EVOLUTION OF THE PERUVIAN CLIMATE DURING THE LATE GLACIAL AND HOLOCENE (18 ka BP - present)

TEMPERATURE, PRECIPITATION, LANDSCAPES AND CULTURES

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1 - **Evolution of the orbital parameters and their climate impact on the northern and southern hemispheres during the Late Glacial and Holocene**

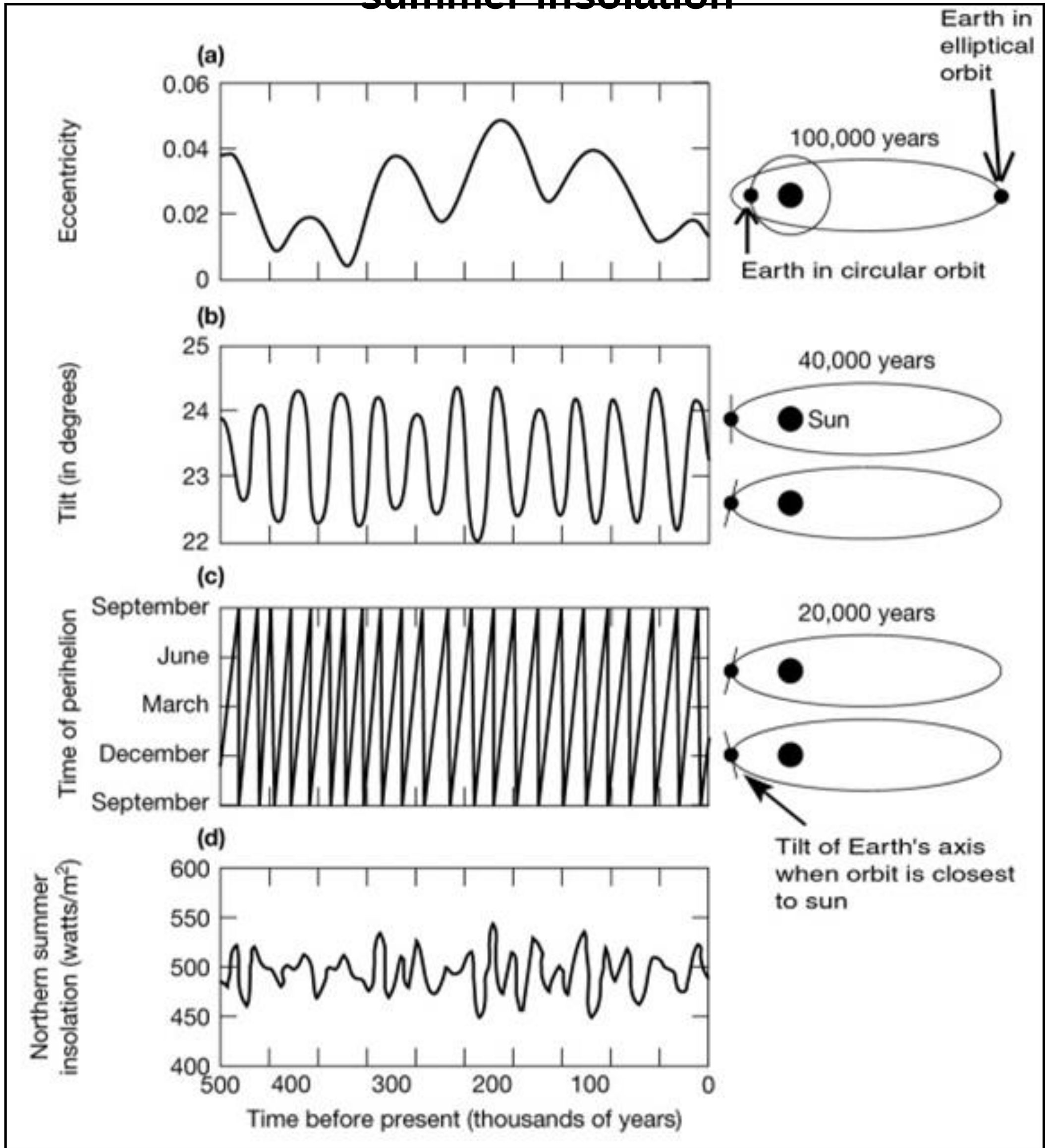
2 - **Evolution of Southern American and Peruvian landscapes from the Late Glacial to the Early Holocene (18-6 ka BP)**

3 - **Evolution of Temperature and Precipitation in the Peruvian region during the Holocene (10.3-0 ka BP)**

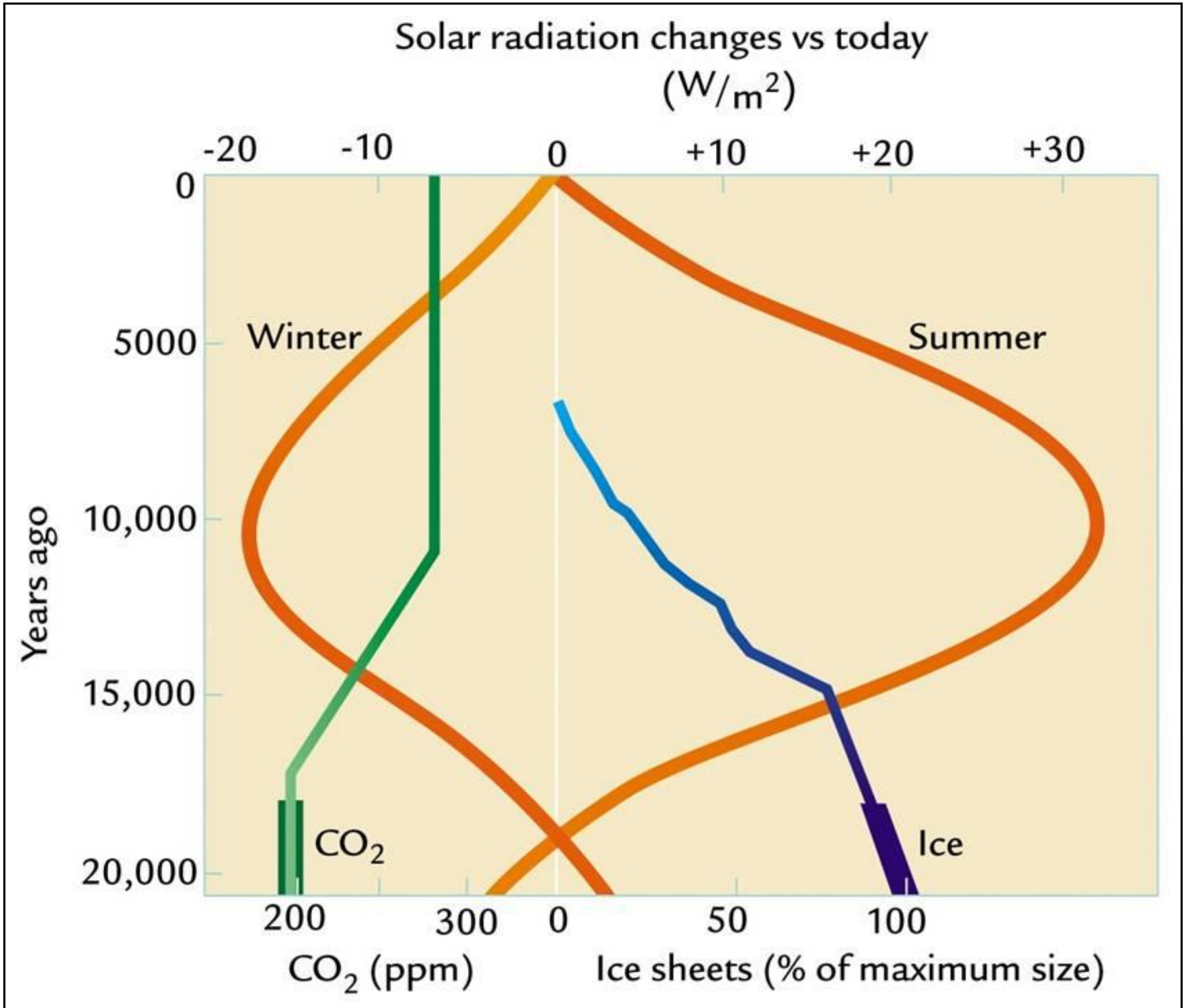
4 - **Climate and cultures in Peru during the Ceramic Period (3.9-0.5 ka BP)**

1 - Orbital parameters and their climate impact on the northern and the southern hemispheres

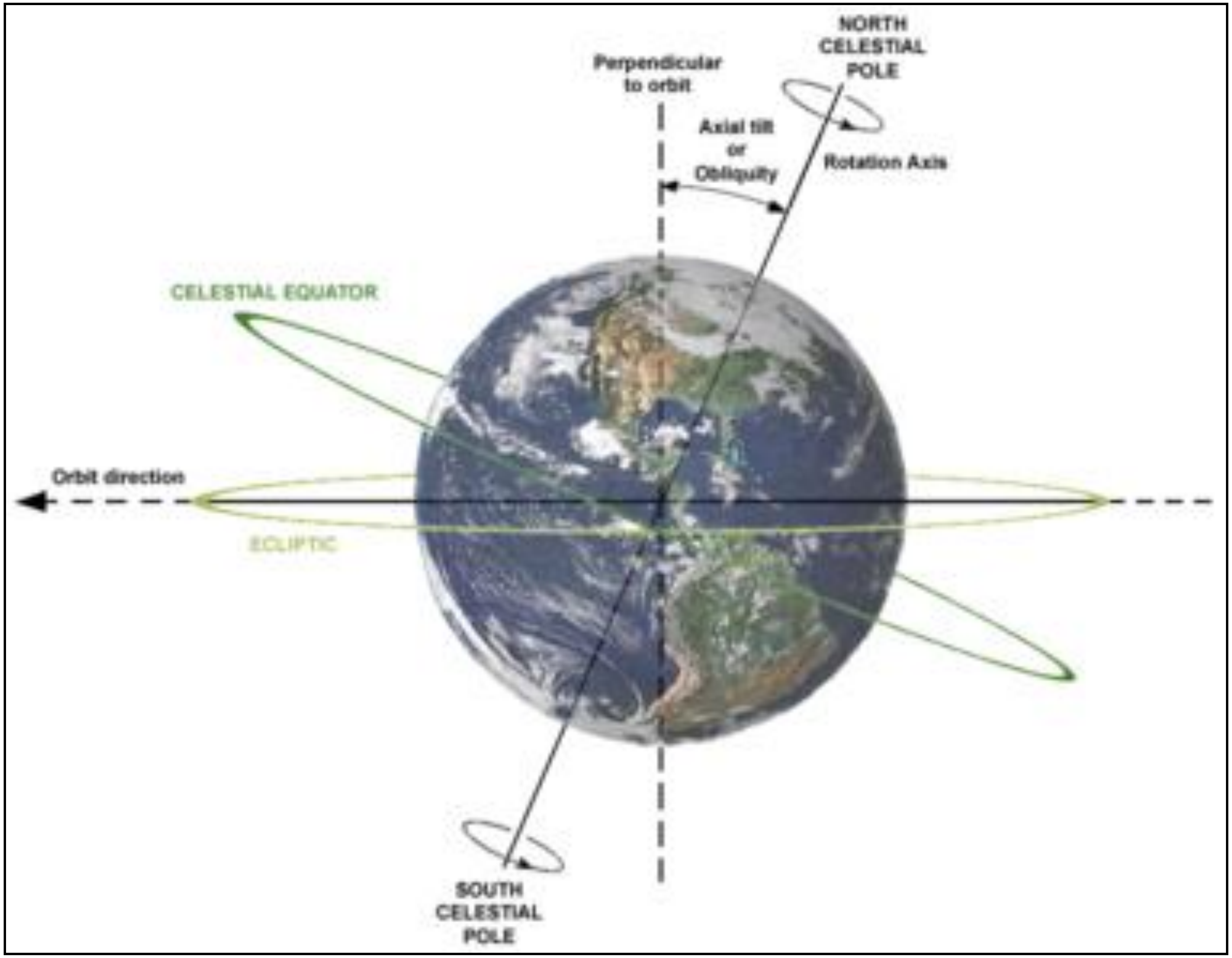
1 - cyclical changes of orbital eccentricity, axial inclination, axial precession and northern summer insolation



