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Moving Window-Based Topographic Normalisation for Landsat 8 Imagery in Mountainous Forest

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Abstract

The launch of Landsat 8 maintains and enhances a continuous environmental-monitoring record. With the free policy of data distribution, Landsat 8 imagery becomes the most important public data source and will be used in wider fields by scientists around the world. As a global scale monitoring data, spectral distortion mainly caused by the terrain models and solar illumination geometry needs to be studied and corrected.

Topographic normalisation models have been widely studied for optical satellite imagery to correct for differences in illumination condition (IC). These approaches aim at adjusting the spectral reflectance for a given land cover class as a function of topographic and illumination characteristics such that image classification is facilitated – and more accurate. Various topographic normalisation models were introduced, where most of the wavelength dependent models (such as C-correction, Minnaert and Rotation-correction model) outperform the wavelength independent ones. For wavelength dependent models, the quality of topographic normalisation depends on the quality of the DEM and global parameter estimation methods tend to overcorrection.

This study focuses on development and evaluation of a moving window-based rotation-correction topographic normalisation model. We tested the algorithm with newest Landsat 8 imagery in Lin4Carbon project study area, a highly forested region in Shitai County, Anhui Province, China, which is characterised by a rough terrain with very steep slopes. We used the ASTER Global Digital Elevation Model Version 2 (ASTER GDEM V2) for the correction algorithm, because its spatial resolution is close to that of Landsat 8 optical bands. Visual comparison and statistical analysis showed that the local moving window-based rotation-correction method applied had a better performance at a range of window sizes compared to uncorrected data or applied global correction methods. The heterogeneity of spectral signatures inside each land cover class could notably be reduced which is probably also due to the fact that a site specific parameterisation was used. The performance did not vary notably with window size in the selected range. The parameter estimation for Topographic Normalisation using moving window is simple and straightforward so that this technique may be a suitable option as a standard pre-processing step for Landsat imagery.

Keywords: ASTER GDEM, empirical parameter estimation, Landsat 8, moving window, rotation-correction model, topographic normalisation

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