Quasi-biennial variations in ionospheric tidal/SPW amplitudes: Observations and Modeling

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In this study, we present the results of observations and numerical experiments examining the variability and driving mechanisms of the ionospheric quasi-biennial oscillation (QBO). The coherent spatial and temporal modes dominating the variation of selected ionospheric tidal and stationary planetary wave signatures from 2007 - 2013 FORMOSAT-3/COSMIC total electron content observations are isolated using Multi-dimensional Ensemble Empirical Mode Decomposition (MEEMD) from the Hilbert-Huang Transform. The DW1, SW2, DE3, and SPW4 components, which are driven by a variety of in-situ and vertical coupling sources, all show one mode of variation corresponding to an ionospheric QBO in the equatorial latitudes maximizing around January of odd numbered years. This TEC QBO variation is in phase with a similar QBO variation isolated in both the GUVI zonal mean column O/N2 density ratio as well as the F10.7 solar radio flux index around solar maximum, while showing temporal variation more similar to that of GUVI O/N2 during the time around the 2008/2009 extended solar minimum. These results point to both quasi-biennial variations in solar irradiance as well as thermosphere / ionosphere composition as possible generation mechanisms for the ionospheric QBO, with the latter potentially driven by the breaking and mixing produced by atmospheric tides modulated by the stratospheric QBO.

A sensitivity study is performed using the Thermosphere Ionosphere Electrodynamics General Circulation Model (TIE-GCM) to quantify the sensitivity of the thermosphere and ionosphere to quasi-biennial variations in modulated atmospheric tides as well as that present in F10.7. The stratospheric QBO modulation of the tides is isolated via an empirical model constructed using assimilated SABER and TIDI observations. Our results show that at both solar maximum and solar minimum, quasi-biennial variations in solar irradiance play a larger role in driving the QBO in ionospheric electron density. These are some of the first numerical experiments examining the generation mechanisms behind the ionospheric QBO from both above and below.

Keywords: Ionosphere, QBO, Tides

