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Seasonal variations of electron densities retrieved from COSMIC radio occultation measurements

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It is well known that there are significant temporal and spatial variations in the Earth's ionospheric F-layer. Among these variations, annual and semiannual variations are outstanding features of the F-layer Ne variations. The characteristics of the seasonal variations of the F-layer Ne depends on altitude, latitude, longitude, local time, and the phase of solar cycle. Although it has been studied for decades, the seasonal variation of the ionosphere is still one of the questions not fully solved.
We collected more than two years worthy of the ionospheric electron density (Ne) profiles from the FORMOSAT-3/COSMIC radio occultation measurements to investigate the seasonal behaviors of daytime Ne. Harmonic analysis of the Ne provides unprecedented detail of the seasonal behaviors of Ne at low solar activity. Maps of seasonal harmonic components indicate that there are strong annual and semiannual variations in daytime Ne, which have distinct latitudinal and altitudinal dependency. The semiannual component predominates over the annual variation in the equatorial regions and at high latitudes in the East Asian and South Atlantic sectors at low altitudes, and at higher altitudes the semiannual component predominates in the equatorial region but recedes in other regions. The semiannual variation peaks in equinoctial months in most regions, while it has maxima in solstice months firstly in the South Pacific region (around 30° S, 120° W) at 250 km altitude and expanding over the South Pacific and South Atlantic oceans at higher altitudes. Moreover, there is a region around (45°S, 30°W) with dominant semiannual component, moving towards east-north with increasing altitude in the range of 200-270 km. These two interesting features are novel, not reported yet. The relative amplitude of the annual component of Ne has hemispheric asymmetry, which is prominent at high altitudes in the southern hemisphere. The winter/seasonal anomaly widely exists in the northern hemisphere and southern low latitudes and in Indian Ocean region at low altitudes but gradually disappears at higher altitudes. Further, in equatorial regions, a new finding is the obvious wave-like pattern in the longitudinal structure of the amplitudes of seasonal harmonic components in equatorial regions, which supports possible couplings of sources with lower atmospheric origins in the longitudinal variations of Ne.

More details for this work can be seen in Liu et al., JGR-Space Physics, 114, doi:10.1029/2008ja013819, 2009.

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