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Characteristics and Causes Analysis of Abnormal Summer Monsoon and Meiyu in 2020

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Meiyu is the most important process in the rainy season in eastern China. The abnormality of the Meiyu will bring severe droughts and floods to the middle and lower reaches of the Yangtze River. Based on the ERA-5 reanalysis dataset of European Centre for Medium-Range Weather Forecasts (ECMWF) and CMORPH precipitation data, the characteristics of abnormal Meiyu and associated large scale circulation during the Meiyu period of 2020 in China are analyzed. The specific conclusions are as follows:

(1) There were obvious regional characteristics of Meiyu in 2020 in China. The Meiyu onset date over monitoring regions was 7 days earlier than normal. The Meiyu outset date was 15 days later than normal with a 22-days longer duration. The precipitation during the Meiyu period was uneven in time and space with more than double of normal Meiyu precipitation, which was ranked the second place after 1954 since 1951. Furthermore, the daily average precipitation was also stronger. The Meiyu onset (outset) date over regions to the south of Yangtze river, over the Yangtze River basin and Yangtze-Huaihe basin were 7(3), 5(18), 11(18) days earlier(later) than normal, respectively. The Meiyu in the Yangtze River basin was the strongest with the amount of 753.9mm.

(2)The combined effect of the winter and summer seasonal adjustments and the significant advancement of the transition of the upper, middle, and lower tropospheric circulation systems has led to an early onset of Meiyu to the south of the Yangtze River in 2020, that is, in the middle of May, the westerly jet in the upper troposphere strengthened its northward jump with obvious increasing of jet to 45 m/s. In addition, the West Pacific Subtropical High (WPSH) also strengthened the northward jump over 18°N maintaining for one week. At the same time, summer monsoon in the low-level began to intensify and pushed northward to the north of 26°N, bringing plenty of water vapor to the south of the Yangtze River; In the mid-June, the WPSH jumped to 28°N, and the westerly jet strengthened more than normal. The WPSH and the summer monsoon phased southward in mid-July, which caused the late outset in the Yangtze River basin and Yangtze-Huaihe basin. At the same time, the low-level southwesterly jet had good correspondence with precipitation processes especially from the mid-June. During the Meiyu period, Eurasia in the middle-to-high latitudes was in the pattern of "one troughs and two ridges". The Ural Mountain and Okhotsk Sea were controlled by a strong high pressure ridge, and Baikal was in the low trough. The anomalous westward and southward movements of WPSH and the anomalous anticyclone observed in northeast China, which exerted a main effect on transportation of cold air and the abundant water vapor to the Meiyu regions, resulting in an abnormally high amount of precipitation.

(3) The decay of the El Niño event in the previous winter and the persistent warming of the Indian Ocean in spring and summer was also a main reason that caused the WPSH to be extremely strong during the Meiyu period in 2020.

In summary, it can be seen that the early onset and late outset of the Meiyu in 2020 is closely related to process of the East Asian atmospheric circulation system from winter to summer. The East Asian subtropical westerly jet and the first northward jump of the WPSH are important signals to the onset of

Meiyu. The amount of rainfall during the Meiyu period is mainly related to that whether the mid-high latitude circulation and the low-latitude subtropical circulation system can achieve a better configuration and stable maintenance. The strength and path of the cold air from the middle and high latitudes, and the strength of the water vapor transport carried by the subtropical circulation, which directly affects the amount and intensity of the rainfall, while the anomaly of the subtropical circulation system is mainly controlled by the anomalies of extra-sea temperature forcing in key regions such as the eastern Pacific and Indian Ocean.