Simulations of vertical ion-drag effect on neutral winds and density at low latitudes

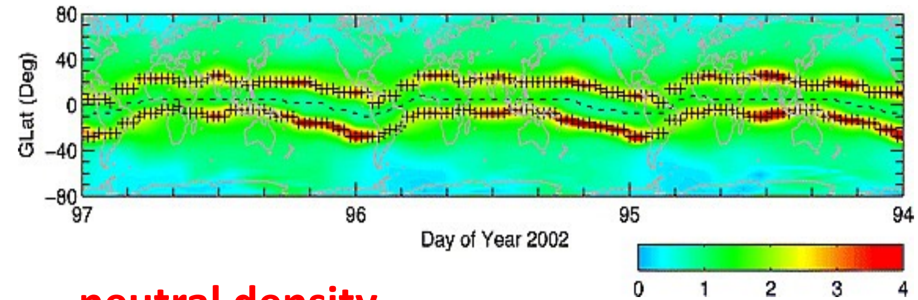
Qingyu Zhu[1](qingyu.zhu@mavs.uta.edu), Yue Deng[1], Astrid Maute[2], Arthur D. Richmond[2]

1. University of Texas at Arlington, Arlington
2. High Altitude Observatory, Boulder

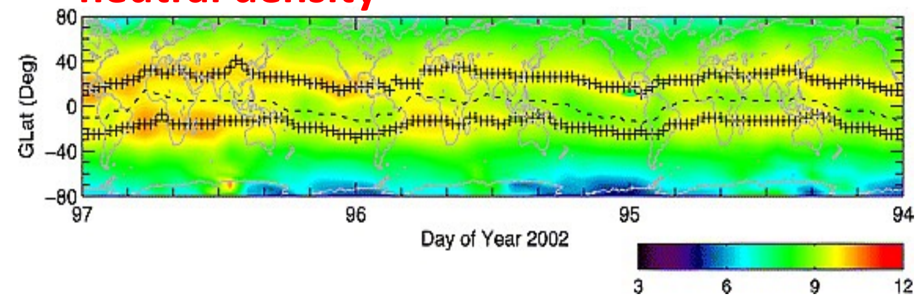
MOTIVATIONS

- Upward ExB → EIA
- Observations shows the coupling of ETA and EIA (e. g. Lei et al. 2010)
- Vertical ion-drag force of the E×B drift might contribute to the formation of ETA
- Most GCMs have difficulty to evaluate such effect due to hydrostatic assumption

electron density



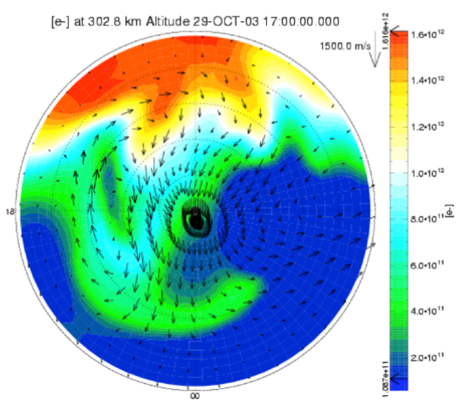
neutral density



Lei et al. 2010,JGR

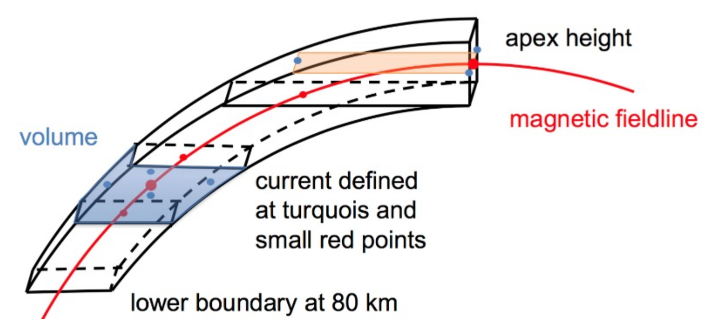
GITM + 3D electrodynamo model

- Global Ionosphere Thermosphere Model (GITM)



