



EGU25-410



Responses of Ionospheric F layer Radial Current to the Enhanced Solar Wind Input

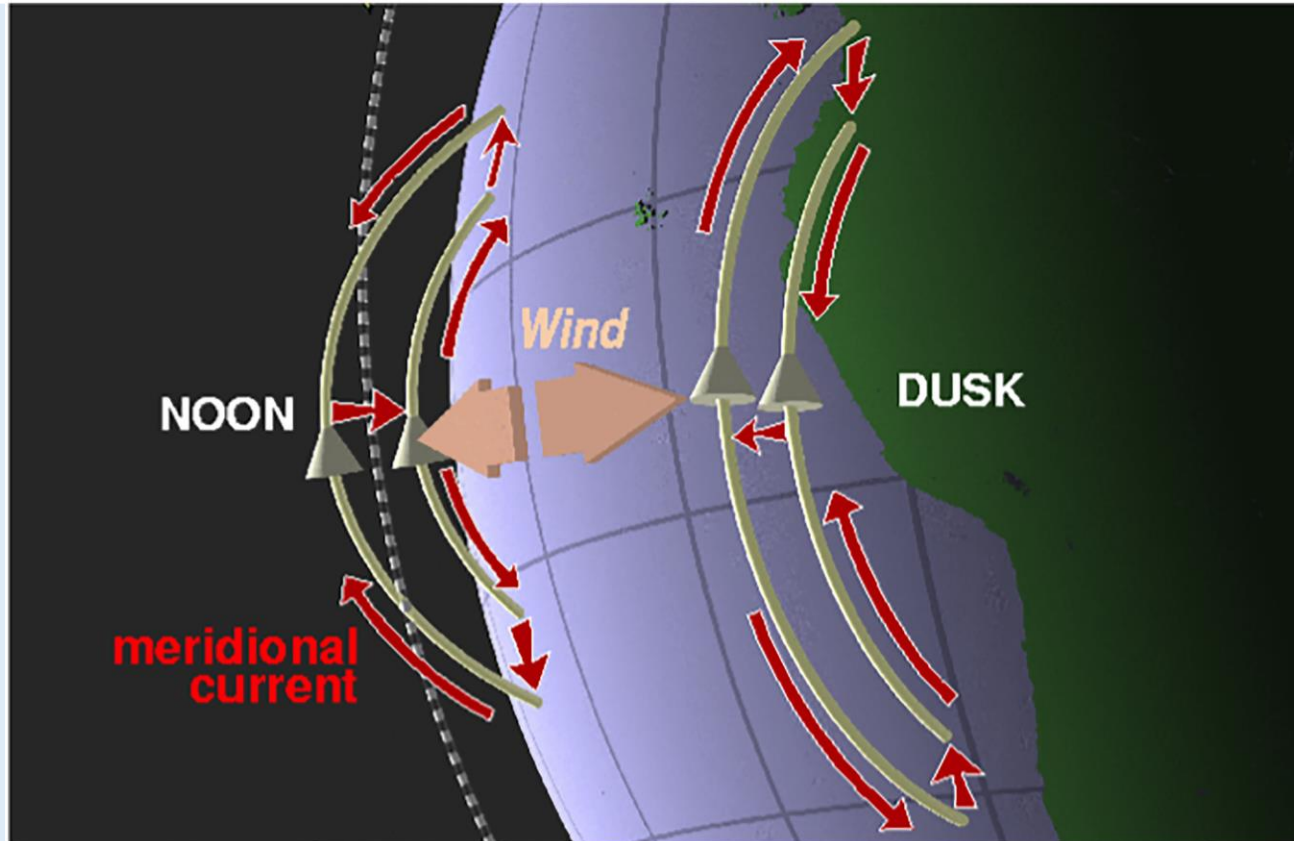
Yunfang Zhong

(yunfang.zhong@whu.edu.cn)

