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SPATIAL AND TEMPORAL VARIATIONS OF EVAPORATION OVER SOUTH CHINA IN AUTUMN

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Abstract: The spatial and temporal variations of the instrument-based evaporation and actual evaporation in autumn during a 45-year period from 1960 to 2004 are studied using the observation data from 66 stations over South China. The results reveal that there are two main anomalous centers of the instrument-based evaporation in autumn in the central and northwestern parts of South China respectively. The instrument-based evaporation over the central part of South China in autumn experiences not only a decreasing trend but also a main interdecadal variation. The solar radiation is best correlated with the instrument-based evaporation among all affecting factors. For the actual evaporation, two main anomalous centers are located at the central and western parts of the South China respectively. The actual evaporation over the two regions illustrates an interannual variation. Among the affecting factors, precipitation is the most remarkable. The actual evaporation is usually 40 percent of the instrument-based one, and the overall rate has a slightly increasing trend from the southern part to the northern part of the South China in autumn.

Key words: South China; autumn; evaporation; spatial and temporal variation

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1 INTRODUCTION

The 20th century marks an era of the most pronounced amplitude of global climate warming and the trend will go on in the 21st century [1], as pointed out in the third assessment report by the Governmental Panel on Climate Change (IPCC). The rise in air temperature speeds up water cycle and will eventually alter the temporal and spatial distribution of water resources on a global scale [2]. Being an important constituent in the equilibrium of surface energy and water balance [3], evaporation is a key factor in determining the weather and climate conditions and plays an essential role in global water cycle and climate change. According to preliminary statistics, the amount of evaporation from global ground surface is about 60% - 65% of that of precipitation [4].

In recent years, much work has been done in analyzing and studying the characteristics of evaporation for different areas or river basins [5-8]. In spite of the intensive efforts at home and abroad, research on the South China evaporation is still not common.

South China is one of the regions where droughts and floods happen frequently in China [9-12]. The amount of water vapor exchanged between the ground surface and air in autumn plays an important role in the amount of ground water resources available in the concurrent season and subsequent winter [13-14]. Based on the observations, the spatial and temporal variations of evaporation over South China in autumn as measured with evaporation dishes are studied and actual evaporation is estimated following empirical equations to examine its temporal and spatial distribution of the actual evaporation over the past 45 years. It will have implications of great importance in better understanding the regional response to global

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change and undertaking the research on the allocation of autumn water resources and the causation of the drought and flood disasters for the region and season.

2 DATA AND METHODS

The data used in this study is from the National Climate Center, China Meteorological Administration, which includes such monthly observations as sunshine duration, mean temperature and wind speed, and evaporation from 20-cm-diameter dishes at 66 national reference and basic weather stations distributed in the south of China (Fig.1). The evaporation data covers a period for the autumn (September, October and November) from 1960 to 2004. The actual monthly evaporation is estimated using empirical equations [15].

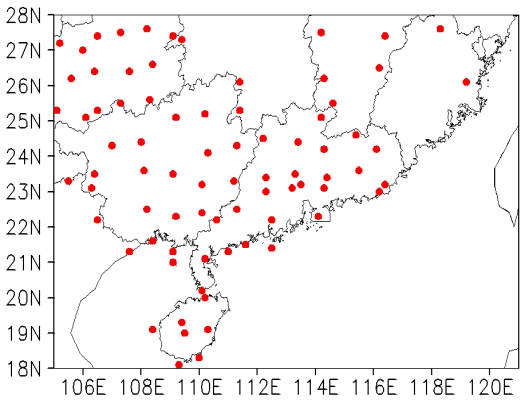

Fig.1 Area of interest and distribution of weather stations.

The statistical methods employed in this study include Empirical Orthogonal Function (EOF) decomposition, correlation analysis and composite analysis.

3 EOF ANALYSIS OF DISH EVAPORATION FOR THE AUTUMN OF SOUTH CHINA

An EOF analysis is run of the autumn evaporation amount for an area of 105°E – 120°E, 18°N – 26.5°N, with the focus on the first and second modes that are closely correlated with South China. Fig.2 and Fig.3 show their characteristic eigenvectors and corresponding point variance contribution. It needs to be stated that compared with the conventional variance contribution of eigenvectors, the modal point variance contribution is able to describe its own spatial distribution in finer details [16]. Analysis of the characteristic eigenvector field shows that the first mode is an important pattern of anomalies that indicates the autumn evaporation over Guangdong and Guangxi, which is much higher prior to the year 1992 than after it. The second mode reflects the interdecadal variations of the autumn evaporation in the northwestern part of the area, which increase before the 1990s but decrease after it.

