Quasi-two-day wave (QTDW) and Quasi-6-day wave Coupling of the Middle Atmosphere and Thermosphere-Ionosphere

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**Self consistent dynamics and electrodynamics**

Geomagnetically quiet condition: \(K_p=0\).

Solar minimum condition: \(F_{10.7} = 75\) SFU

**Perpetual day of year = January 15** (maximum QTDW observed)

Lower boundary (30 km) condition:

Migrating Tides from GSWM forced at the lower boundary. No nonmigrating tides forced.

**Zonal-wavenumber-3 quasi-2-day travelling planetary wave perturbations forced at the lower model boundary of 30 km**
Pathways of PW coupling with the Ionosphere and Thermosphere [Yue et al., 2016]
QTDW coupling of the Atmosphere and I-T system Ionosonde foF2 near EIA during a QTDW Event

- 2 day oscillation in the ionosphere
- Sudden overall change of the ionosphere at the EIA crest

A: QTDW modulation of the mid and low latitude E-region dynamo

Zonal wind QTDW at 105 km (m/s)  
Electric field in the zonal direction at 120 km (mV/m)


Immel, et al., 2006
QTDW modulation of the vertical ion drift and Total Electron Content (TEC)

Vertical ion drift (m/s)

Zonal wavenumber broadening in the ionosphere [Yue et al., 2013]

W3 ± S1 = W2, W4
W2 ± S1 = W1, W3
W3 ± S2 = W1, W5
Background zonal wind in the E-region is accelerated westward (30 m/s) due to the dissipation of the westward propagating QTDW.
QTDW dissipation leads to extra global-scale circulation and mixing in the lower thermosphere (thermosphere spoon effect by Fuller-Rowell)
QTDW induced thermospheric composition change: O decrease and O2 and N2 increase
Decrease of zonal mean O/N2 ratio and electron density

\(~20\%\) decrease in O/N2 and electron density at the F2 peak

foF2 observation by Chen 1992

Change of thermospheric composition (GUVI observation) [Chang et al., 2014]

TEC changes between model results with and without QTDW forcing at 15E (TIME-GCM)

Up to 20% decrease of TEC at EIA crests in the local afternoon [Chang et al., 2014]
Interactions between QTDW and tides can change the tidal amplitude and generate secondary waves.
Local time and longitudinal variation of the ionosphere due to the changed diurnal tide and secondary waves

Same mechanisms applied for quasi-6-day waves

Change of NmF2 due to E-region dynamo modulated by the 6-day wave wind [Gan et al., 2016]
Effect of quasi-6-day wave and DW1 tide interactions [Gan et al., 2017]
Summary

• The way that fast traveling planetary waves coupling the middle and upper atmosphere is complicated and nonlinear

• First mechanism: QTDW wind perturbation of E-region ionospheric dynamo

• Second mechanism: QTDW dissipation and enhanced mixing of O and N2

• Third mechanism: PW-tide interaction, changed tides and secondary waves

• These mechanisms often work together, thus need a more systematic study
References:


