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The task of the algorithm-development activities at USF involve modeling coastal Case II Waters and deriving algorithms based upon those models. Since AVIRIS data are used to simulate the future MODIS-N and SeaWiFS, development of a method to calibrate the AVIRIS data and to apply atmospheric corrections to the data is one of our current primary objectives. We also collecting field data for algorithm development.

While we use and have reported a vicarious calibration method for AVIRIS (Carder et al, 1993), we need to know how stable AVIRIS is from scene-to-scene over a long flight. An atmospheric- correction method is under development that uses cloud-shadowed pixels together with pixels in a neighboring region of similar optical properties, called the shadow-neighbor method. It uses the difference between water-leaving radiance values for these two regions. This allows identical optical contributions to the two signals at the top of the atmosphere (e.g. path radiance and Fresnel-reflected skylight) to be removed, leaving only solar photons backscattered from beneath the sea to dominate the residual signal. Normalization by solar-transmitted irradiance reaching the sea surface provides the remote-sensing reflectance of the ocean at the location of the neighbor region. A similar approach may be useful for land targets. The strength of this approach is that a sensor-calibration inaccuracy of 5%, which results in 50% errors or more in remote-sensing reflectance values determined by traditional methods, should in principle result in little more than 5% error in the remote-sensing reflectance values using the shadow-neighbor method. The limitation of this method is that relatively small, dense clouds must be present, and they are not always available in areas of interest.

This method provides an accurate remote-sensing reflectance spectrum for a surface-target region. This curve will provide the means of atmospherically correcting the entire scene, and recalibrating the sensor if necessary. In this way the recalibrated sensor will provide more accurate data for the entire scene, and atmospheric correction parameters will be available for traditional atmospheric correction methods to be used on adjacent scenes. We are fine tuning this method by using a Monte Carlo method to evaluate pixel-adjacency effects for differing atmospheres and cloud geometries.

Models have been developed for use with hyperspectral remote- sensing reflectance data collected just above the air-sea interface for the West Florida Shelf1,2,3,4,5. They respond to variations in pigment, detrital, and gelbstoff absorption, chlorophyll a and gelbstoff fluorescence, water Raman scattering, backscattering by water and particulate, and bottom depth and albedo. To date these models have not been systematically used to interpret hyperspectral data derived from high-altitude airborne sensors, which can provide a wide variation in component contributions in a single scene.

The water-leaving radiance values collected on a windy day near the mouth of Tampa Bay by AVIRIS on March 15, 1990 were very bright, with a maximum remote-sensing reflectance Rrs values (the ratio of the water-leaving radiance to the downwelling irradiance) of about 0.035 ster-1, even for the deep ship channels. In general, maximum Rrs value (Lw/Ed) for open ocean stations range from about 0.005 to 0.01 ster-1. The high Rrs values for the Bay at the time of the study suggest that the bottom depth was very shallow or the water was very turbid due to the high winds and tidal currents. This enigma can be better understood by modeling the Rrs spectra.

According to Kirk's as well as Morel and Gentili's Monte Carlo simulations, the popular simple expression, Rw0.33bb/a, relating sub-surface irradiance reflectance (R) to the ratio of the back- scattering coefficient (bb) to absorption coefficient (a), is not valid for bb/a > 0.25. This means that it may no longer be valid for values of remote-sensing reflectance (above-surface ratio of water- leaving radiance to downwelling irradiance) where Rrs > 0.01. Since there has been no simple Rrs expression developed for very turbid waters, we developed one based in part on Monte Carlo simulations and empirical adjustments to an Rrs model, we then applied it to rather turbid coastal waters near Tampa Bay to evaluate its utility for unmixing the optical components affecting the water-leaving radiance. With the high spectral (10nm) and spatial (20m) resolution of AVIRIS data, the water depth and bottom type were deduced using the model for shallow waters. Bottom types included sand, grass flats, and emergent vegetation, with a variety of levels of wave and current-induced suspended sediments apparent in the imagery. It also included turbid water in a deep ship channel that had been scoured off an adjacent shoal region, creating the appearance of a "false" bottom at about 1.5m. The results were presented at the SPIE meeting on 14th of April in Orlando, FL and have been submitted to SPIE publication.

Tom Peacock and Zhongping Lee of our group are at this time collecting data on a cruise to the Mississippi plume region and to the west Florida shelf. They are partitioning the absorption coefficient and collecting Rrs data as part of a joint SeaWiFS algorithm-development activity for Case II waters in conjunction with Dr. Alan Weidemann's and Dr. James Mueller's groups.

References

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