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Holocene Paleoenvironmental reconstruction from laminated sediments of the high-alpine lake Anterne (Lake Anterne, 2063 m asl, NW French Alps)

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Lake Anterne detrital sediments are an archive of changes in the intensity of erosion processes at high altitude in the Alps. The formation of laminations is here mainly controlled by precipitations in summer/fall which trigger underflow deposits and by clay settling during the fall water overturn and/or under the ice cover in winter. Intercalated between laminated sediments are flood deposits reflecting extreme summer thunderstorms. High altitude sites are very sensitive to climate variations, but they are also affected by anthropogenic impacts such as grazing and associated deforestation. Fluctuations in detrital input at Lake Anterne were reconstructed from sedimentological and geochemical (mineral and organic) proxies over the last 10,500 years. They were compared with pollen studies from peat bogs close to the lake in order to differentiate climatic and anthropogenic forcing. From 9000-9500 cal BP to 7500 cal BP, the catchment is marked by the progressive settlement of woody vegetation (in particular Pinus cembra). Between 7500 and 6300 cal BP, the total organic carbon (TOC) reaches the highest values and the manganese quantity is almost zero suggesting a period of anoxia in the hypolimnion in response to the supply of terrestrial organic matter in the lake. Decreasing median grain size might reflect the stabilisation of soils through a dense vegetation cover. Then, the TOC decreases until 4800 cal BP. The strong decrease between 5000 and 4800 cal BP is accompanied by a shift in the silica signal towards an enriched Si pole. This is interpreted as an increase of the detrital supplies probably in relation with a change in vegetation cover. Since 4300 cal. BP, higher flood deposits frequency suggests a persistent destabilisation of surrounding soils in response to colder climatic conditions or intensified human impact. At the same time, pollen percentages of Pinus cembra significantly decrease indicating a drop in the timberline altitude and the settlement of the herbaceous vegetation that currently dominates the landscape around the lake. Since then, the hydrological cycle mainly controls the occurrence and thickness of flood deposits. Both medieval and present-day warm periods are marked by thicker deposits during colder periods such as the Little Ice Age. This suggests that extreme summer thunderstorms events are favoured during Holocene warm periods.