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CIRRUS CLOUD EFFECTS ON LAND USE CLASSIFICATION OF MULTITEMPORAL LANDSAT 8 DATA: A CASE STUDY USING HIERARCHICAL/MULTILEVEL MODELS

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ABSTRACT:

Land use classification methods utilizing Landsat multispectral data typically have not accounted for the impact of cirrus clouds. With the launch of Landsat 8, a new band became available that targets cirrus clouds, but methods to incorporate this information into classification procedures have been slow to develop. In this study, we demonstrate and compare two methods that account for cirrus cloud contamination. The first is a simplistic filtering method based on ordinary least-squares regression. The second is a hierarchical model that estimates error due to cirrus cloud contamination in conjunction with the classification routine. Three high-quality "cloud-free" images from WRS-2 path 16, row 34 were used to create a multispectral, multi-temporal layer stack using the optical bands from Landsat 8: 30 May 2013, 21 October 2013, and 9 January 2014. A subset of this scene was classified into four land use categories: water, urban, forest, and agriculture using the NLCD classification scheme (level 1 only). Training and testing information were extracted for 1000 random points (500 for training and 500 for testing) across the scene subset using high resolution (1 m) NAIP orthoimagery. Overall accuracy of the multinomial logistic regression classification was 93.6% and Cohen's Kappa was 0.88. After filtering each band by the cirrus band reflectance using ordinary least-squares regression, overall accuracy increased to 94.4% and Cohen's Kappa increased to 0.89. However, the McNemar statistic suggested that the accuracy improvement was not significant (p-value=0.17). Classification using the hierarchical/multilevel model increased overall accuracy to 95.2% (Kappa = 0.91). The McNemar's statistic (p -value=0.03) suggested that this improvement over the traditional multinomial logistic regression model was greater than expected by chance. We conclude that data from the Landsat 8 cirrus band has potential to improve classification accuracy even when only the best available imagery is used, but additional algorithm development is clearly warranted.