

Research Article

Understanding the Complexity of Temperature Dynamics in Xinjiang, China, from Multitemporal Scale and Spatial Perspectives

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Based on the observed data from 51 meteorological stations during the period from 1958 to 2012 in Xinjiang, China, we investigated the complexity of temperature dynamics from the temporal and spatial perspectives by using a comprehensive approach including the correlation dimension (CD), classical statistics, and geostatistics. The main conclusions are as follows (1) The integer CD values indicate that the temperature dynamics are a complex and chaotic system, which is sensitive to the initial conditions. (2) The complexity of temperature dynamics decreases along with the increase of temporal scale. To describe the temperature dynamics, at least 3 independent variables are needed at daily scale, whereas at least 2 independent variables are needed at monthly, seasonal, and annual scales. (3) The spatial patterns of CD values at different temporal scales indicate that the complex temperature dynamics are derived from the complex landform.

1. Introduction

The Earth's climate system is a complex, interconnected system formed by the atmosphere, the oceans, and other bodies of water, land surface, snow, and ice cover together with all living organisms and linked by flows of energy and matter. To discover the complexity of climate change process, many concepts and methods, such as entropy, fractal, nonlinearity, chaos, wavelet, and artificial neural network, have been used by scholars [1–6]. The climate models used in the research on climate change have become more complex and are today believed to be able to provide fairly reliable predictions of future temperature ranges and climate developments. However, the models still do not cover a complete set of possible mechanisms and they include considerable uncertainties. Specifically, applying global scale simulation results to interpreting and predicting regional situations is challenging, and in fact its applicability is questionable [7].

Studies have suggested that the climatic process is a chaotic dynamic system, with nonlinearity as its basic characteristic; nevertheless, there are still many open questions on the complex system [3, 5, 8, 9] such as how to understand the complexity of spatial and temporal scales of the regional climatic system; the question has no satisfactory answer.

In the last 20 years, many studies have been conducted to evaluate climatic change in the arid and semiarid regions in northwestern China [10–14]. Some studies reached a conclusion that there was a visible climatic transition in the past half-century [15–18]. This transition was characterized by a temperature increase trend. However, the conclusion brought a question whether the increase trend is a regional response to global warming or merely a rising stage in the periodic dynamic process [19].

In order to understand the complexity of climatic dynamics in Xinjiang, China, based on observed data at 51 meteorological stations during the period from 1958 to 2012, this study