Open Journal of Applied Sciences, 2023, 13, 1440-1445
https://www.scirp.org/journal/ojapps
ISSN Online: 2165-3925
ISSN Print: 2165-3917

Pacific Sea Surface Temperature Effect Summer Rainfall in Huanghuai, Jianghuai Region in China

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How to cite this paper: Liu, T.T. and Wang, X. (2023) Pacific Sea Surface Temperature Effect Summer Rainfall in HuangHuai, JiangHuai Region in China. *Open Journal of Applied Sciences*, **13**, 1440-1445.
https://doi.org/10.4236/ojapps.2023.138114

Received: July 21, 2023
Accepted: August 28, 2023
Published: August 31, 2023

Abstract

Summer Precipitation in Eastern China was closely related to the global sea surface temperature field. In this paper, the impact of the main sea surface temperature anomaly on flood season precipitation in China's Huanghuai and Jianghuai regions is examined as an external forcing factor for short-term climate prediction. Through analysis of global sea surface temperature anomalies and regional anomalies in Huanghuai and Jianghuai, a significant effect related to the main area, the North Pacific region, and the Nino3 corresponding index calculation is found. Various key areas are examined for their relevance, and finally, the mechanism of summer precipitation in two key zones, China's Huanghuai and Jianghuai regions, is briefly discussed. The main implication is the prediction of season precipitation based on the external forcing signal of sea surface temperature anomaly in China's Huanghuai and Jianghuai regions.

Keywords

Summer Rainfall, Sea Surface Temperature, II Rain Type, Relative

1. Introduction and Background

Zhang *et al.* (2003) [1] shows that the summer precipitation in China has obvious regional differences in recent years, which are mainly closed to the relationship between changes in summer rainfall and East Asian monsoon. The summer rainfall in China increased in the southeast and northwest regions, and the precipitation between the two regions decreased and the floods in the southeast of China were serious. Its rainfall has reduced in the north and northeast. The drought disaster in southwest China, therefore, is frequent.

The summer precipitation in China is relatively low in 1970 and 1980, and relatively high in 1960, 1990, 2000 and 2012, especially in 1990. The precipitation in 2000 has been lower than that in 1990, but still higher than the national average for summer precipitation.

The factors affecting the summer precipitation in China are mainly SST anomalies. Besides, the soil moisture, snow cover, vegetation, polar ice and so on, directly or indirectly affect the characteristic of rainfall in the flood season.

In this paper, the influence of SST in different regions on summer rainfall in East China, especially focusing on the Huanghuai River basin is introduced. The huge heat capacity of the ocean makes the sea temperature change have obvious lag and persistence. It stores the information of atmospheric change. The unique nature of the ocean makes the interaction of sea and air a factor that is important for short-term climate change.

Based on the comprehensive analysis of sea surface temperature and meteorological factors (**Figure 1**), seven key areas of global air-sea interaction were identified: ME-P, WP, MN-P, NW Pacific (MN-P), Northwest Atlantic (NW-A), Southern Indian Ocean (S-IND) and Central Pacific (MP (S)).

2. Data and Analysis Methods

During the process of data processing, we first screened the global sea temperature 2˚ × 2˚ grid data from 1961 to 2010, so as to eliminate the extraneous forcing factors such as sea ice, land soil temperature and so on, which affect the summer precipitation in China. And the original data of sea surface temperature was preserved. In addition, this paper only studied the influence of pre-winter on summer precipitation in China, and the final data were the global pre-winter SST in December 1961. Secondly, the one-dimensional sequence of the mean precipitation in March was calculated from the summer precipitation data of the Yellow River in the summer of the Yellow River in the three months. Finally, the one-dimensional time-series correlation with global SST was calculated.

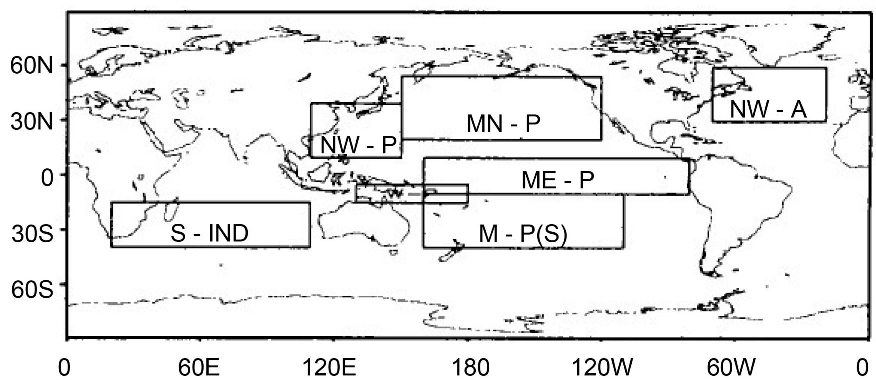

Figure 1. Global sea surface temperature distribution of the key region (Zhao and Zhu, 2008) [2].

