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Mapping and quantifying Submarine Groundwater Discharge in frozen season: a multiproxy approach to meet the challenge!

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Submarine groundwater discharge (SGD) transports many chemical elements from the continent to coastal seas contributing to chemical budgets. It is a key process that coastal managers must consider in any integrated water resources management plan, mainly in the northern regions where recent climate change is driving major hydrological changes exacerbated by a rapid sea-level rise that enhances pressures on coastal zones. However, due to the difficulties of studying SGD in cold regions (low to negative temperatures, ice-foot, sea ice, isolation of the study sites, etc.), there is a knowledge gap regarding SGD dynamics in these regions, particularly in the frozen period. Thus, this presentation aims to provide a multiproxy approach to map and quantify SGD during winter when ice-foot limits the direct access to beach groundwater and to the shoreline. Here, UAV-based thermal infrared imagery was combined with the analysis of short-lived radioisotopes [radon (^{222}Rn) and radium (^{223}Ra and ^{224}Ra)] along two beaches located on the north shore of the St. Lawrence Gulf during the frozen season in February. In spite of their proximity, Longue-Pointe-de-Mingan (LPM) and Rivière St-Jean (RSJ) beaches exhibit different hydrogeological contexts in which we wanted to test our approach. Despite the presence of >1m-deep ice-foot and sea ice, thermal infrared imageries revealed the occurrence of groundwater discharges at the shoreline which were enriched in radium and mostly depleted in radon. Mass-balance models will be developed to quantify these exports. In the two sites, groundwater flow appears to be channeled under the ice-foot and discharges as point sources during ebb tide suggesting the groundwater–coastal water continuum is still active and may be an important heat transfer pathway during the winter.