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Mediterranean high mountain meteorology from continuous data obtained by a permanent meteorological station at Sierra Nevada, Spain

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One of the main sources of uncertainty in a meteorological or hydrological simulation concerns the lack of reliable meteorological data in mountainous regions. Especially if the hydrological processes related to snow play a leading role. All the meteorological variables exhibit non-linear variations with elevation (and topography) which are very difficult to relate consistently to the simplified expressions commonly used in their spatial and temporal interpolations. Long term series of high quality meteorological data are, therefore, the foundation for every study dealing with the meteorology of one particular region. Unfortunately, the installation and maintenance of meteorological stations at high mountainous sites are difficult tasks. Not only due to the adverse meteorological conditions, but also because these are scarcely inhabited places and difficult to reach. However, these regions play an essential role in the hydrology of a basin because of the positive gradients of precipitation with elevation and the presence of snow. In practice, they store a major part of the water resources and constitute a delayed supply to the surface flow by means of snow melting.

This is the case of Sierra Nevada Mountains, in Southern Spain. A mountain range parallel to the Mediterranean Sea, at a latitude of 37ºN that rises up to 3500 m.a.s.l. Precipitation on these mountains is very variable in space and time and is surrounded by low-precipitation regions, some of them even described as semiarid (<300 mm/year). It holds and retains a great amount of water as snow, later released in different melting cycles. Apart from the spring main cycle, several important melting cycles can be found during the winter. Thus, the influence of the mountainous meteorology over the hydrology is essential to temper two undesired characteristics of the Mediterranean climatology: torrential precipitations and long and intense summer droughts. The lack of accurate meteorological data for the whole Sierra Nevada area causes not only uncertainty about the real role played by this region over the hydrology, but even haziness about the real precipitation, temperature or relative humidity values and their variations, mainly based on limited measurements and assumptions up to now.

The Guadalfeo Project was a scientific study whose main objective was to advance in the scientific knowledge of the hydrological processes taking place in the Guadalfeo River Basin at Sierra Nevada Mountains. As part of the Project, the meteorological station of Refugio Poqueira was installed in November 2004 at 2500 m.a.s.l. Since then and up to now, 5-minutes data have been consistently recorded concerning precipitation, temperature, relative humidity, solar radiation, wind speed and direction, and downward longwave radiation. The precipitation reaches in this site a measured mean value of 750 mm/year, 60% of it as snow. The variability between years is outstanding, ranging from 467 mm/year to 1250 mm/year and from 40% to 70% of snow. The mean temperature is 6.4 ºC, falling to 1.4ºC during the winter months. The mean relative humidity of 50% is maintained during the winter as well. The collected data highlight some unique characteristics of high mountain regions in Mediterranean environments, where the snow is subjected to very a special combination of temperature, humidity and radiation. Thanks to this knowledge, we were able to develop, among other applications, a physically based snowmelt model that detected high rates of evaporation from the snow.