Supplementary Information accompanying the manuscript titled:

"Dual clumped isotopes from Mid-Eocene bivalve shell reveal a hot and summer wet climate of the Paris Basin"

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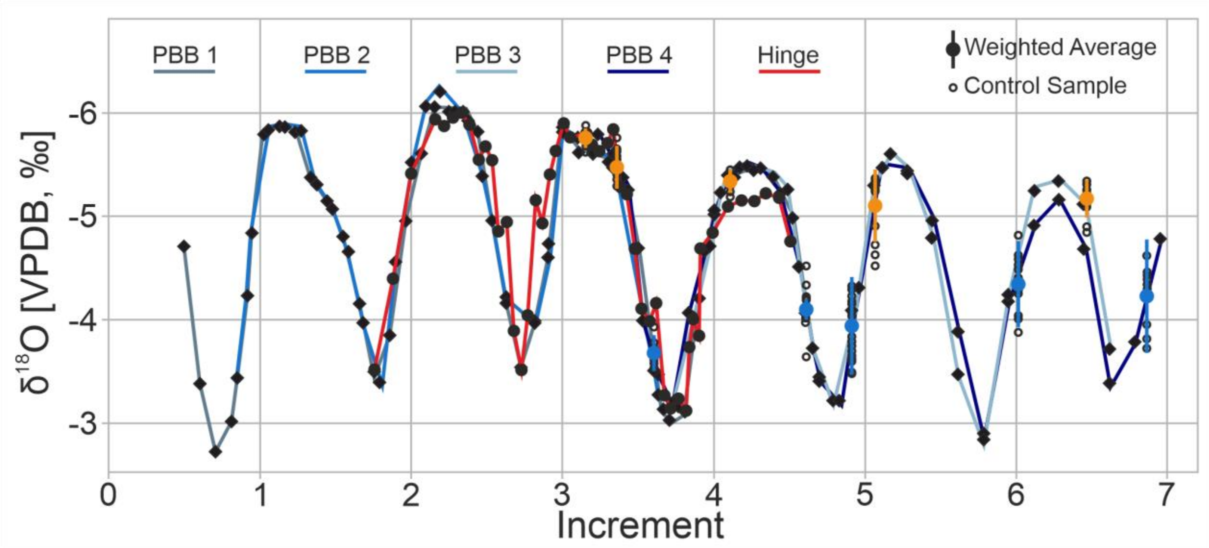

Fig. S1 – Comparison of stable oxygen isotope variability of parallel shell sections – $\delta^{18}O_C$ values (black diamonds) and corresponding shell sections (PBB1 to PBB4) are superimposed as a master record of the shell (Supplementary data 1). Additionally, sampling positions for the dual clumped isotope analyses are shown with the $\delta^{18}O_C$ values of the individual control samples (black rings) and their weighted averages (±2σ) (Supplementary data 2). The colour code of each position corresponds to the subsequent compiled bulk sample (BL – orange; BH - blue).

