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Instrumentation to measure the backscattering coefficient bb for arbitrary phase functions

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Spotlight summary: What is b_b? As light propagates through the ocean, it experiences an exponential attenuation due to absorption and scattering. The backscattering coefficient b_b is that component of the total scattering coefficient at angles greater than 90°. This is important because light that is scattered at angles less than 90° tends to keep going in the general direction of the incident light. If the sun is directly overhead, light scattered at an angle less than 90° will continue deeper into the ocean, while light that is absorbed or scattered at an angle greater than 90° will not. If the sun is not directly overhead, the penetration of sunlight can still be approximated using b_b and a simple correction using the cosine of the sun angle. Because of the importance of photosynthesis, penetration of sunlight is the primary application of b_b, but the same argument applies to moonlight, wide laser beams, and the lights that squid fishers use to attract squid to the surface.

The direct measurement of b_b in the ocean is difficult, because it requires measurement of the scattered light integrated over the 2π steradians of backscatter solid angle for a small length along the incident propagation direction. The most common solution is to measure the volume scattering coefficient at a single angle and estimate b_b assuming that the shape of the volume scattering function is known. Scattering angles of 120° and 140° have been used with some success in regions where the volume scattering function is similar to the one that is assumed. But this is not always the case—especially in dense plankton blooms. The volume scattering function may even have an azimuthal dependence as when, for example, highly elongated diatom chains are aligned by current shear. Haubrich *et al.* describe a new technique to directly measure b_b in the ocean. It is not as simple as using a detector with a large collecting aperture behind the scattering volume; that geometry produces a weighting function proportional to the cosine of the scattering angle, while the correct weighting function is proportional to the sine. They have devised a very clever way to produce the desired weighting function by wrapping the detector collection aperture in a cylinder around the optical axis of the illuminating beam. The normal to the aperture is perpendicular to the illuminating beam rather than parallel, and a sinusoidal weighting function results. In the rest of the paper they relate a very careful theoretical and experimental investigation into the calibration and the performance of such an instrument. The final conclusion is that measurement accuracy of a few percentage less is possible under a wide range of conditions.

--James Churnside

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