Polar Region Activity

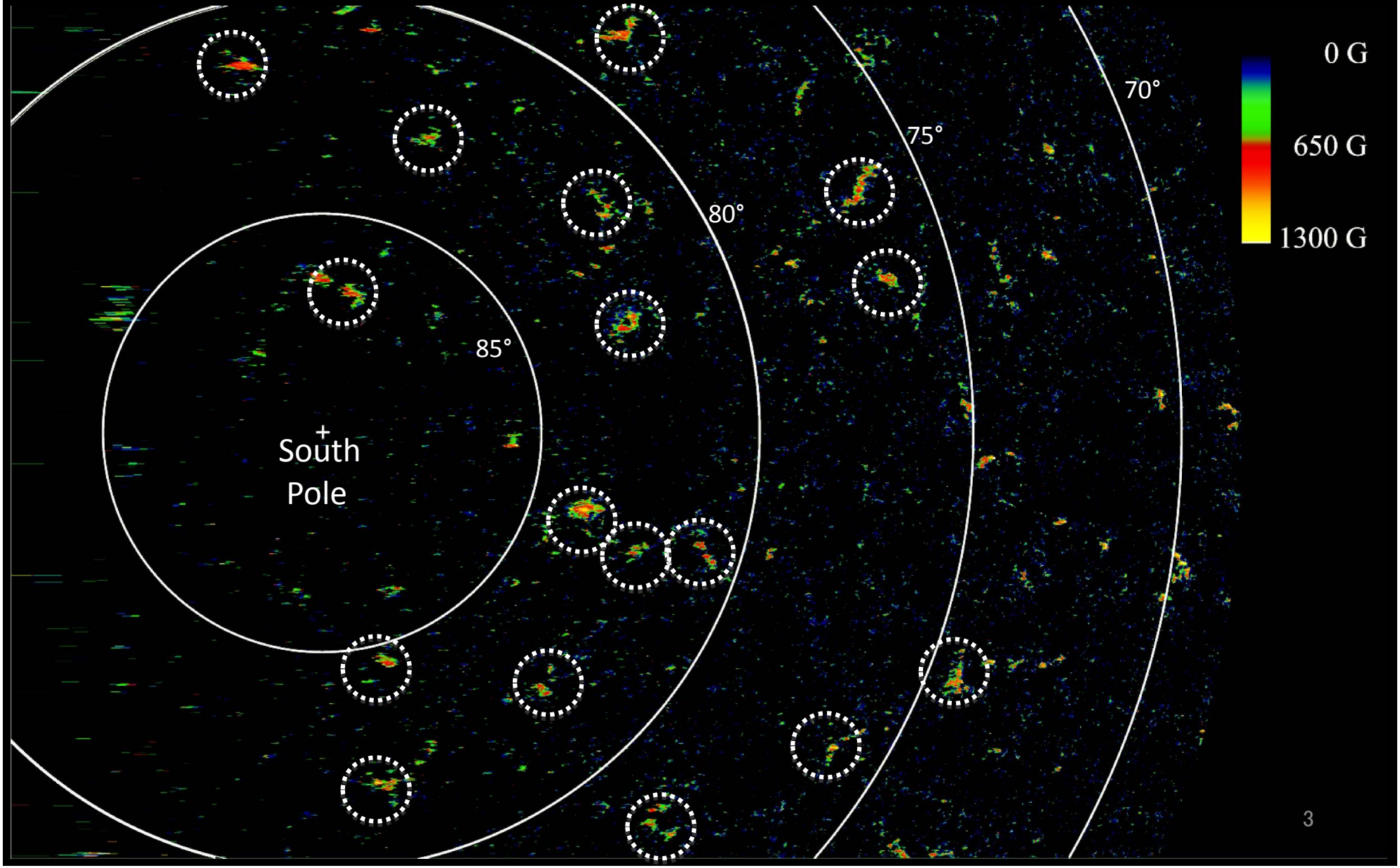
Masumi SHIMOJO
Nobeyama Solar Radio Observatory
NAOJ/NINS