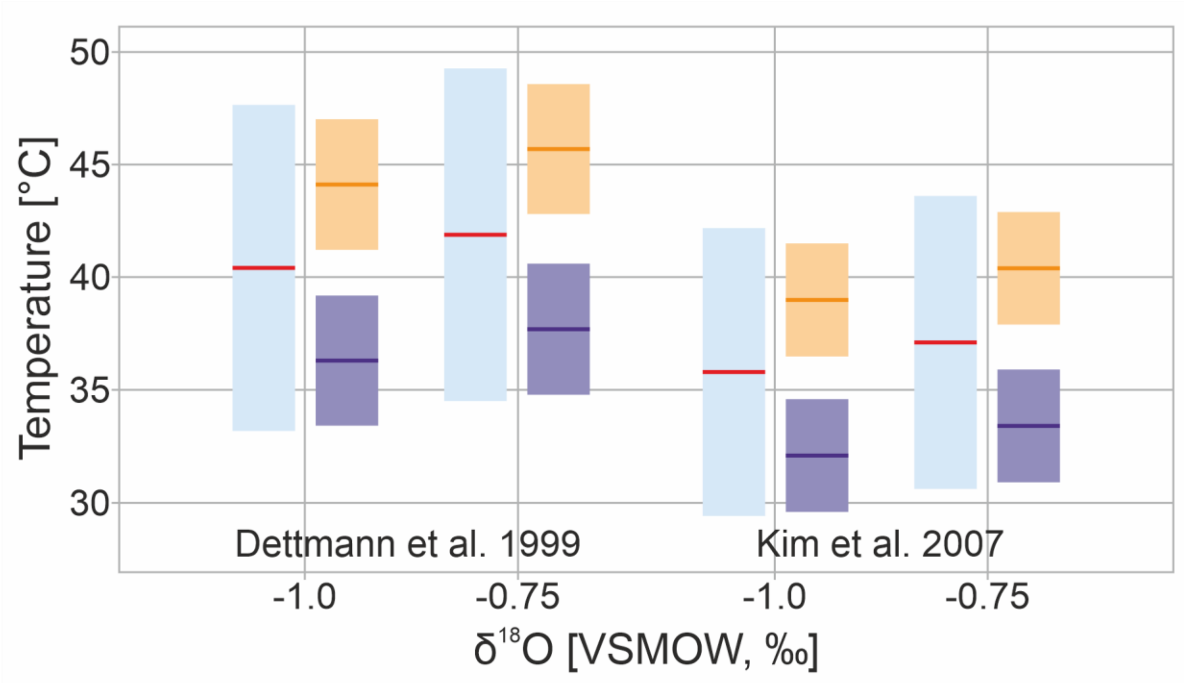

Fig. S2– Comparison of temperature reconstructions in dependence of calibration and sea water isotopic composition – Water temperatures reconstructions from $\delta^{18}O_C$ values are presented depending on the used carbonate-water-fractionation calibration (Dettmann et al.[3], Kim et al.[4]) and $\delta^{18}O_{SW}$ of -1.0 and -0.75‰ (VSMOW). Seasonal amplitude (light blue box) and MAT (red line) are derived from the non-linear regression model. The weighted average (±2σ) of the two bulk samples are display as the orange (BL), respectively, dark blue (BH) boxes.

