Geophysical Research Abstracts
Vol. 17, EGU2015-7938, 2015
EGU General Assembly 2015

Rice yield estimation with multi-temporal Radarsat-2 data

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Rice is the most important food crop in Taiwan. Monitoring rice crop yield is thus crucial for agronomic planners to formulate successful strategies to address national food security and rice grain export issues. However, there is a real challenge for this monitoring purpose because the size of rice fields in Taiwan was generally small and fragmented, and the cropping calendar was also different from region to region. Thus, satellite-based estimation of rice crop yield requires the data that have sufficient spatial and temporal resolutions. This study aimed to develop models to estimate rice crop yield from multi-temporal Radarsat-2 data (5 m resolution). Data processing were carried out for the first rice cropping season from February to July in 2014 in the western part of Taiwan, consisting of four main steps: (1) constructing time-series backscattering coefficient data, (2) spatiotemporal noise filtering of the time-series data, (3) establishment of crop yield models using the time-series backscattering coefficients and in-situ measured yield data, and (4) model validation using field data and government's yield statistics. The results indicated that backscattering behavior varied from region to region due to changes in cultural practices and cropping calendars. The highest correlation coefficient ($R2 > 0.8$) was obtained at the ripening period. The robustness of the established models was evaluated by comparisons between the estimated yields and in-situ measured yield data showed satisfactory results, with the root mean squared error (RMSE) smaller than 10%. Such results were reaffirmed by the correlation analysis between the estimated yields and government's rice yield statistics ($R2 > 0.8$). This study demonstrates advantages of using multi-temporal Radarsat-2 backscattering data for estimating rice crop yields in Taiwan prior to the harvesting period, and thus the methods were proposed for rice yield monitoring in other regions.