Equilibrium Line Altitudes and paleotemperature reconstructions from Nevado Hualcán (9ºS) and Nevado Coropuna (15ºS), Tropical Andes (Peru).

J. Úbeda, C. Giráldez, and D. Palacios

Dep. AGR y Geografía Física. Universidad Complutense. Madrid. Spain.

We have reconstructed the Equilibrium Line Altitude (ELA) in seven valleys on the SW slope of Nevado Hualcán (9ºS, 77ºW; 6122 m asl) and on the SE slope of Nevado Coropuna (15ºS, 72ºW; 6377masl) using the Area x Altitude Balance Ratio method (Osmaston 2005). We have also deduced the paleotemperatures using the following equation: $\Delta T = ATLR \cdot \Delta ELA$; being ΔT (ºC) the paleotemperature depression; ATLR (ºC/m) the Atmospheric Temperature Lapse Rate; and ΔELA (m) the ELA depression. The ATLR for Coropuna was deduced through the use of data loggers. For Hualcán we used the value ATLR =0.0065ºC/m, valid for the tropics (Kaser and Osmaston, 2002).

We obtained the following results:
1) Hualcán: a) ELAs: 5124m (2003); 5018m (1962); 4994m during the Little Ice Age (LIA); and 4652m during the last studied maximum advance considered to be the Younger Dryas (YD, ∼13-11ka) by correlation with nearby mountains (Glasser et al., 2009). b) ΔELAs: 106m (1962); 130m (LIA); and 199m (YD). c) ΔT: -0.69ºC (1962); -0.85ºC (LIA); -3.07ºC (YD).
2) Coropuna: a) ELAs: 5862m (2007); 5853m (1986); 5787m (1955); 5776 (LIA); and 4951m in the 13-1136Cl ka phase (Ubeda, 2011). b) ΔELA: 9m (1986); 66m (1955); 86m (LIA); and 911m in 13-1136Cl ka. C) ΔT: -0.20ºC (1986); -0.71ºC (1955); and -7.65ºC (13-1136Cl ka).

The values ΔT during LIA in Hualcán and Coropuna (0.85 and 0.72ºC) are consistent with the global warming considered to be 0,74ºC between 1906 and 2005 (IPCC, 2007). During the mid XXth century and the LIA, ΔT is higher in Hualcán (0.69ºC and 0.85ºC) than in Coropuna (0.55ºC and 0.72ºC), with a regional gradient of -0.02ºC per degree of latitude (ºC/º). However, during the YD (13-1136Cl ka), ΔT was higher in Coropuna (7.65ºC) than in Hualcán (3.07ºC), with a gradient of 0.76ºC/º. Although other evidences exist of a pantropical cooling of >5ºC during the last glaciation, in Coropuna this cooling was strengthened by the retro-alimentation of its glacial system which in 13-1136Cl ka had a surface of >400 km2 (Ubeda, 2011).

Glasser, N.F., Clemmens, S., Schnabel, C., Fenton, C.R. and McHargue, L., 2009. Tropical glacier fluctuations in the Cordillera Blanca, Peru between 12.5 and 7.6 ka from cosmogenic 10Be dating. Quaternary Science Reviews, 28: 3448–3458.
IPCC, 2007: Climate Change 2007: Synthesis Report. Contribution of Working Groups I, II and III to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change [Core Writing Team, Pachauri, R.K and Reisinger, A. (eds.)]. IPCC, Geneva, Switzerland, 104 pp.
Kaser, G. and Osmaston, H., 2002. Tropical Glaciers. International Hydrology Series. Cambridge University Press, Cambridge (U.K.), 207 pp.
Osmaston, H., 2005. Estimates of glacier equilibrium line altitudes by the Area x Altitude, the Area x Altitude Balance Ratio and the Area x Altitude Balance Index methods and their validation. Quaternary International, 22–31: 138–139.
Úbeda, J., 2011. El impacto del cambio climático en los glaciares del complejo volcánico Nevado Coropuna (cordillera occidental de los Andes, Sur del Perú). PhD Thesis. Universidad Complutense de Madrid, (Spain), 558 pp. Available online: http://eprints.ucm.es/12076/