Ridley et al, 2006 JASP

- 3D electrodynamo model



Maute and Richmond 2016, SSR

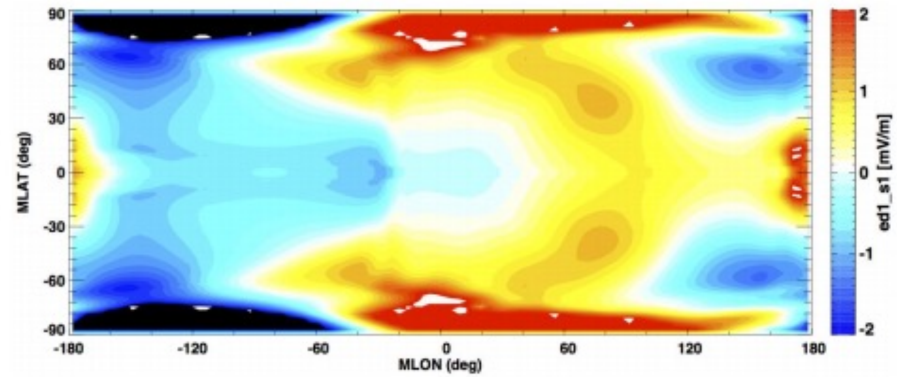
METHODOLOGY

- Get the ed1 from 3D-electrodynamo model with the input of winds and conductivities from the TIEGCM

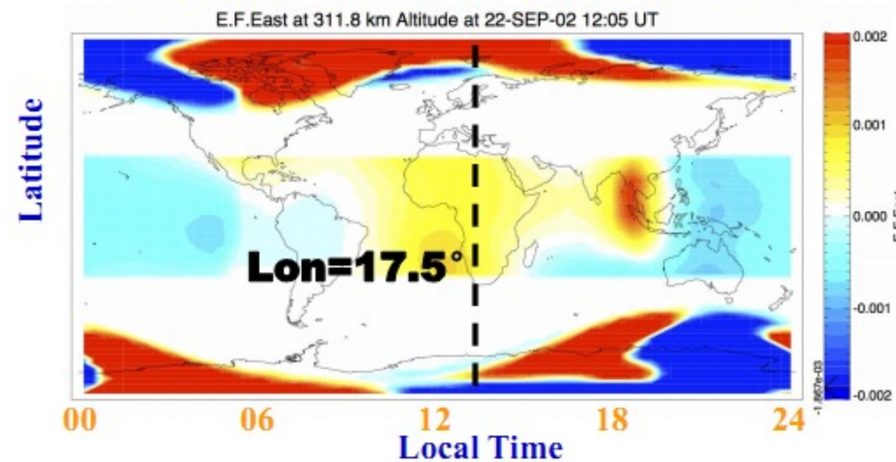
- Ed1 will be interpolated into GITM, only the electric fields within geo-lat ±30° are kept

- Two cases: one is with the equatorial electric fields and the other is without during 1200-1300 UT, differences are shown in the coming figures

