



A Southern Alps and Northern Pyrenees Holocene record of snowmelt-induced flood events and clastic layers associated with negative NAO phases in Western Europe

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The origin of both extreme flood events in Lake Ledro (southern Italian Alps) and coarse sandy layers in two disconnected lakes from the Bassies valley (Lakes Majeur and Sigriou, northern Pyrenees) have been related to the impact of snowmelt processes enhancing erosion of mountainous drainage basins (1, 2) throughout the Holocene. Because of increasing human impact on catchment erosion processes since the mid-Holocene in these western European mountain ranges, this study compares these well-dated lacustrine sequences in order to further document the influence of westerlies and of the North Atlantic Oscillation on clastic supply in contrasted lake basins. The integrative approaches performed on each site allow us to show that organic and minerogenic markers, such as non-pollen microfossils, Rock-Eval pyrolysis or X-ray microfluorescence, are powerful tools to identify clastic sediment source areas. At Ledro, we therefore demonstrated that over the Late Holocene snowmelt-induced flood events essentially remobilized high altitude pasture areas whereas afterwards the flood events affected former forested areas from lower altitude¹. In the Pyrenees, the southern slopes of lakes Majeur and Sigriou are characterized by two narrow canyons whose drainage basins are disconnected, relatively small and limited to the high altitude part of the valley of Bassiès. Our results demonstrated that the mid-late Holocene period was regularly interrupted by coarse sandy layers affecting both lakes Majeur and Sigriou and reflecting the high sensitivity of the two active canyons to intense rainfall or snowmelt periods². While extreme flood deposits in Lake Ledro during the Bronze Age period may result from the combination of both climate and human activities, contemporaneous extreme flood events in Ledro and coarse sandy layers in the Bassiès lakes, dated to AD 1710, AD1530, AD1360, AD940, AD570 and 1850, 1050, 1410, 1850, 2690, 4190, 4800 cal BP, testify of regional hydrological events synchronous with European climatic deterioration phases and remarkably matching negative NAO phases and solar minima over the Mid-Late Holocene^{3,4}.

(1) Simonneau et al., 2013, *Climate of the Past*, 9: 825-840.

(2) Simonneau et al., 2013, *The Holocene*, 23: 1764-1777.

(3) Olsen et al., 2012, *Nature Geoscience*, 5 : 808-812.

(4) Delaygue and Bard, 2011, *Climate Dynamic*, 36: 2201-2218.