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Was Mediterranean region warmer during the Messinian Salinity Crisis?

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Between 5.97-5.33 Ma kilometres-thick evaporite units were deposited in the Mediterranean basin during an event known as the Messinian salinity crisis (MSC). It is generally accepted that the MSC reflects a dry period, with rates of evaporation exceeding those of precipitation and riverine runoff. However, contemporary changes in continental and marine circum-Mediterranean temperature are less well constrained. Here we reconstruct mean annual temperatures (MAT) on continental realm using the branched glycerol dialkyl glycerol tetraether (GDGT). Additionally, sea surface temperatures (SSTs) of the Mediterranean Sea between 5.55 and 5.33 Ma were estimated using isoprenoidal GDGT based TEX_{86} and alkenone derived U^k_{37} proxies. These excellently preserved organic biomarkers were extracted from the Eraclea Minoa section (Sicily) deposited during the 'Upper Gypsum', stage 3 of the MSC (5. 55 to 5.33 Ma). The calculated MATs for the 'Upper Gypsum' interval at Eraclea Minoa are 19 to 22 ºC, slightly higher than the present day temperatures of 15 to 20 ºC on Sicily. For the samples where the branched and isoprenoid tetraether (BIT) index was lower than the 0.4 threshold limit we could calculate TEX_{86} derived SSTs as high as 32 ºC. Furthermore, we compared the TEX_{86} derived SSTs with the alkenone based, U^k_{37} proxy derived SST estimates from the same samples. These values are slightly higher than the U^k_{37} derived SST of 20 to 28 ºC (the maximum of the available calibration range for U^k_{37} proxy). These elevated temperature values are up to 10 ºC higher than temperatures recorded in the past 10 kyr in the Mediterranean Sea using the same U^k_{37} proxy (Cacho et al., 2002) and even up to 18 ºC higher than those estimated for the last glacial period. Values up to 27 ºC were recorded during the latest Pleistocene (Herbert et al., 2015) and between 13 and 8 Ma in the Mediterranean region (Tzanova et al., 2015). For the interval between the 8.0 and 6.4 Ma the U^k_{37} derived SSTs vary between 19 and 27 ºC, close to our calculation for Eraclea Minoa section (20 to 28 ºC). Independent of common pitfalls that may arise in using molecular biomarkers as temperature proxies, both SST estimations independently hint towards much warmer Mediterranean Sea water during the latest phase of the MSC. These elevated temperatures further coincide with higher δD values measured on alkenones and long chain n-alkanes (both records indicating for more arid and/or warmer conditions than today for the 'Upper Gypsum' Eraclea Minoa, between 5.55 and 5.33 Ma). We therefore conclude that the climate during stage 3 of MSC (5.55 to 5.33 Ma), at the paleogeographic position of Sicily, was drier and warmer that present-day conditions.