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Volume 23, Tower-Perturbation Measurements in Above-Water Radiometry

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Chapter 3

In Situ Methods

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Abstract

The *in situ* methods used during the tower-shading campaigns were a direct consequence of making above- and in-water measurements of the radiance field within the coastal ocean environment. The in-water measurements were intended as a *reference* or ground truth, because previous campaigns had established a methodology for correcting the in-water data for tower perturbation effects. Much of the above-water experiments, however, were by definition degraded—they were specifically designed to capture the perturbation of the tower in the surface radiance field. The spatial complexity (primarily vertically for the duration of the experiments considered here) of the coastal ocean makes the interpretation of optical profiles alone very difficult, so a variety of supporting measurements and methods were used to produce a thorough description of the vertical properties of the water column.

3.1 INTRODUCTION

The *in situ* methods considered here are those directly or indirectly used for investigating above-water tower perturbations in the coastal ocean. The distinction between primary and secondary measurements is made, because a full understanding of the variance in the data frequently requires ancillary data not used in the principal analytical variables. One of the advantages of executing the tower-perturbation campaigns at the AAOT was the immediate access to a comprehensive set of environmental data products without the need for adding additional instruments or personnel.

3.2 AOP METHODS

The design and use of the AOP instruments are inexorably tied to the basic equations relating the upward radiance field below the surface with that exiting the surface, the angular bidirectional dependency of these fields, and the transformation of radiance or irradiance into reflectance. The full set of these equations are detailed in Morel and Gentili (1996) and in Mobley (1999) as well as the most recent version of the protocols for above- and in-water radiometry (Mueller and Morel 2002), so only brief summaries are considered here.

The spectral radiance emerging immediately above the ocean (at a depth denoted $z = 0^{+}$), the so-called *water-leaving radiance*, for a given solid angle of the detector, Ω_{FOV}, is a function of the azimuthal and zenith viewing angles of the instrument with respect to the azimuthal and zenith angle of the sun. For brevity, the explicit presentation of Ω_{FOV} and the angular geometries is not repeated hereafter except where needed to clarify specific details of the methods involved.

The illumination conditions above the sea surface depend on a direct component from the sun and a diffuse component from the sky. In addition to the sun position in a cloudless sky, the aerosol nature and optical thickness determine the radiant field above the ocean, and then subsequently the upward radiance field inside the ocean. In the case of partly cloudy skies, the radiant field is more complex, because it depends on the cloud type and distribution. For the above- and in-water methods considered in this study, the above-surface illumination is expressed in a simplified way by only considering the solar zenith angle (and the measurements are made during predominantly clear-sky conditions).

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