Quantitative reconstruction of past climate mean states in the Atacama Desert using hydrogen and triple oxygen isotopes of gypsum hydration water

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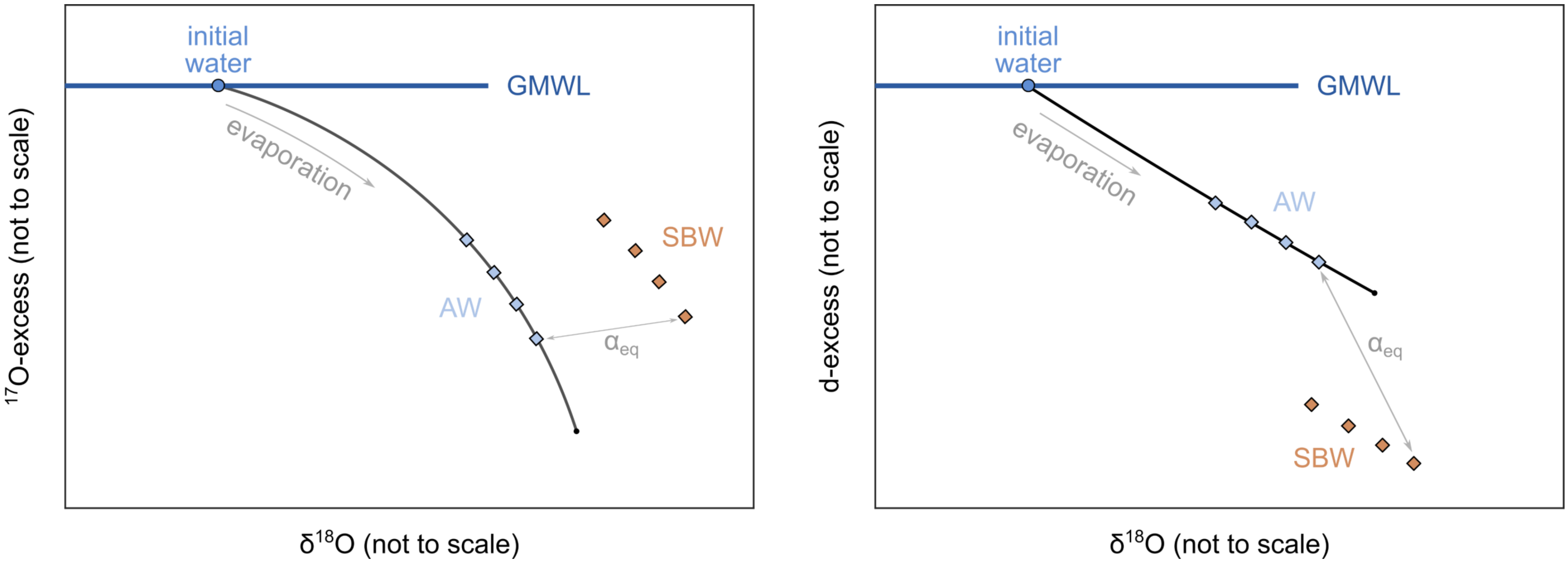
Earth – Evolution at the dry limit

A B C/J geoverbund aachen bonn cologne jülich

Universität zu Köln

Schematic illustration of isotope systematics during evaporation and gypsum precipitation



<u>Craig-Gordon function</u> (describes isotopic composition of an evaporating water body):

f (<u>relative humidity</u>, α_{eq} (f <u>temperature</u>), α_{kin} (f <u>wind parameter</u>), $\delta^{18}O_{inflow}$, $\delta^{18}O_{vapor}$)