Hui Wang

Wuhan University, Wuhan, China

1. Motivation



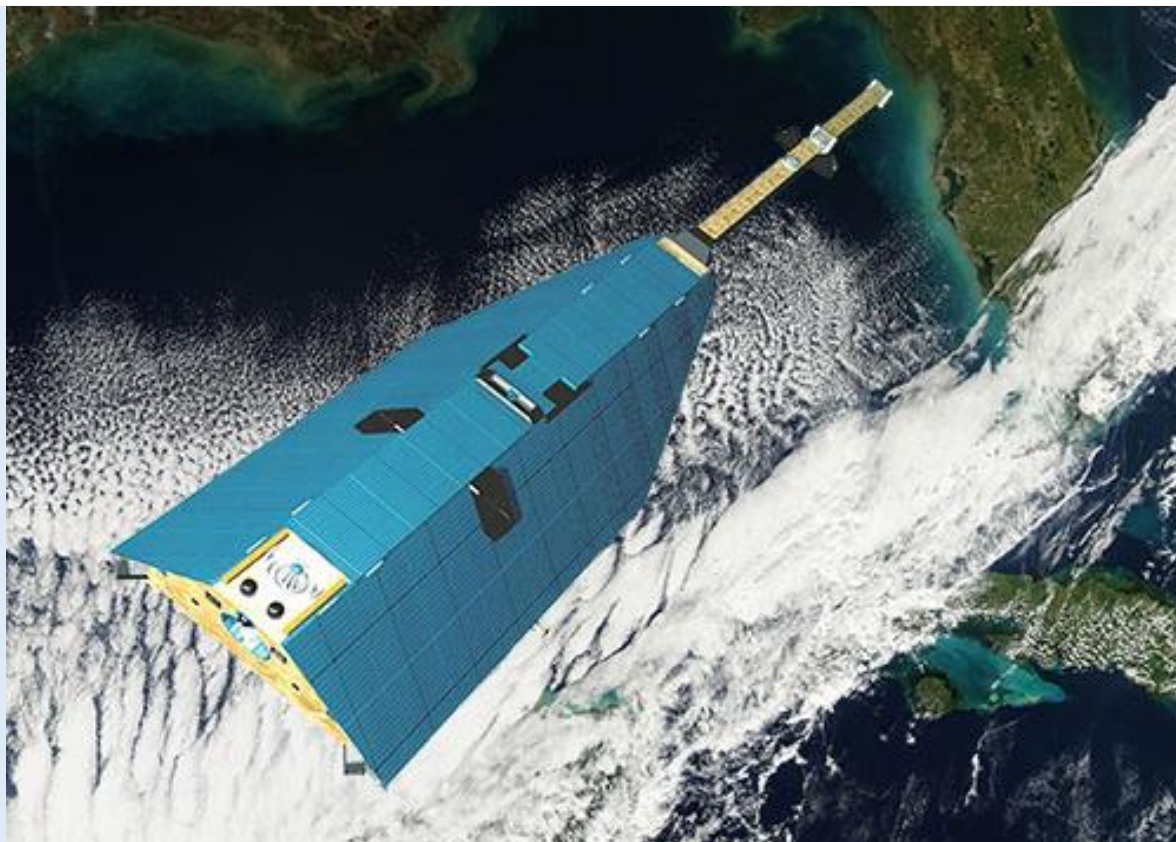
- ◆ Current loop: F layer ionospheric radial current (IRC) , field-aligned meridional currents, and E layer horizontal currents.
- ◆ The IRC flows vertically around the magnetic equator, mainly downward around noon and upward at dusk.

IRC driven by thermospheric winds and related current system around noon and dusk.

$$j_{IRC} = \sigma_P(E_z - u_y B_x)$$

- ◆ $\sigma_P E_z$ represents the polarization current (related to plasma drift).
- ◆ $\sigma_P u_y B_x$ represents the neutral wind dynamo current.
- ◆ IRC is mainly driven by **thermospheric winds**.

