Late Holocene climate variability in the Western Carpathians (East-Central Europe) reconstructed from ice cores records

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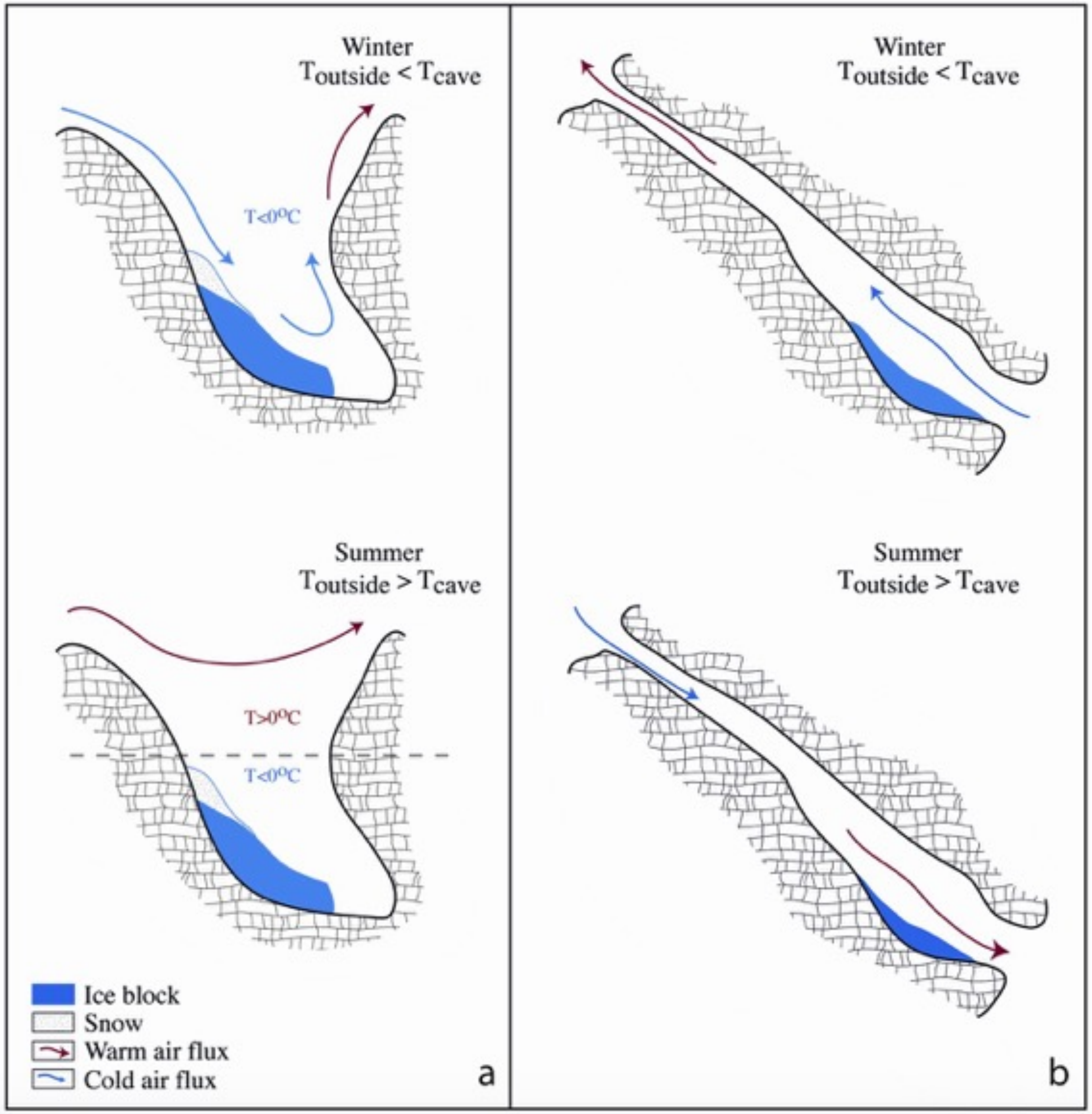
Ice accumulation in caves