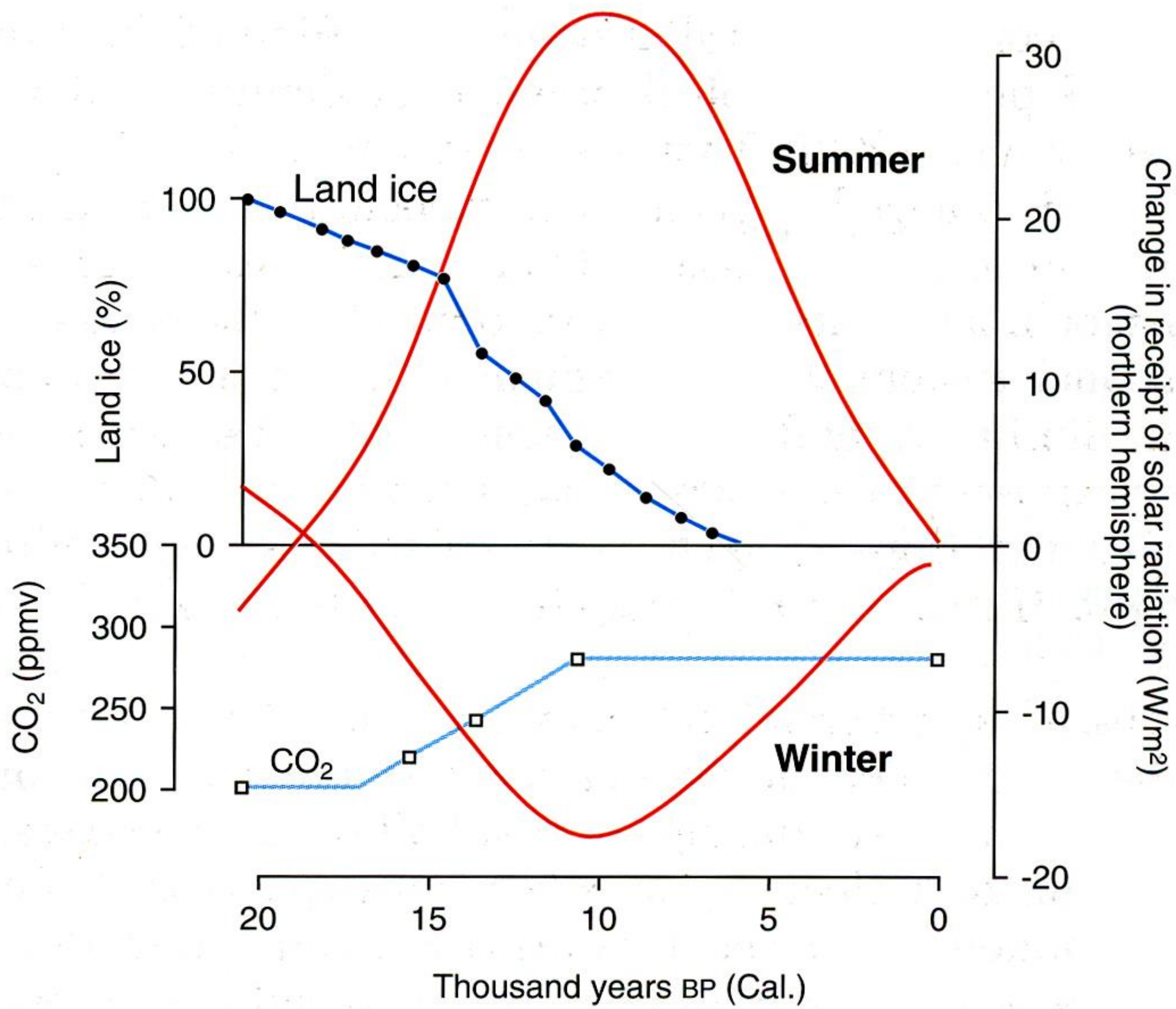
2 - changes of solar radiation by **season (20-0 ka BP)**



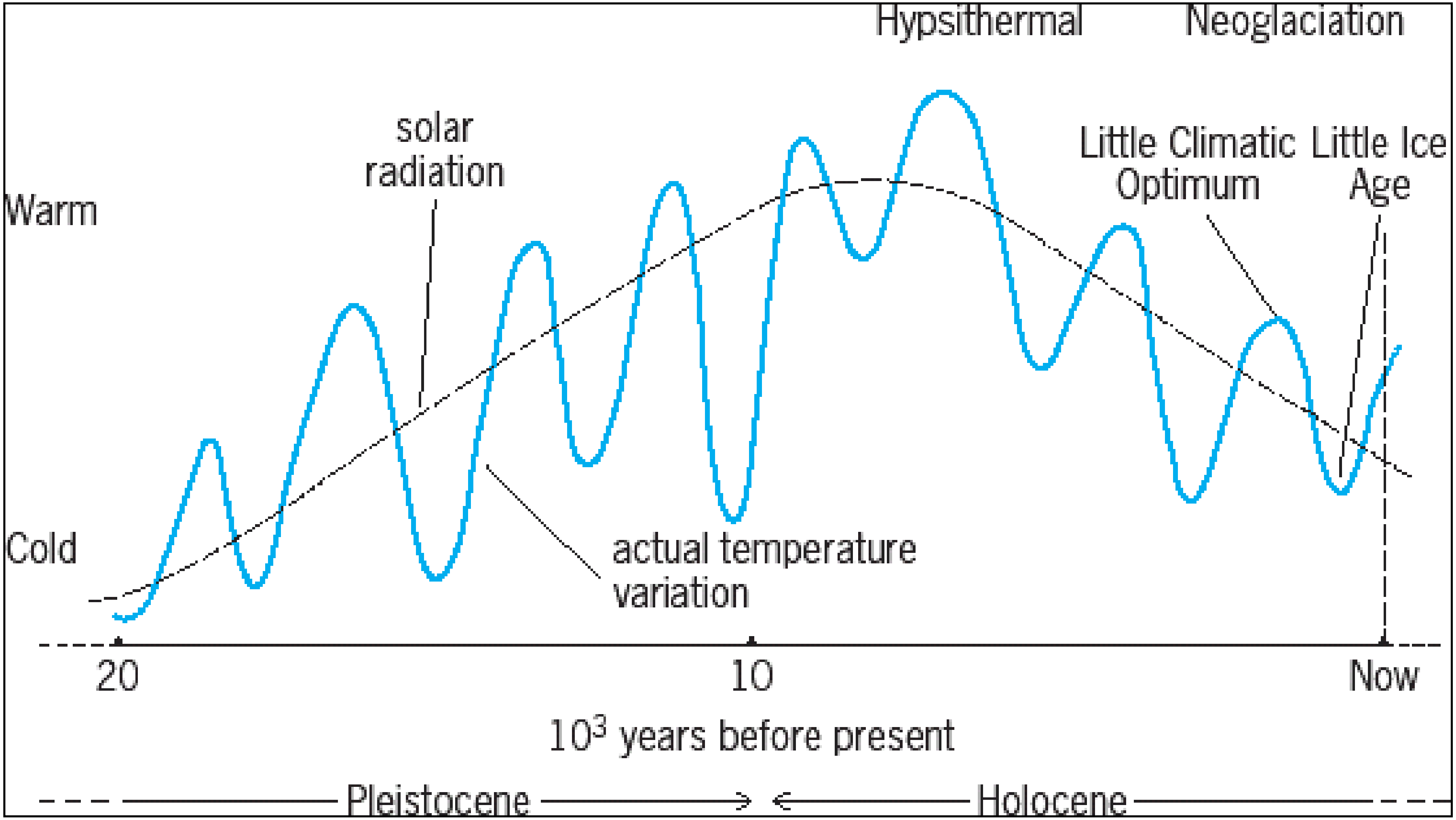
3 - evolution of axial inclination from 24.5 to 22.1 degrees (10.3-0 ka BP)



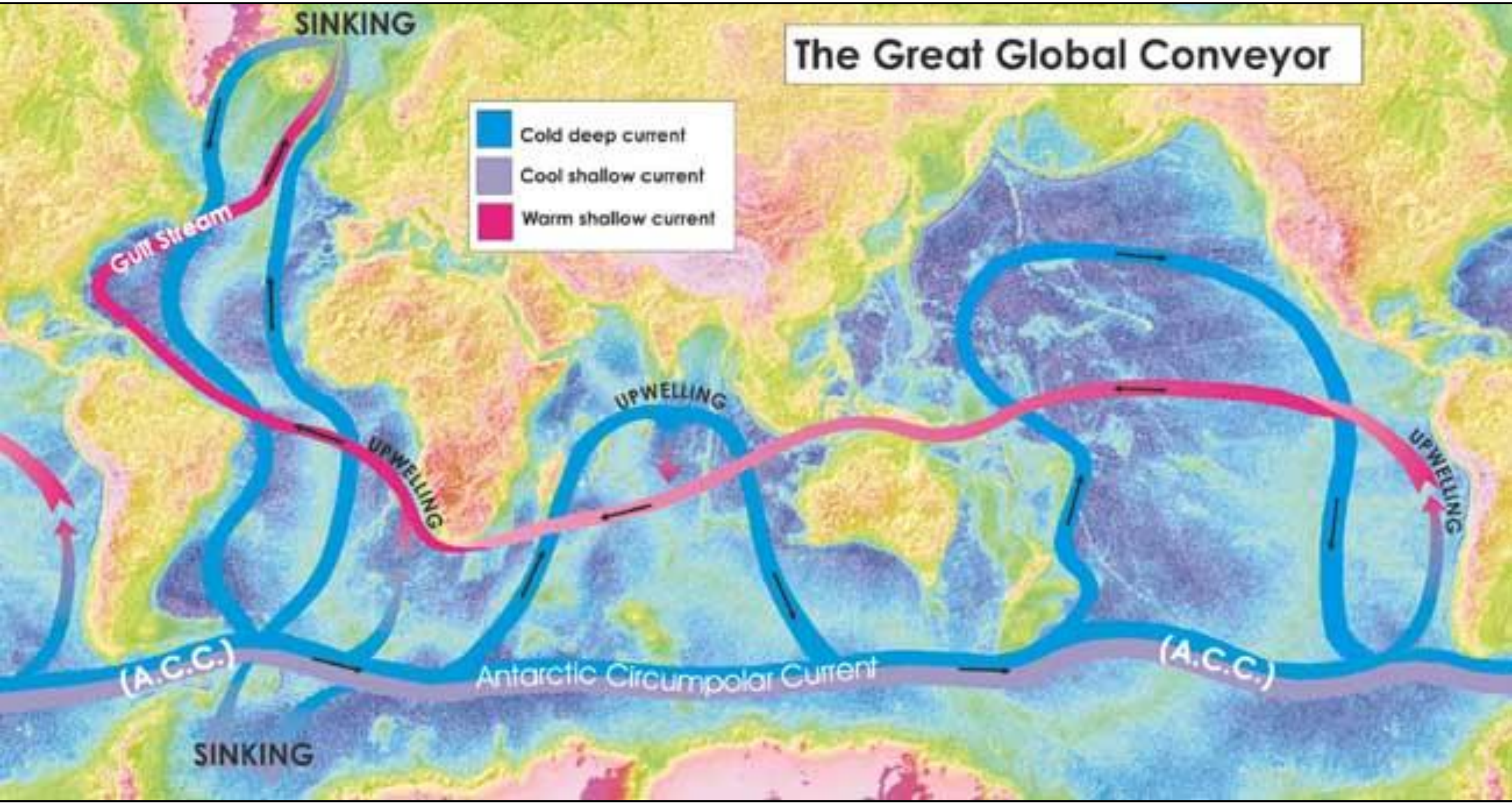
4 - evolution of summer and winter insolation of N-hemisphere (20-0 ka BP)



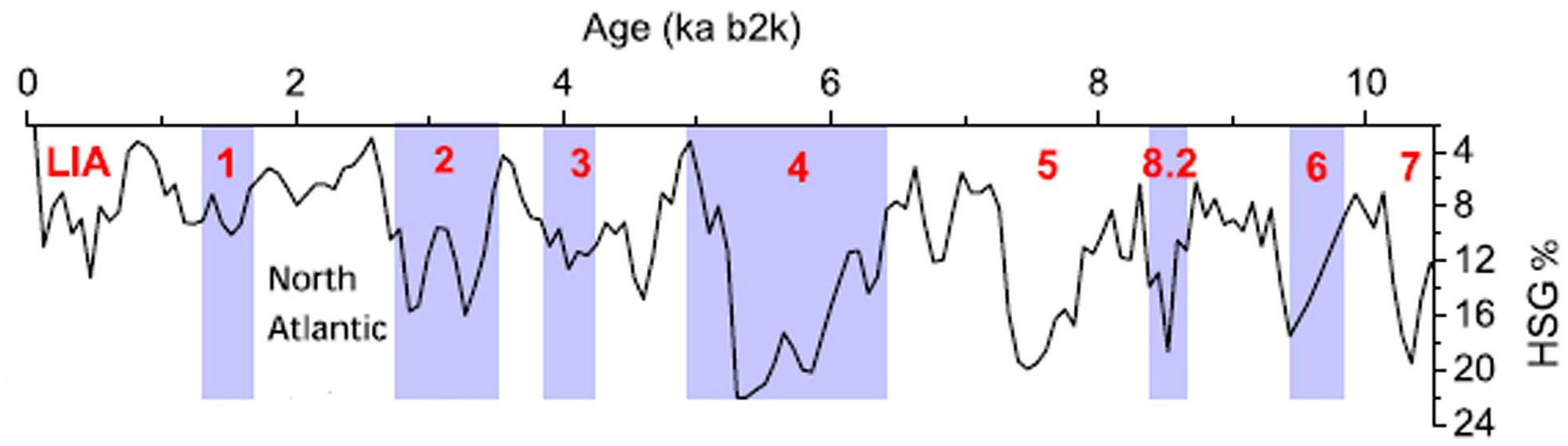
5 - evolution of solar radiation and average global temperature (T) (20-0 ka BP)



6 - Thermo-Haline Circulation (THC) or Ocean Conveyor Belt

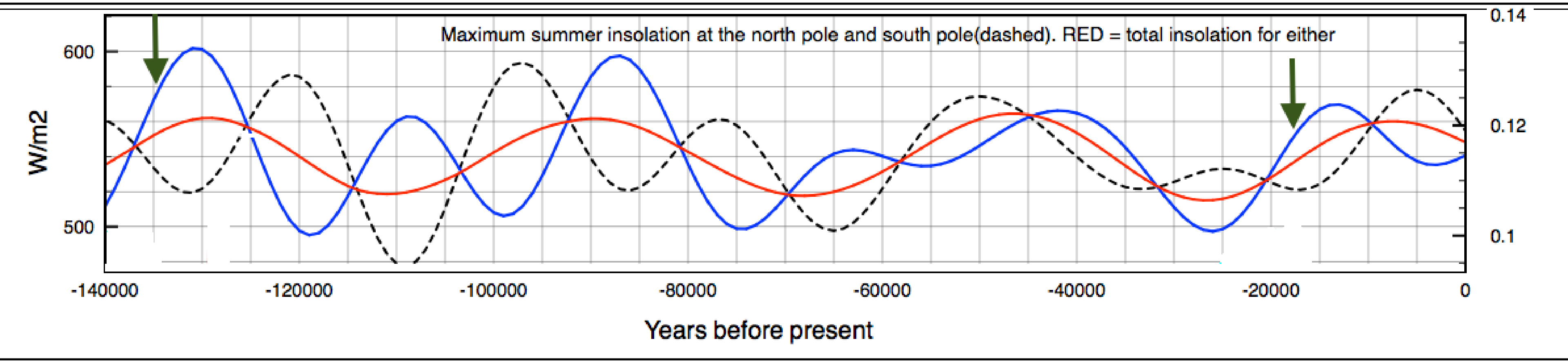


8 - cyclical Bond events in the N-Atlantic (10-0 ka BP)

