Tracking the turbidity maximum zone in the Gironde estuary (SW France) based on continuous monitoring and radionuclides

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Introduction: The Gironde fluvio-estuarine system (SW France) is one of the largest European estuaries in terms of surface area and of annual mean discharge (Fig. 1). The Gironde estuary is marked by a pronounced turbidity maximum zone (TMZ) due to fine sediment trapping by the asymmetry of the tidal wave, resulting on suspended particulate matter (SPM) concentrations in surface water over 1 g L^{-1} [1]. Although the Gironde drains one of the less urbanized/industrialized watersheds of the Europe, it is polluted by heavy metals which prevent shellfish production. Over the last decades, the Gironde estuary also faces to a marked decrease of freshwater discharges (1000 → 800 m^3 s^{-1}), resulting in a longer presence of the TMZ in the estuarine fluvial sections [2].

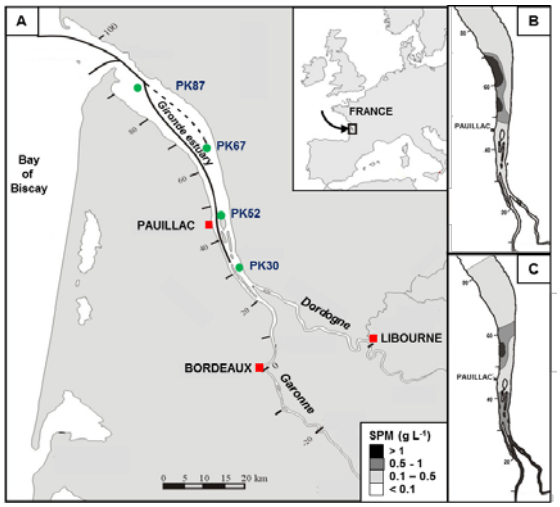

Fig. 1: *The Gironde estuary (A). Pauillac, Libourne and Bordeaux are instrumented with a real-time automated stations. The inserts show SPM concentrations in surface waters at low tide under moderate (B) and low (C) river discharges.*

Our objective is to combine two different approaches (real-time monitoring of turbidity, short-lived radionuclides) to study the tidal-to-seasonal particle dynamics along this continuum under different flow regimes. The information obtained can then be applied to improve the understanding of the processes and mechanisms that control the fate of fine particles, and of associated pollutants, to assess the impact of natural and anthropogenic pressures on the TMZ evolution of Gironde estuary.

Methods: Since 2004, a real-time continuous system (MAGEST network: http://www.magest.u-bordeaux1.fr/) records four key parameters (temperature, salinity, turbidity, dissolved oxygen) to establish a reference database of this fluvio-estuarine system to address current and future water-quality issues [2]. The two fallout radionuclides, ^{7}Be ($T_{1/2}$ = 53 days) and ^{210}Pb ($T_{1/2}$ = 22.3 years), are relevant tracers for particle transport from land to sea [3]. Since 2006, tracer activities are measured in SPM collected at four sites in the estuary, 30 km, 52 km, 67 km and 87 km from Bordeaux city [3].

Results: Turbidity and particulate radionuclides show a large range of concentrations depending on the location and on the hydrological conditions. During low river discharge, the TMZ intrudes into the fluvial estuary, and the lowest $^{7}Be/^{210}Pb_{xs}$ activity ratios (ARs) are observed there due to resuspension of old, ^{7}Be-deficient sediments

Discussion: The $^{7}Be/^{210}Pb_{xs}$ ARs were used to calculate seasonal changes in ages of suspended particles at PK30, a site in the central estuary where TMZ is present most of the year. From 0 during floods, SPM ages increase gradually up to 200 days, emphasizing the link between particle aging in the TMZ and the fluvial discharge. The changes on turbidity at different time scales, recorded by a continuous monitoring, underline the importance of pertinent sampling to obtain reliable datasets and the need of long-term time series to detect potential evolution in TMZ of the Gironde estuary, related to global changes, and land use, from inter-annual variability.

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References: [1] Sottolichio and Castaing (1999) *C.R. Acad Sci Paris* **329**:795-800; [2] Etcheber et al. (2011) *Hydrol Earth Syst Sc* **11**:111-122; [3] Saari et al. (2010) *Sci Total Environ* **408**:4784-4794.