The Relationships between Variations of Sea Surface Temperature Anomalies in the Key Ocean Areas and the Precipitation and Surface Air Temperature in China①

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ABSTRACT

The relationships between variations of sea surface temperature anomalies (SSTVA) in the key ocean areas and the precipitation / temperature anomalies in China are studied based on the monthly mean sea surface temperature data from January 1951 to December 1998 and the same stage monthly mean precipitation / temperature data of 160 stations in China. The purpose of the present study is to discuss whether the relationship between SSTVA and precipitation / temperature is different from that between sea surface temperature anomalies (SSTA) and precipitation / temperature, and whether the uncertainty of prediction can be reduced by use of SSTVA. The results show that the responses of precipitation anomalies to the two kinds of tendency of SSTA are different. This implies that discussing the effects of two kinds of tendency of SSTA on precipitation anomalies is better than just discussing the effects of SSTA on precipitation anomalies. It helps to reduce the uncertainty of prediction. The temperature anomalies have more identical responses to the two kinds of tendency of SSTA than the precipitation except in the western Pacific Ocean. The response of precipitation anomalies to SSTVA is different from that to SSTA, but there are some similarities.

Key words: Variations of sea surface temperature anomalies, Precipitation anomalies, Temperature anomalies, Statistical significance test

1. Introduction

Numerous researches have been done on the relationships between the sea surface temperature anomalies (SSTA) and precipitation / temperature anomalies in China, mainly including the relationships between SSTA and China's precipitation in different ocean areas (see Luo et al., 1985; Li et al., 1987; Chen and Wu, 1998, Wu et al., 1995) and in different seasons (see Tang, 1993; Fei et al., 1993), the impact of ENSO on China's precipitation (see Zhang et al., 1999; liu and Ding., 1995), the impact of SSTA on China's temperature and lower temperature in Northeast China (see Liu and Ding., 1995; Zheng and Ni, 1999) and so on.

Sea surface temperature (SST) is one of the major affecting factors of China's precipitation anomalies, but is not the only one. Therefore the effect of sea surface temperature anomalies (SSTA) on precipitation has somewhat uncertainty. For example, it is believed that

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SSTA of ENSO mode is closely related to droughts / floods in the middle and lower reaches of the Changjiang River, most drought years are connected with El Nino years except for 1969 (see Li et al., 1987). However, the correlation analysis indicates that the anomalies of precipitation in the lower reaches of the Changjiang River lag the SSTA of the equatorial eastern Pacific by about four months and there is an evidently positive correlation between them (see Fei et al., 1993). The increasing (decreasing) SST in the equatorial eastern Pacific will lead to the later increasing (decreasing) precipitation in the lower reaches of the Changjiang River. The results show that the precipitation anomalies in the middle and lower reaches of the Changjiang River caused by SSTA of ENSO mode are not significant in the flood period (Liu and Ding, 1995; Qian and Wang, 2000).

In fact, the SSTA itself is also varying. Under the positive SSTA, there can be positive anomalies of SSTA (SSTA increasing) or negative anomalies of SSTA (SSTA decreasing). So when we concern the effect of SSTA on climate, we should also pay attention to the variations of SSTA which is designated as SSTVA by us.

In this study, EOF, SVD, correlation analysis and a new composite method are used to analyze the effects of variational tendencies of SSTA in different key ocean areas on the precipitation in China. We try to investigate the effects of positive and negative SSTVA on the China's precipitation, respectively, and want to see whether it is helpful for reducing the uncertainty of prediction. Besides, we also want to verify whether the relationship between SSTVA and precipitation is different from that between SSTA and precipitation.

2. Data and methods

The data in this paper are the NCEP / NCAR reanalysis monthly mean SST during the period of 1951– 1998 and the 160–station precipitation / temperature data in the same stage in China.

Firstly, the seasonal mean SSTVA (that is the difference of two adjacent seasonal SSTA without the annual variation) over 48 years are analyzed by EOF and 5 main SSTVA regions are selected from the modes of large contribution. They are the middle eastern Pacific (180°–80°W, 10°S–10°N), the western Pacific (120°E–180°, 10°S–10°N), the South China Sea and the Philippines (100–135°E, 0°–20°N), the northwestern Pacific (120°E–180, 20–40°N) and the equatorial Indian Ocean (50–100°E, 10°S–10°N). Their distributions are shown in Fig. 1. Then the significantly correlated seasons between SSTVA in each key ocean area and the precipitation / temperature in China are determined by using SVD method. The precipitation / temperature in the seasons in which SSTVA have significant impacts is compounded and their significance test is made by t–test.

The composite significance level is tested by $t = [(M - m) / s]\sqrt{n-1}$, where t is a random variable with $n-1$ degree of freedom, n is the number of composition, M and s are the averaged value and standard deviation of precipitation in a composite season, respectively. The signal m is the seasonal mean precipitation over all years.