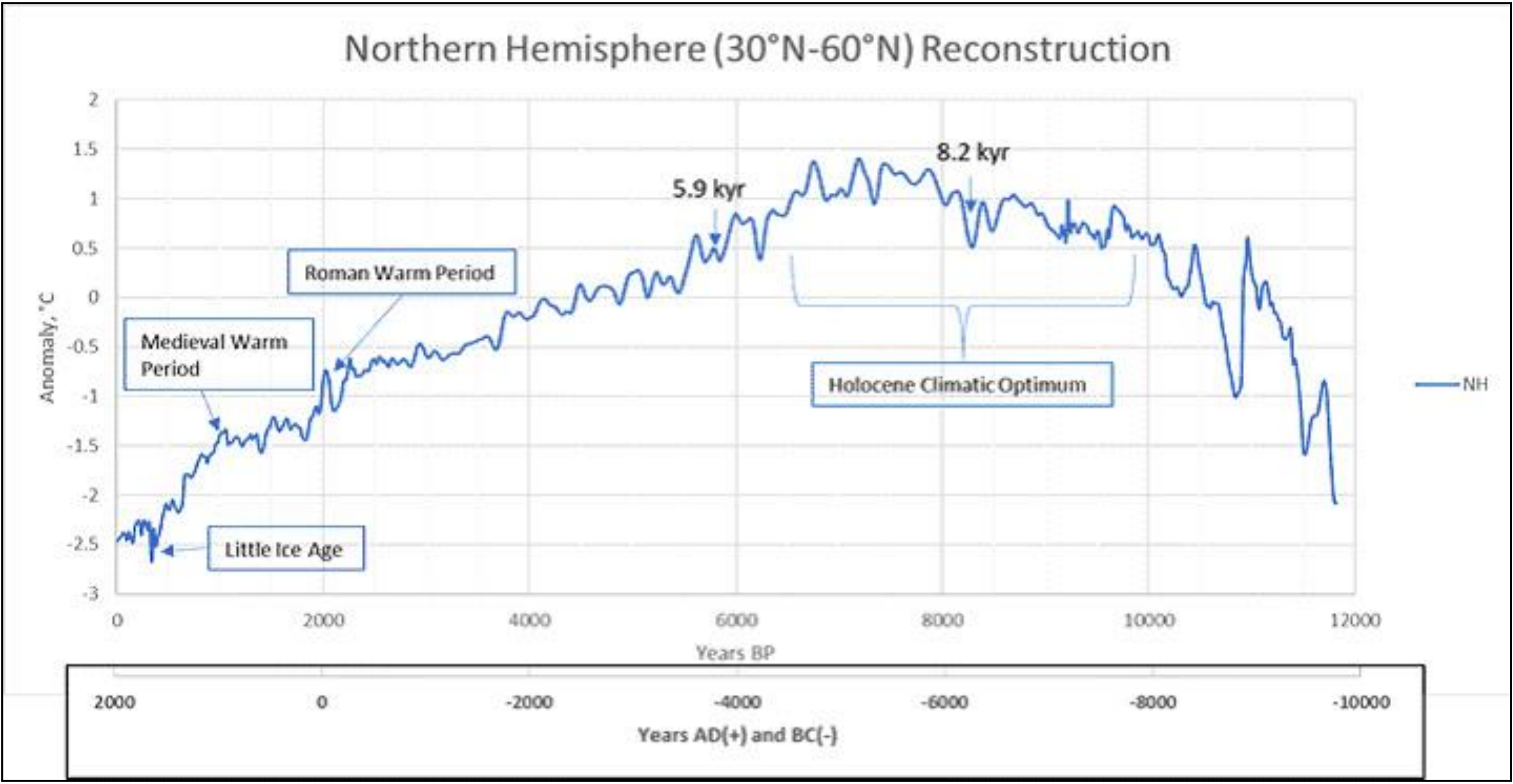


9 - evolution of total insolation (red) and max summer insolation at the N pole (blue) and S pole (dashed)

(140-0 ka BP)

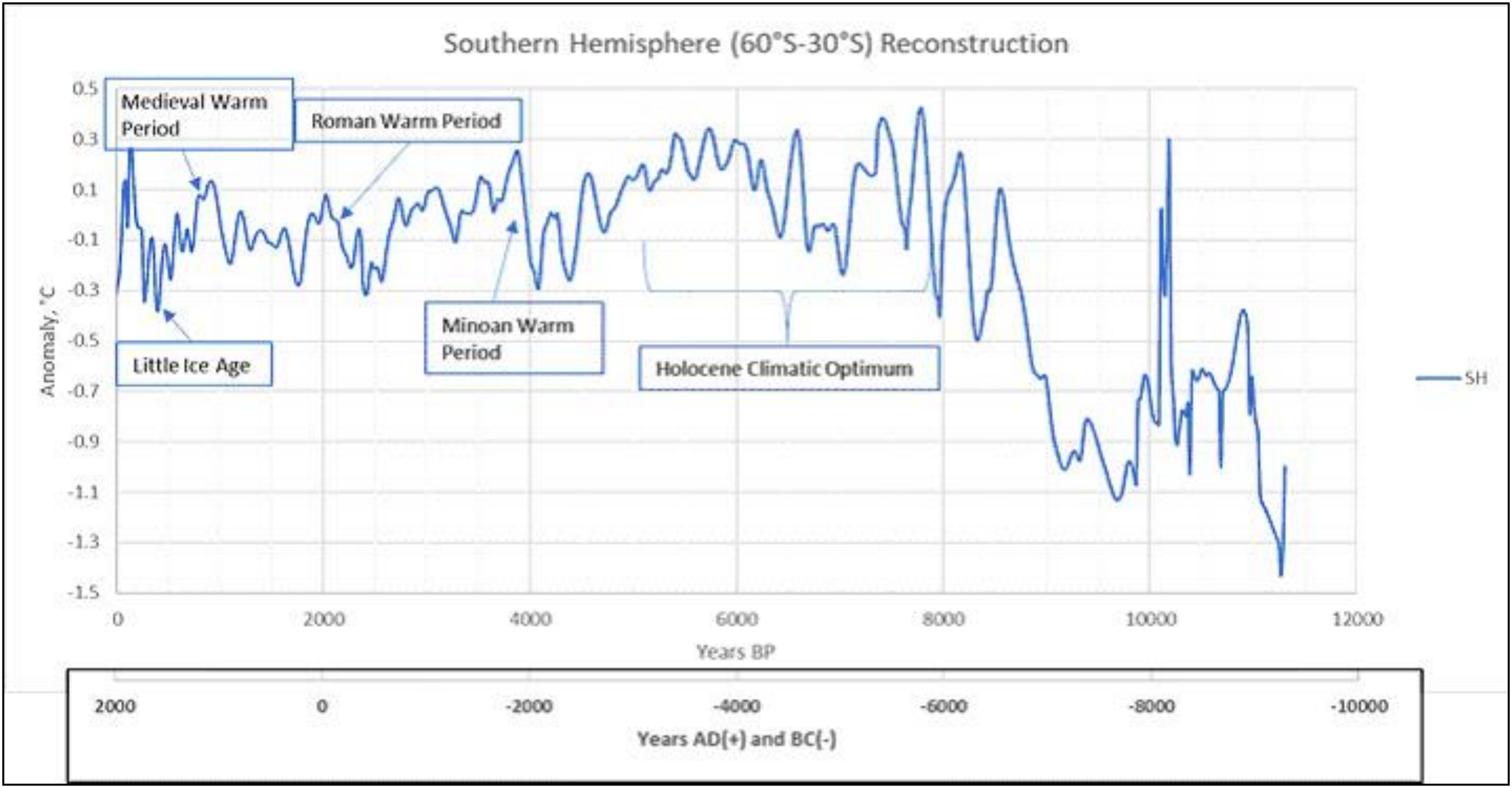


10 - Northern hemisphere: evolution of T (10-0 ka BP)

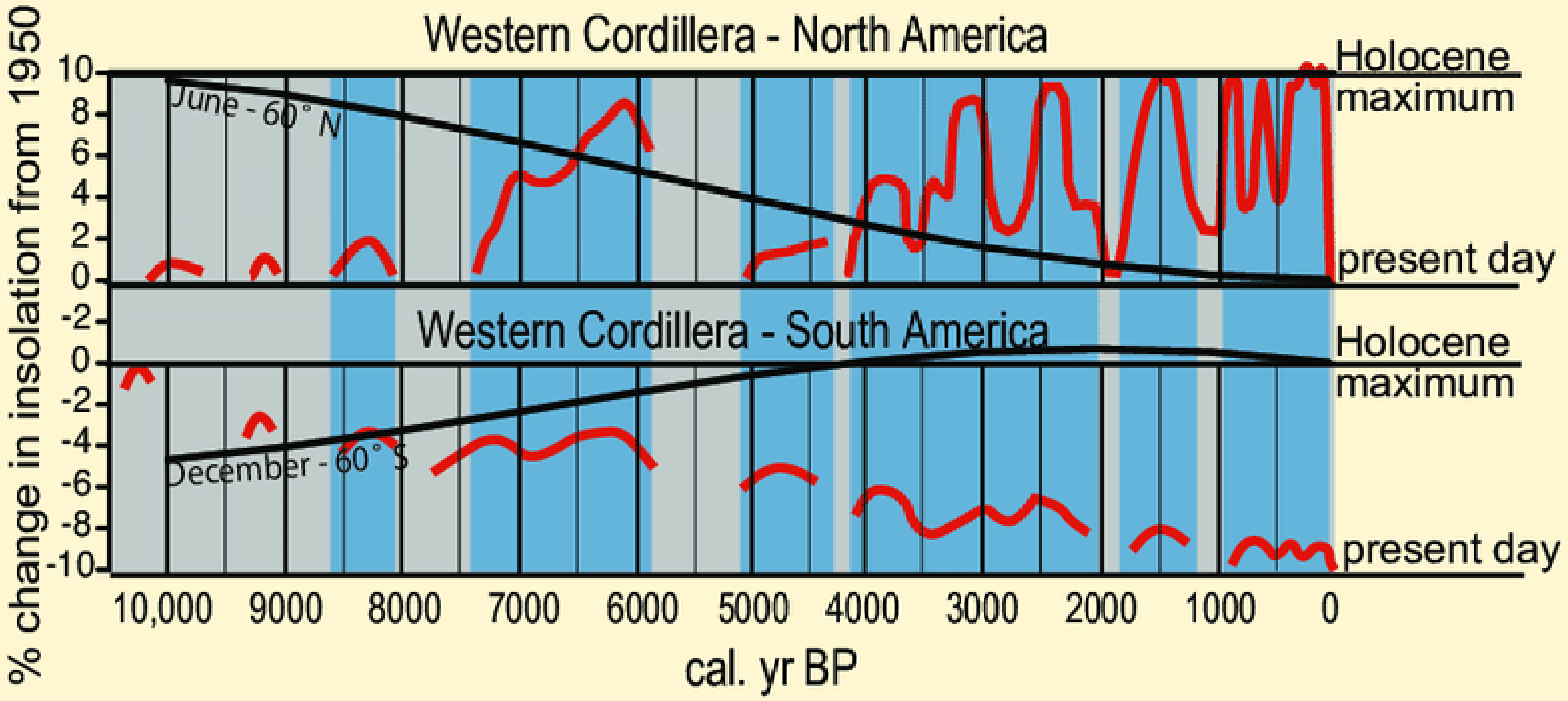


11 - Southern hemisphere: evolution of T (10-0 ka BP)

(climate optimum retarded to 7.8 ka BP, with 2.5 degrees less anomalies than in N-hemisphere)

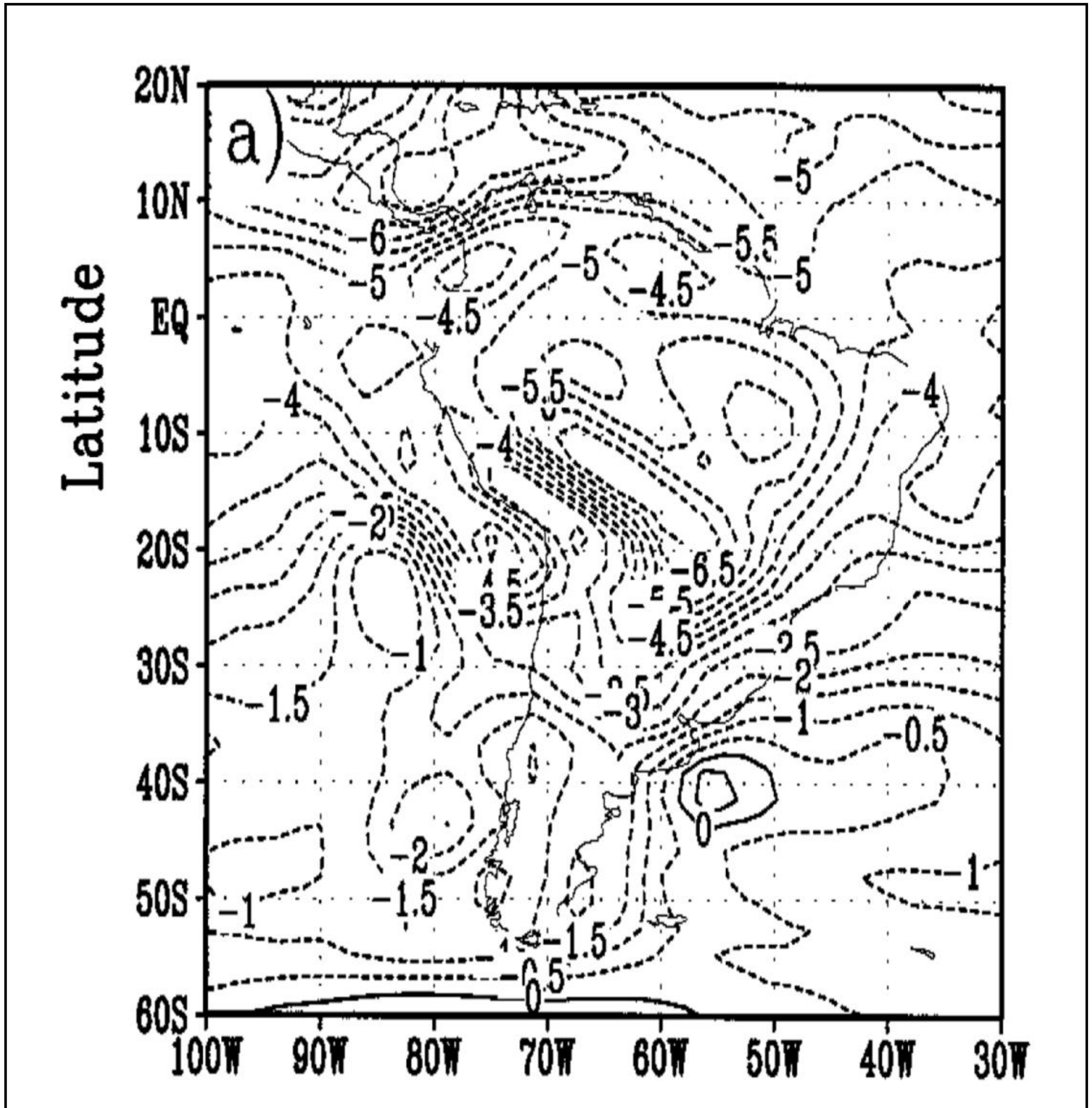


Northern and Southern Hemispheres: changes in insolation (black) and glacial volumes (red) (10-0 ka BP)

