# ID44- IMPLEMENTATION OF A LOW-COST ULTRA-DENSE TIDE GAUGE NETWORK IN THE BALEARIC ISLANDS

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**Abstract**
The VENOM project has developed an unprecedented ultra-dense low-cost, and yet reliable, tide gauge network around the Balearic Islands to understand the very nature of the spatial variability of coastal sea level at different time scales, from sub-hourly processes (e.g., meteotsunamis), to seasonal and interannual variability.

***Keywords***
*Tide Gauge, Sea Level, Meteotsunami, Arduino, Mediterranean Sea*

## INTRODUCTION

Sea level variability is used as an indicator of various short-term and long-term oceanographic processes, such as tsunamis or the sea level rise caused by global warming. Sea level is currently monitored mainly by satellite altimetry and tide gauges, which provide data at different time scales with different spatial resolutions. Despite the extensive network of instruments available, there are still some important limitations for the monitoring of coastal sea level. The tide gauge network is sparse and unevenly distributed, and high frequency data (< 1 hour) is often not available. Furthermore, satellite altimetry measurements are obtained along tracks which can be separated up to 300 km. Also, the validity of altimetry measurements close to the coast is limited and in certain regions may not be representative of the coastal processes.

The mail goal of the VENOM project is to better understand the spatial variability of coastal sea level at different time scales, from sub-hourly processes (e.g., meteotsunamis), to seasonal and interannual variability. In order to cover the short spatial scales associated with the high frequency variability, the project has extended the existing sea level measurement network around the Balearic Islands in the framework of the Western Mediterranean. Namely, we have deployed a new, ultra-dense network of low-cost, and yet reliable, tide gauges.

## TIDE GAUGE DEVICES

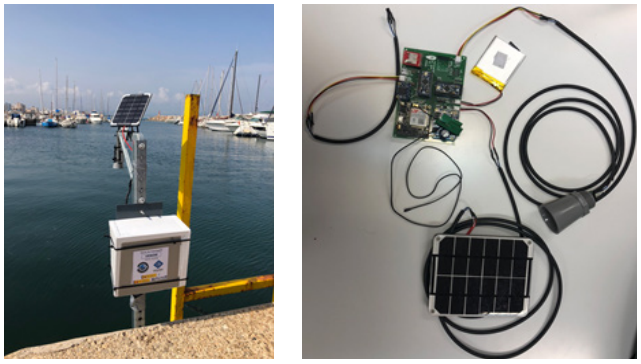
The low-cost tide gauges (Fig. 1) have been developed in the Arduino environment. They consist of an acoustic sensor coupled to a datalogger that registers data at 60 second intervals on a local SD, and that communicates through a GPRS link with a web database at selected intervals. Instruments are solar-powered, so they can be installed almost everywhere. A graphic dashboard allows the monitoring of the network (including the battery status), as well as real-time data visualization. A comparison between a low-cost tide gauge deployed side-by-side with a Puertos del Estado tide gauge (Palma) shows a RMS error of 0.4 cm for hourly data and 0.6 cm for data recorded every minute.

## THE ULTRA-DENSE TIDE GAUGE NETWORK

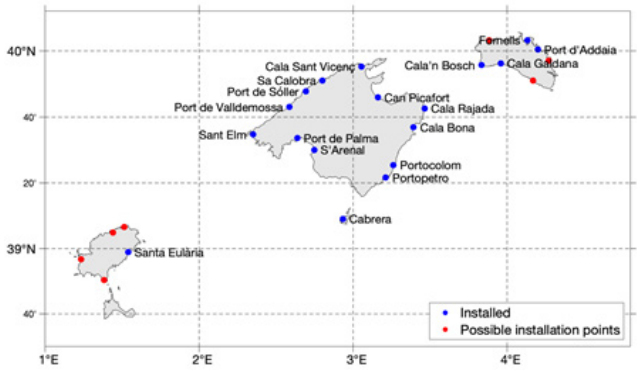
Currently, 19 instruments have already been installed all around the Balearic Islands (12 in Mallorca, 4 in Menorca, 2 in Cabrera and 1 in Eivissa, see Fig. 2) at distances of approximately 10-30 km. Additional sensors like atmospheric pressure or air temperature sensors have also been attached to some of the tide gauges. In the near future, 4 more instruments will be deployed. Their location has been chosen in such a way as to complement the 14 instruments run by other institutions (5 by Puertos del Estado, 5 by SOCIB, 3 by Ports de les Illes Balears and 1 by IEO).

## CONCLUSIONS

The preliminary results of this network are very promising, as the instruments have already measured regional phenomena such as meteotsunamis and downbursts that are currently being analyzed. Our expectation is that with the addition of this new low-cost tide gauge network, it will be possible to achieve an unprecedented advance in understanding the spatial variability of coastal sea level.



'Fig 1.' Low-Cost tide gauge (left) device and Arduino-based data logging circuit board (right).




'Fig 2.' Tide gauge network locations operated by the VENOM project (blue) and future installation points (red).

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