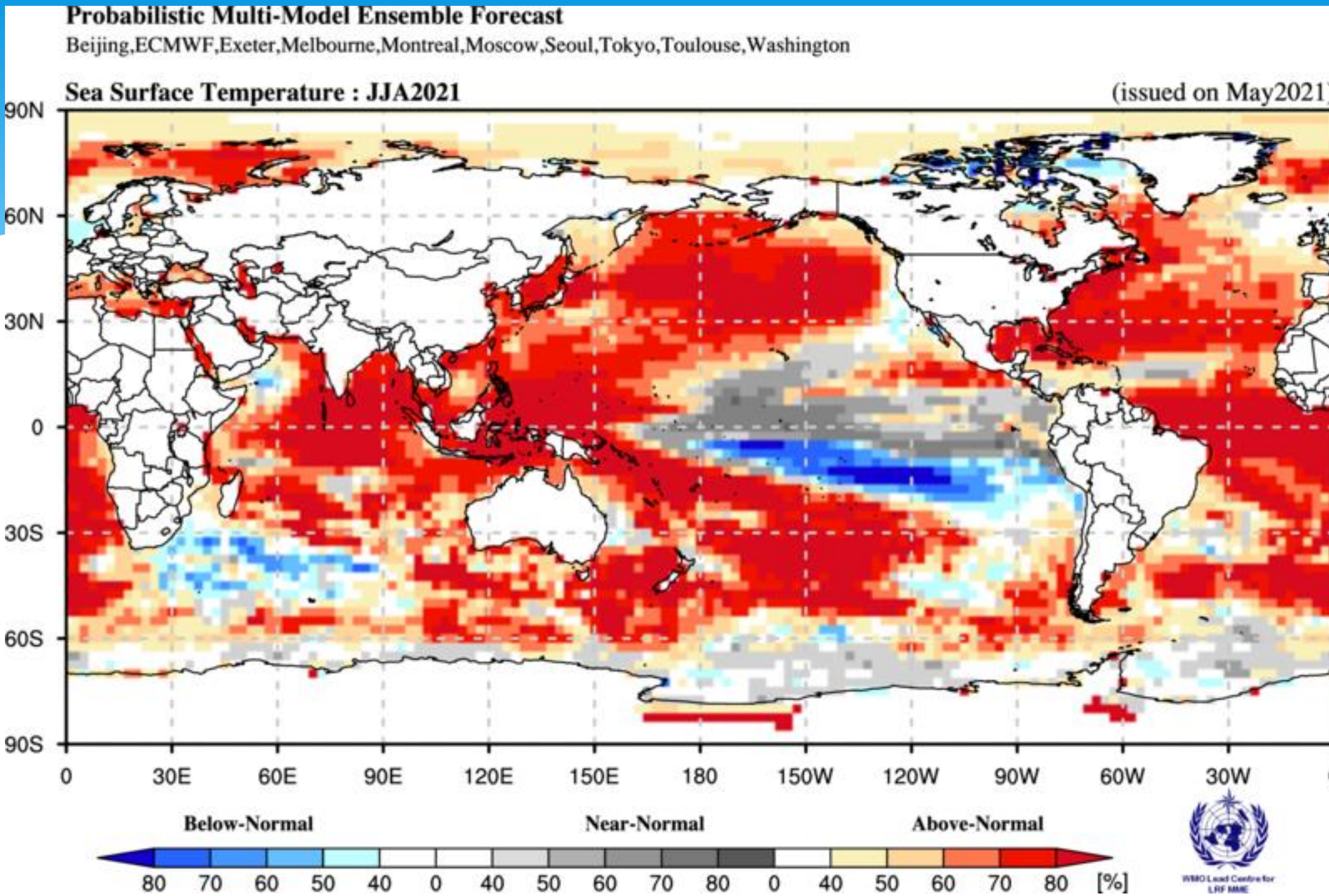
BCC Three-Month Forecast
Started 20210501
Valid 202105 - 202107
Sea Surface Temperature (line) and its Anomaly (shading)
Units: C
BCC_CSM1.1(m)
Member Size = 24
90N
60N
30N
0
30S
60S
90S
0
30E
60E
90E
120E
150E
180
150W
120W
90W
60W
30W
0
24
24
8
8
0
0
-3
-2
-1.5
-1
-0.5
0
0.5
1
1.5
2
3


BCC One-Month Forecast
850 hPa Wind Anomaly
BCC_CSM1.1(m)
Started 20210501
Valid 202105
Units: m/s
Member Size = 24
60N
30N
0
Scale 1:26 000 000
30E
60E
90E
120E
150E
180
1.5
2
3
4
6
3
Reference Vector