1. Glacial ice intrusion
2. Hoar frost accumulation
3. Snow firnification
4. **Water freezing**



Perșoiu and Onac, 2019

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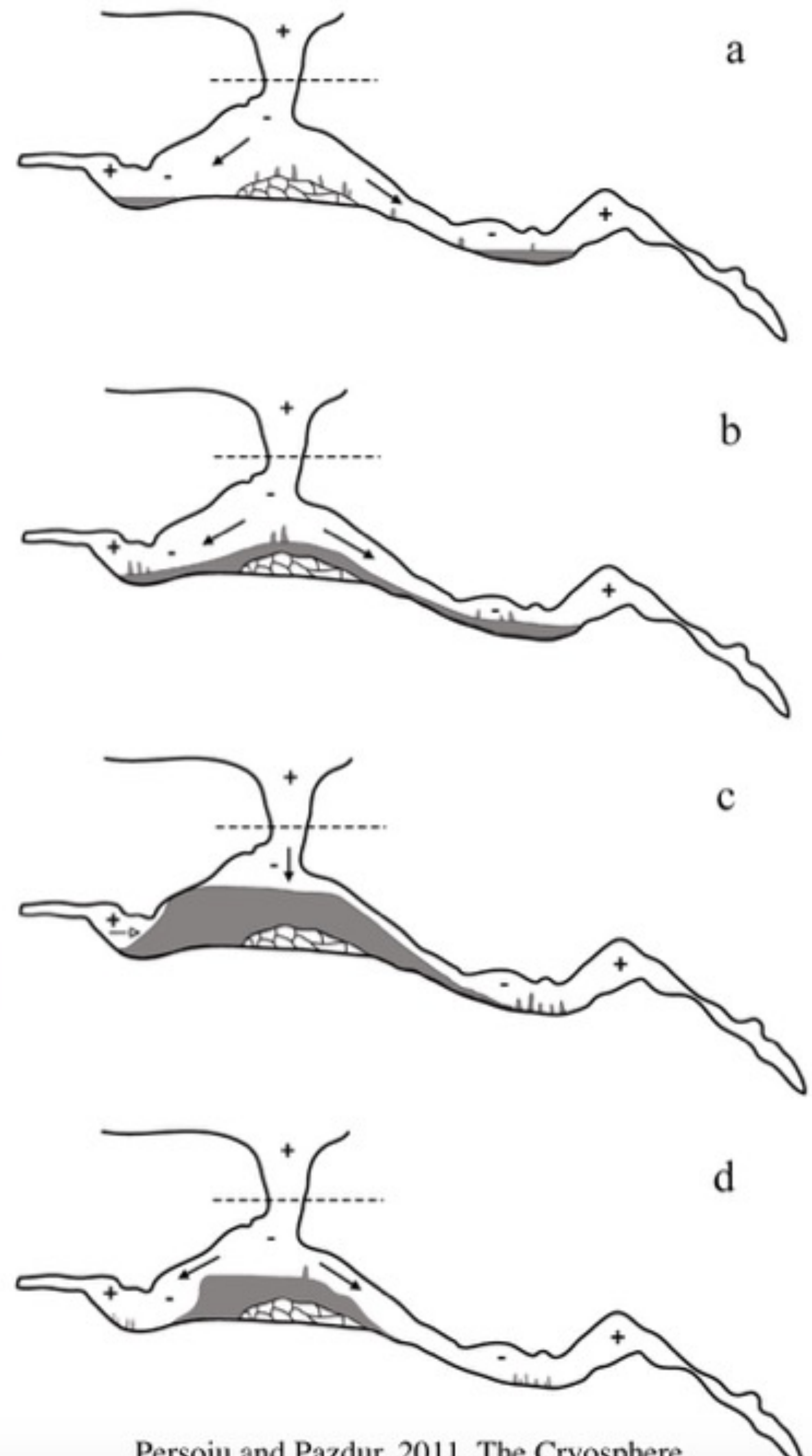
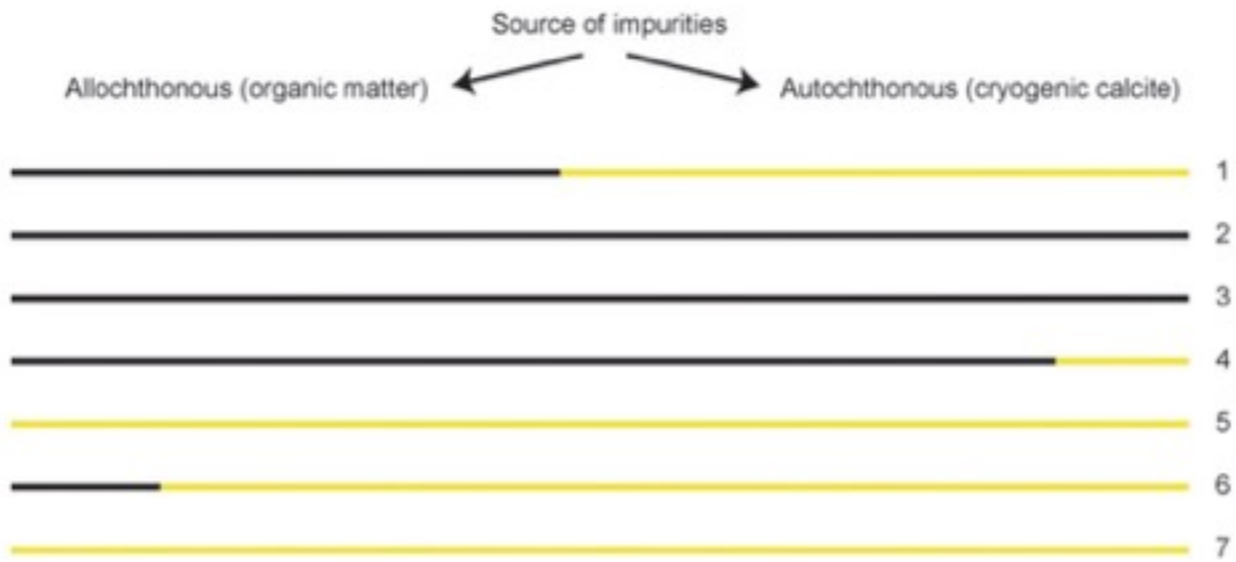
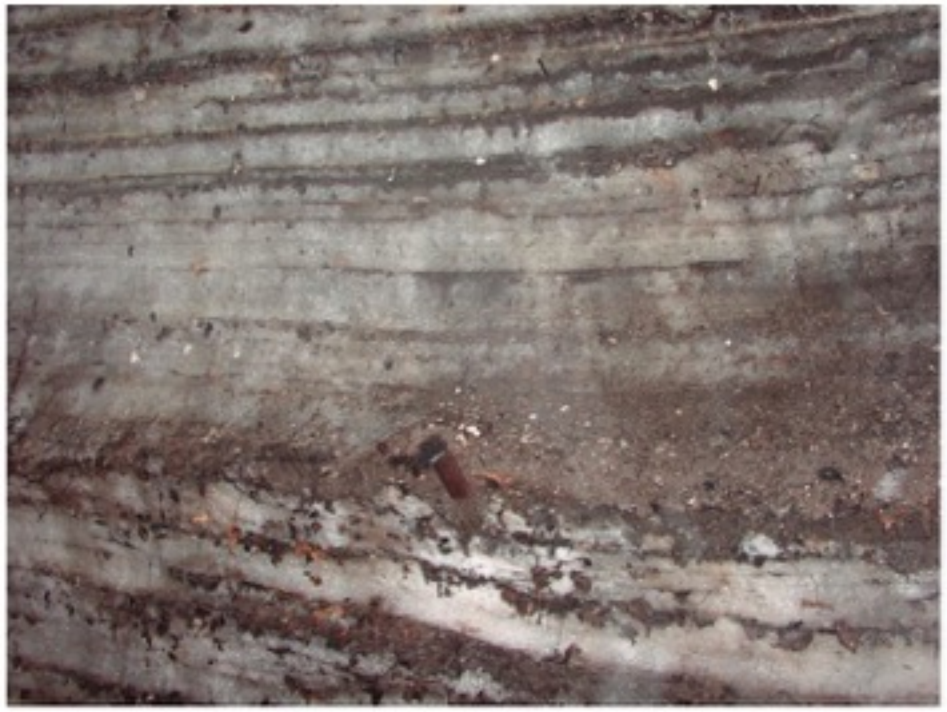
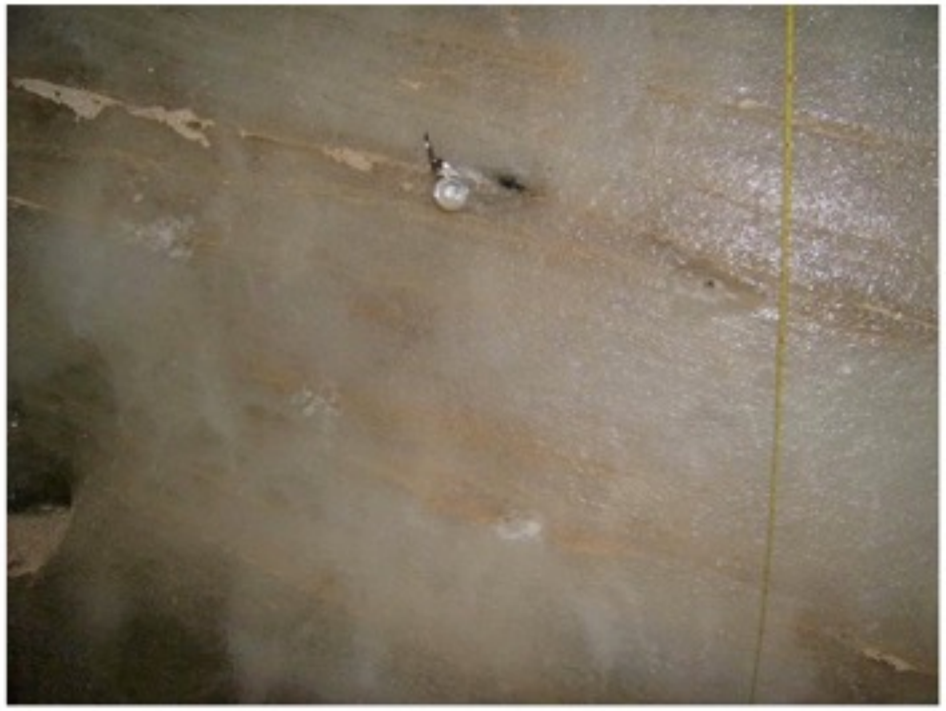