3. The significant correlation seasons between precipitation / temperature anomalies and SSTVA

The homogeneous correlation coefficients between seasonal SSTVA averaged in each key ocean area and the precipitation / temperature averaged in China by SVD are shown in Fig. 2 and Fig. 3. The left field is the regionally averaged seasonal SSTVA of each key ocean area in

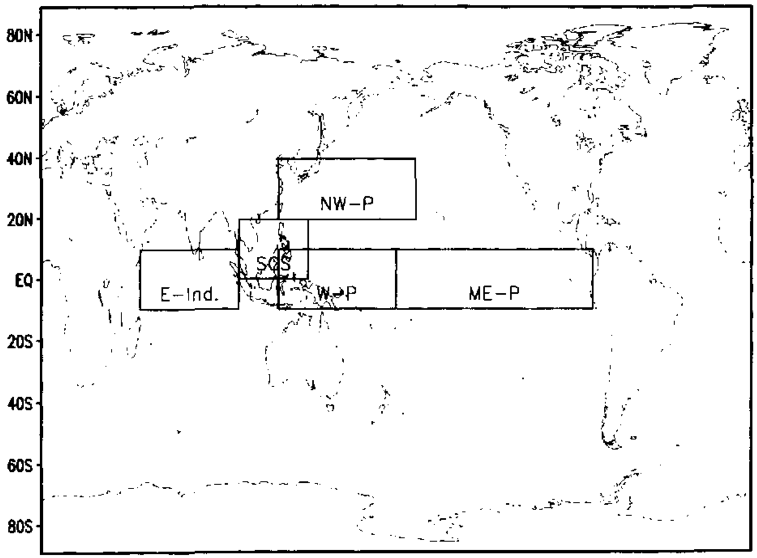

Fig. 1. The distribution of key ocean areas.

the previous and present years, while the right field is the regionally averaged seasonal precipitation / temperature anomalies in the present year. In the figures, from the top to the bottom are the middle eastern Pacific (ME–P), the western Pacific (W–P), the South China Sea and the Philippines (SCS–P), the equatorial India Ocean (Eq–Ind.) and the northwestern Pacific (WN–P), respectively. The leading two modes of each key ocean area are given. The x–axis is season, y–axis is the homogeneous correlation coefficient and the fine solid line is 0.05 level. The value in the brackets is the covariance of two fields.

The homogeneous correlation coefficient of SVD can reveal some information of teleconnection between the left and the right fields (see Jiang et al., 1995). Taking the middle eastern Pacific in Fig. 2 as an example, we find that the covariance coefficient of the two fields in the first mode is up to 85%, then it can be concluded that there is an evidently positive correlation between the SSTVA of the preceding spring, summer, autumn and the precipitation anomalies of the present spring, as well as a negative correlation between the SSTVA of the above same three seasons and the precipitation anomalies of the present winter. Besides, there is a negative and a positive correlation between SSTVA of the present spring and the same stage precipitation anomalies as well as the next winter's precipitation, respectively. Similarly, for the middle eastern Pacific in Fig. 3, there is an outstanding positive correlation between each season's temperature in the present year and SSTVA of the preceding spring, summer and autumn, as well as a negative correlation between the temperature of the above same seasons and the SSTVA of the same spring.

In order to verify whether the correlation seasons obtained by SVD reach the statistically significant level, we make a further analysis of these correlation seasons based on SVD by the classic correlation method. It is demonstrated that not all the correlation seasons gotten from

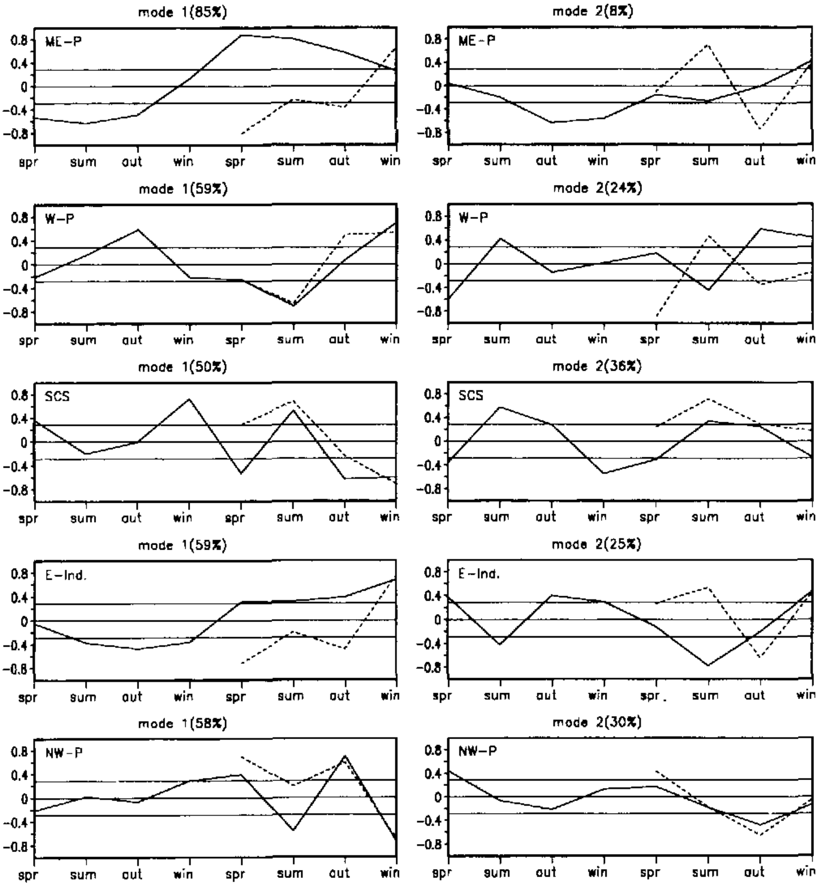

Fig. 2. The significant correlation seasons between precipitation anomalies (dashed line) in China and SSTVA (solid line) of each key ocean area.