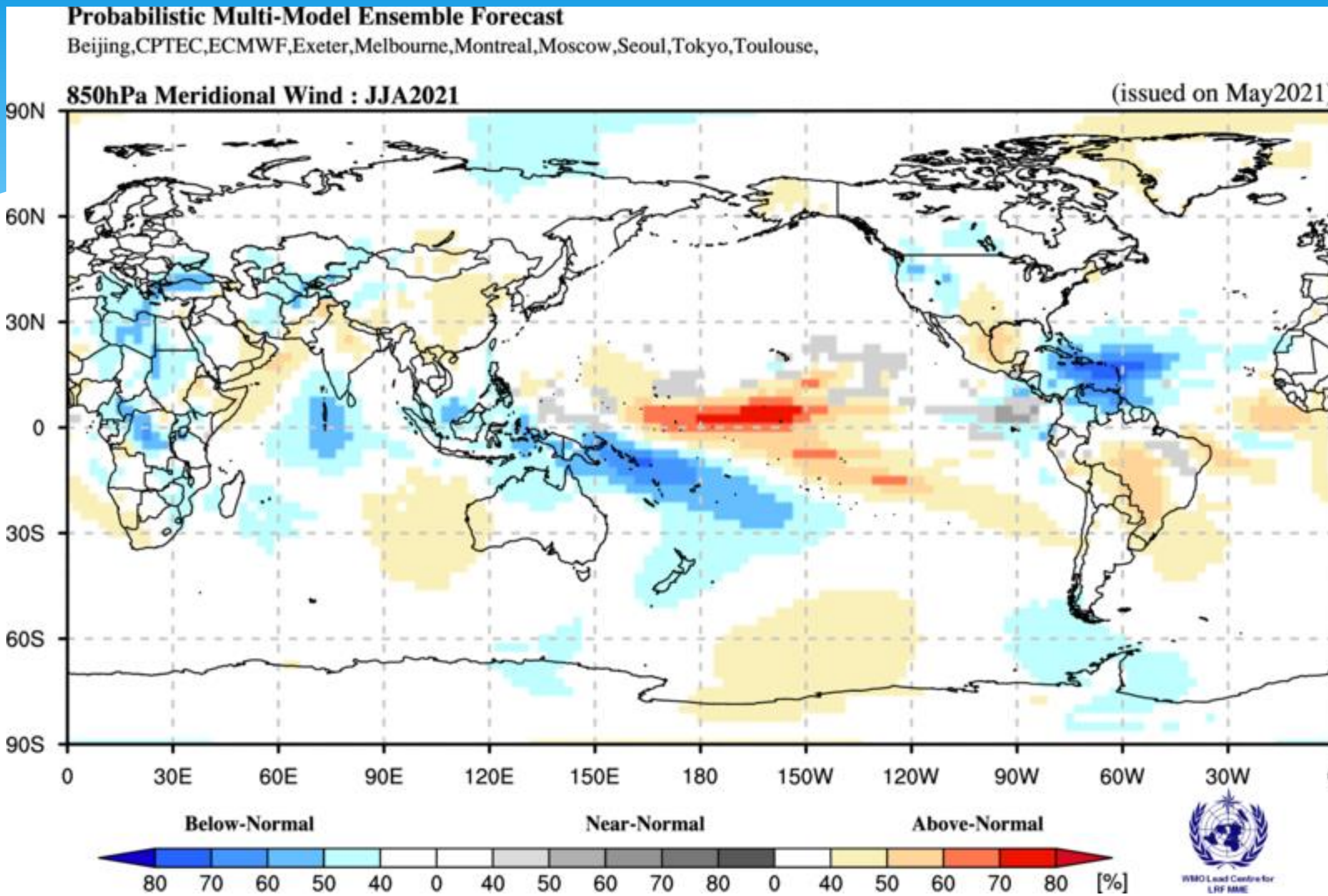

Probabilistic Multi-Model Ensemble Forecast
Beijing,CPTEC,ECMWF,Exeter,Melbourne,Montreal,Moscow,Seoul,Tokyo,Toulouse,Washington
Precipitation : JJA2021
(issued on May2021)
90N
60N
30N
0
30S
60S
90S
0
30E
60E
90E
120E
150E
180
150W
120W
90W
60W
30W
0
Below-Normal
Near-Normal
Above-Normal
80
70
60
50
40
0
40
50
60
70
80
0
40
50
60
70
80
[%]



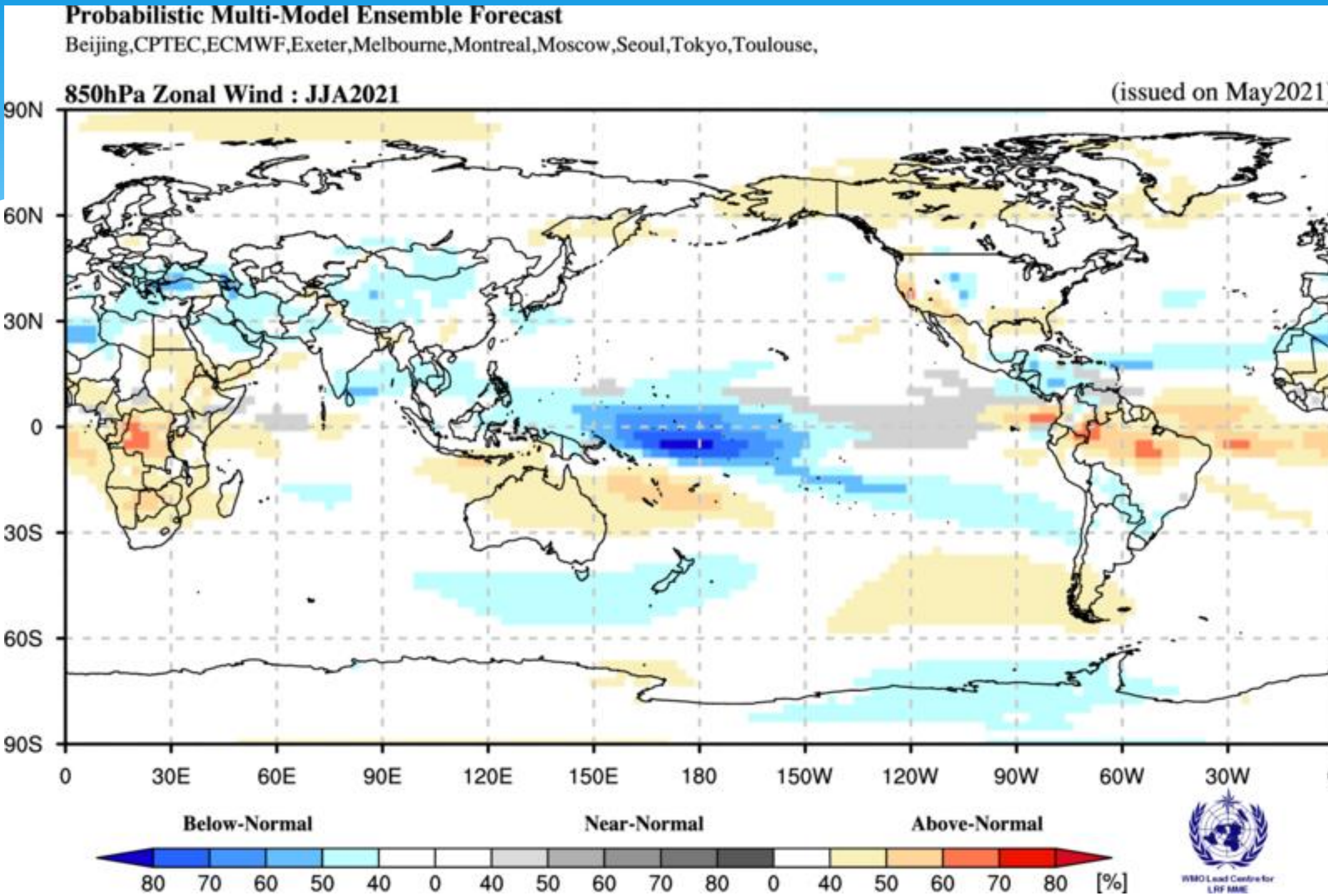
Probabilistic Multi-Model Ensemble Forecast
Beijing,CPTEC,ECMWF,Exeter,Melbourne,Montreal,Moscow,Seoul,Tokyo,Toulouse,Washington
2m Temperature : JJA2021
(issued on May2021)
90N
60N
30N
0
30S
60S
90S
0
30E
60E
90E
120E
150E
180
150W
120W
90W
60W
30W
0
Below-Normal
Near-Normal
Above-Normal
80 70 60 50 40 0 40 50 60 70 80 0 40 50 60 70 80 [%]