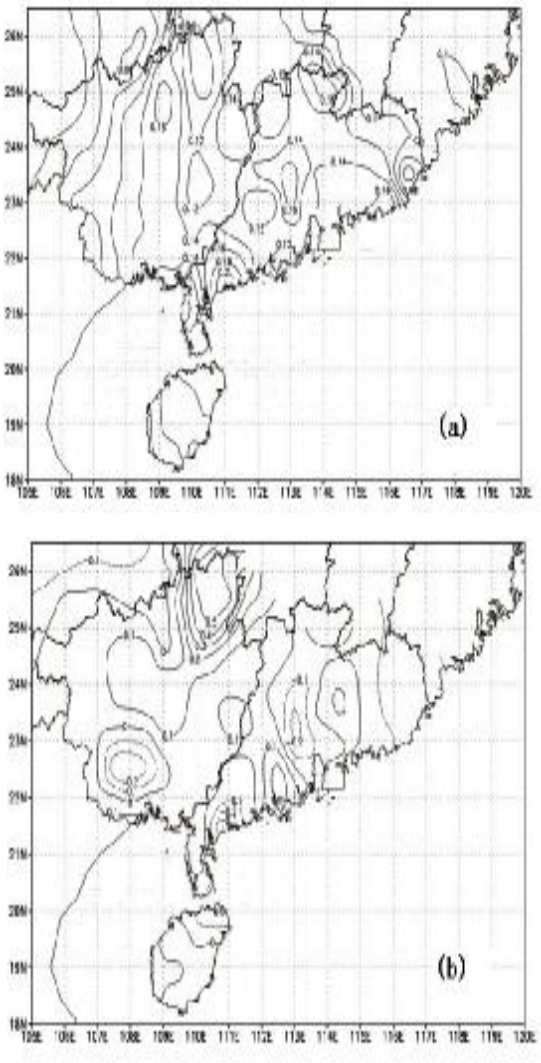

Fig.2 The first (a) and second (b) eigenvectors of the EOF analysis of the autumn evaporation in South China.

Apart from the correlation between the dish evaporation and the surface wind, solar radiation, temperature, precipitation and relative humidity determined for the central part of South China (Table 1), the one between the actual evaporation and these elements needs to be studied for similarity (Table 2).

Table 1 The correlation coefficients for the temporal variation between the dish evaporation and individual physical quantities in central South China in autumn

Physical quantities	Correlation coefficients
Near-surface wind	0.08
Sunshine duration (h)	0.64
Temperature	-0.31
Precipitation	-0.31
Relative humidity	-0.21

Note: The sample size is 45 and the critical correlation coefficient is 30 at the 0.05 significance level.

Table 2 The same as Table 1 but for the actual evaporation

Physical quantities	Correlation coefficients
Near-surface wind	0.31
Sunshine duration (h)	-0.75
Temperature	-0.12
Precipitation	0.91
Relative humidity	0.58

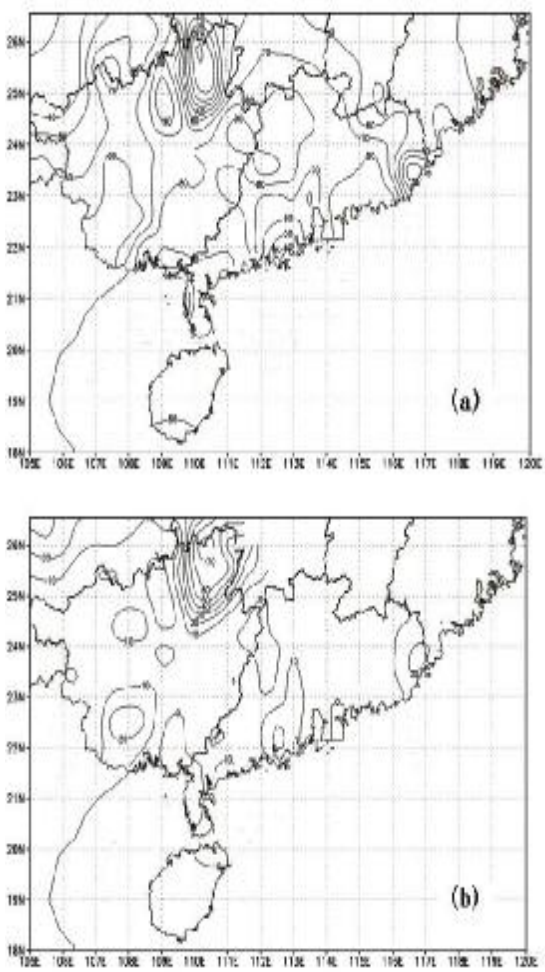

Fig.3 The same as Fig.2 but for modal point variance contribution.

See the Chinese edition of the journal for more details.

4 CONCLUSIONS

(1) The central and northwestern parts of South China are two main centers of climate anomalies for dish evaporation in autumn. For the central part of the area, the autumn dish evaporation, surface wind and temperature are mainly marked with interdecadal variations while the sunshine duration, rainfall and relative humidity with interannual variations; the evaporation amount has a generally decreasing trend and its variation is closely linked with the change in solar radiation for the area.

(2) The central and western South China are two main centers of the actual evaporation anomalies in autumn, which is mainly of interannual variation and precipitation is the most significant factor affecting the change in the actual evaporation.

(3) The actual evaporation in the autumn of South China usually takes up about 40% of the dish evaporation while the real ratio tends to increase slightly from the south to the north.

The temporal variation of the dish evaporation, particularly on the interdecadal scale, is actually a regional response of potential evaporating capabilities to the global climate change. A global warming background arising from global climate change leads to the increase of both atmospheric moisture and cloud amount over South China, tending to reduce the duration of sunshine to decrease evaporation. In addition, evaporation is one of the branches during the exchange of moisture between the earth and atmosphere and also one of the issues that must be taken into account in working on the variation of regional water resources and climate-related droughts and floods. Hence, the results of temporal and spatial variations of South China evaporation as revealed above can provide some basis for future investigation into the anomalies of the regional autumn water resources and causation of climate calamities arisen from droughts and floods.

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