AW = ambient water during gypsum formation

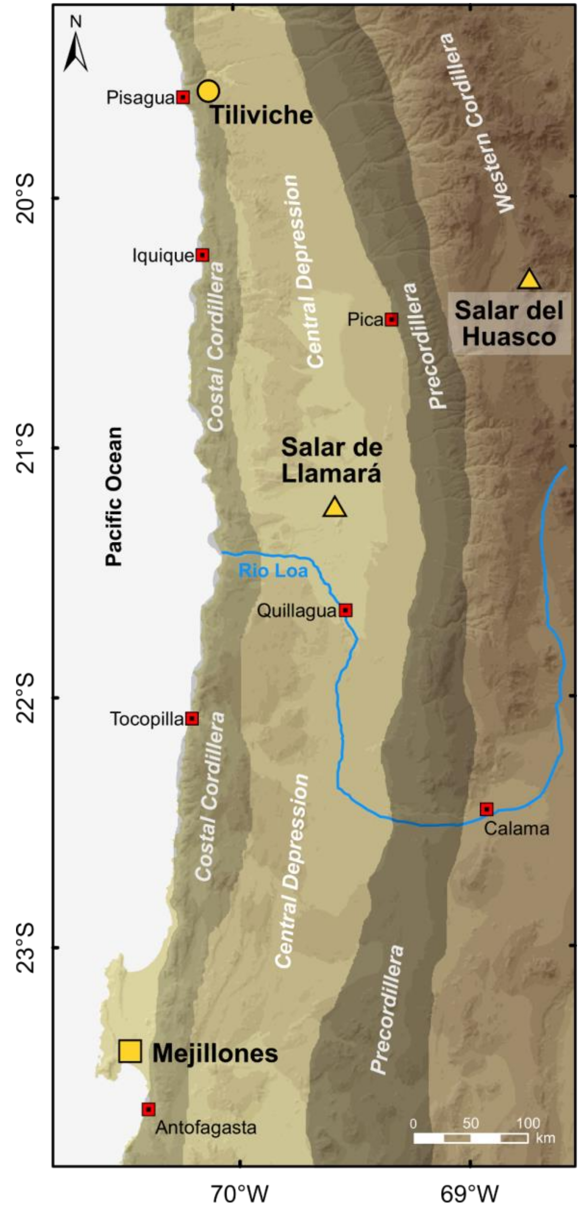
SBW = structurally bonded water in gypsum