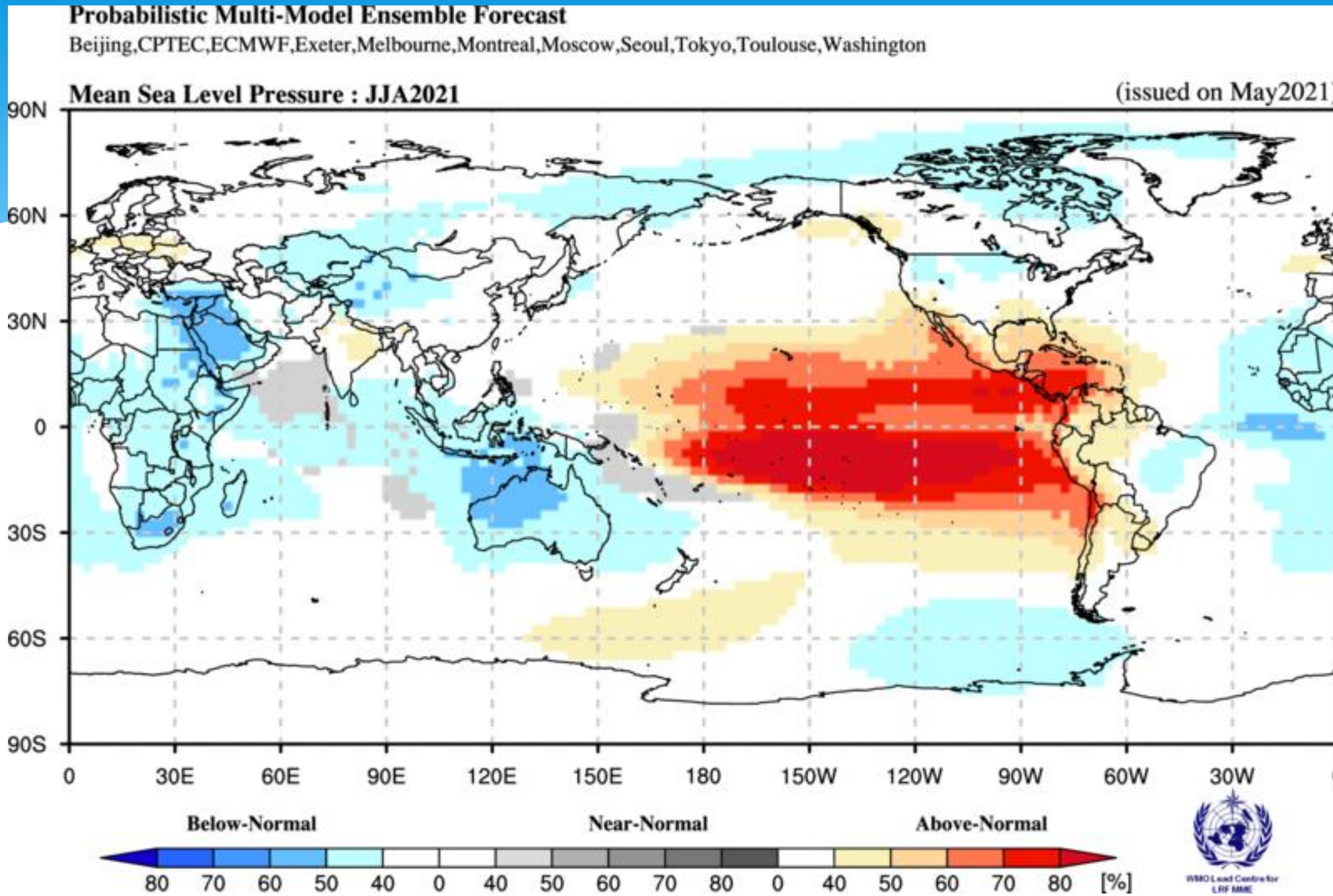


Probabilistic Multi-Model Ensemble Forecast
Beijing,ECMWF,Exeter,Melbourne,Montreal,Moscow,Seoul,Tokyo,Toulouse,Washington
Sea Surface Temperature : JJA2021
(issued on May2021)
90N
60N
30N
0
30S
60S
90S
0
30E
60E
90E
120E
150E
180
150W
120W
90W
60W
30W
0
Below-Normal
Near-Normal
Above-Normal
80
70
60
50
40
0
40
50
60
70
80
0
40
50
60
70
80
[%]



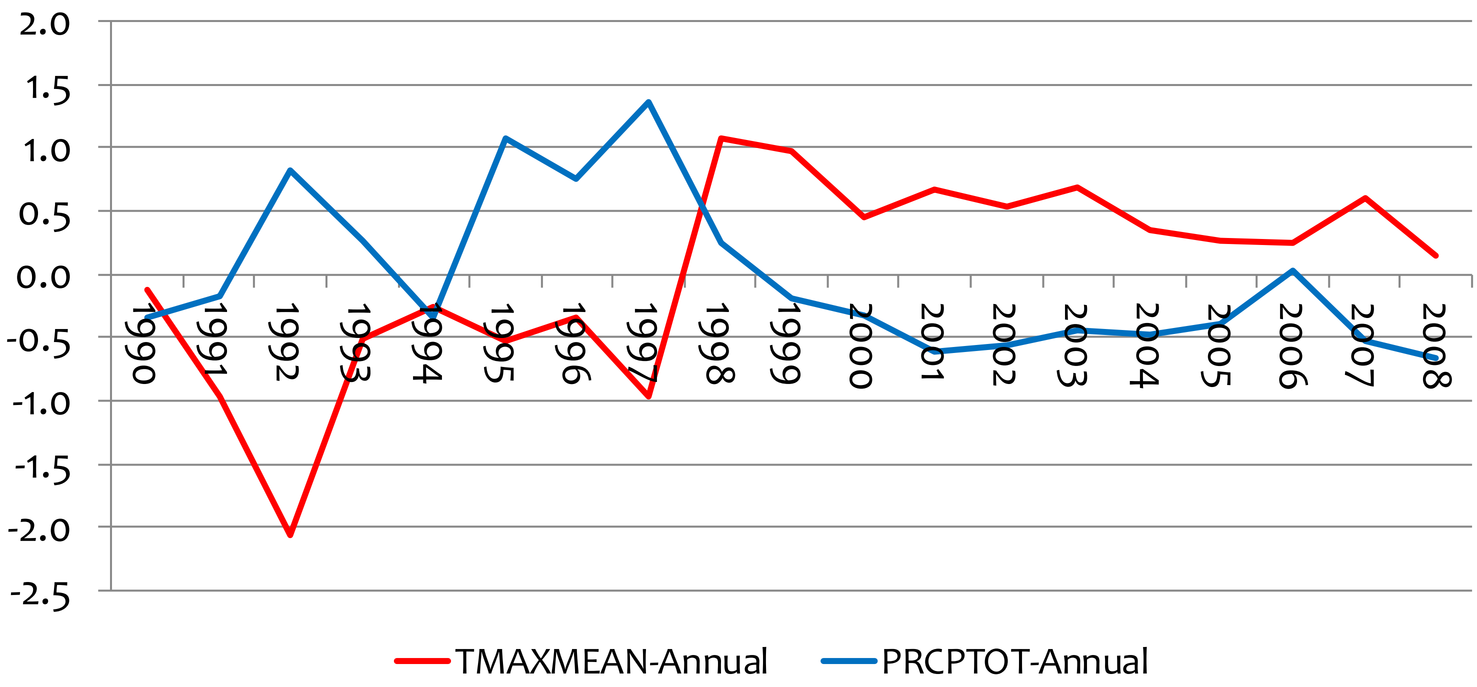
Probabilistic Multi-Model Ensemble Forecast
Beijing,CPTEC,ECMWF,Exeter,Melbourne,Montreal,Moscow,Seoul,Tokyo,Toulouse,
850hPa Meridional Wind : JJA2021
(issued on May2021)
90N
60N
30N
0
30S
60S
90S
0
30E
60E
90E
120E
150E
180
150W
120W
90W
60W
30W
0
Below-Normal
Near-Normal
Above-Normal
80
70
60
50
40
0
40
50
60
70
80
0
40
50
60
70
80
[%]


Probabilistic Multi-Model Ensemble Forecast
Beijing,CPTEC,ECMWF,Exeter,Melbourne,Montreal,Moscow,Seoul,Tokyo,Toulouse,
850hPa Zonal Wind : JJA2021
(issued on May2021)
90N
60N
30N
0
30S
60S
90S
0
30E
60E
90E
120E
150E
180
150W
120W
90W
60W
30W
0
Below-Normal
Near-Normal
Above-Normal
80
70
60
50
40
0
40
50
60
70
80
0
40
50
60
70
80
[%]


