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The climatic and physiographic controls of the eastern Mediterranean over the late Pleistocene climates in the southern Levant and its neighboring deserts

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Abstract

Modern-day synoptic-scale eastern Mediterranean climatology provides a useful context to synthesize the diverse late Pleistocene (60–12 ka) paleohydrologic and paleoenvironmental indicators of past climatic conditions in the Levant and the deserts to its south and east. We first critically evaluate, extract, and summarize paleoenvironmental and paleohydrologic records. Then, we propose a framework of eastern Mediterranean atmospheric circulation features interacting with the morphology and location of the southeast Mediterranean coast. Together they strongly control the spatial distribution of rainfall and wind pattern. This cyclone–physiography interaction enforces the observed rainfall patterns by hampering rainfall generation south and southeast of the latitude of the north Sinai coast, currently at 31°15′.

The proposed framework explains the much-increased rains in Lebanon and northern Israel and Jordan as deduced from pollen, rise and maintenance of Lake Lisan, and speleothem formation in areas currently arid and semiarid. The proposed framework also accounts for the southward and eastward transition into semiarid, arid, and hyperarid deserts as expressed in thick loess accumulation at the deserts' margins, dune migration from west to east in the Sinai and the western Negev, and the formation of hyperarid (<80 mm yr^{-1}) gypsic–salic soils in the southern Negev and Sinai. Our climatic synthesis explains the hyperarid condition in the southern Negev, located only 200–250 km south of the much-increased rains in the north, probably reflecting a steeper rainfall gradient than the present-day gradient from the wetter Levant into its bordering southern and eastern deserts.

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At present, the rainiest winter seasons in Lebanon and northern and central Israel are associated with more frequent (+20%), deeper Cyprus Lows traversing the eastern Mediterranean at approximately the latitude of southern Turkey. Even these wettest years in northern Israel do not yield above average annual rainfall amounts in the hyperarid southern Negev. This region is mainly influenced by the Active Red Sea Troughs that produce only localized rains. The eastern Mediterranean Cyprus Lows also produce more dust storms and transport higher amounts of suspended dust to the loess area than any other atmospheric pattern. Concurrent rainfall and dust are essential to the late Pleistocene formation of the elongated thick loess zone along the desert northern margin. Even with existing dust storms, the lack of rain and very sparse vegetation account for the absence of late Pleistocene loess sequences from the southern Negev and the formation of hyperarid soils.

When the north Sinai coast shifted 30–70 km northwest due to last glacial global sea level lowering, the newly exposed coastal areas supplied the sand and dust to these active eastern Mediterranean cyclones. This enforced the latitude of the northern boundary of the loess zone to be directly due east of the LGM shoreline. This shift of coast to the northwest inhibited rainfall in the southern Levant deserts and maintained their hyperaridity. Concurrently, frequent deep eastern Mediterranean Cyprus Lows were funneled along the northern Mediterranean increasing (probably doubling) the rains in central and northern Israel, Lebanon, southwestern Syria and northern Jordan. These storms and rains formed lakes, forests, and speleothems only a short distance north of the deserts in the southern Levant.

Keywords: eastern Mediterranean; Levant; Negev; desert; paleoclimate; synoptic climatology; late Pleistocene; Israel; Jordan; Sinai; dune; loess; Lake Lisan; speleothems

Contents