

Detectable magnitude of earthquakes and epicentral distance with precursor at 1.5kHz

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[Introduction] Predicting earthquakes has been tried by observing precursory anomaly of electric pulses at 1.5 kHz. The magnitude (M) of earthquakes and epicentral distance (D) are observed, which make the anomaly detectable just before great earthquakes. The pulses are supposed to be radiated by discharge between the ground surface and the ionosphere. The other precursors, such as anomalous reflection from the ionosphere and extraordinary propagation in the atmosphere, are thought to be the other phenomena caused by the similar mechanism. So, M and D of the precursor at 1.5kHz are compared with M and D of the ionospheric anomaly and of the extraordinary propagation.

According to Liu et al. (2006), meaningful precursor is observed where M is equal to or larger than 5.4, and where D is within 150 km. According to Moriya et al. (2005), the minimal M of predicted earthquakes is larger by 1.5 in the ocean off the shore than in the land and near the shore. And the logarithm of the time span of anomaly is inversely proportional to the source depth.

[Observations] The clear precursory 1.5 kHz is observed just before the following two earthquakes.

In SE Off Kii Peninsula Eq. (04/09/05, M: 7.3, Depth: 44 km), D: 180 - 420 km, the anomaly is observed in the period 0.4 - 1.8 days before at three sites nearly simultaneously.

In Mid Niigata Pref Eq. (04/10/23, M: 6.8, Depth: 13 km), D: 230 - 290 km, the anomaly is in the period 0.3 - 3.3 days before.

The above earthquakes satisfy the criterion of M: 6.9 and of M: 5.4., but do not satisfy the criterion of D: 150 km. The reason will be that we observed the radiated wave from under the disturbed ionosphere, where the observable area of 1.5 kHz will be much wider than the disturbed area that Liu et al. observed. In S Ibaraki Pref Eq. (04/10/06, M: 5.7, Depth: 66), D: 69 - 195 km, the criteria of M and D are nearly satisfied, but the precursory 1.5 kHz is not clear. The reason will be that the criterion of depth is not satisfied. There were submarine earthquakes such as Off Ibaraki Pref. Eq., E Off Chiba Pref. Eq. and Off Miyagi Pref. Eq., whose M's are smaller than 6.7. In these earthquakes, no precursory 1.5 kHz is observed, that will show the criterion of M: 6.9 of submarine earthquakes to be valid. About Off Miyagi Pref. Eq. (05/08/16, M: 7.2) and Off Sanriku Eq. (05/11/15, M: 7.1), we failed to get the data. Though there were two other great earthquakes at about 1000 km distance, Off Kusiro Eq. (04/11/29, M: 7.1) and W Off Fukuoka Pref. Eq. (05/03/20, M: 7.0), no precursory 1.5 kHz is detected. The reasons will be as follows: We discriminate the precursory fields from lightning fields by the following relations,

$E(1.5\text{kHz})$ is stronger than $E(3\text{kHz})$, and $E(3\text{kHz})$ is stronger than $E(12\text{kHz})$

where $E(f \text{ kHz})$ is the received field intensity at $f \text{ kHz}$.

The left side is not valid for near lightning fields, because they are maximal in 3 - 10 kHz, and right side is not valid for far lightning fields, because ionosphere propagation loss is heavy in 1 - 3 kHz, i.e., the fields which satisfy the above relations are not caused by lightning. But the precursory 1.5 kHz radiated from the distance of 1000 km will also heavily be attenuated, so the precursory fields will become weaker than the noise and undetectable.

[Concluding Remarks] The detectable minimal magnitude of earthquakes with the precursor at 1.5 kHz is consistent with M: 5.4 in the land and near the shore, and is also consistent with M: 6.9 in the ocean off the shore, by Liu et al. and Moriya et al. The upper limit of epicentral distance to detect the precursory 1.5 kHz is much longer than the criterion 150 km by Liu et al.

References

Liu et al., 2006, J. Geophys. Res., 111, A05304, doi: 10.1029/2005JA011333.

Moriya et al, The Seismological Society of Japan, 2005, Fall Meeting, P004.