Quantifying past changes in Holocene ultraviolet-absorbing compounds (UACs) from Cedrus pollen in Lake Sidi Ali, Morocco, Africa based on fourier-transform infrared spectroscopy (FTIR)

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UV-B radiation may affect atmospheric circulation and influence climate, as well as affecting all biological life on Earth. However, past environmental and climate reconstructions (using various multi-proxy approaches) generally do not focus on UV-B. Ultraviolet-Absorbing Compounds (UACs) in pollen grains are an indicator of the UV-B level received by plants, and it is possible to measure the abundance of UACs in pollen using Fourier Transform Infrared (FTIR) micro-Spectroscopy, providing a promising approach to UV-B reconstruction. This research reconstructed UAC levels in individual Cedrus atlantica (Atlas cedar) pollen grains within sediment samples from a 20 m core at Lake Sidi Ali, Middle Atlas, Morocco, spanning the Holocene. Correlations between UACs and other palaeoenvironmental proxies from the same core are discussed, including, oxygen stable isotopes (¹⁸O) which reflect winter rainfall, local dust sedimentation, and lake sediment CaCO₃ and Total Organic Carbon (TOC), as well as independent ¹⁰Be-derived Total Solar Irradiance (TSI). Correlations between these proxies may indicate solar-related temperature and humidity fluctuations at Lake Sidi Ali, considering mechanisms of varied ocean and terrestrial circulation under different levels of solar activity, although there is some chronological uncertainty due to different sampling resolutions. A positive correlation between UAC levels and winter rainfall at Morocco implies connections between oceanic circulation and solar activity, while the relationship with local dust sedimentation reveals how solar irradiation may influence the Saharan dry air mass contribution to Morocco. Analysis of single pollen grains using FTIR presents several challenges in obtaining clean spectra, which can be a source of uncertainty with this approach. To minimise noise in FTIR spectra, Cedrus pollen grains should be measured using the same orientation under microscope. As this is not always possible, we developed a protocol to evaluate spectra quality to filter out spectra that had excessive noise, or were deemed not to be a pollen grain. We also assess the minimum effective number of pollen grains that require measurement to provide a statistically significant sample and thereby improve the quality of UAC data. Our protocol represents good practice in developing a robust UAC data set, which can allow for UV-B and solar radiation levels to be inferred. Future work aims to quantitatively reconstruct UV-B levels using a
modern UAC calibration.