

# A glider in the plume: an innovative approach to investigate and simulate the fate of Rhône River sediment in the Gulf of Lions during the 2014 winter flood

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## Context

The fate of riverine sediments in Mediterranean coastal environments is driven by two mechanisms: direct transfers associated to the plume dynamics and indirect transfers related to sediment resuspension by storms. Quantifying and modelling sediment fluxes in the Gulf of Lions first require to better observe and understand these mechanisms. Usual but not trivial observations have been collected over the last decades in the Gulf of Lions, and especially close to the Rhône River prodelta: the deployment of the MESURHO fixed observatory, many *in situ* optical and physico-chemical profiles operated from research vessels, towed instrumented vehicles or autonomous floats, the analysis of remote sensing ocean colour data. While all these observations are fully complementary and crucial for our understanding of coastal dynamics, they fail to provide necessary repeated observations, over the full water column, along cross shore or longshore transects. The TUCPA project aimed to i) investigate the interest in deploying gliders within the Rhône River plume, ii) examine with an innovative approach the plume dynamics during a significant flood event ( $Q > 5000 \text{ m}^3 \cdot \text{s}^{-1}$ ), iii) improve our modelling results on the area.

## Methods

A SLOCUM coastal glider, equipped with a CTD, O<sub>2</sub> sensor and optical backscatter sensors at 532, 700 and 880nm, was deployed for two weeks from January, 30<sup>th</sup> to February 14<sup>th</sup> 2014, undulating from top to bottom along a North/South transect from the Rhône River mouth to the continental shelf break (a full transect is completed in 2 days approximately). In parallel to these autonomous real time measurements, two field campaigns were conducted at the beginning and end of the glider deployment to measure additional SPM features and validate glider observations. Profiles with an optical grape (optical backscattering sensors, LISST100X and LISST HOLO and CTD) were realized along the glider transect and also further within the plume. Meantime water samples were also collected close to the bed and near the surface for SPM characterization (microfloc / primary particle distribution, mass concentration, chlorophyll a concentration).

The MARS3D hydrodynamic and sediment transport model was implemented in the Gulf of Lions in order to investigate and quantify SPM fluxes and the role of extreme meteorological and hydrological events. This model is based on a regular 1.2km grid, and is forced by daily measured water and solid river discharges, METEOFRAANCE ARPEGE model wind results and WAVEWATCH3 wave fields. This model reproduces the coastal circulation, and especially the surface plume dynamics. The sediment processes are simulated using the MIXSED module (Le Hir *et al.*, 2011) with 4 sediment classes (2 sands, 2 muds). Flocculation processes are reproduced using the Krone/Van Leussen formulation, with variable settling behaviour for each mud class. The bed sediment distribution is initialized from grab samples collected over the last decades.

## Results and conclusions

The glider was operated during the largest flood event measured during winter 2014, reaching  $5000 \text{ m}^3 \cdot \text{s}^{-1}$  on February, 11<sup>th</sup>. This flood generated a well-defined surface plume, up to 20m thick close to the coast (against few meters during low river discharge), characterized by usual decreasing suspended solid concentrations from coast to shore. Moreover, this plume was observed 50km off shore, with significant concentrations (above  $10 \text{ mg} \cdot \text{l}^{-1}$ ) 20km off shore. A nepheloid benthic layer was also observed on the entire continental shelf, featured by strong temporal and cross-shore thickness variability. These preliminary results are confronted with the model results, both in terms of surface concentration, plume metrics (covered area, central position, distance to the coast, plume thickness) evaluated from glider and MODIS ocean colour observations. The model

is also used to evaluate fluxes through embedded zones from the prodelta region to the Gulf of Lions.

The TUCPA experiment demonstrated the feasibility of tracking sediment dynamics in coastal regions from gliders, and the great potential of such measurements to observe sediment patterns in coastal seas. This approach will be further investigated in the MATUGLI project (2014-2017) combining optical and acoustic approaches to evaluate sediment structures and sediment fluxes.

#### **References**

Le Hir P., F. Cayocca and B. Waeles. 2011. Dynamics of sand and mud mixtures: A multiprocess-based modelling strategy. *Continental Shelf Research* 31(10):S135-S149.  
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