

# Statistical evaluation of anomalous propagation of VHF-band radio wave and reliability of the anomaly that immediately preceded the 2016 Kumamoto Earthquake

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Anomalous propagation of VHF-band radio wave is a candidate of a short-term precursor of earthquakes (Moriya et al., 2010). Some models of physical preparatory processes of earthquakes have suggested a possibility of production of electromagnetic scatterers in the area over the source of the impending earthquake (e.g. Pulinets and Ouzounov, 2011).

Hokkaido University has been monitoring this anomalous propagation in several regions, including Erimo (Hokkaido), Shimabara (Nagasaki). To evaluate the statistical significance of the anomalies being precursory to the impending earthquakes in these regions, we made a spatiotemporal map of earthquake alarm based on observed anomalies (Morita et al., 2016).

In the case of Erimo, the monitoring has continued for more than ten years, while many  $M>5$  earthquakes occurred during this term. Hence, we could evaluate the statistical significance of the claim that some of the anomalies that shortly preceded earthquakes were indeed a precursor of the impending earthquake, not a mere coincidental occurrence of irrelevant anomalies in the time window preceding the earthquake. The test yielded a positive answer [Morita et al., 2016]. However, in the case of Shimabara, while monitoring has continued for five years, earthquake  $M>5$  occurred only five times, and hence we could not judge the statistical significance.

One of the serious noise for detection of anomalous propagation due to an impending earthquake is scattering by the appearance of sporadic E (Es) layer. To extract Es noise, we used detection method of Es by total electron content (TEC) changes in the ionosphere proposed by Maeda and Heki (2016). We developed a system that automatically detects the occurrence of Es from the short-term change of TEC. Thanks to this method, we could check whether a detected anomaly comes from Es. In the case of Kumamoto Earthquake ( $M_w:6.2$ ), which occurred on the night of 14 April 2016, an anomalous propagation was detected at the Shimabara site on the morning of 13th, but Es was not detected in the TEC record. The anomaly observed on the morning of 13th is likely to be related to the earthquake, not the influence of Es at least.

By eliminating the anomalies due to Es in producing our anomaly-based earthquake alarm map, we expect to see a better statistical significance.