A study on the occurrence characteristics and sources of daytime ionospheric irregularities in the mid and low latitudes of the East-Asia region

Presentation file

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1. Introduction

- Based on GPS-TEC observations, daytime MSTIDs over East Asia occurred most often during the December solstice (NH winter).
- Based on satellite observations, low latitude daytime ionospheric irregularities over the East Asian sector occurred most often during the June solstice (NH summer).

→ Our current hypothesis for **the difference in the occurrence of daytime ionospheric irregularities between GPS-TEC observations and in situ observations in LEO** is that **the observations' altitudes differ**.

→ We analyzed Beidou-TEC observations over China to confirm the irregularity characteristics of the East Asia region. Satellite observation data, such as ICON (and COSMIC in the future), was also used to confirm the height dependence of the daytime irregularities.

2. Data and Methodology

Station	GEO PRN	Station Coordinate	IPP Coordinate	IPP Geomagnetic latitude
MHGR	C03	53.5°N	47.8°N	48.1°N
BJMT	C03	40.3°N	36.8°N	35.1°N
SDZB	C03	36.4°N	33.4°N	30.7°N
JSWX	C03	31.7°N	28.7°N	25.6°N
HSJS	C03	28.7°N	26.5°N	22.6°N
GXGL	C03	25.3°N	23.4°N	18.9°N
GXBH	C03	21.5°N	17.0°N	14.7°N
SYBG	C03	18.3°N	13.1°N	11.2°N

Table. 1 *Coordinates of GNSS Receiver Station and GEO IPP*

✓ MSTID activity from Beidou TEC over China

- The BDS GEO TEC data from GNSS receivers at middle and low latitudes during the solar minimum
- To derive perturbation components of TEC (I'), we subtracted the 1-hour running average of TEC.
- MSTIDs activity is defined as the ratio of the standard deviation of I' within 1 hour and the 1-hour average absolute TEC (Kotake et al., 2006)).

✓ Morphology of daytime topside irregularities from ICON observation

- The study used an IVM instrument onboard ICON satellites from January 2020 to December 2021.
- The daytime ionospheric irregularity is detected by parameter S proposed by (Kil et al., 2020). A threshold of 0.002 was employed to identify daytime irregularity.
- The occurrence rate is defined as the number of data points belonging to irregularity divided by the total number of data points.

$$S = \left[\frac{1}{n-1}\sum_{i=0}^{n-1}\left(\log_{10}N_i - L_i\right)^2\right]^{1/2}$$

Kil et al., 2020

3. Results and Discussion

✓ Diurnal and seasonal variations of MSTIDs activity over China based on Beidou's observation during the low solar activity period

- Beidou TEC data over China along 50N to 18N during the solar minimum period is analyzed to study the seasonal and latitudinal variation of the TEC disturbances.
- Daytime irregularity peaks in the winter hemisphere were observed in all cases, with intensity and occurrence increasing in tandem with increasing latitude.
- The low altitude ionosphere, as presented as the TEC, is strongly influenced by the MSTIDs activity.

