A warmer Mediterranean region at the Miocene to Pliocene transition

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Between 5.97-5.33 Ma several kilometre-thick evaporite units were deposited in the Mediterranean Basin during the Messinian Salinity Crisis (MSC). The MSC reflects a period featured by a negative hydrological budget, with a net evaporative loss of water exceeding precipitation and riverine runoff. The contemporary changes in continental and marine circum-Mediterranean temperature are, however, poorly constrained. Here we reconstruct continental mean annual temperatures (MAT) using branched glycerol dialkyl glycerol tetraether (GDGT) biomarkers for the time period corresponding to MSC Stage 3 (5.55-5.33 Ma). Additionally, for the same time interval, we estimate sea surface temperatures (SSTs) of the Mediterranean Sea using isoprenoidal GDGTs based TEX₈₆ proxy. The excellently preserved organic biomarkers were extracted from outcrops and DSDP cores spread over a large part of the onland (Malaga, Sicily, Cyprus) and offshore (holes 124 and 134 from the Balearic abyssal plane and hole 374 from the Ionian Basin) Mediterranean Basin domain. The calculated MATs for the 5.55 to 5.33 Ma interval show values around 16 to 18 ºC for the Malaga, Sicily and Cyprus outcrops. The MAT values calculated for DSDP Leg 13 holes 124, 134 and Leg 42A hole 374 are lower, around 11 to 13 ºC.

For samples where the branched and isoprenoid tetraether (BIT) index was lower than the 0.4 we could calculate TEX₈₆ derived SSTs averaging around 27 ºC for all sampled locations. Where available (i.e. Sicily), we compared the TEX₈₆ derived SSTs with alkenone based, U₃₇ derived SST estimates from the same samples. The TEX₈₆ derived SST values are slightly higher than the U₃₇ derived SST of 20 to 28 ºC. For the Mediterranean region, values between 19 and 27 ºC of the U₃₇ derived SSTs were calculated for the interval between the 8.0 and 6.4 Ma (Tzanova et al., 2015), close to our calculations for Sicily section (20 to 28 ºC). Independent of common pitfalls that may arise in using molecular biomarkers as temperature proxies, both SST estimates independently hint towards much warmer Mediterranean Sea water during the latest phase (Stage 3) of the MSC. These elevated temperatures 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 between 5.55 and 5.33 Ma). We therefore conclude that the climate between 5.55 to 5.33 Ma was
warmer than present-day conditions, recorded both in the Mediterranean Sea and the land surrounding it.