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Coupled ionospheric and telluric electromagnetic fields – seismotectonic relevance

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Statistical analysis of the frequency of earthquakes in major seismogenic regions of the world indicates a systematic diurnal and seasonal dependence (e.g. Conrad, 1932; Duma, 1996; Duma & Ruzhin, 2002; Lipovics, 2005; Schekotov et al., 2005; Rabeh 2010). Only the sun can create such patterns. Essential information is provided by data collected routinely at geomagnetic observatories: the regular sun-induced daily and seasonal magnetic variations, recorded around the globe, correlate with high significance with the regional diurnal and seasonal cycles of seismic activity (Duma & Freund, 2008). The approximate 11 year sunspot cycle is reflected in the seismic activity associated with, for instance, the Vesuvius volcanic edifice (e.g. Duma & Vilardo, 1998). Examples from seismic and magnetic observations will be presented. The coupling is provided by the interaction of the lithosphere with the ionospheric dayside and nightside electric current vortices, which are driven by the influx of ionizing solar radiation. Obviously, we are faced here with an important solar-terrestrial coupling that affects the seismotectonic activity.

To gain insight into this remarkable solar-terrestrial correlation we compare the energy released by earthquakes over large seismically active regions with Kp, a parameter that characterises the planetary magnetic field disturbations caused by the solar particle radiation and its effect on the ionosphere. Kp indices have been continuously published by ISGI, France, since 1932.

A highly significant correlation exists between Kp and the annual seismic energy release at latitudes between 35° and 60° N. For the period 1974-2009 the Kp cycles follow the sunspot cycles, but with a delay of about three years, while the seismicity closely follows Kp. Three regions of continental size (North America, South America, Eurasia) were investigated, using the USGS (PDE) earthquake catalogue. In all three regions, the strongest earthquakes with M6, M7 and M8 occur during Kp maxima.

Several models have been tested to interpret the coupling between the solar induced geomagnetic variations and the Earth's lithosphere. Three types of interactions will be presented.

Ground based magnetic recording and satellite data on ionospheric parameters such as TEC (Total Electron Content) as well as satellite monitoring of TIR (Thermal Infrared) anomalies on the ground may provide crucial information aimed at a near-real time earthquake hazard assessment.