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Sediment dynamics of submarine tidal dunes in the St. Lawrence Estuary (Quebec, Canada)

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Submarine dune fields are important morphological features of estuaries and continental shelves. Their existence and characteristics depends upon the grain size and the current strength. The Upper St. Lawrence Estuary (USLE) between Tadoussac and Quebec City is characterized by several sills and basins, between 30 and 150 m depth, and a tidal range of 6 m. Sediment grain size in the USLE varies from mud to boulders, depending on local currents. The morphology of dune fields was surveyed with a Kongsberg EM2040 multibeam echosounder operated at 300 kHz. Data were recorded on the R/V Coriolis II in September 2013, September 2014, September 2015 and early October 2016. Surface sediments were collected with a Van Veen grab sampler. Numerous dune fields exist in the USLE, covering up to several square kilometres each. Most are large dunes, with heights between 2 and 8 m, wavelengths between 60 and 250 m, and mainly 2-dimensional shapes. Superimposed small dunes (wavelength about 5 m) are often visible in the multibeam backscatter intensity or on side scan sonar records. Grain size varies from medium sand to coarse sand with some gravel, depending on the dune field. Dunes are generally asymmetric, and both ebb- and flood-dominated dunes have been observed. Most dunes are flood-dominated with upstream migration due to estuarine circulation, except in the uppermost part of the USLE, where water depth is less than 20 m and the water column well mixed. The opposing migration directions observed in different sectors of the Île Blanche dune fields reflect the flow divergence between the north and south channels of the USLE. Migration rates from 20 to 50 m/year have been measured. Near bed currents estimated from the STLE400 numerical model are between 0.8 and 1.3 m/s during spring tides. The extent of dune fields in the USLE is controlled mainly by current velocities, i.e. dunes fields are absent in shallower areas of the main channel where currents are too strong.