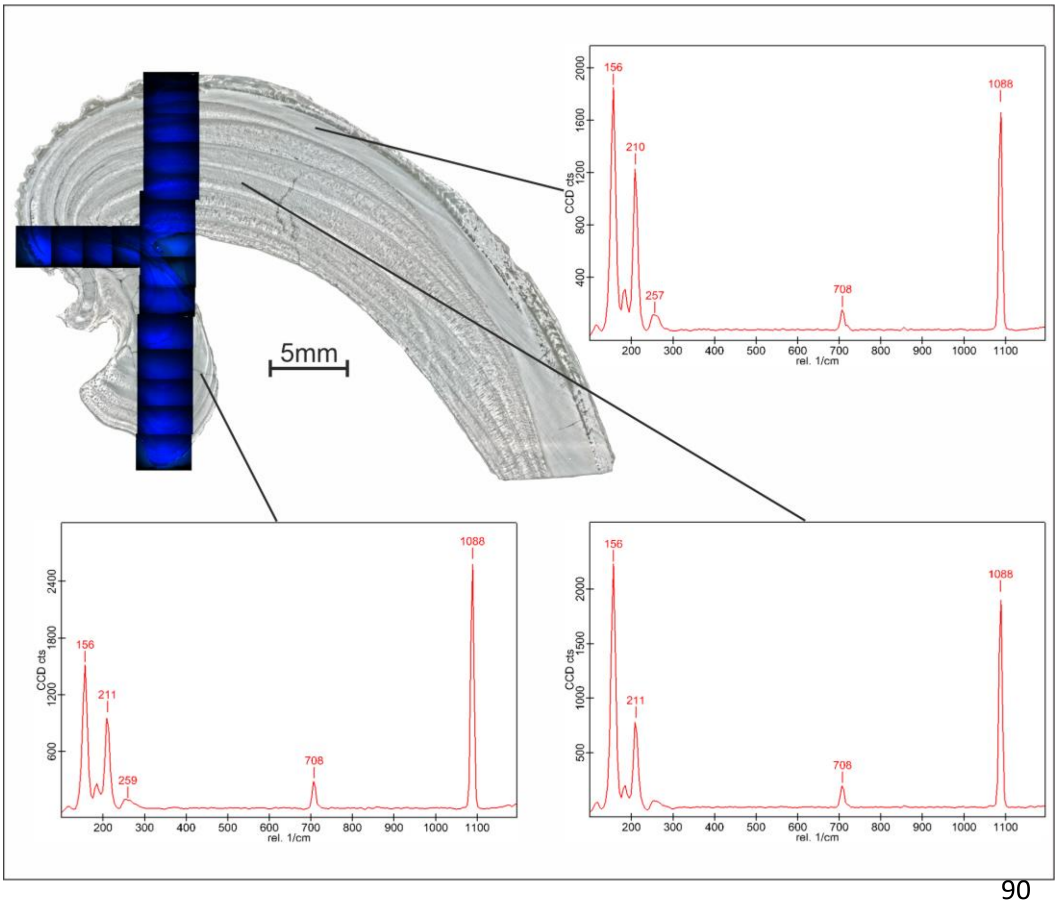

Fig. S3 – Cathodoluminescence and Raman spectra of selected shell parts – CL is carried out with overlapping imaging along two axes of the shell, revealing a dim blue luminescence for the analysed area. Raman spectroscopy exclusively show characteristic aragonite spectra with distinct double peaks at 156 and 211 cm^{-1}.

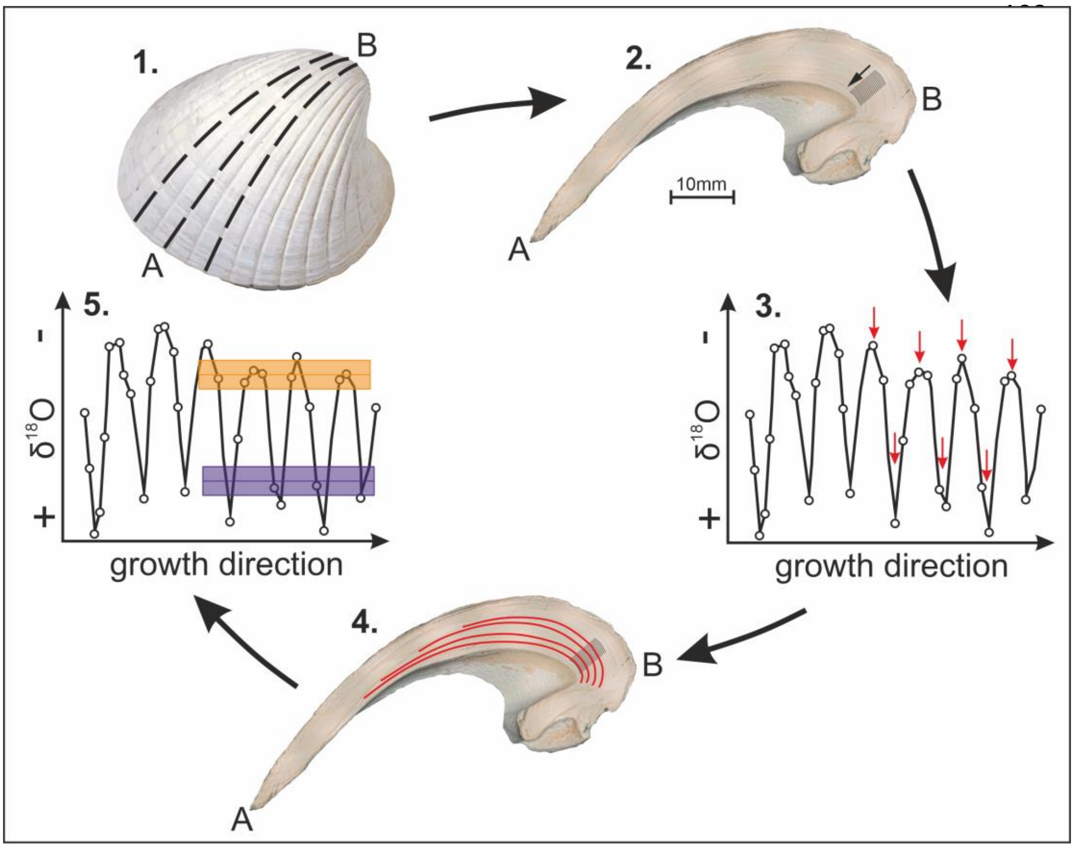

Fig. S4 – Material sampling routine for isotope analysis – 1. Cutting a plane parallel to the maximum growth axis of the shell; 2. Sampling inner shell area along the growth direction for stable isotopes; 3. Identifying annual extrema in the shell isotope record; 4. Resampling longer tracks along the inner shell for the dual clumped analysis; 5. Combing the material to two bulk samples, which represent the lighter, respectively, heavier section of the isotopic record; Steps 1 to 4 are repeated for shell planes PBB1 to PBB4, in order to match the necessary sample amount for step 5.

