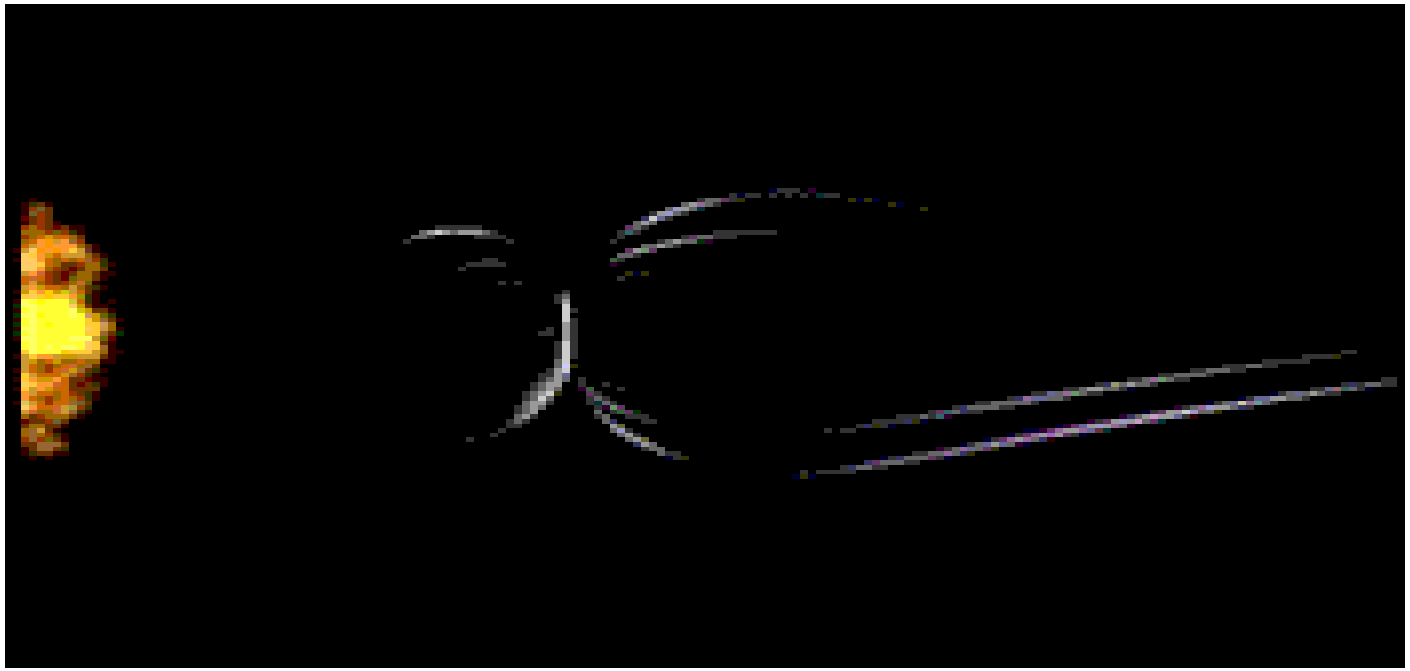
Space Weather monitoring by GNSS/BDS over China



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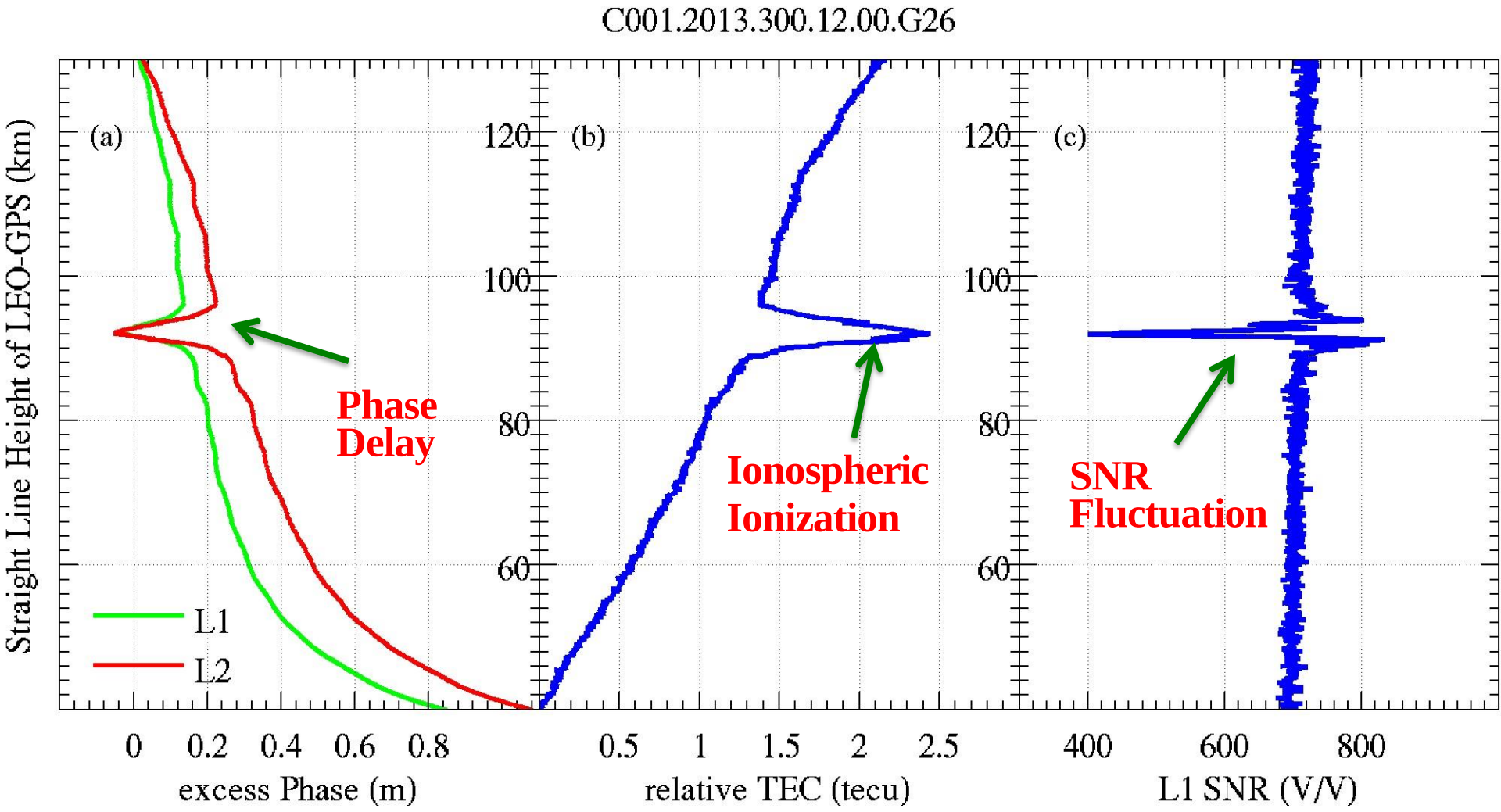
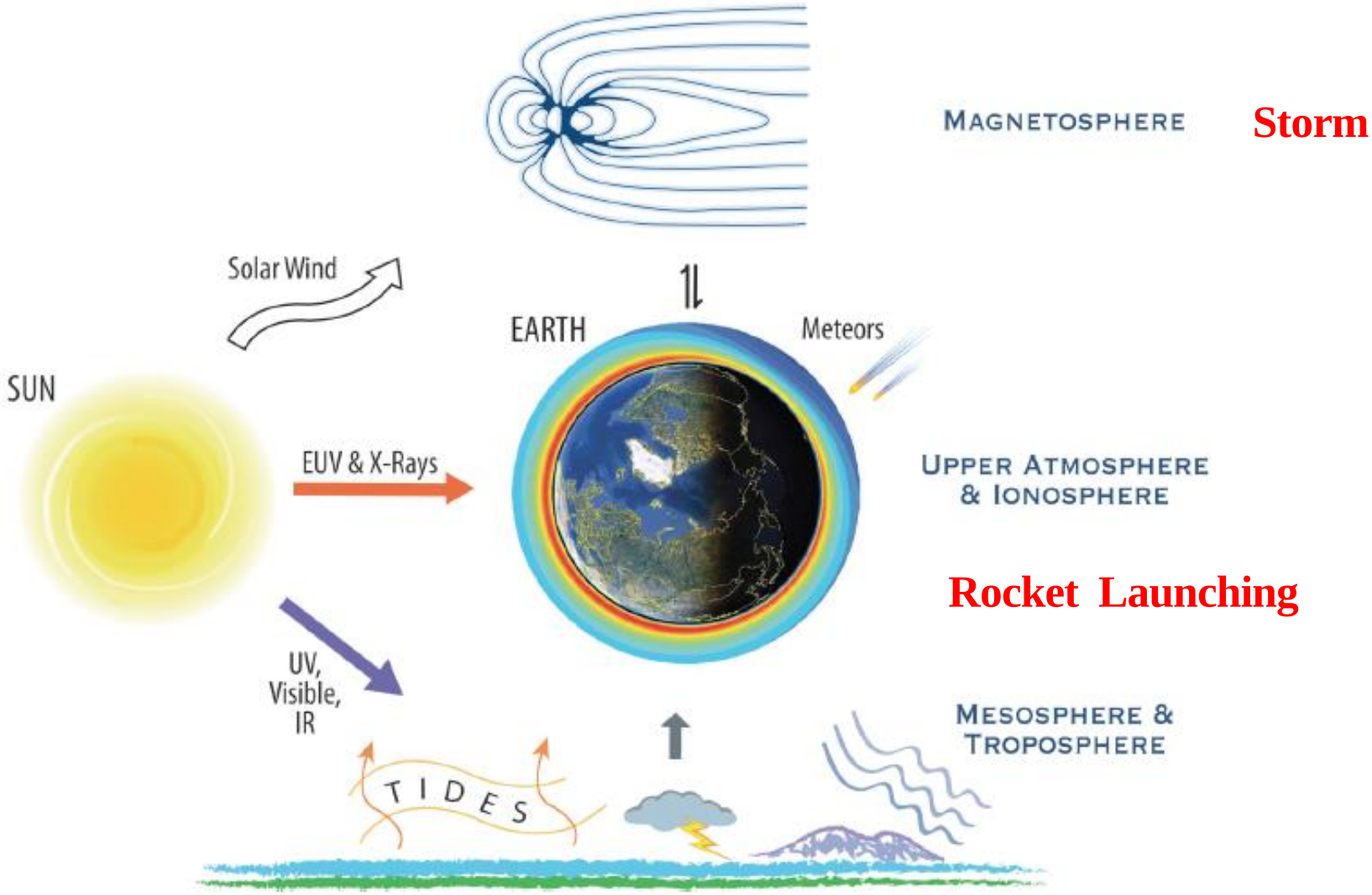
Outline

