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Multiple-site observation of anomalous VHF radio wave propagation associated with the 2011 off Urakawa earthquake (Mw=6.1)

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We have observed VHF-band radio wave propagation anomalies beyond the line of sight prior to earthquakes (EQ echoes) since March 2003 in the Erimo area, Hokkaido, northern Japan. EQ echoes were documented more than 40 times at the Erimo Observatory (ERM) prior to earthquakes that occurred in the Hidaka Mountains. To confirm the region in which an EQ echo was simultaneously observed for each earthquake, we installed (since September 2011) four observation sites with approximately 8-km spacing in the Erimo area. Four-way antennas (every 90 degrees) were installed to detect the arrival direction of EQ echoes at the RSK (8 km NW of ERM) and TYO (8 km SE of ERM) sites, and six-way antennas (every 60 degrees) were installed at FYS (16 km NW of ERM). We also monitor the atmospheric electric field at FYS and TYO to verify a hypothesis to explain why the anomalous radio transmission appears before earthquake is that radon gas emanate from the surface due to increasing pressure of fluid in the preparation process of earthquakes.

EQ echoes associated with the off Urakawa EQ (Mw 6.2) that occurred at 19:25 on 24 Nov 2011 were observed simultaneously at these sites. Larger EQ echoes were documented in every direction on 21 and 22 November, two or three days before the earthquake, at FYS, ERM, and TYO. Although some of the EQ echoes were observed at the same time at these sites, some appeared with a time lag among the sites. We discuss the meaning of these time lags by considering possibilities of their generation and the movement of scattering objects.