Outline

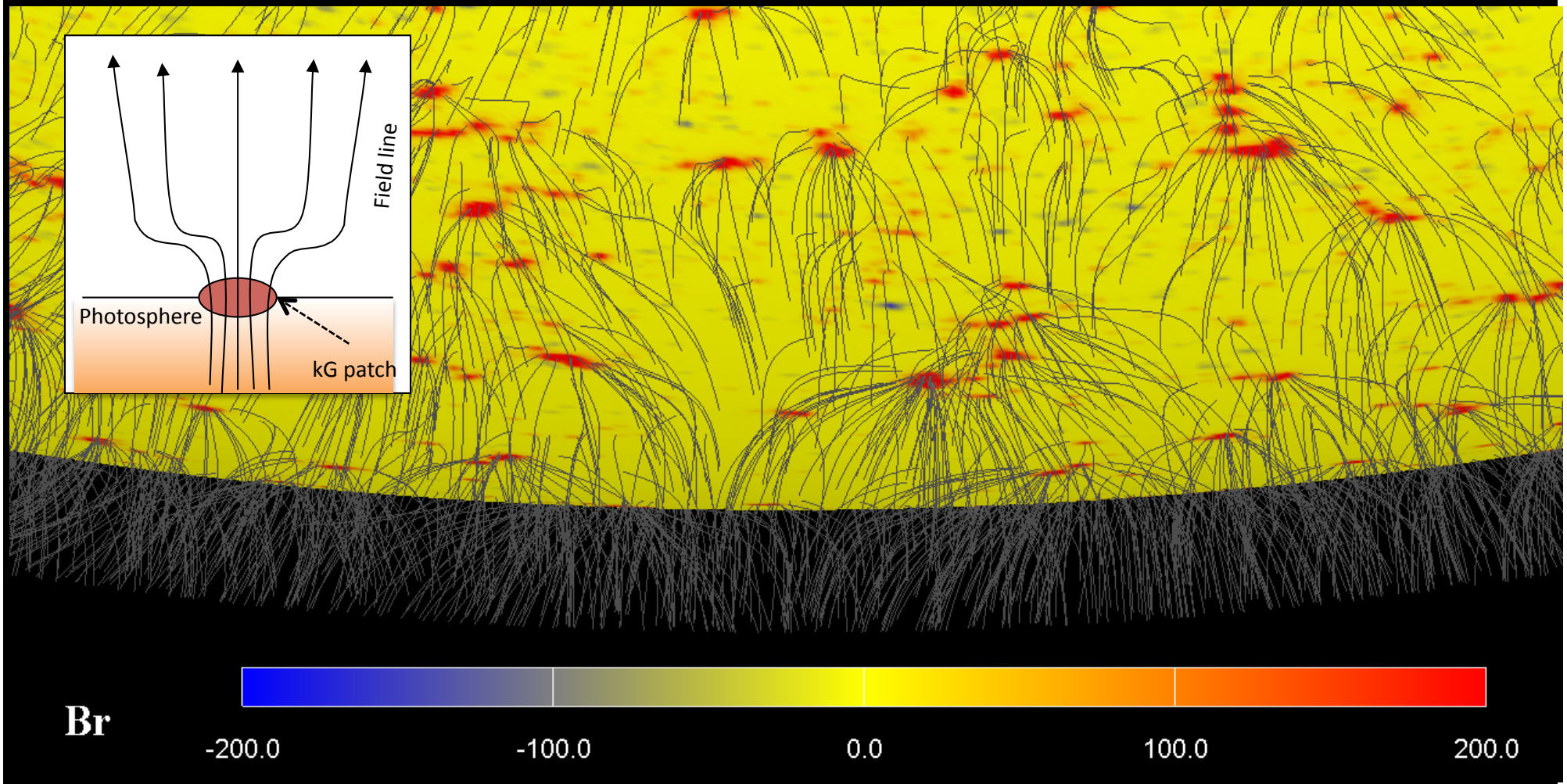
- Introducing the results obtained by *Hinode*.
  - Magnetic field in the polar region
  - Coronal Activity in the polar region.
- What is the next step of the study of polar region.
- Polar region studies by SOLAR-C mission

The Strong Magnetic Patch (kG-Patch) in the Polar Region

(Tsuneta et al. 2008)



