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Local Improvement in Geomagnetic Field Model by Method of Least Squares

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Extended Abstract

Summary

Global and regional geomagnetic field models give the components of the geomagnetic field as functions of place and time. Most of these models utilize polynomials or Fourier series to map the input variables to the geomagnetic field values. The only temporal variation in these models is the long term secular variation. However, there is an increasing need amongst certain users for the models that can provide shorter term temporal variations, such as the geomagnetic daily variation. In this research, we have constructed an empirical model of the quiet daily geomagnetic field variation based on functional fitting.

Introduction

The geomagnetic models provide a universal description of the magnetic field of the earth for scientific and applied applications. However, considering the course of changes in time concerning the geomagnetic field, it seems necessary to provide a magnetic model that can predict the changes in it in the future. Various factors affect the geomagnetic field. These factors appear in regular and sometimes irregular periods and create errors in the prediction of geomagnetic models. It is axiomatic that knowing the above factors and applying them in the models for correct estimation of the changes can have a substantial effect on the increase of the accuracy of the models.

Methodology and Approaches

Many attempts have been made over some past decades to make a comprehensive geomagnetic model using the combination of the geomagnetic data collected in different periods. The investigations into time and location have shown that all real geomagnetic field components have always had average values over certain periods around which the momentary values fluctuate. These fluctuations result from some external factors affecting the geomagnetic field that are usually ignored in the reference models of magnetic fields due to the universal perspective. Thus, the objective of this paper is to investigate into the high frequency fluctuations of the earth magnetic field and to estimate the components affecting them. For this purpose, a mathematical model of the magnetic field fluctuations resulting from the external factors such as solar activities, lunar age, local time and day of year was proposed, and the results were analyzed using the real observations and the reference model EMM2010. In this regard, the coefficients of the proposed model were determined using the long observations of the magnetic field of the earth in a magnetic observatory and the method of least squares through which the high frequency fluctuations of the geomagnetic field were estimated. Furthermore, in this paper, a comparison between measurements taken in the same station and the predicted data by the reference model has been made. The local model proposed in this paper confirms the precision and accuracy of the results.

Results and Conclusions

A comparison between the real observations of the observatories and the results resulting from the combination of the reference model and the local model proposed in this paper indicates 90% increase of local precision in modelling of the magnetic field of the earth. On the other hand, calculation of the local model in different observatories and applying the estimated coefficients of each observatory to the next one have shown that the model of local changes of the earth magnetic field differs in different latitudes having a certain longitude, and also, in different longitudes having a certain latitude. Therefore, determination of the coefficients of this model is possible only locally, and its effect is lessened

through the change in its geographical coordinates in relation to the location of the observatory.