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Climate variability during the Holocene inferred from northeastern Iberian speleothems

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Although the general climate trends during the Holocene in the Iberian Peninsula have been well described after the study of marine and lacustrine records, many questions regarding the timing of some of the events together with the characterization of the higher-frequency climate variability are still poorly understood. New speleothem records from several caves in northeastern Iberia provide data to explore Holocene climate changes. The selected caves are located in a latitudinal transect from the Pyrenees to the Iberian Range and placed at different altitude. Two of them, 5 de Agosto and Pot au Feu, belong to the same karstic complex in Cotiella massif (Central Pyrenees, 1600 m asl). Seso Cave, also in the Central Pyrenees but at 781 m of altitude, and Molinos cave, a cavity very rich in speleothems located at 1040 m in the Iberian Range, complete the transect. Although in all the caves precipitation coming from Atlantic fronts dominates over the year, a significant Mediterranean influence, specially in summer months, is identified after rainfall monitoring.

Speleothem formation during the Holocene occurred at a very low pace in 5 de Agosto cave (80yrs/mm) and increased dramatically at low-altitude caves and during particular periods proved to be wetter (eg. Early Holocene in Molinos cave, less than 10yr/mm). In Seso and Pot au Feu caves, up to seven studied speleothems only grew during short climatic events such as the Iron Cold Period (3000-2500 cal yr BP) or the Little Ice Age (1300-1850 yr AD) that, although cold, were particularly humid periods in northeastern Spain. First stable isotope results highlight the importance of comparing speleothems with similar growing rates and from the same cave to extract climate information and discard other influences. From the integration of four stalagmites from Molinos cave covering since the Holocene onset to 2000 cal yrs BP, the Early Holocene (11.7-8.5 ka BP) with d13C values between -11 and – 9‰ appears as the wetter interval. The highest isotopic values are reached during Middle Holocene (8.5-5.5 ka BP) while there is a tendency towards more negative values during Late Holocene (last 5000 yrs). The range of d18O values is low (about 2‰ but still lighter values during Early Holocene and heavier afterwards are well marked. Shorter events characterized by more negative d13C values are observed at 4 ka, 6 ka, 7.5 ka, 8.2, 8.7, 9.2, 10.3 ka and interpreted as cold but probably wetter periods with denser vegetation cover and soil development over the cave. However, changes in the source of precipitation (Atlantic vs Mediterranean) or the influence of fresh-water outbursts in North Atlantic can not be neglected.