Assessing Drought Conditions in Cloudy Regions Using Reconstructed Land Surface Temperature

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ABSTRACT

Temperature vegetation dryness index (TVDI) in a triangular or trapezoidal feature space can be calculated from the land surface temperature (LST) and normalized difference vegetation index (NDVI), and has been widely applied to regional drought monitoring. However, thermal infrared sensors cannot penetrate clouds to detect surface information of sub-cloud pixels. In cloudy areas, LST data include a large number of cloudy pixels, seriously degrading the spatial and temporal continuity of drought monitoring. In this paper, the Remotely Sensed Daily Land Surface Temperature Reconstruction model (RSDAST) is combined with the LST reconstructed (RLST) by the RSDAST and applied to drought monitoring in a cloudy area. The drought monitoring capability of the reconstructed temperature vegetation drought index (RTVDI) under cloudy conditions is evaluated by comparing the correlation between land surface observations for soil moisture and the TVDI before and after surface temperature reconstruction. Results show that the effective duration and area of the RTVDI in the study area were larger than those of the original TVDI (OTVDI) in 2011. In addition, RLST/NDVI scatter plots cover a wide range of values, with the fitted dry–wet boundaries more representative of real soil moisture conditions. Under continuously cloudy conditions, the OTVDI inverted from the original LST (OLST) loses its drought monitoring capability, whereas RTVDI can completely and accurately reconstruct surface moisture conditions across the entire study area. The correlation between TVDI and soil moisture is stronger for RTVDI ($R = -0.45$) than that for OTVDI ($R = -0.33$). In terms of the spatial and temporal distributions, the R value for correlation between RTVDI and soil moisture was higher than that for OTVDI. Hence, in continuously cloudy areas, RTVDI not only expands drought monitoring capability in time and space, but also improves the accuracy of surface soil moisture monitoring and enhances the applicability and reliability of thermal infrared data under extreme conditions.

Key words: land surface temperature reconstruction, Remotely Sensed Daily Land Surface Temperature Reconstruction model (RSDAST), temperature vegetation dryness index (TVDI), soil moisture, drought

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1. Introduction

Drought is a complex and multi-attribute natural phenomenon characterized by high frequency, long duration, and widespread influence; thus, it has a serious impact on the national economy, especially agricultural production. Statistics show that economic losses caused by global meteorological disasters account for 85% of the losses caused by all natural disasters. The losses from drought account for more than half of the losses caused by meteorological disasters (Yi, 2010; Wang, 2017; Zhang et al., 2017). Insufficient understanding of drought development and the lack of timely preparation and effective responses are possible reasons for the great losses caused by drought events (Yan et al., 2018). In comparison with other natural disasters, droughts develop slowly across a

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