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Vicarious Calibration of the Hyperspectral Imager for Coastal Oceans (HICO) to Improve Bio-Optical Property Retrievals for Hydrodynamic Models

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The Hyperspectral Imager for the Coastal Oceans (HICO) is a new hyperspectral sensor that is operational on the International Space Station (ISS). The low-cost, rapid-development sensor was built by the Naval Research Laboratory (NRL). NRL is also responsible for mission planning and operational data processing for this new sensor. HICO is the first spaceborne hyperspectral sensor optimized for environmental characterization of both the coastal and open ocean. HICO samples the 353 to 1080 nanometer spectral range in 128 spectral channels and has a spatial ground sampling distance (GSD) of 100 meters. The sensor can acquire up to 16 scenes over selected targets during each 24-hour period.

A variety of bio-optical products (chlorophyll concentration, absorption and backscattering coefficients) are generated using the NRL Automated Processing System (APS). In order to facilitate processing, two data streams have been established: a 9 band "MODIS-like" data set and a full 128-band data set. The "MODIS-like" bands are generated by convolving the full 128 spectral bands of HICO with the spectral response function of the MODIS sensor. Thus, we can generate HICO bio-optical products using the same multispectral atmospheric and bio-optical inversion algorithms that are applied to MODIS data, thereby facilitating product inter-comparisons. We have also developed new techniques to generate products from the full hyperspectral data set of HICO. This involves "hyperspectralizing" the standard NASA multispectral atmospheric correction routines, performing vicarious calibration, and implementing an optimization approach to take full advantage of the hyperspectral data. Products resulting from the optimization, such as bathymetry, can be used in coastal circulation models.

The Aerosol Robotic Network (AERONET) is a network of sites that provide aerosol measurements. Sites designated as AERONET-Ocean Color (OC) also provide normalized water-leaving radiances. The in situ data provided by the network of AERONET-OC sites enables vicarious calibration of the HICO sensor and helps track sensor degradation over time.

Vicarious calibration was performed to augment the HICO sensor characterization and calibration. The vicarious calibration activity matched coincident AERONET-OC data with HICO data at several sites. The AERONET-OC normalized water-leaving radiances (nLw) were transformed into top-of-the-atmosphere (TOA) radiance measurements by inverting the standard APS atmospheric correction routines. Through linear regreassion analysis, spectral gain factors (AERONET-OC TOA radiance/HICO TOA radiance) and offsets were calculated and applied to the HICO data. HICO TOA radiances were then adjusted by the new gain and offset values so that after atmospheric correction more accurate nLw values were retrieved at the AERONET sites.

TOA radiances for HICO scenes were then adjusted by the new gain and offset values to enhance the operational capability of HICO. In addition to remote sensing reflectances and nLw at each spectral band wavelength, APS can generate various ocean color products including backscattering coefficients, chlorophyll-a, diffuse attenuation, particulate organic matter, particulate inorganic matter, phytoplankton absorption, sediment/detrital absorption, and gelbstuff absorption. These products are available for integration into oceanographic hydrodynamic models.