Land Surface Temperature Retrieval based on Thermal Infrared Remotely Sensed Data of Aster

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Abstract. For the geothermal area in the southern part of Gongchangling, Liaoyang City, Liaoning Province, China based on ENVI 5.1 software, Aster thermal infrared remote sensing data was used for surface temperature retrieval. Based on the split windowing algorithm, the ground temperature retrieval result graph is finally obtained. According to this analysis, the temperature in the study area is mainly concentrated at 23-28°C. The average temperature is approximately 22°C. The minimum temperature is 12°C and the maximum temperature is 35°C. The low temperature area is mainly near the Tanghe River and the Taizi River Basin in the study area. High-temperature areas are concentrated in the eastern fringe, where a large number of urban buildings are presented. The three hot springs are located in the study area, which is the high temperature area. In addition, the high temperature zone and the fracture structure in the study area have a large degree of fit.

Keywords: Remote sensing, Split window algorithm, Aster thermal infrared data.

1. Introduction

The use of thermal infrared remote sensing data to extract surface temperature [1] information originated in the 1970s. After years of research and development, significant progress has been made [2, 3, 4, 5]. Various inversion algorithms have emerged in an endless stream [6, 7, 8, 9], bringing great convenience to the in-depth development of earth science research and other fields. However, these algorithms often face the same problem: non-isothermal hybrid pixels are common on the surface, but we use thermal infrared remote sensing to extract the surface temperature to a uniform temperature. Therefore, the physical meaning of the object produced in this way is unknown and can only reflect the average temperature of the surface-mixed pixels. The Aster sensor mounted on the TERRA satellite is advanced among many sensors and offers significant advantages in terms of spatial resolution, spectral resolution and thermal infrared [10, 11, 12]. Based on the above analysis, the surface temperature inversion will use the ENVI 5.1 software as a platform to use the window algorithm to study the geothermal area in southern Liaoyang and explore geothermal resource exploration methods.
2. Surface specific emissivity and brightness temperature calculation

2.1. Surface specific emissivity calculation

The Normalized Difference Vegetation Index (NDVI) can convert multi-spectral data into a single image band, which is mainly used to analyze the remote sensing data and determine the surface vegetation coverage of the study area.

\[
\text{NDVI} = (r_4 - r_3)(r_4 + r_3)
\]

Where \(r_3\) and \(r_4\) are the surface reflectances of the corresponding bands.

The calculation of vegetation coverage (FVC) is based on the mixed pixel decomposition method, which roughly divides the surface objects into water, vegetation and buildings. The calculation method is as follows:

\[
\begin{align*}
\text{FVC} &= \left(\frac{\text{NDVI} - \text{NDVI}_{\text{Is}}}{\text{NDVI}_{\text{v}} - \text{NDVI}_{\text{Is}}}\right)^2 \\
&= \left(\frac{\text{NDVI} - 0.05}{0.7 - 0.05}\right)^2
\end{align*}
\]

And we have to continue to process the FVC after calculation, because the FVC value has a value limit: \(1 \geq \text{FVC} \geq 0\).

The surface specific emissivity refers to the ratio of the radiation output of an object to a black body of the same temperature and the same wavelength. In general, we think they remain the same. The specific emissivity of the water body pixel in this paper is 0.995. The specific emissivity of the natural surface and the town pixel is calculated as follows:

\[
\begin{align*}
\varepsilon_{\text{surface}} &= 0.9625 + 0.0614F_{\text{VC}} - 0.0461F_{\text{VC}}^2 \\
\varepsilon_{\text{building}} &= 0.9589 + 0.086F_{\text{VC}} - 0.0671F_{\text{VC}}^2
\end{align*}
\]

\(\varepsilon_{\text{surface}}\) is the specific emissivity of the natural surface pixel. \(\varepsilon_{\text{building}}\) is the specific emissivity of the town pixel.

We generally use LOWTRAN, MODTRAN and other software to estimate the atmospheric transmittance. However, the results of the atmospheric radiation transmission model are also affected by factors such as atmospheric radiation transmission theory, surface conditions, and atmospheric parameter acquisition. Therefore, the results of our previous simulations are only approximate data. This time, we used an atmospheric transmittance of 0.07.

2.2. Calculation of brightness temperature

When an object has the same spectral radiance as the absolute black body at the same wavelength, the temperature of the black body is the brightness temperature. The radiation transfer equation is used to calculate the brightness temperature:

\[
L_\lambda = \left[ \varepsilon \cdot B(T) + (1 - \varepsilon) \cdot L \downarrow \right] \cdot \tau + L \uparrow
\]

\(\varepsilon\) is the surface emissivity; \(T\) is the true temperature of the surface; the thermal radiance of the black body at \(B(T)\); \(\tau\) is the transmittance of the atmosphere in the thermal infrared band;

When the temperature is \(T\), the radiance \(B(T)\) of the black body is:

\[
B(T) = \left[ L_\lambda - L \uparrow - \tau \cdot (1 - \varepsilon) \cdot L \downarrow \right] / \tau \cdot \varepsilon
\]

3. Calculation of land surface temperature

3.1. Split window algorithm

The basic principle of the split window algorithm is that there are large differences in the absorption characteristics of two adjacent thermal infrared spectral windows in the remote sensing data. Therefore, we can use the difference between the brightness temperature of these two channels to get the
The use of Aster data for surface temperature retrieval is affected by many factors, hence there is a certain error. Therefore, when using Aster thermal infrared remote sensing data for
The objective is to retrieve surface temperature retrieval, and we are going to choose sunny climatic conditions to reduce the impact of clouds.

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