PALSARと電離層異常について
PALSAR and Ionospheric disturbances

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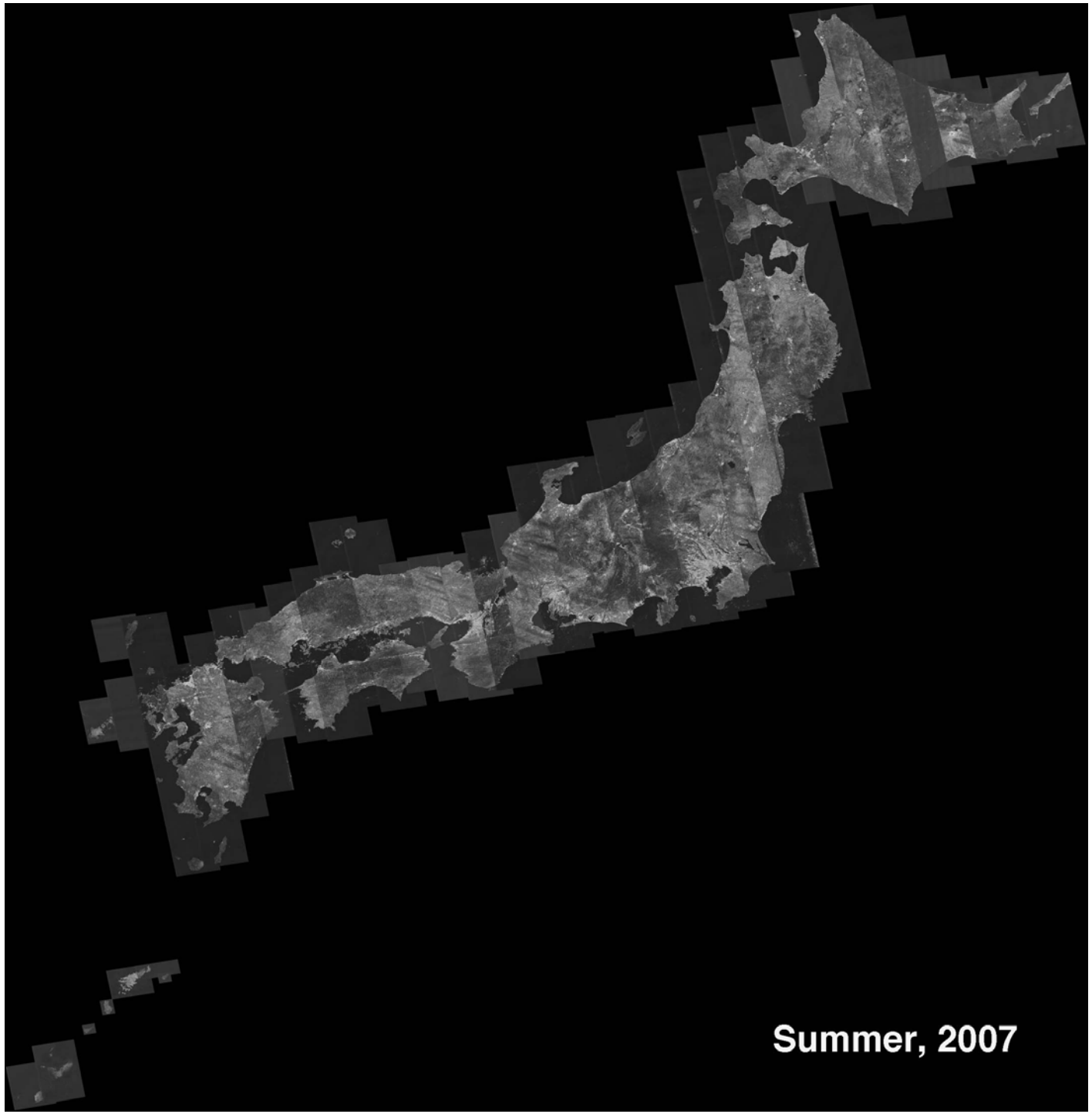
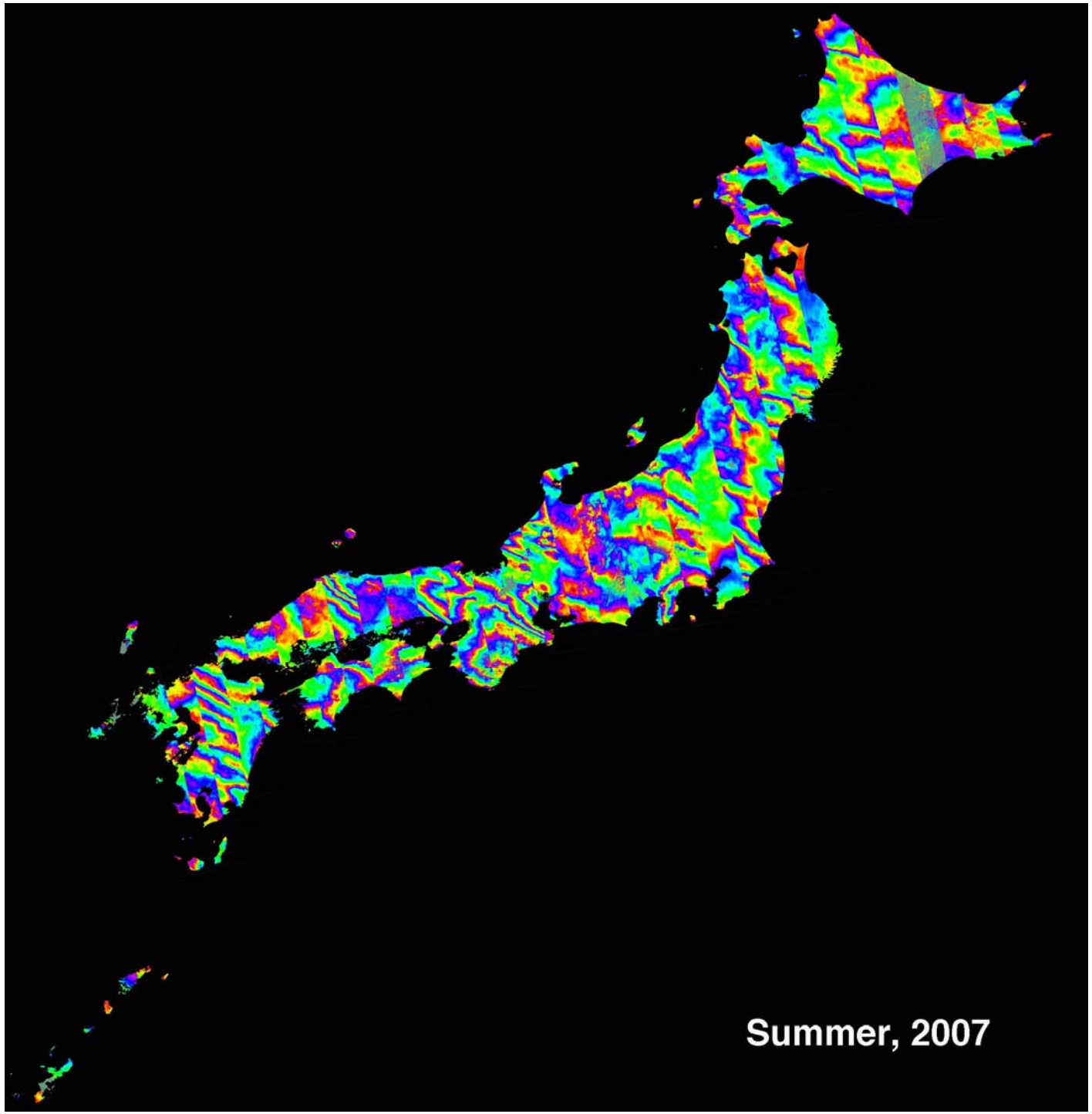
