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## Abstract

We have been collecting aurora images from color-CCD All-Sky Camera (ASC) at Jang Bogo Station (JBS), Antarctica (74° 37' S, 164° 13' E) since 2018. JBS is located mostly in the boundary between the polar cap and the auroral region and since the establishment in 2014, various observations for the polar upper atmosphere and the magnetosphere have been performed simultaneously together with the auroral observation. In this study, we analyze the 1-year observation for the aurora as well as the polar upper atmosphere and the magnetosphere from the various ground instruments such as ionosonde (VIPIR), Fabry-Perot interferometer (FPI), magnetometers, and ASCs in order to study on the possible changes of the polar upper atmosphere during the occurrence of the aurora over JBS. In this presentation, we will show some preliminary results of this comparative study mainly using the auroral images from ASC and the simultaneous observations for the ionosphere and the thermosphere.

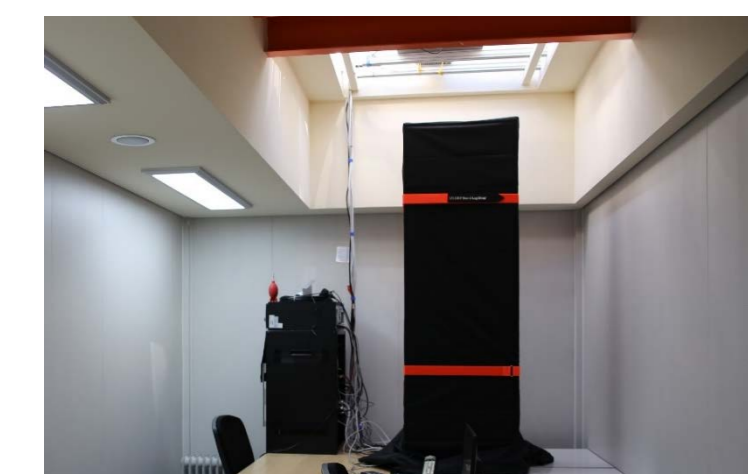
## Instruments



**Ionosonde (Dynasonde-VIPIR)**  
 - Target: Ionosphere  
 - Data: Ionospheric profile from E-region to bottom side F-region  
 - 2 min. temporal resolution (with Dynasonde B-mode pulse scheme)



**Color CCD All Sky Camera**  
 - Target: Aurora  
 - Data: True color all sky images  
 - 1 min. temporal resolution (5 sec. exposure time)

