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Correlation of solar activity and solar wind structures with geomagnetic, ionospheric and cosmic-ray ground-data from Iberian Peninsula and Canary Islands Observatories

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It is well known that traveling solar wind structures like interplanetary shocks, magnetic clouds, interaction regions, etc., strongly affect the magnetosphere and the ionosphere when they arrive to the Earth, causing perturbations in the geomagnetic field and the ionospheric electron content and distribution that can be measured by ground level stations. At the same time, certain solar wind structures, mainly magnetic clouds, may produce also measurable decreases in the arrival rate of galactic cosmic rays to the ground (Forbush decreases). Both effects have their ultimate cause in solar activity, but they seem to respond differently to different solar wind structures. In this work we present combined data of geomagnetic field, ionospheric total electron content and cosmic ray arrival rate during events caused by solar activity, obtained by six ground stations in the Iberian Peninsula (southwestern Europe) and the Canary Islands (northwestern Africa). These stations are: Ebro Geomagnetic and Ionospheric Observatory (northeastern Spain); San Pablo Geomagnetic Observatory (central Spain); San Fernando Geomagnetic Observatory (southern Spain); Coimbra Geomagnetic Observatory (central Portugal); Güímar Geomagnetic Observatory (Canary Islands, Spain); and CaLMa neutron monitor (central Spain). The dataset presented gathers all the main cosmic ray and geomagnetic/ionospheric events since January 2012. We compare these ground data with solar wind structures derived from solar wind satellite data and we analyze them looking for systematic differences and/or similarities in the response of cosmic rays and geomagnetic/ionospheric effects. We present also the results of Principal Component Analysis applied to ionospheric and geomagnetic variations during the studied events, showing the main variation modes, both "quiet" and "perturbed", that in combination can explain the observed temporal behavior.