

## Atmospheric anomalies observed during earthquake occurrences

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Study of seismo-electromagnetics has been developed for a few decades. In particular, ionospheric anomalies associated with earthquakes have been proposed since the 1980s and a few of recent publications showed strong evidence for the existence of seismo-ionospheric anomalies. Consequently, we tried to investigate whether atmospheric anomalies associated with earthquakes also exist, by measuring anomalous transmission of VHF electromagnetic waves. The VHF electromagnetic waves scattered by the atmospheric or ionospheric disturbances beyond the line-of-sight distance could be observed through our one-year and 8 month observation. For our analysis, we used one data a day that was derived by the variation of the amplitude of the received VHF electromagnetic waves during the midnight after a wavelet noise-reduction was performed. When we compare the variation of such a one-day data with the upper bound derived by the previous 15-days running median of the one-day data and the associated 2.4 times inter-quartile range, some signatures over the upper bound might appear within 5 days before earthquakes (more than M4.8) that occur between transmitter and receiver. We finally obtained 15 anomalies that appeared a few days before earthquakes. Furthermore, it was investigated that the polarization of the 15 anomalies, carefully comparing the anomalous transmission caused by foEs, meteor shower and so on. It is concluded that there also was a possibility of the atmospheric anomalies associated with the earthquakes such as the ionospheric one because the transmission path was not the ionosphere but the atmosphere due to no change of the polarization of the received VHF electromagnetic waves. The significant relationship between the larger magnitude and the higher appearance rate of earthquake-preceding anomalies was consistently obtained.

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