Geophysical Research Abstracts
Vol. 21, EGU2019-16497, 2019
EGU General Assembly 2019

Boulder transport by sea ice on a rock coast of St. Lawrence marine estuary (Canada)

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Sea ice, which is present 3-4 months each winter in the St. Lawrence estuary, is a significant sediment transport agent in the intertidal and nearshore areas of rock coasts. Over five winters (2012-2017), we surveyed the movements of large boulders (1-5 m) on a shore platform of the south coast of the St. Lawrence marine estuary, at Sainte-Luce (Quebec).

Winter transport of 100 boulders, tagged with an electronic chip, was measured using a differential GPS. 90% of the boulders were mobile during at least one of the studied winters, mostly pushed on a short distance by ice-floes. Long distance movements of boulders by ice-rafting were less frequent, the transport exceeded 5 m in only 19% of the displacements (maximum: 152 m).

Boulder transport seams relatively unpredictable with an interannual variability and a great spatial variability. Nevertheless, morphology of the rock coast appears as the key parameter explaining differences in transport. The boulders isolated on the shore platform were transported over greater distances than the ones jammed by other boulders on the rocky platform or those located on a cobble pavement or a boulder barricade.

Boulder transport capacity is also different depending on ice conditions. Thus, during the mild winter, with low ice coverage, displacements were shorter and less numerous than during the cold winters.

During one winter, three boulders were equipped with an accelerometer to determine the periods of movement of the boulders during the sea-ice season. The 24 transport episodes recorded were compared to marine, meteorological and ice conditions, based on acoustic wave and current sensor data, climatic data and image analysis from an in situ camera.

Half of these episodes took place at the beginning of the pleniglacial stage, when the lower-icefoot partially broke up or moved due to a high tide or a storm. The other episodes proceeded at the end of the ice period, during the thermal destruction of the lower-icefoot. Meteo-marine conditions during these ice break-up (abundance of ice-floes, wind, waves and currents) affect direction and extent of the transports.