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Sediment carbon and oxygen cycling and its temporal variations at the continent-ocean interface

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River deltas are among the most biogeochemically active areas on Earth. They receive large amounts of organic matter from the continent, which, added to nutrient inputs, stimulate primary production of coastal waters. They also contribute significantly to the global ocean carbon burial (> 80%) and are, at the same time, considered as net sources of CO_2 to the atmosphere due to their heterotrophic nature. This occurs in a context of large temporal variability linked to hydrological variations in river discharge, interaction with seasonal variability of the ocean, and extreme events characterized by floods and storms.

It is thus of prime importance to decipher the processes controlling the transformation of carbon leading to recycling and burial, and to disentangle the different frequencies of temporal variability in order to understand its influence on the deltaic systems and the coastal ocean in river-dominated areas. We present a case study on the Rhône River delta, the largest river in the Western Mediterranean Sea, and dig into the processes that lead to the recycling of organic carbon and the alkalinity production which is a strong counteracting mechanism to the air-sea CO_2 exchange. This involves anoxic diagenesis processes including recombination of reduced species as a key-process in alkalinity generation and fluxes from the deltaic sediments to the seawater. We examine the temporal variability of oxygen consumption as an indicator of carbon recycling over different time scales (from hours to decades). This variability is observed using a combination of in situ techniques: a novel observatory, the LSCE benthic station, which performs in situ oxygen profiles at the sediment-water interface at a fixed station and conventional in situ profilers which allow spatial investigations during sea expeditions. The results display large inter-annual modulations linked to the organic matter discharge from the river, large variability linked to floods and storms and rapid relaxation of the benthic system after resuspension events.