P-4241

Carbon burial variability in high altitude Pyrenean Lakes during the last two millennia

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Abstract

Lakes are a central component of the carbon cycle and several paleolimnological studies have shown organic carbon burial rate increases during the last century, although, the rates and controls on OC burial by lakes remain uncertain, as do the possible effects of future global change processes. We used short sediment cores from eight high altitude lakes along a West - East transect in the Pyrenees to reconstruct the OC production and preservation during the last two millennia. Several sediment cores from the lakes - Acherito, La Sierra, Sabocos, Marboré, Urdiceto, Basa de la Mora, Cregüeña and Montmalús - were retrieved to characterized the depositional environments. The cores were dated with ^{210}Pb, ^{137}Cs and ^{14}C techniques, sedimentologically described and analyzed for textural, mineralogical and geochemical properties, including TOC, TN, TS, XRF scanner, δ^{13}C, and δ^{15}N. Sediment traps were deployed and limnological parameters (temperature, pH, conductivity, oxygen content) were measured in mid Summer and early Autumn. The drainage network, geology, geomorphology and soils of the watersheds were characterized from available information and field surveys. Climate variability during the last millennia in the Pyrenees was summarized from instrumental data and available regional reconstructions.

Sediment traps data show that recent sediment fluxes range between 16 and 400 g/m2/yr. The TOC content in the lake sequences ranges between 1 and 13 %. Sediment trap samples show lower C/N and δ^{13}C than surface and core sediment samples. Relatively high C/N ratios suggest a significant contribution of terrestrial carbon, even in lakes located at high altitude with watersheds almost devoid of soils, likely due to the low bioproductivity in these settings. Most lakes show changes in carbon dynamics associated to the Roman period, the Medieval Ages, the Little Ice Age and the Current Global Warming, with higher carbon accumulation in the sediments during warmer phases and higher clastic sediment input during colder periods with increased glacial activity. During the last decades, higher TOC and Br/Ti, lower δ^{13}Cand C/N suggest an increase in carbon accumulation in most sites. The δ^{15}N signatures show a large variability likely controlled by site-specific limnological parameters: several lakes show a decreasing trend, others have a smaller variability, but lower δ^{15}N during the recent decades that could indicate an increase in atmospheric deposition of reactive nitrogen due to human activities in the valleys. The effects of damming are clear in Urdiceto Lake as finer, relatively more organic sediments dominate since 1930s. Climate change seems to be the main responsible of increasing carbon deposition fluxes during the last two millennia. However, recent trends in carbon accumulation could also have been favored by higher productivity as fluxes from anthropically-derived nutrient have increased even in these high altitude settings.