Conceptual uncertainties in Radium and Radon mass balances to estimate groundwater and porewater fluxes

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Groundwater and porewater fluxes into the coastal zone are recognized as important contributors to the hydrological and biogeochemical budgets of coastal systems. Radium isotopes and radon have emerged as powerful tracers to quantify these fluxes, usually through the application of mass balances that allow estimating the groundwater- or porewater-driven tracer flux by making allowances for all of the tracer sources and sinks. However, the uncertainties associated to the determination of the tracer flux via mass balances are poorly addressed and are often only attributed to analytical uncertainties of individual parameters (e.g. tracer concentrations, water volumes, residence times). This approach neglects all the potential errors associated with the conceptualization of the system. The main conceptual uncertainties are often linked to the assumption of steady state, the determination of radon evasion to atmosphere from a given wind-dependent emprical equation, the choice of the endmember, etc.

In this study, we assess the magnitude of the conceptual uncertainties related to the determination of the radium and radon inputs supplied by porewater fluxes into a coastal lagoon. We evaluated the most relevant parameters of the mass balance via a sensitivity test and re-evaluated them using different assumptions and approaches. Whereas there is not a general framework for assessing the uncertainties associated with the conceptual model, results from this work suggest that conceptual uncertainties are commonly the main source of uncertainty on the estimation of groundwater- or porewater-driven tracer fluxes. Neglecting these conceptual uncertainties may thus introduce a significant bias on the flux estimates and lead to overconfidence in the final results.