Observation and Change of Surface Air Temperature over Eastern Contiguous China

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Abstract

With a thorough analysis of rainfall and surface air temperature data in late summer over eastern contiguous China, a new method to classify the moderate, intense and extreme precipitation based on hourly rainfall data is proposed. It uses e-folding decay intensity (I_{mi}) and double e-folding decay intensity (I_e) as the classification thresholds. Data analysis shows, between the two periods, 1966-1985 and 1986-2005, the ratio between moderate and intense rainfall has experienced significant changes. And the spatial pattern of the change in the percentage of moderate rainfall presents a direct relation with that of the surface air temperature.

1. Introduction

The relation between temperature and precipitation has received considerable attention and many studies have shown that climate change has profound impact on rainfall intensity. In recent years, decadal changes in late summer precipitation over eastern China have been studied and are described as the southern flooding and northern drought (SFND) pattern. And cooling (warming) trends in surface air temperature were found in the Yangtze River valley (North China). The eastern China is affected by the anomalous northerly wind to the east of the anticyclonic center which is more critical than the thermodynamic condition. Therefore, there should be some unique features in the relation between the rainfall structure with respect to intensity and the surface air temperature in this region.

2. Observation System

2.1 Surface Observation System

CMA operates a large surface observation system which consist of 2423 national level stations and more than 30000 regional stations.

In the past decade, all national surface stations have been upgraded to AWS. The observations contain parameters such as wind direction and speed, temperature (atmospheric, ground and grass), atmospheric pressure, humidity, amount of precipitation, radiation automatically.

2.2 Meteorological Satellite Observation System

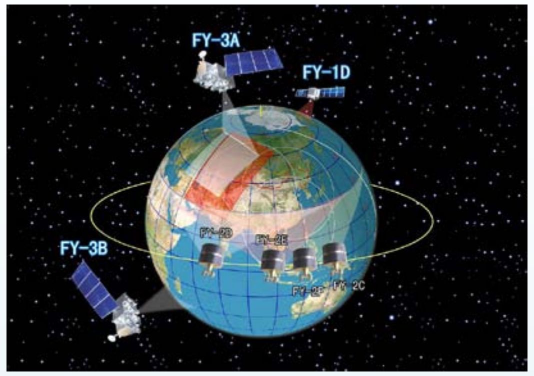

Fig.2

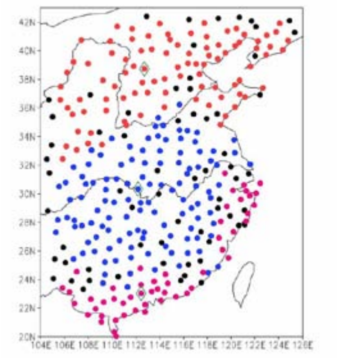

Fig.3

Fig.2: The Chinese meteorological satellites Fengyun, or FY in acronym, take place in series. The odd number series is the polar-orbiting satellite series, the even number series the geostationary. So far there are seven FY- series satellites in orbit. The FY-1D, FY-3A and FY-3B polar-orbiting, sun-synchronous meteorological satellites provide visible and infrared radiometry measurements. Derived products include the sea surface temperature (SST). FY-2 series satellites carry the Visible and Infrared Spin Scan Radiometer capable of cloud imagery of 5 spectral observational channels.

3. Data and Methodology

The temperature and rainfall data set used in this study was collected from the surface observation system. Fig. 3 shows the spatial distribution of stations. Three climate regimes are identified by red (Regime N), blue (Regime C) and pink (Regime S) dots respectively. Green diamonds indicate sample stations which are referred to as Station North, Middle and South according to their locations. In this study, 40 years(1966-2005) of temperature and hourly rainfall data over eastern contiguous China are used. For each station, the following exponential function was used to fit the distribution of rainfall amount.

$$R(I) = A_r \cdot e^{-B_r \cdot I}$$

Here I represents hourly rainfall intensity and R(I) is for the accumulated rainfall amount. The parameters, A_r and B_r, are determined by the least squares fitting of the following equation.

$$\ln[R(I)] = \ln A_r - B_r \cdot I$$

4. Impact

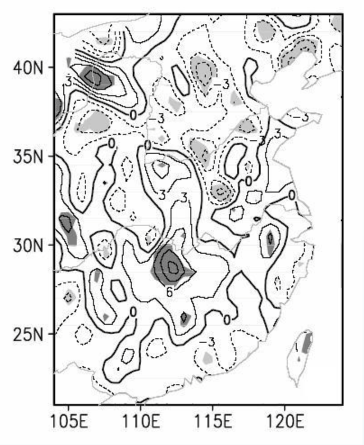

Fig.4a

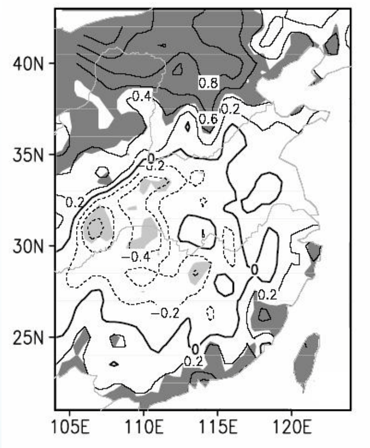

Fig.4b

Fig. 4a. The 20-yr mean changes (1986-2005 minus 1966-85) in the percentage of later summer moderate rainfall amount. Regions where the changes are statistically significant at 10% confidence level according to Student’s t test are shaded. The contour intervals are 3%.

Fig. 4b. The 20-yr mean changes (1986-2005 minus 1966-85) in the later summer daily surface air temperature. Regions where the changes are statistically significant at 10% confidence level according to Student’s t test are shaded. The contour intervals are 0.2°C.

5. Summary

- The shift in the intensity-related rainfall structure is closely correlated with the variation of the surface air temperature.
- In the warming regimes (Regime N and S), the percentage of moderate rainfall has reduced. In the cooling regime (Regime C), the percentage of moderate rainfall exhibits an increasing trend.
- In all three regimes, the percentage of moderate rainfall is negatively correlated with the surface air temperature.
- Significant trends of extreme precipitation amount and frequency are only found in Regime S.

References

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