Perşoiu and Pazdur, 2011, The Cryosphere

Ice accumulation in caves







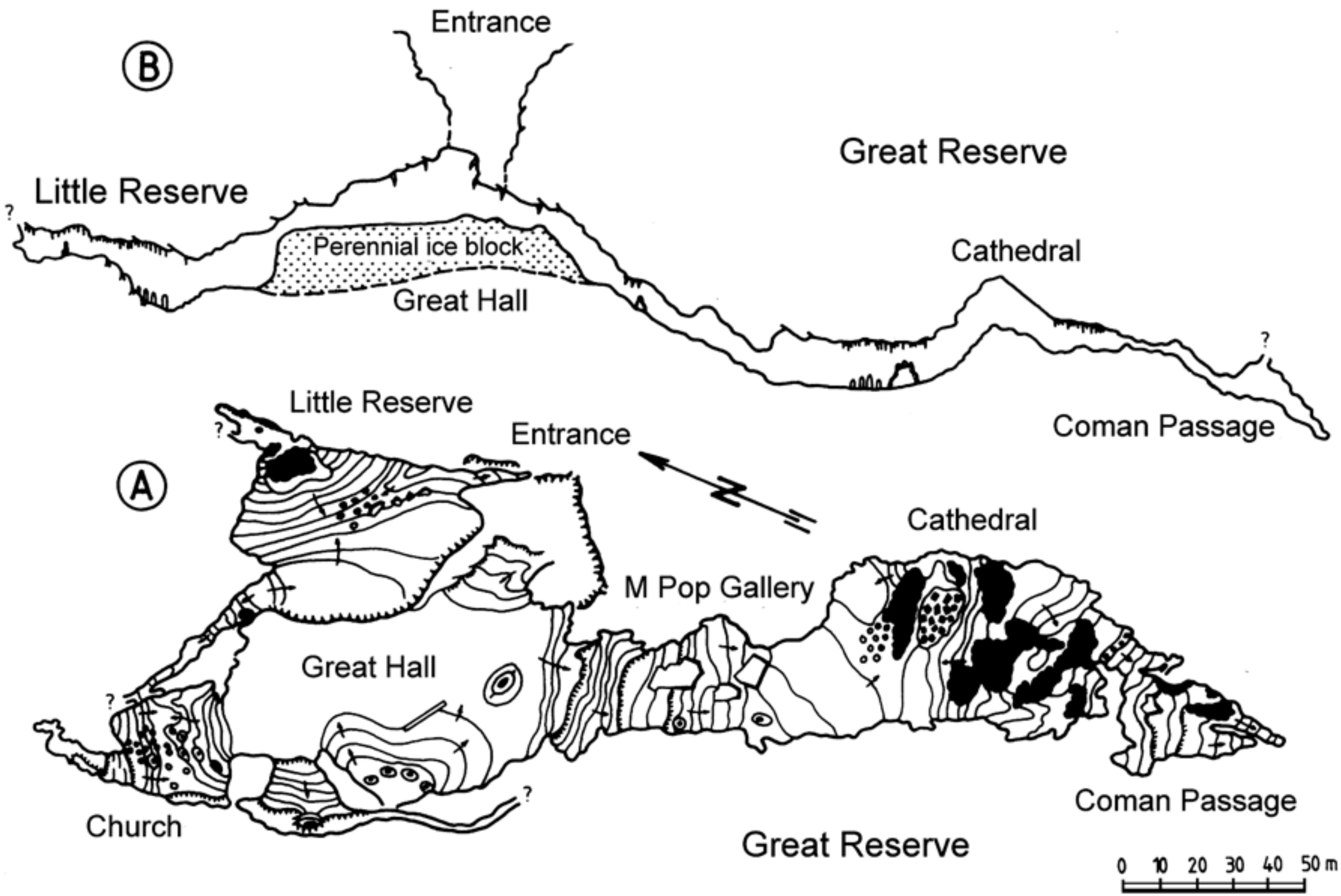
Scărişoara Ice Cave

1165 m asl, 700 m long, - 105 m
MAT ~5 °C outside, 0 ° inside

~10,000 years old (26 ^{14}C ages)
$\delta^{18}O$ proxy for autumn/early winter air temperature

Better than decadal resolution for the last 2k years

Multidecadal resolution for the entire Holocene



B
Entrance
Great Reserve
Little Reserve
Perennial ice block
Great Hall
Cathedral
Coman Passage
A
Little Reserve
Entrance
Cathedral
M Pop Gallery
Great Hall
Church
Coman Passage
Great Reserve
0 10 20 30 40 50 m

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Holocene winter climate variability in Central and Eastern Europe

Aurel Perşoiu[1,2], Bogdan P. Onac[1,3], Jonathan G. Wynn[3], Maarten Blaauw[4], Monica Ionita[5,6] & Margareta Hansson[7]

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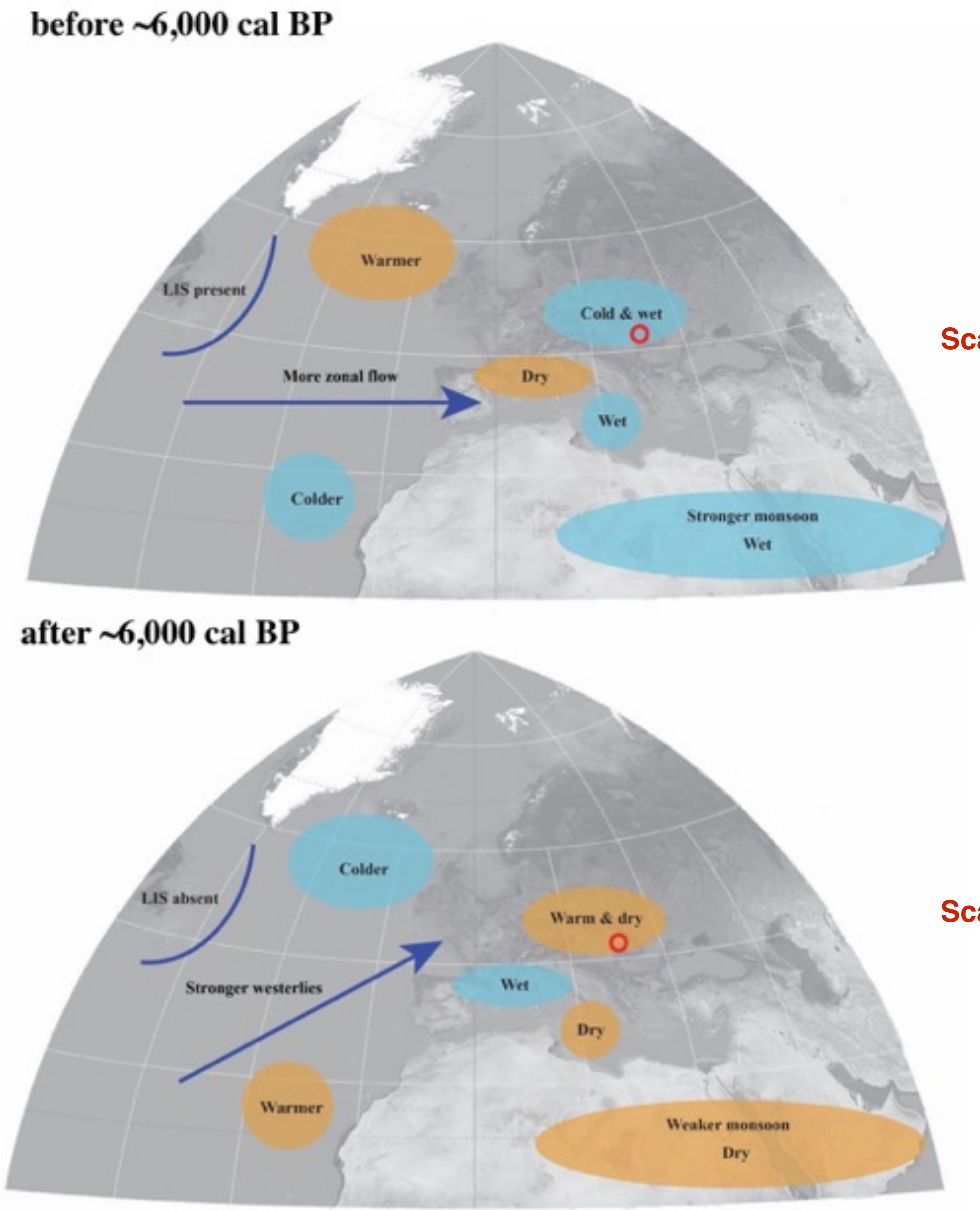
Among abundant reconstructions of Holocene climate in Europe, only a handful has addressed winter conditions, and most of these are restricted in length and/or resolution. Here we present a record of late autumn through early winter air temperature and moisture source changes in East-Central Europe for the Holocene, based on stable isotopic analysis of an ice core recovered from a cave in the Romanian Carpathian Mountains. During the past 10,000 years, reconstructed temperature changes followed insolation, with a minimum in the early Holocene, followed by gradual and continuous increase towards the mid-to-late-Holocene peak (between 4-2 kcal BP), and finally by a decrease after 0.8 kcal BP towards a minimum during the Little Ice Age (AD 1300–1850). Reconstructed early Holocene atmospheric circulation patterns were similar to those characteristics of the negative phase of the North Atlantic Oscillation (NAO), while in the late Holocene they resembled those prevailing in the positive NAO phase. The transition between the two regimes occurred abruptly at around 4.7 kcal BP. Remarkably, the widespread cooling at 8.2 kcal BP is not seen very well as a temperature change, but as a shift in moisture source, suggesting weaker westerlies and increased Mediterranean cyclones penetrating northward at this time.



