Global Disastrous Weather Report in June 2023

Abstract: In June 2023, the global average temperature was 0.53℃ higher than that in the same period of the year, breaking the previous average temperature record of June 2019. South Asia, Southeast Asia, East Asia, South America and other places have successively experienced high temperature and heatwave, among which the highest temperature in Sheikhpura in North India has reached 45.1℃. The heat wave caused power shortage and serious casualties in northern India. Tropical Strom Biparjoy was generated over North Indian Ocean on June 7. Affected by it, rainstorm or heavy rainstorm occurred in Pakistan and parts of western India, resulting in 27 deaths, including 8 children, and 147 injuries in Khyber Pakhtunkhwa Province, northwest Pakistan.

1. Overview of global weather

In June 2023, most of the middle and high latitudes in the Northern Hemisphere experienced unusually higher temperatures compared to the same period in previous years. Notably, northwestern Europe, including Ireland, the UK, Belgium, and the Netherlands, recorded the highest temperatures ever observed for this time of year. However, certain regions in the southern Balkans, Greece, Turkey, and western Russia did not witness such temperature increases. In the North Atlantic, there were abnormally high sea surface temperatures, leading to ocean heat waves around Ireland and Britain. Additionally, El Niño continued to develop over the eastern equatorial Pacific Ocean. Abnormal warmth was also observed in the Weddell Sea, with relatively moderate temperatures extending northward to encompass most parts of the South Atlantic, Indian Ocean, and Pacific Ocean. The entire tropical region and most parts of the North Pacific experienced temperatures higher than the average levels recorded from 1991 to 2020. In contrast, regions spanning from southeast South America to the Amundsen Sea, southeast Australia, southern Africa, and western North America experienced temperatures lower than the historical average (Fig. 1). Moreover, numerous stations in Indo-China Peninsula, Central Asia, eastern North America, eastern Australia, and southern Africa, among other locations, surpassed historical temperature records, reaching extreme values (Fig. 2). These observations indicate widespread high temperatures and heatwaves in the Northern Hemisphere while also highlighting that, despite June marking the gradual entry into the winter half-year for the southern hemisphere, cold air remained weak in many areas, resulting in relatively high temperatures.