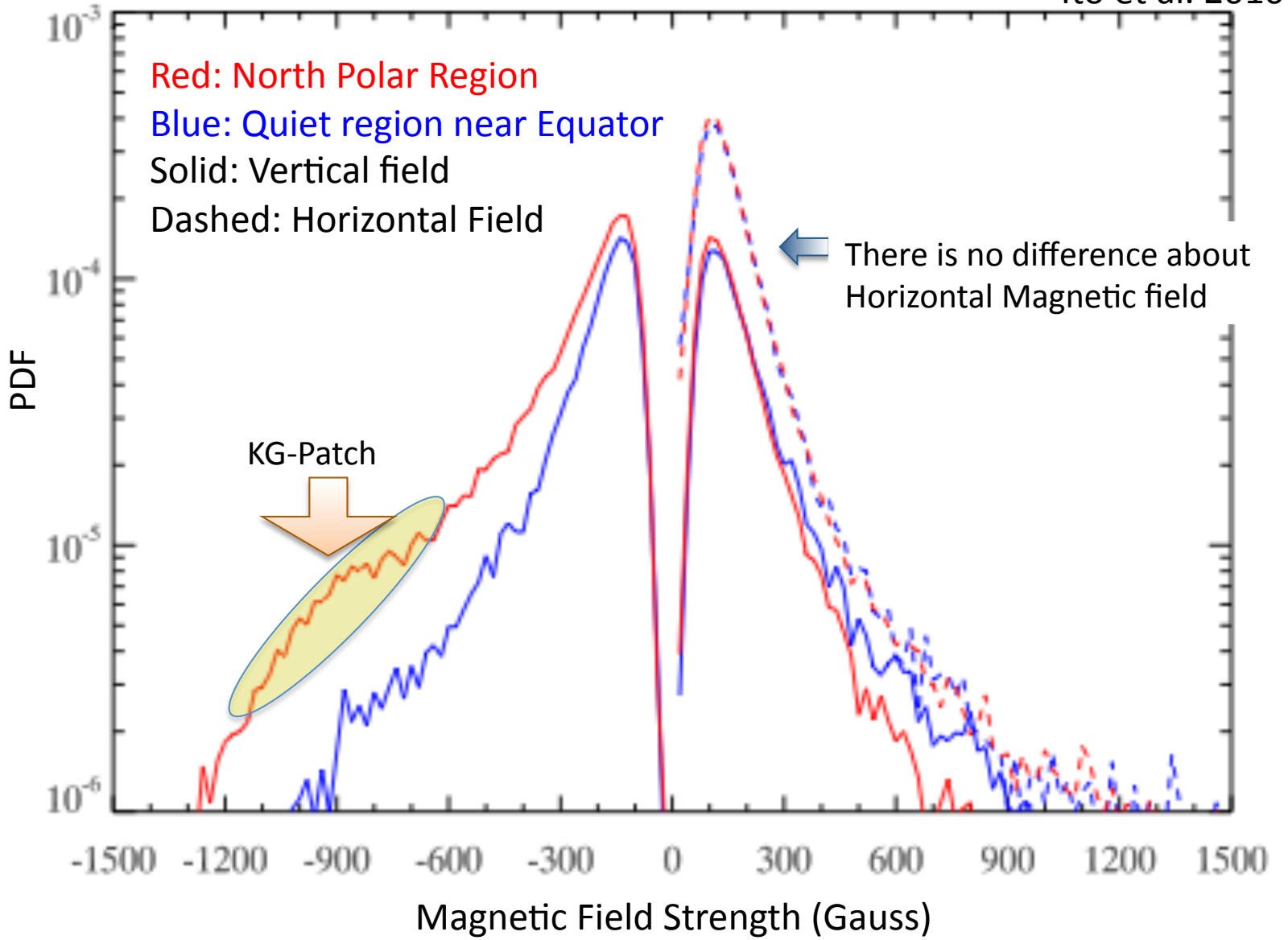
Fanning magnetic field lines of kG-patches



(Ito et al. 2010, Shiota et al. 2010)

