An improvement of method for monitoring drought using remote sensing

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Abstract

The remote sensing has evident advantages in monitoring drought, and there have been a lot of achievements in this field. But, up to now, the methods, which have been found for monitoring drought using remote sensing, can not solve this problem completely. VCI (Vegetation Condition Index), TCI (Temperature Condition Index) and VTCI (Vegetation and Temperature Condition Index) were introduced into drought monitoring by Kogan in 1990. The methods are practical, and simple to be implemented. For the sake of improving drought monitoring, the Kogan's methods are modified in the article.

According to Kogan', TCI is obtained only in light of brightness temperature as following,

$$TCI = \frac{BT_{\max} - BT_i}{BT_{\max} - BT_{\min}} \times 100 \qquad (1)$$

Where BT, BT_{max}, and BT_{min} are smoothed brightness temperature derived from the CH 4 data of AVHRR, its maximum and minimum, respectively, calculated for each pixel and ten-day from multiyear data; *i* is a given ten-day in a year.

Kogan and other researchers all computed TCI with brightness temperature, because, they thought that the brightness temperature was close to ground temperature, and the inversion of ground temperature was very difficult from remotely sensed data.

In the article, the ground temperature is used in place of brightness temperature in the TCI calculated formula. Recently, the method inverting ground temperature through remotely sensed data is more and more reliable; therefore, it is very necessary to introduce ground temperature into TCI. If the inversion algorithm of ground temperature is reliable, and its obtained ground temperature will be accurate, TCI of ground temperature should be better than that of brightness temperature for drought monitoring.

In the article, we have used the CH4 and CH5 data of AVHRR data between 1982 and 2001, and corresponding in-situ data of soil moisture. The CH4 and CH5 data are inverted into brightness temperature firstly. Then, the TCI of brightness temperature can be obtained through the CH4 brightness temperature.

The ground temperature is obtained through the CH4 and CH5 data on the basis of the split window algorithm. Kerr introduced such a reliable algorithm into inverting the ground temperature through the AVHRR data in 1990, which was applied in the article. Based on the ground temperature, its TCI can also be obtained.

Therefore, there are the two kinds of TCI here, such as TCI's of ground temperature and brightness temperature.

In light of the regression analysis of TCI data vs in-situ data of soil moisture, models of drought monitoring can be obtained. Certainly, there are also two kinds of TCI model of drought monitoring. For example, the following is the model of ground temperature in second ten-day of August,

$$TCI_{TG} = 15 + 0.48 \times SHI \tag{2}$$

Where, TCI_{TG} is the TCI of ground temperature, and SHI is the normalized soil moisture. According to the SHI classification of drought, that of TCI_{TG} can be obtained, and used to monitor the drought.

Each kind of model of drought monitoring is validated through two methods: statistical and compared against truth. The two models can all pass statistical test, however, the model of ground temperature is more reliable than that of brightness temperature. In addition, when the results of models were compared against truth, the model of ground temperature is also better than of brightness temperature.
Keywords: TCI; Ground temperature; Drought monitoring