The nitrogen cycle in Lake Kinneret - evidences from nitrogen isotopes

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The sources, sinks, dynamics and mass balance of dissolved nitrogen species in Lake Kinneret (Sea of Galilee) and their relations to the seasonal variations and the limnological cycle were studied. The study uses the isotopic composition of the dissolved inorganic species of nitrogen, nitrate (NO_3^-), nitrite (NO_2^-) and ammonium (NH_4^+) and of particular organic matter (POM) to track the origin and cycling of these species. Depth profiles were collected seasonally over three annual limnological cycles and the concentration and $\delta^{15}N$ values were determined. The total nitrogen content in the water column shows significant seasonal variations of up to 50% during an annual cycle, indicating a significant external source, and sinks to and from the lake.

During winter mixing, nitrate concentration increases as a result of nitrification as well as nitrate supply by external sources (run-off, mainly from the Jorden River). $\delta^{15}N(NO_3^-)$ is depleted relative to the ammonium from which it is formed, whereas the remaining enriched ammonium is assimilated, forming POM with relatively high $\delta^{15}N$. In spring, nitrate concentration decreases due to: 1) assimilation in the epilimnion (after ammonium has been fully consumed); and 2) denitrification in the hypolimnion. $\delta^{15}N(POM)$ values indicate that it is derived from epilimnetic nitrate. These processes are associated with increase in $\delta^{15}N(NO_3^-)$ of the residual nitrate. During summer, ammonium accumulates in the hypolimnion following ammonification of POM which sinks from the epilimnion. $\delta^{15}N(NH_4^+)$ was found to be higher than the $\delta^{15}N(POM)$ from which it is derived. This could stem from either selective decomposition of different organic compounds or isotopic fractionation during the decomposition. Early fall is characterized by high $\delta^{15}N(POM)$ in the epilimnion and low $\delta^{15}N(POM)$ in the hypolimnion. Deepening of the thermocline in late fall supplies hypolimnetic ammonium to the oxidized epilimnion, where it is nitrified or assimilated, resulting in $\delta^{15}N$ increase of the residual ammonium.