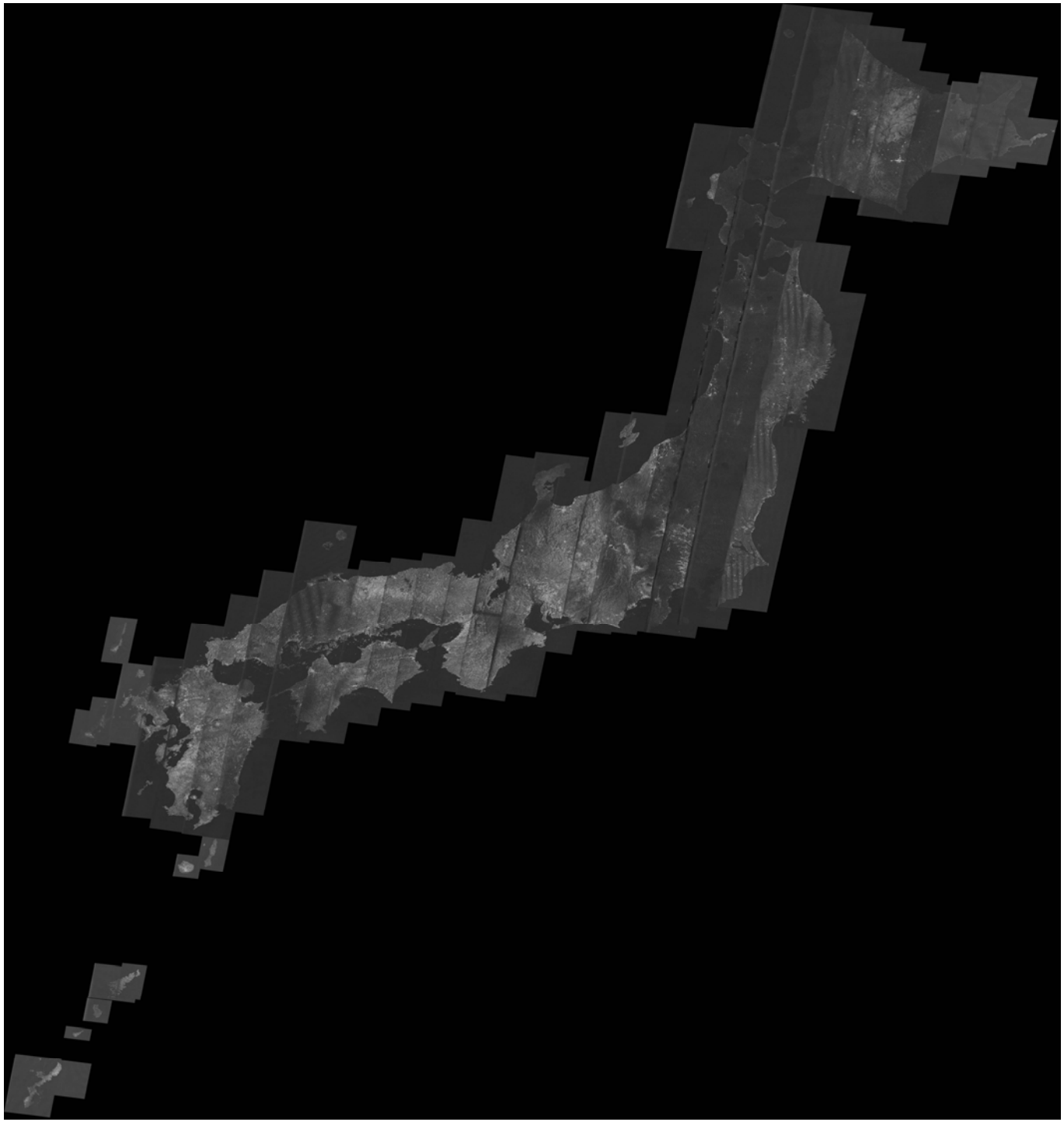
Shimada.masanobu@jaxa.jp

