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Qualitative and quantitative water assessment of Lake Geneva on the basis of Stable H- and O-Isotope Compositions

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The expected increase of average annual temperatures and changes in precipitation patterns linked to the changes in climate may alter the physical, chemical, and biological dynamics of a lake and could thus affect future water quality in ways that are still unknown. Because the stable H- and O-isotope compositions of water are clearly linked to climatic changes, variations in their compositions as a function of time and place within a big lake such as Lake Geneva may help to interpret changes in its hydrology and dynamics of the water budget. The main research goal of this study is to evaluate the variability of the H- and O-isotope composition of Lake Geneva in order to apply it to a qualitative and quantitative assessment of the water budget.

Lake Geneva, Europe's largest freshwater reservoir located in a temperate climate zone, is mainly recharged by the Rhone river ($\sim$ 75%). Given the large volume (89 km^3, maximum depth 310 m) and long residence time of water ($\sim$11.4yrs), its dynamic system, that is the interaction with surface and underground in/out-flows, precipitation, and evaporation fluxes may well be complex. As a first step of the study, water samples and CTD profiles were taken from morphometrically different basins of the lake in August 2009 and data are compared to those of a previous study conducted in 2005. Depth profiles taken during the summer indicate a stratified water body. The epilimnion (uppermost 2-12 m) is relatively enriched in ^{18}O with δ^{18}O values between -11.8 and -12.1‰ at the water surface. All profiles show a progressive depletion in ^{18}O with depth, reaching minimum values in the middle of the metalimnion (20 m) of between-12.4 and -12.8‰. In the lower part of the metalimnion (20-40 m) the water becomes increasingly enriched in ^{18}O with depth again (-12.1 and -12.3‰), reaching more or less constant values in the hypolimnium. The profiles from summer 2009 are also very similar in terms of curve progression compared to those from the summer of 2005; in both cases the differences are related to the thermal stratification of the lake. The parallelism in profiles 2009 and 2005 is surprising though as the profile in the summer 2005 was measured only four months after a complete turnover of the lake (end of February 2005) that resulted in an invariable vertical profile in δ^{18}O measured the 1^{st} of March 2005. However, in summer 2009 the average isotopic composition of the lake is 0.4‰ enriched in ^{18}O relative to the summer of 2005. The latter is compatible with the effects of an increase in average annual temperature for the whole drainage basin. In addition, waters closer to the Rhone inlet are on average 0.2‰ more depleted in ^{18}O, than those closer to the Rhone outlet, indicating the influence of evaporation during the residence of the water in the lake and/or the mixture with water derived from rivers other than the Rhone. In order to apply the results to a qualitative and quantitative assessment of the water budget further samples will be taken in summer and winter of 2010. In contrast to the isotopic compositions, the results from the major ion analyses indicate that the lake water and its different sources are well-mixed as the variations are smaller than the analytical errors associated with the analyses via liquid chromatography.