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Temporal and spatial analysis of groundwater inflow into lakes by ^{222}Rn

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For the investigation of the groundwater - surface water interaction ^{222}Rn is increasingly used as an important tracer due to its unique properties. It is especially suitable as its concentration in surface waters is about three orders of magnitude lower compared to groundwater and, therefore, enables the tracing of even small amounts of groundwater seeping into surface waters such as lakes.
So far, simple one or two box models have been used to determine a general estimate of the groundwater inflow in lakes with ^{222}Rn. We introduce and discuss a multi-box model for the vertical radon distribution in a lake which accounts for inhomogeneities in the groundwater inflow and transport between the boxes. Measurements of precise profiles during different states of stratification from 2005 to 2009 enabled the depth-resolved calculation of the groundwater inflow and the validation of previous mass balance calculations. Furthermore, the multi-box model yields the possibility to detect depth levels of enhanced or suppressed groundwater input and to trace seasonal changes in the interstratification of groundwater in the lake. Additionally, the depth-dependent calculation helps to constrain several parameters in the Rn mass balance (e.g. the diffusive radon sediment flux and the gas exchange with the atmosphere).
Exemplary data from the studied lake (Lake Willersinnweiher, Germany) show the groundwater inflow to be restricted to a limited layer (upper 5 m) whereas the groundwater interstratification signal and depth varies with the stratification pattern in the water column. The average inflow rate determined from the multi-box model (440 $\pm$ 140 m^3/d) agrees with previous one-box model calculations (400 $\pm$ 410 m^3/d) and a simple estimate based on Darcy's law, however, the new approach is more precise and yields substantially more information about the system.

References:
Kluge, T., Ilmberger, J., von Rohden, C., Aeschbach-Hertig, W., 2007. Tracing and quantifying groundwater inflow into lakes using radon-222. Hydrol. Earth Sys. Sci. 11, 1621–1631.