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Centennial-scale climate variability inferred from Las Gloces cave in Central Pyrenees: evidences of rapid changes during last glacial cycle

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Paleoclimate records from the Pyrenees covering last glacial period are scarce since many lakes were covered by the glaciers, glacier deposits just provide discontinuous information and in very few caves we can find speleothem growth during that cold and generally dry time period. Las Gloces cave, located close to Ordesa and Monte Perdido National Park (Central Pyrenees, Iberian Peninsula) at 1240 m a.s.l., is one the few examples to study that time interval. Thus, for the first time, we present a speleothem in the Pyrenees that was growing during the Maximum Ice Extent in the last glacial period in a cave located just 3 km away from the glacier. Two speleothems from las Gloces were sampled, one covering the Holocene and last deglaciation (last 16.6 ka) and the other one growing from MIS4 (67.8 ka) to Mid-Holocene (4.7 ka), with two hiatuses at 50-47 ky and 30-21 ka coinciding with cold/dry periods. Both stalagmites were dated and analyzed for stable i sotopes and trace elements.

During MIS4, the lowest growth-rates correspond with Heinrich Stadial (HS) 6 while there is an increase in growth rate during MIS3 onset, reaching the maximum at Greenland Interstadial (GI)-14. After this, and corresponding with HS5, the growing stopped and it will reactivate again during GI-12, but with low growth rates. A new interruption took place 30 ka ago, with a second hiatus (30-21 ka), corresponding with an important retreat of Central Pyrenees glaciers and maximum regional aridity. During last glacial period, $\delta^{13}C$ and $\delta^{18}O$ records vary with rather small amplitude of change (4 ‰ and only 1‰, respectively) and showing low correlation between them

indicating they were likely affected by different influences. At 21 ka BP, there is a new speleothem growth that will be characterized by the heaviest $\delta^{13}C$ and $\delta^{18}O$ values in the record (0‰ and -7‰, respectively) that occurred during the global LGM period.

Changes in the growth rate in those stalagmites could be related to precipitation oscillations during GS-GI cycles while the variation in $\delta^{13}C$ could respond with changes in the temperature and rainfall on a glacial landscape with reduced vegetation cover. Differences in mean values of $\delta^{13}C$ between MIS3 (-5‰) and Holocene (-9‰) represent a forest revegetation over the cave related with the climatic amelioration experienced during last deglaciation due to the increase in temperature and humidity. Drivers on $\delta^{18}O$ change during MIS 3 are multiple and more complex but they may correspond to changes in amount of rainfall, temperature or moisture source. The drastic change in $d^{18}O$ during last deglaciation (from -10‰ at HS1 to -7 ‰ at the onset of the Holocene) could be additionally related to the well-known isotopic change of sea surface water due to the massive entrance of freshwater into the north Atlantic region.