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Methodology of Cloud Height Estimation over Rugged Terrain using Landsat TM Imagery

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Abstract

Horizontal distance between a cloud and its shadow appeared in a satellite image over flat terrain has been used to estimate the cloud height. This paper describes methodology of the cloud height estimation over rugged terrain using spatial correlation as an evaluation function. Because of three dimensional effects of satellite observation such as sensor scanning and solar radiation over the rugged terrain, satellite images should be accurately overlaid with digital elevation model on the map coordinate system (UTM). In order to pair a cloud pixel with a shadow pixel for calculating the spatial correlation, the shadow pixel with known terrain elevation is projected onto a flat plane, which is shown to be more efficient than to find a shadow pixel from a cloud pixel. The evaluation function is optimized with regard not only to cloud height but also solar azimuth direction in order to take displacement of cloud position caused by the sensor scanning into account. The proposed method was applied to a Landsat TM image which contains a number of small cloud with clear shape. For verifying the proposed method, the positional change in estimated solar azimuth directions was identified, which was explained by meridional aberration of the UTM coordinate system with high accuracy.

Keywords: cloud shadow, solar position, scan direction, ortho-rectificaation, meridional aberration