Magnetic Field Distribution in the Polar Region and near the Equator

Ito et al. 2010

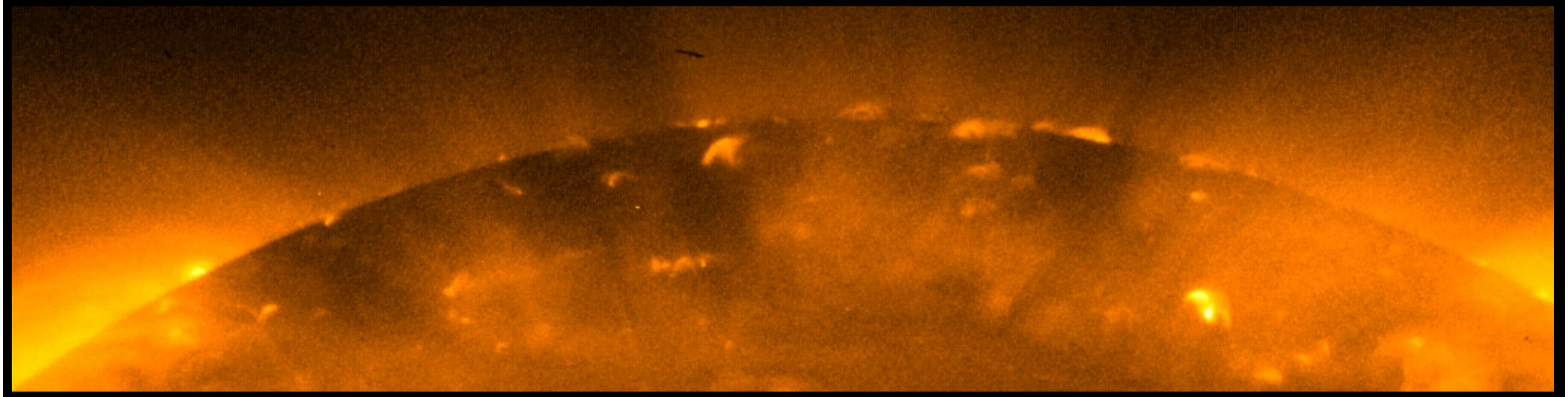


Magnetic Field in the Polar Region by *Hinode* Observations

(Tsuneta et al. 2008 and Ito et al. 2010)

- The polar region is dotted with small (~4000km) and strong (~1000 gauss) magnetic patches (kG-patches).
- The kG-patches in the polar region larger and stronger than the network magnetic field in the quiet region of low latitude.
- The KG-patches in a polar region have one polarity. There is no patch that has the other polarity.
- The magnetic field lines from the kG-patches extend to the interplanetary space, and contracts the fan-like structures.
- Although the vertical magnetic field in the polar region is differ from that in the quiet region, there is no difference the horizontal magnetic field around the pole and the equator.

X-ray jets frequently occur in the polar region

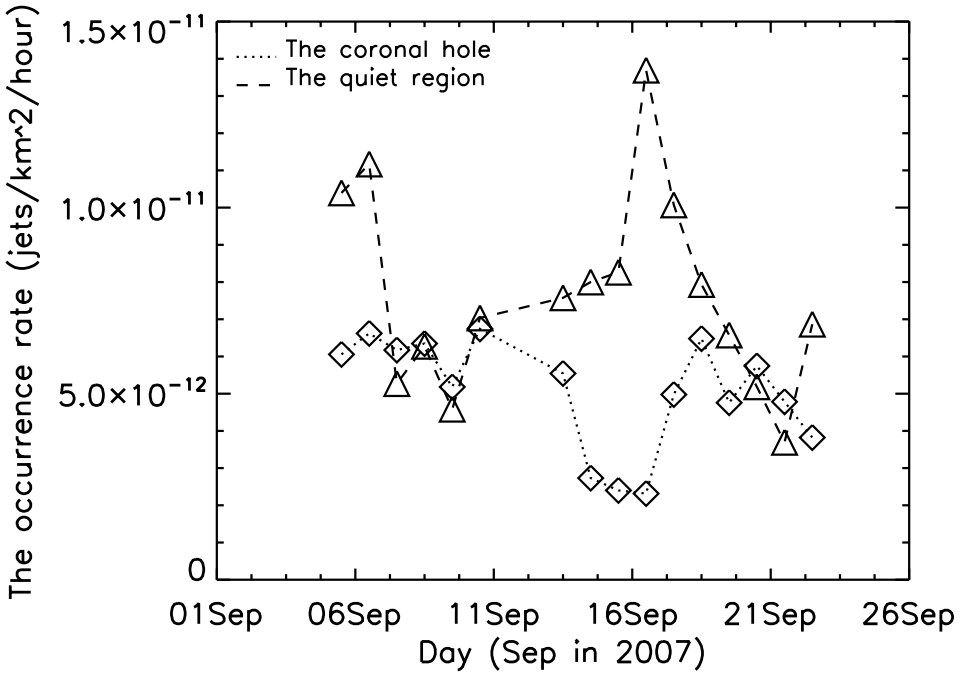


- The number of X-ray jets in the polar coronal hole is about 60 jets/day. (Savcheva et al. 2007)
- Cirtain et al. 2007 found the two velocity components.
  - One is sound speed, the other one is alfven speed

