A moored profiling platform to study turbulent mixing in density currents in a large lake

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1. Introduction

Differential cooling ⇒ density gradient between shallow shelfs and deep pelagic zones ⇒ **cold density currents** (Figure 1; Fer et al., 2001).

Intrusion depth depends on the hydrodynamics of the current and the entrainment of warm ambient water (Figure 1; Legg, 2012). ⇒ **Great importance for deep mixing**.

How to measure turbulence in the mixing layer of a density current and characterize entrainment at short temporal and spatial scales?

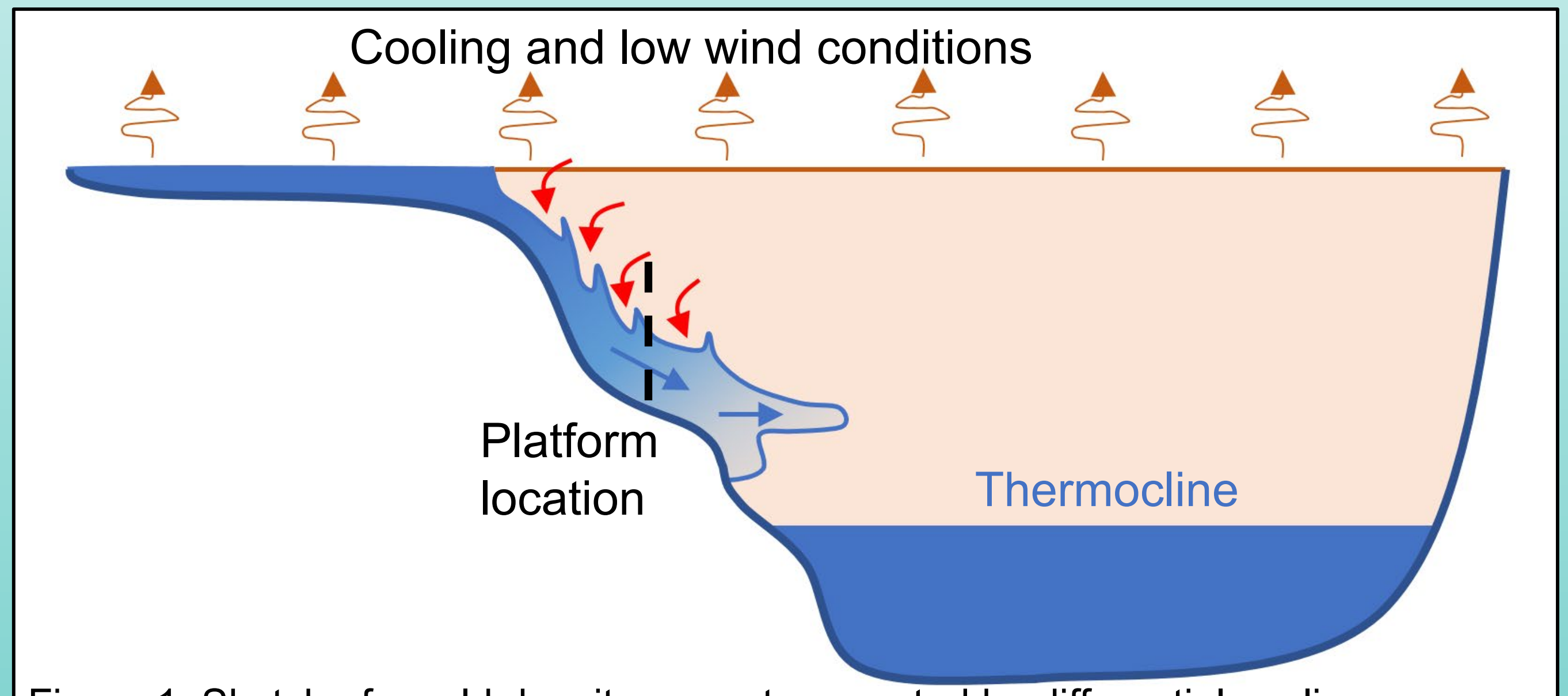

Figure 1. Sketch of a cold density current generated by differential cooling.

2. Methods. Turbulence platform. (Figures 2-4)

Connected to shore ⇒ no limitation in data storage and power.
Vertical position and sensor settings adjusted remotely.
Background measurements from additional moorings.
Alignment of the platform to the current by its rudder.
9 RBR temperature sensors, > 5 s response time.
RBR temperature and oxygen sensor, > 5 s response time.
Fastip Probe thermistor FP07, < 10 ms response time.
Nortek Vector, single-point 3D velocimeter.
Nortek Aquadopp (2 MHz ADCP).
Synchronous FP07 and Vector measurements at 64 Hz.
Inertial Measurement Unit (IMU).
Pressure sensor.