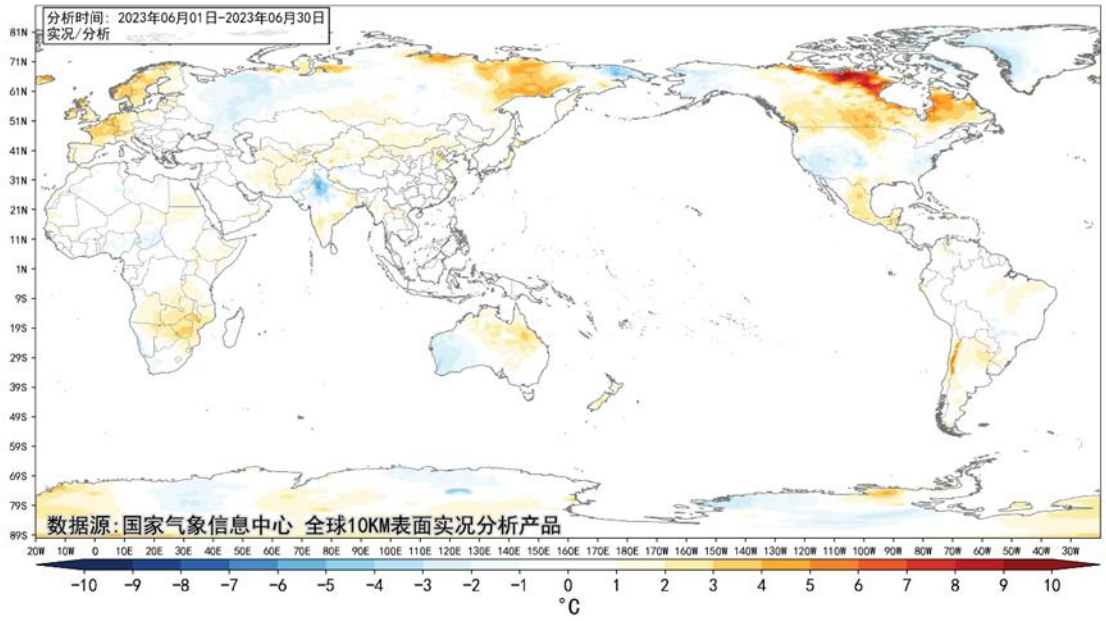

Fig.1 Monthly 2m temperature anomaly in June 2023 (unit:℃)

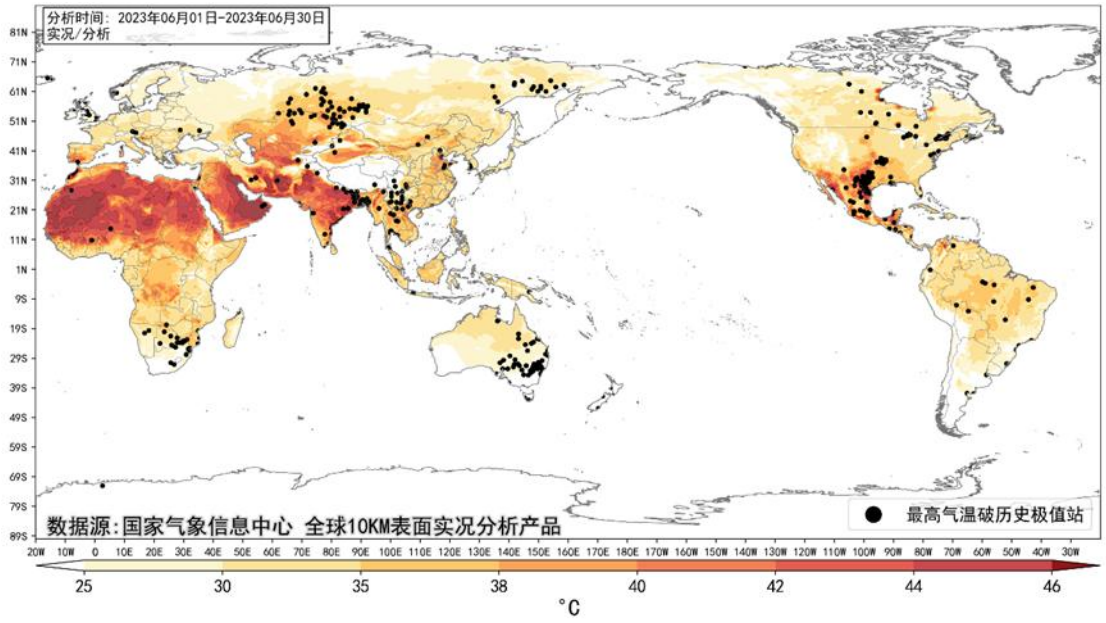

Fig.2 Maximum 2m temperature in June 2023 (unit:℃) and the stations breaking the historical extreme value in the same period (black dots)

In June 2023, the cumulative precipitation from India to Mainland Southeast Asia and southern North America was lower than the corresponding period in the previous year, primarily due to the influence of the relatively strong western Pacific subtropical high. Conversely, Pakistan, southwestern India, and the Mediterranean coast received significantly higher rainfall, experiencing 2-3 times more precipitation, while certain localized areas received up to 4 times more rainfall, a result of the combined impact of tropical cyclones and monsoons (Fig. 3).

