Particulate absorption methodology

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Document: Version 1, 2017-01-17

I. Description

Particulate absorption was quantified utilizing the transmittance/reflectance (T-R) method of Tassan and Ferrari 1995 along with the NASA Ocean Optics Protocols, Revision 4, Volume IV protocol (Mitchell *et al.* 2003). Updates/modifications to this method were also followed (Tassan and Ferrari 2002, Lohrenz 2000 and Lohrenz *et al.* 2003). Percent transmittance and reflectance were measured using a Lambda 35 UV/VIS dual-beam spectrophotometer (Perkin-Elmer) fit with a 50 mm integrating sphere (LabSphere). Data were resolved from 300-800 nm in 1 nm increments using a slit-width of 2 nm and a scan rate of 240 nm min^{-1}.

II. Sample collection and processing

Briefly, water samples were retrieved from the field and filtered within 8 hours of collection onto GF/F filters (Whatman, 0.7µm pore size, 25 mm diameter) under low vacuum. Triplicate filters were created for each sample depth. Field blanks were created by filtering 25 mL of 0.2µm filtrate in duplicate for each cruise. Sample filters were immediately frozen in liquid nitrogen and stored at -80°C until analysis. The diameter of each filtration tower was measured using a digital caliper to a precision of 10^{-2} mm. Corresponding tower diameters were recorded for each sample filter at the time of filtration. These values were used during data processing to calculate geometric path length (see Section III).

The 50 mm integrating sphere only contains ports for the sample beam; the reference beam remains as in a standard configuration. All measurements were made against an empty reference beam path. Samples can be placed flush with the outside sphere surface along the sample beam path either at the front or back of the sphere. A custom filter holder was manufactured by mounting a thin O-ring onto a quartz microscope slide. This design served to hold the filter in place during measurement while preventing it from touching the sphere surface.

A blank was created each analysis day by filtering ~50 mL of purified, particle-free water through a GF/F filter. This analysis blank was then placed in a covered petri dish and kept moist. Samples were brought to room temperature and then stored in covered petri dishes in the refrigerator until analysis. Samples were kept moist throughout. Percent T and R were measured for each sample filter and the analysis blank. Field blanks were treated as samples. Filters were then bleached with ~20 mL of 0.1% sodium hypochlorite for 20 to 30 minutes. De-pigmented percent T and R were measured for each filter.

III. Data Processing

For a detailed derivation and discussion of particulate absorption retrieval, refer to the references listed in Section I. A brief listing of data processing steps and equations are provided here.

1) Percent T and R are normalized to the analysis blank:

$$T_s = \frac{T_{sf}}{T_f}$$

$$R_s = \frac{R_{sf}}{R_f}$$

where *sf* refers to the sample filter and *f* refers to the blank filter.

2) Global sample absorption (a_s^*, dimensionless) can then be retrieved as (Tassan and Ferrari 1995, their Eq. 13):

$$a_s^* = 1 - T_s + R_f(T_s - R_s)$$

3) The absorption coefficient (a, m^{-1}) is retrieved as (Lohrenz 2000, his Eq. 11, and Lohrenz *et al*. 2003, their Eq. 1):

$$a(\lambda) = \frac{a_s^*(\lambda)}{\beta\ d_g\ [1 - a_s^*(\lambda)]}$$

where β (unitless) is the pathlength amplification factor (can be thought of as the ratio of optical to geometric pathlength) and d_g is the geometric pathlength of the sample:

$$d_g = \frac{V}{s}$$

where V is the volume filtered (m^3) and s is the clearance area of the filter (m^2) calculated from recorded tower diameter. We apply β=4.8 (Lohrenz *et al*. 2003) to our data set. At this point, retrieved absorption coefficients for unbleached samples represent total particulate absorption (a_p, m^{-1}) and bleached samples represent non-algal particles (a_d, m^{-1}).

4) Phytoplankton absorption (a_{ph}, m^{-1}) was retrieved as:

$$a_{ph} = a_p - a_d$$

5) The mean and standard deviation of replicate filters are reported.

IV. References

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