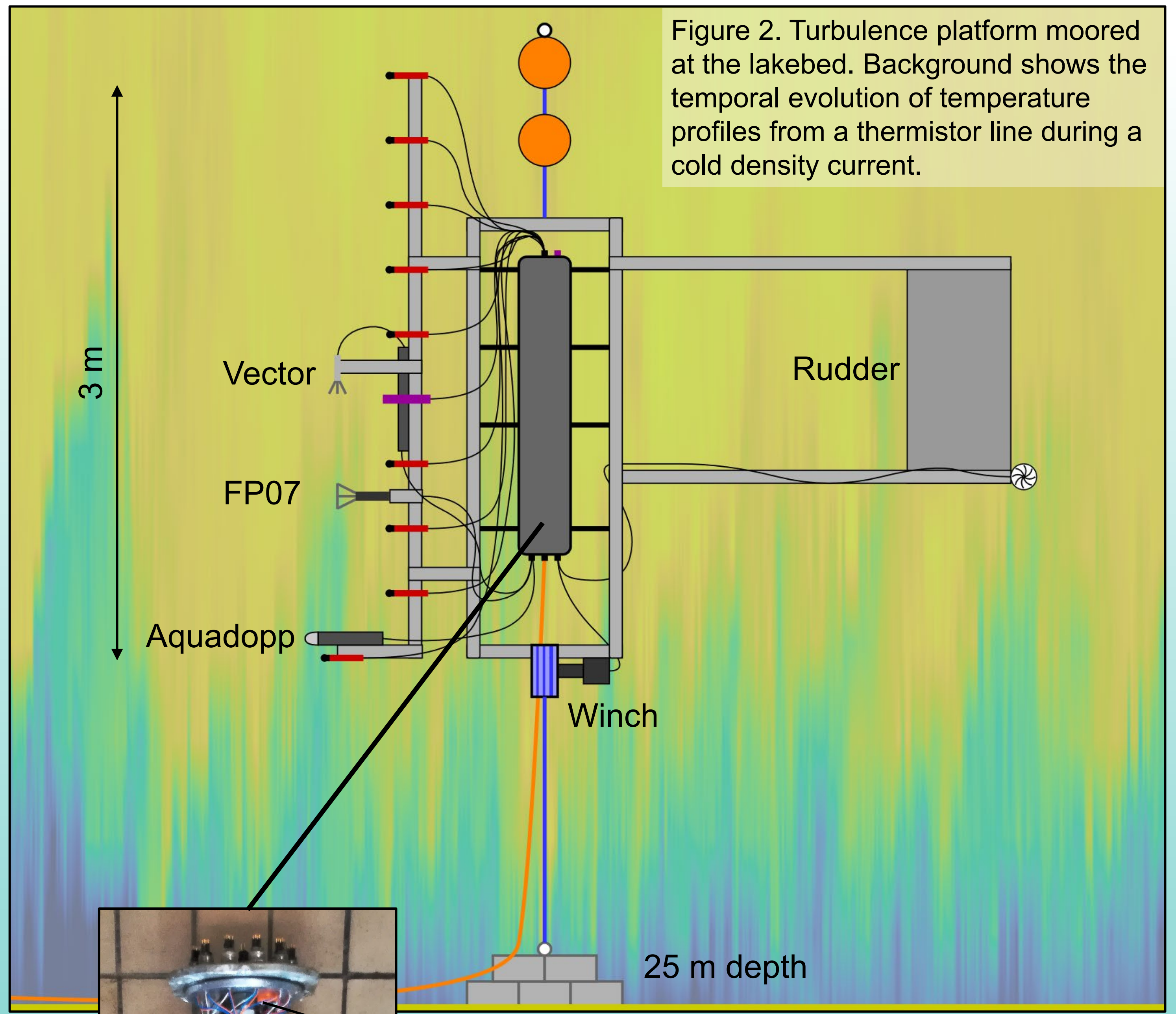

Figure 2. Turbulence platform moored at the lakebed. Background shows the temporal evolution of temperature profiles from a thermistor line during a cold density current.