In addition, correlations between the SST could be removed using the associated de-linear trend (M *et al.*, 2008) [3], with independent effects on the correlation between precipitation and SST.

$$R_{xy} = \frac{\sum_{i=1}^{n}\left[x(i)-\bar{x}\right]\left[y(i)-\bar{y}\right]}{\sqrt{\sum_{i=1}^{n}\left[x(i)-\bar{x}\right]^2 \times \sum_{i=1}^{n}\left[y(i)-\bar{y}\right]^2}}$$

In this paper, the summer precipitation in the Huanghuai and Jianghuai regions was averaged over a period of three months, and the time series was correlated with the global sea surface temperature. The key area of SST affecting regional precipitation in China could be obtained.

To find out the index of the key area corresponding to SST, and it made pointwise correlation distribution with the summer rainfall in China.

During the process of data processing, we first screened the global sea temperature 2˚ × 2˚ grid data from 1961 to 2010, so as to eliminate the extraneous forcing factors such as sea ice, land soil temperature and so on, which affect the summer precipitation in China. And the original data of sea surface temperature (SST) was preserved. In addition, this paper only studied the influence of pre-winter on the summer precipitation in China, so the final data were the global pre-winter SST in 1961. Secondly, the one-dimensional sequence of the mean precipitation in March was calculated from the summer precipitation data of the Yellow River in the summer of the Yellow River in the three months. Finally, the one-dimensional time-series correlation with global SST was calculated.

In addition, correlations among SST could be removed using the associated de-linear trend, with independent effects on the correlation between precipitation and SST (Bretherton, 2000) [4].

3. Results

3.1. Synthesis Analysis

In this paper, the typical rain years of 1961-2010 were used in 1962, 1963, 1965, 1971, 1972, 1975, 1979, 1982, 1984, 1989, 1990, 1991, 2000 (2˚ × 2˚) in 2003, 2005, 2007, 2008, 2009, and 2010, respectively. The results show that, for the Pacific region, the results were basically consistent with those in the literature (Zhao and Zhu 2008) [2]. It was pointed out in the literature that the main difference between SST anomalies was in two regions: the North Pacific and the equatorial eastern and Central Pacific. In the Yellow River and Huaihe River area, the main rain belt was located between the Yellow River and the Yangtze River. The interdecadal variation of the center was in the period from 1951 to 1975, Year was significantly less than the period, and from 2000 to 2010 rainfall was significantly higher than other years (Zhao and Liao, 1992) [5].

There (see **Figure 2**) were obvious negative anomalies in the Southeastern Pacific region extending to the Bering Strait during the early winter in the yearly

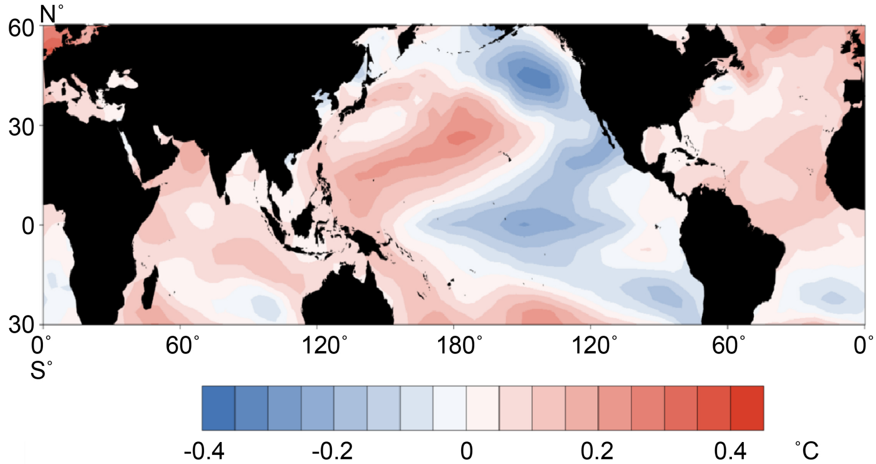

Figure 2. SST synthesis analysis (˚C).

precipitation in the Huanghuai during the following year. The westerly drift region was extended into the central North Pacific. The distribution was a positive anomaly in the Kuroshio.

The area near the Sea of Japan was obvious. This indicated that the precipitation in the Huanghuai and Jianghuai regions was normally in the southeastern Pacific southeast negative anomaly to the central and southwest positive anomalies.

