R004-P02
ポスター 1：11/25　AM1/AM2（9:15-12:35）

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Preliminary results of some budget analyses of a dynamo model in terms of equatorial symmetry

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The geomagnetic field shows some asymmetric features with respect to the equator, such as the South-Atlantic Anomaly. The asymmetric structure comes from the fact that the geomagnetic field consists of superposition of the equatorially anti-symmetric and symmetric components. The anti-symmetric component is referred to as the dipole family, while the other is to the quadrupole family. It is well known that the geomagnetic field is dominated by the dipole family components. Other than the Earth, the magnetic field of Mercury shows a notable deviation from that of the dipole family alone due to significant contribution from the quadrupole family component. Our previous study suggests that such a field morphology is maintained by the helical flows biased in one hemisphere. Moreover, such a biased flow is induced by the biased magnetic field via the self-regulation process (Takahashi et al. 2019). However, it is still not well understood that how the self-regulation process generates and maintains the biased flows and magnetic fields. Here, we examine the self-regulation process focusing on interaction between the equatorially symmetric and anti-symmetric components of the flow and magnetic field. For this purpose, budget analyses on energy, enstrophy, and helicity are considered to grasp their flows. In this presentation, our preliminary results for a purely dipole family dynamo, and the corresponding mixed-family dynamo at the same parameter values will be shown and discussed.

This work was supported by JSPS KAKENHI Grant Number JP24K07119.