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A method of representing standard secular variations around such as Japan

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Geomagnetic reference field models are mathematical or numerical expression of the geomagnetic field or its secular variation at a specific point (and a time). Geomagnetic reference field models aiming at representing only a specific region is sometimes called regional geomagnetic reference field models. Determining procedure of geomagnetic field models from a discrete set of data is regarded as an interpolation. Also, it is regarded as a high-cut filtering when the model is expressed by a combination of analytical functions. Many procedures have been used to determine geomagnetic field models. A classical method is using polynomial functions. In Japan, Tazima et al. (1976) reported. Sumitomo, 19xx. Ji et al. (2006) published an example of around Japan by using Spherical Cap Harmonic Analysis (SCHA). Recently, revised SCHA (R-SCH) was proposed and applied to several regions in the globe (Thebault et al., 2006).

One of applications of geomagnetic reference field models is extracting the crustal geomagnetic field. Given that spatial scales of variations in the crustal geomagnetic field are considered to be smaller than those represented by geomagnetic reference field models, differences between observed values and predicted values by a model are regarded as the crustal field.

However, conventiomnal models are unsatisfactory, at least when our purpose is on extracting crustal field for several region such as Japan. Two horizontal components (i.e. B_X and B_Y) represented by polynomials do not always satisfy the irrotationality condition: $\partial B_X / \partial Y$ - $\partial B_Y / \partial X$=0, which should be satisfied in a region with no electric currents. Quantitative relationship between the order of polynomials and the precision of the model is also unsure. SCHA and R-SCHA are designed for a region with a shape of a sperical cap, which is considerably different from Japan islands. The difference in shape yields instability in determining model parameters. Indeed, results presented in Ji et al. (2006) demonstrate unnaturally large secular variations at marginal regions of their analysis.

In this presentation, the author propose a method of representing the regional reference field around Japan using conventional Spherical Harmonic (SH) Functions. To reduce a number of SH functions for representing the spatial distribution, the Principal Component Analysis is applied to SH functions after restricting the variables' range of position to Japan Islands. Obtained major components of the Principal Components are used as the basis functions for representing spatial distribution. This method have three advantages compared with conventional methods. First, the obtained field model automatically satisfies Laplace's equation. Second, we can stably determine corresponding model parameters because orthogonality of basis functions over the target region is assured. Third, truncation errors can be evaluated by assuming an experimental spectrum law of Gauss's coefficients.

Keywords: geomagnetic secular variation, regional geomagnetic field model, spatial distribution, Spherical Harmonic Functions, Principal Component Analysis