TT-MARINE: a new open modular cost-effective board to monitor coastal ecosystems

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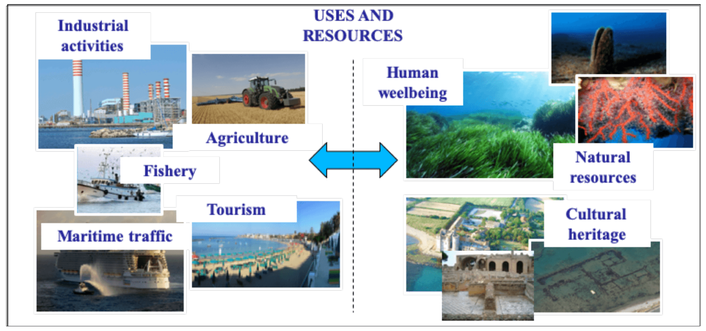
THE COASTAL SYSTEM AND THE DEVELOPMENT NECESSITY OF A GLOBAL COASTAL OBSERVATION SYSTEM

Global Ocean Observing System now needs to extend the measurement of EOVs from the open ocean into continental shelf and coastal systems, expanding spatial coverage of observing into coastal oceans, thus requiring additional technologies



Concerning the measures to consider, the "GOOS Expert Panels" have identified the Essential Ocean Variables based on the following criteria: <u>Relevance, Feasibility, Cost effectiveness</u>

Only some of the GOOS EOVs has been selected as the subset that provides the minimum information to meet the socio-economic requirements. This does not mean that other EOVs are not relevant or different or that more advanced technologies are not useful; this means that they cannot be safely deployed in the frame of the routine monitoring of a harsh environment such as the coastal zone of developing countries.

EOVs and readiness level

CONCEPT PILOT MATURE

Physics
- Sea State
- Ocean surface vector stress
- Sea Ice
- Sea level
- SST
- Subsurface temperature
- Surface currents
- Subsurface currents
- SSS
- Subsurface salinity

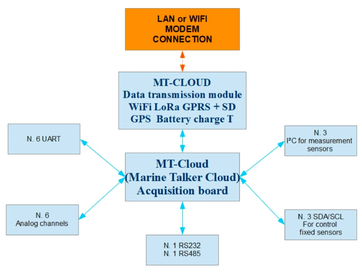
Biogeochemistry
- Oxygen
- Inorganic macro nutrients
- Carbonate system
- Transient tracers
- Suspended particulates
- Nitrous oxide
- Carbon isotope (^{13}C)
- Dissolved organic carbon

Biology and Ecosystems
- Phytoplankton biomass and productivity
- HAB incidence
- Zooplankton diversity
- Fish abundance and distribution
- Apex predator abundance and distribution
- Live coral cover
- Seagrass cover
- Mangrove cover
- Microalgal canopy cover

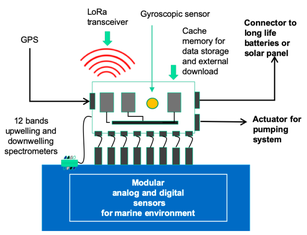
MARINE TALKER TT-MARINE AS A TOOL TO ENABLE THE REALIZATION OF A COOT (COASTAL OCEAN OF THINGS)

Developments for observing systems:
- cost-effective
- modularity
- low-consumption
- enough accuracy for coastal monitoring

TT-MARINE Architecture



TT-MARINE Prototype configuration



ABSTRACT

The coastal marine system is characterized by multiple uses and it represents a vulnerable area highly subjected to anthropogenic pressures. Coastal marine ecosystems monitoring therefore requires an integrated multidisciplinary approach. The modelling of marine coastal dynamics and processes and the development of new observational technologies are fundamental in order to increase the available amount of data needed for the application of integrated approaches. New technologies and coastal observation networks are therefore a priority of the Global Ocean Observation System (GOOS) and of the Agenda 2030 strategy to improve the sustainable management of marine ecosystems and to contribute to future climate change scenarios. In this context a big effort is carried out by existing observing programs (ARGO, DPCP, GO-SHIP, OceanSITES, SOOP), which focus on open ocean waters and do not cover coastal areas. To do this, a significant reduction in the costs of platforms and instruments is necessary while maintaining sufficient measurement precision and consequently data quality. To face this issue, an Arduino based technology has been developed starting from the Tree-Talker-Cloud Technology (TT-Cloud board), a data acquisition and transmission system to monitor the health of trees and the impacts of climate change. From this technology, a new low-cost board, TT-Marine, has been developed, characterized by a high modularity allowing to manage the sensors by different types of communication protocols: RS232, UART, i2c, RS485; analog sensors can be managed by 16 and 24 bit AD converters. Depending on the characteristics and opportunities of the site, the system can manage LoRa, WiFi, gprs/gsm or cable data transmission systems. The TT-Marine is designed to be used in different modes: autonomous, ship-like as a profiler, on buoys and other measuring platforms.Here we present several operating modalities, with different missions and instrumental configurations.

