

Japanese geomagnetic field variation model based on the IGRF (2): modeling on the oblique Mercator projection

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For geomagnetic field variation observations around tectonic areas to detect the variations related to tectonic activities in Japan, geomagnetic field model or geomagnetic field variation model around Japan with high accuracy is indispensable as a reference field. The geomagnetic field variation model around Japan proposed by Abe and Miyahara (2015) using the principal component analysis of geomagnetic data is a statistical model but not a physical model of the field variation, for the vector field model is not in general divergence-free. The model also lacked the error estimation for arbitrary positions. The present study evaluates the new geomagnetic field variation model around Japan which corrects the following two points in the model by Ogawa (2018, JpGU) which attempted to overcome the difficulties in the previous work: 1) the geomagnetic field variation is expressed in the Cartesian coordinate system on the map using the oblique Mercator projection of the Japanese island arc along NE-SW direction with a great ellipse centered and oriented along the direction, instead of the Mercator projection, and 2) annual variations in the model residuals of data which correlate with sensor temperature variations at the geoelectromagnetic continuous measurement stations of GIAJ are removed.

The new geomagnetic field variation model is expressed with the magnetic scalar potential by a cubic polynomial with respect to the coordinates in the coordinate system with its origin on the ground in the SE area of Ishikawa prefecture, expressing the difference of the 1-day geomagnetic data at 5 observatories of JMA and GIAJ and 10 stations of GIAJ from the IGRF, between 2005 and 2014. By obtaining the time series of expansion coefficients using the robust least square technique, the model shows the following features: 1) the mean of the model residuals amounts to 1.28nT, 2) by the leave-one-out cross-validation, the mean of the prediction error amounts to 1.94nT, 3) the mean of the prediction error at all the observation points obtained by the propagation of the jackknife standard error of expansion coefficients amounts to 1.16nT, as large as the mean of the model residuals, and 4) the mean of the prediction errors at Chichijima station of JMA, data of which are unused for the model, because of the large distance of the station from the principal part of the Japanese island arc, amounts to 5.06nT.

The mean prediction error along the principal part of the Japanese island arc estimated using the propagation of the jackknife standard errors of estimated expansion coefficients amounts at most to about 2nT for the horizontal two components and about 3nT for the vertical component, respectively. The present geomagnetic field variation model around Japan has the accuracy of a few nT for the principal part of the Japanese island arc.

Keywords: Geomagnetic field variation model, oblique Mercator projection, Leave-one-out cross-validation, jackknife standard error