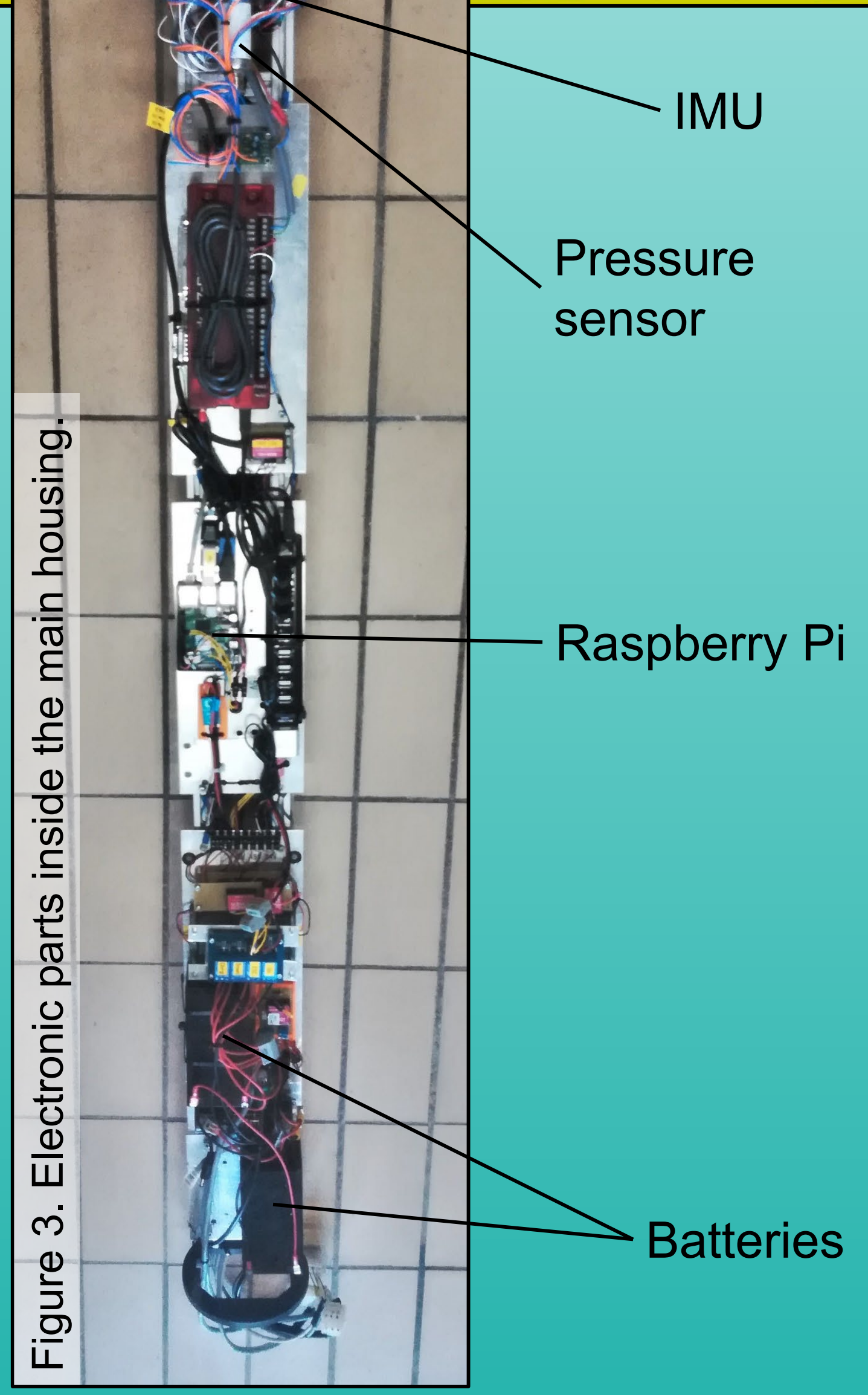

Figure 3. Electronic parts inside the main housing.