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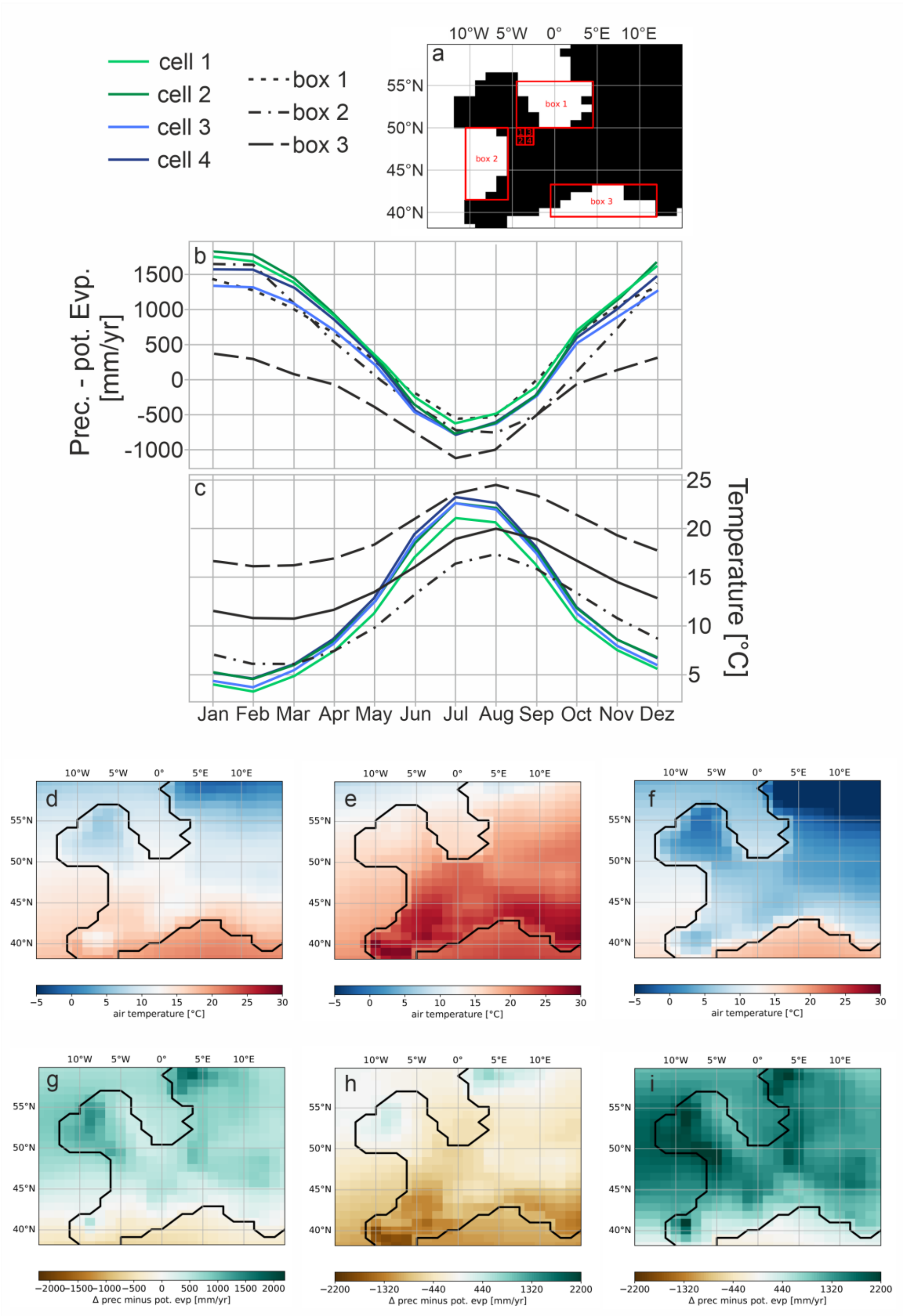

cell 1
cell 2
cell 3
cell 4
box 1
box 2
box 3
10°W 5°W 0° 5°E 10°E
a
55°N
50°N
45°N
40°N
box 1
box 2
box 3
b
Prec. - pot. Evp. [mm/yr]
1500
1000
500
0
-500
-1000
c
Temperature [°C]
25
20
15
10
5
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dez
d
e
f
air temperature [°C]
−5 0 5 10 15 20 25 30
g
h
i
−2000 −1500 −1000 −500 0 500 1000 1500 2000
−2200 −1320 −440 440 1320 2200
Δ prec minus pot. evp [mm/yr]