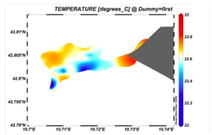
CITIZEN SCIENCE - SAILING VOS PROJECT

Sailing boats become independent measurement platforms, where even the simple drift can be an acquisition system for oceanography

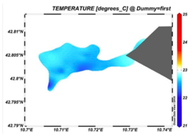
It is necessary to adapt the T, S, or FIs Chl sensors to the type of platform, by installing an independent acquisition system, which can become increasingly complex based on the existing space

Prototype of TT-MARINE sailing VOS system for sea surface temperature acquisition

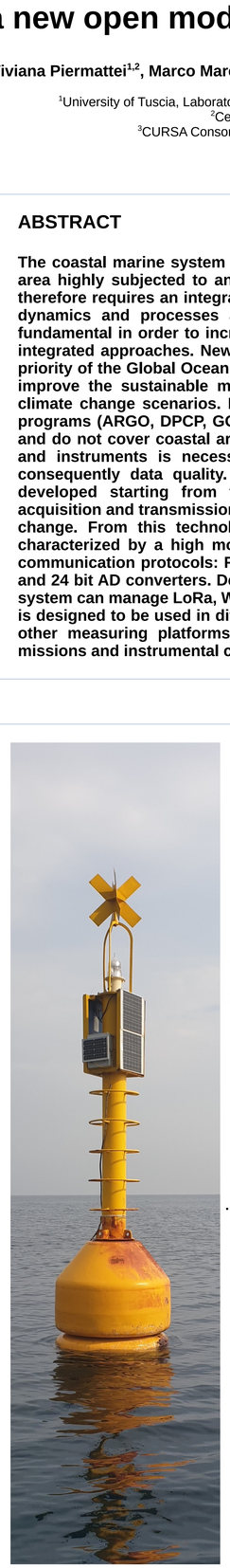
Test 13.09.19



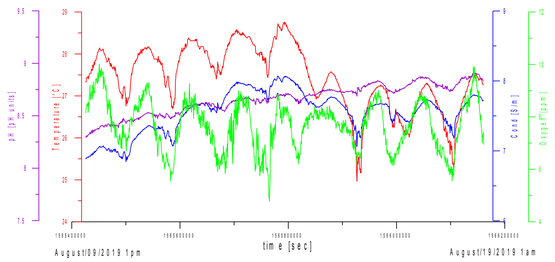
Test 06.09.19



TT-MARINE EXPERIMENTAL APPLICATIONS

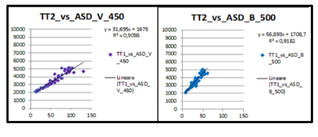


Buoy of Opportunity experiments in south Adriatic Sea



PT100 1/3 Din, low-cost conductivity, oxygen and pH sensors have been integrated and assembled on an already deployed signal buoy in a Marine Protected Area

Multispectral 18 Channels Sensor



Very low-cost passive acoustic

Low-cost audio recorder device

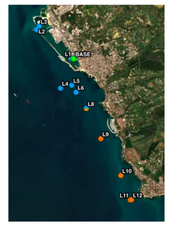
First Laboratory Prototype

The Teensy USB Development Board Version 3.6 features a 32 bit 180 MHz ARM Cortex-M4 processor with floating point unit.

Audio Adaptor high quality 16 bit 44.1 kHz sample rate

Condenser microphone DC3.5 MIC Input

LoRa Marine Transmission Experiments

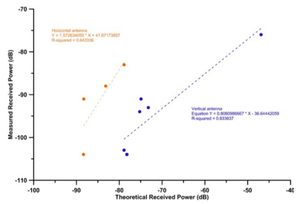


LoRa is a low power wide area network, developed to connect Internet of Things devices and sensors for mass deployment. It can be like a 'star-of-stars' topology in which gateways relay messages between end-devices and a central network server. The wireless communication takes advantage of the Long Range characteristics of the LoRa

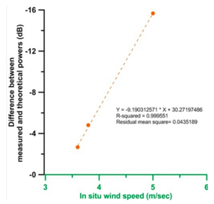
In 12nd March 2019 an experiment was conducted to test the signal attenuation in marine environment.
The LoRa antenna (signal frequency 868MHz) was tested in different positions (vertical and horizontal) and at different distances from the Base.

Attenuation Equation
FSPL (dB) = 20log10(d) 20 log10(f) -27.55

Transmission Equation
Prec(dBm) = Ptr(dBm) + Gtr(dB) + Grc(dB) - Asl(dB)



Comparison between measured signal and theoretical signal: orange horizontal antenna; blue vertical antenna



Correlation between ∂dB and distance. A strong correlation between signal loss and sea surface wind speed was observed