SAMPLER: An instrumentation project for studying the effect of turbulence in aquatic systems.

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1. Introduction

Hydrodynamics plays a primary role in aquatic ecosystems, affecting processes across a wide range of temporal and spatial scales. At small scales, turbulence affects the dynamics of aquatic ecosystems by enhancing the transport of heat, solutes (salt, nutrients, pollutants) and particles (microorganisms, sediments) within the water column. The understanding of any biological-physical interaction requires the characterization of the environmental changes derived from the transport mechanisms and the response of organisms to these changes. Interest in the interaction of small-scale physical and biological processes is reflected in the increasing number of review papers being recently published. However, most of these reviews indicate that our present understanding is still largely speculative, mainly due to the technical limitations of field and laboratory data sampling.

The SAMPLER has been conceived to develop a system of data acquisition for improving the spatial and temporal resolution of field data. The SMAPLER project is integrated in the coordinated project VARITEC, which will address the multiscale study of the variability of turbulence in relation to the structure and dynamics of the coastal ecosystem in the NW Mediterranean. One of the coordinated tasks of the SAMPLER project is to develop an analysis system with new algorithms for processing the high-resolution data obtained with the new instrument. The system will also include the capability to integrate the data for analyzing and characterizing the physical and biological processes at larger scales.

2. The integrated instrumental system

In order to obtain information of the physical and biological processes at small scale, an oceanographic sonde will be developed with specialized sensors. The instrument (figure 1)

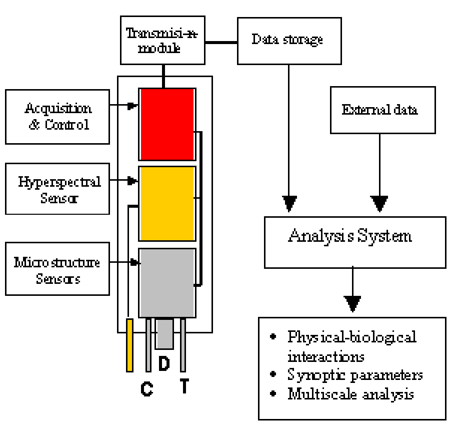

Figure 1. Diagram of the instrumental and analysis system

will be able to measure simultaneously temperature, conductivity and pressure at microstructure scale (de order of mm) and upwelling-downwelling irradiance spectra with high resolution.

The microstructure sensor system will be based on the fast temperature thermistors (FP07, Thermometrics), fast conductivity sensor (PME [1]) and pressure sensor (Keller PSI). The spectra measurements will be obtained with a new hyperspectral sensor based on the novel microsystems technology known as LIGA. The commercially available LIGA spectrometer is very small. It is fitted into a protective casing that measures 25 mm x 35 mm and only 5 mm in height (figure 2). The optical components making up the spectrometer have been made using the LIGA process developed at the Karlsruhe Research Center in Germany [1]. The process allows for very fine structures, in the 0.1 m range, to be realised using a mould made with the aid of x-ray lithography. Entering the spectrometer the light is diffracted as it leaves the optical fibre; this acts as an entrance slit focusing the light onto a grating. A reflection prism, as part of the monolithic construction, reflects the spectrum onto an externally fixed diode array.

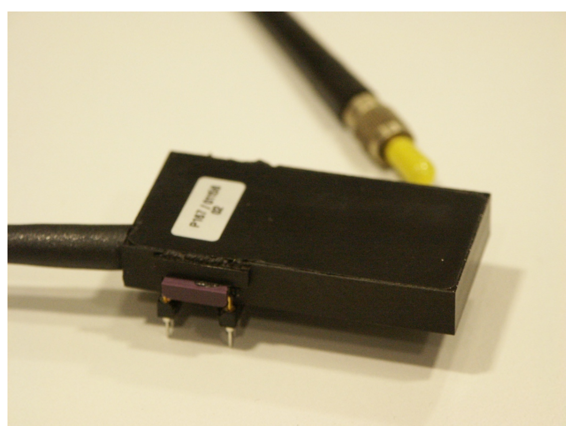

Figure 2. LIGA spectrometer.

The analysis software will be developed in three main blocks. The first block corresponds to the microstructure data analysis, which will include not only the standard methods of microscale characterization from high-resolution CTD measurements (estimation of the turbulent dissipation rate based on Batchelor spectral fitting [3] and eddy diffusivity [4]) but also complementary approaches (turbulent patch detection [5] and estimation of non-local mixing parameters [6]).

The second analysis block corresponds to the hyperspectral analysis. Different optical parameters (planar and scalar irradiances) will be estimated from the uprising and downrising spectral profiles. The averaged values will be used to estimate apparent (AOP) and inherent (IOP) optical properties [7][8].

The last analysis block will combine the data obtained with the sonde with external data obtained from different instruments and methods. Calibration methods will be developed for using the hyperspectral measurements as a reference for remote sensing (multispectral and hyperspectral) observations. Utilities for analyzing time and space series will also be included, specially for relating the biological experimental data (obtained at much coarser resolution) with the measurements obtained with the new instrumentation.

3. Acknowledgements

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Turbulent oceanic flow characterization derived from high-resolution CTD data processing.

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1. Introduction

The characterization of the turbulent oceanic flow dynamics has many important implications in environmental studies (to name a few: dispersion of contaminants, harmful algal blooms or climate change).
The analysis of microstructure density profiles, obtained from high-resolution measurements of conductivity, temperature and depth (CTD), is a common approach for characterizing environmental turbulent fluid dynamics. In particular, Thorpe [1] proposed a simple method for analyzing the effects of the turbulent flows on the microstructure density profiles, which allows to compute the Thorpe displacement dT(z). Thorpe displacement is the vertical distance that an individual fluid particle (i.e. a single density value) of the original profile s(z) has to be moved in order to generate the stable density profile sm(z) (figure 1).

Many applications are derived from Thorpe displacement analysis like, for example, the detection of turbulent regions or the scale analysis of turbulent flows [2].

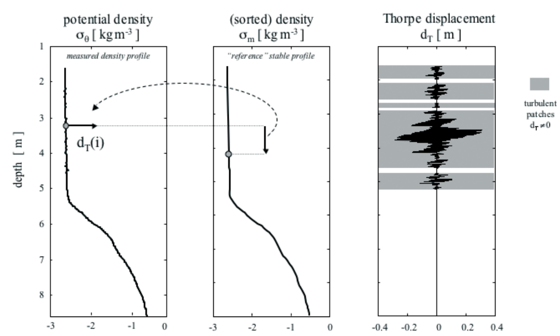

Figure 1 Method computing the Thorpe displacement profile. Turbulent regions (in gray) are identified as regions of non-null dT.

2. Noise reduction method

The characterization of the turbulent flow based on Thorpe displacements has been usually focused in high-stratified layers of the water column, mainly because is in these regions where there are most of the critical turbulent fluxes but also because in these case it is possible to avoid the problems related with instrumental noise [2]. Due to the instrumental noise of CTD measurements, the previous