2. Data and Methods

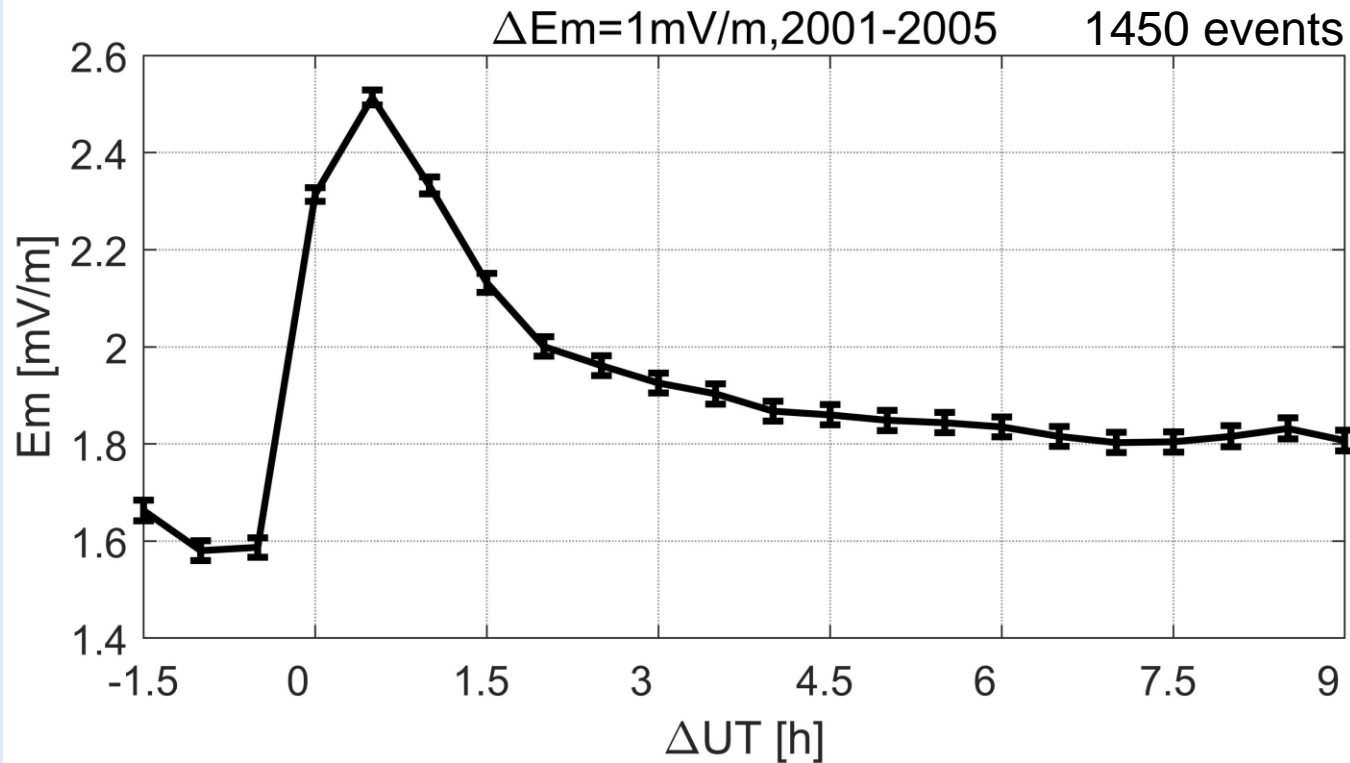


IRC is derived from **vector magnetic field data** (50 Hz) from CHAMP.

$$j_r = -\frac{1}{2000\mu_0 dt} \left(\frac{dB_y^{\text{VSC}}}{V_x^{\text{VSC}}} - \frac{dB_x^{\text{VSC}}}{V_y^{\text{VSC}}} \right)$$

$dt = 1\text{s}$, μ_0 : vacuum permeability
 dB_x^{VSC} , dB_y^{VSC} : horizontal gradients of magnetic field
 V_x^{VSC} , V_y^{VSC} : horizontal spacecraft velocity components