Probabilistic Multi-Model Ensemble Forecast
Beijing,CPTEC,ECMWF,Exeter,Melbourne,Montreal,Moscow,Seoul,Tokyo,Toulouse,Washington
Mean Sea Level Pressure : JJA2021
(issued on May2021)
90N
60N
30N
0
30S
60S
90S
0
30E
60E
90E
120E
150E
180
150W
120W
90W
60W
30W
0
Below-Normal
Near-Normal
Above-Normal
80 70 60 50 40 0 40 50 60 70 80 0 40 50 60 70 80 [%]

Climate Change Impacts over Arabia

1- standardize timeseries (extremes and monthly for annual/seasons)



Almazroui (2012)

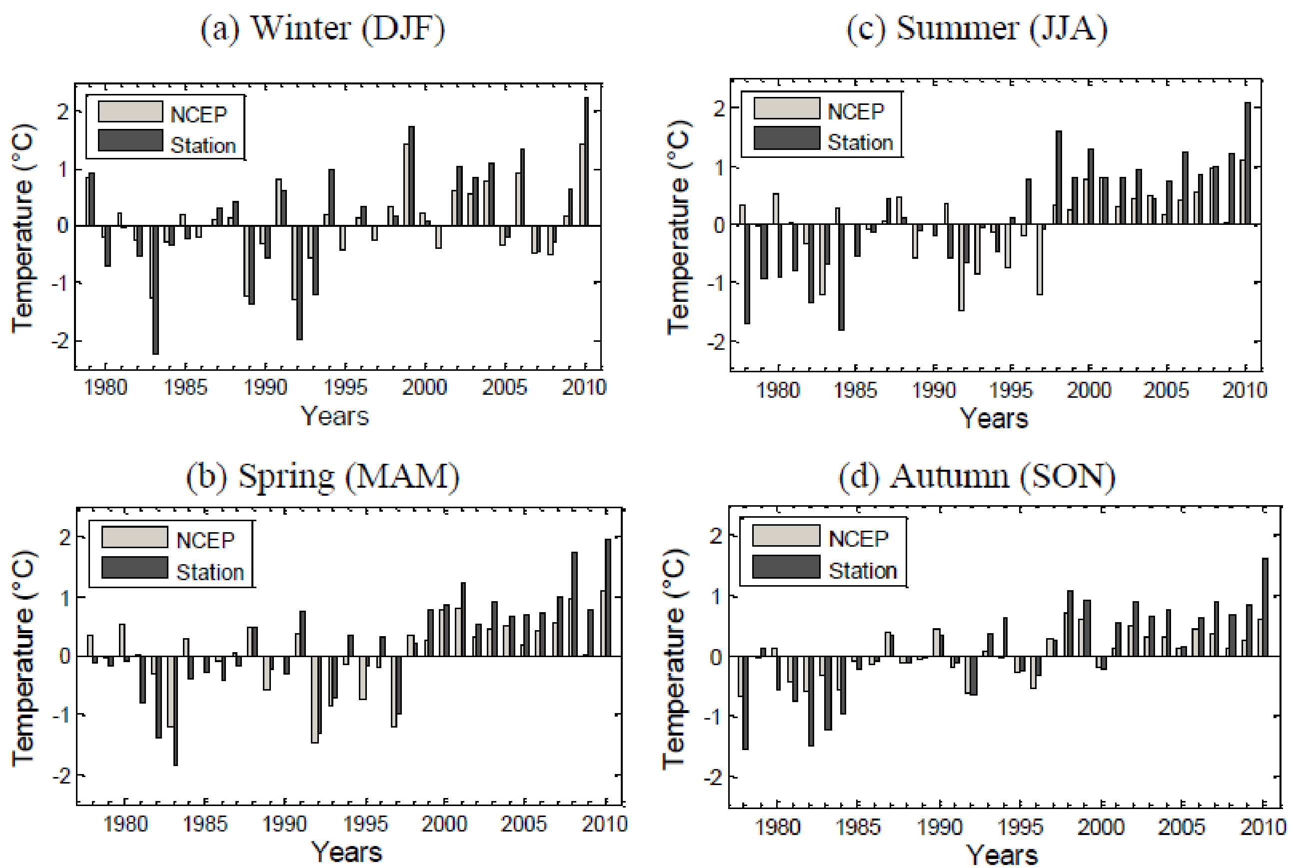
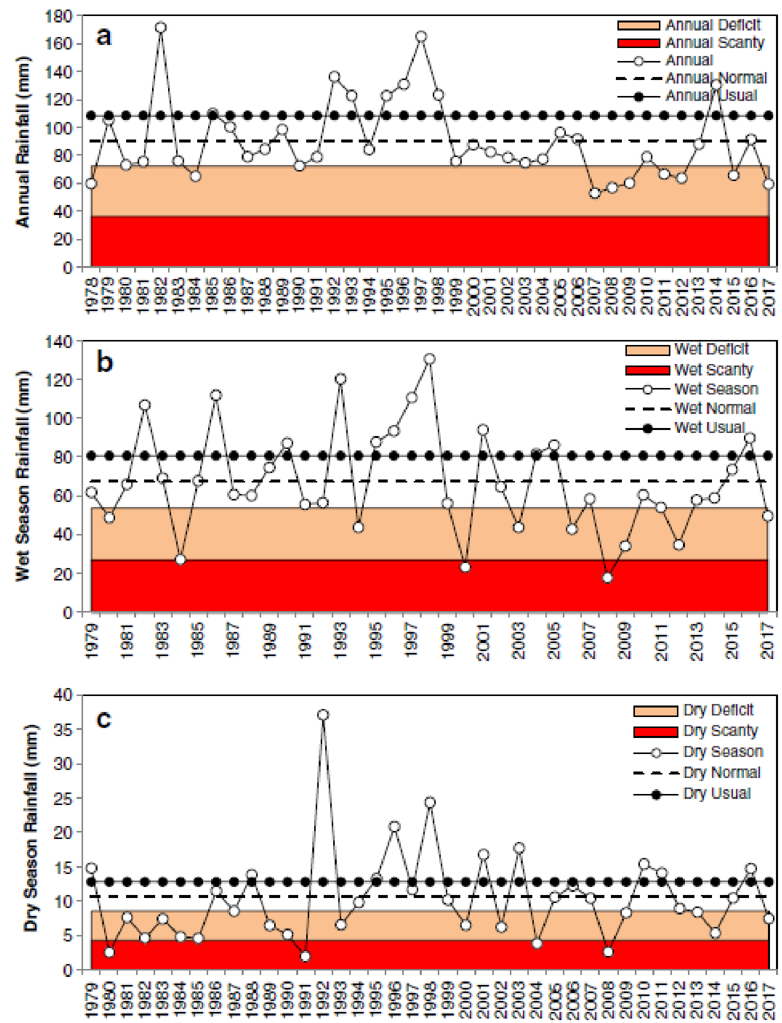