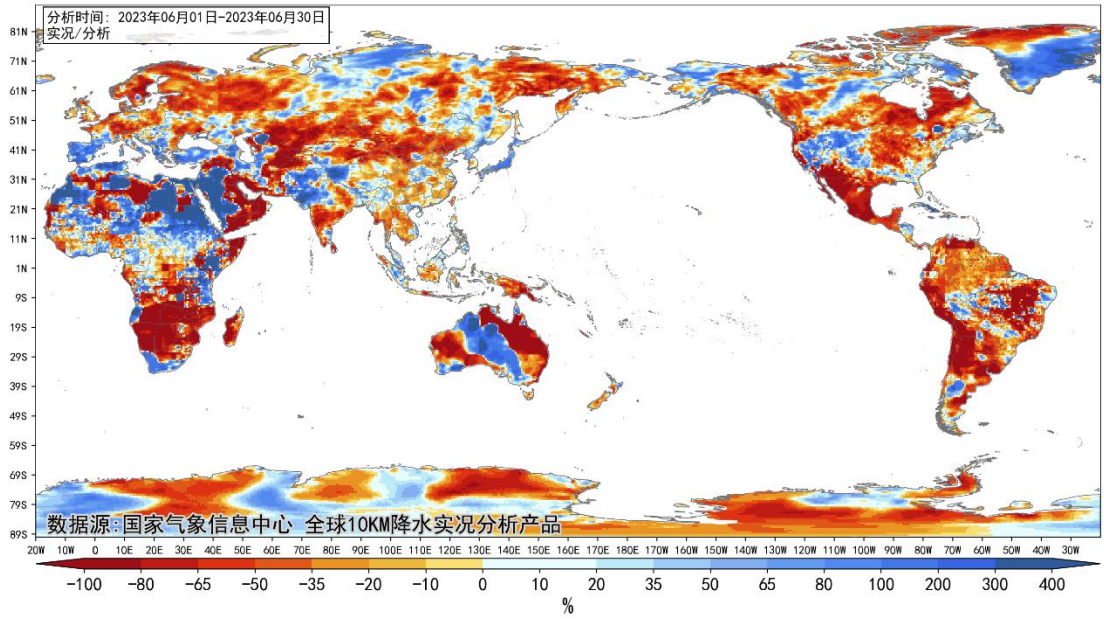

Fig.3 Monthly total accumulated precipitation percentage anomaly in June 2023（unit:%）

2. Severe weather

2.1 Brazil was hit by extratropical cyclone, resulting in 16 deaths

On June 16, an extratropical cyclone struck Rio Grande do Sul and Santa Catalina in southern Brazil, bringing heavy rain and strong winds. Within 24 hours, many places in Rio Grande do Sul and Santa Catalina received over 100 mm of precipitation, with Maquiné City, Rio Grande do Sul, recording more than 254 mm, resulting in severe flooding, flash floods, and landslides. The impact of the cyclone was extensive, affecting 41 cities in Rio Grande do Sul and 31 cities in Santa Catalina, leading to a tragic death toll of at least 16 people. Furthermore, 22 individuals in Rio Grande do Sul were reported missing in the aftermath of the disaster.

2.2 Intertropical Convergent Zone was active and heavy rainfall occurred in many countries at low latitudes

In June, the world experienced a total of 7 tropical cyclones, which was 1.8 more than the number generated during the same period in the previous year. These cyclones were named ARLENE, BRET, and CINDY in the North Atlantic region, GUCHOL in the Northwest Pacific, and ADRIAN and BEATRIZ in the Northeast Pacific. Additionally, there was a cyclone named Biparjoy in the North Indian Ocean. Among these cyclones, Biparjoy made landfall in Gujarat, Uttarapatha (as indicated in Table 1).

