Japan geomagnetic field variation model based on IGRF(1) : comparison with the GIAJ model

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The geomagnetic field variation model around Japan constructed with the principal component analysis (Abe and Miyahara, 2015), which is referred to as the GIAJ model, does not guarantee that the geomagnetic field is divergence-free. In the present study, the geomagnetic field variation model is constructed with the coefficients which express the geomagnetic scalar potential, with the geomagnetic data for ten years since January 2005 at five geomagnetic observatories and ten geomagnetic stations of JMA and GIAJ. The mathematical expression of the geomagnetic scalar potential is a power series with the maximum order of three of the coordinate defined in the Cartesian coordinate system on Japan with an approximation that the earth is flat. The horizontal coordinate axes are northward and eastward positive. Nine coefficients for two horizontal components and six coefficients for the vertical components of the geomagnetic field are obtained with the least square technique to express the difference between the geomagnetic data and IGRF. Daily data defined as the mean of the hourly data from 22h to 24h JST are used. The difference at each observatory and station is decomposed into the offset defined as the difference averaged over ten years and the residual, the latter of which is defined as the initial residual. The annual model is at first evaluated to express the annual mean of the initial residual. The monthly model is then evaluated to express the monthly mean of the difference between the initial residual and the annual model. Finally the daily model is evaluated to express the difference of the initial model from the superposition of the annual and monthly models. The superposition of the annual, monthly, and daily models is defined as the geomagnetic field variation model. The final difference is defined as the difference between the initial difference and the geomagnetic field variation model. In the least square evaluation of coefficients, larger weights are given to the data at five observatories. To avoid the influence of noises which are expected to be contained more in the data at ten stations, the robust least square technique together with the weighting is adopted to evaluate the coefficients. The mean RMSE over fifteen observation points obtained from the final residual amounts to less than 2 nT which is smaller than those obtained by Abe and Miyahara (2015) by about 1 nT. By leave-one-out cross validation (LOOCV), the mean RMS over fifteen observation points is up to about 2.5 nT for the Y component, which is smaller than those obtained by Abe and Miyahara (2015) by about 2 nT.

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