Nonmigrating tidal modulation of the equatorial thermosphere and ionosphere anomaly

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Oct 14, 2014, Xi’an
Outline

1. Observed longitudinal variations in the equatorial thermosphere and ionosphere anomaly

2. TIME-GCM simulations

3. Summary
The longitudinal variations between the ETA and the EIA are different!
The EIA crests show strong wave 4 structures, but the primary component in the ETA is wave 1.

**Wave-number Spectrum**

**Mass density**

**Electron density**
What are the causes for the wave-4 structure in the ETA?

- direct response to nonmigrating tides?
- and/or ion-neutral coupling?
TIMEGCM Simulations

Thermosphere Ionosphere Mesosphere Electrodynamics General Circulation Model (TIMEGCM) is used in this study:

- **Latitude**: -87.5° to 87.5° in 2.5° increments
- **Longitude**: -180° to 180° in 2.5° increments
- **Lower boundary**: ~30 km
- **Upper boundary**: ~500–700 km depending on solar activity
- **Tides from GSWM** (migrating tides and non-migrating tides)
- **F107=180**
- **DoY=80**
TIMEGCM Simulations
with migrating tides only (run 1)

Run 1 with migrating tides only: the primary component is Wave-1 in both the EIA and ETA. Why?
TIMEGCM Simulations with migrating tides only and an aligned dipole

Run 0 with migrating tides only and an aligned dipole: there is no obvious longitudinal variation! The simulated zonal wave-1 structure in runs 1-2 is associated with the longitudinal structure of the geomagnetic field configuration.
Run 2 with both non-migrating and migrating tides: Wave-1 and wave-4 structures are seen in both the EIA and ETA, and wave-1 is more obvious in the ETA, which is consistent with the CHAMP observations!
TIMEGCM Simulations

**NmF2**

- **NmF2: Run2**
- **NmF2: Run1**
- **δNmF2 (Run2-Run1)**

**Mass density**

- **ρ: Run2**
- **ρ: Run1**
- **δρ (Run2-Run1)**

- non-mig + mig
- mig only
- difference
EIA crest-trough out-of-phase

ETA crest-trough in-phase

EIA-ETA crest phase different

EIA-ETA trough Quasi in-phase
The simulated wave-4 agrees with that from the CHAMP observations.
Effect of ion-neutral coupling

The contribution of ion-neutral coupling to the wave-4 is small!

non-mig + mig

but Ne is replaced from mig run

difference

The contribution of ion-neutral coupling to the wave-4 is small!
The wave-4 structure of the ETA at high solar activity is primarily caused by the direct response of the upper thermosphere to the DE3 and SE2 nonmigrating tides from the lower atmosphere.

The coupling processes of ion-neutral collision and electrodynamics only play a secondary role.

Lei et al., JGR, 2014
Thanks!