Re-evaluation of the linear trend of the submarine cable voltages and the probable cause of the residuals

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Geoelectric field observations using thousand-km scale submarine cables, initiated as a part of the Ocean Hemisphere Network Project, have been performed for more than 10 years. Linear trends of the geoelectric field were obtained using several years of cable data in a previous study in order to estimate the amplitude of the toroidal magnetic field decadal variation at the CMB. Several years has passed since the estimate had been done, and we re-evaluated the linear trend of the geoelectric field in the long-term submarine cable data.

Linear trends of the geoelectric field data for the cables between Ninomiya-Guam, Philippine-Guam, Guam-Okinawa, Okinawa-Ninomiya, Shanghai(sea)-Amakusa, and Nakhodka-Naoetsu are re-evaluated. The trends are of order 10^-5 – 10^-4 (mV/km.day), and they are in the same order of magnitude as those estimated previously. If it is supposed that the linear trend is due entirely to the decadal variation of the toroidal magnetic field at the CMB, the variation of the toroidal field there is about the same as that of the poloidal field. This is consistent with an estimate of the toroidal field variation using a kinematic dynamo model made by Shimizu and Utada (2004).

On the other hand, Shimizu and Utada (2004) showed that the electric field variations induced in the ocean by the variations of the current might have about the same amplitude as the obtained linear trend. It is necessary to remove the part due to the oceanic dynamo from the geoelectric field data to detect that of core origin correctly. Also, the residual in the geoelectric field is most probably caused by the motionally induced field in the ocean.

There are several studies to estimate the geoelectric field induced by the ocean current using numerical simulation of oceanic dynamo employing global scale ocean flow models. In this study, as a first step, we take a more experimental approach (see Larsen, 1992). It is expected that the relationship between the variations of ocean current and resulting geoelectric field variations are the same if the time scale is long enough. We will estimate the coefficients which convert the ocean flux to the geoelectric field for variations having the periods of oceanic tide. The tidal flow models by Matsumoto et al. (2000) are employed, and the flux over the cables between Ninomiya-Okinawa, Shanghai-Amakusa, and Nakhodka-Naoetsu are estimated. The differences of the converting coefficients among the tidal components are shown and the causes of them are discussed.

Reference,

Matsumoto, K., T. Takanezawa, and M. Ooe, Ocean Tide Models Developed by Assimilating TOPEX/POSEIDON Altimeter Data into Hydrodynamical Model: A Global Model and a Regional Model Around Japan, Journal of Oceanography, 56, 567-581, 2000.