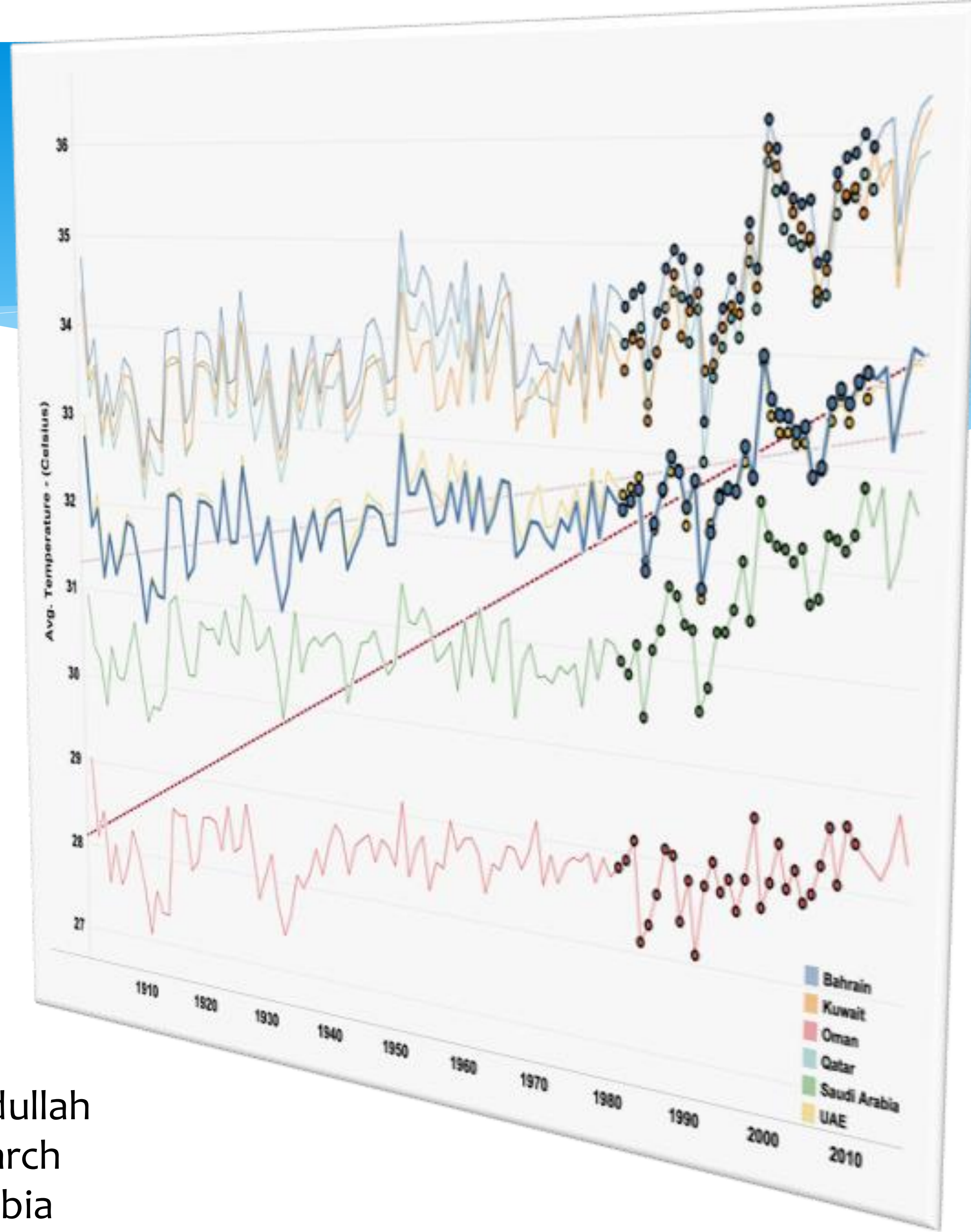
Fig. 4. Area averaged mean temperature anomalies obtained from the observed and the NCEP data for the (a) Winter, (b) Spring, (c) Summer and (d) Autumn seasons. The anomaly is taken with respect to the reference period 1978-2010.

AlMazroui (2019)

Fig. 4 The time sequences of **a** annual, **b** wet season, and **c** dry season rainfall (mm) with their classes obtained from the observed dataset. The normal (country average from 27 stations), deficit (20% below normal), scanty (60% below normal), and surplus (within ± 20% of normal) are used to identify drought year over the country



Average Annual GCC Summer Temperature (May-September 1981-2010). Source: World Bank Group.



