Abstract

The success of MODIS (Moderate Resolution Imaging Spectroradiometer) in creating unprecedented, timely, high-quality data for vegetation and other studies has created great anticipation for data from VIIRS (the Visible/Infrared Imaging Radiometer Suite). VIIRS will be carried onboard the joint NASA/Department of Defense/National Oceanic and Atmospheric Administration NPP (NP03) (National Polar-orbiting Operational Environmental Satellite System) Preparatory Project. Because the VIIRS instruments will have lower spatial resolution than the current MODIS instruments at nadir—400 m versus 250 m—for the channels used to generate Normalized Difference Vegetation Index data, scientists need the answer to this question: how will the changes in resolution affect vegetation studies? By using simulated VIIRS measurements, this question may be answered to a great degree before the VIIRS instruments are deployed in space. Using simulated VIIRS products, the U.S. Department of Agriculture and other operational agencies can then modify their decision support systems appropriately in preparation of receipt of actual VIIRS data. One pathway to achieving VIIRS simulations and validations is the ART (Application Research Toolbox), an integrated set of algorithms and models developed in MATLAB® that enables users to perform a suite of simulations and statistical trade studies on remote sensing systems. Specifically, the ART provides the capability to generate simulated multispectral image products, at various scales, from high spatial hyperspectral and/or multispectral image products. The ART uses acquired (i.e., "real") or synthetic datasets, along with sensor specifications, to create simulated datasets. Existing data products (such as those from MODIS) can be generated to validate the simulation process. In this study, VIIRS simulations were performed using Hyperion and MODIS datasets. The hyperspectral and hyperspatial properties of Hyperion data were used to produce simulated MODIS and VIIRS products. Hyperion-derived MODIS data were compared with near-concurrent MODIS collects to validate spatial systems, which provided a basis to ascertain the accuracy of converting from MODIS to VIIRS. MODIS-derived VIIRS data is needed for global coverage and for the generation of time series for regional and global investigations. These types of simulations have errors associated with aliasing for some scene types. This study helps quantify these errors and identify common cases where high-quality, MODIS-derived VIIRS data can be effectively simulated.

Problem

Vegetation monitoring applications that have come to depend on daily MODIS data must convert VISR, but significant differences exist between the two instruments.

Simulation Approach for VIIRS

- To satisfy the needs of data experiments requiring simulated VIIRS vegetation indices for high temporal frequency regional applications, multipixel VIIRS red and near-infrared data from must be simulated from MODIS red and near-infrared bands. The initial simulation approach is limited to differences in spatial characteristics between the imaging systems, so PSF (point spread function synthesis) and pixel degradation are applied.
- Initial simulation is based on nadir PSF only.

Results

- The MODIS case demonstrates expected results from higher spatial spectral fidelity.
- The VIIRS case demonstrates that simulation of VIIRS from MODIS has limitations.
- Spatially, MODIS does not meet the Nyquist criterion, so there are aliasing errors in challenging scenes like this Kenner urban/rural mix.

Conclusions

- The usefulness of the ART software is borne out the excellent correlative results in simulating MODIS from coincident Hyperion.
- The simulation of VIIRS from MODIS performed reasonably well in a challenging scene. Better results can be expected in more homogeneous scenes such as one might expect in agricultural and forest-dominated landscapes.

Next Steps

- Conduct additional validation experiments in areas of extensive large field agriculture and large managed timberlands to establish usefulness for vegetation monitoring.
- Update spatial simulation to more closely model the across-track variation of MODIS and VIIRS spatial characteristics.
- Refine metadata to more closely conform to that currently available for MODIS products.

References


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Simulating Visible/Infrared Imager Radiometer Suite Normalized Difference Vegetation Index Data Using Hyperion and MODIS

VIIRS simulations and validations will be based on the Application Research Toolbox, an integrated set of algorithms and models developed in MATLAB® that enables users to perform a suite of simulations and statistical trade studies on remote sensing systems. The hyperspectral and hyperspatial properties of Hyperion data will be used to produce simulated MODIS and VIIRS products. Hyperion-derived MODIS data will be compared with near-coincident MODIS collects to validate both spectral and spatial synthesis, which will ascertain the accuracy of converting from MODIS to VIIRS.