the SVD can reach the statistically significant level. So in order to select the correlation seasons, we use the following three rules: 1) Those correlation seasons not only meet SVD teleconnection but also exceed the statistical level of 90% ($r \geqslant 0.26$); 2) the seasons of the SSTVA leading the precipitation / temperature are less than one year; 3) the correlation between the SSTVA and the winter precipitation is not considered at present (due to the length of paper). The finally significant correlation seasons between each season's SSTVA in the preceding and present years and the precipitation / temperature of each season in the present year based on the above rules are listed in Table 1 and Table 2, in which the sign "0" implies the present year and the sign "–" the preceding year. The determination of the significant response areas of precipitation / temperature to SSTVA will be discussed later on.

From the correlation seasons in the tables we can see that it is only in some seasons that the SSTVA in different key ocean areas has contribution to China's precipitation and

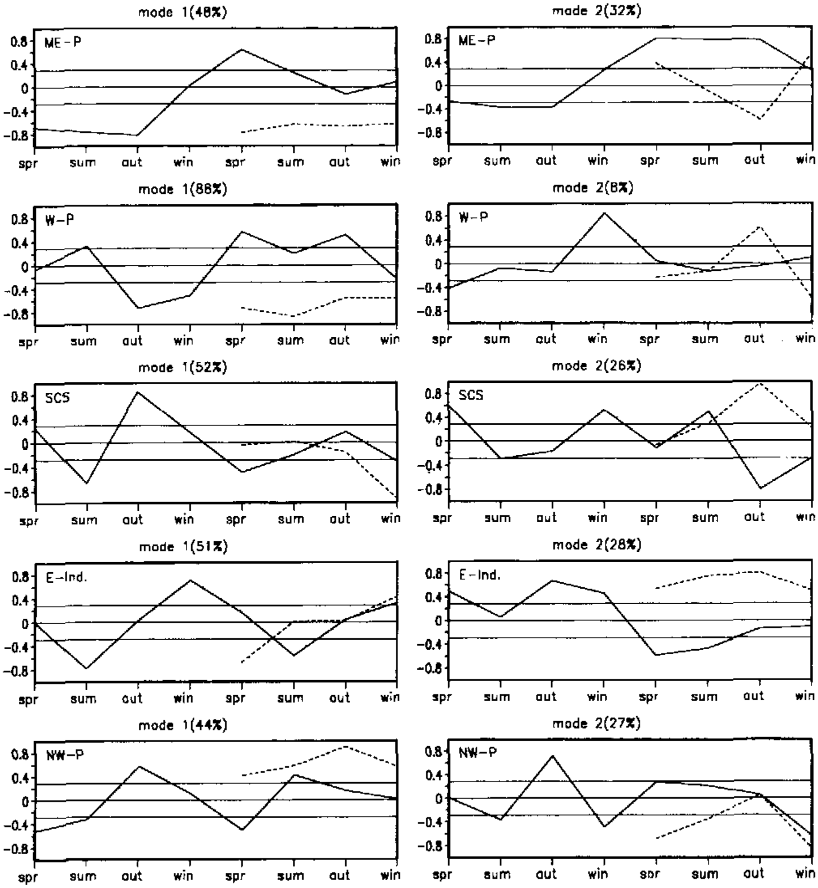

Fig. 3. The significant correlation seasons between temperature anomalies (dashed line) in China and SSTVA (solid line) of each key ocean area.

Table 1. The significant correlation seasons between SSTVA in each key ocean area and precipitation anomalies and the significant response areas of precipitation to SSTVA

Key ocean areas		The middle eastern Pacific	The western Pacific	The SCS and the Philippines	The equatorial Indian Ocean	The northwestern Pacific
Correlation seasons		1. Spr. SSTVA(0)—Spr. Rainfall (0) 2. Sum. SSTVA (−)— Spr. Rainfall (0)	Wint. SSTVA (−)—Sum. Rainfall (0)	Sum. SSTVA (0)—Sum. Rainfall (0)	Sum. SSTVA (0)—Sum. rainfall (0)	Aut. SSTVA (0)—Aut. Rainfall (0)
Correlation coefficient		1. R1 = −0.35 2. R2 = 0.37	R = 0.31	R = 0.29	R = −0.26	R = 0.30
Significant response areas	Positive SSTVA	The middle and the low reaches of the Changjiang River, the mid regions of Mongolia.	The north part of North China, the south part of Yicang.	The north part of North China, the south part of Yibin.	South China, Lanzhou and the south part of it.	The mid part of North China, the lower reaches of the Changjiang River and South China
	Negative SSTVA	The lower reaches of the Changjiang River	South China	South China, the west side of Yungui Plateau and the nearby of Lanzhou	The mid regions of East China (the nearby of Hebei)	The middle reaches of the Changjiang River, the Hetao regions and the mid of Xingjiang

