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EIA structure observed by VHF/ UHF phase difference

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✧ Abstract

To monitor EIA structures in Southeast Asia, meridional chain of GNU Radio Beacon Receivers (GRBRs) have been being conducted along 100 degree longitude. GRBRs receive VHF and UHF signals from LEO satellites of which the orbits' altitude are about 1000 km. Therefore GRBR has a merit in a rapid scanning. EIA structure and EIA crests' locations are precisely revealed. EIA structures obtained in 2012 are presented in this paper. IRI-TECs integrated between 50 km- and 1000 km- altitudes are shown for comparison.

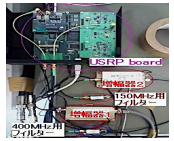
✧ Limitations on previous EIA studies

- Low-latitude Ionospheric tomography network (LITN) of Taiwan provided high spatial resolution but was limited only over the northern hemisphere.
- GPS occultation (e.g. FORMOSAT-3/COSMIC or F3/C) provided global scale information including over the ocean but could not provide high spatial resolution in the same longitude continuously.
- Satellite observations (e.g. CHAMP and GRACE) have a drawback on their altitude change. Also they took many months to cover all local times in the same longitude sector.
- Finally, there was no significant study of precise structures of the EIA asymmetry across the geomagnetic equator.

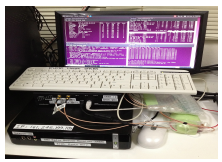
✧ GRBR: a unique receiver for EIA study

GRBRs receive VHF/ UHF signals from LEO satellite to measure the TEC. We focus on the **polar** LEO satellites in order to capture the EIA structure.

✓ *QFH (Quadriliar Helix) Antenna*
✓ *$550*



✓ *Pre-amplifier for 150 MHz signal.*
✓ *Filters for both 150 MHz and 400 MHz signals.*
✓ *USRP board*
✓ *Less than $2000*

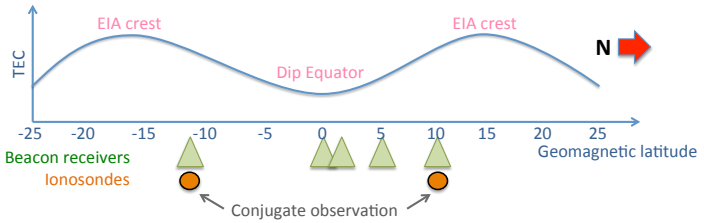


✓ *Linux PC*
✓ *CPU faster than 1GHz is enough for observations.*
✓ *Single-frequency GPS receiver as an additional time reference.*

(http://www.rish.kyoto-u.ac.jp/digitalbeacon/index.html)

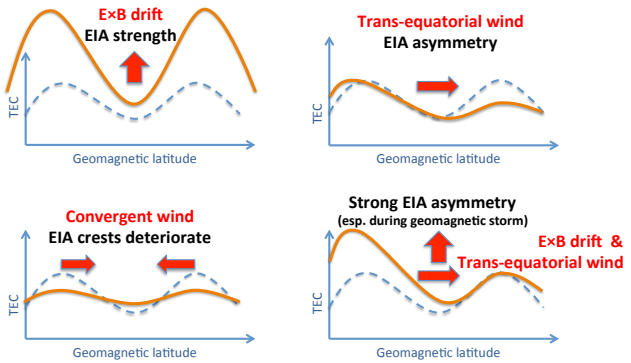
✧ Observation features

- Beacon receiver network receiving signals from polar-orbit satellite observes EIA in narrow longitudinal coverage (~100 km).
- Latitudinal extent at the ionospheric pierce point (IPP) covers ±25 geomagnetic latitude.
- Each observation has quick scan within 20 minutes on average.