Table 1 Global Tropical Cyclone Activity Information for June 2023

Area	Name	Maximum Category	Dates	Land information（UTC+8）
North Atlantic	ARLENE	TS	June 2-3	/
West Pacific	GUCHOL	2	June 6-12	/

North Indian	BIPARJOY	3	June 7-16	Landed on the northwest coast of Gujarat, India on June 16th
North Atlantic	BRET	TS	June 20-25	/
North Atlantic	CINDY	TS	June 23-26	/
East Pacific	ADRIAN	2	June 28-July 2	/
East Pacific	BEATRIZ	1	June 30-July 2	/

2.3 Heatewaves in northern India caused heavy casualties

North India is facing severe and prolonged heatwaves, with the maximum temperature soaring to 44℃, leading to the tragic death toll of nearly 170 people. Meteorological data reveals that Ballia, Uttar Pradesh, experienced a scorching maximum temperature of 42.2℃ on June 16, which was 4.7℃ higher than the normal level. The capital city of Bihar, Patna, recorded a maximum temperature of 44.7℃, and the hottest area, Sheikhpura, even reached a scalding 45.1℃. Normally, India declares a heatwave when the temperature is at least 4.5℃ higher than the same period in the previous year or when the maximum temperature exceeds 45℃. The continuous heatwave has led to power outages in the affected areas, resulting in a shortage of tap water and the inability of cooling equipment such as fans or air conditioning to function properly. Moreover, hospitals are struggling to cope with the increasing number of patients as their capacity exceeds the daily load due to continuous power and cooling system interruptions.

3. Major disastrous weather processes and their main synoptic systems

3.1 The causes of high temperature and heatwaves in India

Since June 2023, parts of the eastern Indian Peninsula, the Arabian Peninsula, and Central Asia have experienced extreme temperatures, surpassing 37℃, with some local areas exceeding 42℃. This has had a severe impact on the local ecological environment, agricultural production, and people's daily lives. As depicted in Fig.4, the circulation in the low latitude area of the Northern Hemisphere, stretching from the Arabian Peninsula to South Asia, has been stable. The geopotential height in the 5-30°N region, including India, has been unusually high, with the subtropical high system being significantly stronger, approximately 1 standard deviation higher than the average for the same period in previous years. This strengthened subtropical high has remained in place for an extended period. Furthermore, the lower atmospheric levels have experienced a prevailing southerly wind, contributing to higher temperatures in most parts of India compared to the same period in previous years. As June progressed, the subtropical high significantly intensified and expanded its influence northward, covering the northern part of the Indian mainland. In the early part of the last ten days of June, the strengthened subtropical high reached more than two standard deviations, leading to a prolonged and intense heatwave in northern

North India.

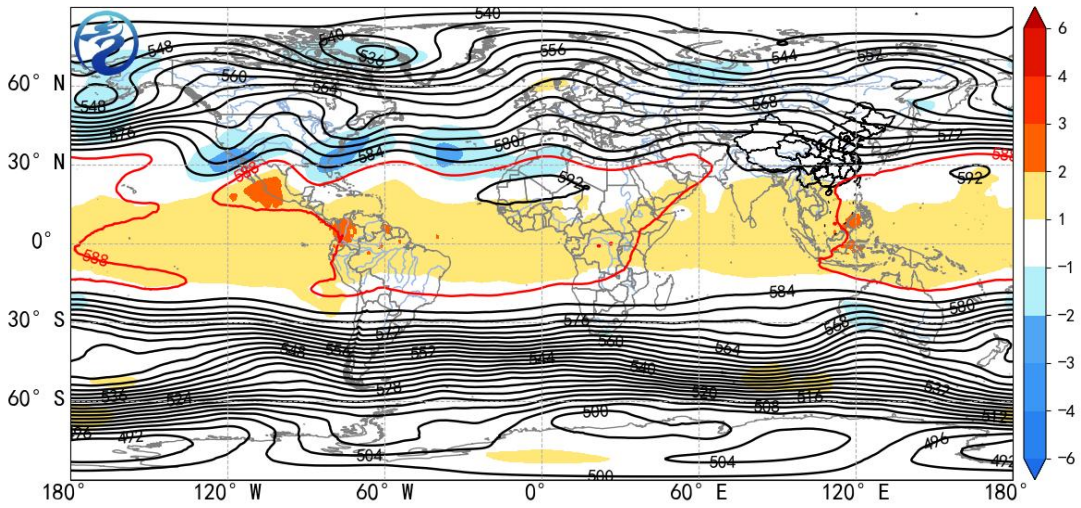

Fig.4 The geopotential height (contour, unit: dagpm) and its standardized anomaly (shading)