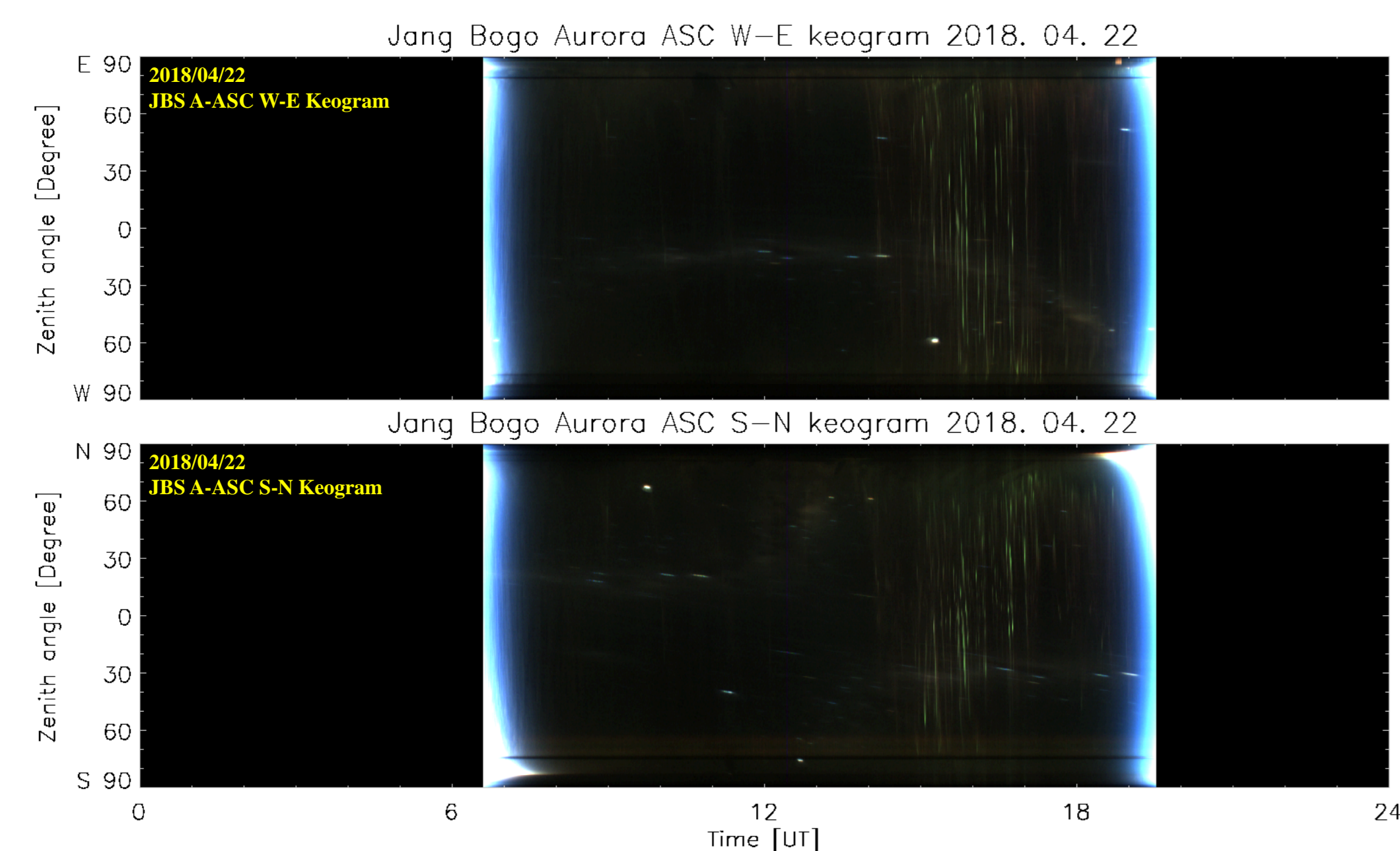
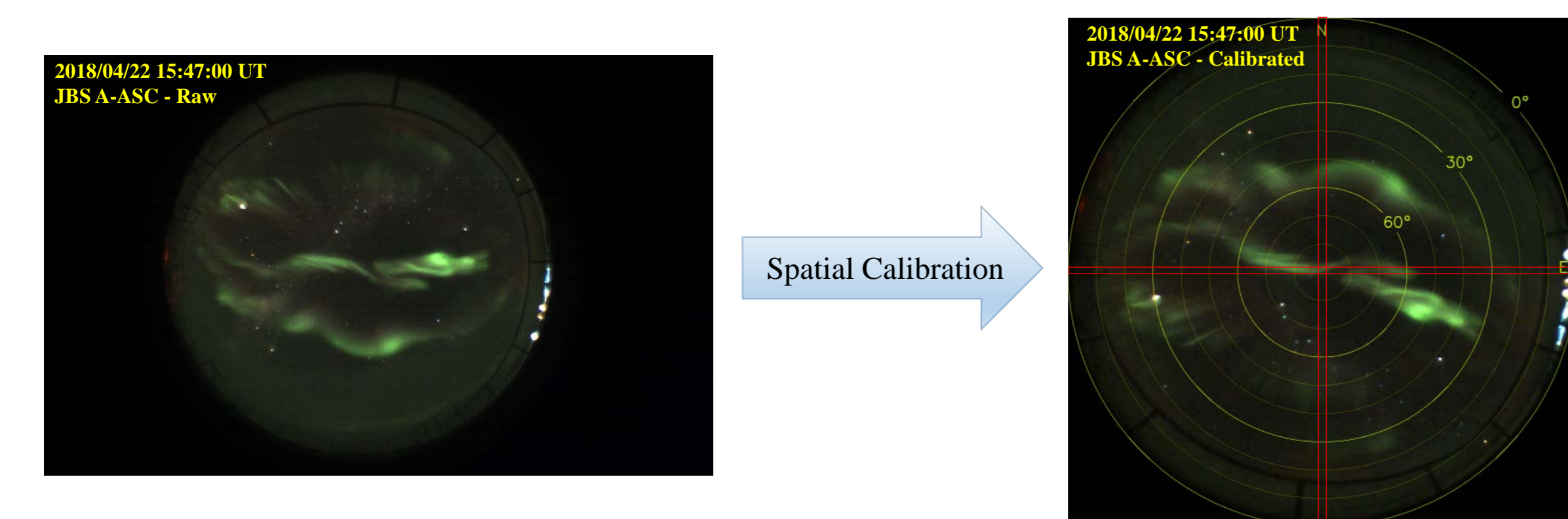