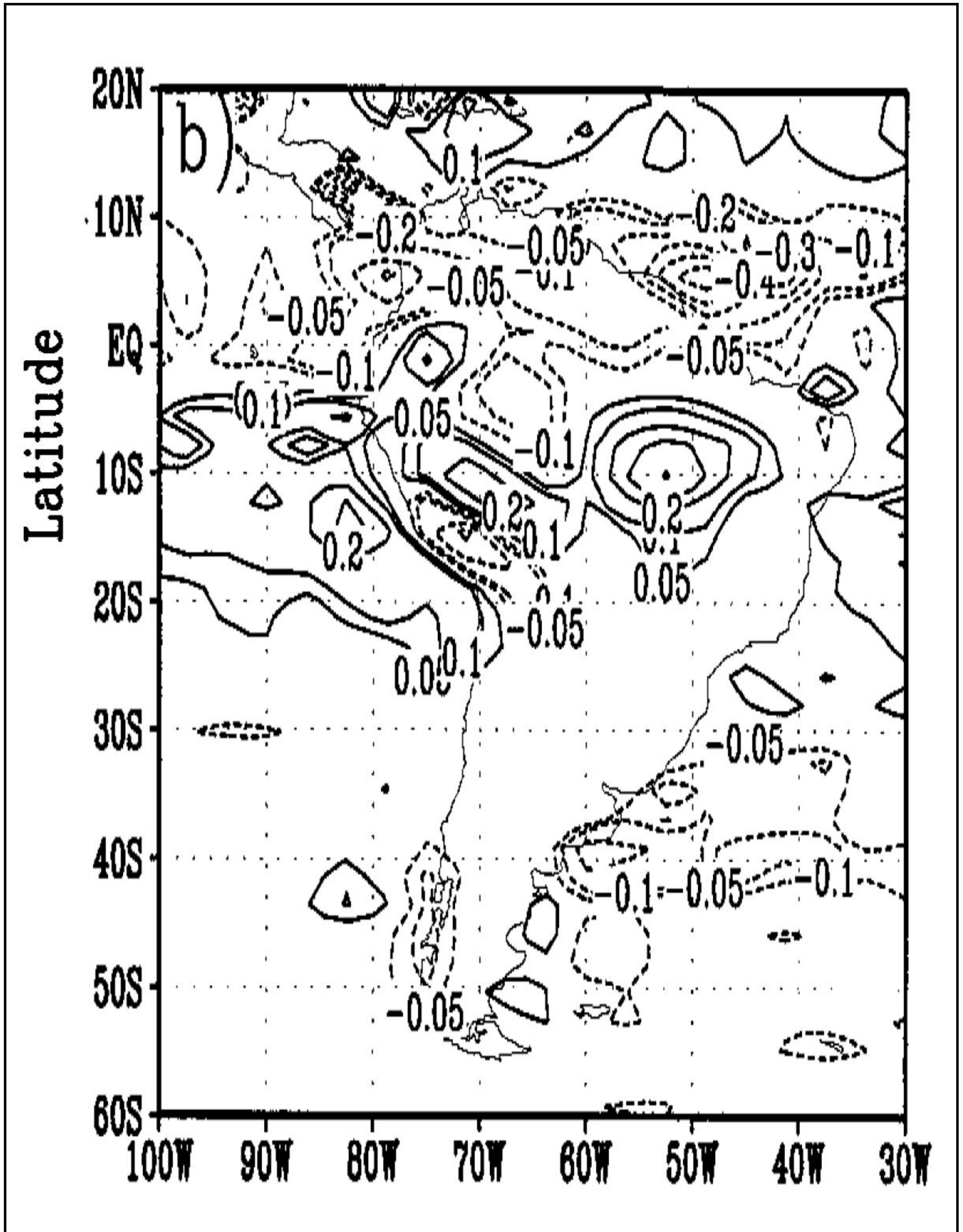


2 - Evolution of Southern American and Peruvian landscapes from the Last Glacial Maximum to the Early Holocene (18-6 ka BP)

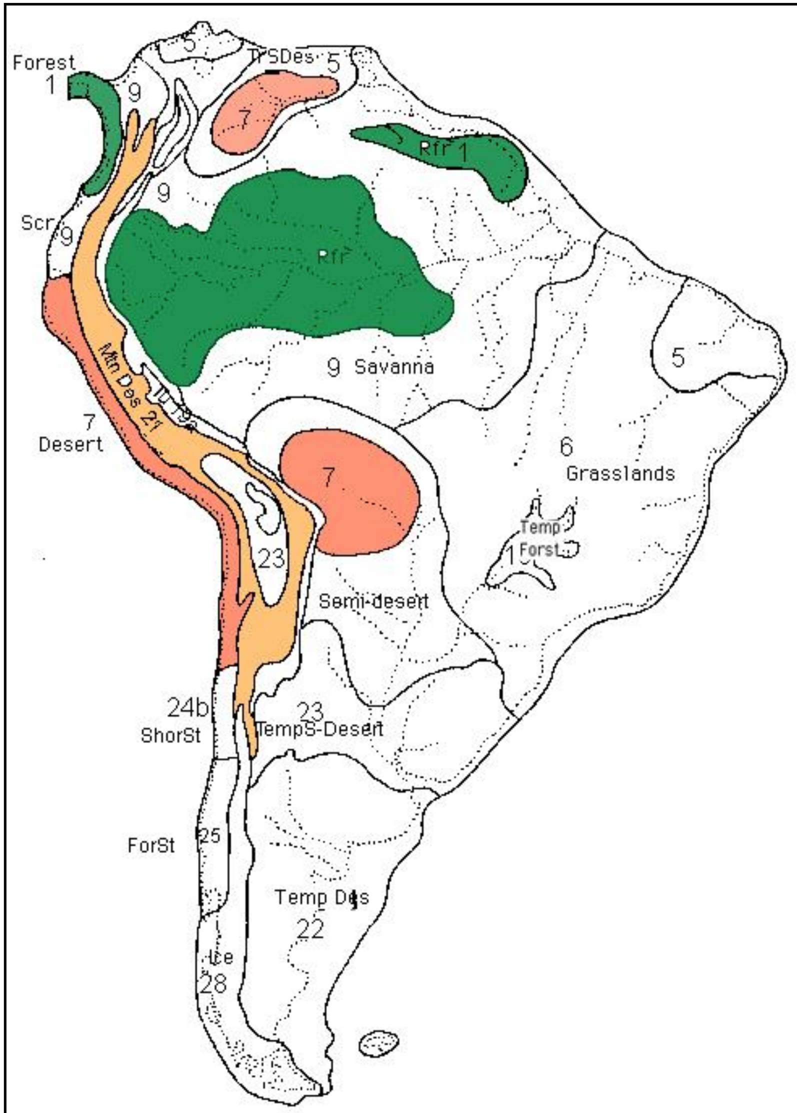
13 - South America (LGM, 18 ka BP) : differential T values from present



14 - South America (LGM, 18 ka BP) : differential runoff indices from present

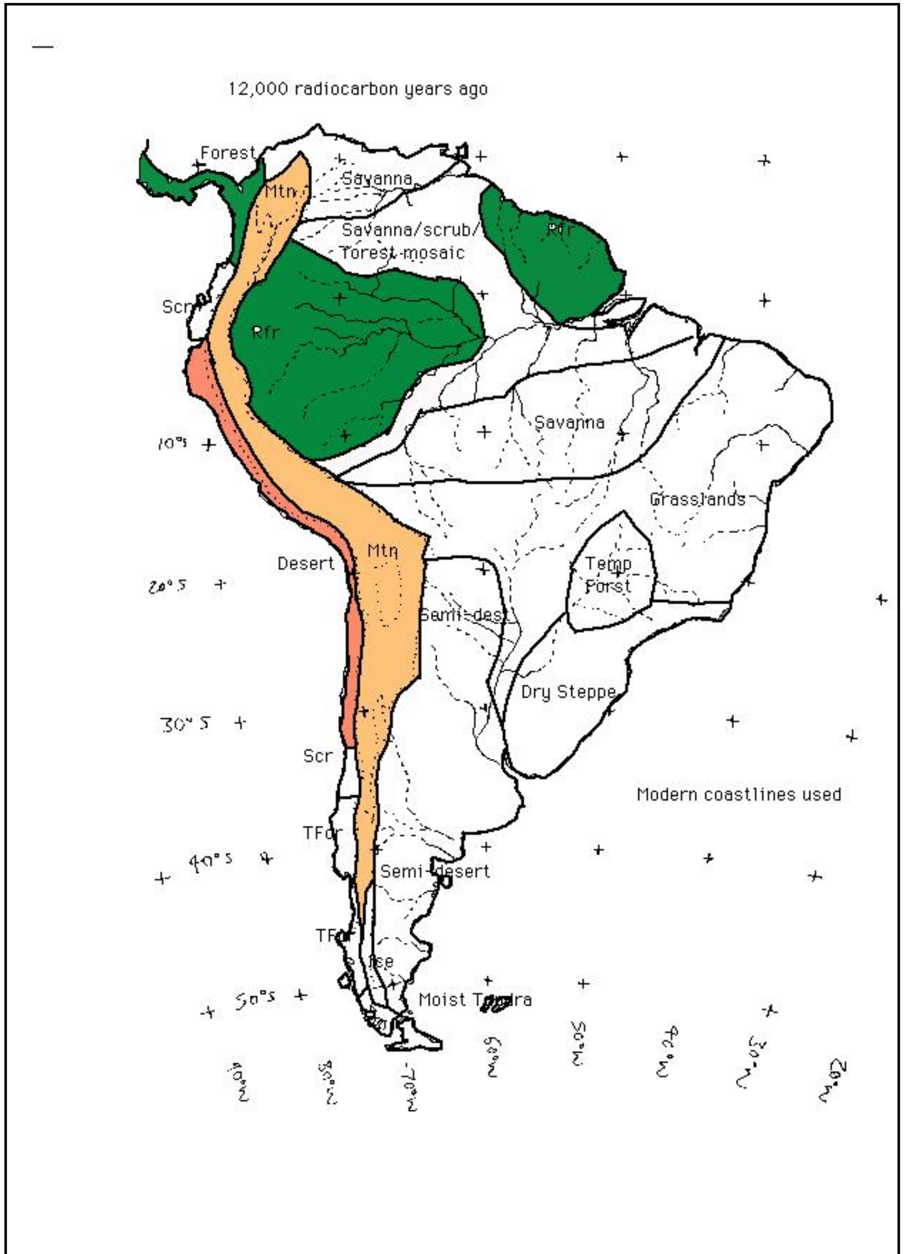


15 - South America (LGM, 18 ka BP) : environmental aridity

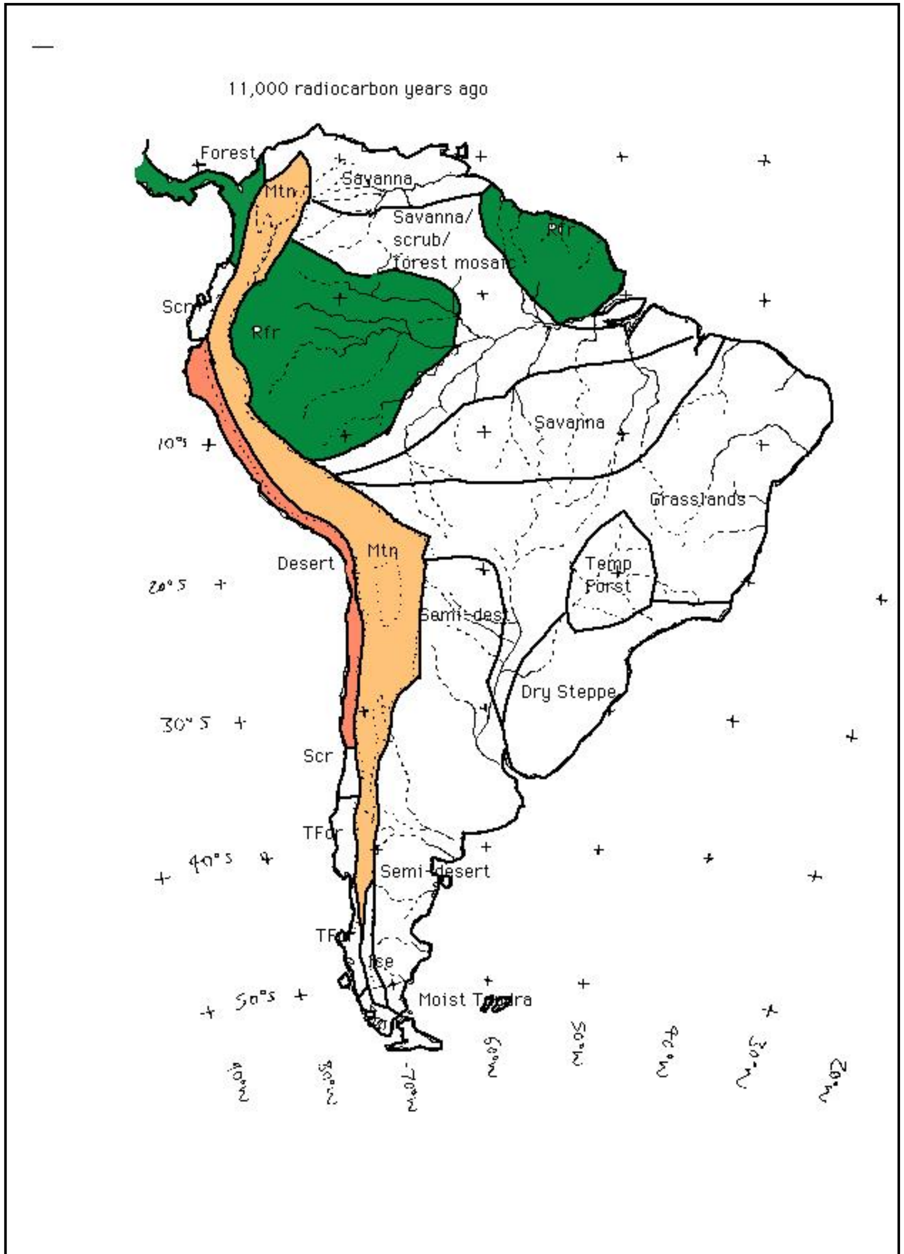


Reconstructed vegetation cover, 18000 C14 years ago.