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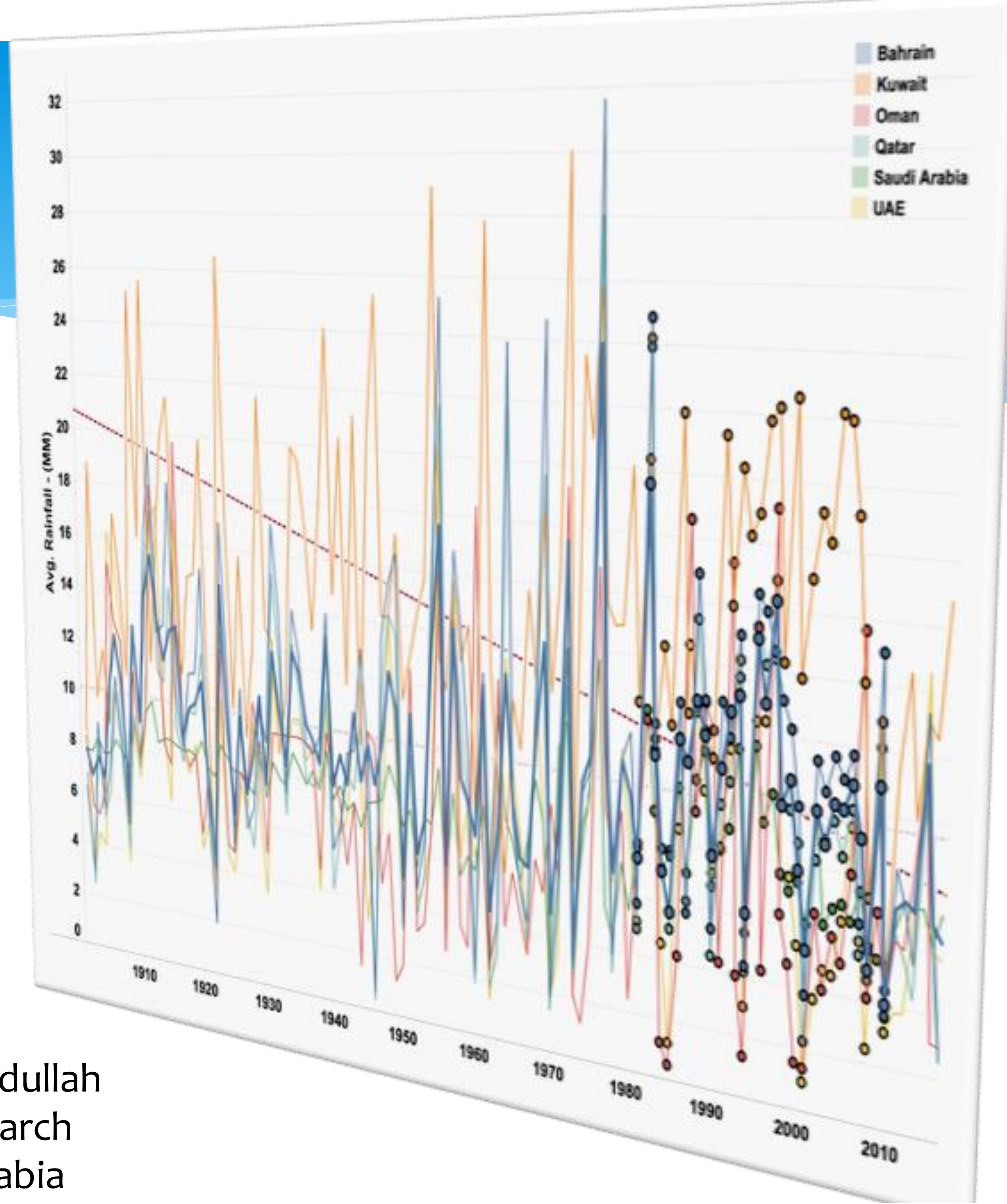
Average Annual GCC Rainfall (October-April 1901-2016). Source: World Bank Group.



