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Abstract

This report documents the scientific activities during the seventh SeaWiFS Intercalibration Round-Robin Experiment (SIRREX-7) held at Satlantic, Inc. (Halifax, Canada). The overall objective of SIRREX-7 was to determine the uncertainties of radiometric calibrations and measurements at a single calibration facility. Specifically, this involved the estimation of the uncertainties in a) lamp standards, b) plaque standards (including the uncertainties associated with plaque illumination non-uniformity), c) radiance calibrations, and d) irradiance calibrations. The investigation of the uncertainties in lamp standards included a comparison between a calibration of a new FEL by the National Institute of Standards and Technology (NIST) and Optronic Laboratories, Inc. In addition, the rotation and polarization sensitivity of radiometers were determined, and a procedure for transferring an absolute calibration to portable light sources was defined and executed.

Prologue

The Sea-viewing Wide Field-of-view Sensor (SeaWiFS) Project at the National Aeronautics and Space Administration (NASA) Goddard Space Flight Center (GSFC) has two important goals with respect to the spaceborne radiance measurements (Hooker and Esaias 1993): a) normalized water-leaving radiance with an uncertainty to within 5%, and b) chlorophyll *a* concentration with an uncertainty to within 35%. These goals are very ambitious, and can only be achieved by augmenting the SeaWiFS measurements with a program of ongoing validation measurements to a) verify the radiometric uncertainty and long-term stability of the SeaWiFS instrument's radiance responsivities, and b) validate the atmospheric correction models and algorithms used to convert SeaWiFS radiances to water-leaving radiances, $L_W(\lambda)$. One of the principal approaches to this critical aspect of the SeaWiFS mission are frequent direct comparisons between spaceborne and *in situ* measurements of $L_W(\lambda)$. Because there are many sources of uncertainty contributing to the final uncertainty objective (5%), each source must be minimized and kept at the lowest level possible. The goal for the calibration of the field instruments has always been to have reproducible calibrations from 400–850 nm as close to 1% as possible (with 2% as a hoped for upper limit).

The calibration goal for SeaWiFS field instruments is not only driven by a simple argument of sums. Given the myriad objectives associated with SeaWiFS validation, the only economically feasible approach for acquiring a large and globally distributed database of *in situ* radiometric measurements, is to solicit contributions of data from the oceanographic community at large. Such an approach demands an assurance that the aggregate data set will be of uniform quality, and one of the first points of quality control is maintaining a high standard for instrument calibration (Hooker and McClain 2000).

The entire process is more complicated than a careful scrutiny of calibration facilities, and the SeaWiFS Project is addressing this problem through the SeaWiFS Calibration and Validation Program (McClain et al. 1992). At the outset, the Project sponsored a workshop to draft protocols for ocean optics measurements to support SeaWiFS validation (Mueller and Austin 1992), which included instrument performance specifications, and requirements for instrument characterization and calibration. The importance of the protocols to the community was established by the considerable expansion of the original document to accommodate a broader range of measurements, techniques, and sampling considerations (Mueller and Austin 1995).

The strategy adopted for the validation of the SeaWiFS remote sensing data is to calibrate all of the field instruments within a network consisting of the instrument manufacturers plus a few additional laboratories that have recurringly provided instrument calibrations. In recognition of the need to maintain internal consistency between calibrations of *in situ* instruments and that of the SeaWiFS instrument itself, the SeaWiFS Project, under the Calibration and Validation Program, implemented an ongoing series of SeaWiFS Intercalibration Round-Robin Experiments (SIRREXs). The objectives of the SIRREX activity, at each separate event and over time, are to accomplish the following:

1. Intercalibrate FEL lamp working standards of spectral irradiance and to reference each to the National Institute of Standards and Technology (NIST) scale of spectral irradiance via a secondary or tertiary standard;
2. Intercalibrate the integrating sphere sources of spectral radiance;
3. Intercompare the plaques used to transfer the scale of spectral irradiance from an FEL lamp to a scale of spectral radiance, as well as the support electronics involved (most critically shunts and voltmeters);
4. Evaluate the suitability of the equipment and laboratory methods being employed for radiometric calibrations at each institution; and
5. Intercompare radiometers in the field while evaluating the measurement protocols being used.