

# Pre-seismic anomalies on Earth's magnetic field and ionosphere electron density using Swarm data

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An earthquake is a rapid release of stress in the lithosphere and often leads to serious damages on human lives and society. Even though the short-time forecast of earthquake is important, it is not achieved yet. However, many electromagnetic phenomena that may be related to seismic activity have been reported recently. The satellite, one of the useful tools to observe these phenomena, can cover the global areas and can collect a large amount of data related to earthquakes which have large magnitude worldwide in short time. The Swarm satellites mission started to operate on November 22, 2013 by European Space Agency, with the constellation of three satellites (A, B, C) The anomalies preceded to the Ecuador earthquake in 2016 have been reported using the Swarm data. In this paper, in order to validate these results using the magnetic vector Y data by VFM and electron density data by Langmuir probe, we have analyzed the Swarm data related the M6.3~6.9 earthquakes occurred at Lombok Island, Indonesia, in July 28, August 5, and 19, 2018. The study area is a 1000 km square from the epicenter of 20180805 earthquake and the analyzed period is from May 28 to September 27, 2018. In this paper we report night-time orbit data at 18:00-6:00 LT.

As results, we found the following tendencies; (1) positive anomalies on magnetic Y vector about 1-2 weeks before the earthquakes and (2) negative anomalies on electron density from 1 week to 1 month before the earthquakes. We performed the same analysis to the data on the same period in 2016 and 2017 for reference when there were no M6+ earthquakes. We found that the number of anomaly track is only abruptly increased in the short period from the end of June to July in 2018, and that the trend is not able to be found in 2016 and 2017. From this unique trend in 2018, it is suggestive of the existence of the relation between the local seismic activity and in-situ satellite anomalies in the magnetic field and electron density in Lombok area.