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# Seismo electro-magnetic parameter study of sub-ionospheric VLF radio links in Europe

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In the course of the European VLF/LF radio receiver network (INFREP), radio signals in the frequency range from 10-50 kilohertz are received, continuously recorded (temporal resolution 20 seconds) and analyzed in Graz/Austria. The radio signals are generated by 8 transmitters in Europe.
In case the signal is crossing an earthquake preparation zone, we are in principle able to detect seismic activity. The links from the transmitters to the receivers are sometimes more, sometimes less influenced by various disturbances. Here we can distinguish between ionospheric or atmospheric disturbances, influences which depend on the earthquake properties and transmitter variations itself. Ionospheric/Atmospheric disturbances can be generated, e.g. by geomagnetic or solar activity or even in the troposphere. The properties of the sub-ionospheric waveguide are influenced by the length of the radio path, the distance to the earthquake preparation zone and the parameters of the earthquake (magnitude, depth, type). Beside we have to distinguish between daytime and nighttime measurements, because the non-seismic ionospheric influences on the radio path are less in nighttime. Therefore we have to focus especially on nighttime ascendancies on the signal. Beside the terminator time method where only the VLF sunrise and sunset period is analyzed, we are using the residual method where the difference between the monthly mean amplitude and the nighttime variation is calculated. Anomalous signal variations outside the two sigma borderline are used to determine seismo electro-magnetic events.
As pointed out by Rozhnoi et al. (2009), the VLF methods are suitable for earthquakes larger than magnitude M=5.0. Thereby we only consider $M \geq 5.0$ earthquakes in Europe in the time period 2009 to 2011.
It is our aim to differentiate seismic from non-seismic variations along the radio paths. This refined analysis should finally lead to a more reliable earthquake forecasting procedure.

References:
[1] A. Rozhnoi et al.: Anomalies in VLF radio signals prior Abruzzo earthquake (M=6.3) on 6 April 2009, National Hazards and Earth System Sciences, 9, 1727-1732, 2009.