DROUGHT MONITORING USING THERMAL INERTIA MODEL FROM MODIS DATA IN THE HENAN PROVINCE, CHINA

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ABSTRACT

Extreme droughts were occurred in Northern China in spring, 2009. It has resulted in a big loss in the food production. Henan province, one of the major food production areas, suffered from the most extremely drought [1]. So the Henan province was selected as our study area. Another reason for selecting Henan is that there were also many investigated in situ data on drought. MODIS data were used in this paper because of its' almost real time and large covered area. Drought, one of the natural disasters, threatens agriculture development and less harvest which might cause series environment, social and economical consequences. An effect way to monitor the drought condition operationally is very important for local and national government to make some measurements. There are many indexes developed from remotely data for monitoring the drought, such as NDVI (Normalized Difference Vegetable Index), CWSI (Crop water stress index), and temperature-vegetation index [2]. Because the subsurface of Northern China is bare soil or scarce vegetation covered area in spring, thermal inertia model which is suitable for this kink was used in this paper. Thermal inertia is a physical parameter representing the ability of a material to conduct and store heat, and in the context of planetary science, it is a measure of the subsurface's ability to store heat during the day and reradiate it during the night. Soil moisture effects thermal inertia to a large extent, so if thermal inertia is derived from remotely sensed data, then the soil moisture will be obtained based on the models about the relationship between thermal inertia and soil moisture. The drought distribution could be acquired according to the status of soil moisture.

Thermal inertia is defined as $P = \sqrt{K\rho c}$, where P represents thermal inertia, K is conductivity, ρ is density, and c is specific heat capacity[3]. It is hard to obtain the thermal inertia from satellite images based on it's definition because the parameters mentioned above are difficult to acquire. An improved real thermal inertia model developed by Cai et al. (2007) was used in this paper [2]. It needs temperature difference, surface albedo, both of which could be retrieved from MODIS data. Daytime and nighttime MODIS 1B data covering governmental areas of Henan province on January 12, 2009 were downloaded from NASA official website [4]. Before deriving temperatures and surface albedo, several

pre-processing steps are needed as: (1) geometric calibration: MODIS 1B data sets provide us with the latitude and longitude data set, which can be used to correct the MODIS 1B data. Geometric calibration is good for us to do some registration between images that were performed using ENVI software; (2) cloud screen: to remove the cloud influences, cloud screening should be done in the studied area. The near infrared reflection method is used in our paper [5]. The images were subset to cover whole Henan province; (3) water body removing: because what we focused is the land surface, so we removed the water body before calculating thermal inertia. The surface temperature difference lies in the determination of Earth surface temperature that can be obtained based on the improved iterative self-consistent split-window algorithm presented by Xue et al.(2005) [6]. Three MODIS thermal infrared channels 29, 31 and 32 were used to derive the surface temperature according to the fact that the actual land surface temperatures are the same for all thermal bands. The surface albedo can be calculated by weighting spectral reflectivities in the visible and near infrared bands of MODIS data. The spectral reflectivities can be obtained after performing the atmospheric correction using 6S model. Thermal inertia can be calculated after getting temperature difference and surface albedo. The soil moisture can be computed by the complex relationship between soil moisture and thermal inertia [2]. According to the relationship between water content and drought status, the drought distribution was obtained in Henan province. Our results showed that most areas of the Henan province were in status of severe drought which is almost consistent with the in situ data. Which indicated that thermal inertia model can be used to detect and monitor the drought in spring.

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