**FPI**  
 - Target: Neutral atmosphere  
 - Data: 250 km neutral wind and temperatures  
 - 15 min. temporal resolution (6300 nm)



**Vector magnetometer**  
 - Target: Earth's magnetic field  
 - Data: Three vector component, inclination and declination of the earth's magnetic field  
 - 1 sec. temporal resolution

## Preparation of the Aurora ASC data

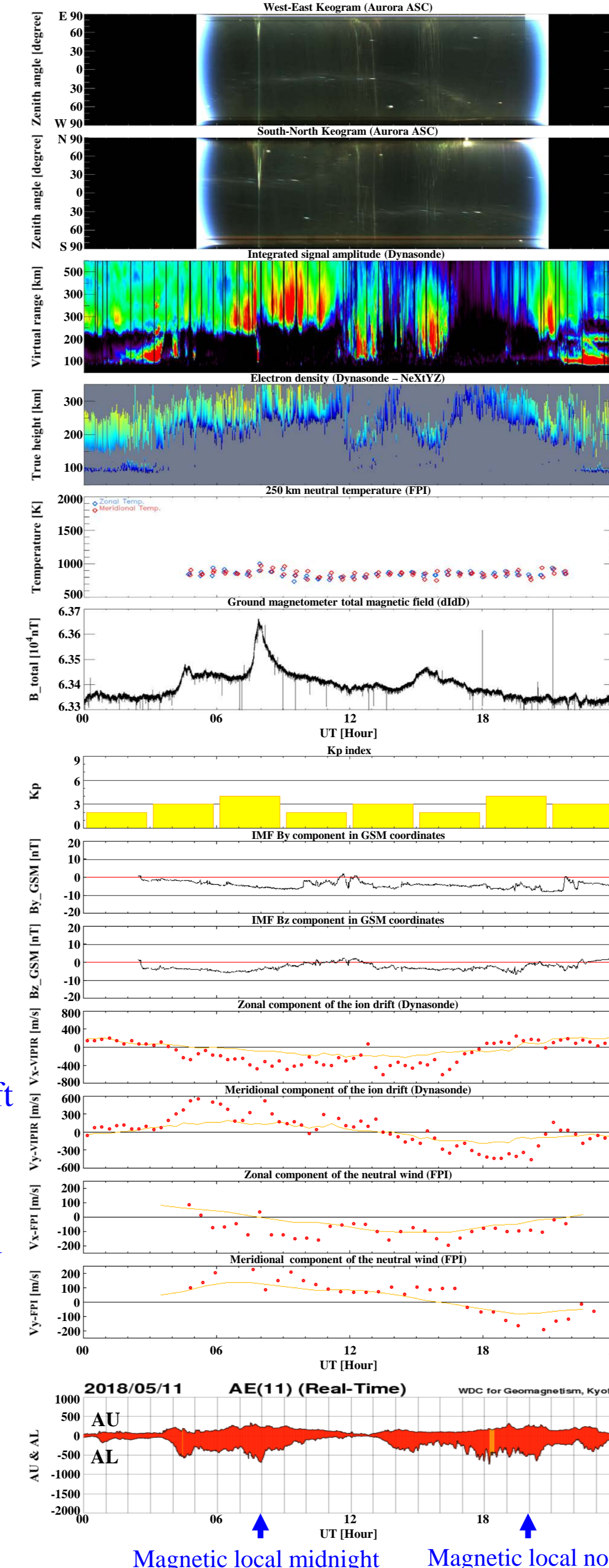


- The raw aurora ASC data have been pre-processed for the analysis.
- Because the auroral activities are closely related to the earth's magnetic field, the images are corrected to be aligned with the geomagnetic north-south and east-west.

## Aurora observation by JBS instruments

- In general, auroras are observed in the magnetic local midnight sector and in the magnetic local morning to noon sectors.
  - The midnight auroras appears at the northern horizon and it indicates that JBS location is inside the polar cap.
  - The noon and the morning auroras are observed in the whole sky and it indicates that JBS location is close to the auroral oval.
- JBS FPI, which uses 6300 nm filter only, shows temperature increases when the red aurora occurs.
- Similarly to the AE index, the vector magnetometer shows B-field increases when aurora occurs.