- Introduction
- Space Weather Monitoring by GNSS/BDS over China
  - Traveling Ionospheric Disturbance during Geomagnetic storm
  - Earthquake induced ionospheric disturbance
  - Rocket Launching induced ionospheric disturbance
  - Ionosphere Climate
  - Data Assimilation

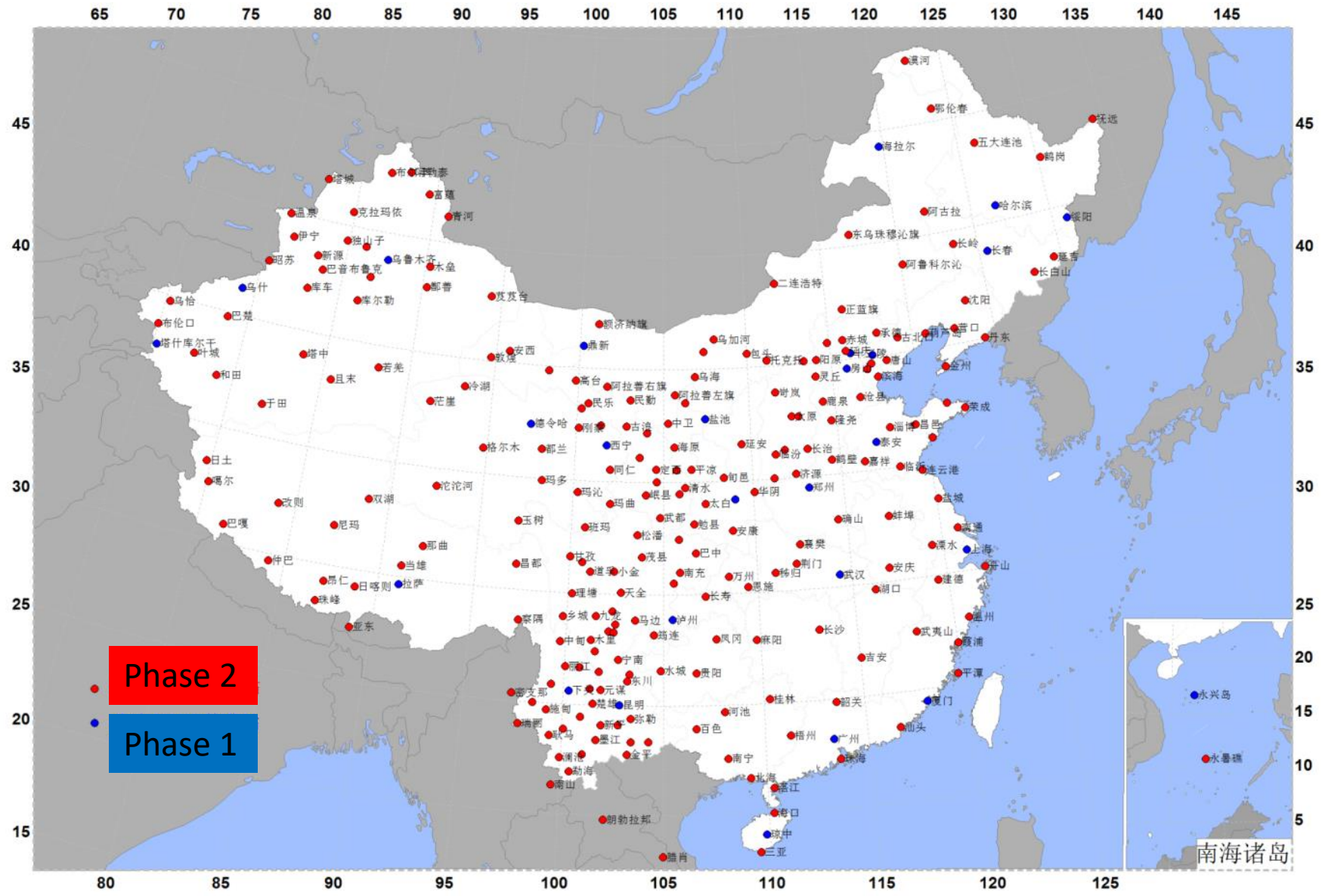
Ionosphere as noise and signal in GNSS observations



