Effect of intrinsic magnetic field decrease on the low-to-middle latitude ionosphere-thermosphere dynamics simulated by GAIA

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The Earth's intrinsic magnetic field has been fluctuated between 10^{22}-10^{23} Am^2 in past 0.8 million years and now under decreases at a rate of ~6% per century. The intrinsic field decrease would modify not only the ionosphere via electromagnetics, but also the atmosphere under interactions with the ionosphere. The relationship between long-term variations of observed Sq field and the intrinsic magnetic field has evaluated by simulation studies. Cooling of the upper atmosphere observed over past decades is also suggested to be contributed by the intrinsic field variation in addition to the effect by CO_2 enhancement in the low altitude. The upper atmosphere dynamics is largely affected by the lower atmosphere. This study investigates the effect of intrinsic magnetic field on the coupled system using a numerical model, GAIA (Ground-to-Topside Model of Atmosphere and Ionosphere for Aeronomy), which solves physical and chemical dynamics of the whole atmosphere region from troposphere to exosphere under interaction with the ionosphere.
The model simulation is operated with a reduced (50% and 75%) intrinsic magnetic field referring to February 2008 when the wave-4 structure is appeared and solar activity was quiet. In order to focus on the low-to-middle latitude profiles, this experiment excludes the cross-polar cap potential and auroral electron input.
The calculated parameters averaged over the 250 km shows small variations in the neutral wind velocity and electron density with magnetic field changes, while the dynamo electric field decreases and the ionospheric horizontal current increases with increasing magnetic field. In addition to the proportional dependence of the dynamo field on the magnetic field, the ionospheric conductance dependence with $\sim B^{-2\sim-1}$ due to an upward shift of the conductance shift affects the horizontal current. The decreased magnetic field provides the zonal wind enhancement and upward shift of electron peak altitude in the equatorial region. We will report the cause of these variations and their effects on the wave propagation.

Keywords: thermosphere-ionosphere, low-to-middle latitude, intrinsic magnetic field dependence

