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Volume 20, Coastal Atmosphere and Sea Time Series (CoASTS), Part 2: Data Analysis

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ABSTRACT

In this document, the first three years of a time series of bio-optical marine and atmospheric measurements are presented and analyzed. These measurements were performed from an oceanographic tower in the northern Adriatic Sea within the framework of the Coastal Atmosphere and Sea Time Series (CoASTS) project, an ocean color calibration and validation activity. The data set collected includes spectral measurements of the in-water apparent (diffuse attenuation coefficient, reflectance, Q-factor, etc.) and inherent (absorption and scattering coefficients) optical properties, as well as the concentrations of the main optical components (pigment and suspended matter concentrations). Clear seasonal patterns are exhibited by the marine quantities on which an appreciable short-term variability (on the order of a half day to one day) is superimposed. This short-term variability is well correlated with the changes in salinity at the surface resulting from the southward transport of freshwater coming from the northern rivers. Concentrations of chlorophyll a and total suspended matter span more than two orders of magnitude. The bio-optical characteristics of the measurement site pertain to both Case-1 (about 64%) and Case-2 (about 36%) waters, based on a relationship between the beam attenuation coefficient at 660 nm and the chlorophyll a concentration. Empirical algorithms relating in-water remote sensing reflectance ratios and optical components or properties of interest (chlorophyll a, total suspended matter, and the diffuse attenuation coefficient) are presented.

1. INTRODUCTION

The use of remotely-sensed ocean color data has increased considerably over the last years, since several new sensors were put in orbit more than 10 years after the Coastal Zone Color Scanner (CZCS) ceased its activity. These sensors, specifically, the Sea-viewing Wide Field-of-view Sensor (SeaWiFS), the Ocean Color and Temperature Scanner (OCTS), the Marine Optical Spectroradiometer (MOS), the Moderate Resolution Imaging Spectroradiometer (MODIS), and the Medium Resolution Imaging Spectrometer (MERIS), present advanced characteristics compared to CZCS, in the addition of a certain number of channels, and an increased signal-to-noise ratio and dynamic range (IOCCG 1998). These increased capacities are intended, in particular, to improve the retrieval of chlorophyll a concentration in the open ocean (Hooker et al. 1992 and O'Reilly et al. 1998), as well as eventually allowing the retrieval of additional marine quantities such as total suspended matter or colored dissolved organic matter (Carder et al. 1999).

For the open ocean, the possibility of retrieving chlorophyll a and additional water components from remotely-sensed data is presumably simplified, because in most cases, they all co-vary (but see Carder et al. 1991). In coastal waters (where most of the so-called optical "Case-2" waters can be found), however, this retrieval is less successful. In effect, because of the diversity of the sources (rivers, atmospheric input, bottom resuspension, etc.) the simplifying assumption of co-variation may not be verified. Consequently, by contributing—often antagonistically—to the total marine signal, the occurrence of these different components makes their separation much more difficult on an optical basis.

As a consequence of the number of sensors now operational, there is an increasing demand for *in situ* bio-optical data (water and atmosphere) in order to address two main topics:

1) The development of models and algorithms allowing the retrieval of marine and atmospheric quantities from the signal at the top of the atmosphere; and
2) The vicarious calibration of the sensors, and the validation of their different products.

Programs including time-series of measurements on specific sites such as the Marine Optical Buoy (MOBY, Clark et al. 1997), the Yamato Bank Optical Mooring (YBOM, Kishino et al. 1997), and the Plymouth Marine Bio-Optical Data Buoy (PlyMBODy, Pinkerton and Aiken 1999), or repetitive ship cruises such as the Atlantic Meridional Transect (AMT) program (Aiken et al. 2000) were developed considerably in the past years. Basing the investigation of the environment on a long time or space scale, one of their objectives was, in particular, to encompass a wide range of optical properties and concentration of optically significant components.

In this context, a program of extensive *in situ* measurements called the Coastal Atmosphere and Sea Time Series (CoASTS), was set up (Zibordi et al. 2002). Within this program, a series of marine and atmospheric measurements are performed from an oceanographic tower located in the northern Adriatic Sea, off the Venice Lagoon. As of this writing, the project has provided more than six years of data (with a frequency of 1–2 campaigns per month) including water apparent and inherent optical properties and the corresponding optically significant components, as well as atmospheric measurements, which allows for the estimation of aerosol properties. The resulting data set was