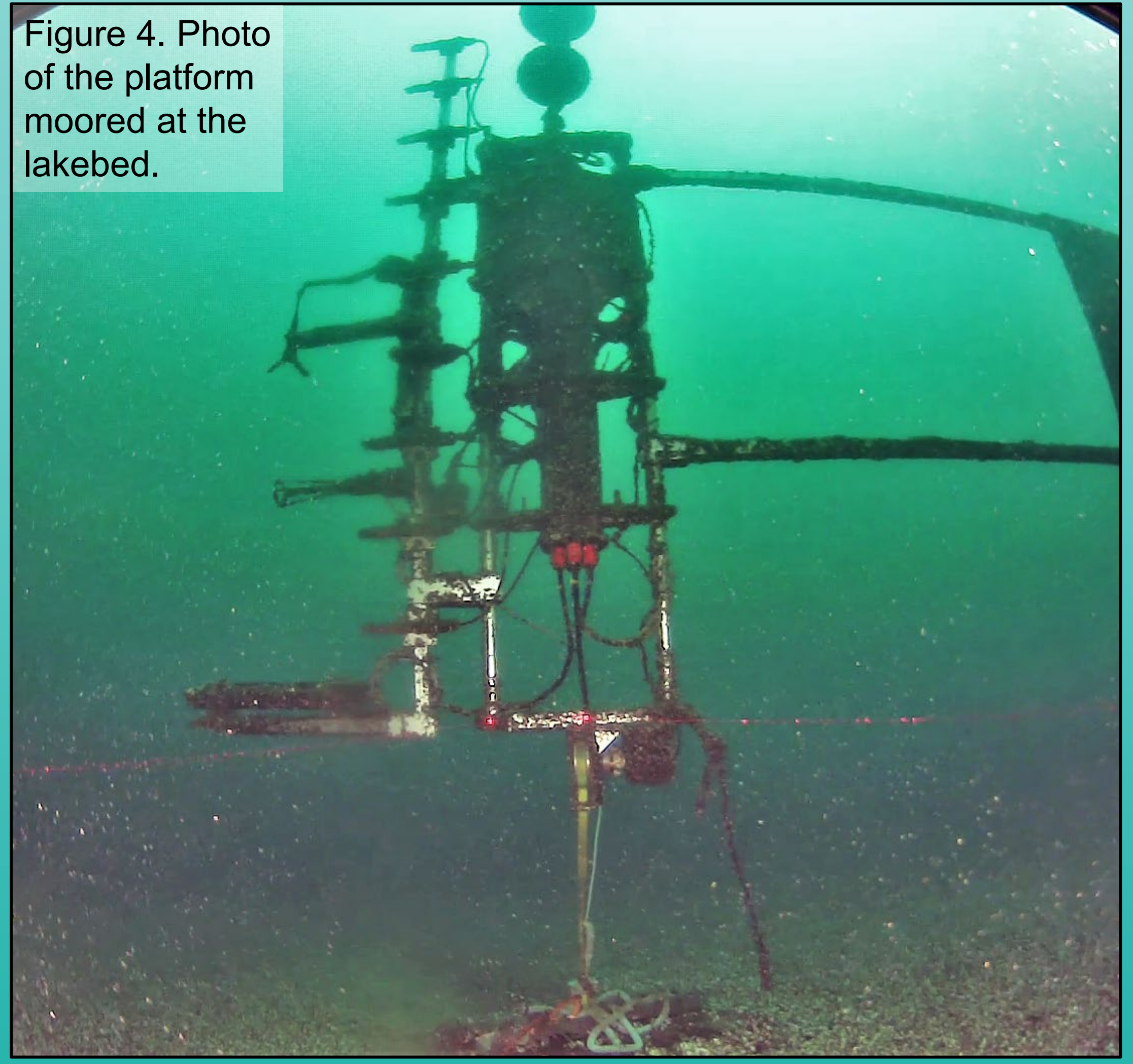

Figure 4. Photo of the platform moored at the lakebed.

3. Preliminary results

Scales of temperature fluctuations from **seconds to hours** (Figures 5C and D; Fer et al, 2001).

At the minute scale, **cross-shore velocity and temperature vary concomitantly**, and velocity is upward at the front of large cold pulses (Figures 5A, B and C).

At the shortest scales (≤ 2 s), temperatures do not seem to follow velocity fluctuations (Figures 5D and E), which could mean that **at the corresponding spatial scales (≤ 10 cm) the fluid is relatively well-mixed**.