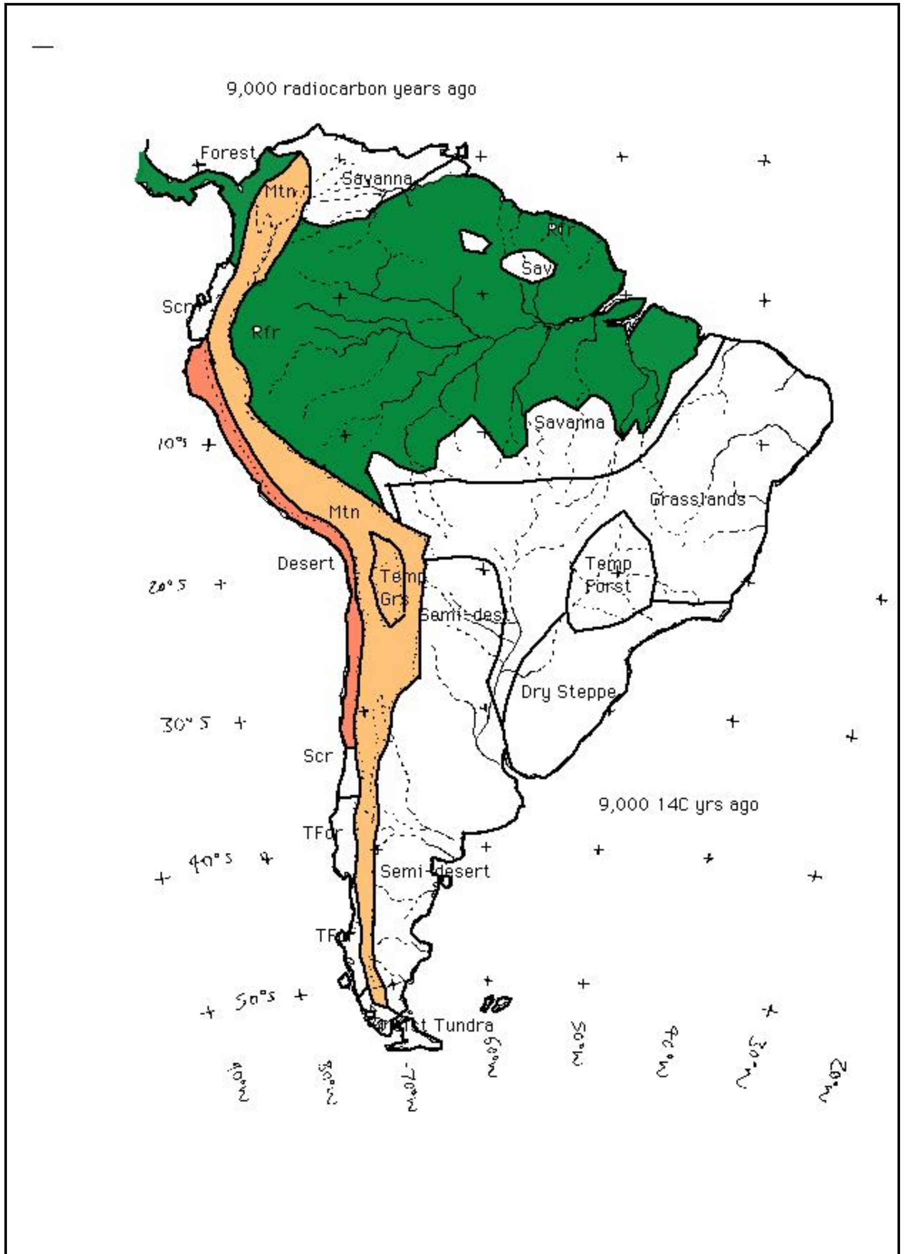
16 - South America (before 12 ka BP): minor environmental amelioration



17 - South America (Younger Dryas (12 ka BP): :environmental reversal



18 - South America (9.5-8.0 ka): Holocene climate optimum



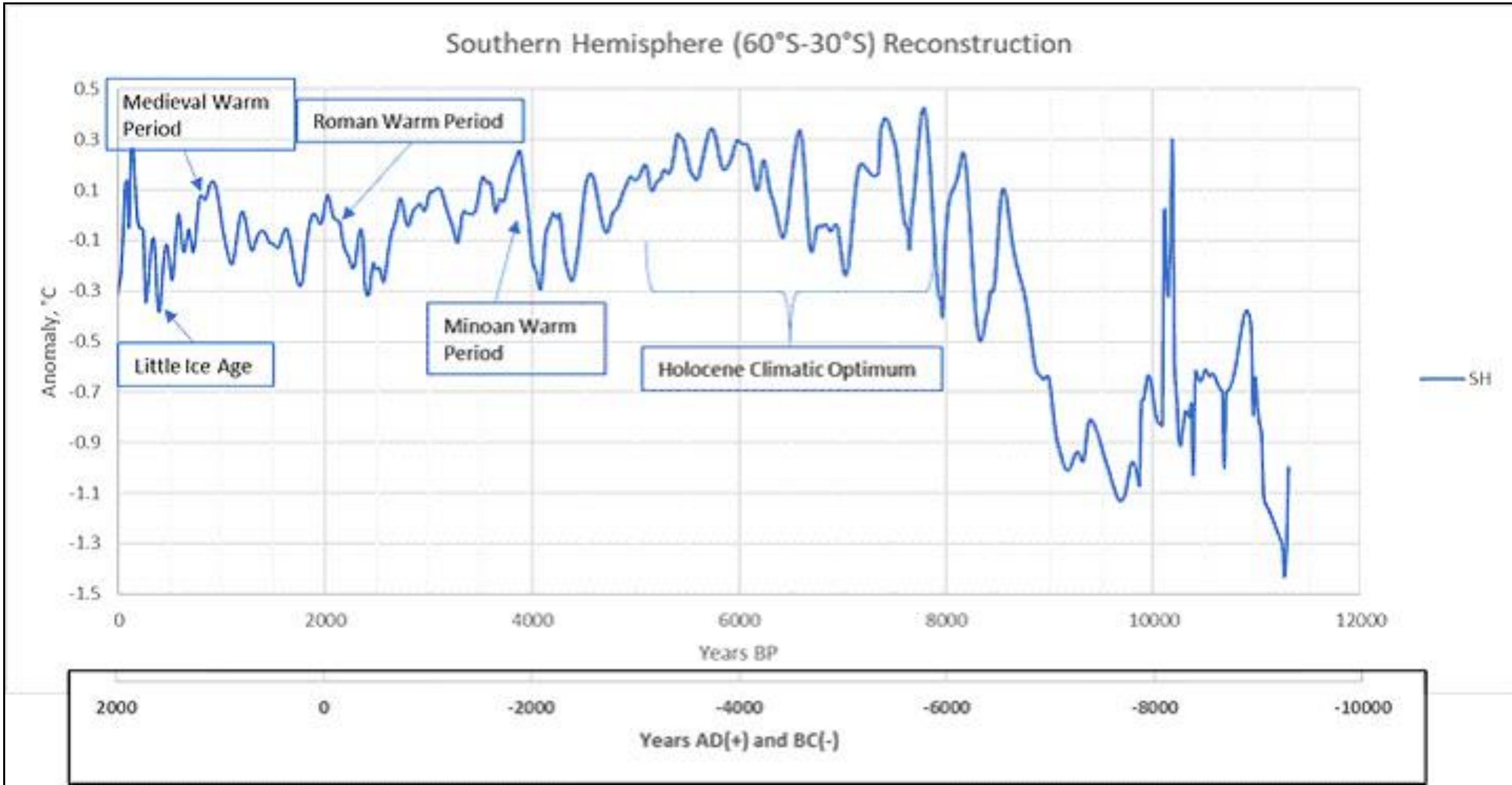
19 - South America (6 ka BP): : full recovery of vegetation

3 - Evolution of Temperature and Precipitation in the Peruvian region during the Holocene (10.3-0 BP)

3.1 – Temperature

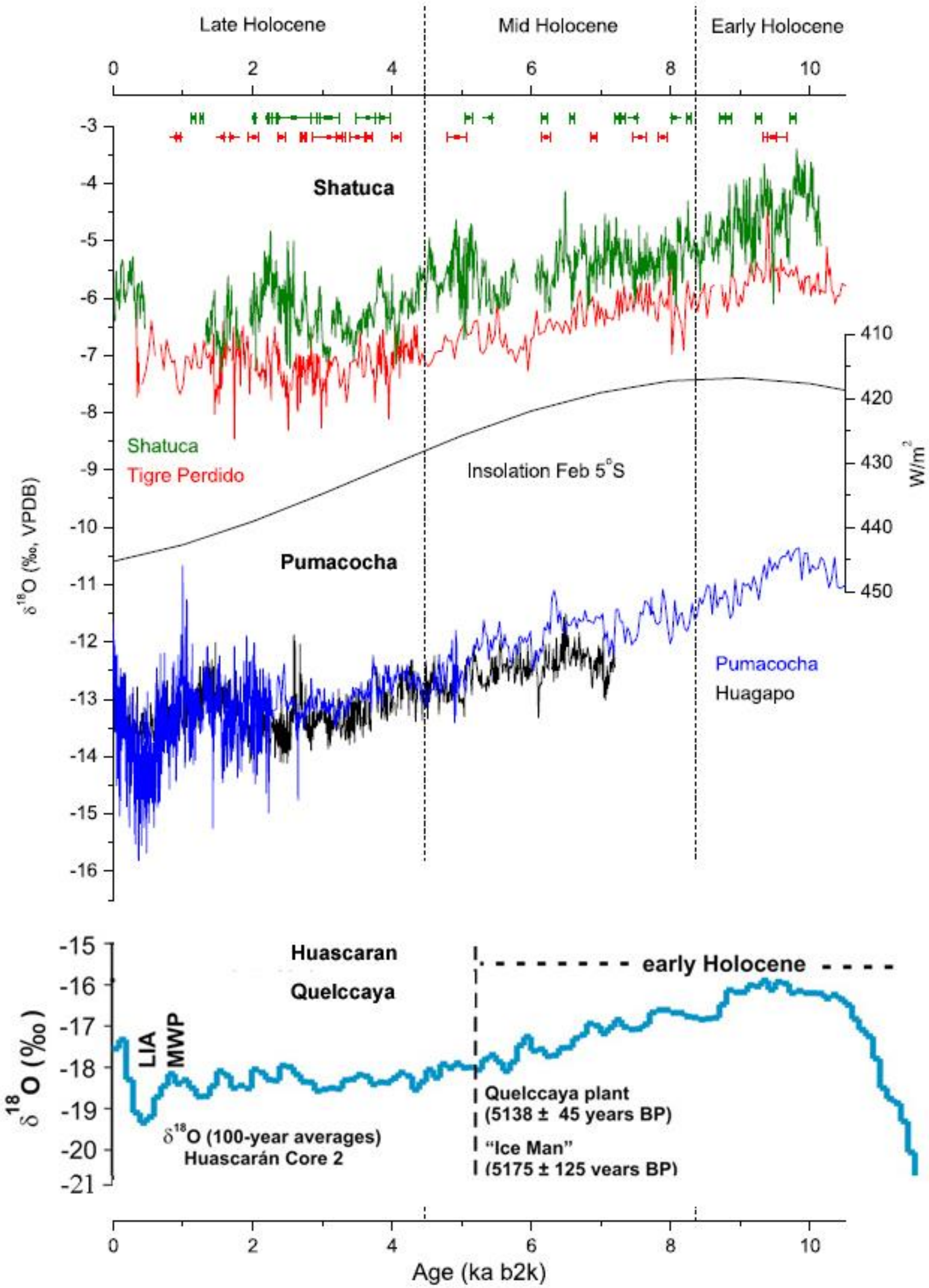
20 - Southern hemisphere: evolution of T (10-0 ka BP)

(climate optimum retarded to 7.8 ka BP, with 2.5 degrees less anomalies than in N-hemisphere)