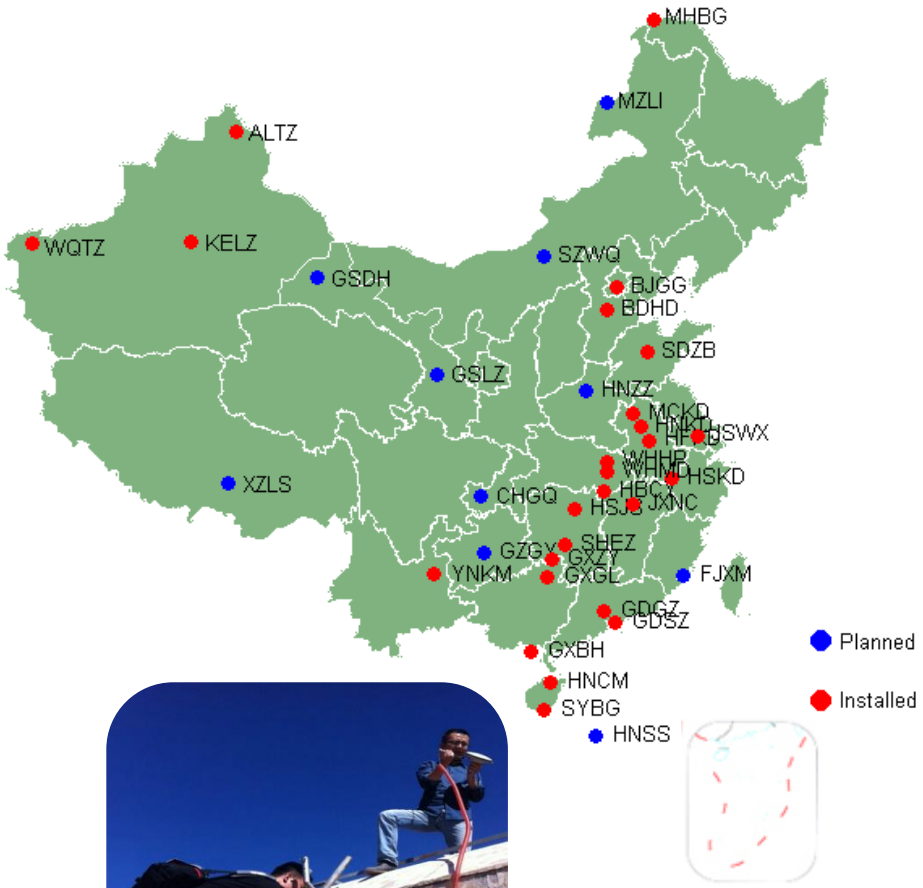
Drivers of Ionospheric Weather



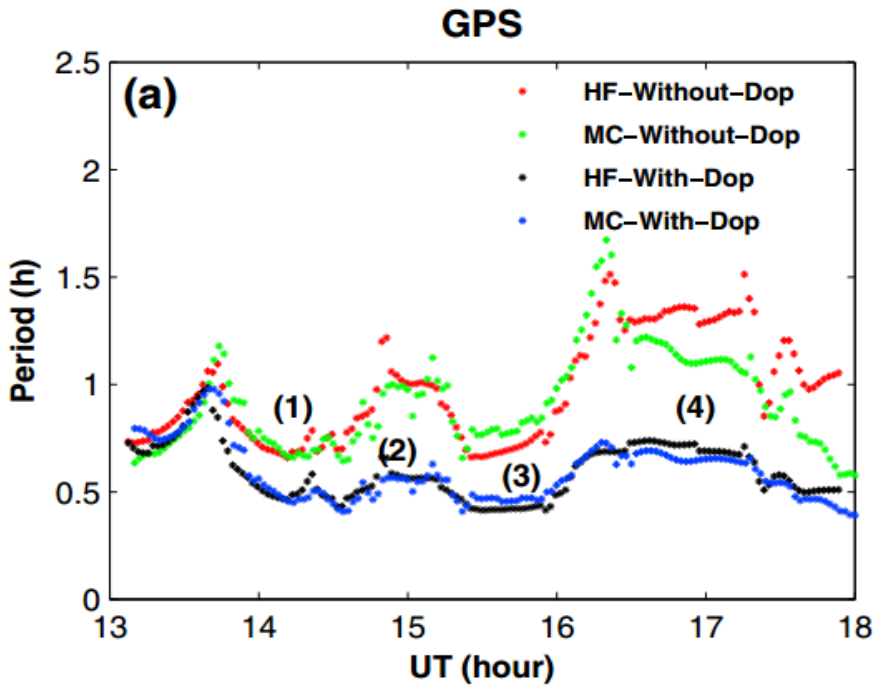
Data Source: GNSS stations managed by CEA

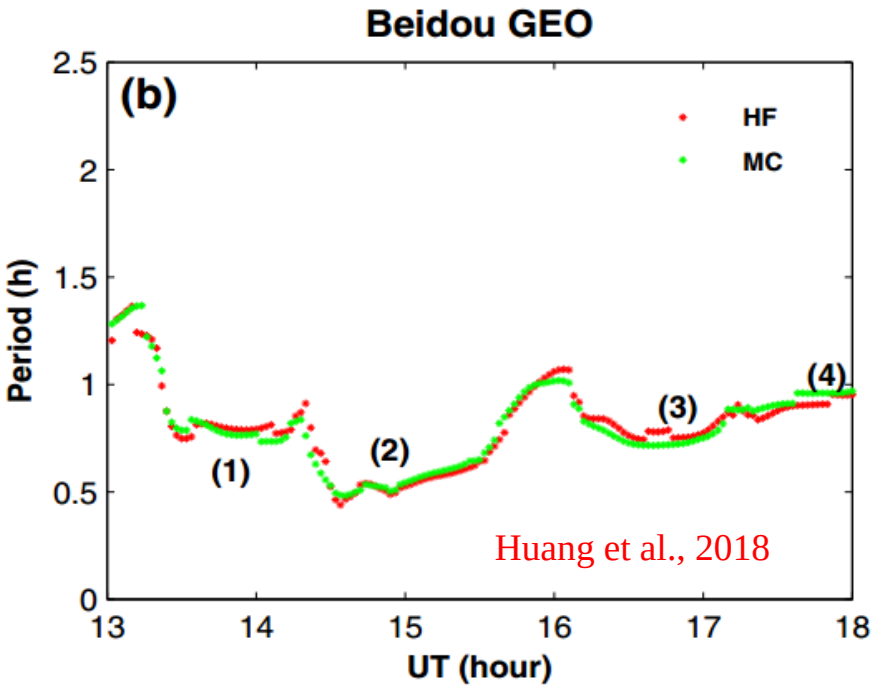


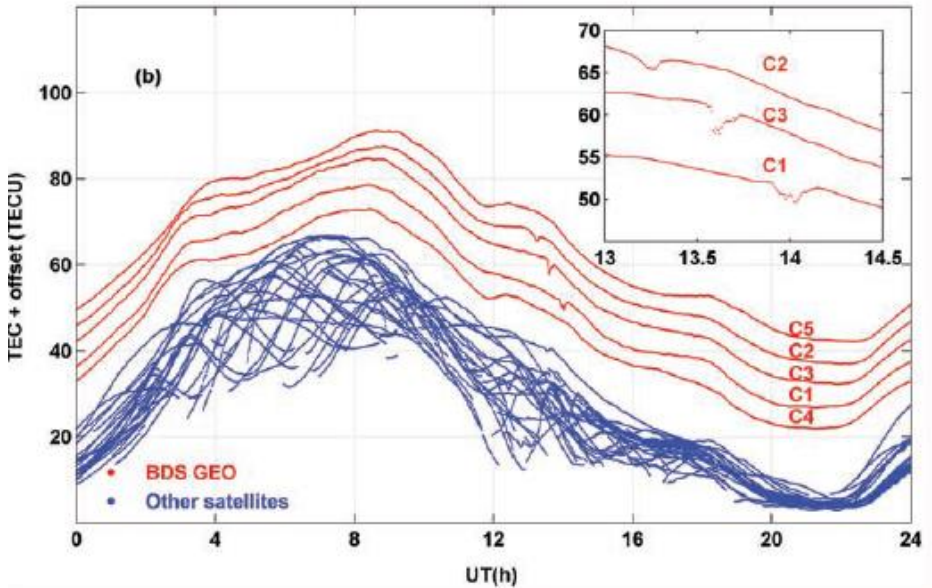
Data Source: BeiDou Ionospheric Observing Network (BION)



