Thermospheric Neutral Winds Observed by CHAMP

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Utilizing measurements from the accelerometer on board the CHAMP satellite, we present the thermospheric wind patterns in both equatorial and polar regions. In equatorial regions, three years data are used to decompose the seasonal, geomagnetic, and solar flux influences on the equatorial zonal wind. Main features include: 1. The solar flux significantly influences both the day- and night-time winds. It overrides the geomagnetic activity effect, which is found to be rather limited to the night side. An elevation of the solar flux level enhances the night-time eastward wind, but suppresses the day-time westward wind. 2. A seasonal variation with weaker wind around June solstice than in other seasons has been observed regardless of solar flux and geomagnetic activity levels. 3. The day-time wind is found to be generally more stable than the night-time wind, particularly unresponsive to geomagnetic activities. Predictions from the Horizontal Wind Model find good agreement with the CHAMP-observed wind at high solar flux levels during night time. Major deviations are seen at low solar flux levels and on the day side, most of which can be readily explained with the limitation of the data set used by the model. Comparisons with ground FPI observations and the NCAR Thermosphere-Ionosphere-Electrodynamics General Circulation Model (TIEGCM) predictions show that the solar flux effect obtained from CHAMP is consistent with that modeled by TIEGCM.

In polar regions, we emphasize the seasonal variation of the wind pattern. Our analysis reveals clear wind features in the summer (northern) hemisphere. Over the polar cap there is a fast day-to-night flow at speeds surpassing 500 m/s. At auroral latitudes we find strong westward zonal winds on the dawn side, however, on the dusk side an anti-cyclonic vortex is forming. The dawn/dusk asymmetry is attributed to the combined action of Coriolis and centrifugal forces. The winter (southern) hemisphere reveals similar wind features, but they are less well ordered. The mean day-to-night wind over the polar cap is significantly weaker, and its direction is rotated by about 2 hours towards the pre-midnight sector. We regard this as an indication for the stronger influence of the Coriolis force on the slower anti-sunward air flow. Also the fast zonal wind on the dawn side is not well developed here. Generally, the hydrodynamic forces seem to be weaker here, thus allowing for a stronger influence of the plasma dynamics. The enhanced ion-neutral coupling in the dark polar region is manifested by the significantly larger standard deviation of the thermospheric wind velocities.

Neutral winds can affect the distribution and dynamics of ionospheric plasma, either by directly moving the plasma up or down the magnetic field line, or by wind dynamo-produced electric field. Therefore, climatological features obtained here are useful in improving our understanding of various ionospheric phenomena. In addition, coordinated observations with other satellite or ground based instruments could help to elucidate the underlying dynamical processes.