Building a secular variation model for IGRF-13

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International Geomagnetic Reference Fields (IGRFs) are international standard models of our planet’s magnetic field provided by International Association of Geomagnetism and Aeronomy (IAGA) and revised every five years. Although IGRFs have its own legend dating back to the middle of the last century, Japan has never contributed to any model development so far. This study, therefore, will be the very first attempt to Japan's international contribution to this academic activity. One goal of this study is placed naturally on development of a candidate model of the geomagnetic secular variation (GSV) for the next IGRF revision planned in December, 2020 (IGRF-13).

To submit candidate models to IGRFs, each national team proposes either a field model or a GSV model (or both). We are going to propose a GSV model because forecasting the GSV based on data assimilation is new in the sense that we can make use of knowledge of geodynamo simulation rather than forecasting the GSV empirically based on past field models. Although majority of GSV models has been still empirical in the sense that their time derivatives are mostly linear extrapolation of trends estimated from field models at different epochs, we think physics-driven forecasting of time derivatives of the geomagnetic field becomes important in the future if it is achieved by a combination of geodynamo simulation and data assimilation techniques. Thus, the goal of this study is development of an effective data assimilation scheme using geodynamo simulation for a relatively short time scale of 5 years.

What was found so far in 5-year forecasting of the GSV by data assimilation is that it is better to neglect 'flow acceleration' in the Earth's liquid outer core to forecast the GSV (Fournier et al., 2015). However, this assumption has not yet been proved valid for every epoch. One obstacle of successful 5-year forecasting of the GSV is presence of so-called 'geomagnetic jerks', which are characterized by sudden changes in the geomagnetic acceleration occurring intermittently with a time scale of decades. In this study, we will first estimate to what extent the 'flow acceleration' is negligible even in the presence of the 'geomagnetic jerk'. To achieve this, we will make a rigorous examination of forecasting results between two epochs with a jerk (e.g., 1969) and without any jerks (say, 2015). This examination can tell us to what extent we should turn on 'flow acceleration' in forecasting the geomagnetic secular variation for a specific epoch.

In the presentation, we will make a report on building initial field models for the GSV assimilation as well as strategy for successful assimilation such as application of length of day (LoD) data to it as a protection against occurrence of the geomagnetic jerks

Keywords: IGRF-13, geomagnetic secular variation, data assimilation, geodynamo, geomagnetic jerk, distribution of the geomagnetic field