Advantages of GEO data







- No Doppler effect due to IPP moving
- More accurate in period estimation of TID than GPS/GLONASS
- Less noise than GPS/GLONASS data for specific study

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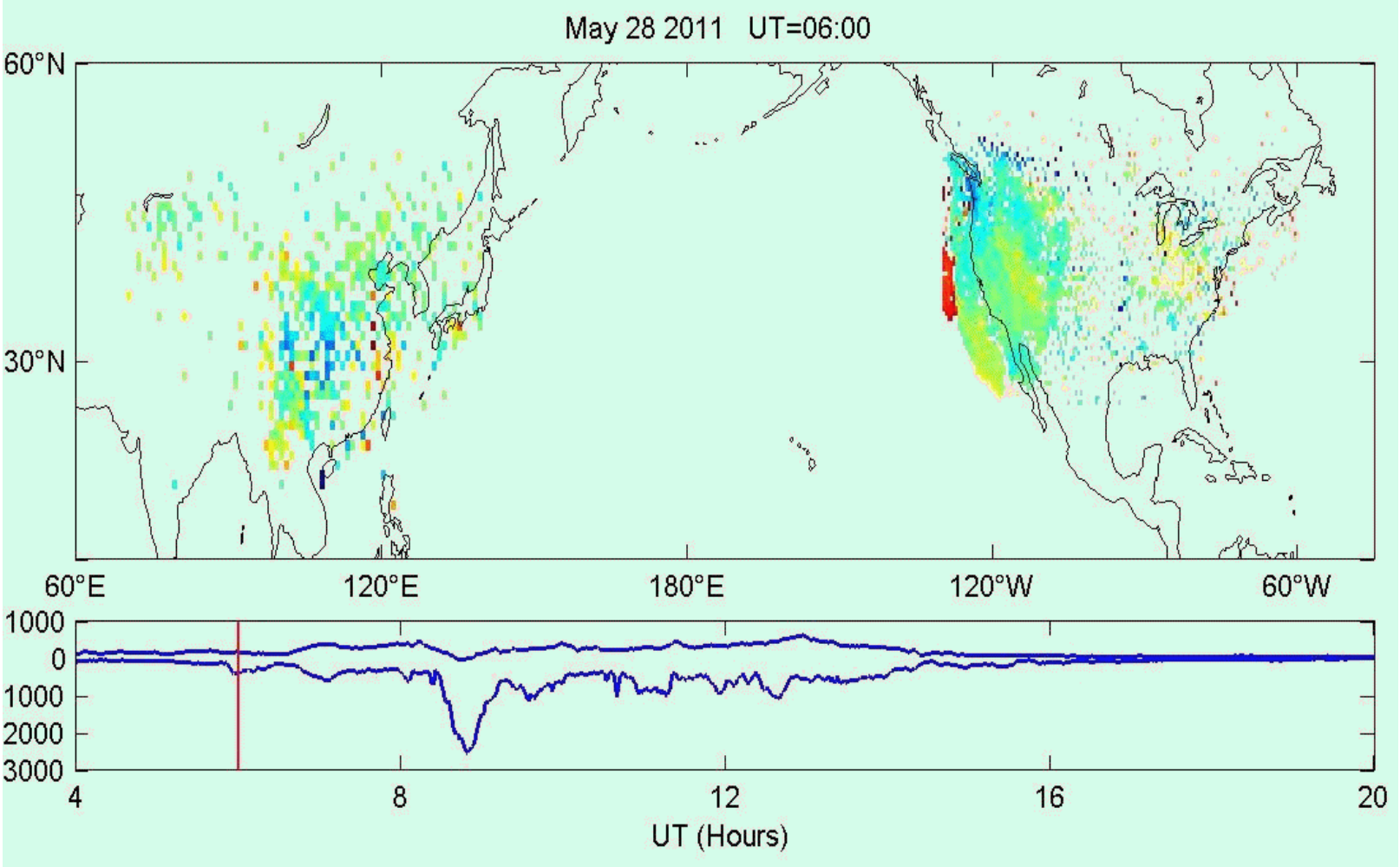
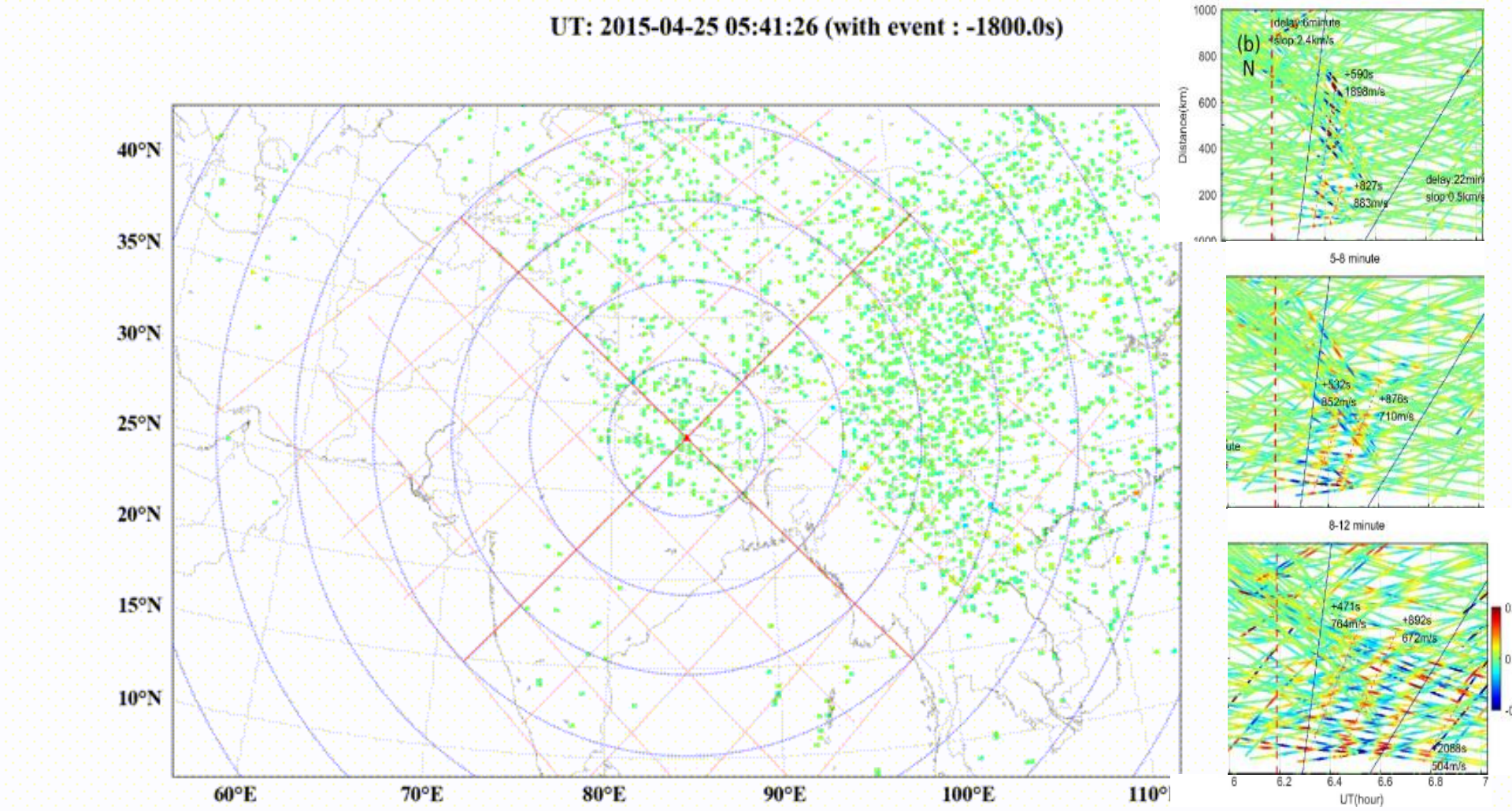
TID during May 28, 2011 Storm



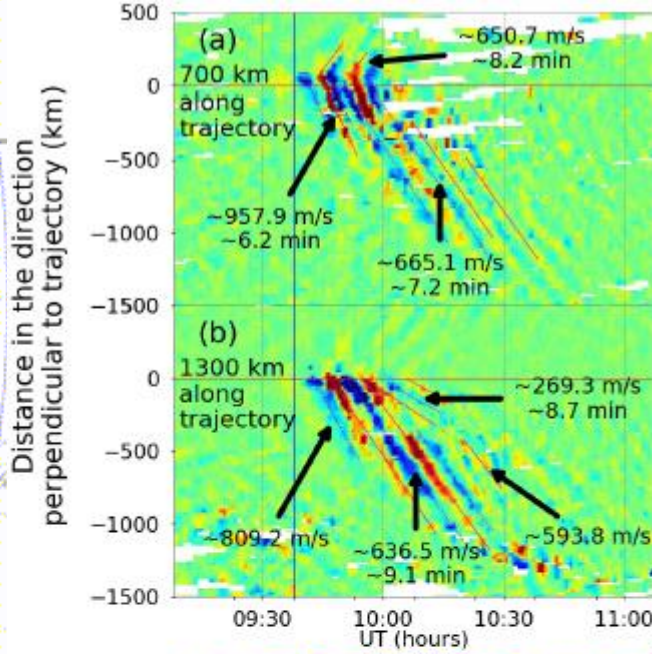
- Simultaneous TID observed in US and China
- Global data availability is essential for such kind study

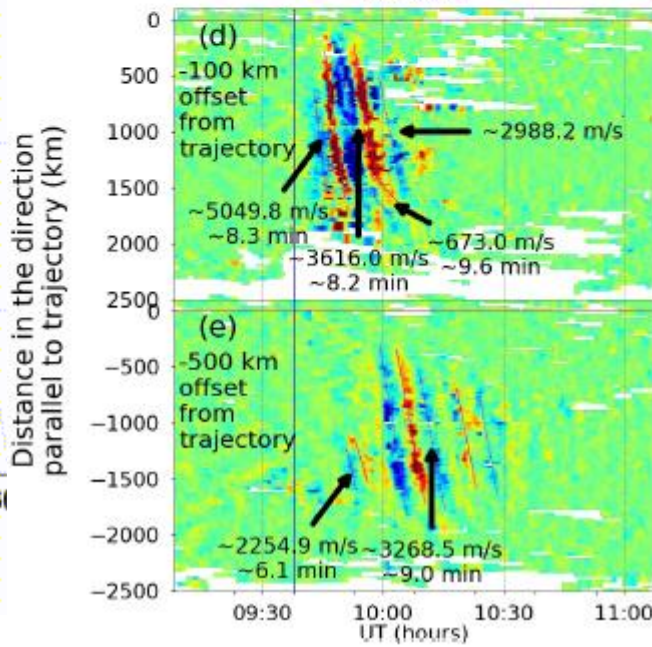
Ionospheric Disturbance after Nepal Earthquake (Mw7.8, 2015-4-25)



- Begin ~7 mins after Earthquake, last ~1 hour
- Gravity Wave, Acoustic Wave, Rayleigh Surface Wave

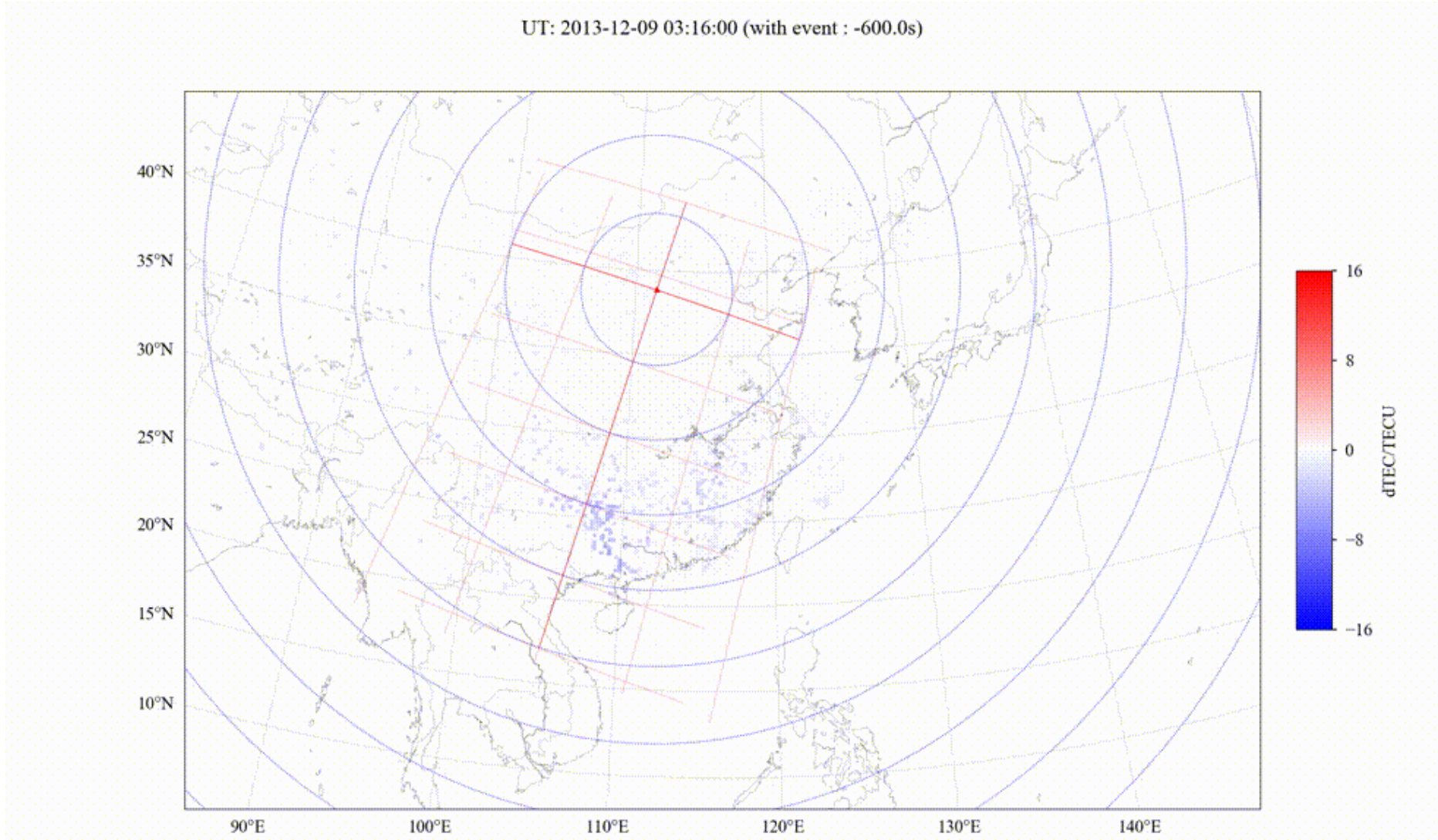
Disturbance after LM2F Launching(SZ, TG)