Study sites in the Atacama Desert, N-Chile

Recent salt lakes

Salar del Huasco

Salar de Llamará

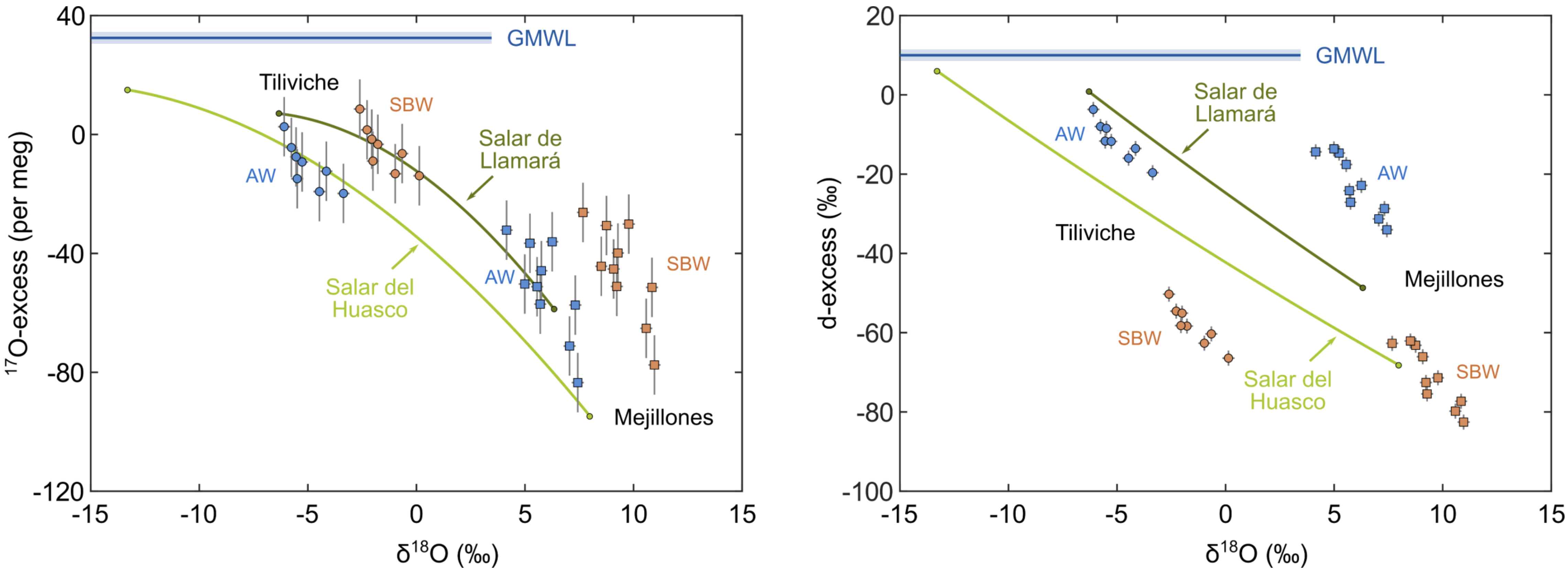


Paleo sites (both Pliocene age)