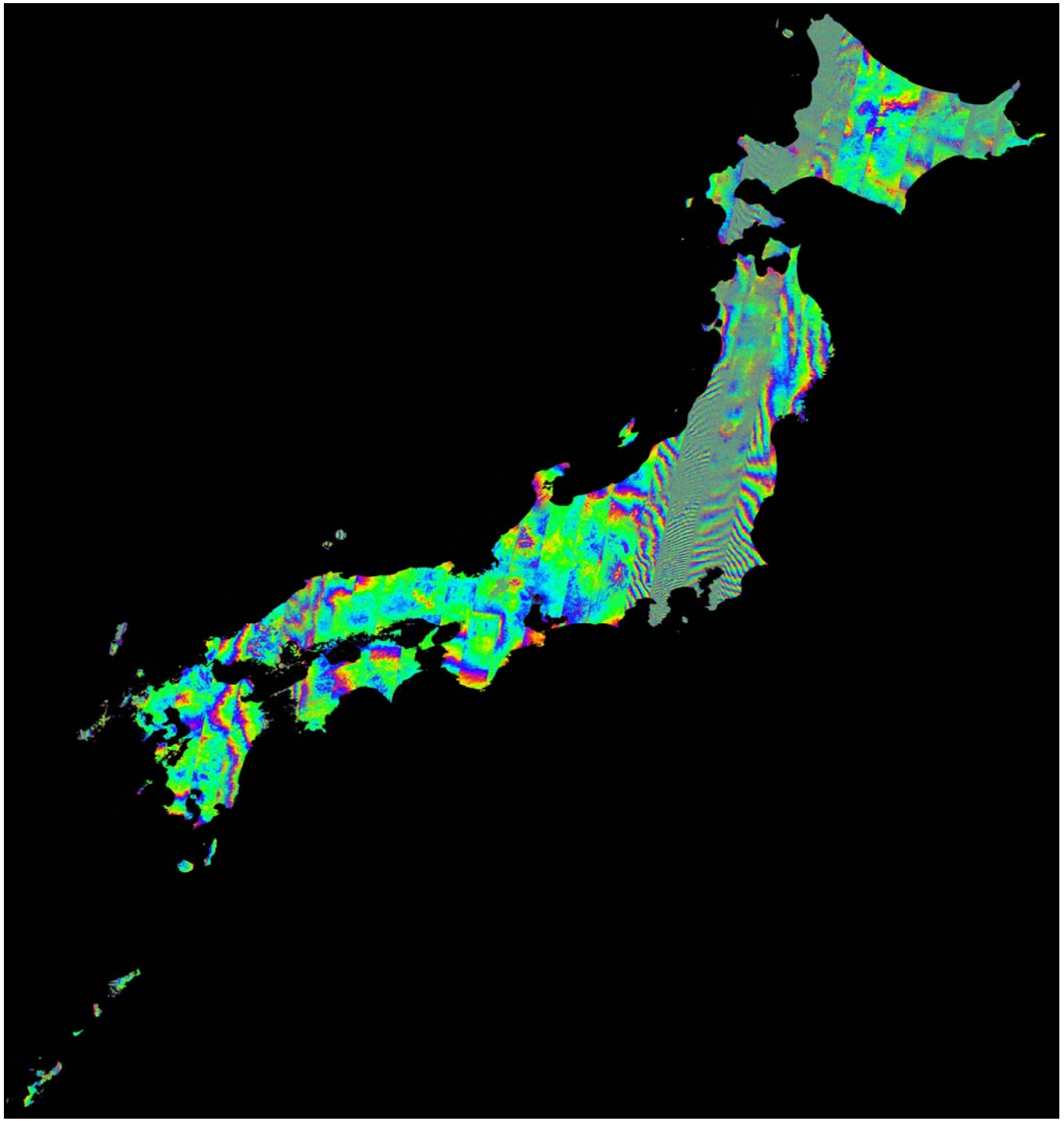
2007夏



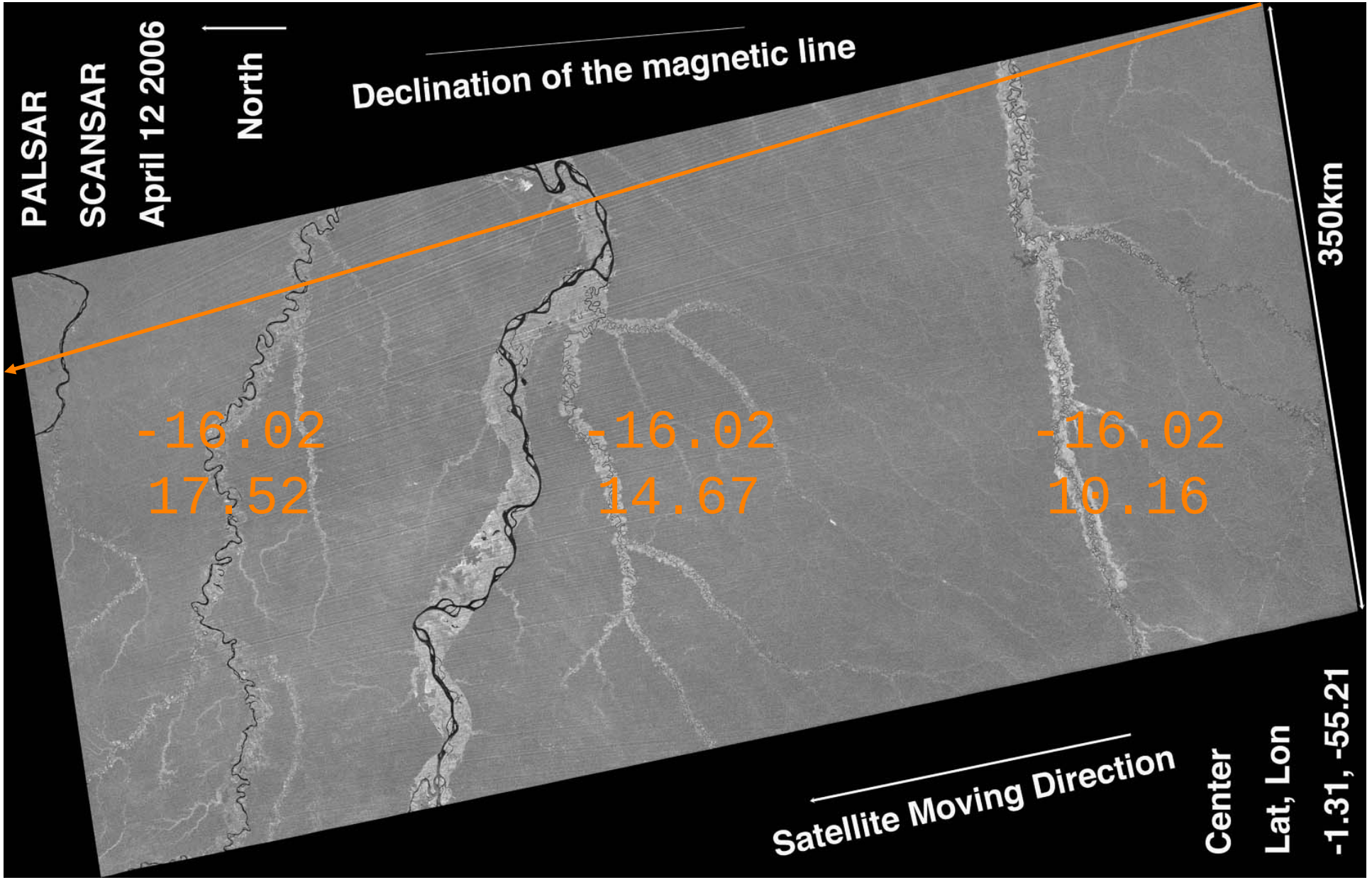
2007夏





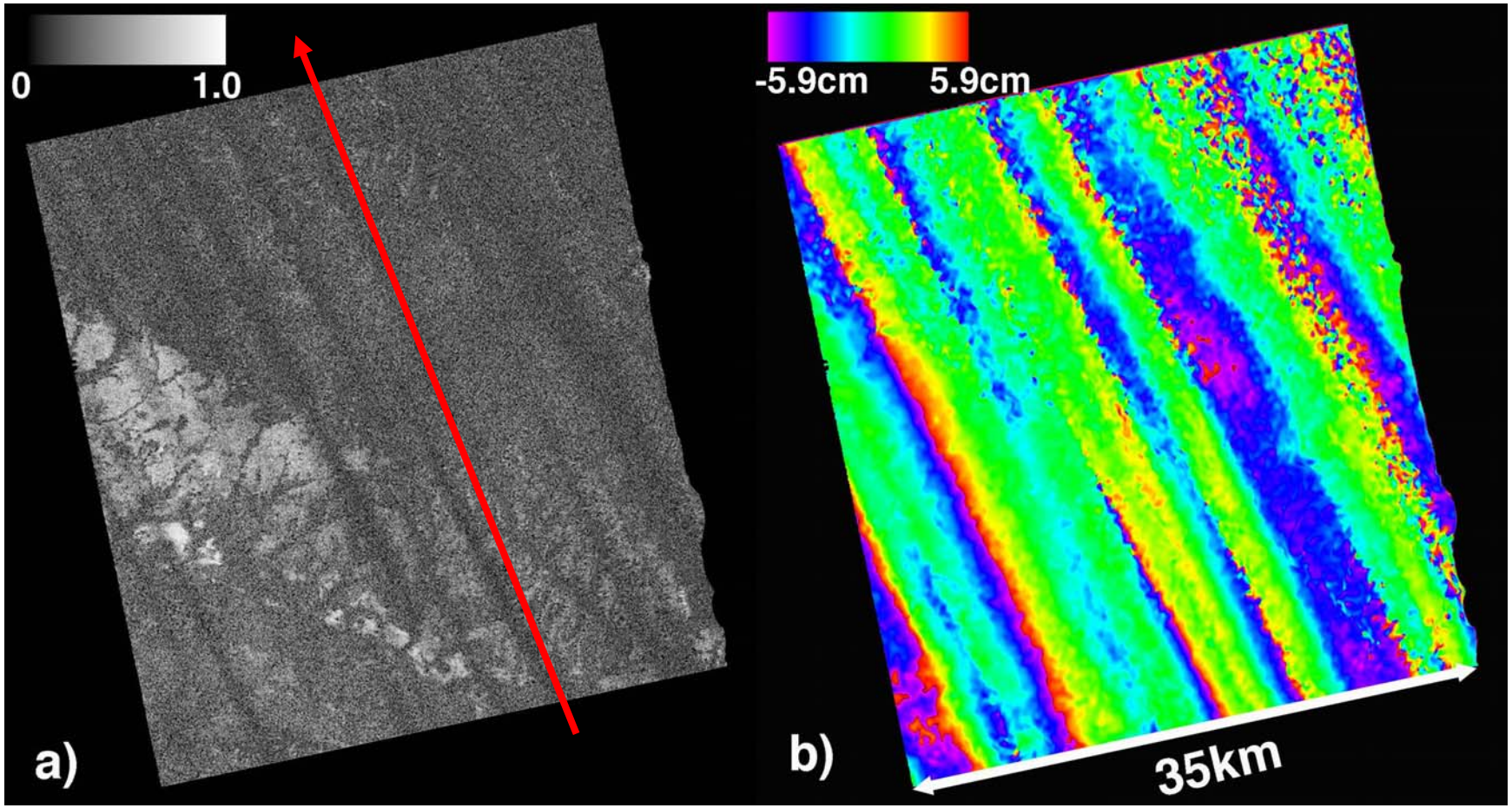