Table 2. The significant correlation seasons between the SSTVA in each key ocean area and temperature anomalies and the significant response areas of temperature to SSTVA

Key ocean areas		The middle eastern Pacific	The western Pacific	The SCS and the Phillipines	The equatorial Indian Ocean	The northwestern Pacific
Correlation seasons		Aut. SSTVA(−)—Aut. Temp. (0)	Spr. SSTVA(0)—Sum. Temp.(0)	Sum. SSTVA (−)—Wint. Temp. (0)	Sum. SSTVA (−)—Spr. Temp. (0)	Aut. SSTVA (−)—Aut. Temp.(0)
Correlation coefficient		R = 0.36	R = −0.30	R = 0.25	R −0.27	R = 0.36
Significant response areas	Positive SSTVA	The north part of the Changjiang River the northwest bound of China and the middle and lower reaches of the Changjiang River	The north part of East China, the south part of Northeast China, the Hetao regions and the south of the middle and lower reaches of the Changjiang River	The east regions between 110°E and 120°E, the north part of Xinjiang	Northeast China, the mid part of mongolia and the middle and lower reaches of the Changjiang River	The upper and middle reaches of the Huanghe River and two sides of the lower reaches of the Changjiang River
	Negative SSTVA	The mid regions between the Changjiang River and the Huanghe River, the upper and middle reaches of the Changjiang River	The mid regions between the Changjiang River and the Huanghe River	The east part of China and the south part of Northeast China	The east part of China to the east of 110°E except for the South China.	The north part of the Changjiang River
Correlation seasons		Aut. SSTVA(0)—Wint. Temp.(0)	Aut. SSTVA (−)—Sum. Temp (0)	Aut. SSVTA(−)—Wint. Temp(0)		Sum. SSTVA(0)—Sum. Temp(0)
Correlation coefficient		R = 0.31	R = 0.54	R = −0.30		R −0.36
Significant response areas	Positive SSTVA	The Huanghe, Changjiang River and Huaihe River valleys and the coastal areas along South China	The regions between the Huanghe River and Changjiang River valleys	The east part of China to the east of 105°E		The Changjiang River and the Huanghe River valley and the coastal regions along the Bohai Sea
	Negative SSTVA	The east part of China to the south of the Huanghe River	The Changjiang River valley and the north part of North China	The north part of Northeast China, North China, the Changjiang River and the Huaihe River, the middle and lower reaches of the Changjiang River		North China and the north part of the Changjiang River
Correlation seasons		Sum. SSTVA(−)—Spr. Temp (0)				Wint. SSTvA0)--Wint. Temp (0)
Correlation coefficient		R = 0.28				R = 0.45
Significant response areas	Positive SSTVA	Northeast China and the south part of the Changjiang River				North China, the south part of Northeast China, the east coast region and the Huanghe River and the Huaihe River valley
	Negative SSTVA	The east part of China				South China, the coast region of East China, the south regions of North China and the east part of Northeast China

temperature. In addition, the seasonal precipitation anomalies mainly respond to the same stage SSTVA (Table 1), while the seasonal temperature anomalies mainly respond to the earlier stage SSTVA (Table 2), except that the temperature anomalies in summer and winter in the northwestern Pacific respond significantly to the same stage SSTVA.

4. The composite method of precipitation and temperature in significant correlation seasons

The time series of spring SSTVA in the middle eastern Pacific from 1952 to 1997 and the same stage interannual series of precipitation anomalies are shown in Fig. 4a. Fig. 4b is the same as Fig. 4a, but for the preceding autumn SSTVA and the present year's temperature. Their correlation coefficients are −0.35 and 0.36, respectively.

It can be found from Fig. 4 that although the correlation between precipitation / temperature anomalies in China and the SSTVA in the middle eastern Pacific exceed the statistically significant level, there is a large uncertainty to predict the precipitation or temperature according to the SSTVA because the correlation coefficient is not high enough and we do not know the anomalous response regions of the precipitation / temperature, either. So a new composite method is employed to reduce the prediction uncertainty as possible. The new

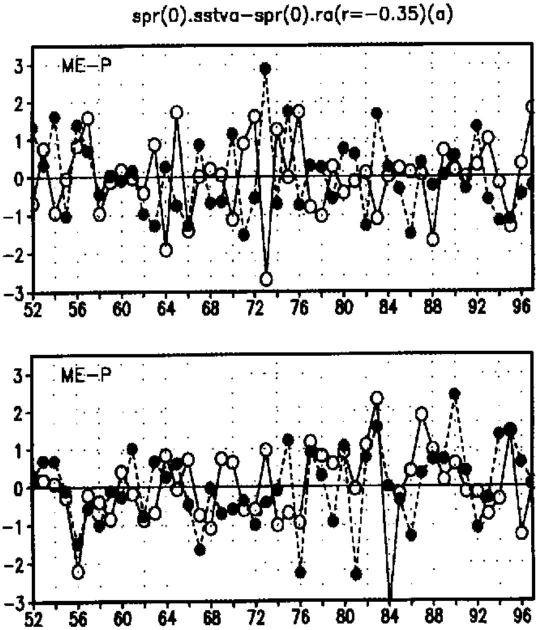

Fig. 4. (a) The time series of spring SSTVA (solid line) in the middle eastern Pacific and the same stage interannual series of precipitation anomalies (dashed line) in China. (b) The time series of the preceding autumn SSTVA (solid line) in the middle eastern Pacific and the present year's interannual series of temperature anomalies (dashed line) in China.

