EGU22-12490
https://doi.org/10.5194/egusphere-egu22-12490
EGU General Assembly 2022

Exploring the potential of cosmic muon scattering to measure the snow water equivalent

Aitor Orio[1], Esteban Alonso[2], Pablo Martínez[3], Carlos Díez[1], and Pablo Gómez[1]
[1]Muon Tomography Systems S.L, Barakaldo, Spain
[2]Instituto Pirenaico de Ecología (IPE) - CSIC, Zaragoza, Spain
[3]Instituto de Física de Cantabria (IFCA) - Universidad de Cantabria - CSIC, Santander, Spain

The seasonal snowpack influences the hydrology, ecology and economy of the areas where it is present. However, the real time monitoring of the seasonal snowpack is a still well known scientific challenge. In this study, we have explored the potential of *muon scattering radiography* (MSR) to infer the *snow water equivalent* (SWE) of the snowpack. We have used the energy and mass balance model Snowpack to realistically simulate the time evolution and microstructure of the snowpack. The ERA5-Land reanalysis was used as forcing of Snowpack, in a location close to the Monte Perdido massif (Central, Pyrenees) at an elevation of 2041m above sea level. The simulations cover the hydrologic year 2015/2016, approximately reaching up to 700mm of peak SWE. Then, we have coupled the Snowpack numerical simulations with the Geant4 model to simulate the propagation of the muons through the snow layers and to collect the deviation of the muon trajectories. We have measured these deviations with a virtual muon detector based in multiwire proportional chambers, replicating a real detection system designed by us. The obtained distributions of muon deviations have exhibited a strong correlation with the simulated SWE, showing a coefficient of determination of 0.99. This model presents a *root-mean-square error* (RMSE) of 23.9mm in the SWE estimation. In order to validate the simulation analysis results, we have replicated the numerical experiments under controlled conditions, measuring three artificial snow samples ranging from 0 to 200 mm of SWE in our laboratory. We have measured the samples with an experimental setup composed of the real muon detector whose hardware was virtually replicated for the numerical experiments. Then, we have applied the model derived from the numerical simulations to the muon deviations measured in our laboratory. We have calibrated the real measurements and we have obtained a RMSE of 38.4mm in the SWE estimation. These results show that MSR is a promising non-destructive technique that can be used for the deployment of accurate SWE monitoring networks and can eventually provide information from the internal layered structure of the snowpack.