The upper atmospheric responses to tidal and planetary waves

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Tidal and planetary waves (PWs) in the mesosphere and lower thermosphere region could have significant impact on the upper thermosphere/ionosphere system through direct propagations, E region wind dynamo, and the change of residual circulations. We would like to show some results from BeiDou and COSMIC observations, as well as TIME-GCM simulations, to illustrate the lower/upper atmospheric couplings through different mechanisms. Generally, the spatial structures of the ionospheric responses to planetary waves agree with the ionospheric fountain effect, which indicates the important roles of equatorial wind dynamos in transmitting planetary wave signals to the ionosphere. The TIME-GCM simulations show that the zonal and meridional components of the planetary waves could result in evident vertical ion drift perturbations, while the net ionospheric effect is related to both their latitudinal structures and phases. The simulations also show that the change of tidal amplitudes and secondary PWs generated by PW-tide interaction are also important to the ionospheric variabilities. Besides, the couplings through PW-induced residual circulations are exhibited by both model simulations and TEC observations from BeiDou satellite system.