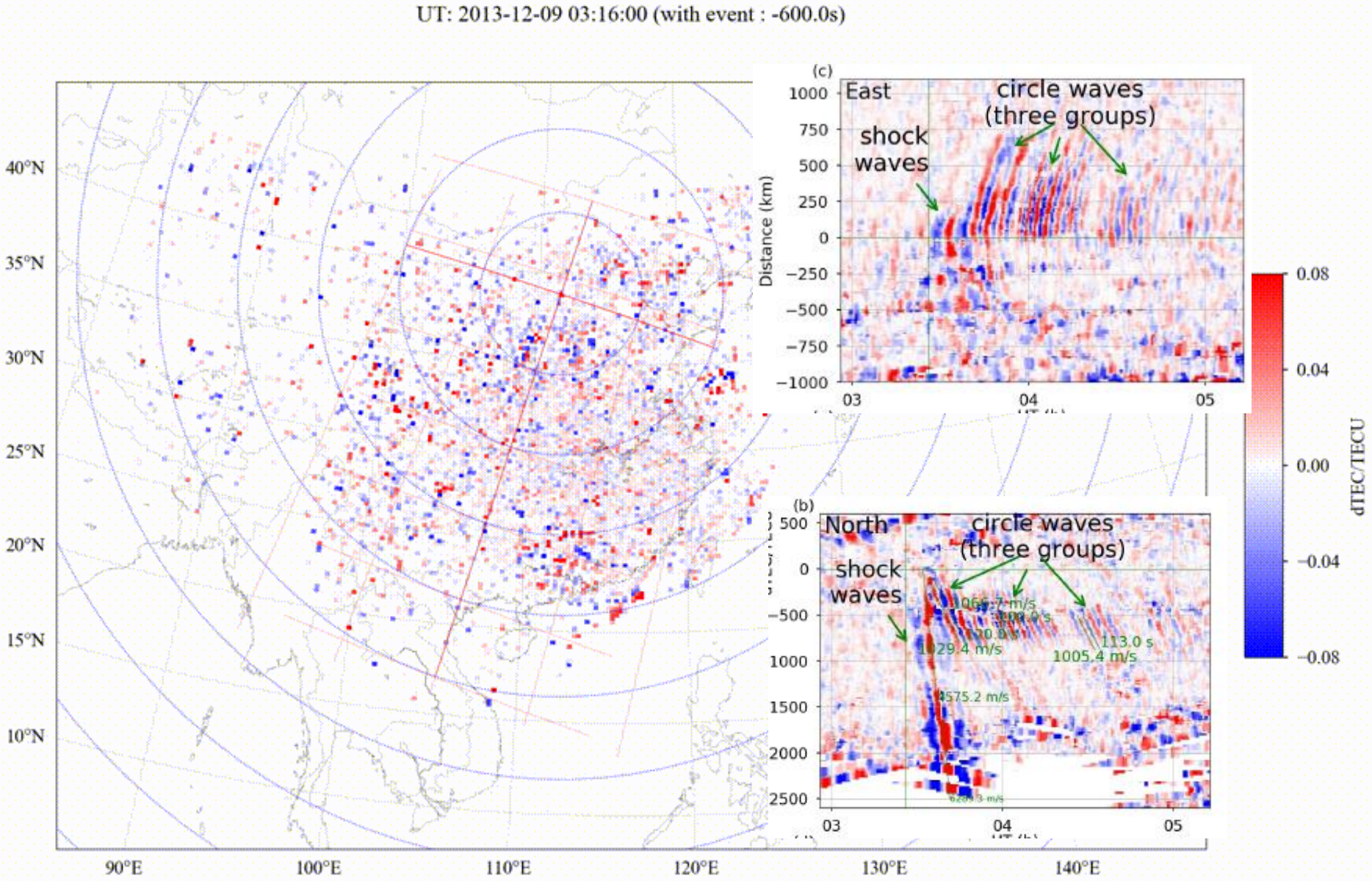
- Two phases TID after the shock wave

Disturbance after LM4B Launching(CBERS)



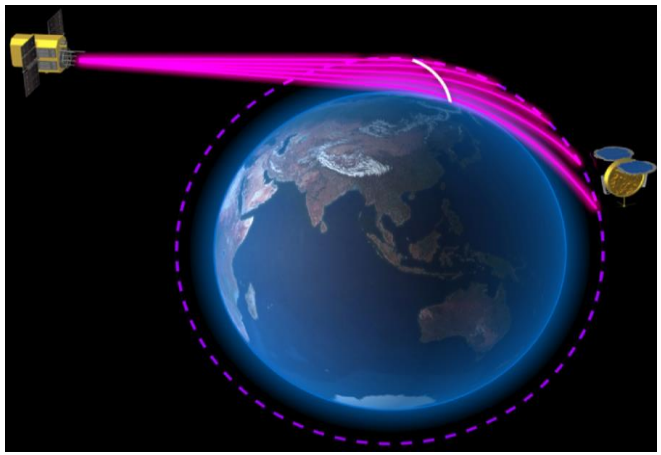
- The enter point is ~ 700 km, higher than LM2F;the rocket engine is still working in ionosphere, tons of water release, increase the ionosphere recombination rate, result in ionization hole

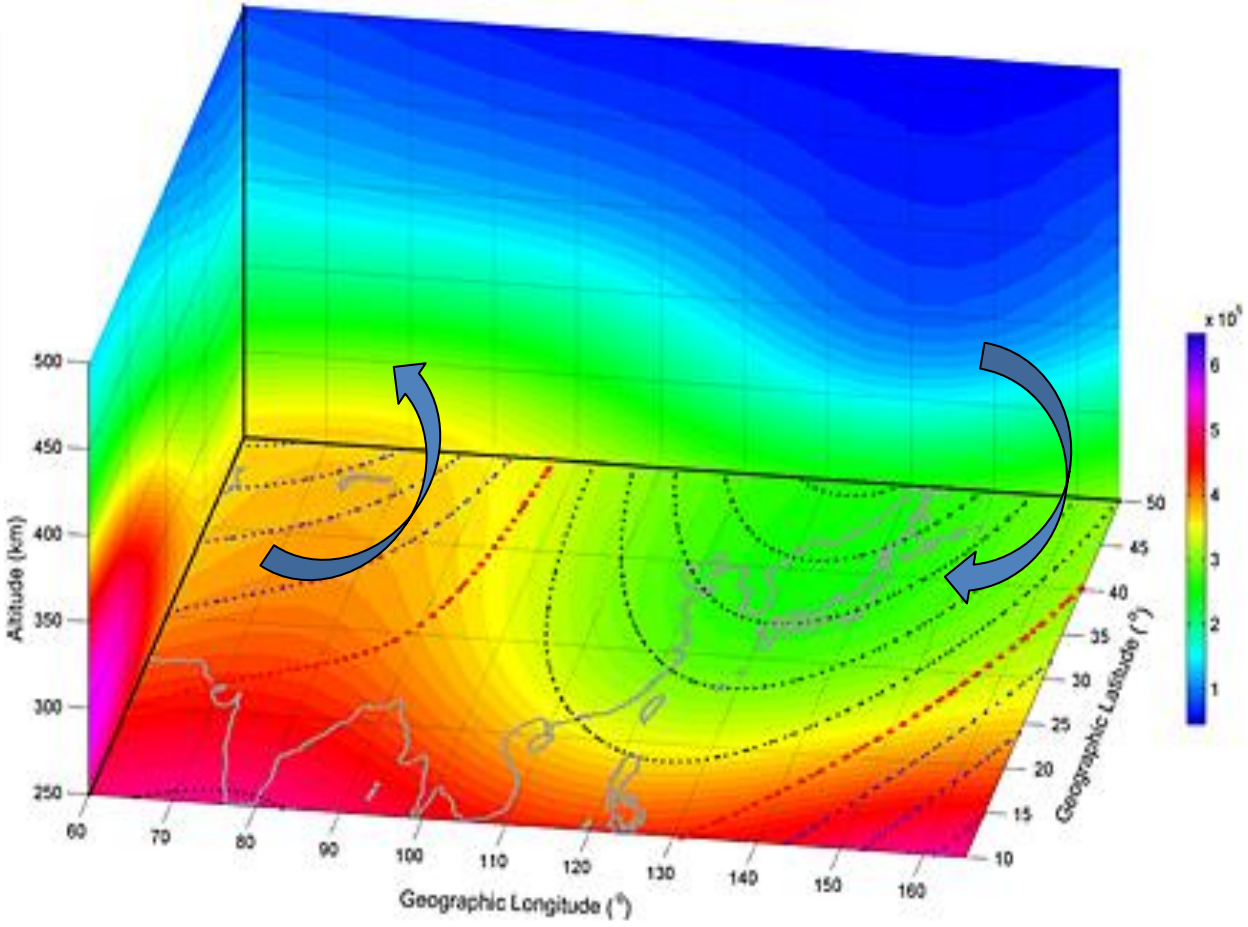
Disturbance after LM4B Launching(CBERS)