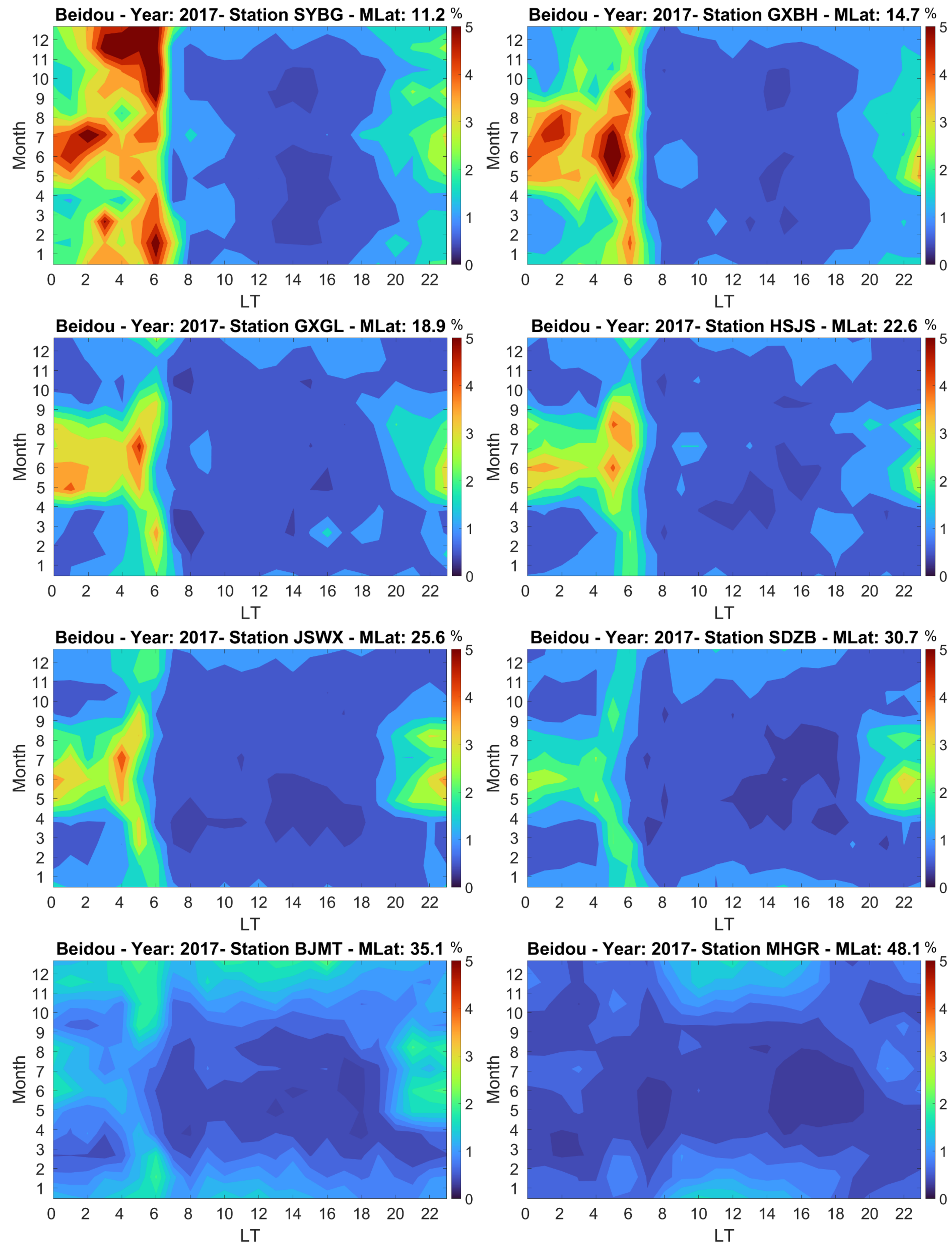

Figure. 1 *Local time and seasonal variations of MSTIDs activity over China in 2017 with the observation from Beidou*

✓ Distributions of dayside topside irregularity occurrence rates from ICON data in 2020-2021

- The daytime topside irregularities during 09:00–15:00 LT preferred to appear at low latitudes away from the magnetic equator.
- Electron density irregularities occurrence characteristics over the East Asian sector peak during June solstice.
- The result provides strong evidence of the latitudinal redistribution of fossil bubbles by the fountain effect (Kil et al. 2020).