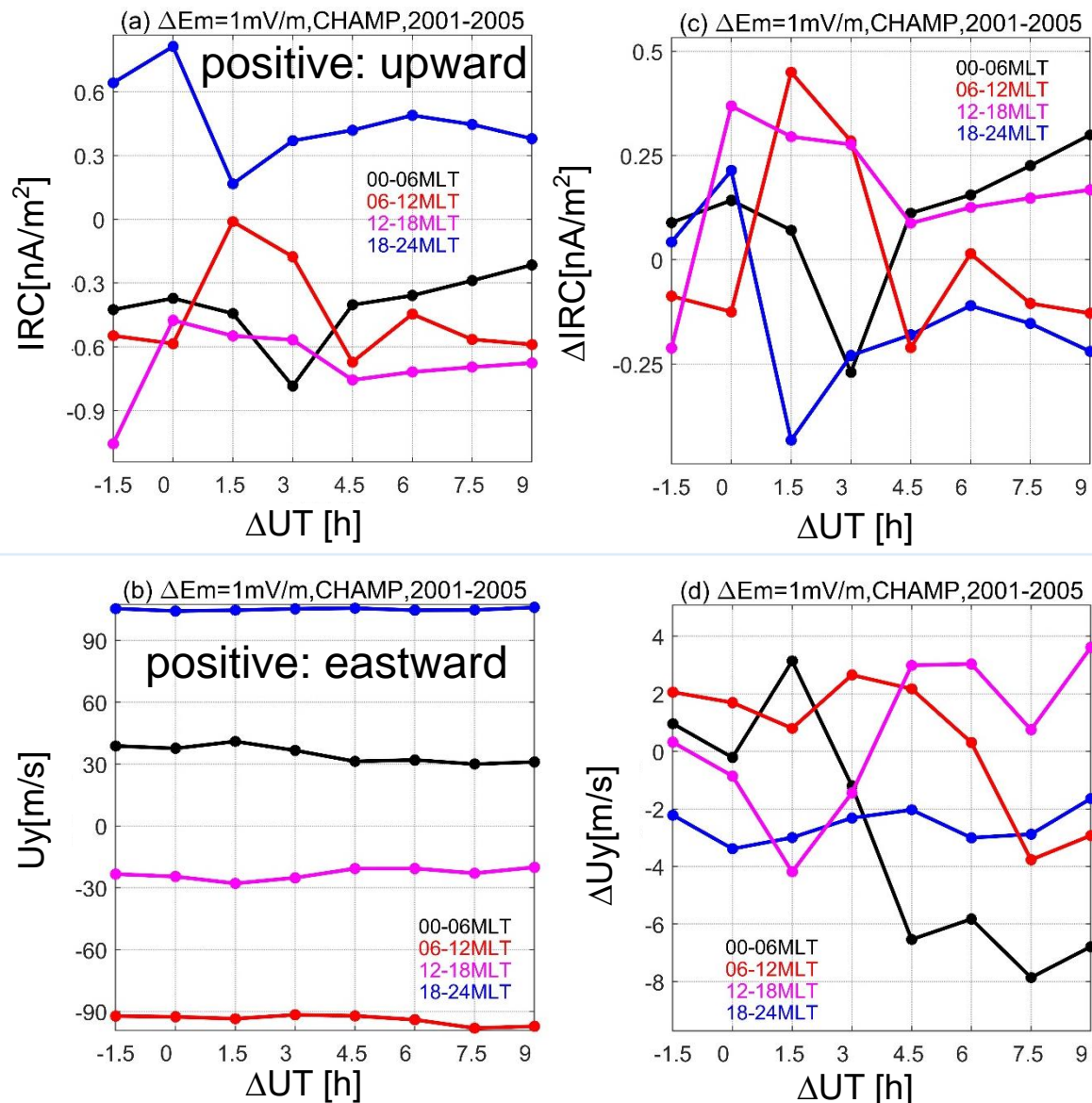
3. Results



E_m enhancement events:
 $E_m(n+1) - E_m(n) > 1 \text{ mV/m}$

Superposed epoch analysis of merging electric field (E_m) during E_m enhancement.

3. Results



Zonal wind effect:

eastward U_y \rightarrow upward IRC

westward U_y \rightarrow downward IRC

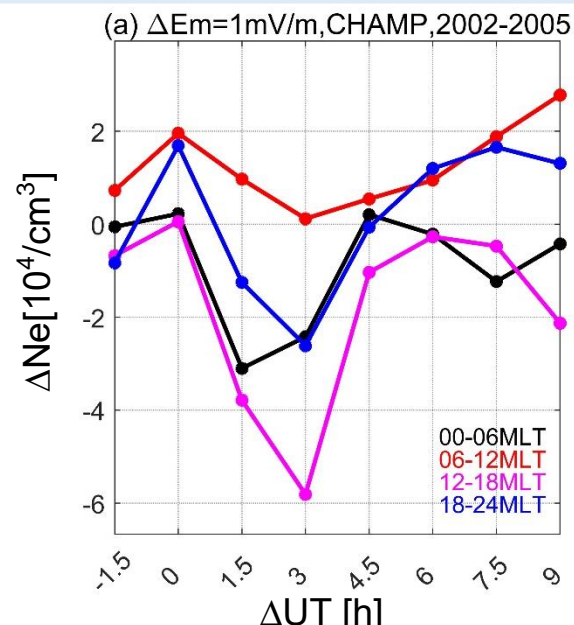
IRC increases in the **upward** direction in the **daytime**, but in the **downward** direction at **night**.