method is to select and compound all the anomalous years that meet the correlation in both positive and negative SSTVA period, respectively. For example, for the positive correlation between precipitation and SSTVA, the seasonal precipitation anomalies of the same sign with the SSTVA are selected and compounded, while for the negative correlation between SSTVA and precipitation, the seasonal precipitation anomalies of the opposite sign with the SSTVA are selected and compounded. Therefore the anomalous years of precipitation / temperature which are not in agreement with the correlative rules are removed by this method, since they may not be caused by SSTVA. So the correlation between composite fields and SSTVA is enhanced and the prediction uncertainty may be reduced significantly.

Most previous studies are focused on classifying the areas of precipitation anomalies and then investigating the connection between the SSTVA in different ocean areas or combined ocean areas and precipitation anomalies in different rain areas. Since the rain areas are different due to the different standard of classification, the rain areas are not classified in this paper. The key response regions of precipitation / temperature are selected by the spatial patterns of the composite precipitation / temperature based on the new composite method, and the significance test is made to determine in which areas the precipitation / temperature anomalies in significant correlation seasons evidently respond to the SSTVA.

5. The composite precipitation anomalies responding to each key ocean area and their significance test

The composite percentage of seasonal precipitation anomalies related to each ocean area's SSTVA is shown in Fig. 5—Fig. 10. The left column and the right column correspond to the positive SSTVA and the negative SSTVA period, respectively, and are expressed by the sign "+" and "−" in the brackets. In Fig. 7 and Fig. 8 the composite SSTVA of the western and northwestern Pacific in the positive and negative period are shown in the upper panel, respectively. It can be seen that the composite SSTVA in the positive and negative period in these two areas agree reasonably well with the positive and negative SSTVA, and the features of other ocean areas are of similarity (figures omitted). The shaded areas in the figures are the statistically significant areas of 0.05 level, that is, they are significantly different from the corresponding seasonal precipitation / temperature of the normal years. The significant response areas of precipitation to each ocean area are shown in Table 1.

From the regional features of the composite precipitation it can be seen that the anomalous response areas of precipitation exceeding the significance test exist for all ocean areas in the significant correlation seasons. It is further proved that this composite method is believable.

From the significant response areas of precipitation in Table 1, it is seen that no matter in the positive or negative SSTVA period the anomalous areas of precipitation responding significantly to the SSTVA of the present spring and the preceding summer of the middle eastern Pacific are all located in the middle and lower reaches of the Changjiang River and south of it. These significant response areas are consistent with that of previous studies, however the significant response season of precipitation to the SSTVA is spring, not summer. Nevertheless the areas of precipitation anomalies are all located in the middle and lower reaches of the Changjiang River, no matter responding to SSTA or SSTVA of the middle eastern Pacific. In addition, the SSTVA no matter of the present spring or of the preceding summer has obvious contribution to the present spring precipitation anomalies and this may be helpful for overcoming the spring prediction obstacle.

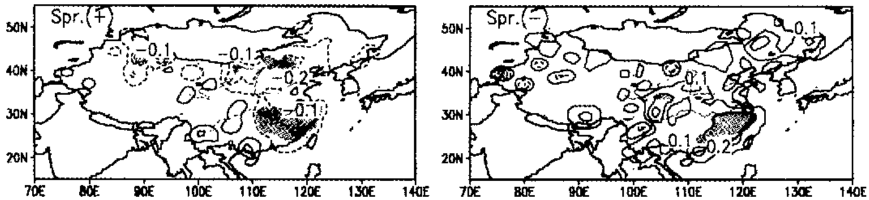

Fig. 5. The present spring's composite precipitation anomalies responding significantly to the preceding year's summer SSTVA in the middle eastern Pacific.

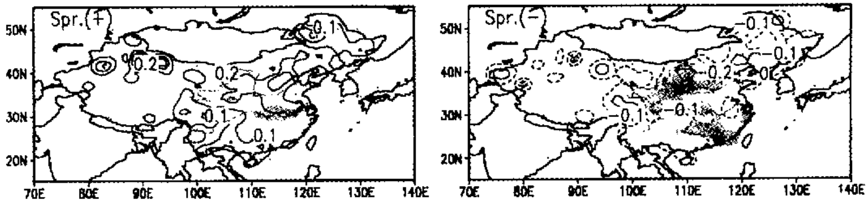

Fig. 6. The spring's composite precipitation anomalies responding to the same spring SSTVA.

