CORRECTION OF SECOND ORDER LIGHT FOR THE HICO SENSOR ONBOARD THE INTERNATIONAL SPACE SATATION

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ABSTRACT

The Hyperspectral Imager for the Coastal Ocean (HICO) [1] instrument is a new spaceborne senor designed specifically for monitoring the turbid coastal waters. It was launched with a Japanese HII-B rocket on September 11, 2009 and docked onto the International Space Station (ISS) on September 24, 2009. HICO is now collecting hyperspectral imaging data in the wavelength range of 0.35 – 1.07 micron with a spatial resolution of approximately 100 meters and a spectral resolution of 5.7 nanometers. It will provide unique hyperspectral data sets for the coastal ocean around the world. It is expected that the HICO data will be studied for better understanding of the global coastal waters as well as certain inland lakes [2].

During the construction of the HICO instrument, it was not feasible to install a filter in front of the detectors to block the second-order light in the wavelength range between 0.8 and 1.07 micron. As a result, the second-order light from the shorter wavelength range between 0.35 and 0.535 micron will fall in the same spatial pixels as the first-order light of wavelengths from 0.7 to 1.07 micron. If the second order effect is not removed, the radiances of the longer wavelength channels are not correct. After the construction of the HICO instrument, spatial, spectral, and radiometric calibrations were performed in the calibration lab at the Naval Research Laboratory (NRL). Calibration coefficients were generated from the HICO lab data. Applications of these lab calibration coefficients to the space HICO data did not result in a complete removal of the second order effects.

Through analysis of ISS HICO data acquired over water surfaces with underwater features, such as coral reefs, we have developed an empirical but very effective method for quantifying the second order light effect. This method is based on the fact that, if the second order light effects are not present, spatial

features of coral reefs and other objects in shallow water areas should not be observed in images of narrow channels near 1 micron. This is because the 1-micron solar radiation transmitted into water is totally absorbed by liquid water in the ocean. The observation of spatial features of shallow water objects in 1-micron channel images is an indication of the presence of the second order effects. Figure 1 shows an example of spectral plots for HICO data acquired over shallow water and deep water areas before and after the second-order light removal. The extra counts for the shallow water spectrum above 0.8 micron before correction are due to the second order effects. After the correction, both the shallow water and deep water spectra above 0.8 micron become identical.

