Geophysical Research Abstracts
Vol. 21, EGU2019-17114, 2019
EGU General Assembly 2019

Can we use time-lapse camera imagery to partition snowfall/rainfall? A pilot study in Sierra Nevada (Spain)

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An adequate partition between snow and rainfall events is key for both understanding and modelling not only the snowpack dynamics but also its hydrological impacts. This is particularly relevant in Mediterranean-like areas, where additionally to the highly variable regime a high spatial variability of precipitation occurrence can be found. A fixed temperature threshold is usually adopted as practical criteria in most models, but the temperature at which precipitation occurs as snowfall ranges within an interval that changes both locally and seasonality. The thermodynamic state of the atmosphere and the height at which precipitation generates are the major drivers for snowfall reaching the soil surface, but these are complicated to include in models that perform continuous simulations on a distributed basis. The use of disdrometers on-site adds valuable information to the standard weather stations in mountain areas; however, they are not usually available, especially in high altitudes.

This work shows a pilot study to assess the capability of time-lapse camera imagery to provide information to partition snowfall/rainfall in precipitation time series. The study was carried out in the experimental station Refugio Poqueira (PG2) in the Guadalfeo Monitoring Network, (Sierra Nevada, Spain, at 2500 m a.s.l.) where a 9-yr of time-lapse (2 hours) terrestrial pictures is available covering a 30x30 m scene coupled to an advanced weather station. The joint analysis of the pre-treated images and the weather variables time series regarding i) change of snow accumulation between successive images, ii) precipitation and temperature, and iii) wind and other drivers that may interfere with the accumulation rates resulted in a multivariate dataset of snowfall/rainfall events during the study period. This dataset was used to test different temperature thresholds that were fixed during different time scales (global, annual, seasonal, season and year). Two metrics were used to classify the approaches' performance: number of successful identification events, and the difference of snow amount (in terms of SWE) modelled over the sampling period; the results obtained with a fixed threshold of 0ºC was used as a baseline.

Among other results, the choice of a fixed threshold for every year and season showed the best performance when compared to the baseline, and improved a 12% the representation of snowfall amount with annual errors ranging between -75 mm and 4 mm depending on the year in the 9-yr period under study.

The use of time-lapse camera imagery constitutes a low cost method to improve rainfall/snowfall partition in remote areas when combined with high frequency weather monitoring stations. Limitations of this approach are the lack of images during nighttime, and the potential misidentification of the images in which accumulation is the result of other processes (i.e. wind advection). However, the results constitute a promising step to improve both monitoring and modelling of this partition.