There are a few studies about the relationship between the SSTA of the western Pacific and the precipitation in China. Wu et al. (1995) pointed out that there is obvious teleconnection between the western Pacific and the northwestern Pacific, the distributive pattern of positive SSTA in summer in the above two areas can lead to the patterns of above normal summer rainfall in East China and North China and below normal summer rainfall in the Changjiang River and the Huaihe River valleys. Fig. 7 and Fig. 8 show that the teleconnection of SSTVA between the western Pacific and the northwestern Pacific also exists, which is consistent with the results of Wu et al. (1995). We can find from the corresponding composite precipitation anomalies that the significant response areas of summer precipitation anomalies to the preceding winter SSTVA of the western Pacific are the middle reaches of the Changjiang River and the north part of North China during the positive SSTVA, while during the negative SSTVA period the evident response areas are South China and the north part of North China. The significant response areas of autumn precipitation anomalies to the same stage SSTVA of the northwestern Pacific are the south part of the lower reaches of the Changjiang River, South China and the mid part of North China during the positive SSTVA. Whereas during the negative SSTVA period the corresponding significant response areas are the middle and lower reaches of the Changjiang River and the south part of it, the south part of North China and the Hetao regions. The distributions of significant response areas of precipitation are in agreement with the result of Wu et al. (1995), but the significant seasons of precipitation are with some discrepancies. The significant response seasons of precipitation to the SSTVA of the western Pacific and the northwestern Pacific are summer and autumn respectively, this is similar to Wu et al. (1995) for the western Pacific, but different for the northwestern Pacific.

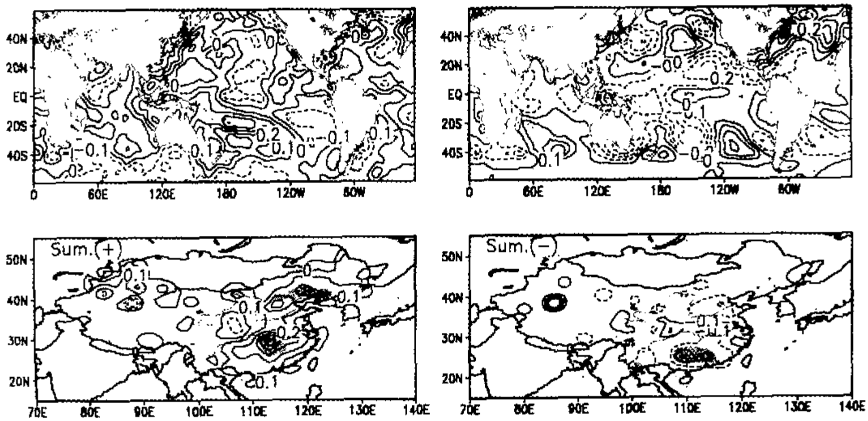

Fig. 7. The same as in Fig. 5, but for the western Pacific.

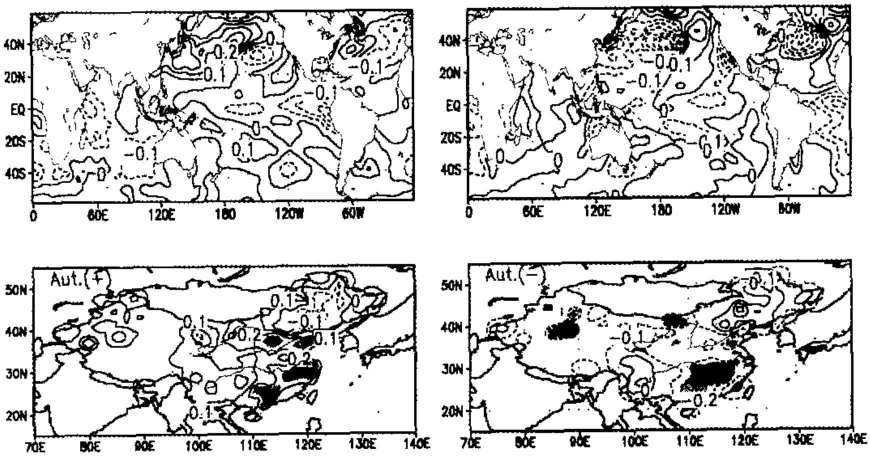

Fig. 8. The same as in Fig. 5, but for the northwestern Pacific.

The seasons of precipitation anomalies responding significantly to the summer SSTVA of the SCS (Fig. 9) and the equatorial Indian Ocean (Fig. 10) are summer, which is consistent with other previous results, but the significant response areas are different. The positive SSTVA of the SCS have primary contribution to the anomalous precipitation of the north part of North China and the south part of Hubei in the upper reaches of the Changjiang River, while during the negative SSTVA period the regions of South China are mainly affected. This is different from that pointed by Luo et al. (1985) who said that there is a significantly positive correlation between the previous stage SSTA of the SCS and the next summer precipitation anomalies in the lower reaches of the Changjiang River. As for the equatorial Indian Ocean, during the positive SSTVA period the precipitation of South China and the south part

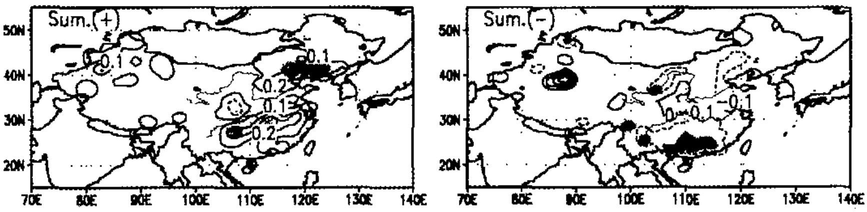

Fig. 9. The same as in Fig. 5, but for SCS.