downward IRC

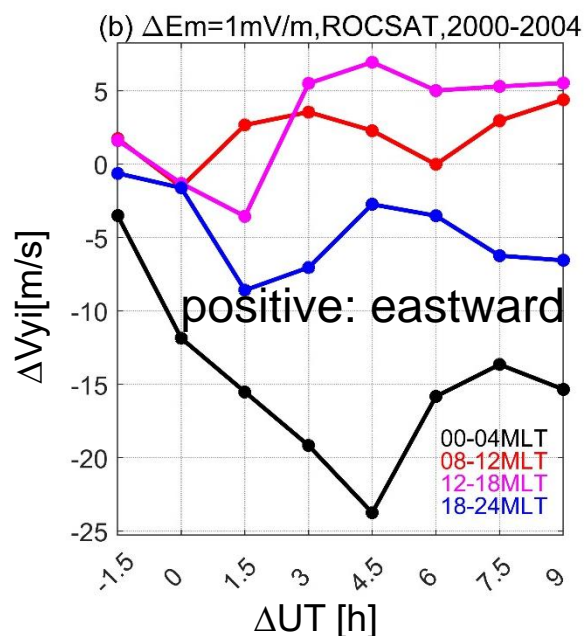
F layer **zonal wind** increases in the **westward** direction in the **daytime** and in the **eastward** direction at **night**.

upward IRC

3. Results



The reduced **electron density** **cannot** explain the enhanced IRC intensity at 00–06 MLT.



Zonal plasma drift effect:

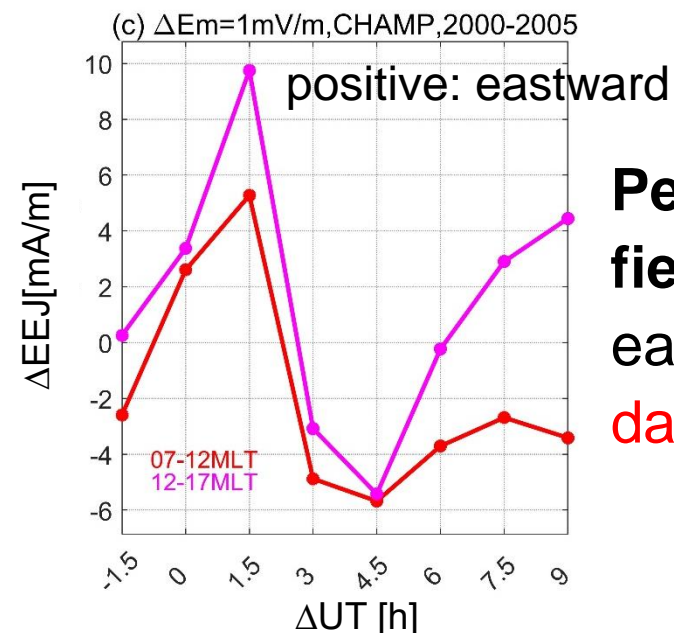
eastward V_{yi} → downward IRC

westward V_{yi} → upward IRC

V_{yi} increases in the **eastward** direction in the **daytime** and in the **westward** direction at **night**.

