

RELIABILITY AND ACCURACY OF IBUTTON SENSORS FOR TEMPERATURE MEASUREMENTS IN CAVES

O. Pisani¹, G. Coppa², F. Acquaotta¹

¹ *Università di Torino, Turin, Italy*

² *Istituto Nazionale di Ricerca Metrologica (INRiM), Turin, Italy*

E-mail (corresponding author): g.coppa@inrim.it

Global climate change is one of the most critical challenges of our time, impacting various ecosystems, including those underground. Caves are unique environments with stable climatic conditions compared to the surface. However, recent studies (reference) show that these conditions can be influenced by external climate changes, with consequences for thermoregulation and biodiversity that rely on these stable habitats.

Cave temperatures are generally closely linked to the external climate, influenced by factors such as air and water entering the cave. However, cave temperatures remain relatively constant because rock has a much higher thermal capacity. This thermal inertia dampens daily and seasonal temperature fluctuations, and caves react to long-term temperature changes with a delay. This makes caves ideal models for studying the dynamics of global climate change in a more stable context than the surface. Furthermore, some organisms that inhabit these environments are highly adapted to constant conditions and are particularly sensitive to small temperature changes, making underground ecosystems unique models for studying the effects of global climate change. Therefore, the thermal stability of caves is crucial for the microclimate and underground ecosystems, highlighting the importance of monitoring abiotic conditions in caves.

However, these measurements are not easy to obtain, as caves are not always accessible (due to weather) or easy to traverse (they can be very deep or have challenging paths); moreover, except for a few tourist caves, there is no electricity or internet network, and high humidity can damage electronic instrumentation. It is therefore crucial that the thermometers used are suitable for this purpose and simultaneously sufficiently accurate to measure the small fluctuations of underground environments. In 2012 a temperature monitoring campaign of 20 Piedmontese caves began with practical iButton thermometers. These thermometers were chosen for their compact size and robustness, with a battery capable of lasting about 4 years and sufficient memory for prolonged measurements. However, even if the sensitivity of these instruments is good (0.065 °C), the declared uncertainty is 0.5 °C, a value too high for accurate measurements in caves.

Therefore, this work aimed to calibrate the iButton thermometers to determine systematic errors and enhance the previously mentioned accuracy, thus establishing whether these instruments are suitable for cave acquisitions. The calibration was carried out using a climatic chamber and a thermostatic bath at the National Institute of Metrological Research (INRiM). For the various sensors, calibration curves and the agreement between the instruments were obtained, deriving the uncertainties on the measurements. Finally, thanks to the calibration, it was possible to correct the data collected in the period 2020-2023 and compare them to observe the trend of climate change in recent years.