RETRIEVAL OF INHERENT OPTICAL PROPERTIES OF TURBID COASTAL WATERS USING ACTIVE AND PASSIVE OPTICAL REMOTE SENSING

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1. ABSTRACT

The flight synchronization of the Moderate-Resolution Imaging Spectroradiometer (MODIS), mounted on the Aqua platform, and the Cloud-Aerosol Lidar with Orthogonal Polarization (CALIOP), mounted on the CALIPSO platform, provides an opportunity to provide near-simultaneous observations of turbid water under two different lighting conditions, which can be used to constrain the inherent optical properties of that water column. The use of lidar data can also aid in the atmospheric correction of the spectroradiometer data over turbid water, where traditional algorithms are not reliable. Both lidar backscatter and remote-sensing reflectance can be shown to be dependent on the backscattering and absorption coefficients of the water mixture. A method is presented for the combination of these two measurement types to determine the values of these coefficients.

First, the lidar backscatter (532 nm) and the spectroradiometer radiance (MODIS Channel 11: 526 – 536 nm) are both corrected using the lidar optical thickness measurements for cloud and aerosol layers, and using Lowtran-7 to estimate the aerosol-free atmospheric optical thickness. Ozone and meteorological data are derived from GMAO climate data included in the CALIOP data.

The blue-green lidar backscatter data is then processed to remove the Fresnel reflection from the water surface. A study was conducted over low-chlorophyll, deep, oceanic waters to establish a relationship between the surface reflectance in the near infrared channel and surface reflectance in the blue-green channel, with a correction made for chlorophyll contribution to the blue-green using an existing bio-optical model. This relationship allows the use of the near infrared channel over turbid water to predict the Fresnel reflection from the water surface in the blue-green channel.

Equations relating lidar backscatter to the absorption and backscattering coefficients and equations relating remote-sensing reflectance to the absorption and backscattering coefficients are then solved simultaneously.

These results were tested by relating the backscattering coefficient to the water turbidity using the method of Kirk.[1] The Irish Sea was selected as a study site because of the presence of daily turbidity monitoring along a ferry route from Dublin to Liverpool. Early comparison of the remote sensing results to the turbidity measurements shows qualified agreement between the datasets.

A combination of active and passive optical technologies can give added insight into the inherent optical properties of turbid waters. Because this methodology was developed independently from a particular region, its use is not expected to be limited in geographic extent, but may be useful for all waters greater

than ten meters depth. At less than ten meters, there is evidence that bottom reflectance effects in the lidar data may contaminate the optical properties of the water; higher vertical resolution in the lidar would be needed to correct for this effect.

2. REFERENCES

[1] Kirk, J. T. O., Relationship between nephelometric turbidity and scattering coefficients in certain Australian waters, *Aust. J. Mar. Freshwater Res.*, 31, 1-12, 1980.