

Detecting Phycocyanin-Pigmented Microbes in Reflected Light

Concentrations are estimated from ratios between spectral radiances.

John H. Glenn Research Center, Cleveland, Ohio

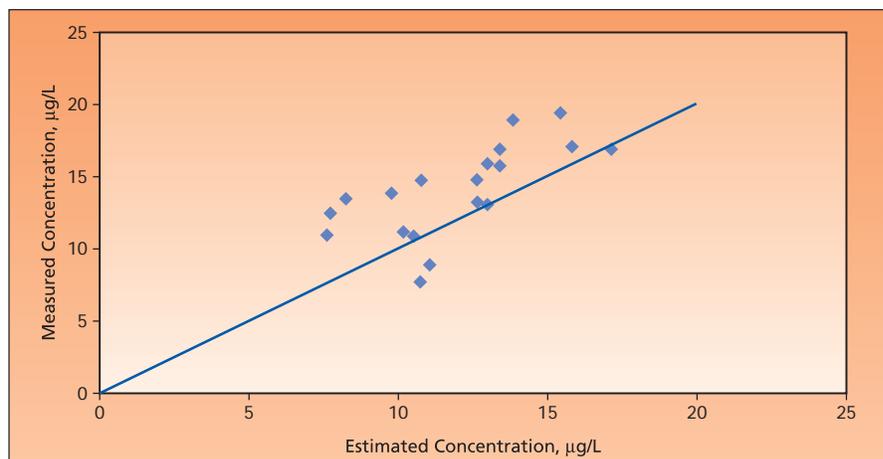
A recently invented method of measuring concentrations of phycocyanin-pigmented algae and bacteria in water is based on measurement of the spectrum of reflected sunlight. When present in sufficiently high concentrations, phycocyanin-pigmented microorganisms can be hazardous to the health of humans who use, and of animals that depend on, an affected body of water. The present method is intended to satisfy a need for a rapid, convenient means of detecting hazardous concentrations of phycocyanin-pigmented microorganisms. Rapid detection will speed up the issuance of public health warnings and performance of corrective actions.

The method involves the measurement of light reflected from a body of water in at least two, but preferably five wavelength bands. In one version of the method, the five wavelength bands are bands 1, 3, 4, 5, and 7 of the Thematic Mapper (TM) multispectral imaging instrument aboard the Landsat-7 satellite (see table). In principle, other wavelength bands indicative of phycocyanin could be used alternatively or in addition to these five. Moreover, although the method was originally intended specifically for processing Landsat-7 TM data, it is equally applicable to processing of data from other satellite-borne instruments or from airborne, hand-held, buoy-mounted, tower-mounted, or otherwise mounted instruments that measure radiances of light reflected from water in the wavelength bands of interest.

The radiance measurements are digitized and used to estimate the concentration of phycocyanin-pigmented microbes by means of the equation $X = K_1 - K_2R_{31} + K_3R_{41} - K_4R_{43} - K_5R_{53} + K_6R_{73} - K_7R_{74}$, where X is the approximate concentration of phycocyanin-pigmented

| Band Index | Approximate Lower Wavelength Limit, μm | Approximate Upper Wavelength Limit, μm |
|------------|---|---|
| 1 | 0.45 | 0.52 |
| 3 | 0.63 | 0.69 |
| 4 | 0.76 | 0.90 |
| 5 | 1.55 | 1.75 |
| 7 | 2.08 | 2.35 |

Reflected Light in These Wavelength Bands is measured, and the measurements are used to estimate concentrations of phycocyanin-pigmented microbes in water.



Measured Concentrations of Phycocyanin in water samples (represented by the dots) collected from Lake Erie on September 27, 2000 are compared with concentration estimated by means of the equation in the text (represented by the straight line) incorporating K_i values obtained by correlation with water-sample concentrations measured on July 1, 2000.

microbes; for any pair of band indices i and j , R_{ij} is the radiance in band i divided by the radiance in band j , calculated after subtraction for atmospheric haze in each band; and the K_i values are chosen to obtain the best correlation between the estimated concentrations and concentrations determined by laboratory analysis of water samples. The figure presents an example of concentrations estimated from a set of Landsat data by use of this equation and the cor-

responding concentrations determined from water samples.

This work was done by Robert K. Vincent of Bowling Green State University for Glenn Research Center. Further information is contained in a TSP (see page 1).

Inquiries concerning rights for the commercial use of this invention should be addressed to NASA Glenn Research Center, Innovative Partnerships Office, Attn: Steve Fedor, Mail Stop 4-8, 21000 Brookpark Road, Cleveland, Ohio 44135. Refer to LEW-18202-1.