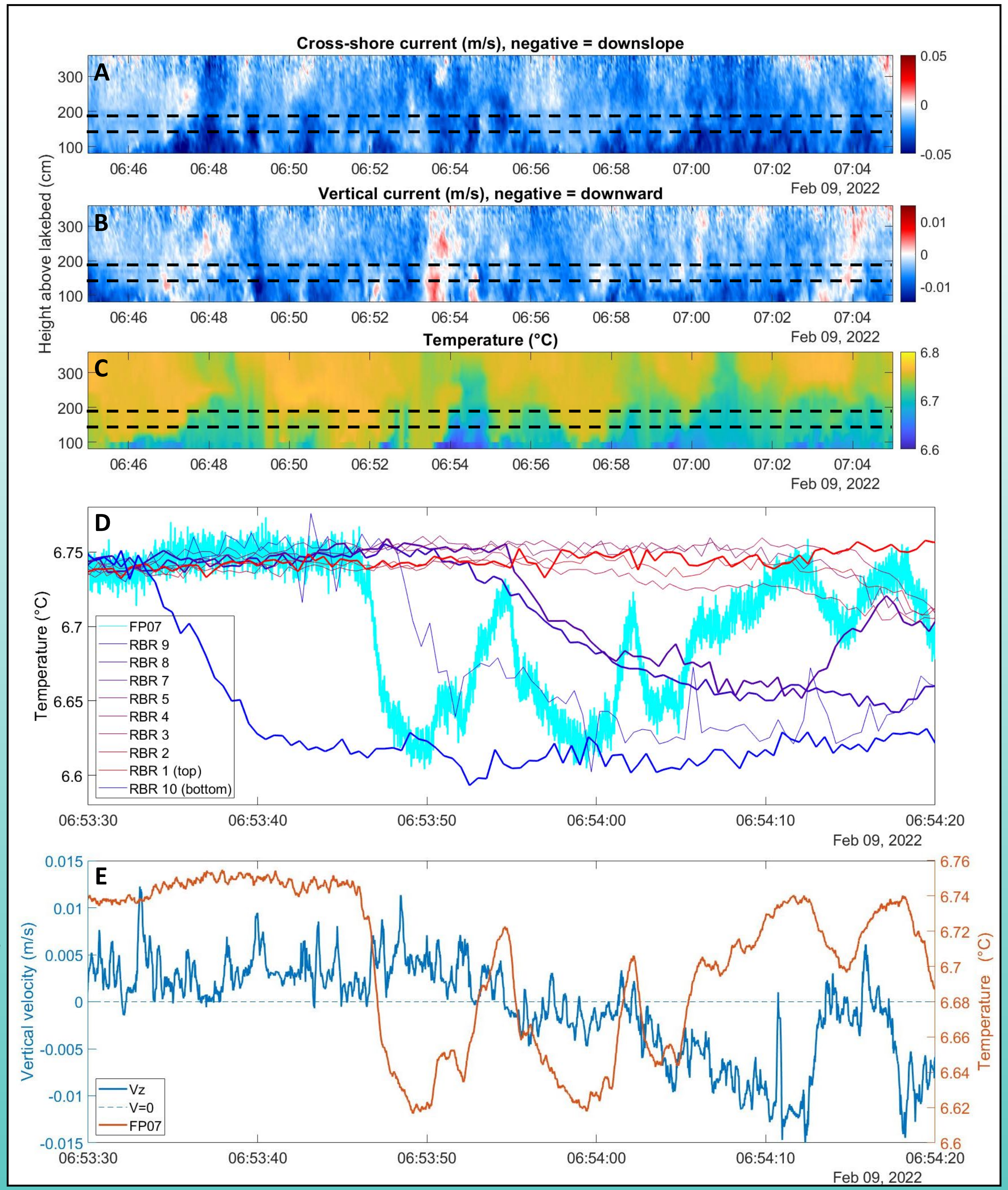

Figure 5. Example of data from the platform. Cross-shore (A) and vertical (B) velocities from the Aquadopp, and evolution of the temperature profile (C) showing several pulses of cold water flowing down the lake side. Black dashed lines in A, B and C show the FP07 and Vector positions. Temperature time series (D) during one pulse and comparison with vertical velocity Vz from the Vector (E).

4. Technical and scientific challenges

Electronic noise ⇒ cable shielding, position of the batteries and the winch.
Clear water ⇒ substantial processing needed to clean Vector data.
Impossibility to measure velocity and temperature at the same location.
Moving platform ⇒ data processing and cleaning.
Difficulty to **distinguish the intermittency of cold water release** (from the shelf) **from the intrinsic variability of the density currents.**

References.
Fer, I., Lemmin, U., & Thorpe, S. A. (2001). Cascading of water down the sloping sides of a deep lake in winter. Geophysical Research Letters, 28(10), 2093–2096.
Legg, S. (2012). Overflows and convectively driven flows. In E. Chassignet, C. Cenedese, & J. Verron (Eds.), Buoyancy-Driven Flows (pp. 203-239). Cambridge: Cambridge University Press.

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