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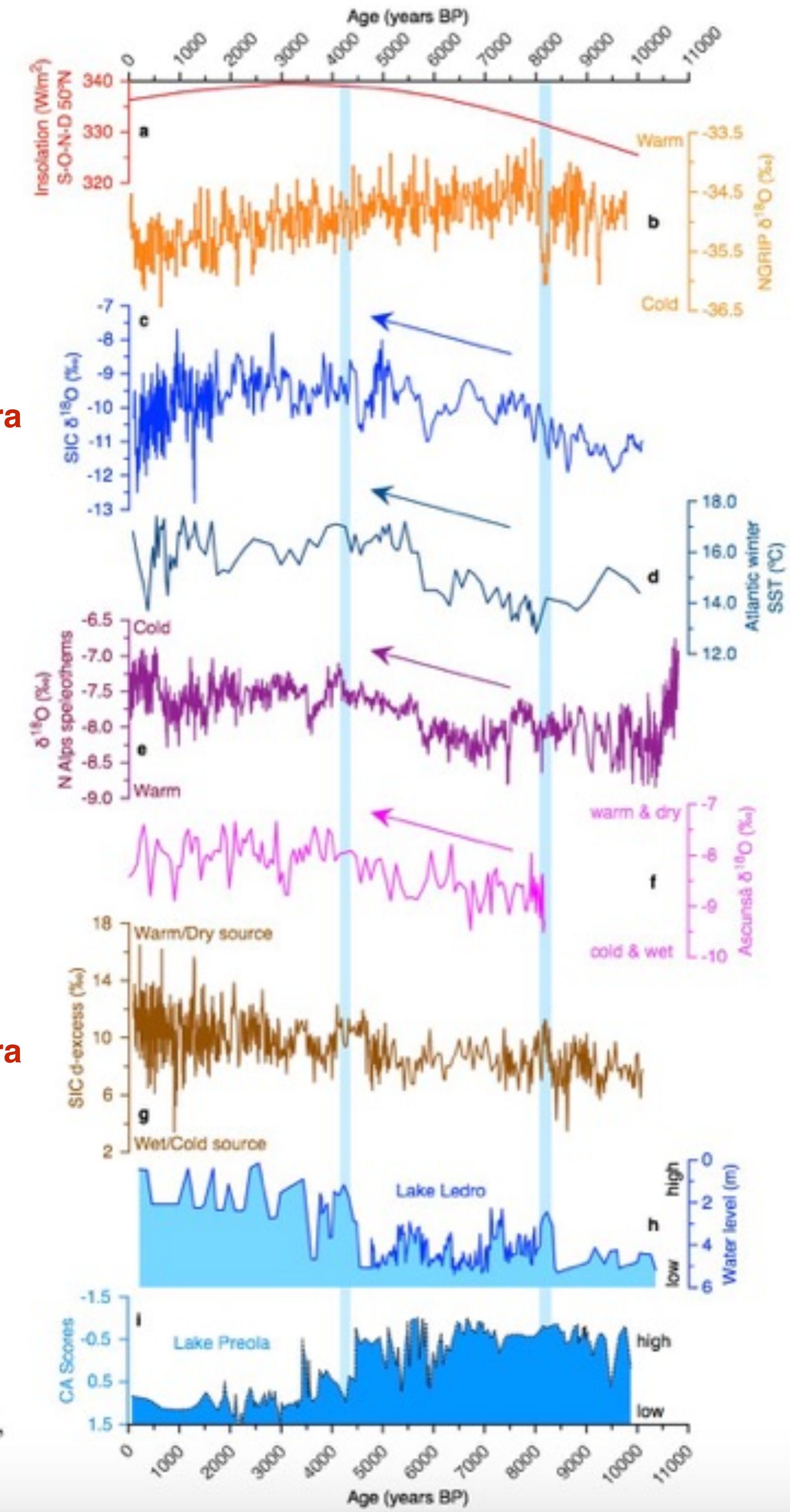

