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AC/DC Global Electric Circuit response to the Hunga Tonga eruption

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In this contribution, we analyze the response of the AC and DC components of the Global Electric Circuit (GEC) to the giant eruption of the Hunga Tonga volcano on 15 January 2022. The Hunga Tonga–Hunga Ha‘apai submarine volcano (20°32’ S, 175°22’ W) is a part of the tectonically highly active Kermadec–Tonga subduction zone and its associated volcanic arc located east of Australia and north-northeast of New-Zealand in the South Pacific Ocean. It is a volcano that was thought to be dormant after its eruption in 2014. However, a large eruption of the Hunga Tonga–Hunga Ha‘apai volcano was observed on 14th January 2022. Following the first eruption, a more powerful one commenced at around 04 UTC 15th of January. This powerful explosion created tsunamis along the rim of the Pacific Ocean and sent a massive, about 200 km wide volcanic plume up to the stratosphere more than 20 km high, and with some satellite reports to 55 km. Extremely intensive lightning activity was detected in the plume by several lightning detection networks of global coverage. This exceptional scenario made it realistic for the GEC, too, to be possibly perturbed by the eruption.

Our investigation is based on Schumann resonance (SR) and atmospheric electric potential gradient (PG) measurements in the Széchenyi István Geophysical Observatory (SZIGO), Hungary as well as on further SR measurements at distant stations on the globe. WWLLN and GLD lightning detection is used to characterize global lightning activity including lightning activity around the Hunga Tonga island on the investigated day (the 15th of January, 2022). The appearance of “Volcanic whistlers” connected to the Hunga Tonga eruption are also analyzed based on the AWDA Network.

The observations reveal a global intensification of SR connected to the enhanced lightning activity in response to the eruption while the PG data from Hungary do not show a clear response to the lightning activity enhancement. The SR data together with the global network observations indicate that the lightning activity in the eruption dominates the naturally occurring global activity for a period of at least one hour. To the best of the authors’ knowledge this is the first work which shows a globally detectable response in the Earth’s Schumann Resonances connected with a volcanic eruption. The highly localized increase in lightning activity over Tonga provides a unique point source of excitation for the Schumann resonances, which could form the basis for a number of subsequent studies. Transient extremely low frequency (ELF) electromagnetic signals associated with the volcanic eruption are studied as well. Applicability of a machine learning-based method for the detection and classification of ELF-ban transients associated with this event is also examined.