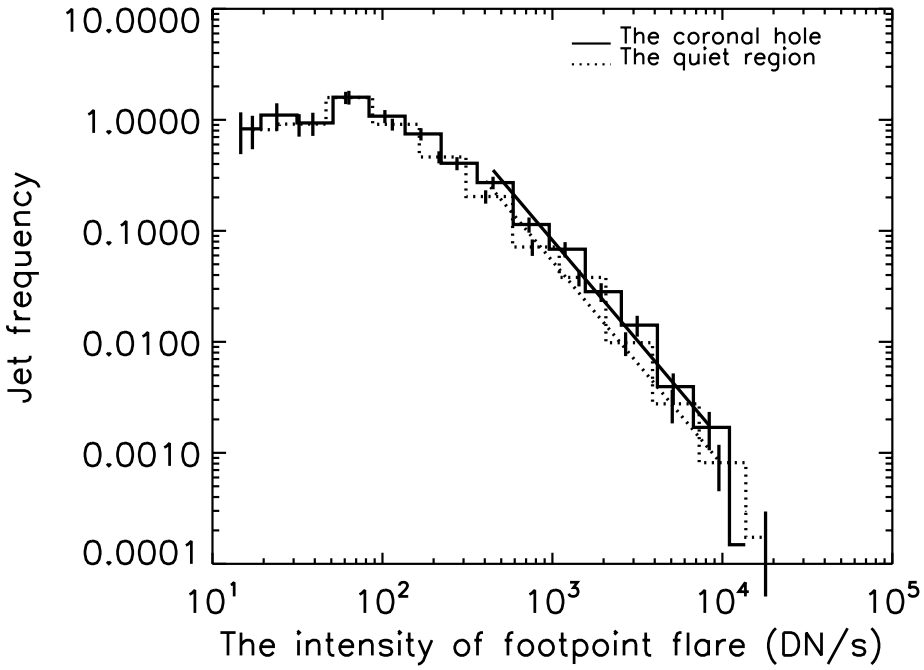
The occurrence rates and frequency distributions of of X-ray jets

(Sako and Shimojo, 2010)

Occurrence rates in CH and QR near the pole



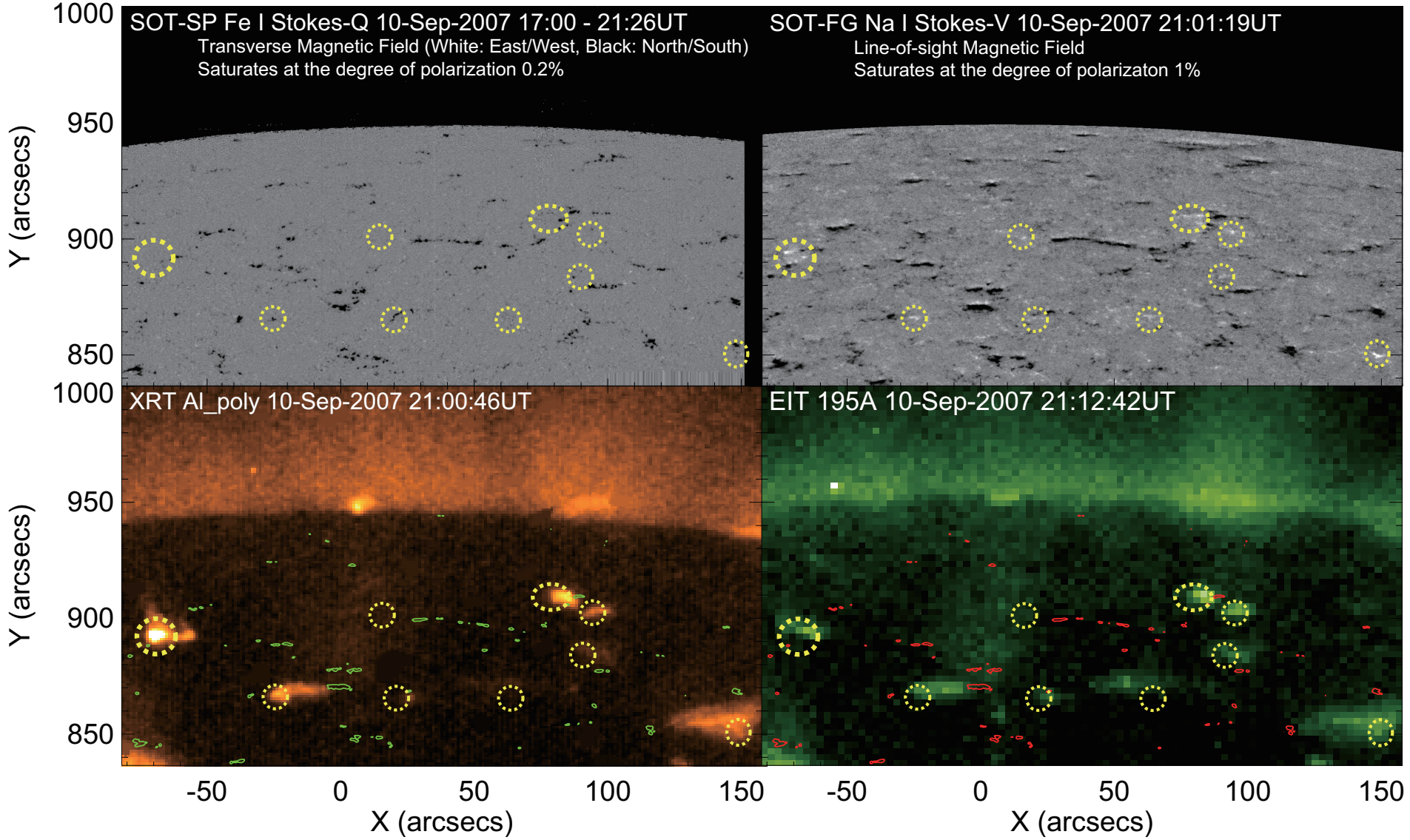
The frequency distribution of the footpoint flare of the polar X-ray jets in CH and QR near the pole