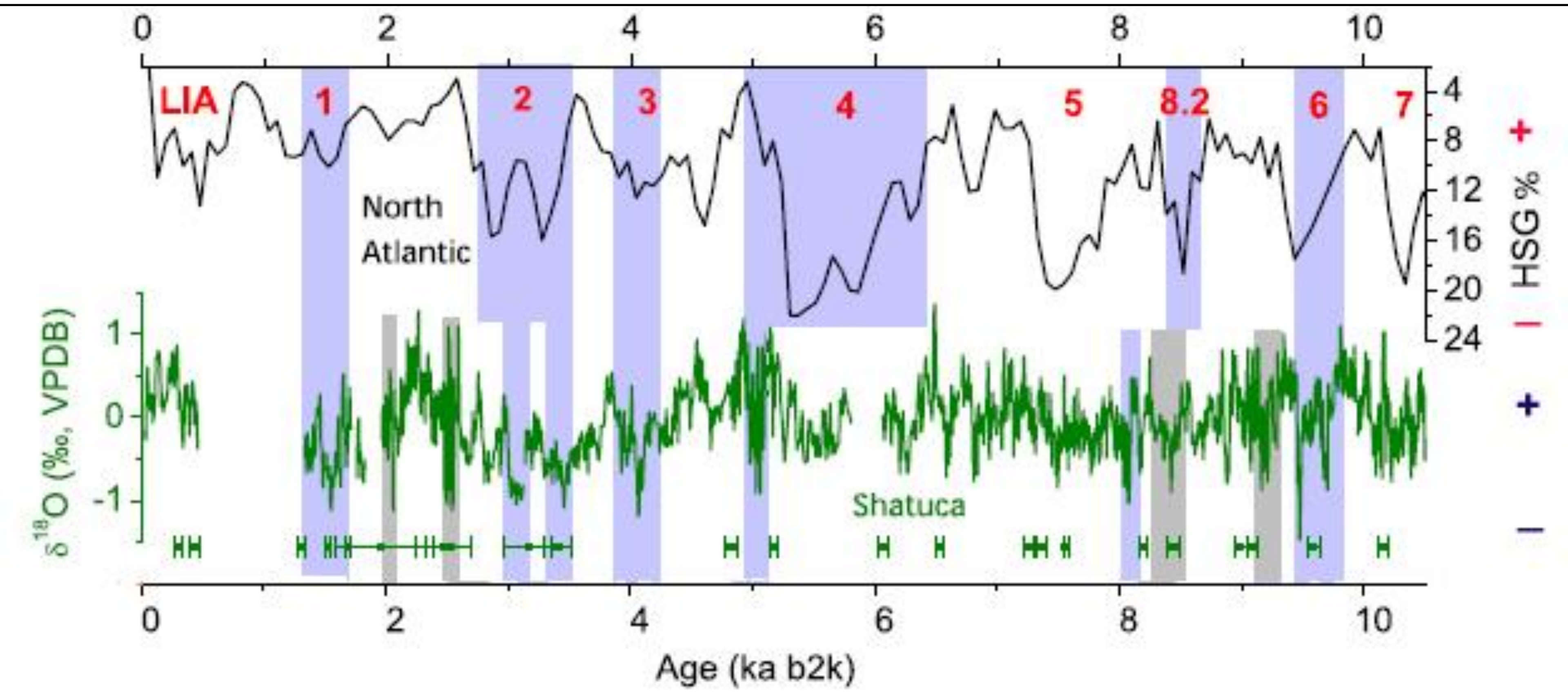
21 - Homogeneous d18O in four glaciers along the N, C, S part of the Andes

d18C increasing values point to ice depletion (warm phases); decreasing values to ice accumulation (cold phases).



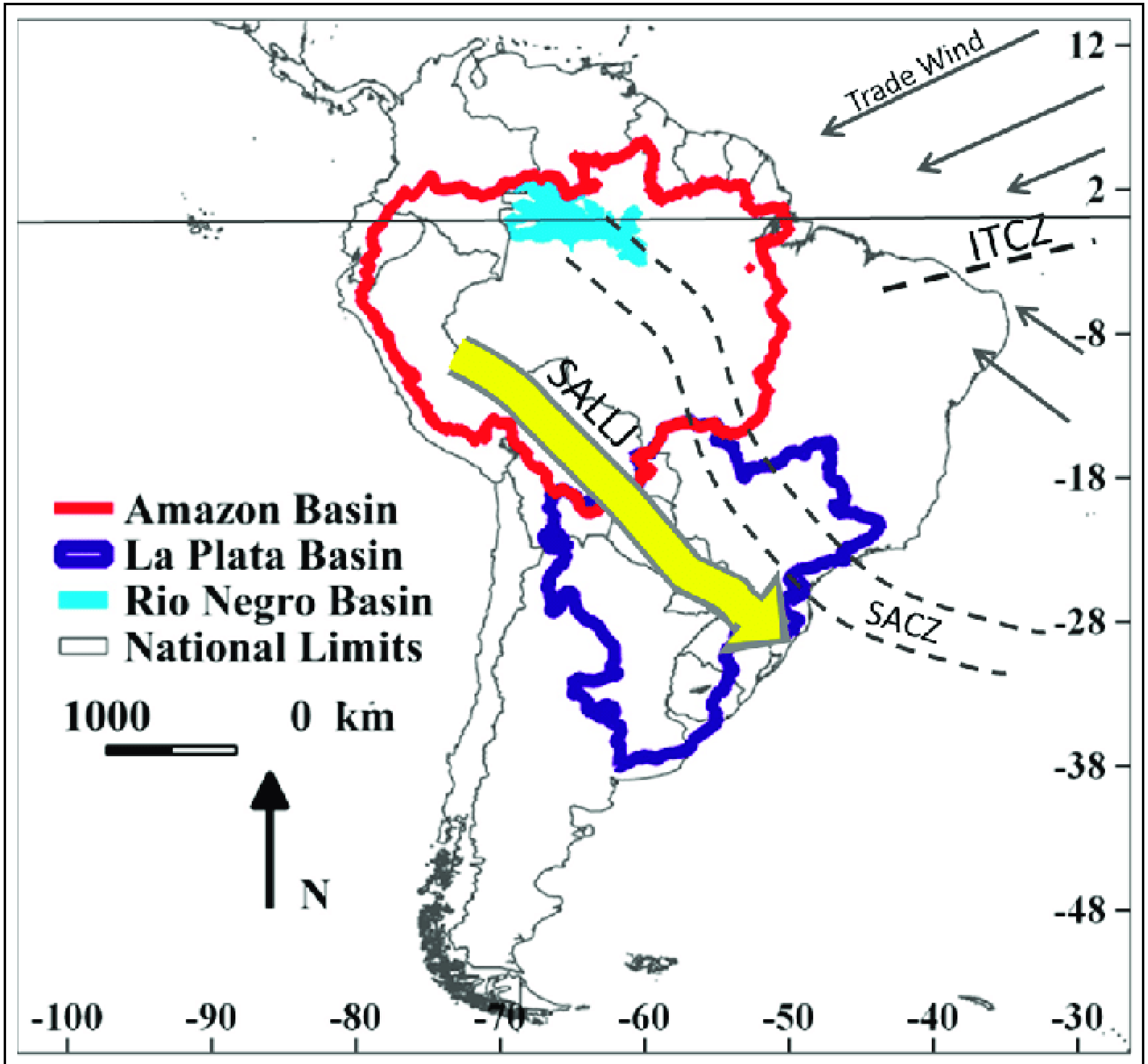
22 –Shatuca ice core (N-Andes) and Bond cycles

Warming T and ice depletion in antiphase with cold Bond events in N-Atlantic (graphic detrended of the trend of increasing insolation at the southern hemisphere).



23 - Southern America: scheme of atmospheric circulation patterns from the Atlantic ocean

Impact of the South Atlantic Convergence Zone (SACZ) and Southern American Low Level Jet (SALLJ)



24 - Walker cell atmospheric circulation under normal and ENSO (El-Nino) modes and thermoclines

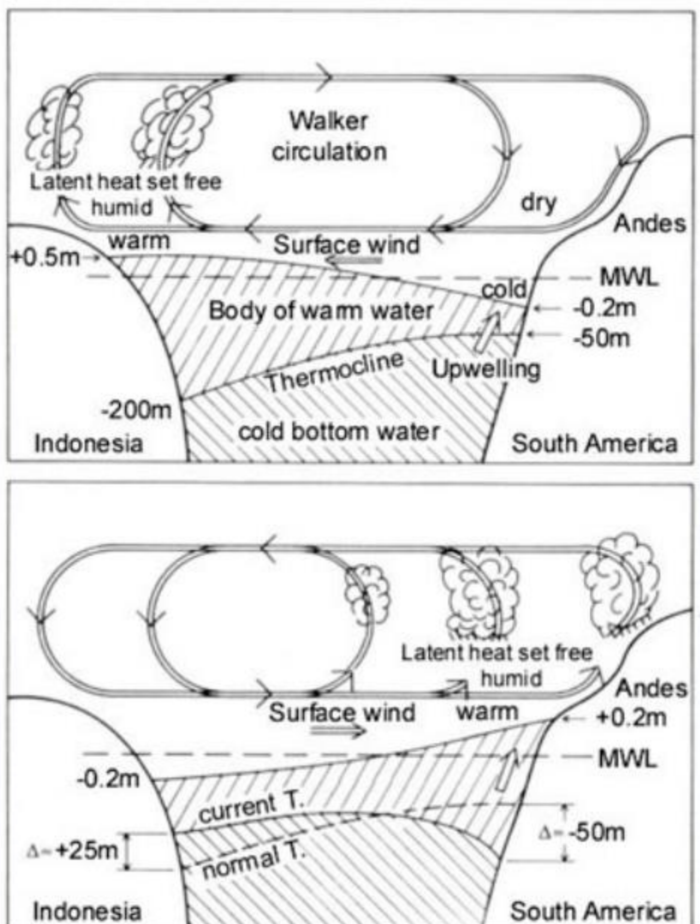


Fig.11 Idealized schematic diagram reflecting the ENSO Phenomenon. Normal non-ENSO conditions are shown above, while a the climax of a ENSO event is pictured below. In either cases both the slope of the sea level as well as the thermocline change considerably.

- When El Niño occurs, there is extensive rainfall on the Peruvian coast. Convective storms generate so much rain that flash flooding often occurs in the region.

