Etienne DUREUIL (2022-2025)

PhD project : Characterisation of the mixing of flows with variable density

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Fundings :

We study the mixing of two flows of different densities due to temperature, turbidity or salinity such as natural confluences of rivers and thermal discharges of nuclear power plants. We focus on the mixing processes downstream the river confluences and thermal liquid discharges of nuclear power plants. Several studies (in situ, laboratory or numerical experiments) describe the hydrodynamic structure of confluences, but very few take into account the possible effects of density differences between the tributaries, and, for 1-D hydrodynamic models applications, we have no example of a correction factor allowing to characterize the buoyancy effects on the extent of the incomplete lateral mixing zone [3]. This problematic needs to understand how shear effects (in a vertical plane) are balanced with density effects (stratification). This issue requires understanding how the balance between the shear gradients and the density gradients controls the cross flow [1]. For the operational framework, improving knowledge of these mechanisms will make it possible to better characterize the mixing zones downstream of confluences and industrial discharges, and to improve their monitoring and the assessment of their impact on the environment and the various water uses. [2]. This study is made in cooperation between the IRSN, INRAE and the LMFA.

This project will gather many field measurements at confluences, and downstream of thermal rejects by nuclear power plants. These measurements will be made with towed CTD probes, and Acoustic Doppler Current Profiler (ADCP) along cross sections upstream in affluents, and outflows from the confluence. We will present some first in situ measurements performed in 2023, and discuss the laboratory experiments that will be performed later in the open channel of LMFA.

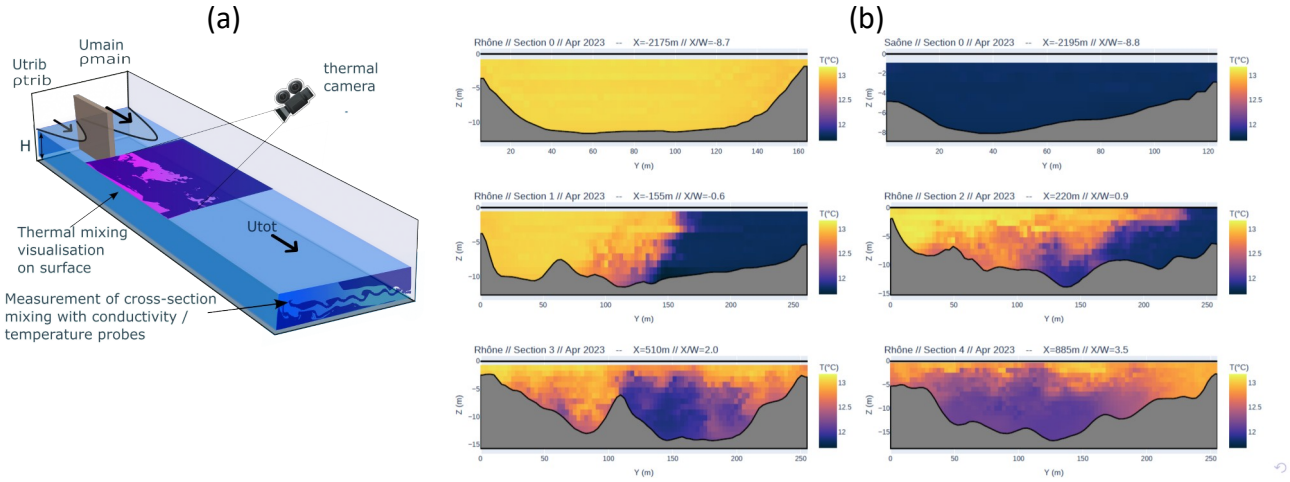

Figure 1 : Schématisation de l'expérience en canal avec une caméra thermique (a) représentation du mélange de température sur la confluence Rhône-Saône (b).

Figure 2 : Photo d'une campagne de mesure en bateau

References:

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