

Warm intervals in the Levant: reconstructing temporal and spatial rainfall distribution from Dead Sea sediment geochemistry

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The present climate in the Levant is highly variable and suffers from periodic droughts. There is a strong meridional gradient in precipitation and evaporation and influence from both tropical and northern hemisphere climates. The ICDP Dead Sea Deep Drilling Project cores allow for the first time reconstruction of past climate during the warmest and driest periods in the region. We focus here on the Holocene and Marine Isotope Stage (MIS) 5e intervals. These contain thick layers of halite, reflecting the driest periods over the past 220 ky. The fast sedimentation rate (up to several cm per year) allows identification of climatic changes at high temporal resolution. From salt and major element (Mg, Cl and Na) balances in pore waters and fluid inclusions, we have quantified the average runoff, which was 30-50% of the present-day (pre-1964 diversion of the Jordan River) during that time, reaching 20% during the most arid intervals, lasting decades to centuries. $^{234}\text{U}/^{238}\text{U}$ activity ratios in authigenic minerals (aragonite, gypsum and halite), which reflect the water sources around the Dead Sea watershed, show drastic shifts in the lake's hydrology during the driest times, both during MIS 5e and the Holocene. $^{234}\text{U}/^{238}\text{U}$ activity ratio decreased during the driest periods from the typical value of ~1.5 to ~1.1, indicating a shift from the typical Mediterranean (northern/western) influence toward tropical (southern/eastern) influence. Combining the ICDP core record with other climate records and with NCAR climate model (CCSM3) runs of the last interglacial (130, 125 and 120 ka) highlights the temporal variability due to changes in the orbital forcings between 125 ka (peak summer insolation) and 120 ka. While 125 ka, which is salt-free in the core, is characterized by summer and winter precipitation, 120 ka, which is reflected by the thickest salt accumulation, is characterized by dry winters, increases in fall season precipitation and scarce but intense rainfall flooding events.