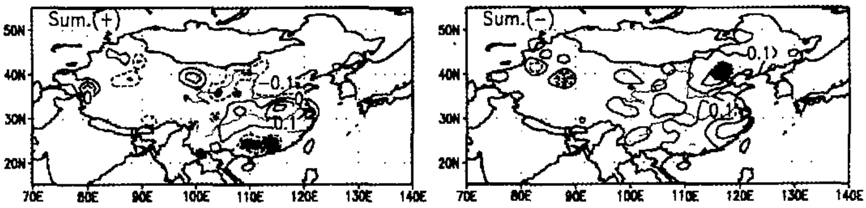

Fig. 10. The same as in Fig. 5, but for the equatorial Indian Ocean.

of the upper reaches of the Huanghe River are mainly influenced, while during the negative SSTVA period the north part of North China is affected. The distribution of rain pattern in China during the positive summer SSTVA in the SCS is that the precipitation in the Huaihe River valley is less than that in the south part of the Changjiang River and North China. While during the negative SSTVA period the pattern is reversed. The rain pattern caused by the SSTVA of the equatorial Indian Ocean is opposite compared with the SCS no matter during positive SSTVA or negative SSTVA period and it is similar to the " W" pattern pointed out by Wu et al. (1995).

The above analysis indicates that the relationship between SSTVA and precipitation and that between the SSTA and precipitation have both similarity and differences. As mentioned above the significant response areas of precipitation to the SSTVA in the middle eastern Pacific, the western Pacific and the northwestern Pacific are consistent with the existing results, but the significant response seasons are somewhat different. However, the significant response seasons of precipitation to SSTVA in the SCS and the equatorial Indian Ocean are consistent with the existing results, but the significant response areas are also somewhat different. The rain patterns caused by SSTVA of the SCS and the equatorial Indian Ocean are in agreement with that of other authors.

Another point which should be mentioned is that in the significant correlation seasons between the SSTVA and precipitation / temperature there are some areas unsatisfying the correlation rules, moreover, the distributions of these areas are different during the positive and the negative SSTVA period. Although these areas do not satisfy the correlation rules in the correlation seasons and are not located in the statistically significant regions, they should be noticed since the precipitation anomalies in these areas do not significantly respond to SSTVA and other factors should be noticed much more in prediction.

6. The composite temperature anomalies responding to each key ocean region and their significance test

The composite method of temperature is similar to that of precipitation. The figures of composite SSTVA and temperature show that the positive and negative correlation between the SSTVA of each key ocean area and temperature anomalies is well identical with the regionally averaged correlation between SSTVA and temperature. This indicates that the whole response of temperature to SSTVA is better than that of precipitation and the seasonal vacillation of precipitation is stronger than that of temperature. In order to save space only the composite figures of SSTVA in the western Pacific and the corresponding temperature anomalies in China are given.

The temperature anomalies in autumn and winter are mainly affected by three key ocean areas' SSTVA. There is a positive correlation between the temperature anomalies and the SSTVA of the preceding summer, autumn and the present autumn of the middle eastern Pacific as well as the SSTVA of the preceding autumn of the northwestern Pacific. In addition, there is a negative correlation between the temperature anomalies and the SSTVA of the preceding autumn of the SCS as well as a positive correlation between the temperature and the SSTVA of the present summer, respectively (figures omitted).

The temperature anomalies in summer are mainly affected by the SSTVA of the western Pacific. Zheng and Ni (1999) pointed out that the western Pacific Ocean is the key region which has larger contribution to the lower temperature of Northeast China. It can be seen from the present study that the western pacific is not only the key region affecting the temperature of Northeast China, but also the key region affecting the temperature of the most areas of China (figures omitted).

The preceding summer SSTVA of the equatorial Indian Ocean has major contribution to the temperature anomalies in the next spring in China with the exception of the east side of the Tibetan Plateau (figures omitted).

The whole response of temperature to SSTVA is better than that of precipitation (Fig. 11, Fig. 12 and Table 2). The response areas of temperature to positive and negative SSTVA are basically identical except for the western Pacific. During the positive SSTVA period of the preceding spring and the negative SSTVA period of the preceding autumn in the western Pacific the summer temperature in the north part of North China, the south part of Northeast China, the Changjiang River and the Huaihe River valleys is lower than normal. Whereas during the negative SSTVA period of the preceding spring and the positive SSTVA period of the preceding autumn, respectively, the summer temperature in the Huanghe River, the Huaihe River and the Changjiang River valleys is higher than normal. The differences of temperature anomalies responding to SSTVA in the other ocean areas are only in the domains.

It can be seen from the statistical significance test that the precipitation and the temperature anomalies are regional, and the influence of each ocean area on precipitation and temperature during the positive and negative SSTVA period is different. So it can be concluded that discussing the effects of two kinds of tendency of SSTVA on precipitation / temperature anomalies respectively is better than just discussing the effects of SSTA on precipitation / temperature anomalies.