Perşoiu et al., 2017, Sci. Rep


Focul Viu Ice Cave

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Preprints

Abstract | Discussion | Metrics

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Stable isotopes in cave ice suggest summer temperatures in East-Central Europe are linked to AMO variability

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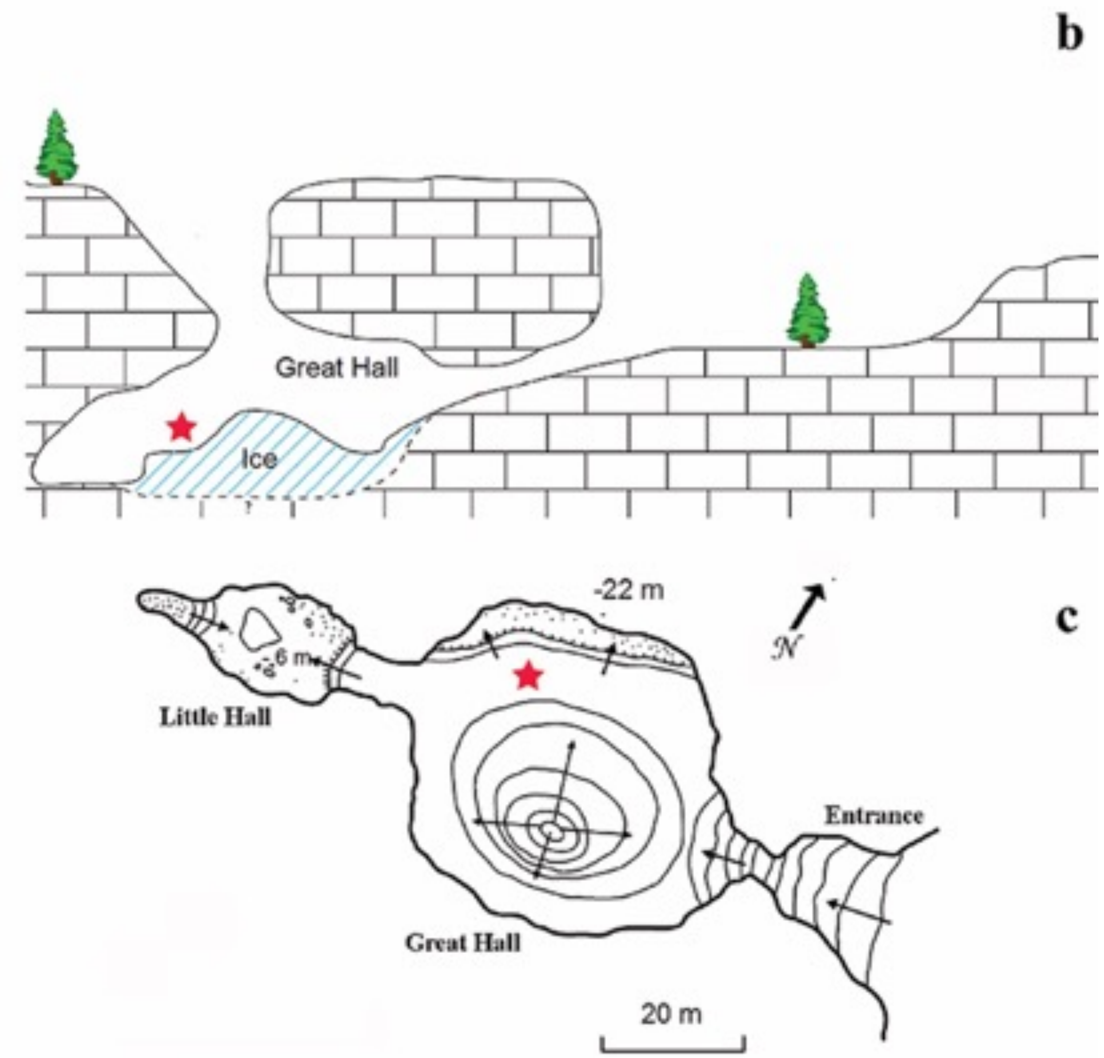
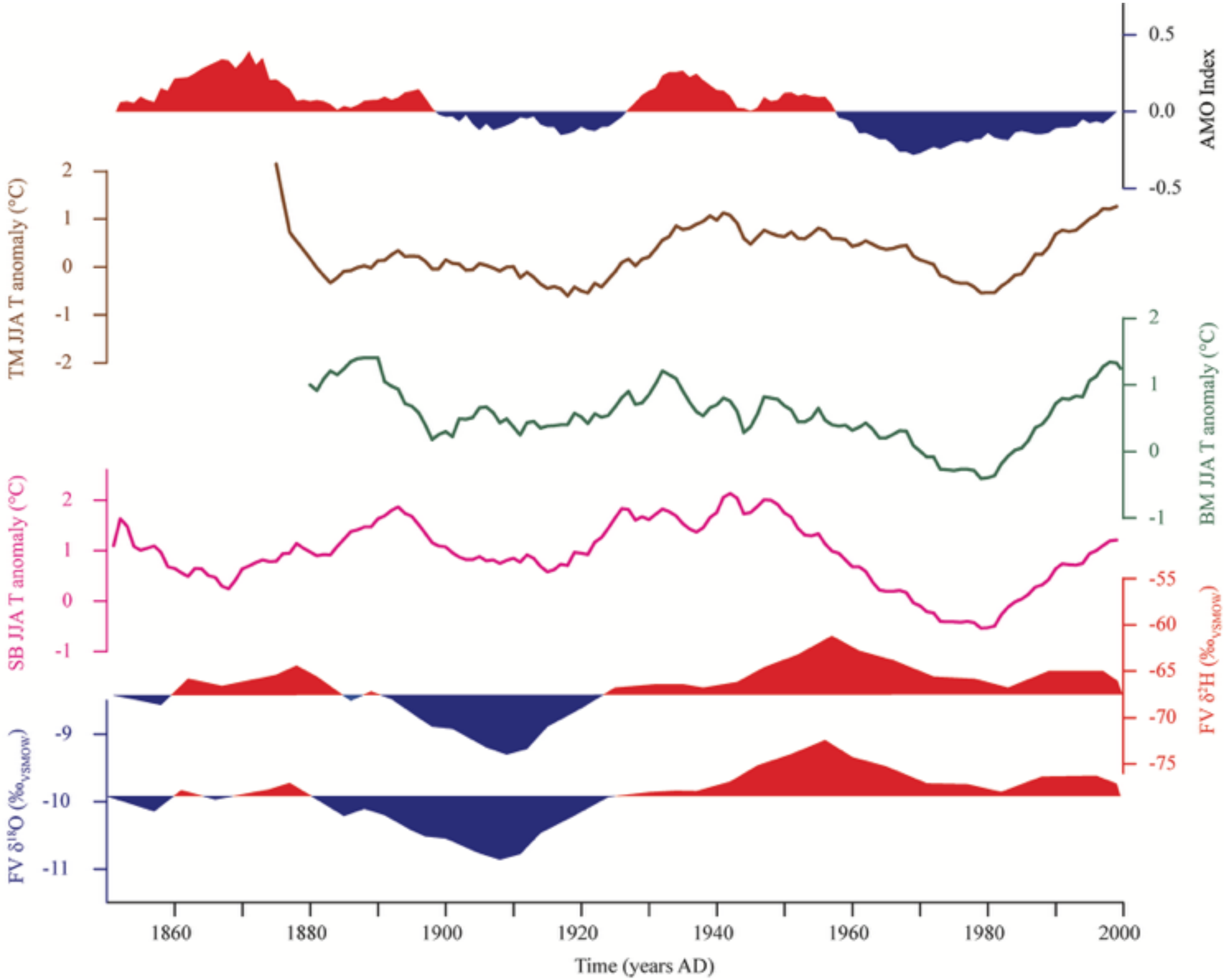
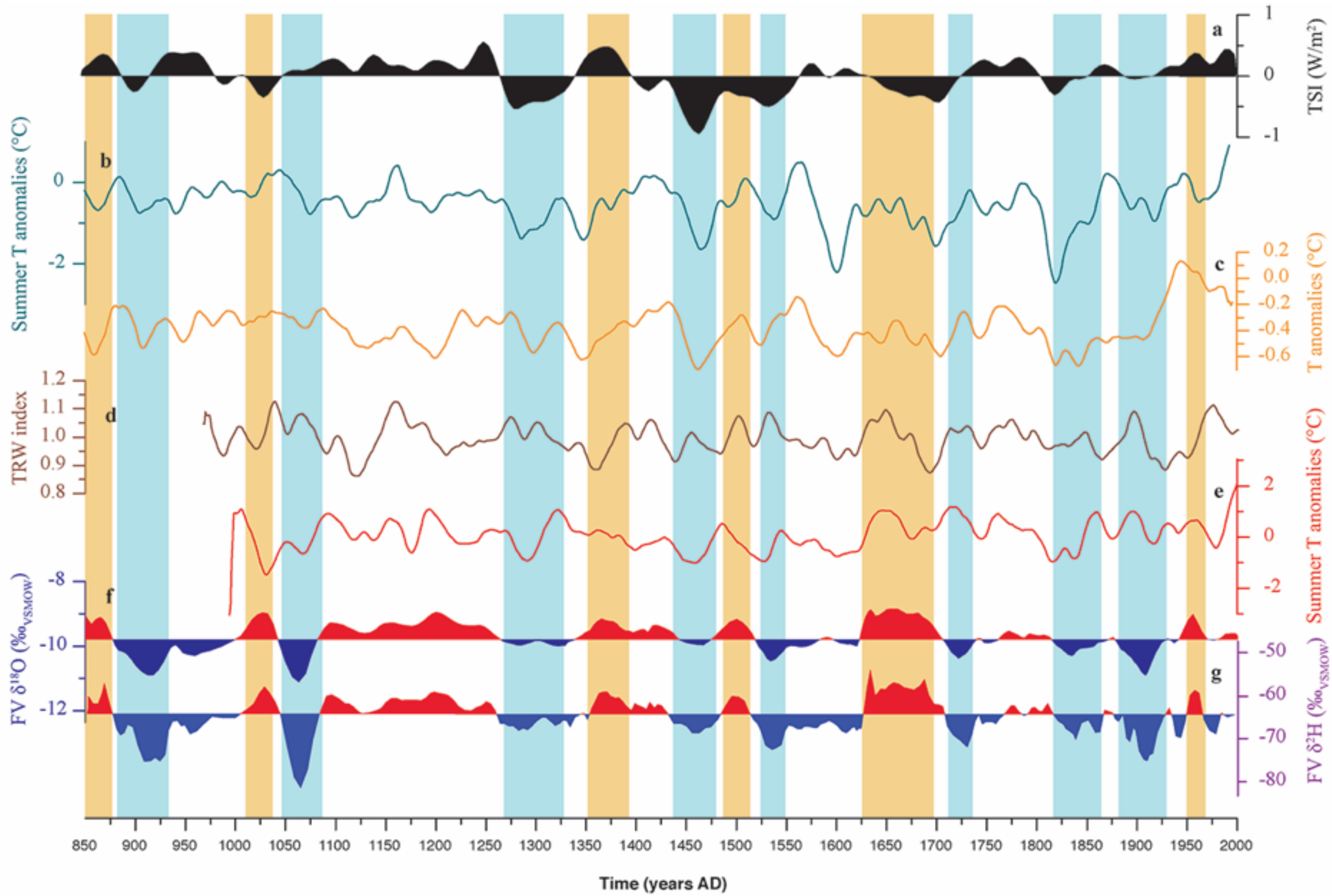
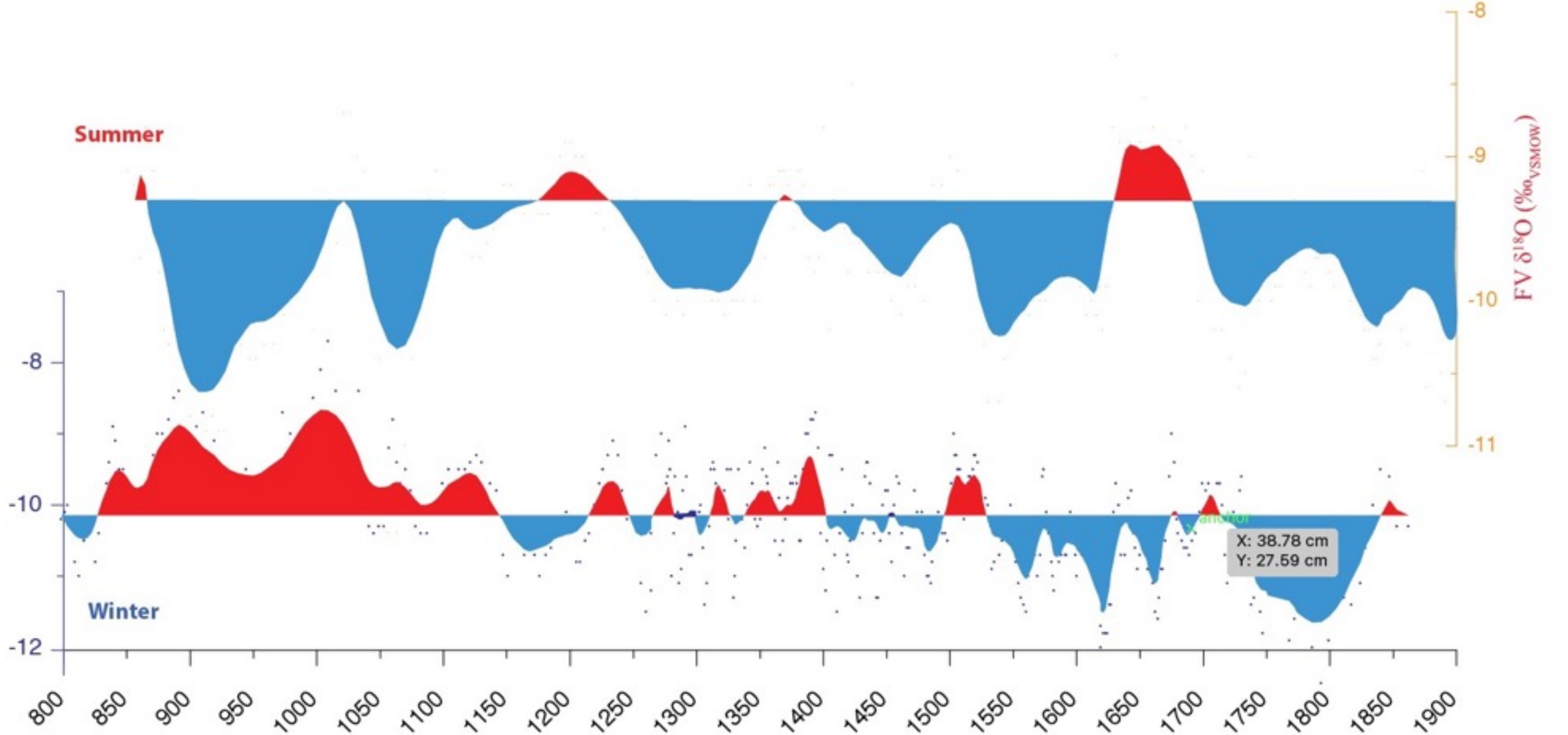