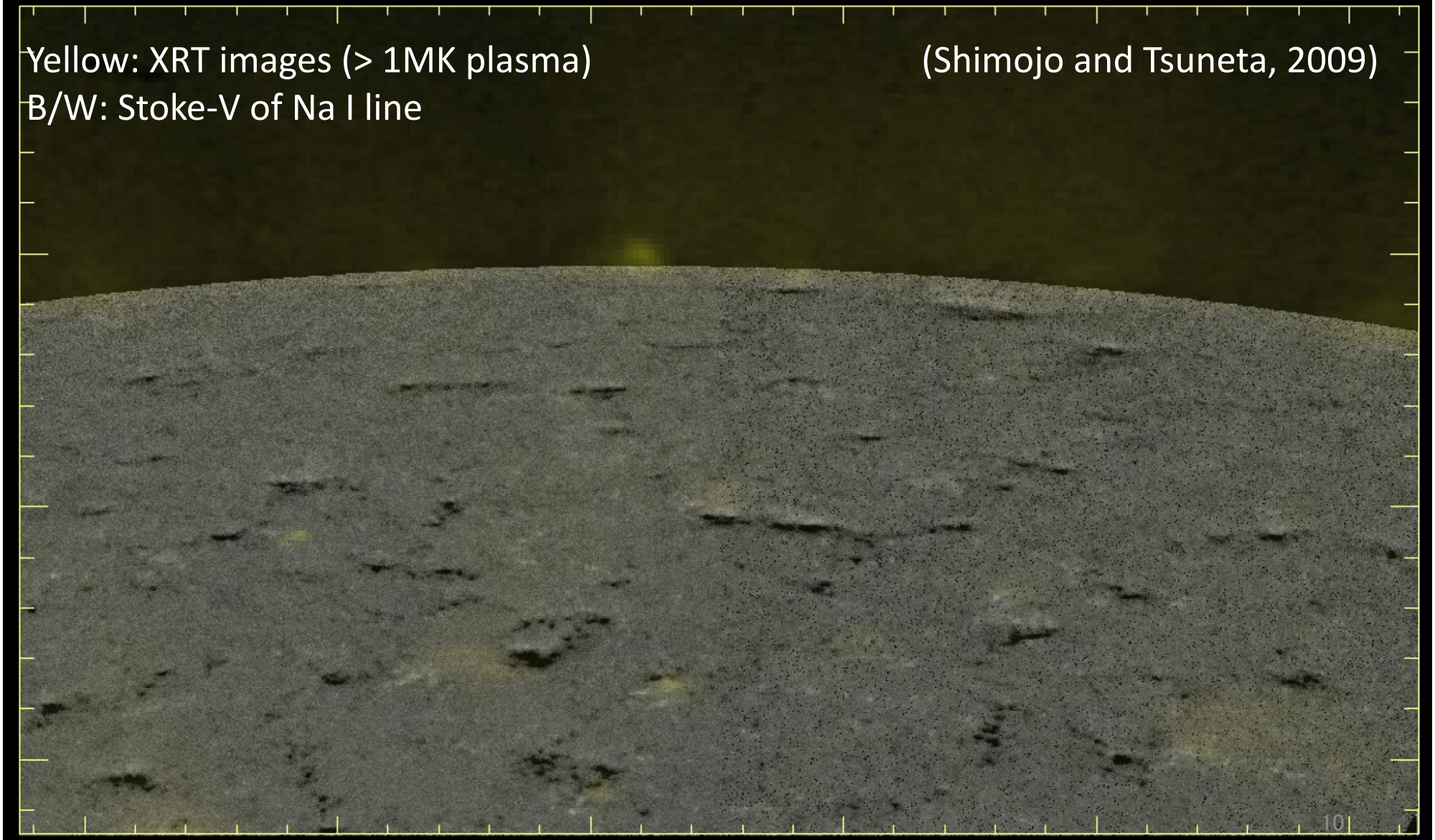
- The QR near the pole is more productive than the polar CH.
- The power-law index of the frequency distributions of the footpoint flare of polar X-ray jets in CH and QR is 1.8. It is steeper than that of the previous study. (Shimojo et al. 1996 : 1.2 mainly near AR.)

