MULTI - PARAMETRIC - RADIOMETRIC PROFILER "PRISMA"

A submergible radiometric profiler with an automatic multi-parameter system developed and manufactured by

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Introduction

The launching into orbit of new multi-spectral sensors whose bands are to be defined by the different spectral characteristics of oceans and by the experience gained from the CZCS (**C**oastal **Z**one **C**olor **S**canner) will make images available from which to retrieve important marine geophysical parameters.

To derive the data quantitatively it is necessary to develop *models* for which experimental measurements can be made *in situ* using an optical instrument along with the conventional oceanographic instruments. The idea of this activity stems basically from the fact that the ocean has strongly differentiated characteristics requiring a whole series of programmed measurements necessary to describe it. Optical measurements are rarely made because there are a number of problems concerning:

- the instruments available;
- calibration of sensors;
- the lack of a coded methodology;
- the limitation of the useful period for measurement (which can only be made those hours in which there is the maximum insulation.

Satellite sensors such as the *Sea-viewing Wide Field* of view Sensors (SeaWiFS), to be launched within the year, and the Japanese *Ocean Color Temperature Sensor* (OCTS), already launched by NASDA, require good accuracy of sea-truth data since radiometric characteristics enable the extraction of highly accurate bio-optical parameters. Other than the sensors just mentioned, the following sensors will be launched into orbit.

- *Moderate Resolution Imaging Spectroradiometer*, MODIS (NASA);
- *Medium Resolution Imaging Spectroradiometer*, MERIS (ESA);
- *Reflecting Optics System Imaging Spectrometer,* (ESA-DIR).

NASA published a protocol for optical measurements [1] which makes reference to the IOC for oceanographic measurements [2]. Experimental data are needed for the calibration and validation of satellite imagery, for the development of algorithms and for radiative transfer models.

To collect optical data, a sensor was built by assembling sensors with characteristics conforming to the specifications of the protocol and based also on the experience acquired within the CoASTS and CEVEX projects during the experimental activity carried out from the CNR oceanographic platform, "*Acqua Alta*" [3]. The hardware and software for the acquisition and handling of data were developed by the Italian company, IDRONAUT Srl, Milan.

General Characteristics

The sensor was conceived by selecting and putting together instruments with the following specifications.

- Respond to the specifications indicated by the NASA protocol,
- Be light, compact (heeding to the optical geometry) and able to be used on-board any type of small boat,
- Capable of acquiring profiles even without the help of an on-board PC,
- Operate with any oceanographic winch.

The resulting product represents definitely a system which can acquire up to 28 parameters (plus the calculated ones) and which has a light weight and is easy to handle.

The instruments making up the system are:

- *SATLANTIC*: Ocean Color Radiometer System, composed of two seven-band sensors (SeaWiFS), OCI-200 (downwelling irradiance) and OCR-200 (upwelling radiance),
- *WET Labs*: WETStar Miniature Fluorometer to measure the chlorophyll concentration from the fluorescence emission,
- *D&A instrument company*: OBS-3 to measure turbidity and suspended matter with an infrared sensor,
- *IDRONAUT*: Ocean Seven 316 interface sensor for telemetry and RS232C complete with oceanographic sensors and sufficiently sized internal memory,
- X-Y *Electrolytic TILT* Sensor.

In the mechanical assembly of the instruments care was taken to ensure that the optical sensors felt as little as possible the effects of the reflection and shadow of the main body of the sensor and, particularly, that the measurement of the incident light and backscatter happen definitely at the same depth.

Measured Parameters

The sensor was built to measure those *primary optical parameters* and the *properties of the environment* needed to formulate, as well as the *radiative transfer* model and the bio-optical algorithms, also a *product verification* of the optical data (SeaWiFS images).

The primary optical parameters measured with the sensors OCI-200 and OCR-200 are:

- *Downwelling spectral irradiance*, Ed (z, λ),
- *Upwelling spectral radiance*, Lu (z, λ), measured by silicon photodiodes in seven 20 nm-wide spectral bands centered at the following wavelengths: 412.2, 435.5, 490.4, 509.3, 555.7, 665.5, 683.8, through a 86 mm^2 diffuser for the former, and a 10º FOV, for the latter.

Environmental parameters measured with the Ocean Seven 316 Probe are:

- Temperature,
- Conductivity, Salinity and Density,
- Oxygen, pH, and Redox,
- Depth and speed of sound,
- X-Y inclination,
- Florescence induced by chlorophyll pigments (RU), with OBS-3,
- Suspended matter concentrations (FTU).

Data Usage

Coastal waters, denominated generically "*case 2 waters*" , are specially rich in phytoplankton and their coloration is determined by terrigenous suspended substances and dissolved organic matter (DOM). Algorithms defined by band ratios have a relative value because the two or more substances present, with different optical properties, are not covariants with chlorophyll concentration. The presence of high mesoscale or sub-mesoscale variability of the water mass is another critical aspect and in addition to this there is the induced mixing of tidal currents, the stratification in areas influenced by the fresh water input and seasonal warming. In situ sampling procedures, because of the complexity of the phenomena involved, differ from the aforementioned protocol regulations.

The guideline defined by the Workshop is that the calibration algorithms can not be based directly on the SeaWiFS images but with the in situ upwelling radiance spectra of the water measured simultaneously with the water samples. In the case in which observations are directed to study the frontal system, the measurements will be made within and beyond the front characterizing the two water masses. In a system of water belonging to case 2 the comparison between radiometric measurements will serve mainly to develop regional algorithms.

At present there is another acquisition system operating in the Adriatic with the same type of sensors for radiometers, fluorometer and turbidimeter. The radiometric system was built by the JRC, Ispra, and installed on the CNR-oceanographic platform, Acqua Alta. It has been working for two years and is used in field measurements on a biweekly basis. The instruments are mounted on a guide that moves on cables anchored on the bottom. The guide was positioned so as to avoid shadowing and glittering effects of the platform on the sensor.

The critical part of the measurements from a ship is represented specifically by the absence of this element that sometimes cause the poor quality of the datum. This drawback may be partially corrected using the tilt datum.

References

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[2] I.O.C.; "*Protocols for Joint Global Ocean Lfux Study (JGOFS) core measurements*"; Manuals and Guides 29, 1994 UNESCO.

[3] G. Zibordi et alt; "*Coastal Athmosphere and Sea Time-Series Project (CoASTS)*"; Remote Sensing for Marine and Coastal Environments, Sept. 95 Seattle.

[4] Idronaut; "*Ocean Seven 316 Multiparametric Probe Operator's manual*".

[5] Idronaut; "*Ocean Seven 316 Multiparametric Probe Optional Sensors/Probes Addendum Manual*".

[6] D & A Instrument Company; "*OBS-1 & 3 Instruction manual*".

[7] Wet Labs; "*WETStar Miniature Fluorometer User's guide Version 1.0*".

[8] H. R. Gordon, A.Y. Morel; "*Remote Assessment of Ocean Colour for Interpretation of Satellite Visible Imagery*"; Springer Verlag 1983.

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