Temporal variability of the Atlantic Multidecadal Oscillation instrumental index, air temperature (anomalies with respect to the 1961-1990 period) recorded at Baia Mare (BM), Timișoara (TM) and Sibiu (SB) meteorological stations and FV $\delta^{18}O$ and $\delta^{2}H$ (‰) during the instrumental period. The positive (red) and negative (blue) anomalies are shown against the 1850-2000 averages for the FV values.



Summer climatic conditions recorded by $\delta^{18}O$ and $\delta^{2}H$ from FV ice core (panels f and g, bottom) and comparison with proxy indicator from the Northern Hemisphere: a) Total Solar Radiation (Steinhilber et al., 2009), b) Central Europe summer temperature anomalies (against the 1901-2000 mean, Buntgen et al., 2011); c) Northern Hemisphere air temperature anomalies (against the 1961-1990 mean, D'Arrigo et al., 2006), d) Tree Ring width index from Albania, SE Europe (Seim et al., 2012), e) Summer temperature anomalies in Romania (against the 1961-1990 mean, Popa and Kern, 2009).



The analysis of d18O values indicate that on centennial scales, air temperature variability during the last 1000 years was controlled by changes during the winter season, summer temperatures being relatively constant (on these time scales). Contrary, short-term variability (decadal to multi-decadal) was well expressed in both seasons. In summer, the main controlling factors seem to be changes in solar radiation and possibly in the strength of the Atlantic Multidecadal Oscillation, while in winter, the strength of the Siberian High could have acted as the main forcing factor.