



## Analysis of VLF/LF transmitter signals during the minimum of solar activity in the year 2018

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We report on VLF/LF transmitter signals observed in the year 2018 during the minimum of solar activity. Those signals were recorded in Graz (Austria) using INFREP (Biagi et al., *Nat. Hazards Earth Syst. Sci.*, 11, 2011) and UltraMSK (Schwingenschuh et al., *Nat. Hazards Earth Syst. Sci.*, 11, 2011) systems. This leads us to record fourteen transmitter signals in the frequency range between 19 kHz and up to 270 kHz. Six transmitter channels are common to both systems and are localized in Great-Britain (Anthorn, GBZ, 19.58kHz), Italy (Tavolara, ICV, 20.27kHz), Germany (Rhauderfehn, 23.4kHz,) and Island (Keflavik, NRK, 37.5kHz). Others are mainly LF broadcasting transmitters from Romania (Brasov, 153kHz), Luxembourg (Felsberg-Berus, 183kHz), Algeria (Berkaoui, 198kHz), Monte-Carlo (Roumoules, 216kHz) and Tchecki (Lualualei, 270kHz). In the year 2018, the solar activity decreased reaching its minimum in the end of 2019. We emphasize in this work on three aspects: (a) C-flares related to the solar activity, (b) Kp-index linked to the geomagnetic activity, and (c) seismic events in the southern part of Europe, i.e. Greece and Italy. The dominant patterns observed on almost all transmitters are due to the solar flares. Geomagnetic activity is found to depend on the seasonal effect and mainly observed few weeks before and after the summer solstice in the northern hemisphere. Few earthquakes occurred in the southern part of Europe, in Greece (6 events) and in Italy (2 events) with a magnitude of 5.5 Mw and depths less than 10 km. We discuss the disturbances of VLF/LF transmitter signals prior to EQs occurrences, and their links to external effects. Our results are compared to recent investigations of Zhang et al. (*Radio Sci.*, 52, 2017) and Rozhnoi et al. (*Ann. Geophys.*, 37, 2019) concerning, respectively, the spatial distribution of VLF transmitter signals recorded by Demeter satellite, and the solar X-flare effects on VLF/LF transmitter signals.