25 - scheme of positive ENSO (El-Nino) mode

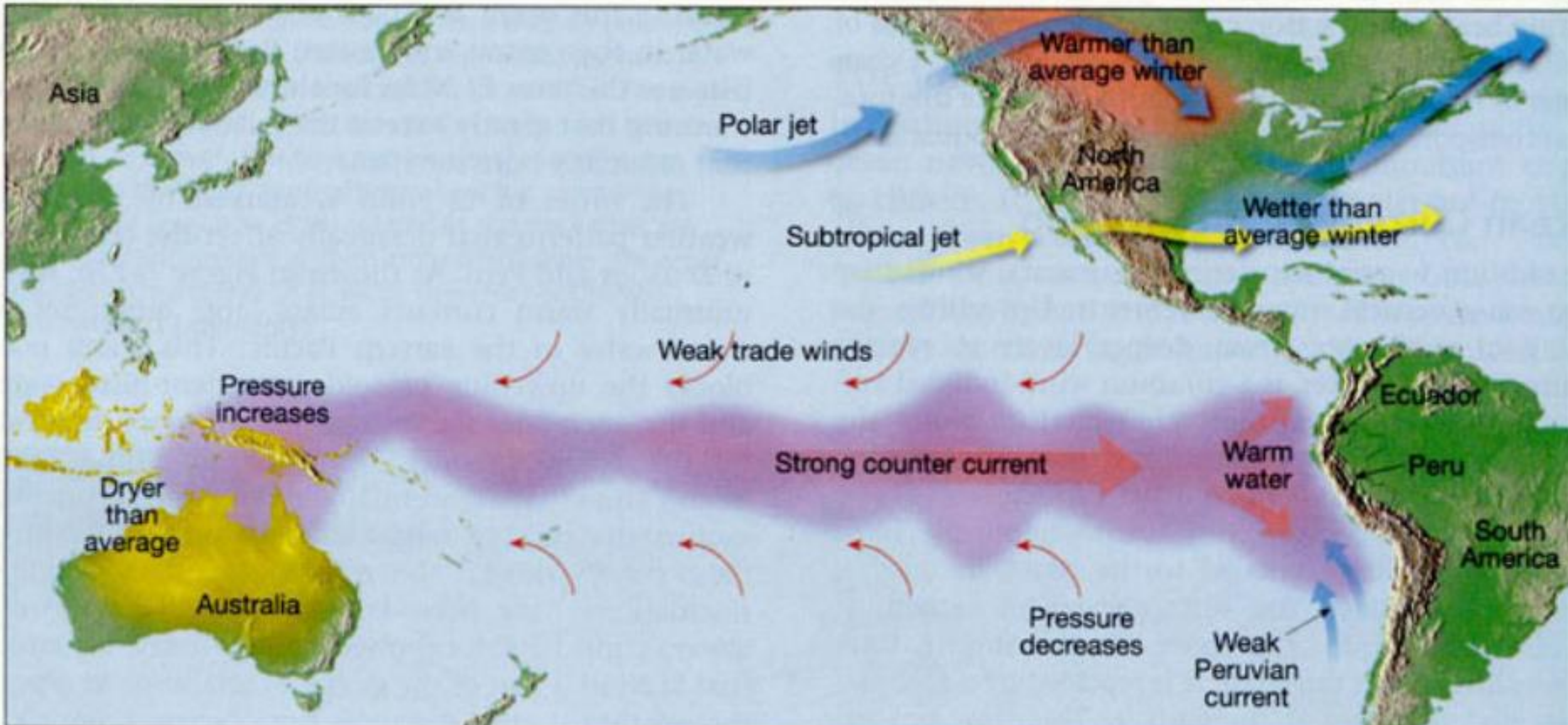
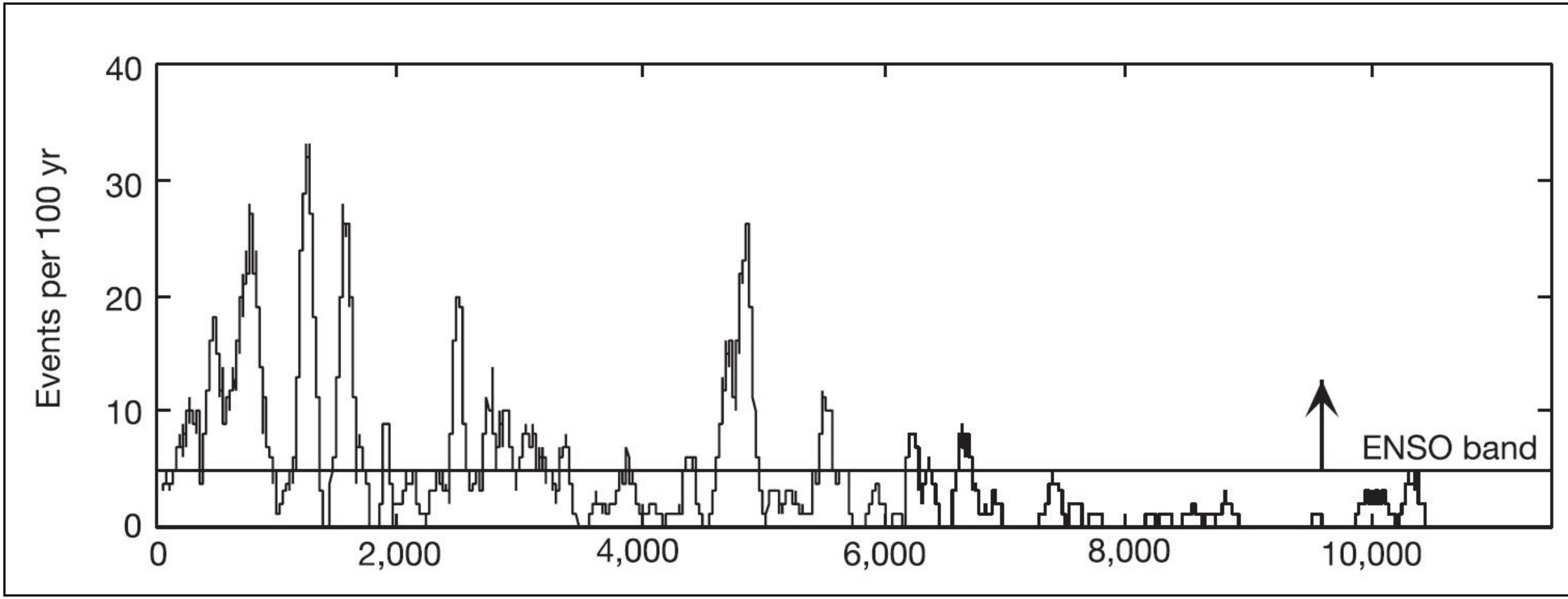
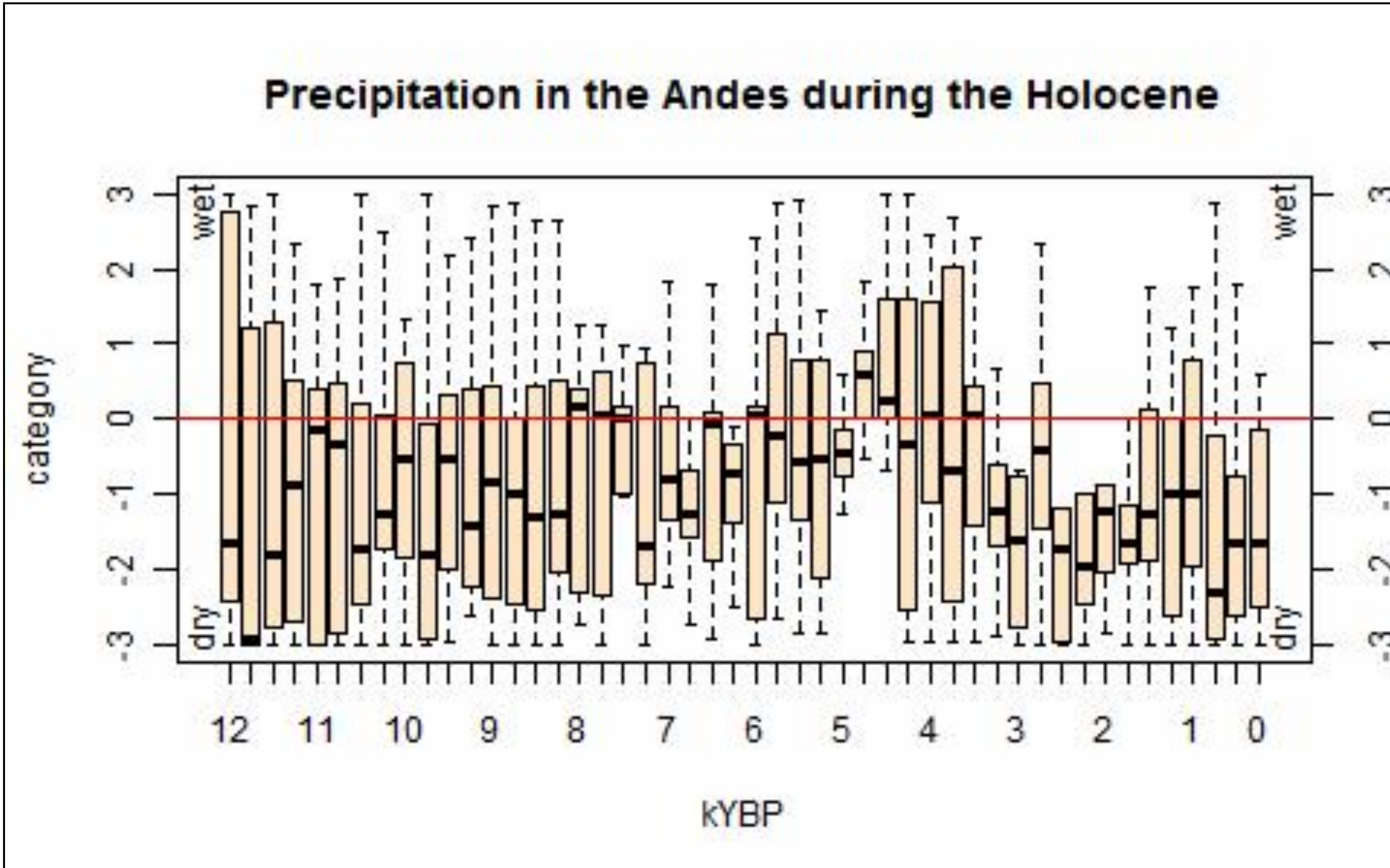


Fig.14 Upon the advent of an ENSO event, the pressure over the eastern and western Pacific flip-flops. This causes the trade winds to diminish, leading to an eastward movement of warm water along the equator. As a result, the surface waters of the central and eastern Pacific warm, with far-reaching consequences to weather patterns.

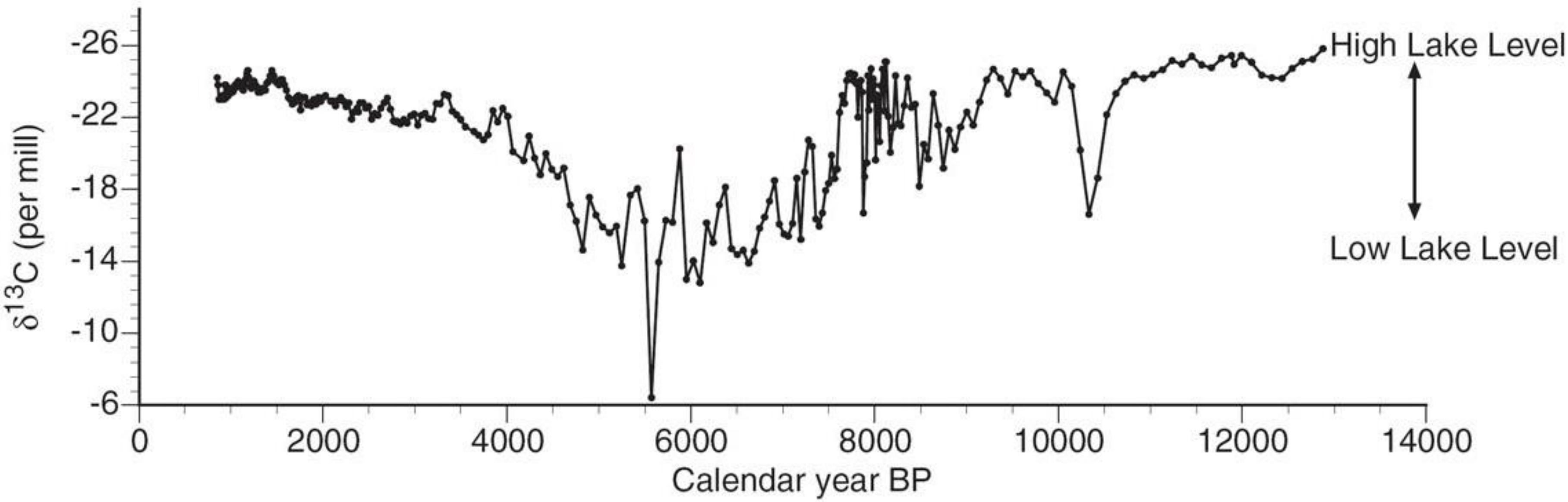
26 - evolution of frequency of El-Nino events (10-0 ka BP)



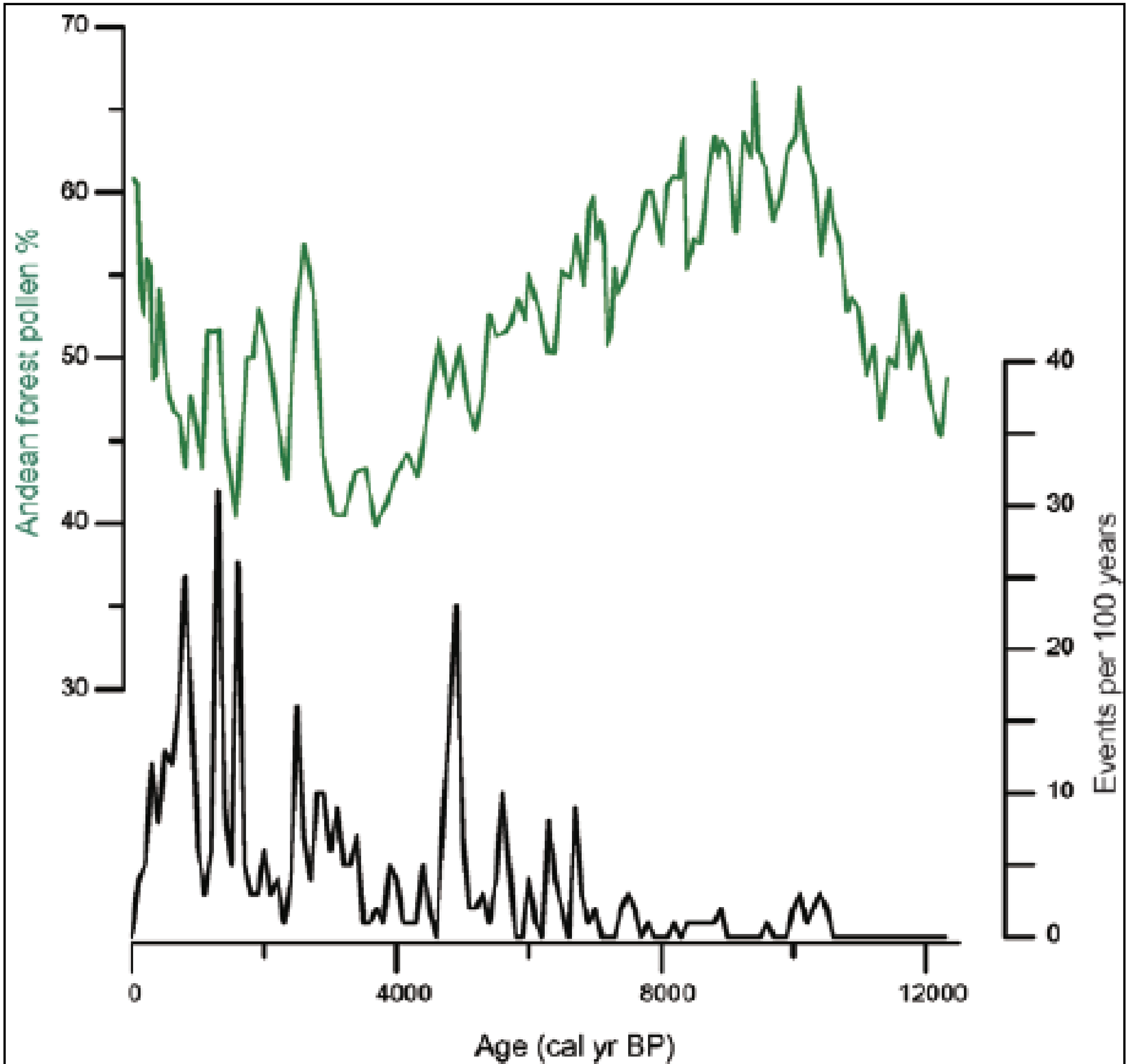
27 - Andes: evolution of P during 12-0 ka BP (Hammerly 2010)