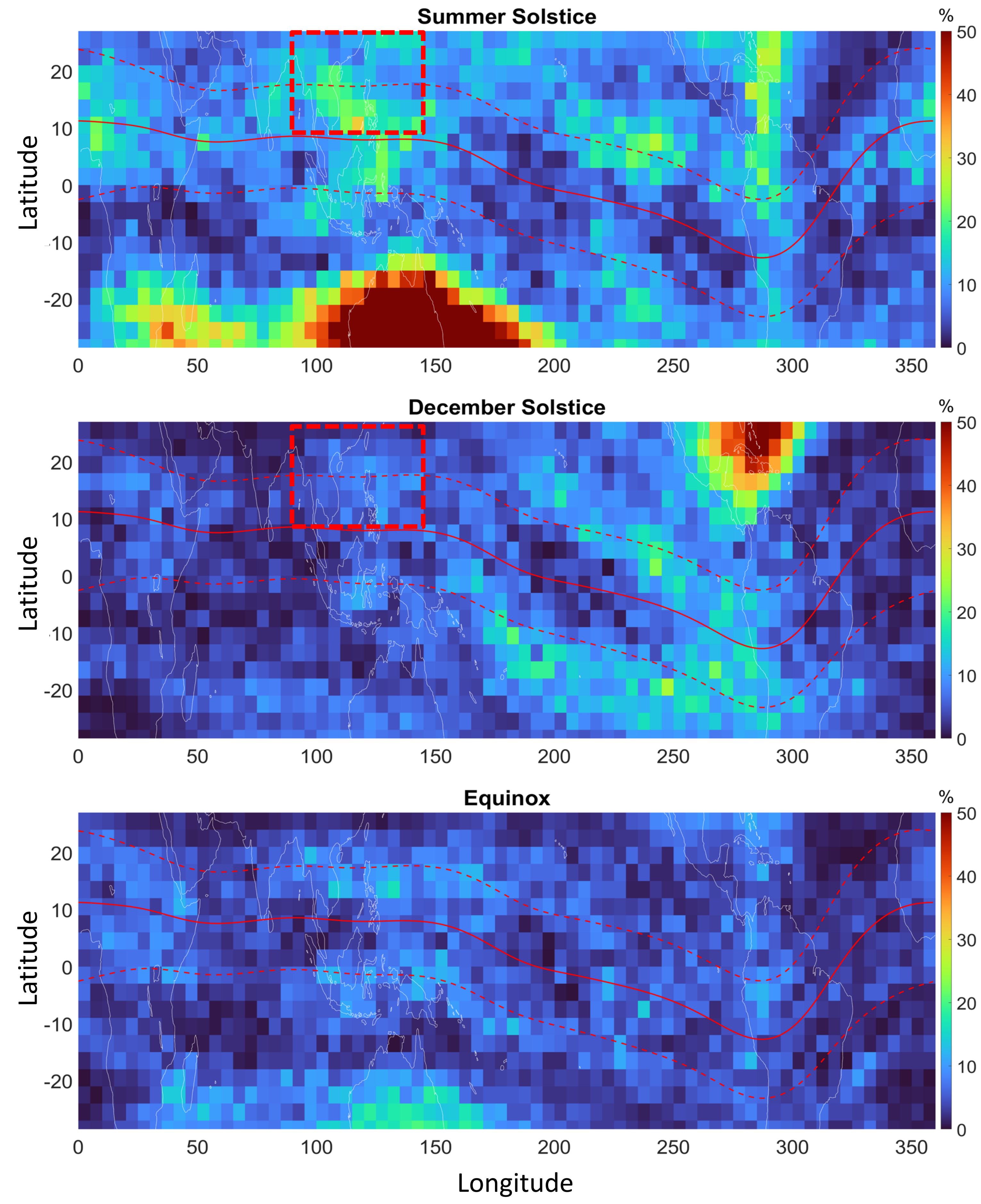

Figure. 2 *Longitudinal and latitudinal distributions of topside irregularity occurrence rates in Equinox, June solstice, and December solstice during 09:00–15:00 LT in 2020-2021*

➢ **It is possible that the MSTID effect is more prominent at lower altitudes and can be considered a main source of irregularity, while at altitudes over 600km, the plasma bubbles can overcome the MSTID effect.**

4. Future works

- COSMIC RO data can observe the electron density altitude profile; hence, they can be useful for studying the height dependence of daytime irregularity.
- Our next step in this study is to observe the bottom and topside ionosphere change using COSMIC data over the East Asian sector.
- We will analyze the characteristics of the daytime irregularity at both high (~600km) and low altitudes (~300km) using COSMIC RO data to confirm the height dependence of the daytime irregularities.

Reference

- Huang et al. (2019). Daytime periodic wave-like structures in the ionosphere observed at low latitudes over the Asian-Australian sector using total electron content from Beidou geostationary satellites.
- Kil et al., (2020). Origin and distribution of daytime electron density irregularities in the low-latitude F region.
- Kotake et al., (2006), Climatological study of GPS total electron content variations caused by medium-scale traveling ionospheric disturbances