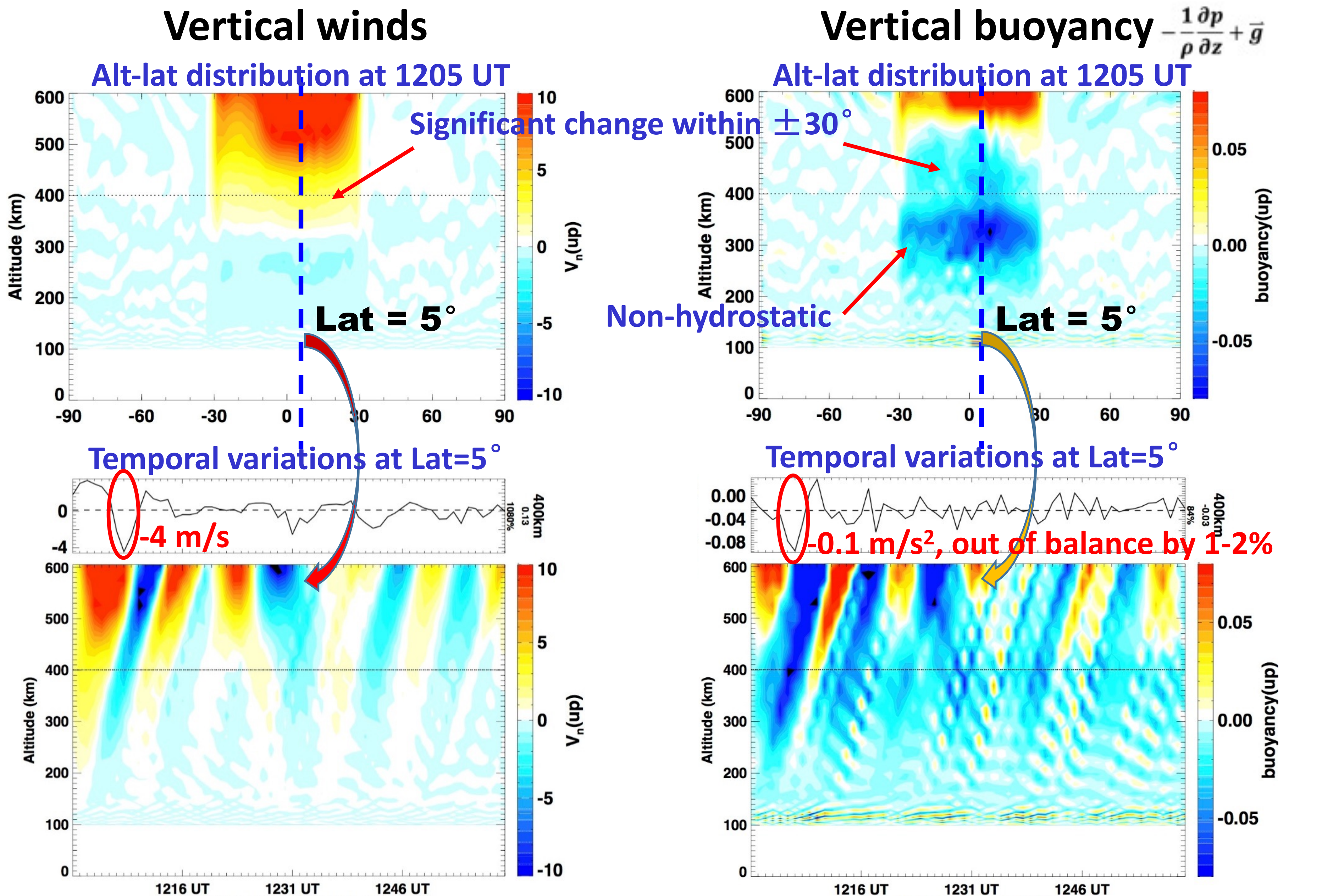
mLat-mLon distribution of Ed1 in APEX frame 1200 UT



