

# Reconstructing Holocene climate variability in Northwestern Europe from stalagmites of Belgium

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## Abstract

The Holocene epoch was once thought to be characterized by a relatively stable climate. The stable Holocene comes from the arctic, where indeed the records show a stable Holocene except the 8.2 ky event. However, it's important to note that the Holocene Epoch does exhibit significant climate variations worldwide, which encompass events such as droughts, floods, and cooling periods. In this study, we present a detailed record of past climate variability spanning the last 5,000 years, based on a speleothem archive from the Vilaine Source cave in Belgium. Through detailed analysis of growth patterns, isotopic compositions, and trace element concentrations within the speleothem, we aim to reconstruct the climatic changes that have occurred during this timeframe. Changes in the stable oxygen isotope record inform us about past precipitation, while variations in the stable carbon isotope are indicative of shifts in vegetation development and soil bio-productivity. Furthermore, the changes in the Mg/Ca ratio are linked to prior calcite precipitation. Based on the interpretation of shifts in the stable isotope signals and trace element ratio we examined these shifts, and we interpreted them within the context of climate. Our findings indicate the occurrence of cold and dry periods around 4.5, 3.3, 2.6, 2.4, and 0.8 thousand years ago. This variability in climate patterns can be attributed to a marked negative phase of the North Atlantic Oscillation and the influence of Bond cycles. The proxy signals derived from the Medusa stalagmite within the Vilaine Source cave align closely with the palaeo-redox record is derived from a dimictic lake (Lake SS1220), Greenland and thus, suggesting that the records are representative of Holocene climate variability in western Europe. In conclusion, our investigation underscores the fluctuating climate conditions of the Holocene. Through the analysis of speleothem records from the Vilaine Source cave, we advance the understanding of Holocene climate dynamics of western Europe.