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Chapter 6

Cosine Response Measurements

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ABSTRACT

In addition to the immersion factor characterizations, the cosine response was measured for one irradiance sensor at CHORS and Satlantic (motivated by some preliminary measurements at the JRC). The angular response of an OCI-200 in-water radiometer was characterized by CHORS and by Satlantic using a similar methodology, although the former relied on a point source with a horizontal rotation of the sensor, and the latter relied on a collimated source and a vertical rotation. Results from the analysis of the data from Satlantic show deviations from the ideal cosine response for most of the collectors within, or very close to, the limits suggested by the SeaWiFS Ocean Optics Protocols (i.e., 2% between 0–65° and 10% above 65°). Results obtained from the analysis of the CHORS data show deviations from the ideal cosine response within the suggested limits for the OCI-200 central collector, but consistently higher deviations for the six collectors symmetrically located around the centermost one. The latter result is primarily explained by the use of different sources at the two laboratories (i.e., a lamp at CHORS and a lamp plus a collimator at Satlantic).

6.1 INTRODUCTION

The calibration of irradiance sensors takes place in air with light arriving normal to the plane of the cosine collector faceplate. To properly measure all irradiance arriving at the collector plane, the response should follow a cosine function, such that

$$E_\theta \ = \ E_0 \cos\theta, \tag{7}$$

where E_θ is the measured irradiance in response to the light flux arriving at angle θ with respect to the normal of the collector plane, and E_0 is the measured irradiance the same light flux would produce if it were measured normal to the collector plane. Irradiance sensors have a field of view that extends over the hemisphere normal to the sensor faceplate, which is usually separated into two 90° halves, i.e., during a characterization, $-90° < \theta < +90°$.

If (7) is satisfied, an on-axis calibration can be used, and the device will correctly measure the irradiance arriving at the collector plane (regardless of the directional origin of the light). Of course, for an in-water sensor to correctly measure irradiance, there is the added requirement that the immersion factor must be correctly characterized. For in-water irradiance sensors, which were the only ones considered in SIRREX-8, the cosine response must be made with the radiometer under water.

6.2 PRELIMINARY INQUIRIES

A continuing philosophy of the entire SIRREX activity has been to incrementally investigate the sources of uncertainty in radiometric calibrations and measurements. The primary reason for this approach has been the difficulty of assembling the needed resources (personnel, equipment,