Tiliviche

Mejillones

Results of isotopic measurements



Evaporation trendlines observed in recent salt lake systems

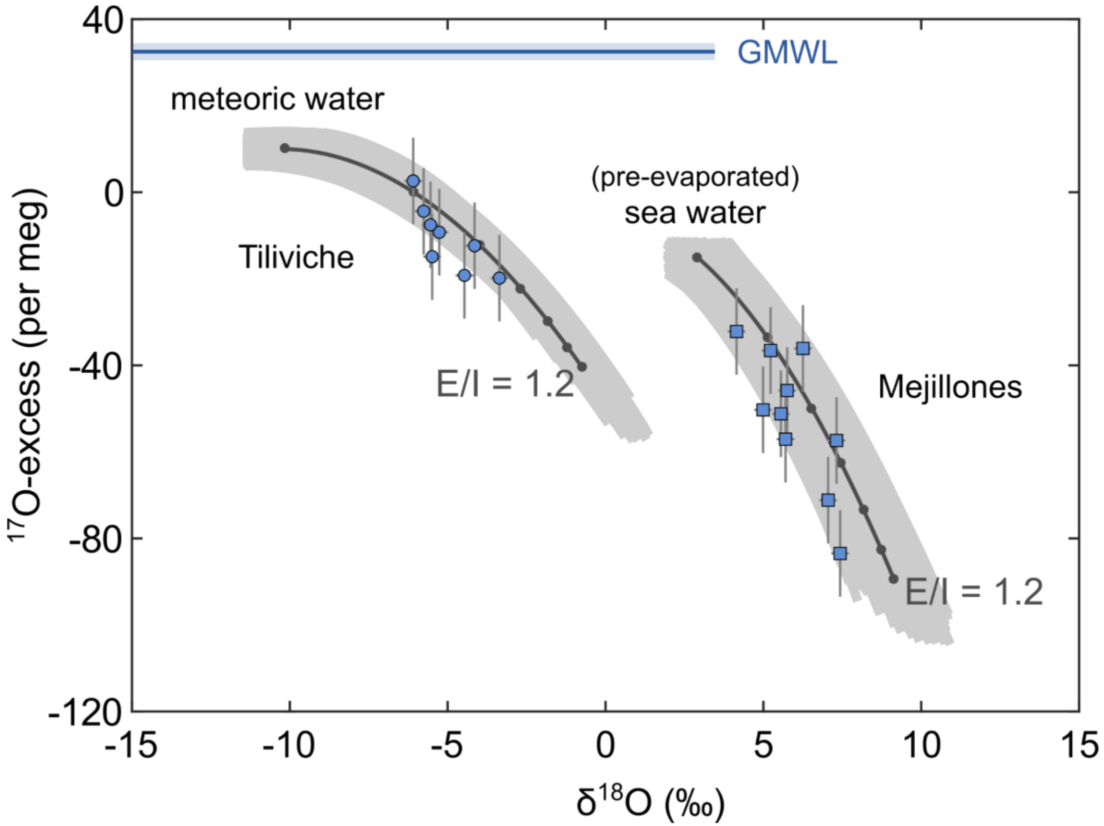
○ Tiliviche

□ Mejillones

SBW = structurally bonded water in gypsum
-> measured

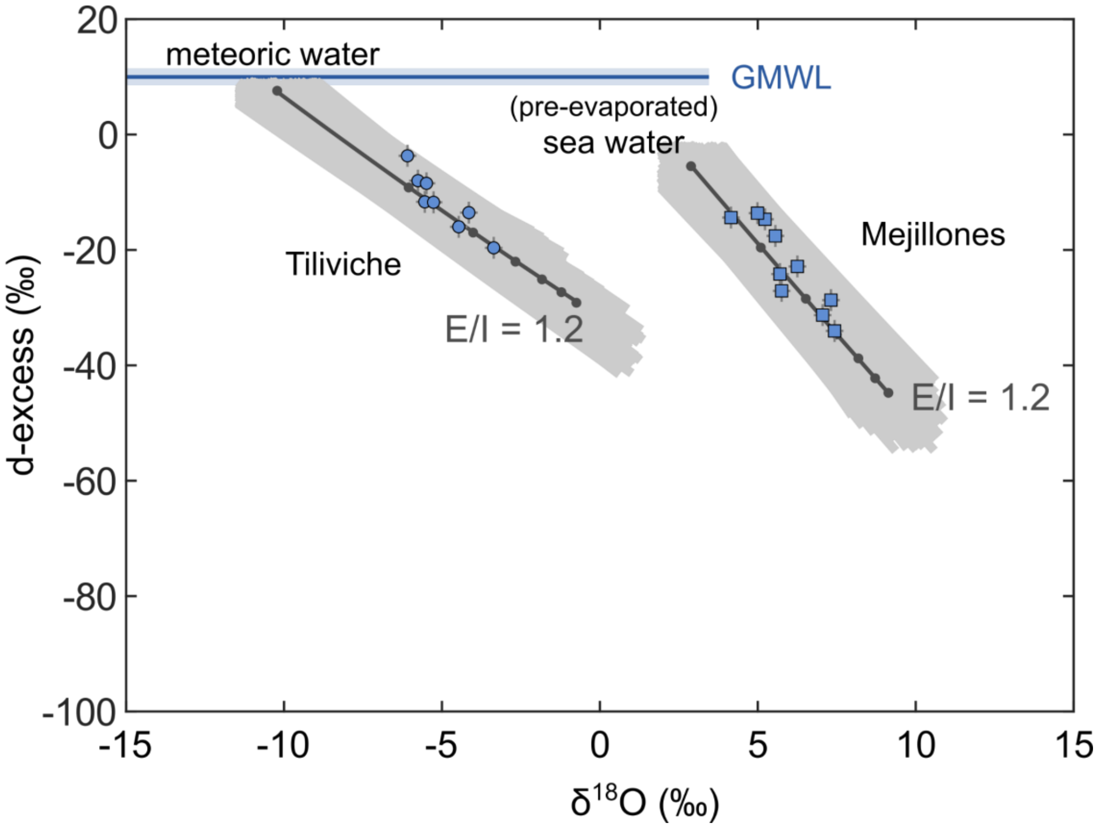
AW = ambient water during gypsum formation
-> calculated using $\alpha_{eq,\ SBW\text{-}AW}$

