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New results on the solar impact on global seismicity

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Seismicity in the Earth's crust exhibits a remarkable and systematic diurnal and seasonal dependence (e.g. Conrad, 1932; Duma & Vilardo, 1998; Duma & Ruzhin, 2002; Lipovics, 2005; Schekotov et al., 2005). Since such a correlation can only be caused by the sun's activity, we are obviously faced here with a powerful solar-terrestrial coupling mechanism. This is confirmed by reports, which indicate that the earthquake activity varies in the same 11 yr cycle as in the sunspots, too.

In particular the regular solar-induced daily and seasonal magnetic variations, recorded at geomagnetic observatories, correlate with high significance with the regional diurnal and seasonal cycles of seismic activity (Duma & Freund, 2008; Rabeh, 2010). This points to a strong electromagnetic interaction affecting the seismogenic zones in the Earth's lithosphere.

To study the solar impact on seismicity more closely we compare the magnetic index Kp with the seismic energy released over wide seismically active regions. Kp characterises the planetary magnetic field disturbances, mainly caused by solar particle radiation, the solar wind. Kp indices, given as 3-hr averages, have been continuously published by ISGI, France, since 1932.

Our study covers three regions of continental size, using the USGS (PDE) earthquake catalogue. For latitudes between 35° and 60° N a highly significant correlation was found to exist between Kp and the annual seismic energy release. For the period 1974-2009 the Kp cycles follow the 10-11 year sunspot cycles, but with a delay of about 3 years, and the seismicity closely follows the Kp cycles.

As to the North American continent, the total amount of seismic energy released per year changes with Kp by a factor up to 100. For instance, during years of high Kp there were up to one M7, four M6 and thirty M5 events/yr compared to only about ten M5 events in years with the lowest Kp. For the South American continent the seismicity also clearly follows the Kp cycles but the number of events during Kp maxima are about twice as high as than for North America. The same holds true for the entire Eurasian continent. In all regions, the strongest events M6, M7 and M8 appear to occur mainly during Kp maxima.

Three possible triggering mechanisms have been considered to address the coupling between the solar-induced geomagnetic variations and mechanical forces acting on the lithosphere: (1) Lorentz forces, (2) magnetostriction, (3) the Einstein-De Haas effect.

We propose that these are geodynamic processes, which are generally valid and applicable to nearly all main seismically active regions on the globe. The results presented here add a novel aspect to the probability of strong earthquake occurrence and their hazard assessment.