In the eastern equatorial Pacific which was called the Nino region, a significant negative anomaly transition from the west to the east was observed for the positive anomaly of the sea surface temperature, which corresponds to the precipitation over the Huanghuai and Jianghuai area in the next year. The Nino key area affected the Huanghuai and Jianghuai region's summer precipitation.

3.2. Relationship between SST and Rainfall

The North Pacific, as the most significant area affecting the Huanghuai area, could be further tested by significance correlation. As shown in **Figure 3**, the SST anomalies in the central westerly drift region (35˚N - 45˚N, 170˚E - 170˚W) in the North Pacific Ocean were significantly positively correlated with precipitation in the Huanghuai and JAC regions, The SST anomalies in the southeastern North Pacific Ocean (20˚N - 45˚N, 120˚W - 170˚W) were consistent with the results of the above-mentioned synthetic analysis. The results showed that the lower the sea surface temperature was more prone to precipitation in the Huanghuai and Jianghuai areas. The negative anomaly of the SSTA in the northern Pacific was southeast of the allowable error range. The SST of the Pacific Ocean was obviously lower than that of the north and corresponds to the precipitation characteristics of China II rain type.

As was shown in **Figure 3** and **Figure 4**, the summer rainfall precipitation in the Huanghuai and Jianghuai regions was closely related to the SST in the western equatorial Pacific warm pool, which is similar to the results obtained in the former study shown in Wu *et al.* (2003) [6].

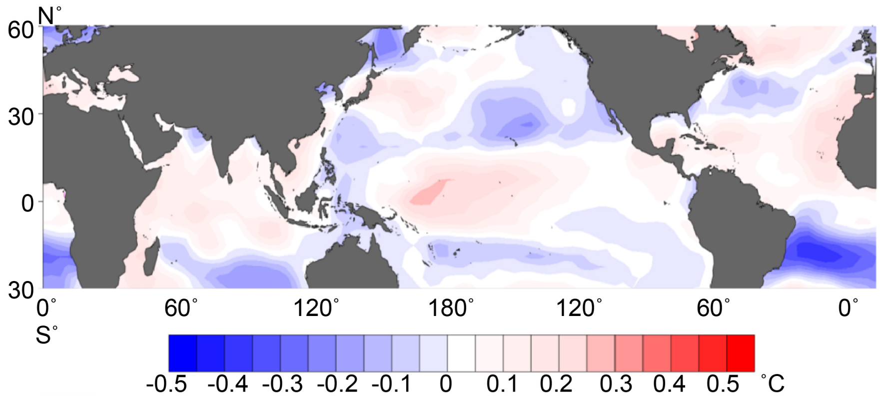

Figure 3. The linear trend for the world top winter SST and global sea surface temperature in summer rainfall region (˚C).

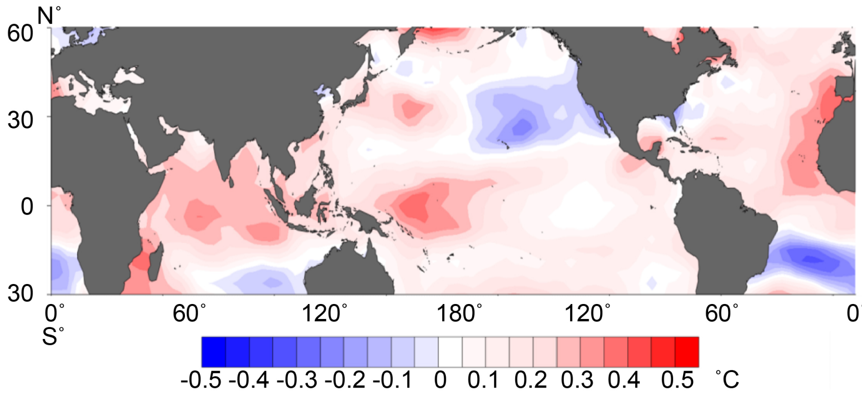

Figure 4. Global sea surface temperature in summer rainfall region to the linear trend and the world's top winter SST Related (˚C).

4. Summary

The key area of SST anomaly which is closely related to the summer rainfall in the Huanghuai and Jianghuai region is the key area of the North Pacific and the key area of Nino.

When the North Pacific Oscillation Index is weak, the precipitation in the Huanghuai and Jianghuai areas is correspondingly high, while the Huanghuai and Jianghuai areas are correspondingly high when the Southern Oscillation Index is strong.

The El Niño distribution in the central Pacific equatorial region of the central equatorial Pacific corresponds to the precipitation in the Huanghuai and Huaihe River regions. The central El Niño has a significant effect on the precipitation in the Huanghuai area and El Niño in the east. Therefore, in the flood forecasting period, the reference opinion of ENSO to flood season forecast should be analyzed from many factors.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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