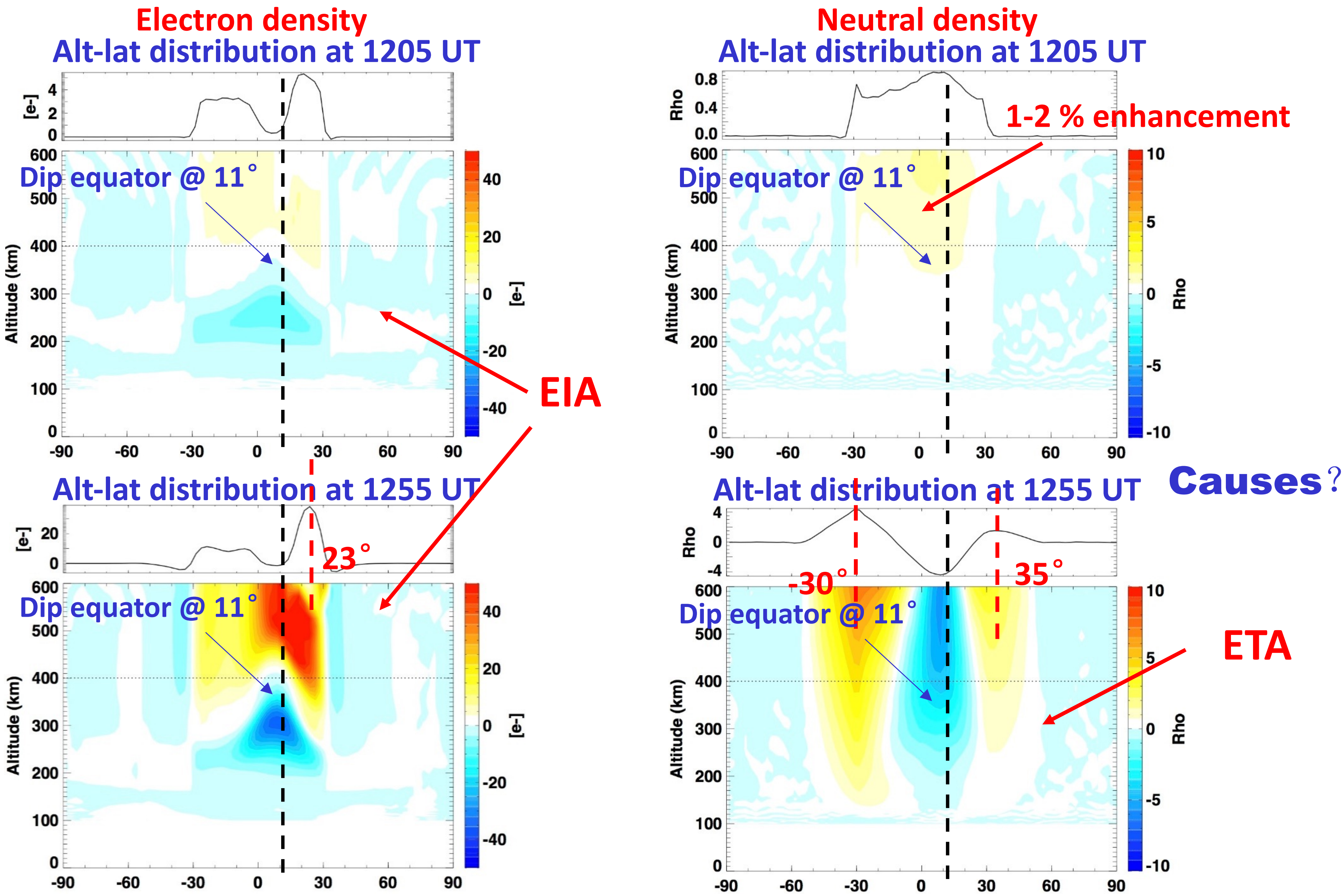
(a) Lat-Lon distribution of eastward electric field 1205UT



