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PACKMAN - PORTABLE INSTRUMENT TO STUDY SPACE WEATHER

Abstract

The Earth's atmosphere is continuously bombarded by energetic charged particles from space. To date, there is a missing gap of information regarding the amount, energy, time variability, and type of space radiation that reaches the lower layers of the atmosphere, as well as on its geographic and altitude distribution and the implications on infrastructures and climate. To generate a long-time, multiple-site, open-access record of space radiation on Earth we designed an open source, autonomous instrument, called PACKMAN (PArticle Counter k-index Magnetic ANomaly), with Commercial Off-The-Shelf (COTS) components.

PACKMAN is a robust and light scalable instrument that monitors gamma, beta, alpha radiation and muons and includes environmental sensors to monitor pressure, temperature, relative humidity, and magnetic perturbations. PACKMAN has demonstrated its operability at different latitudes and atmospheric heights (in balloons). As of today, several PACKMAN units have been installed and have operated already at multiple latitudes: 1) Space campus LTU, Kiruna, Sweden (67.84N, 20.41E, 390 m); 2) LTU Main campus, Luleå, Sweden (65.62N, 22.14E, 15 m); 3) University of Edinburgh, United Kingdom (55.94N, 3.19W, 98 m); 4) Boulby Mine, United Kingdom (54.56N, 0.82W, 93 m and -1.1 km). Finally, two PACKMAN units have been flown in balloons to the stratosphere: 5) Cordoba airport, Cordoba, Spain (37.84N, 4.84W, 90 m to 27 km); 6) Esrange Space Center, Sweden (67.88N, 21.12E, 328 m to 27 km). In this work, we present the design and operation of these instruments, and summarize the main scientific discoveries. The data are compared to various ground based and orbiter instruments such as the Geostationary Operational Environmental Satellite (GOES).

The observations acquired by PACKMAN will be used to provide open access, real time information, for: 1) education and public awareness of space weather phenomena; 2) to compare with Earth climate observations; 3) to provide real-time information of space weather variability for potential damage to infrastructures (telecommunications, power generation facilities, aviation, transport, etc.); 4) to monitor natural radiation sources at multiple environments; 5) to monitor the variability of the Pfotzer maximum height during different stages of solar activity and seasons and 6) finally, this project may serve as a reference for future scalable networks where multiple instruments are deployed at different sites or conditions and with different initiation times, and where the informational value increases by adhering to a common PDS4 format and analysing the data in a concurrent way.

Keywords: Space weather; Radiation; Stratosphere; Magnetic Anomaly; Earth observation; COTS