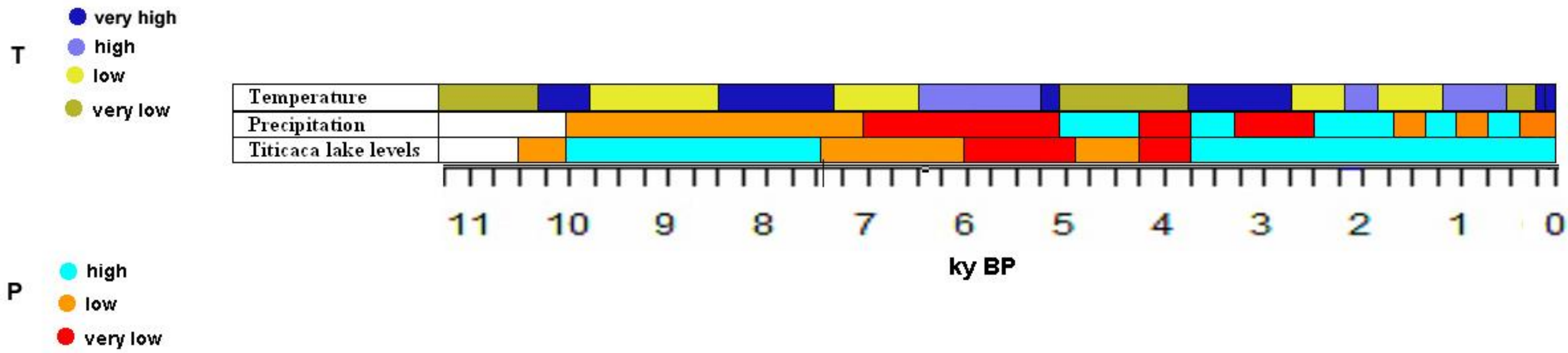
28 - evolution of water level of the Titicaca lake (14-1 ka)



29 - evolution of Andean forest pollen and El-Nino events (12-0 ka BP)



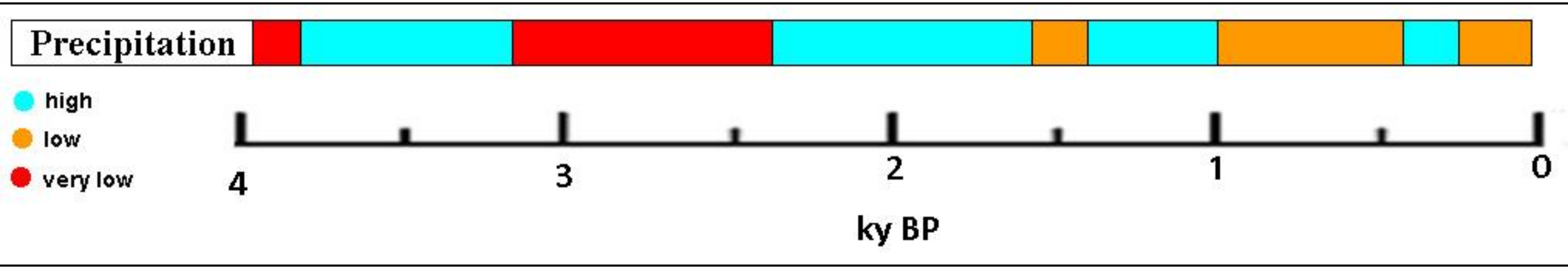
30 – Peruvian Andes: summary graphic of evolution of T, P and lake water levels (11-0 ka BP)



4 - Climate and cultures in Peru during the Ceramic period (3.9-0.5 ka BP)

31 – Evolution of Precipitation during the Ceramic period

(4.0-0 ka BP)



32 - Quelccaya ice cap: evolution of total particles (winds), conductivity, d18O and ice accumulation (1.7-0 ka BP)

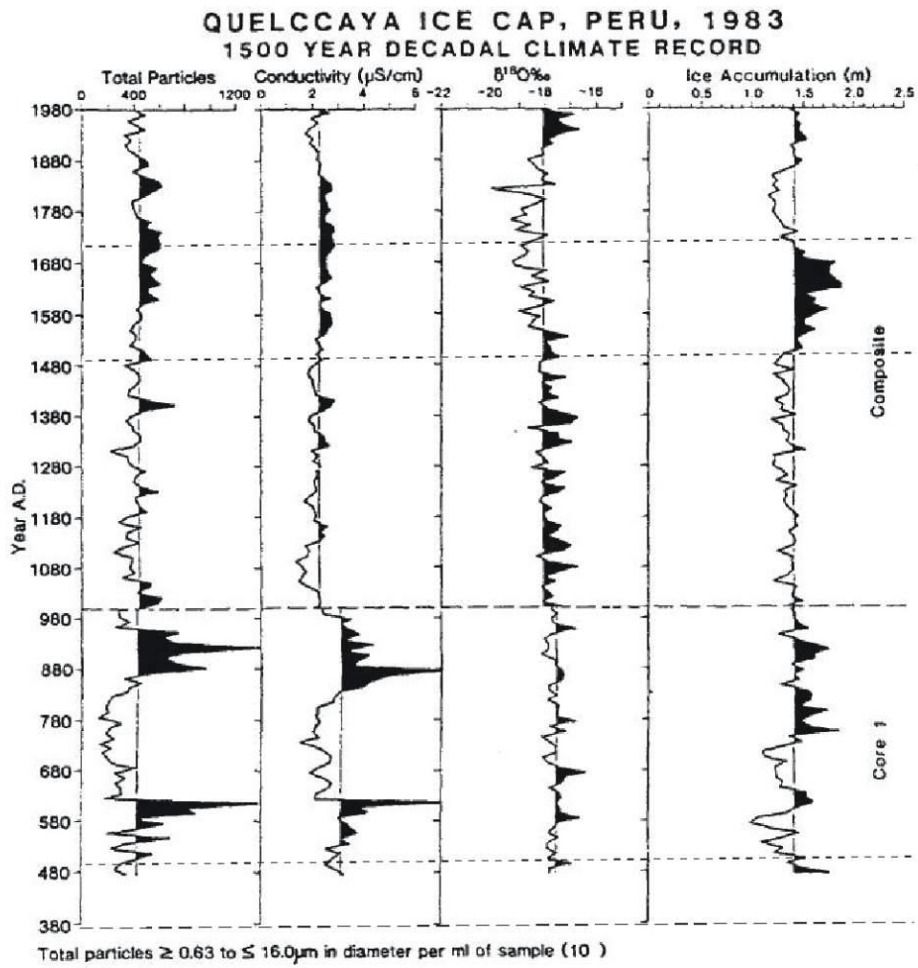
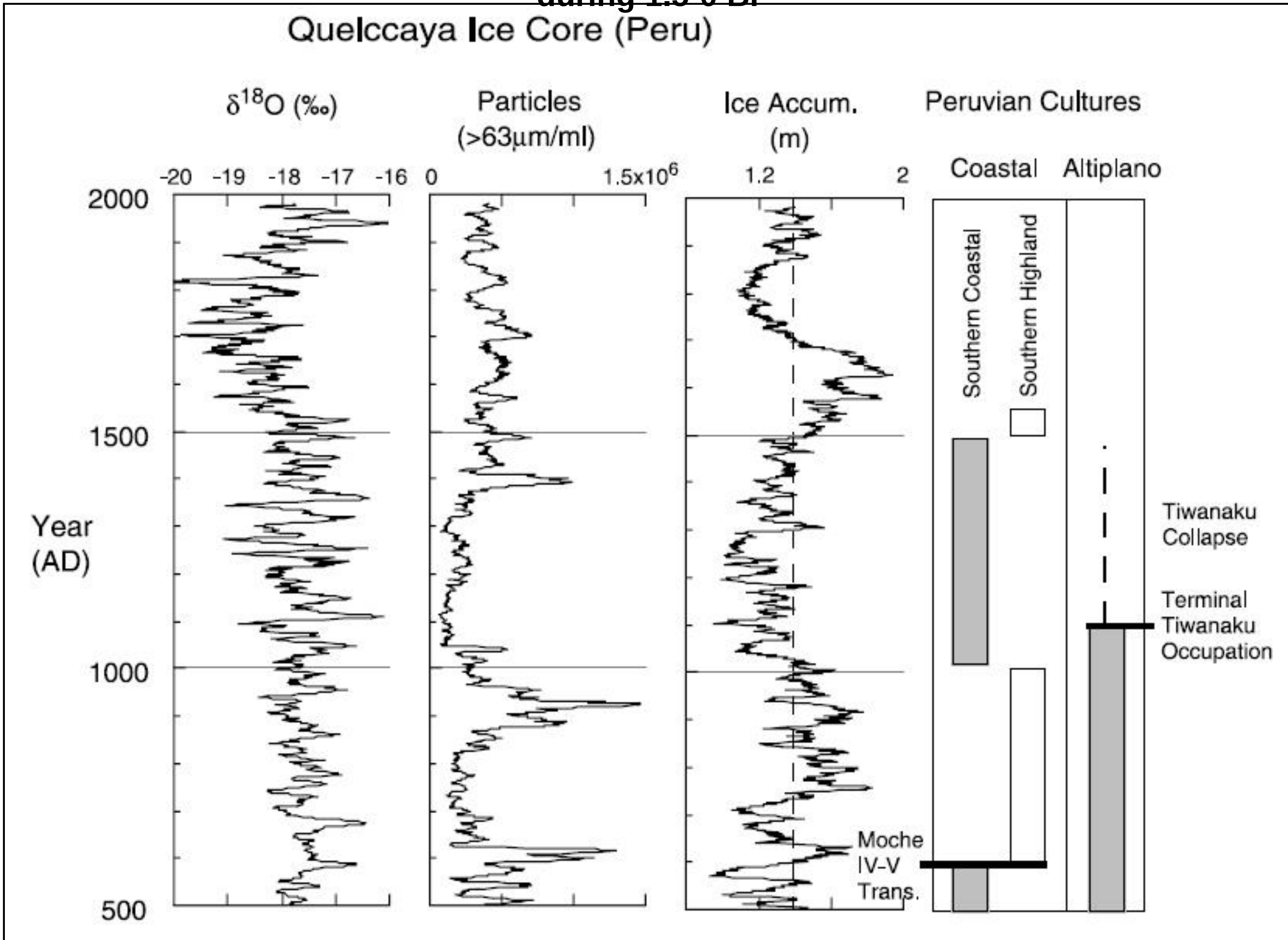


Fig. 2. Profiles of decadal averages from AD 470 to 1980 of total particles (≥ 0.63 to ≤16.0 µm in diameter per ml of sample × 10^3), conductivity, $\delta^{18}0$ and net accumulation (meters of ice equivalent). The dust events of AD 920 and 600 are dominant in the microparticle and conductivity profiles.

33 - evolution of Quelccaya ice cap, S and N coastal cultures and altiplano cultures during 1.5-0 BP



34 - evolution of Quelccaya ice cap, S highland cultures and S and N coastal cultures during 1.5-0 BP

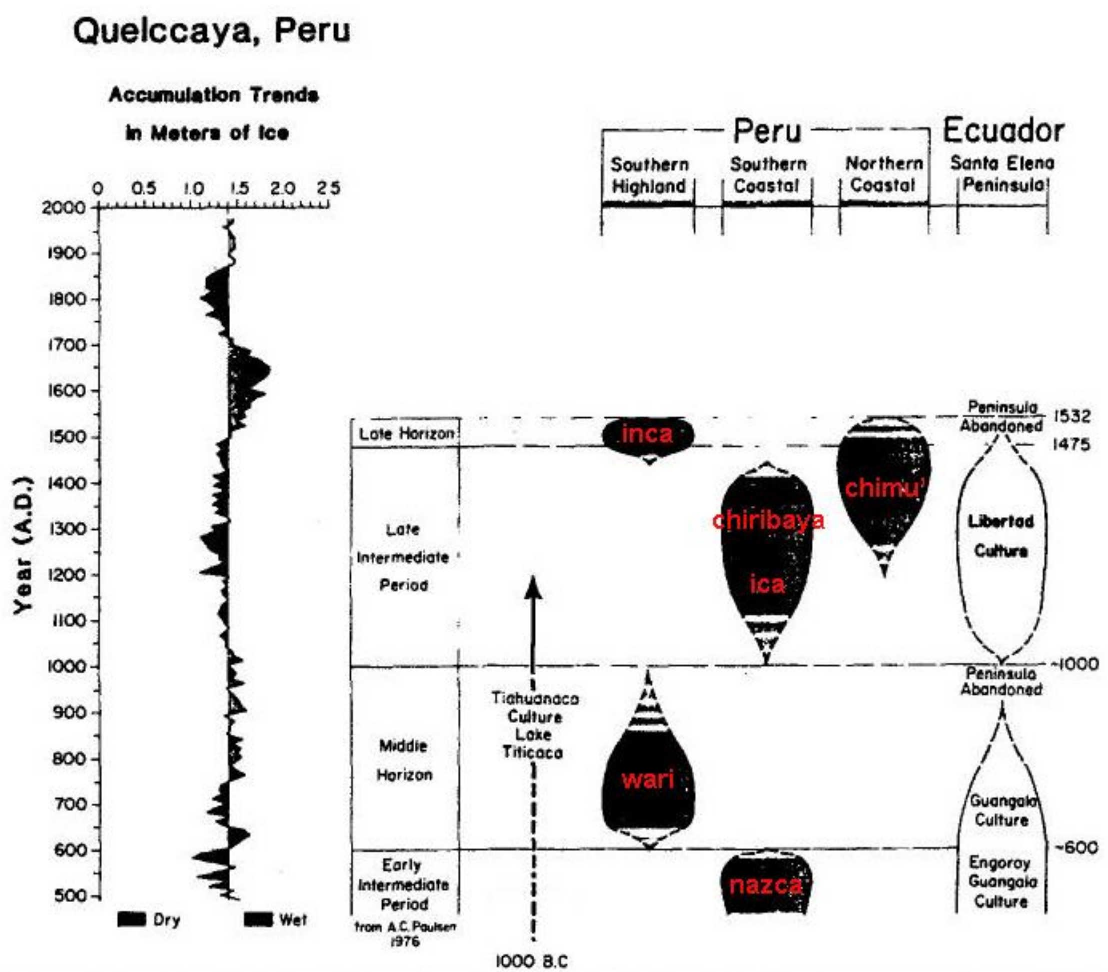


Fig. 3. Decadal accumulation trends in meters of ice presented as a composite of core 1 and summit core records. Wet and dry periods are indicated. On the right the periods of the rise and fall of coastal and highland cultures of Ecuador and Peru are indicated (taken mainly from Paulsen, 1976).

35 - Ica (Nazca): evolution of settlement patterns between 3.0-0.4 BP