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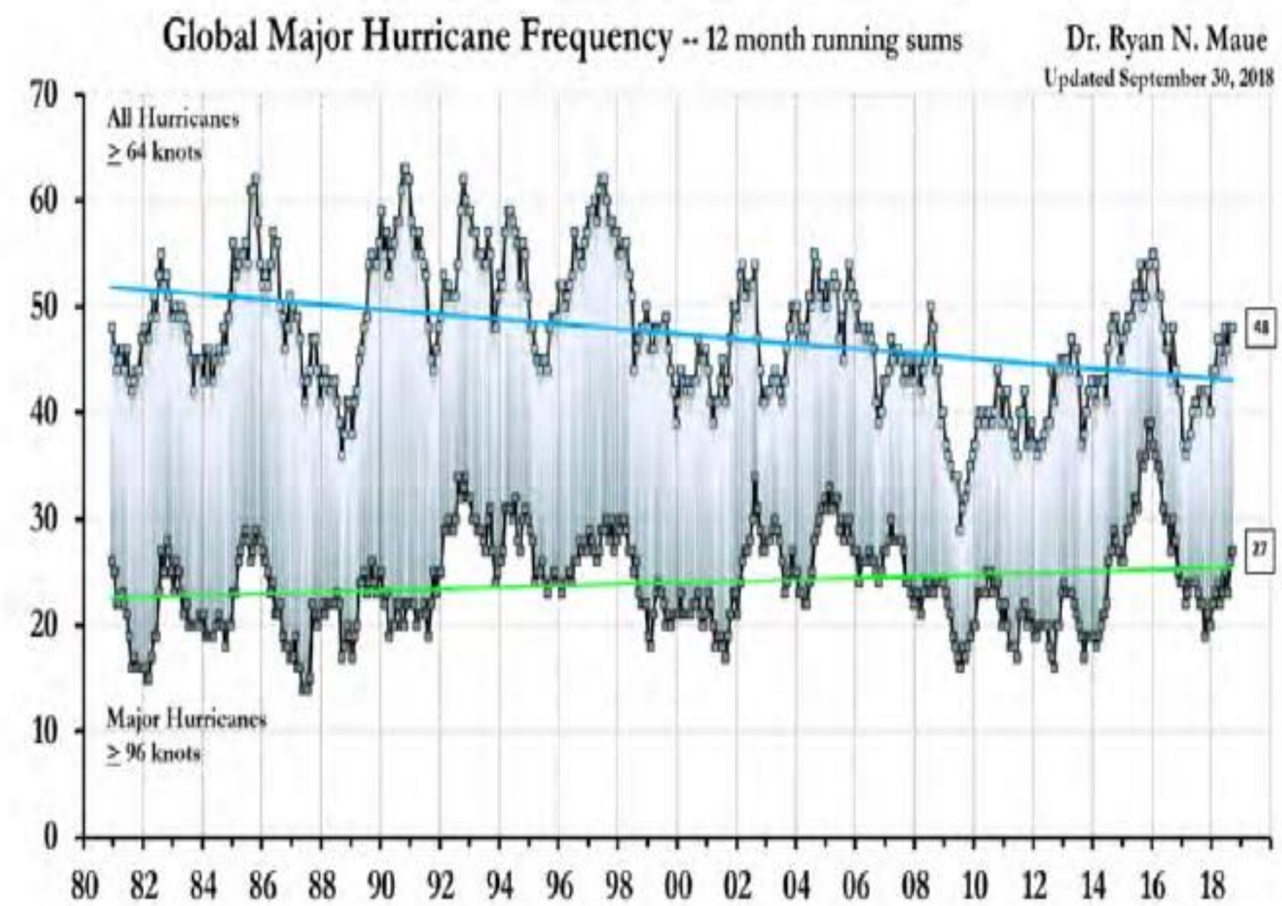

Figure 3.1: Global Hurricane Frequency (all & major) since 1981 – 12-month running means. The top time series is the number of global tropical cyclones that reached at least hurricane-force (maximum lifetime wind speed exceeds 64-knots). The bottom time series is the number of global tropical cyclones that reached major hurricane strength. Source: Maue (2018).

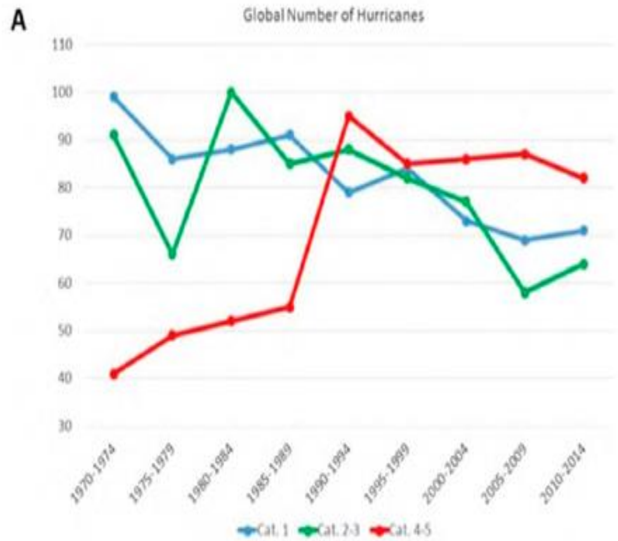

Figure 3.3. (a) Pentad total of the number of hurricanes that achieved a maximum intensity of each category grouping as delineated by the Saffir–Simpson scale. (b) As in (a), but for the percentage of total hurricanes achieving each category grouping. Klotzbach and Landsea (2015)

Other Possible Important Teleconnections

- Charabi and Al-Hatrushi (2009) found that : According to the data, a major part of Oman Winter Rainfall (OWR) is controlled by a large scale process coupled with two main anticyclonic centers, i.e. the Azorian and **Siberian Highs**.
- Raziei et al. (2008) reported that: Winter precip modulated by interaction Siberian high and ENSO.
- Hasanean et al (2012) found that **Siberian High Index (SHI)** is positively correlated to surface air temperatures over Saudi Arabia, and this is statistically significant in the western and north-western regions.
- Hafez and Almazroui (2012) indicated that the present studies uncover the climatic relationship between the **anomalies in geopotential height over Europe** and weather conditions over KSA. The results revealed that air current aloft in the upper atmosphere over Europe, blocking systems, and climatic indices (NAO, SOI and El Nino3.4) have played a great role to impact full control of the weather conditions over KSA through the study period 1948–2012.
- Hasanean and Almazroui (2015) draw the attention of the role of the strength and **oscillation of subtropical jet stream** play a big role in pulling hot, dry air masses of Saudi Arabia.
- Hasanean and Almazroui (2016) found that the change in **Indo-Pacific warm pool (IPWP) SST** can be considered as one of the factors linked to increase surface air temperature over Saudi Arabia.

Final remarks

* La Niña event is coming close to its end.
* NINO.3 SST is likely to return to a neutral level in boreal spring (80%).
* ENSO-neutral conditions are likely to continue during boreal summer and autumn (70%).
* IOD is expected to continue weak and neutral.
* Drivers conditions suggest more probability for near normal to above normal Temp (while southern coast and Yemen might receive below normal Temp) and no clear signal for Precip.
* Climate change may contribute to increasing temperature in the upcoming JJA season.