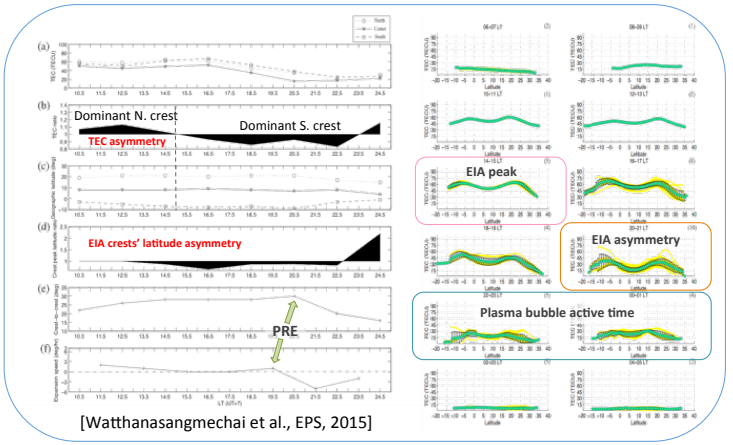


✧ Two main players on EIA structure

- **Electric fields (E×B drift):** EIA strength
- **Meridional wind:** EIA asymmetry

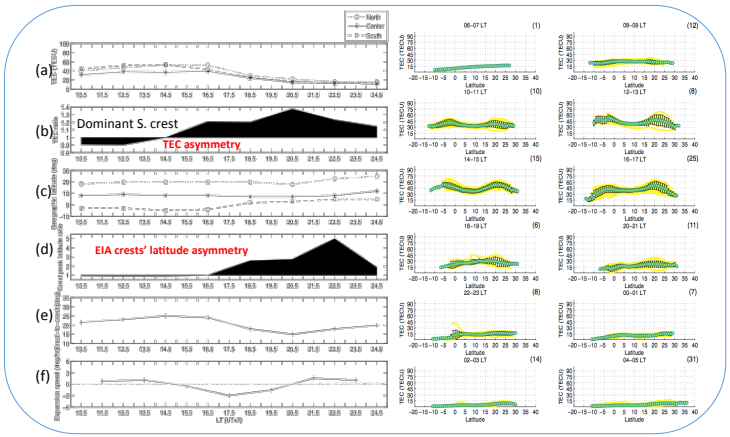


✧ Daily variation of EIA (For Kp <3-, Equinox 2012)

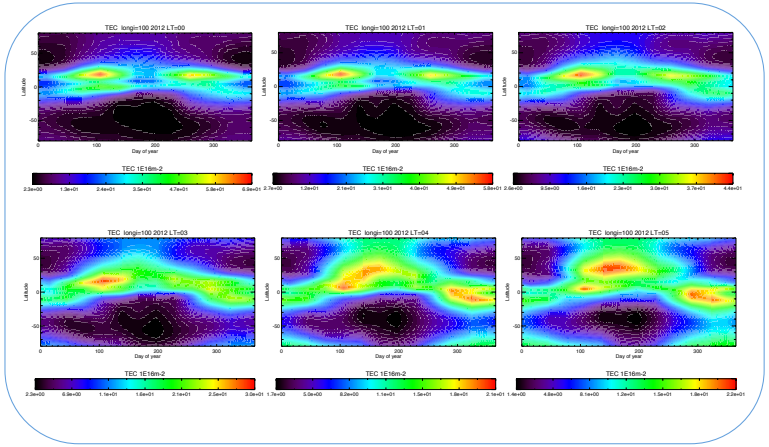


[Watthanasangmechai et al., EPS, 2015]

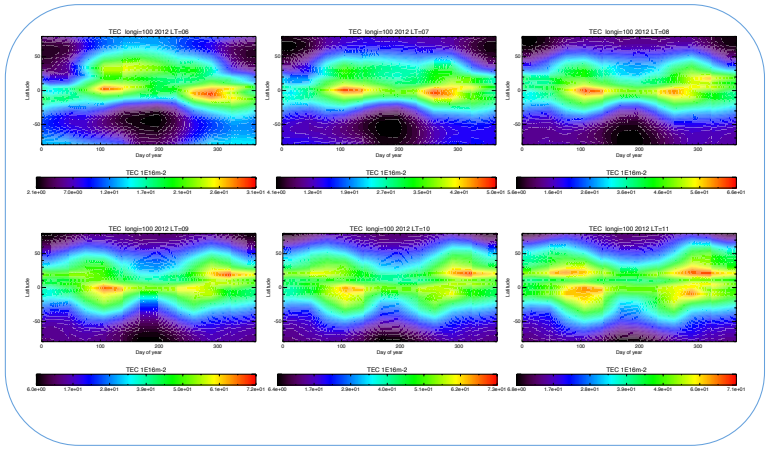
✧ Daily variation of EIA (For Kp <3-, Solstice 2012)



