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# Soil thermal regime and geomorphogenesis at Fuentes Carrionas massif (Cantabrian Range, NW Iberian Peninsula).

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Fuentes Carrionas is a massif within the Cantabrian Range, in NW Iberian Peninsula. Its altitude ranges between 1400 and 2500 meters and its climate is an oceanic/Mediterranean transition one, with cold temperatures and heavy snowfall in the winter/early spring season, and a warm and dry summer season. Due to its outstanding altitude and lithological variety in the Cantabrian Range context, Fuentes Carrionas holds some periglacial activity (gelifluction, frost shattering) which is absent elsewhere in NW Iberian Peninsula. This work is relates the soil thermal regime across the mountain gradient to landforms formation.

14 thermometers (11 i-button, protected in a plastic can, and three UTL data loggers) were buried at a shallow depth (10 cm.) between autumn 2009 and summer 2012. 12 thermometers were placed between 1900 and 2400 m.a.s.l. at 250 meters altitude interval at the four main aspects. Two additional thermometers were place in the Curavacas N face for permafrost identification. Thermometers were calibrated to yield a measurement every 6 hours starting from 8 AM during one year's time. Data was collected annually in the summer season. Some additional soil temperature data was obtained from an external project in the same area for the 2007-2009 interval. In this case thermometers were "Hobbo" model, and they were also buried to a shallow depth.

Results show a permafrost free mountain range. Annual average soil temperatures range between 1 and 8 degrees Celsius. Snow pack appears as a decisive factor in winter temperatures, as the zero curtain effect can be tracked in many cases. Snow cover patterns show a distinctive behavior between S and N aspects, with a 3 months snow cover on the southern faces and between 6 and 9 at the northern analogues. This cover has a relevant impact on geomorphological processes. There is a clear relation between spring snow melt and solifluction or channelized erosion. Also, snow cover prevents the occurrence of freeze/thaw cycles. On western and southern aspects and flat high areas, where snow is wind-blown during the winter, freeze/thaw cycles amount up to 58 for one single year. As a consequence frost-shatter block surfaces develop here. Also, the effect of low temperatures and thin or no snow cover makes the temperatures to drop to -8 degrees Celsius on 10 cm. depth. This increases the thickness of the active layer, so a deeper solifluction occurs. If fine material is supplied by mudstones or shales disaggregation, solifluction lobes form. Northern faced slopes are out of this dynamics due to snow protection, but highest screes in this orientation show a thermal inversion due to "chimney effect".

By the use of shallow-buried thermometers we have been able to describe the thermal regime of a mountain area. The 1000 m. range between the lowest and the highest thermometers have permitted us to distinguish at least 4 different geo-ecological and geomorphological belts. Thermal conditions have been related to geomorphological processes and landform occurrence in the area. Further research on landforms activity or landform-vegetation interplay would be desirable.