New development and operation of the EM-ACROSS: an investigation at Mount Kusatsu-Shirane

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The Electromagnetic Accurately Controlled, Routinely Operated Signal System (EM-ACROSS) is a specially designed system for controlled source electromagnetic investigation. The EM-ACROSS combines with a stable transmitter system and at least one receiver for obtaining the electric and magnetic field at the observation site. The core purpose of this system is a specifically designed signal which is repeatedly transmitted with high accuracy and precision to against the noise.

An initial experiment was made at Volcano Kusatsu-Shirane in 2017. We designed a superimposed signal with 10 geometric sequences frequencies, same amplitude and randomly chosen phase shift. A function generator, which was synchronized with a GPS clock, stored our designed waveform and sent the signal to an amplifier. There were two sets of grounded dipoles, north-south and east-west. After that signal was enlarged 80 times, the current was injected to the earth by one set of the grounded dipoles for at least 12 hours before switching. The amplifier was monitored and recorded by a digital data logger for obtaining the transmitter data. At the observation area, nine receivers measured the changing of electric and magnetic field. The data was processed by a simply stacking method in frequency domain. This initial experiment presented a good anti-noise ability at higher frequencies (between 1~5 Hz) and indicated a necessity of longer investigation for lower frequency band.

In 2018, we made a new development and operation of this system based on the result of initial experiment. The transmitter system had one more amplifier to inject both the grounded dipole sets at the same time. The chosen frequencies of superimposed signal were selected from the prime number as two sets of quasi-geometric series. The amplitude of lower frequency band was increased to against the noise floor. The system was operated three months for obtaining a better anti-noise ability in low frequency band. A new procedure of data processing was applied to eliminate the non-stationary and non-Gaussian noise. We used weighted stacking method to calculate the final electric and magnetic field.

Compare with the initial experiment, this investigation presents an obvious enhancement in lower frequencies. The large effect of non-Gaussian noise is reduced. A smaller error of the initialized electric field is acceptable for the modeling work.

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