### Example

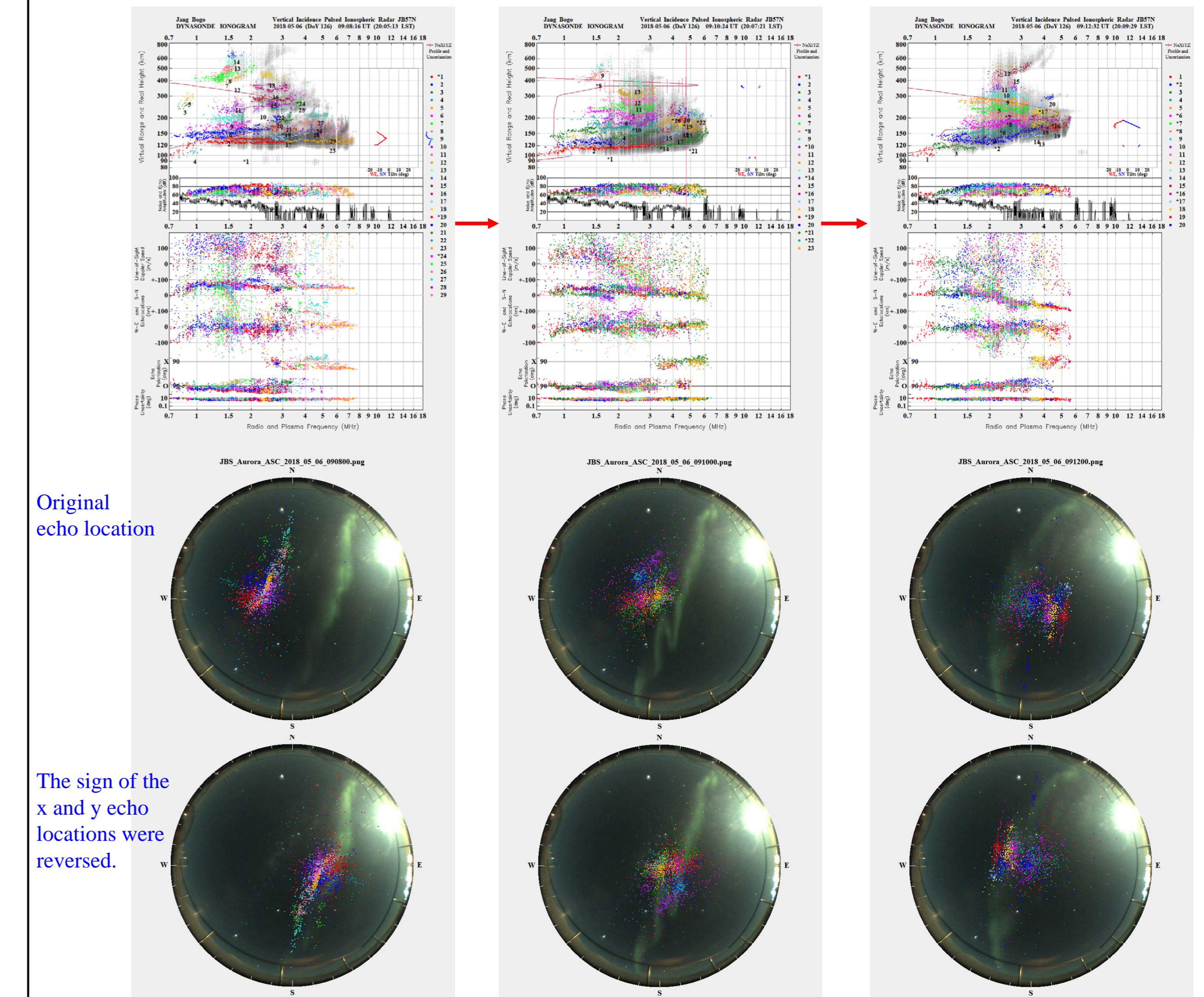


Ion drift

Neutral wind

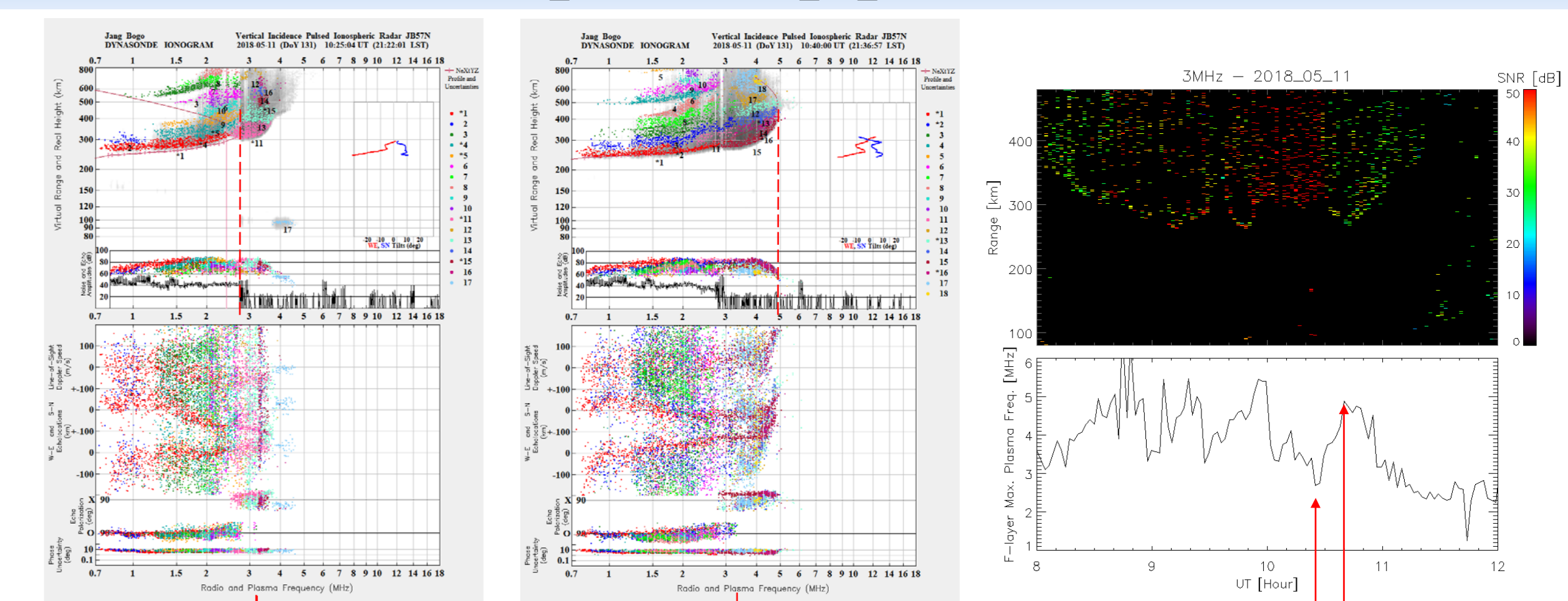
- In the above example, Dynasonde F-region ion drift and FPI 250 km neutral wind measurements showed noticeable variations when the aurora occurred.
- At 0500 UT and 0800 UT, there are two peaks in the meridional component of the ion drifts.
- The neutral winds also showed two peaks, but the time is delayed about 1~1.5 hours.
- 0800 UT is the magnetic local midnight, thus the mentioned variations in the ion drifts and the neutral winds seem to be related to the substorm.

## Relation between Dynasonde echo location and aurora



- We found weird relation between Dynasonde echo location and the aurora observed by Aurora ASC. The echo locations matched well with the location of the aurora when the sign of x and y echo locations were reversed.
- In 2018 data, we selected 50 non-complex auroras that move and have long shape.
- Among the 50 cases, 44 cases showed this weird relation.

## Candidate for the polar cap patch observation



- Dynasonde recorded some signatures that looks like polar cap patch.
- For example, from 1030 UT to 1100 UT, 3 MHz fixed-frequency signal amplitude showed a V-shaped feature (it may indicate an ionospheric structure that moves the radar overhead) at 300 km height. During this time interval, F-region x-mode echoes were observed moving across the zenith. At the same time the F-region peak plasma frequency increased from ~3 MHz to ~5MHz. It means the electron density has increased ~2.8 times.

## Summary

- In most cases, echo locations (observed by Dynasonde) and the aurora (observed by ASC) moved in opposite direction. We are still finding possible reasons.
- It looks like Dynasonde can observe the polar cap patch.
- When aurora occurred the ion drift and the neutral wind changed. The variations in the neutral wind showed time-delay with respect to those in the ion drift. It seems that these are related to the electrojet and further investigation is needed.