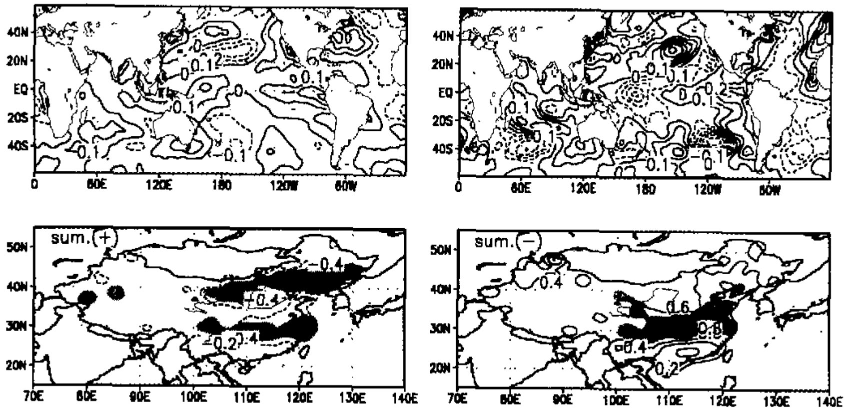

Fig. 11. The composition of the first spring SSTVA in the western Pacific and the next summer temperature anomalies in China.

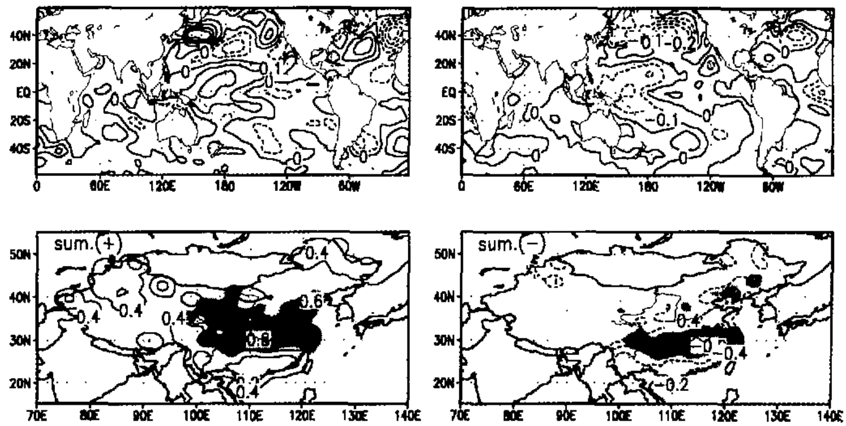

Fig. 12. The same as in Fig. 11, but for the first autumn SSTVA and the same summer temperature.

7. Summary and concluding remarks

From above analyses and discussions on the relationship between the SSTVA of key ocean areas and the precipitation / temperature anomalies in China it can be seen that the SSTVA in different sea areas contribute to the China's precipitation and temperature only in some seasons, the precipitation and temperature anomalies are regional. The seasonal precipitation anomaly mainly responds to the same stage SSTVA, while the seasonal temperature anomaly mainly responds to the earlier stage SSTVA.

The response of precipitation / temperature anomalies to the two kinds of tendency of SSTA is not similar exactly. This implies that discussing the effect of the two tendencies of

SSTA on precipitation anomalies is better than just discussing the effect of SSTA on precipitation anomalies. It helps to reduce the uncertainty of prediction.

The relationships between SSTVA and precipitation and that between SSTA and precipitation have both similarities and differences. As mentioned in Section 6, the significant response areas of precipitation to SSTVA in the middle eastern Pacific, the western Pacific and the northwestern Pacific are consistent with the existing results, but the significant response seasons are of some differences. While the significant response seasons of precipitation to SSTVA in the SCS and the equatorial Indian Ocean are consistent with the existing results, but the significant response areas are of some differences. However, the rain patterns caused by SSTVA of the SCS and the equatorial Indian Ocean are in agreement with that of other authors.

In the significant correlation seasons between the SSTVA and precipitation / temperature there are some areas unsatisfying the correlation rules, moreover, distributions of these areas are different during the positive and negative SSTVA. Although these areas are not in agreement with the correlation rules in the correlation seasons and not located in the statistically significant regions, they are worth noticing. It implies that the precipitation anomalies in these areas are not significantly responsive to SSTVA and other factors should be noticed much more in prediction.

The whole response of temperature to SSTVA is better than that of precipitation and this indicates that the seasonal vacillation of precipitation is much more complex than that of temperature.

The relationships between SSTVA and precipitation / temperature are discussed in the present paper and compared with the results obtained in previous studies. Later on we will do some researches through case study and simulation to demonstrate our results further.

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关键海区海温异常的变化与中国区域降水和气温的关系

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摘　要

利用1951年到1998年的月平均海温资料及同时期中国160个测站的降水和气温的月平均资料，选用海温异常的变化趋势—变温，讨论了关键海区海温异常的变化与我国降水和气温的关系，旨在探讨变温因子与我国降水和气温的关系与海温距平与降水和气温的关系有什么不同，用变温因子能否降低降水预报的不确定性。结果表明：降水异常对海温异常两种变化趋势的响应不完全相同，说明分别讨论同一种海温异常态的两种变化趋势对降水的影响比单独讨论海温距平对降水的影响更有效一些，有助于降低预报的不确定性；除西太平洋海区外，气温异常对各海区海温异常两种变化趋势的响应较一致. 降水异常对变温的响应与对海温异常的响应，有一致之处，也有不同之处.

关键词: 变温，降水异常，气温异常，信度检验