VERTICAL WINDS AND BUOYANCY



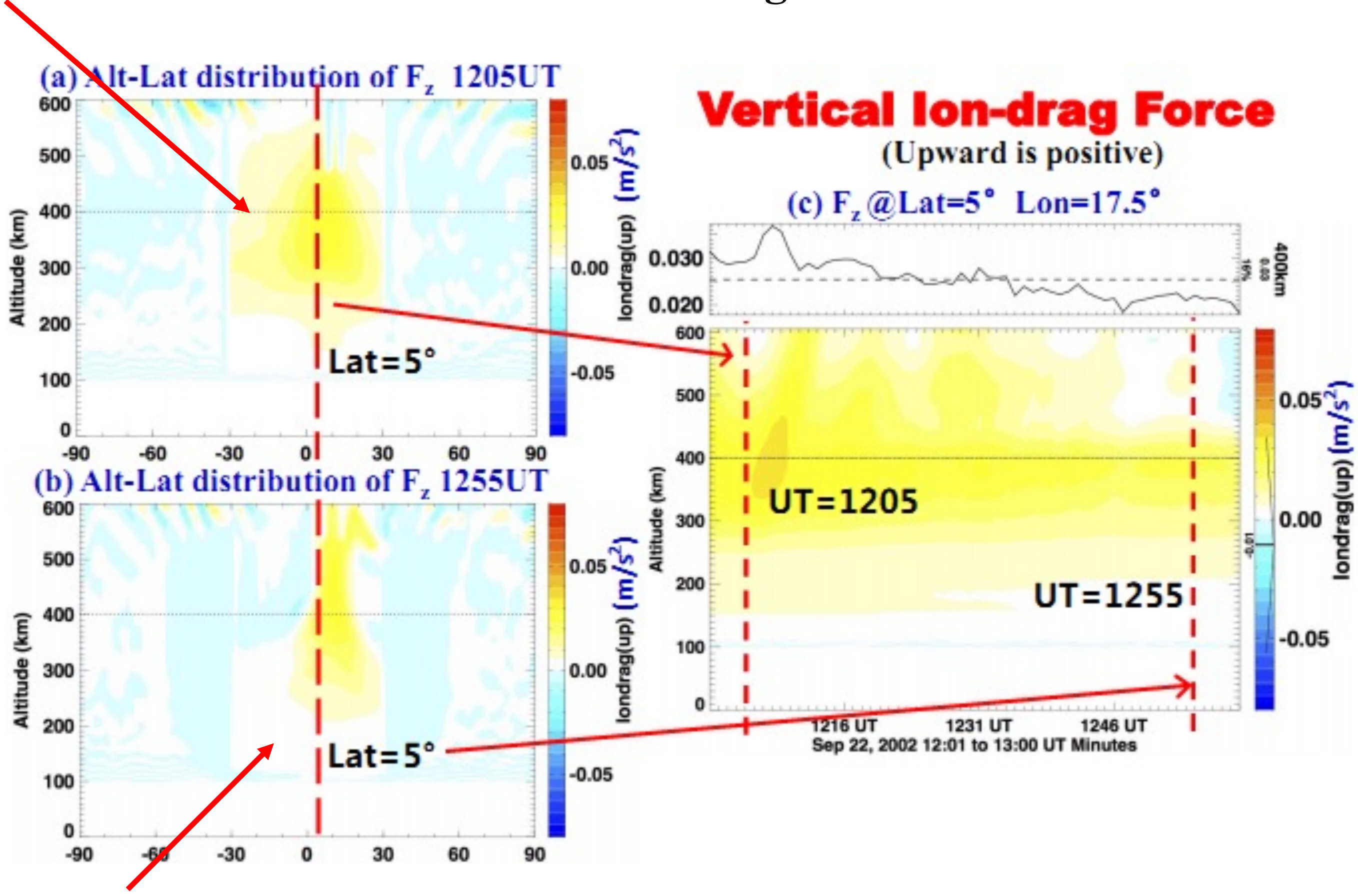
ELECTRON DENSITY AND NEUTRAL DENSITY



VERTICAL ION-DRAG FORCE

Significant increase within ±30°
Can reach 0.03m/s²

Push the density to the high altitudes

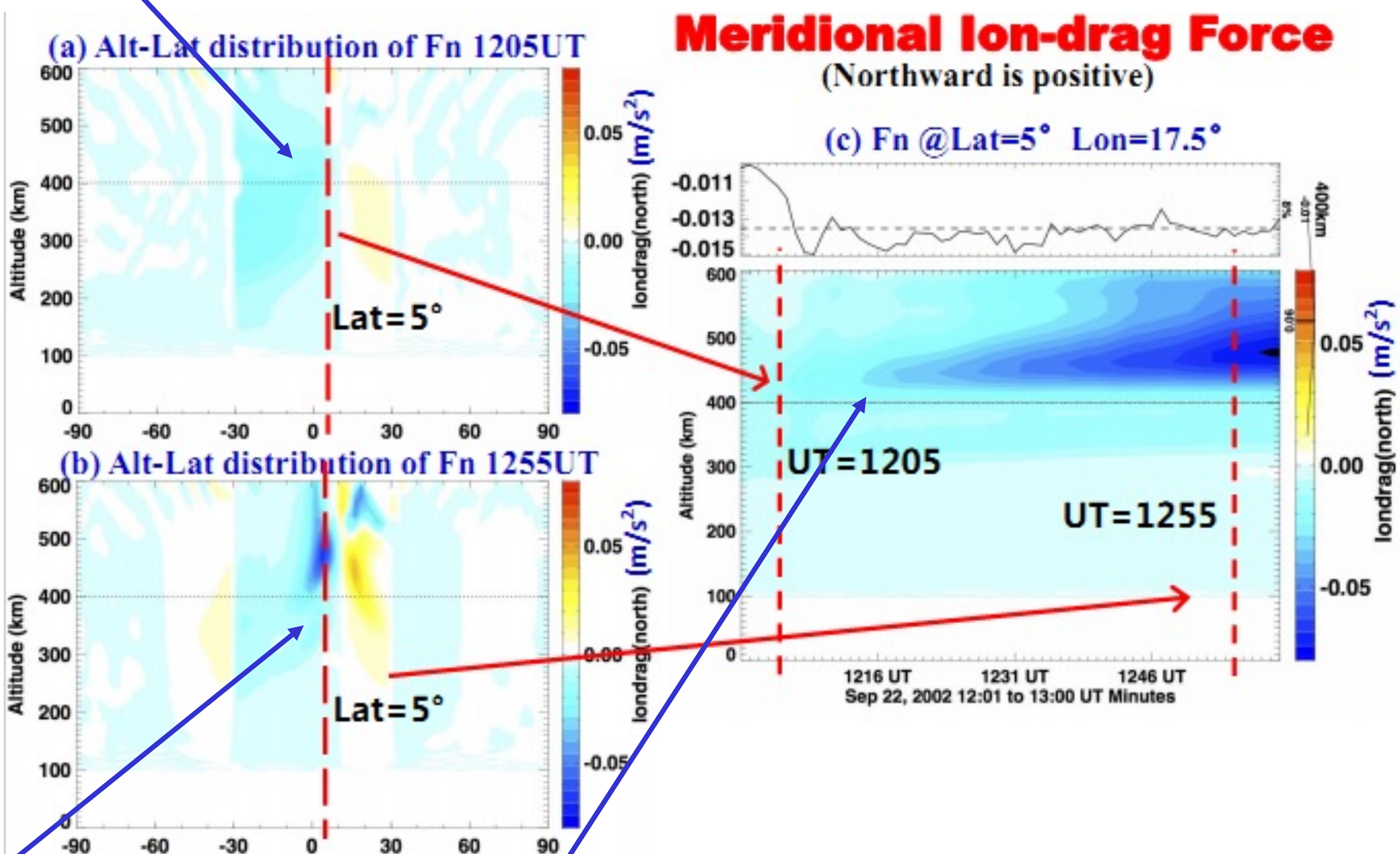


Positive but narrower range

Further development of ETA ?

MERIDIONAL ION-DRAG FORCE

- Meridional ion-drag force does exist at beginning
- A little bit weaker than vertical ion-drag force (±0.02 m/s²)



- More preeminent above 400 km as the time increases

CONCLUSION

- The vertical ion drift influences the motion of vertical wind through the vertical ion drag force, leading the imbalance between pressure gradient force and gravity.
- EIA and ETA features show up after the inclusion of equatorial electric fields. The ETA crests are more poleward than EIA crests.
- Vertical ion-drag force may contribute to the initial enhancement of the neutral density at equatorial region. The poleward ion-drag force may contribute to the formation of ETA.