- Shock wave, circular waves

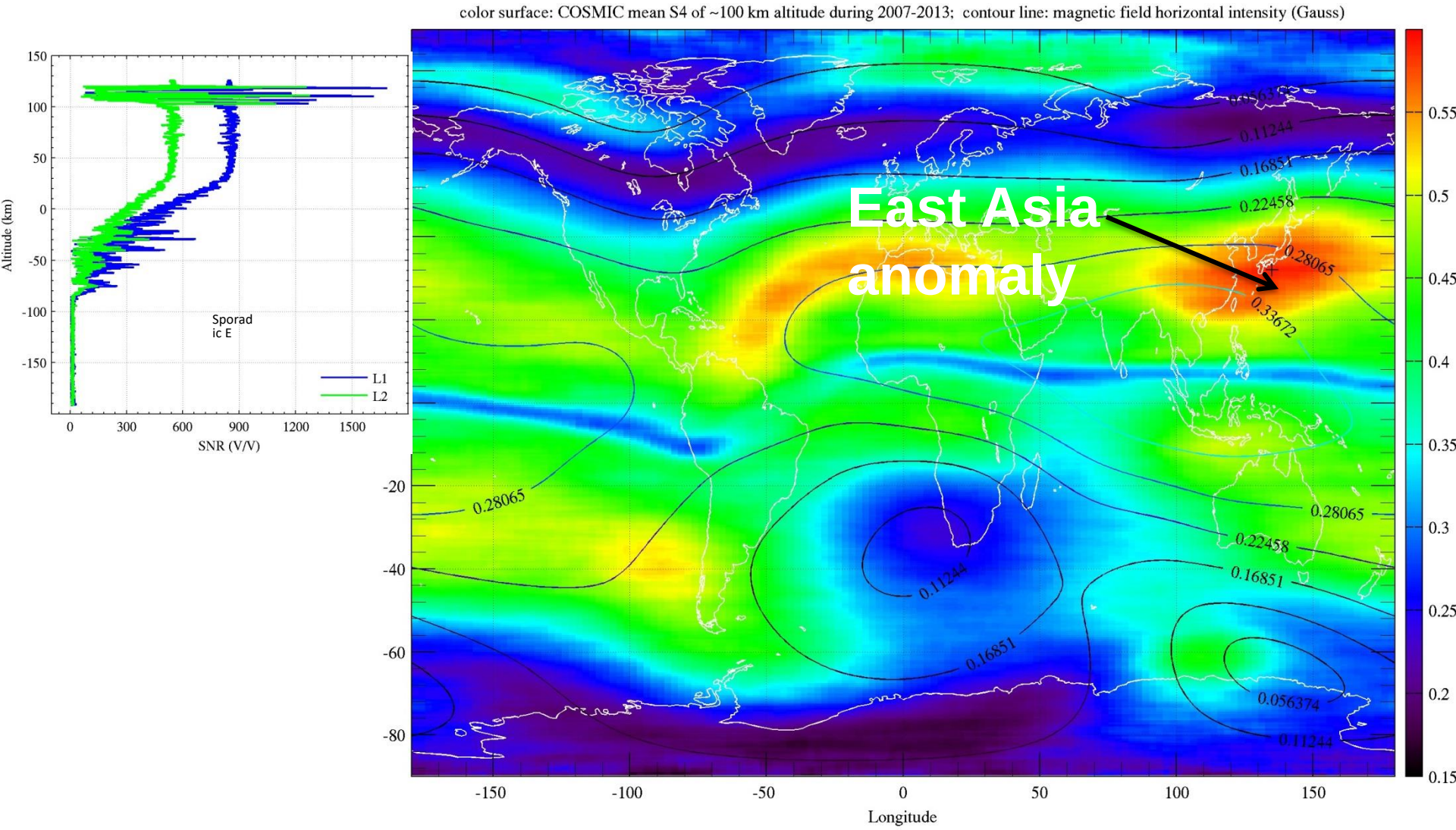
Ionospheric electron density difference due to declination difference





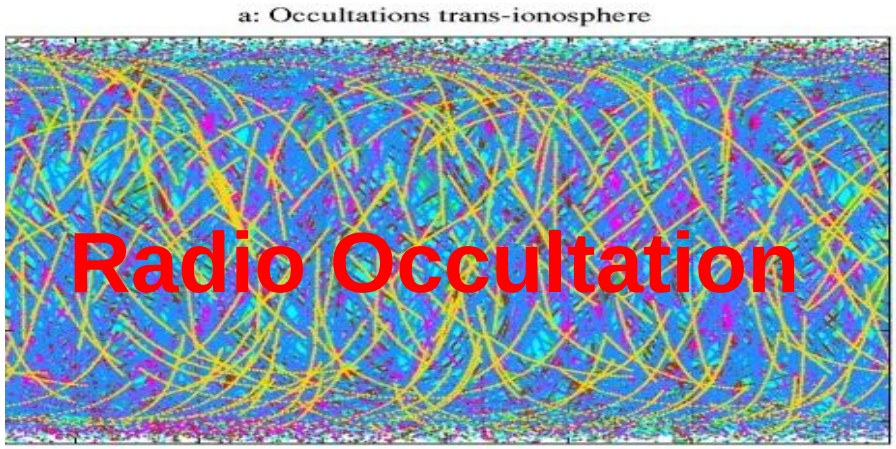
- Local Time： 10 am
- COSMIC Radio Occultation data over China
- Declination regulates the effect of zonal wind on ionosphere
- Could not be identified from traditional data

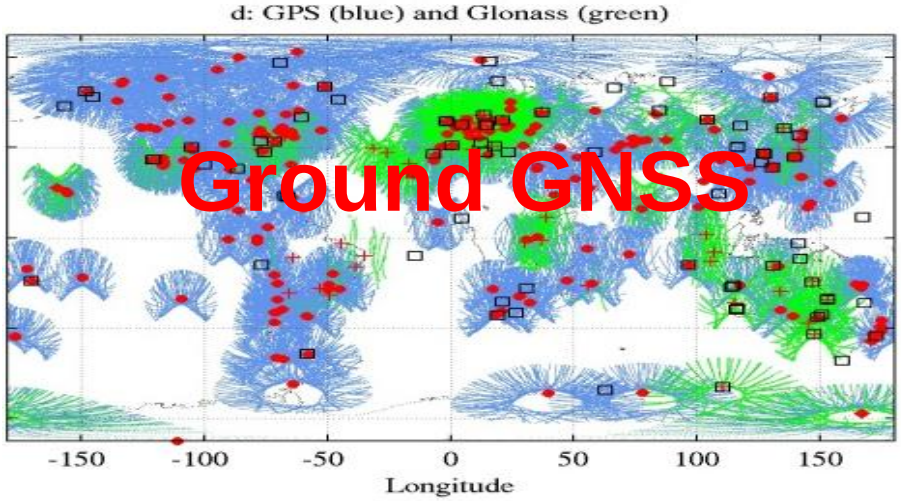
sporadic E climatology observed by COSMIC

