National Climate Trend Outlook for Summer 2017: Postprint

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Abstract

Sea surface temperatures in the equatorial central and eastern Pacific are expected to remain neutral from spring through early summer 2017. During summer 2017 (June–August), the overall precipitation pattern across the country will be near climatological normal, with a low probability of large-scale flooding disasters. Precipitation is forecast to be slightly above normal in most of South China, the Huang-Huai River Valley, eastern North China, southern Northeast China, northern Northeast China, most of Xinjiang, and southern Tibet, with northern Xinjiang receiving approximately 20% more precipitation than normal. Precipitation in most other regions of the country will be slightly below normal. The number of landfalling typhoons in 2017 is expected to be near normal.

Full Text

Preamble

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Seasonal Climate Outlook for Summer 2017 in China*

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Abstract

The equatorial sea surface temperatures (SSTs) over the central and east-central Pacific are in a neutral state at present and would keep this state through the

coming spring and early summer of 2017, according to the real-time prediction result of the ENSO prediction system of Institute of Atmospheric Physics, Chinese Academy of Sciences (IAP, CAS). According to the seasonal rainfall prediction at IAP, in summer (June to August) of 2017, the overall rainfall situation in China tends to perennial, there is little possibility of a large extent of flooding. A wetter-than-normal condition is predicted for most parts of South China, the Huang-Huai basin, the eastern part of North China, the southern and northern parts of Northeast China, most parts of Xinjiang, and the southern part of the Tibetan Plateau, whereas the other parts of China will experience a drier-than-normal condition during the boreal summer. In this summer, the number of landing typhoons is predicted to be near normal.

Keywords: summer precipitation anomalies, climate prediction, landing typhoon

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Meteorological disasters are the most significant natural disasters affecting China. Studies have shown that from 1994 to 2013, meteorological disasters accounted for 55% of deaths and 87% of direct economic losses from all natural disasters in China [1]. Short-term climate trend prediction primarily focuses on forecasting temperature, precipitation, and meteorological disasters across seasons, which is of great significance for disaster prevention and mitigation.

Currently, there are two common approaches to short-term climate prediction internationally: (1) developing large-scale numerical models, as practiced by Europe, Japan, the United States, and South Korea; and (2) establishing statistical models for direct prediction or dynamical downscaling of numerical model results. Because China is located in the East Asian monsoon region with numerous factors influencing its climate, the prediction accuracy of numerical models for East Asian climate anomalies still cannot meet practical needs. Statistical models rely on the stability of relationships between predictors and predictands. Using only numerical models or statistical models for short-term climate prediction in East Asia cannot yield sufficiently accurate prediction information. In view of this, Chinese research and operational departments have developed a prediction system that combines dynamical models and statistical models.

The short-term climate prediction system of the Institute of Atmospheric Physics, Chinese Academy of Sciences (IAP) includes: an ENSO (El Niño/Southern Oscillation) prediction system, atmospheric general circulation models, ocean-atmosphere coupled models, statistical models, and dynamical-statistical models. ENSO events refer to abnormal warming or cooling of sea surface temperatures in the equatorial central and eastern Pacific. Due to the ocean' s enormous heat capacity, ENSO events exert tremendous influence on atmospheric circulation and global climate. They not only disrupt the normal distribution of convection and precipitation in the tropics, but tropical anomaly signals also propagate through atmospheric internal dynamical processes to affect mid- and high-latitude atmospheric circulation [Figure 1: see original

paper]. Therefore, ENSO is the most important external forcing for global interannual climate variability and the primary signal of concern for seasonal prediction. The ENSO large-ensemble prediction system developed at IAP can predict the formation, development, and decay of ENSO events one year in advance, representing a world-class forecasting capability. IAP' s short-term climate prediction process begins with the ENSO prediction system providing sea temperature evolution in the equatorial Pacific region to numerical models and some statistical models. Next, under the forcing of predicted sea temperature anomalies, numerical and statistical models predict atmospheric circulation patterns. Based on estimates of atmospheric circulation conditions, combined with predictions of temperature and precipitation from multiple models and statistical models, and after expert consultation, final prediction opinions are provided to relevant departments [Figure 1: see original paper]. Through years of prediction practice, this system' s forecasting skill has gradually improved and matured.

