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Response of the background ionosphere and the TIDs to atmospheric tides in the bottom F-Layer as determined from Dynasonde measurements

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The study of atmospheric tides is a particularly challenging proposition in the thermosphere-ionosphere. In addition to purely thermal tides propagating from the lower atmosphere, the spectrum of tidal waves is complicated by in-situ generation through EUV absorption and non-linear interactions with gravity and planetary waves. A largely unexplored aspect is the extent to which tidal amplitudes and phases exhibit variations about the steady state values on time scales shorter than the so called "setup time" of 10-15 days. Such a goal is currently beyond the capabilities of existing satellite missions. We address the issue by means of ground based Dynasonde measurements covering the bottom-side ionosphere. The inversion procedure produces vertical profiles of electron density and ionospheric tilts at a cadence of 2 minutes and with a vertical resolution typically below 1 km. Because of the normal day-night variability of the ionosphere, the sampling at any given altitude is non-uniform, with data gaps of up to 12 hours. An implementation of the Lomb-Scargle method is used to determine both the magnitude and phase of the diurnal, semidiurnal and terdiurnal harmonics. The raw measurements of electron density and the X (East-West) tilt, together with the derived zonal plasma density gradient are analyzed. Measurements are used from Wallops Island, Virginia and San Juan, Puerto Rico for 2013 and 2014. The dominant seasonal variability is captured using month-long subsets of the data. Day-to-day variations in tidal parameters are obtained by using a subset size of only several days. Finally, the contribution of non-linear interactions between tides and acoustic gravity waves is investigated by measuring the correlation between tidal to AGW spectral amplitudes. To our knowledge, this is the only method that allows for continuous observation of tidal induced perturbations over a broad range of thermospheric heights.