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Analysis of spatial isotopic variability of chlorine in precipitation in Montérégie, Canada

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Chlorine is regarded as a conservative element within the water cycle; thus, the ratio of chlorine concentrations in precipitation compared to groundwater serves as a reliable indicator of evapotranspiration [1]. In the case of Montérégie (Quebec, Canada), anthropogenic contributions from road salts prevent the direct use of this ratio. Chlorine isotopes could enable the separation of the portion of chlorine derived from road salts and that originated from precipitation. Among the road de-icing salts used in Quebec, KCl, $MgCl_2$, $CaCl_2$, and mainly NaCl [2,3] are expected to have slightly positive (δ^{37}Cl-NaCl = 0.35‰ ± 0.08; [4]) to near-zero δ^{37}Cl values ([4,5] and preliminary data). In contrast, precipitation can present negative δ^{37}Cl values (≈ -3‰; [6]). Improved characterisation of chlorine isotopic composition in precipitation, road salts, and groundwater will enable the development of a chlorine mixing model that better constrains evapotranspiration and infiltration processes in the peri-urban and agricultural watershed.

However, the chlorine isotopic signature in precipitation depends mainly on the equilibrium involving the concentrations of nitric and sulfuric acids in the atmosphere [6], which can be introduced into the atmosphere by the combustion of fossil fuels [7]. We expect seasonal and spatial variation, with differences across the Montérégie region, Canada (around 10^4 km^2), where we sampled 19 snow profile sites at the beginning and end of winter 2023. A comparison is made using monthly precipitation collected in Montreal since October 2025, allowing for a comparison of rural and urban data.

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