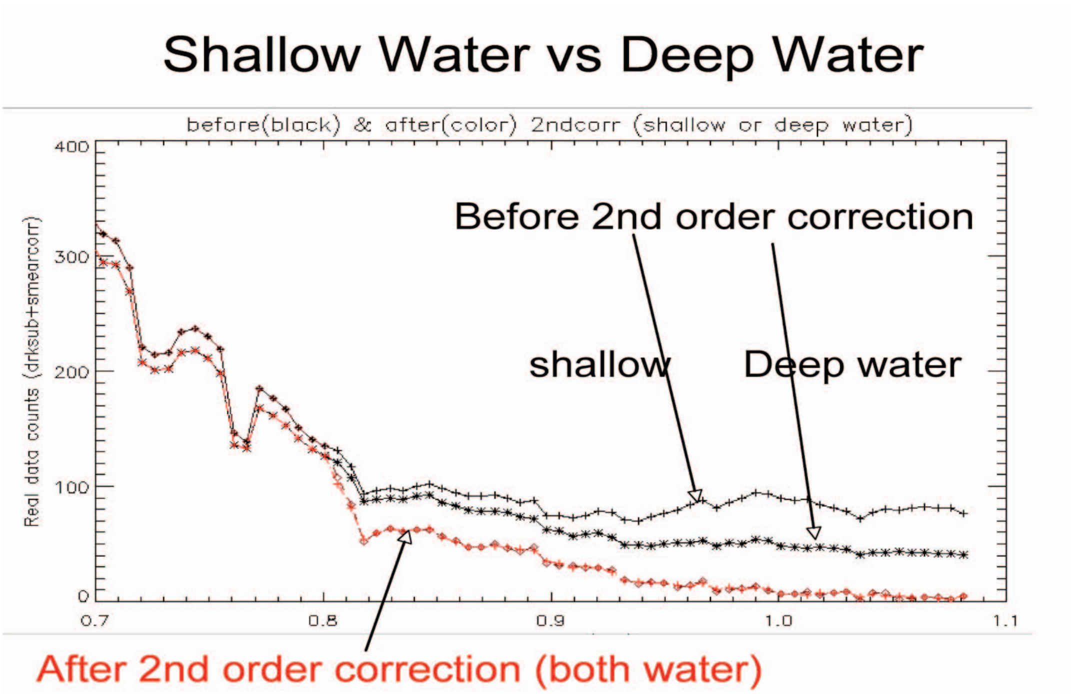

Figure 1: spectral plots for shallow water and deep water areas before and after second-order light correction.

Figure 2 shows a HICO RGB image and a single channel image at the wavelength of 1.067 um. The shallow water features at the 1.067-micron channel image are clearly seen (center image). This is due to the second order light from the short wavelength channel leaking into the longer wavelength channel. The right panel image shows the removal of the second-order light effects. No shallow water features are seen in this image.

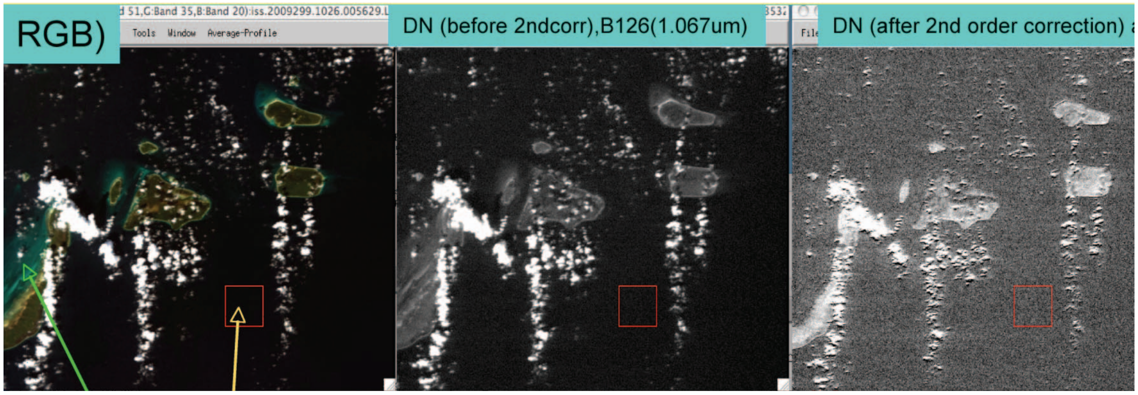

Figure 2: A RGB image over a scene with features under shallow waters (left plot), the corresponding 1.067-micron channel image (middle plot), and the second order effect corrected 1.067-micron channel image (right plot).

In this paper, we will describe in detail the second order correction method and present sample additional imaging results before and after the corrections.

REFERENCES

[1] R. L. Locke, M. Corson, N. R. McGlothlin, et al., The Hyperspectral Imager for the Coastal Ocean (HICO): Instrument Description and Early Results (in preparation).

[2] C. O. Davis, M. Kavanaugh, R. Letelier, W. P. Bissett and D. Kohler, "Spatial and spectral resolution considerations for imaging coastal waters", SPIE Vol. 6680, 66800P: 1-12,2007.

BRIEF BIOGRAPHY

Rong-Rong Li is a research physicist with Remote Sensing Division of Naval Research Laboratory (NRL). She received the Ph. D. degree in Physics from University of Cincinnati in 1995. She has extensive experience in validating retrieving algorithms for aerosols, vegetation indices, fire, clouds, and coastal waters. At NRL, she has performed radiometric and spectral calibrations for several hyperspectral instruments, including CASI, PHILLS, SWIR, and HICO.

Poster Presentation Requested.