Model results



Tiliviche

rH = 71 ± 6 %, T = 37 ± 2°C

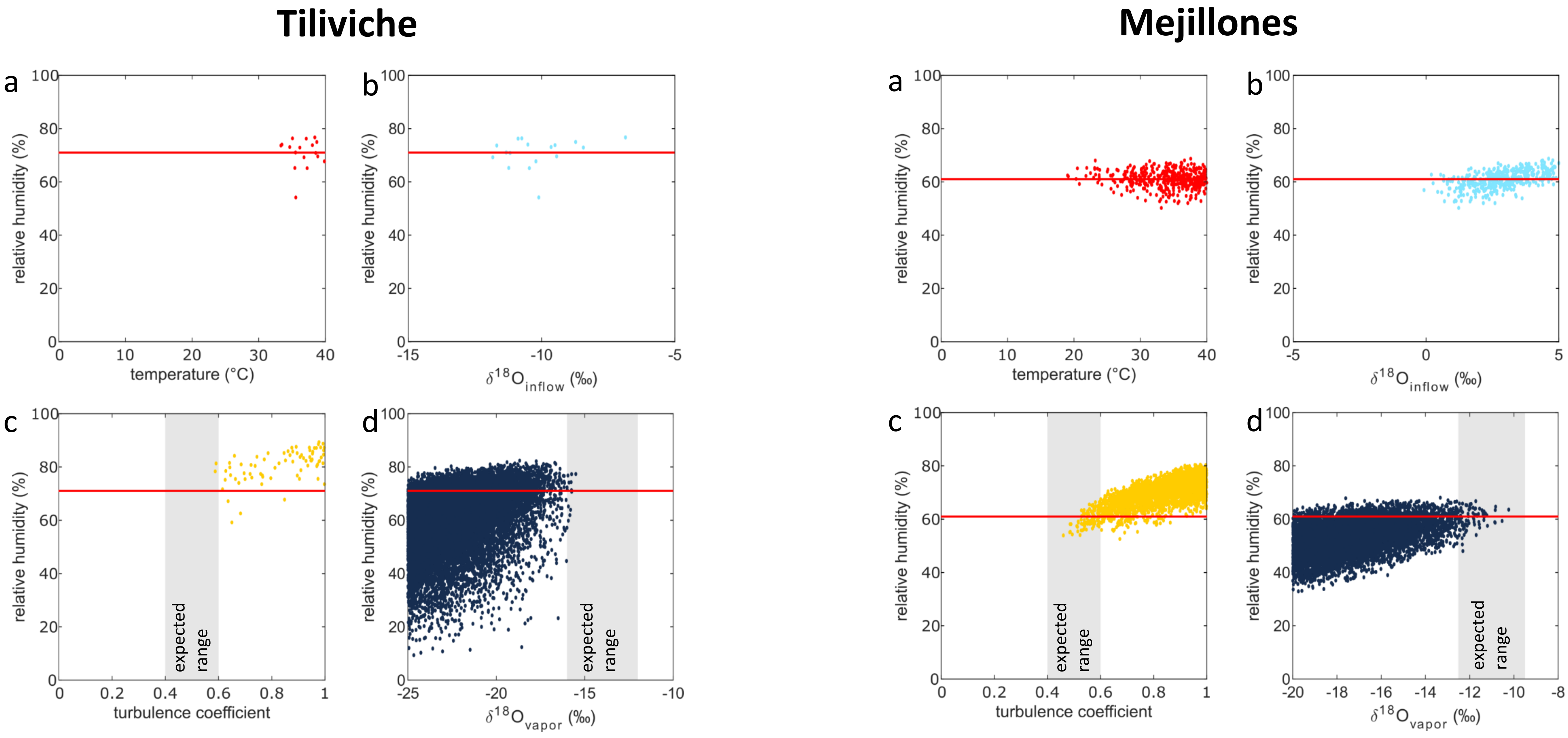


Mejillones

rH = 61 ± 3 %, T = 34 ± 4°C

The best fit model solution for relative humidity (rH) and temperature (T) were determined by fitting the C-G function through measured isotopic data constraining other model input parameters (δ_{inflow}, δ_{vapor}, and a parametrized value for wind-induced turbulence (n)) in site-specific reasonable ranges.

Sensitivity of modelled relative humidity to major input variables



The modelled value of rH (red line) is relatively robust to changes in T (a) and $\delta^{18}O_{inflow}$ (b). In contrast, increasing uncertainty in the turbulence coefficient *n* (c) and $\delta^{18}O_{vapor}$ (d) may lead to over- or underestimation of rH. The model suggests about 10 % higher rH using *n* as a free variable and about 10 % lower rH for the extended range of $\delta^{18}O_{vapor}$ as shown.