The relation between kG-patches and Coronal Activities

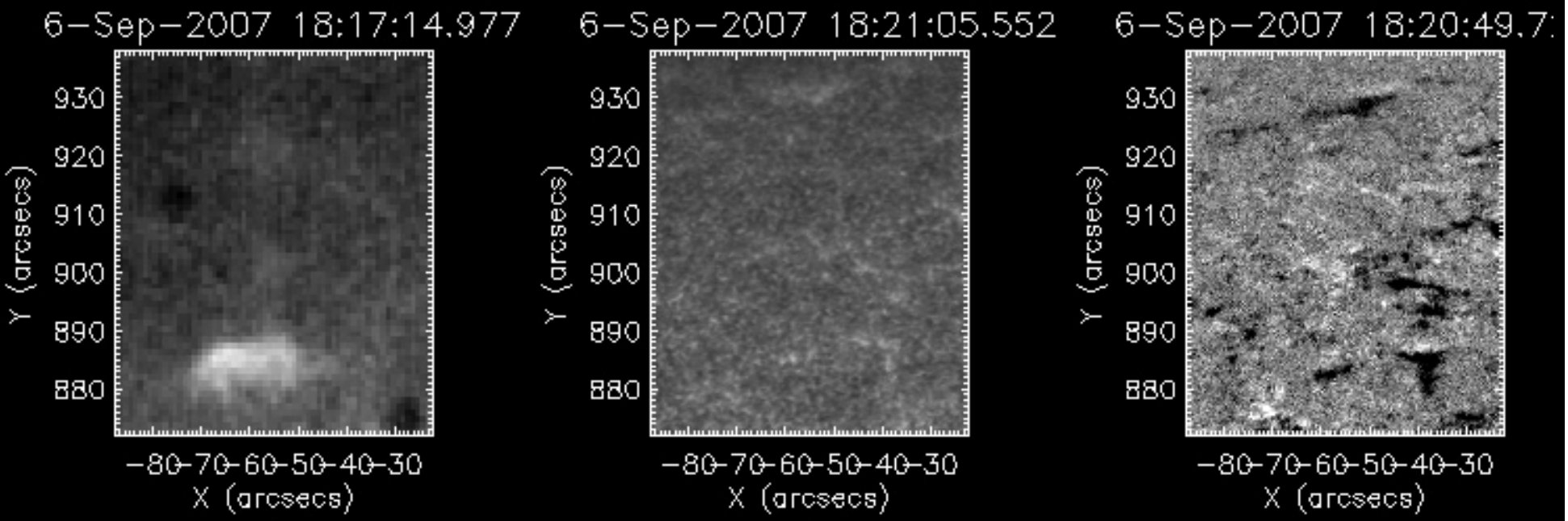
(Shimojo and Tsuneta, 2009)



The coronal activities occur on the kG-pathes with “small emerging fluxes”.