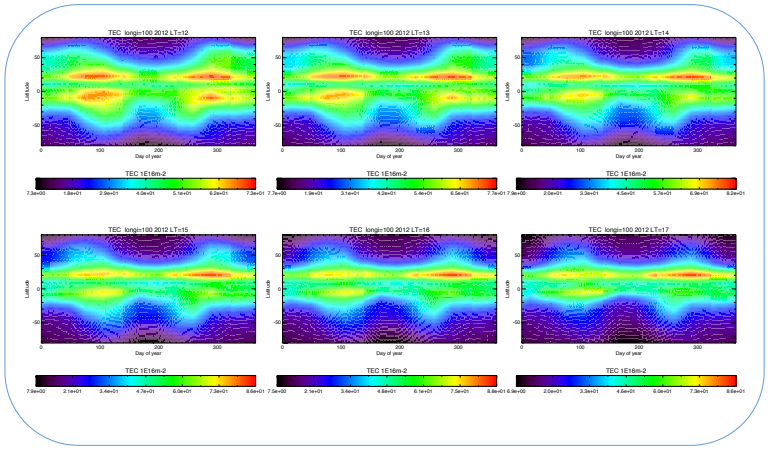
✧ IRI TEC along 100 degree E (2012, 00-05 LT)



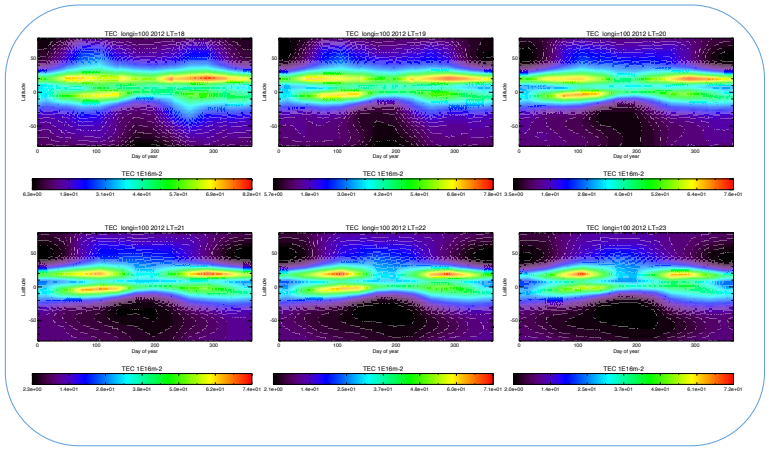
✧ IRI TEC along 100 degree E (2012, 06-11 LT)



✧ IRI TEC along 100 degree E (2012, 12-17 LT)



✧ IRI TEC along 100 degree E (2012, 18-23 LT)



✧ Conclusions

- TEC background in Equinox is higher than that in solstice.
- TEC asymmetry
  (TEC Ratio (R), R=1: symmetry, R<1: southern crest is dominant,
  R>1: northern crest is dominant)
  - Equinox: TEC ratio is in the range of [0.85, 1.15].
  - Solstice: TEC ratio is in the range of [0.9, 1.35].
- latitudinal asymmetry
  (Crest-peak-latitude ratio (C), C=1: symmetry,
  C<1: southern crest is far to the dip equator (well developed),
  C>1: northern crest is far to the dip equator (well developed))
  - Equinox: latitude ratio is in the range of [0.6, 2.25].
  - Solstice: latitude ratio is in the range of [1, 5].