EGU2020-9194
https://doi.org/10.5194/egusphere-egu2020-9194
EGU General Assembly 2020

Study of seasonal and short-term temperature variations in the middle atmosphere using cosmic muons

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In the last decades, large particle-physics experiments have shown that muon rate variations detected in underground laboratories are sensitive to regional, middle-atmosphere temperature variations. Therefore, muon measurements may be used to study middle-atmosphere dynamics, including short-term phenomena such as Sudden Stratospheric Warmings. In this work we use a portable muon detector conceived for geosciences applications. We study seasonal and short-term variations in the middle-atmosphere's temperature by analyzing a year of continuous muon measurements at the Mont Terri underground rock laboratory. This site is located in the Jura Mountains in north-western Switzerland, at a depth of ~300 meters below the Earth's surface. We observe a direct correlation between middle□atmosphere seasonal temperature variations and muon rate. Muon rate variations are also sensitive to the abnormal atmosphere heating in January-February 2017, associated to a major Sudden Stratospheric Warming that in a few days increased the zonal mean temperature in the polar region by more than 20 K. We estimate the effective temperature coefficient for our particular case and found that it agrees with theoretical models and with those calculated from large neutrino experiments under comparable conditions. Finally, we discuss the implications of our observations for the Atmospheric Sciences community.