The Polar X-ray Jet with the EFR



The coronal activity in the polar region

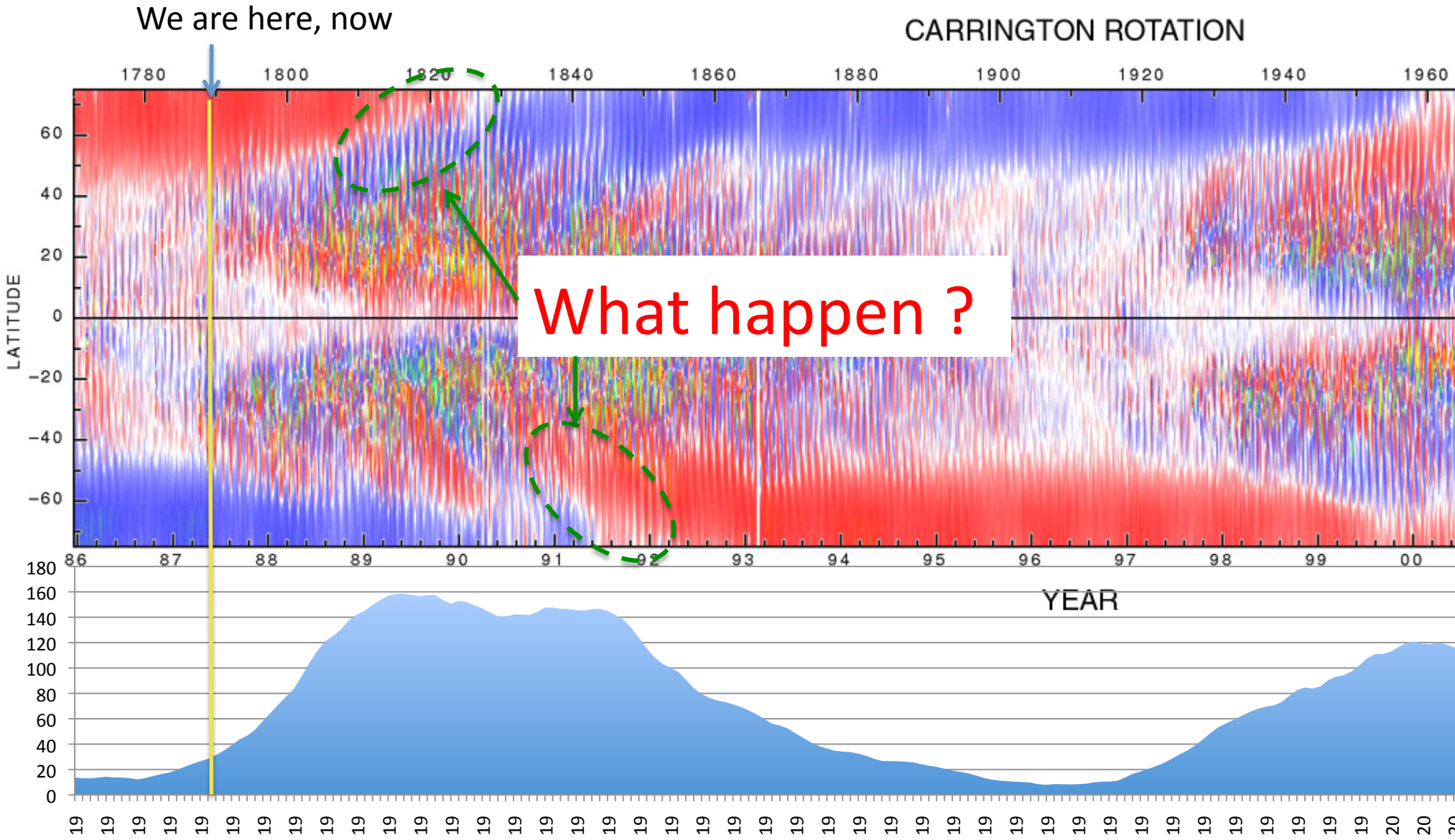
(Savcheva et al. 2007, Shimojo & Tsuneta 2009, Sako & Shimojo 2010)

- X-ray jets frequently occur in the polar region.
- The power-law index of the frequency distribution as a function of the X-ray intensity of footpoint flare of jets is 1.8. It is steeper than that of X-ray jets around ARs.
- Most of kG-patches are not associated with coronal structures.
- The coronal activities occur on the kG-patches with small EFRs.

The X-ray jets in the polar region can be used as the proxy of the magnetic activity (EFR) in the polar region.

The next step of the polar activity study

“We need long term (>5 years) monitoring obs.”



Polar Activity study by SOLAR-C

- Magnetic field in the polar region
  - Targets for Plan-A
    - The global surface flow and magnetic pattern in the polar region and their time evolution.
    - The long time evolution of the vertical (poloidal) magnetic field. (Plan-A can not measure weak horizontal field.)
  - Targets for Plan-B
    - The long time evolution of total magnetic field.
    - The height variation of magnetic fields from photosphere to corona
    - Small Emerging flux, Horizontal magnetic field in the polar region.
- Coronal Activities in the polar region
  - Target for Plan-A:
    - The coronal hole boundary variation and transient events (brightening, jets) obtained by X-ray Imager
    - Velocity field in the corona hole obtained by UV/EUV spectrograph
  - Target for Plan-B
    - The velocity field above the polar region (It is realized by the low-scatter light spectrograph)
    - Magnetic reconnection in Chromosphere and Corona with spectrograph