ADU07 と Elog の周波数特性について

Frequency Characteristics of the data acquired by ADU07 and Elog

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Abstract

In order to estimate MT response functions between the electric field obtained by the Elog (manufactured by the NT System Design) and the magnetic field obtained by the ADU07(e) and the coils of MFS06(e) and/or MFS07(e) (manufactured by the Metronix), we have to understand the frequency characteristics of all the units for measuring electrical potential difference in both of the Elog and the ADU07(e) systems and those of coils connected to the ADU07(e). When we only use the Metronix System, the frequency characteristics of the electric potential difference measurements are the same both for the electric field and the magnetic field. Here, the magnetic field is measured also by recording the electrical potential difference as outputs from the coils. Then, in order to estimate the MT responses, it is sufficient for us to know frequency characteristics only of the coils. In contrast to this situation, if we use both of the Elog and the ADU07(e) systems, we must grasp frequency characteristics of the electric potential difference acquisition units in both of the systems. The frequency characteristics includes those of an analog antialiasing filter, those of AD converter including GPS timer synchronization and internal decimation digital filters, and those of additional antialiasing digital filter for obtaining the final time series data, e.g. of 1024 and 32 Hz sampling.

All of the information about the frequency characteristics are apparently given by the respective manufactures. For the Metronix ADU07(e) system, all the necessary specifications are available, as is described by Ogawa (2017) in detail. As for the Elog system, frequency characteristics combining those of the antialiasing analog filter and the AD converter are supplied from the NT System Design by tables for respective Elog systems with respective serial numbers, which contains amplitude and phase characteristics versus frequencies. Digital filter coefficients of the last stage, which is applied to the outputs from the AD converter to yield final 1024 or 32 Hz data are also given by the NT System Design (or can be arbitrary designed by the user) and installed in the SD memory card, which is also used as the data storage.

From July 20th to 21st, 2015, we demonstrated the MT survey in the Summit Area of the Izu-Oshima Island for undergraduate students of Department of Earth and Planetary Physics, Faculty of Science, the University of Tokyo. We used two ADU07 systems and one Elog system. We continuously obtained 1024 Hz data both for the ADU07 and the Elog systems throughout the acquisition period. After applying the BIRRP code (Chave and Thomson, 2004) to estimate response functions between the electric field obtained by the Elog and the magnetic field obtained

by the ADU07, we tried to rectify the frequency characteristics by referring the synthetic responses, calibration files for the coils (both of which are described in Ogawa, 2017) and the frequency characteristics of the Elog mentioned above. We also estimated the MT response functions for two normal sites only with the MTU07. Since geomagnetic activity was very calm and we acquired only one night data, we could estimate sound responses from several hundred Hz only to several Hz. In the frequency range, the structural dimension could be safely assumed as 1-D, since the off-diagonal impedances were mutually almost the same. The apparent resistivity monotonically decreases from the higher frequency to the lower frequency at all the three sites. Only at the Elog site, however, phase values gets smaller than 45 degree in the higher frequency range, whereas phase values are always higher than 45 degree for the two MTU07 sites throughout the frequency range, which seems concordant with the apparent resistivity.

We thus realized that there still existed some factor(s) to be considered to obtain correct MT responses between the Elog electric field and the MTU07 magnetic field. In order to clarify the factor(s), at a test site in the northern Ibaraki Prefecture, we measured the same electrical potential difference by using the same electrode pair by using an ADU07, an ADU07e and 7 Elogs from Oct. 19th to 21st, 2016. Throughout the test acquisition, we continuously obtained both of 1024 and 32 Hz data. We then estimated the response functions between electric channels of ADU07e and ADU07, and those of Elogs and ADU07, again with the aid of the BIRRP code. The response functions can be directly used to correct the MT response function between the electric field of Elogs and the magnetic field of ADU07(e)s. First, we confirmed that the response functions between electric channels of ADU07(e)s can be assumed to be unity without any phase shift. Second, we examined how well the synthetic ADU07(e) response in Ogawa (2017) combined with the above mentioned frequency characteristics of the Elog explains the measured response functions between the electric channels of Elogs and ADU07(e)s. We found that the synthetic response well explained the amplitude characteristics of the real response. However, there existed a group delay, e.g., of 360.6 μs between ADU07 #64 and Elog #019. This little difference may be due to difference in GPS synchronization between ADU07(e)s and Elogs. Please note, however, that we only know relative time shift in the GPS synchronizations of the both systems so far.

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