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Volume 19, Coastal Atmosphere and Sea Time Series (CoASTS), Part 1: A Tower-Based, Long-Term Measurement Program

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Abstract

The Coastal Atmosphere and Sea Time Series (CoASTS) Project, aimed at supporting ocean color research and applications, from 1995 up to the time of publication of this document, has ensured the collection of a comprehensive atmospheric and marine data set from an oceanographic tower located in the northern Adriatic Sea. The instruments and the measurement methodologies used to gather quantities relevant for bio-optical modeling and for the calibration and validation of ocean color sensors, are described. Particular emphasis is placed on four items: 1) the evaluation of perturbation effects in radiometric data (i.e., tower-shading, instrument self-shading, and bottom effects); 2) the intercomparison of seawater absorption coefficients from *in situ* measurements and from laboratory spectrometric analysis on discrete samples; 3) the intercomparison of two filter techniques for *in vivo* measurement of particulate absorption coefficients; and 4) the analysis of repeatability and reproducibility of the most relevant laboratory measurements carried out on seawater samples (i.e., particulate and yellow substance absorption coefficients, and pigment and total suspended matter concentrations). Sample data are also presented and discussed to illustrate the typical features characterizing the CoASTS measurement site in view of supporting the suitability of the CoASTS data set for bio-optical modeling and ocean color calibration and validation.

1. INTRODUCTION

Optical measurements from space enable estimates of the concentration of materials suspended or dissolved in seawater (i.e., pigment, sediment, and colored dissolved organic matter) which are of great relevance in environmental and climate-related studies. Because of this, a number of new advanced ocean color sensors were designed to support oceanographic studies and applications including the Modular Opto-electronic Sensor (MOS), the Ocean Color and Temperature Scanner (OCTS), the Polarization and Directionality of the Earth's Reflectance (POLDER) sensor, the Sea-viewing Wide Field-of-view Sensor (SeaWiFS), the Moderate Resolution Imaging Spectroradiometer (MODIS), and the Medium Resolution Imaging Spectrometer (MERIS). All of these sensors were successfully launched and have contributed significantly to the general problem of inverting optical measurements to derive concentration estimates of biogeochemical parameters; several continue to provide regular coverage of the global biosphere.

To ensure a better exploitation of the data supplied by spaceborne sensors, national and international calibration and validation projects have been started. Their major objectives are the development of the bio-optical algorithms required for extracting quantitative information from space data; the validation of products obtained from satellite imagery; and the indirect absolute calibration (i.e., vicarious calibration) of the radiometers in space. All of these activities require comprehensive *in situ* atmospheric and marine measurements. In agreement with this requirement, the Coastal Atmosphere and Sea Time Series (CoASTS) Project was set up at the Joint Research Centre (JRC) in Ispra, Italy to support bio-optical modeling and ocean color calibration and validation exercises at a coastal site in the northern Adriatic Sea.

In order to provide a comprehensive overview of the CoASTS measurement activities, this report has three primary objectives:

1) Present the instrumentation and the measurement methodologies,
2) Assess the accuracy of the most relevant measurements needed for bio-optical modeling as well as ocean color vicarious calibration and algorithm validation activities; and
3) Discuss sample data that display the relevant features of the measurement site.

10. CONCLUSIONS

This report presented the measurement program used within the CoASTS Project (at the AAOT site) and extensively discussed the applied methods with a particular emphasis on those more relevant for bio-optical modeling and the calibration and validation of ocean color sensors. The methods discussed for the analysis of radiometric measurements highlighted the importance of correcting in-water radiance and irradiance data from superstructure (tower-shading) effects, instrument self-shading, and bottom effects. These perturbations for the specific measurement conditions analyzed in this study, may induce an overall spectral uncertainty in $L_u(0^-\lambda)$ ranging from 4–18% at 412 nm, −2 to +10% at 490 nm, −9 to +10% at 555 nm, and 6–16% at 665 nm.

The intercomparison of seawater absorption coefficients from AC-9 *in situ* measurements and from laboratory spectrometric analysis of discrete seawater samples, showed the best agreement when the scattering correction—for perturbation effects induced in AC-9 data by the finite acceptance angle of the optics and the non-ideal reflective surface of the absorption chamber—is performed removing a variable percentage of the scattering coefficient. In this case, the scatterplots of the absorption coefficients from spectrometric analysis of seawater samples and AC-9 measurements showed average absolute percentage differences of −2, −19, −18, and −18% at 412, 488, 555, and 676 nm, respectively.