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FDTD Simulation for ULF electromagnetic phenomena observed at the Southern Boso Stations

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The ULF electromagnetic anomalous changes were observed at the Southern Boso stations on Oct. 6, 2002. These anomalous signatures appeared in both the electric and the magnetic fields simultaneously. The characteristics of these signals are as follows; (1) the wave forms similar to DC driven train noise and (2) the magnetic anomalies also appear at Kanozan Geodetic Observatory (KNZ), which belongs to Geological Survey Institute, Japan and is apart from about 25 km west of our Southern Boso stations. (3) However, the DC driven train noises from near our ULF stations are not observed in KNZ. We investigated the difference between DC driven train noises and anomalous signals observed on Oct. 6 in the point of electromagnetic environment of direction of signal arrival and polarization.

The directions of the electric field vectors were estimated. The results show that the directions corresponding to the train noises change with the location of the train. On the other hand, the directions of anomalous signals showed the southern direction from out stations and did not give large variations. Polarization of magnetic fields for train noises and anomalous signals is different each other.

Then, we carried out the 2-D FDTD (Finite Difference Time Domain method) simulation to evaluate the received signals, that is to estimate the source location. For realistic computation, the electric conductivity structure around the sites are required. Therefore we apply the MT (magnetotelluric) investigation to obtain the electric conductivity structure. In the FDTD computation, the line source current is assumed and ionospheric model is also adopted.

The results in the case of d (depth) = 0, whish assume the source is leak current of DC driven train system and it flows just beneath the rail track, show that the electromagnetic fields are not capable to reach to KNZ. This fact means that the anomalous signals are different from train noises at least. If we assume the source locate under the ground, the simulation results suggest the possible current source should locate at the depth d less than 1 km in the point of view of the observed amplitude