2. Summer 2017 Climate Trend Prediction

2.1 Atmospheric and Oceanic Precursor Signals

According to monitoring by the U.S. Climate Prediction Center, SSTs in the Niño3 region have transitioned from cold to warm anomalies around mid-January 2017, while SSTs in the Niño3.4 and Niño4 regions to its west remain in cold anomalies [2]. Figure 2 shows the IAP ENSO prediction system' s forecast for SST anomalies in the Niño3.4 region. It can be seen that from spring to early summer 2017, Niño3.4 SSTs will remain in a neutral phase (i.e., SST anomalies within ±0.5°C).

Based on sea temperature evolution provided by the IAP ENSO prediction system and predictions from the IAP-AGCM(2L) atmospheric general circulation model and the newly developed IAP-AGCM4.1 atmospheric general circulation model, northerly wind anomalies will control northern China in summer 2017 [Figure 3: see original paper]. For short-term climate prediction, IAP has for the first time in 2017 employed a short-term climate prediction system based on the Chinese Academy of Sciences Earth System Model (CAS-ESM-C, an ocean-atmosphere coupled model). Its prediction of wind field anomalies in northern China is basically consistent with the above model results. Such wind field anomalies are conducive to above-normal precipitation in northern China.

The Western Pacific subtropical high is one of the most important circulation systems affecting summer precipitation in China. During summer, precipitation in eastern China occurs mainly on its northwest side, while areas under its control typically experience hot and sunny weather [2-8]. According to predictions from the IAP-AGCM(9L) and IAP-AGCM4.1 atmospheric general circulation models and the NZC-PCCSM4 ocean-atmosphere coupled model, the Western Pacific subtropical high will be stronger and shifted westward in summer 2017, with its northern boundary extending northward, favoring a northward shift of

the rain belt [Figure 4: see original paper].

China is located in the East Asian monsoon region. As the monsoon advances northward, the summer rain belt exhibits distinct intraseasonal variations, generally divided into: the South China pre-flood season (mid-May to early June), the Yangtze River Meiyu period (mid-June to mid-July), and the North China rainy season (late July to August). Studies show that during the decaying phase of La Niña events, precipitation during the South China pre-flood season and Meiyu period is mainly concentrated in South China [9,10] [Figure 5: see original paper].

In addition to sea temperature, snow cover is another important factor affecting China' s summer climate. Land-sea thermal contrast is the direct cause of the East Asian monsoon. In summer, the continent is warmer and the ocean relatively cooler, resulting in southerly winds over China. In winter, the land-sea thermal contrast reverses, and northerly winds prevail. When continental snow cover is above normal in winter, snowmelt is slow from spring to summer, continental warming is slow, land-sea thermal contrast decreases, and the summer monsoon tends to be weaker [11]. Studies have shown that Eurasian snow cover and Tibetan Plateau snow cover are important factors affecting summer precipitation in China [12-15]. Recent research indicates that the area of new snow cover in northern Eurasia during winter has a significant relationship with summer climate anomalies in China. When the area of new snow cover is larger, precipitation decreases from Jiangnan to South China. Moreover, the impact of new snow cover in Eurasia on China' s climate is independent of ENSO events [16]. Under neutral ENSO conditions in 2017, oceanic signals may be weak, making the snow cover influence potentially more important. In the winter of 2016/2017, the area of new snow cover in northern Eurasia was the third smallest since 1967, which is conducive to above-normal summer precipitation in South China.

Based on the above dynamical numerical model results and statistical model results, we predict that in summer 2017, the overall precipitation situation across China will be near normal. Most parts of South China, the Huang-Huai basin, eastern North China, southern Northeast China, northern Northeast China, most parts of Xinjiang, and southern Tibet will experience slightly above-normal precipitation, with precipitation in northern Xinjiang about 20% above normal. Most other parts of China will have slightly below-normal precipitation [Figure 6: see original paper].

3. Conclusion

According to the IAP ENSO prediction system, sea surface temperatures in the equatorial central and eastern Pacific will be in a neutral phase from spring to early summer 2017. Against this sea temperature background, the overall precipitation situation in China for summer 2017 will be near normal, though some regions may experience above- or below-normal conditions. It is predicted

that most parts of South China, the Huang-Huai basin, eastern North China, southern Northeast China, northern Northeast China, most parts of Xinjiang, and southern Tibet will have slightly above-normal precipitation, with northern Xinjiang receiving about 20% more precipitation than normal. Most other regions of China will have slightly below-normal precipitation.

It should be noted that currently important external forcing signals such as oceanic conditions are not prominent, so there is some uncertainty in this prediction of China's summer 2017 climate trend. Therefore, we will closely monitor the latest oceanic and atmospheric observations and timely update the prediction results.

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Note: Figure translations are in progress. See original paper for figures.