Characteristics between the equatorial electrojet and neutral wind in the MTI region: observation and simulation results

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The equatorial electrojet (EEJ) is a huge eastward current which flows at the dayside equatorial region of the Earth's ionosphere, in a narrow channel (+-3˜5 degrees in latitudinal range). The EEJ current is observed as an enhanced magnetic variation of the horizontal component of geomagnetic field at the dayside magnetic dip equator. In the past studies, many researchers showed that the main mechanism of EEJ is an effect of polarization electric field in the E region of the ionosphere at the dip equator caused by the horizontal magnetic field at the magnetic equator [e.g., Forbes, 1981]. In a recent study, the observation of atmospheric radars located at the equatorial region showed the existence of neutral wind in the E region of the ionosphere and vertical polarization electric field derived from ionospheric dynamo generated by the gravity wave originating from the lower atmosphere [Aveiro et al., 2009]. In addition, Fang et al. (2008) shows the relationship between wind dynamo effect and EEJ by using their simulation model. However, lack of the long-term comparison analysis of geomagnetic field and wind data obtained from ground magnetometer and atmospheric radars, the detailed relationship between the EEJ and neutral wind fluctuations in the mesosphere and lower thermosphere (MLT) regions has not yet been revealed.

In our previous study, we compared the long-term variation of geomagnetic field and neutral wind data obtained from ground magnetometer and medium frequency (MF) radar located at the equatorial region. As a result, we found that the relationship between the variations of zonal wind and the residual-EEJ showed a clear inverse correlation. Here, the residual-EEJ is defined as the deviation from the second order fitting curve between the EUV flux and the EEJ amplitude. These results suggest that the vertical current (Jz), which is generated by the dynamo action due to the zonal wind perpendicularly across to the background magnetic field, changes the Cowling conductivity derived under the condition of Jz=0. This trend is observed in not only the Asia Pacific region (close to the radar) but also the South Africa region (far from the radar site). In addition, we performed the frequency analysis to quantitatively define the relationship of zonal wind and residual-EEJ, and found that both of the neutral wind and residual-EEJ have most of the same dominant frequency.

To more clarify the relationship of ionosphere-aerosphere coupling at the equatorial region, we analyzed more neutral wind data estimated from the radars (MF, EAR, and meteor), and more magnetometer data observed around the equatorial region. The radars have been operated by Research Institute for Sustainable Humanosphere, Kyoto University, and the magnetometers belong to MAGDAS managed by International Center for Space Weather Science and Education, Kyushu University. The analysis period is from 1990 to the current. In addition, we perform the comparative analyses between the observational (magnetometers, radars, and satellite) data and simulation results at the MLT region. These results allow us to solve the Cowling conductivity including the neutral wind effect, and offer new insight into the study of ionosphere-aerosphere coupling at the equatorial region.