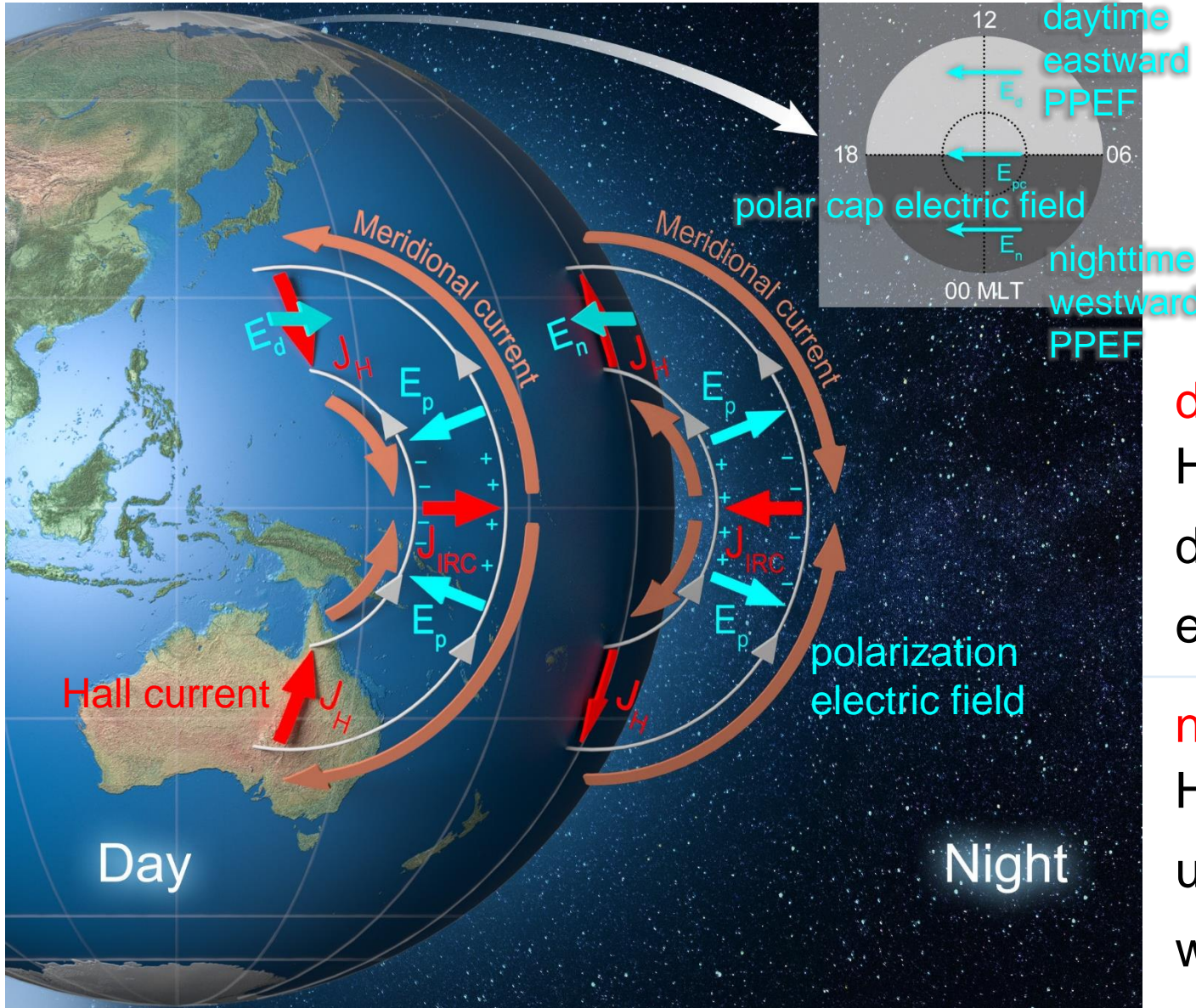
Downward IRC

Upward IRC



Penetration electric field (PPEF) induces eastward EEJ in the daytime.

4. Discussion



$$j_x = \frac{\sigma_P}{\sin I} E_x + \frac{\sigma_H}{\sin I} E_y$$

equatorward current equatorward electric field eastward electric field

inclination of the geomagnetic field

daytime eastward PPEF → equatorward
Hall current → upward IRC →
downward polarization electric field →
eastward plasma drift

nighttime westward PPEF → poleward
Hall current → downward IRC →
upward polarization electric field →
westward plasma drift

1. Within 3 h of E_m enhancement, the disturbance IRC increases in the upward direction in the daytime, but in the downward direction at night.
2. The fast responses of IRC to E_m enhancement are due to penetration electric field rather than neutral wind.



EGU25-410



Thanks!