SURVEILLANCE DES SÉDIMENTS EN SUSPENSION EN RIVIÈRE AVEC UN PROFILEUR ACOUSTIQUE HYPERBANDE, EXEMPLE SUR LE RHÔNE ET L'ISÈRE EN FRANCE

Suspended sediment monitoring in a river with a hyperband acoustic profiler, example on the Rhône and Isère river in France

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1. Introduction

Suspended Particulate Matter (SPM) measurements are a very important challenge of operational flow monitoring. The ANR project MESURE (ANR-16-ASMA-0005, 2017-2020) proposed to advance further regarding the SPM metrology (sediment concentration, size and flux) using multifrequency hydro-acoustic observations. A dual-frequency ABS (Acoustic Backscattering System) prototype was first developed by Ubertone and tested in laboratory and field campaigns. This prototype was then upgraded to allow a larger range of emission frequencies. In this paper, we present field campaign results of the hyperband ABS UB-SediFlow.

2.Method

The UB-SediFlow is a multi-frequency acoustic profiler (Fig. 1), which measures backscattered echo profiles along 4 acoustic beams. The system is composed of two hardware modules linked by a cable. The waterproof acoustic module (up to 20m) includes 4 wideband transducers (covering the full range 300kHz to 6MHz) and an acoustics electronic board. The splashproof logger (acquisition and communication module) includes a battery (autonomy of 12 hours) and communicates through wifi (signal range between 50 and 100m).

Figure 1 : From left to right: the UB-SediFlow on a floating board, the acoustic module and the user interface

The acoustic module UB-Sediflow was installed on a CNR floating board (Fig. 1) which was deployed with a rope from the bridge on the river at a fixed position or moving to get a transect.

The acoustic backscattered intensities measured by acoustic profilers can be inverted through different methods to get concentration and grain size information [1]. All the methods derive from the sonar equation [2], which includes the necessity of a calibration.

During the sediment managing operations APAVER of May 2021 on the Rhône river, France, the UB-SediFlow was set with 6 acoustic configurations: 0.5 ; 1.0 ; 1.5 ; 2.3 ; 4.5 and 5.2 MHz. The inversion of the acoustic data has been compared with pycnometer samples and the CNR's reference measurement over 5 days (May 19 to 21, 25 and 26th, 2021).

3.Results and discussion

When analysing the acoustic data, the distinction between fine (<100µm) and coarse particles (>100µm) is made. The fine sediment concentration estimator was calibrated on May 19th in the morning with a pycnometer near the water surface at the very beginning of the campaign. The coarse sediment concentration estimator is calibrated near the water surface on the 20th, during a peak of concentration.

The acoustic measurement of the concentration of fine sediments has an uncertainty close to the 20% of the reference pycnometer. Fig. 2 shows concentration evolutions on May 20th according to different measurement methods, including the reference value computed by the CNR from several methods.

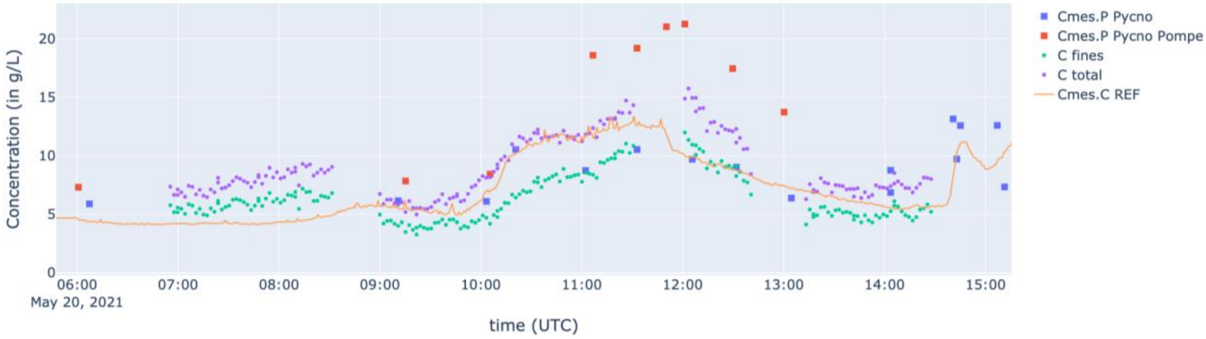

Figure 2 : Concentration measurements, in the first meter under the surface, by UB-SediFlow (dots) and pycnometer (squares) compared to reference value (line), on May 20th.

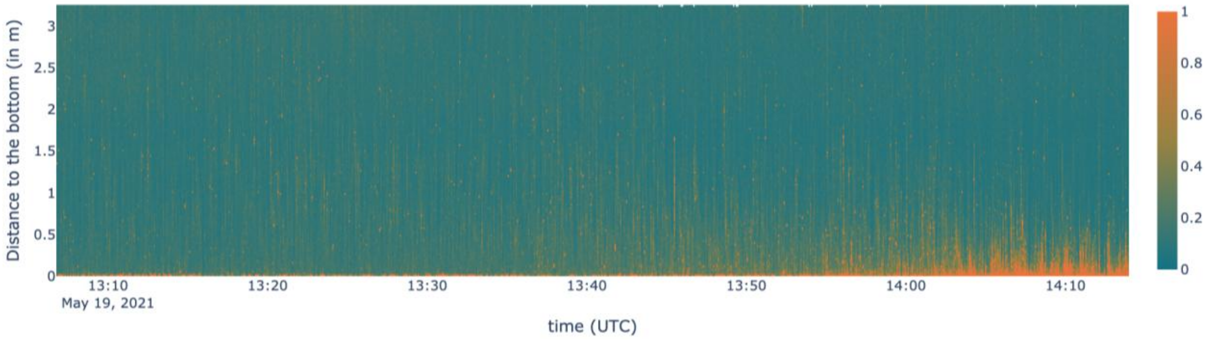

Figure 3 : Coarse particles concentration profiles (in g/L) measured by acoustic method, on May 19th in the afternoon.

Coarse particle concentration measurements over the whole vertical allow a quantification of the concentration along the depth (see Fig. 3 on May 19th afternoon). The data show a high temporal variability. This measurement could be improved with two points of calibration at the surface and near the bottom.

4.Conclusion

The UB-SediFlow gave quality data over a large frequency range and showed an easy deployable instrument allowing real time data visualization. The first result led the CNR team to improve the knowledge of sand flux spatially and temporally. The advantage of this sensor is the optimization of the number of samples on site to estimate SPM flux. A laboratory calibration campaign on the DEXMES facility is planned to confirm consistency of the field in-situ calibration. The next step will be to qualify this instrument with more SPM reference values.

REFERENCES

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[2] Hurther, D., Thorne, P. D., Bricault, M., Lemmin, U. & Barnoud, J.-M. (2011). A multifrequency Acoustic Concentration and Velocity Profiler (ACVP) for boundary layer measurements of fine-scale flow and sediment transport processes, Coastal Engineering, vol. 58, p. 594–605.