3.2 Tropical storm Biparjoy landed in India

Biparjoy originated in the Arabian Sea on the morning of June 7 (BT, the same below) and initially moved northward, gradually gaining intensity. By the morning of June 8, it had transformed into a super tropical storm and later altered its course, moving northeastward starting from the 14th. In the early hours of June 16, Biparjoy made landfall on the northwest coast of Gujarat, India, with maximum winds near the center reaching 30 m/s. Upon landing, its intensity decreased, and by 20:00 on the 16th, it weakened into a tropical storm in northern Gujarat, India. Subsequently, at 02:00 on the 17th, it further weakened into a deep depression in southeast Pakistan. The impact of Biparjoy resulted in cumulative precipitation of 100-250 mm in northwestern India and southeastern Pakistan, with some isolated areas receiving up to 300 mm of rainfall, leading to widespread flooding in the affected regions.

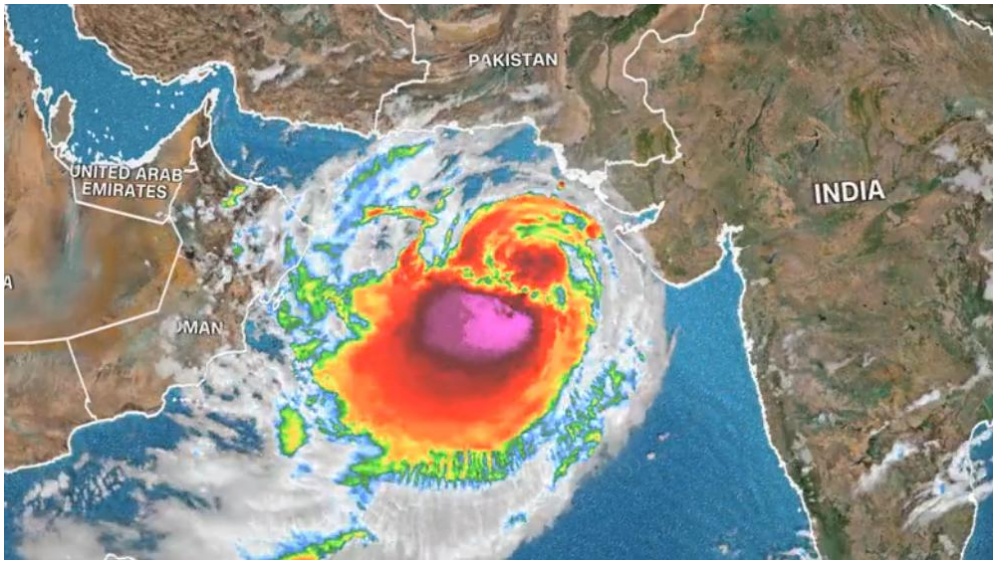

Fig.5 Satellite infrared monitoring image of tropical storm Biparjoy (14:00 BT, June

15, 2023)

4. Outlook

The weather forecast for the next two weeks indicates that the middle and eastern regions of Eurasia will experience relatively high temperatures. Specifically, northern Siberia, Central Asia, most of East Asia, Southeast Asia, northern Africa, eastern North America, and northern South America are expected to be 2-3℃ warmer than the same period last year. In contrast, western Europe, eastern America, southern South America, and central and western Australia will experience significantly lower temperatures. The regions with the highest expected rainfall in the world are primarily located in northern Europe, central India, Southeast Asia, and eastern North America. Tropical cyclones will impact the Philippines, Bangladesh, and Thailand, leading to considerable precipitation in these areas, with moderate to heavy rain expected. Some regions may even experience rainstorms or heavy rainstorms due to the influence of these tropical cyclones.