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The influences of the AMO and NAO on an Iberian alpine lake during the Late Holocene

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High mountain lakes, usually oligotrophic, in the Iberian Peninsula are particularly sensitive to the influence of North Atlantic large-scale modes of climate variability due to their geographical position and the reduced direct anthropic disturbances. In this context, Serra da Estrela (Portugal), in the westernmost of the Sistema Central Range, constitutes a physical barrier to air masses coming from the Atlantic Ocean. However, long-term climate reconstructions have not yet been conducted. We present a climate reconstruction in terms of precipitation and temperature changes of this setting based on facies analysis, X-ray fluorescence core scanning, elemental and isotope geochemistry on bulk organic matter and a preliminary study of diatom assemblages from the sedimentary record of Lake Peixão (1677 m a.s.l.; Serra da Estrela) for the last ca. 3500 years. A multivariate statistical analysis has been performed to recognize the main environmental factors controlling the lake sedimentation. Our results reveal that two main processes explain 70% of the total variance, with PC1 (accumulation of siliciclastic material vs organic matter), and PC2 (variations in lacustrine productivity, related to nutrient inputs from the catchment), explaining 53% and 17% respectively. In mountain lakes, siliciclastic and/or external organic matter accumulation tend to be governed by the snowmelt which, in turn, are frequently controlled by winter and spring temperatures. On the other hand, lake productivity, usually limited by phosphorus and nitrogen, is dependent of internal recycling and/or external inputs, mainly by catchment leaching (climatically driven by summer precipitation) and atmospheric deposition (anthropic influence). The results from Lake Peixão have been compared to other Western Iberia and Northeastern Atlantic records, as well as the Atlantic Multidecadal Oscillation (AMO) and North Atlantic Oscillation (NAO) indices. Thus, a tentative Late Holocene climate reconstruction from Western Iberia has been performed. Two relative colder phases (ca. 2500-2000 and 550-100 cal yrs BP) and two relative colder events (ca. 1380 and 1200 cal yrs BP) have been identified. These cold periods are likely influenced by negative NAO and AMO phases, whereas relative warmer conditions would be related periods in which NAO and AMO phases are both in positive phase. Additionally, five relative wetter phases (ca. 3600-2850; 2750-2500; 2200-2100; 1500-1400 and 400-150 cal yrs BP) have also been recognised. These relative wetter periods were usually linked to NAO and AMO both in negative phase, whereas background and relative drier conditions would be concurrent with NAO and AMO in positive phase. Hence, our results highlight that although the climate regime in this area is clearly influenced by the NAO, the slow-varying AMO also plays a key role at long-term time-scales.

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