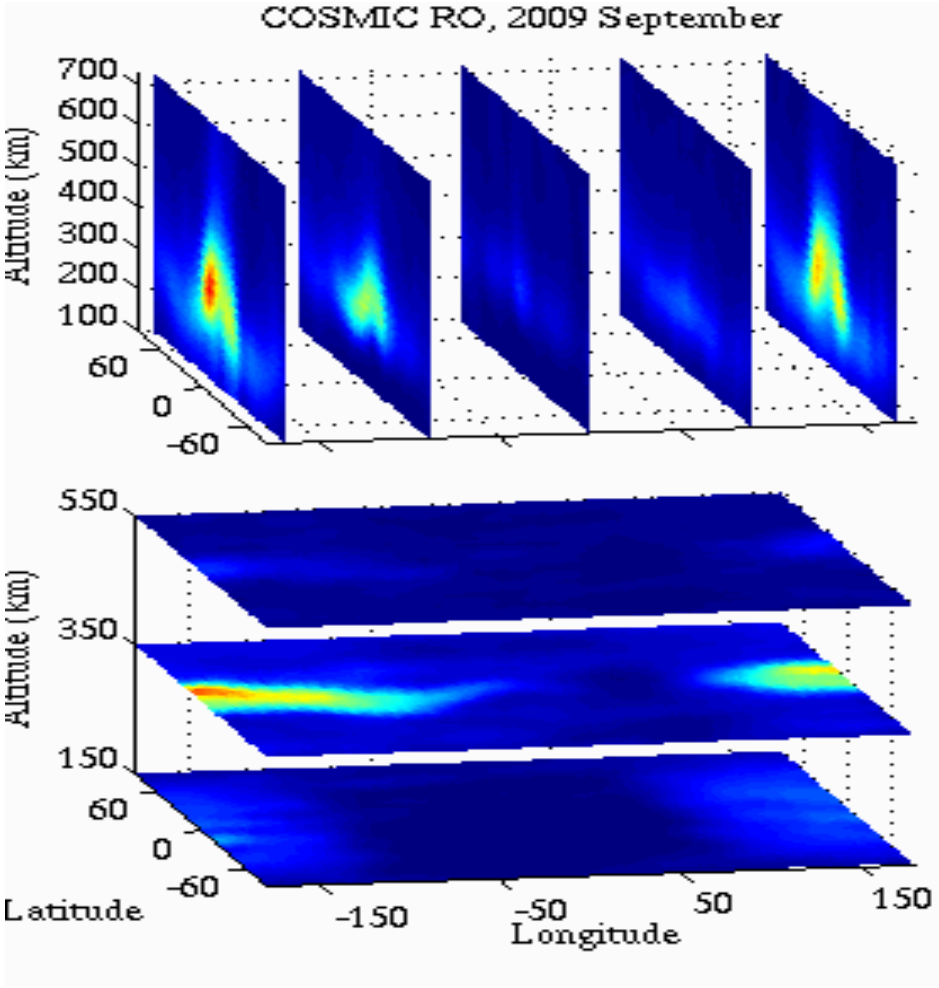


- COSMIC Radio Occultation data, unique data for this study
- Support winder shear theory in middle latitude

Data Assimilation: Space + Ground GNSS





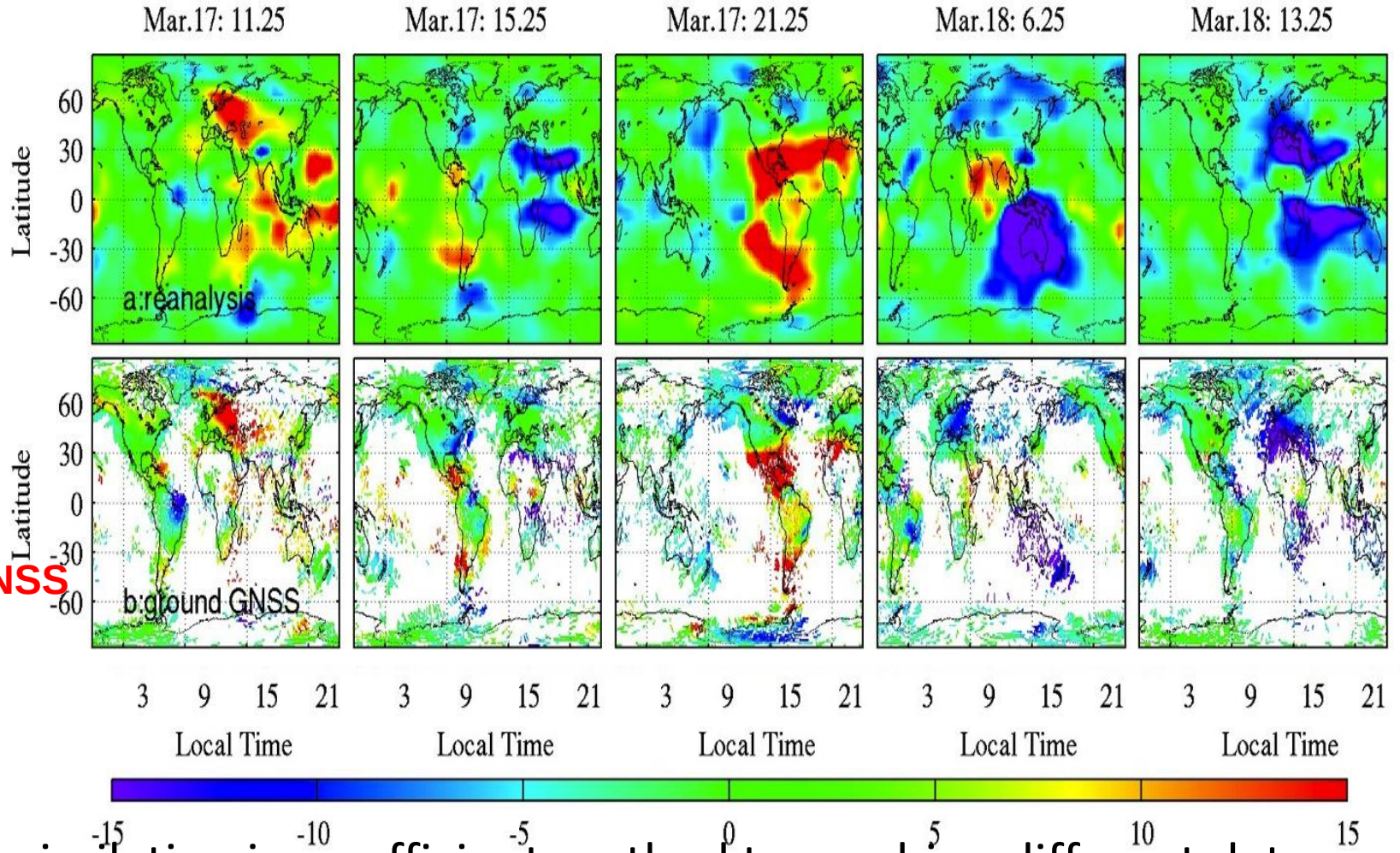


- Combining ground GNSS and LEO based Radio Occultation data
- Kalman Filter data assimilation

Data Assimilation: storm time global ionosphere disturbance

6 RO + 450 GNSS

4000 Ground GNSS



- Data assimilation is an efficient method to combine different data
- LEO based Radio Occultation is important for vertical resolution

Conclusions

- BDS, especially its GEO satellites, have advantages in space weather monitoring
- GNSS data has been widely used in space weather monitoring in China
- The combination of multiple source of GNSS data could generate better global ionospheric specification

Thanks for your attention
Comments and Suggestions?

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