Fig. S5 - Climate model derived distribution of temperature and precipitation minus evapotranspiration – Seasonal distribution of air temperature and precipitation minus evapotranspiration for western Europe during the MECO (40Ma) derived from the compiled dataset of Li et al.[2] using the Community Earth System Model (CESM1.2.2). (a) Paleo-geography and selected continental cells and marginal sea basins; (b and c): Seasonal distribution of air temperature and precipitation minus evapotranspiration for box 1 to 3 and cell 1 to 4; (d to f): annual mean, summer and winter air temperatures; (g to i): annual mean, summer and winter precipitation minus potential evapotranspiration

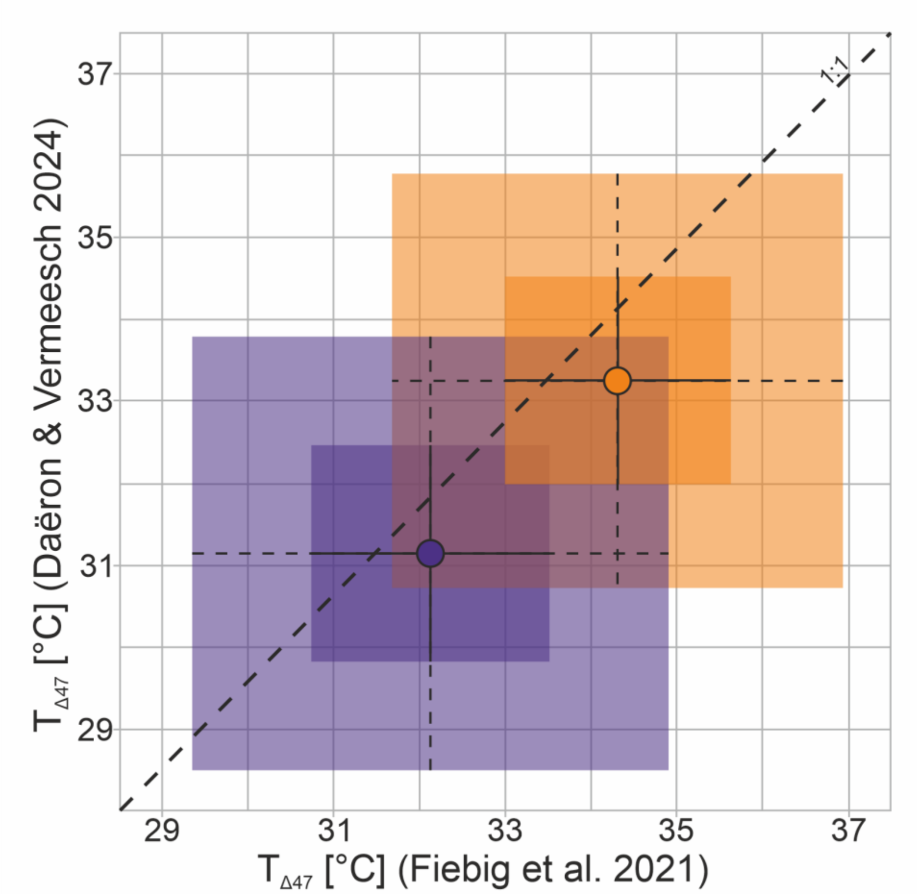

Fig. S6 – Comparison of Δ_{47}-temperature calibration output – Δ_{47} values of BL (orange box) and BH (blue box) are converted into temperatures using the calibrations of Fiebig et al.[5] and Daëron & Vermeesch[6]. Uncertainties for Δ_{47} measurements are fully error propagated and represent 68% (solid line) and 95% (dashed line) confidence intervals. The dashed black line indicates the proposed 1:1-relationship between the two temperature reconstructions.

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