JERS-1



First PALSAR image detected the scintilla

Coherence drop due to the distance deformation



Coherence

Phase difference

Geomagnetic line

6 cycles -> 3 TE

Summary for the streaks

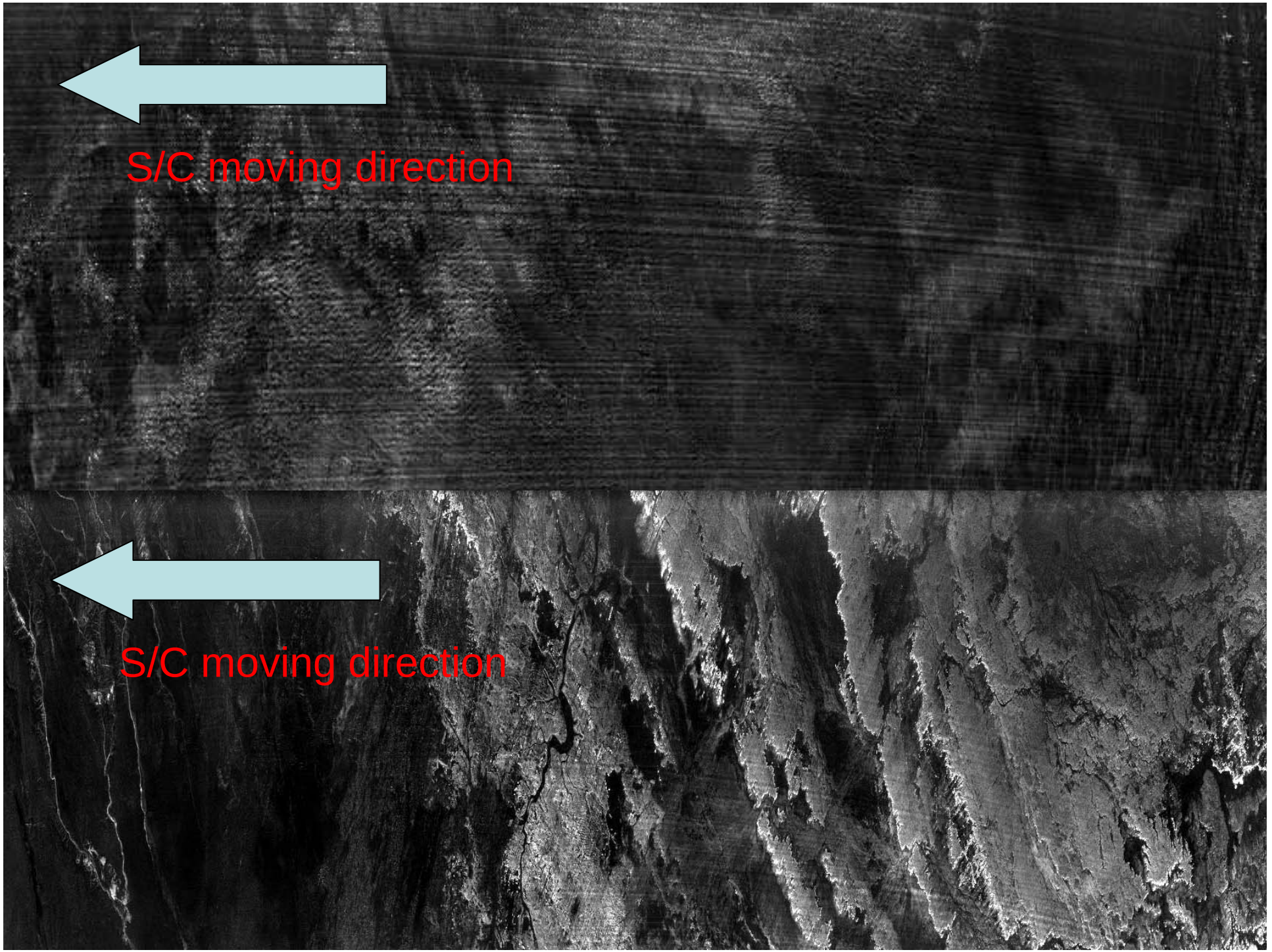
Steaks in the amplitude at mainly zero magnetic latitude
Range period of shorter cases deviates 1000m~4000m.
Steaks deviate the phases as well
InSAR Phase in azimuth varies at the mid-latitude regions

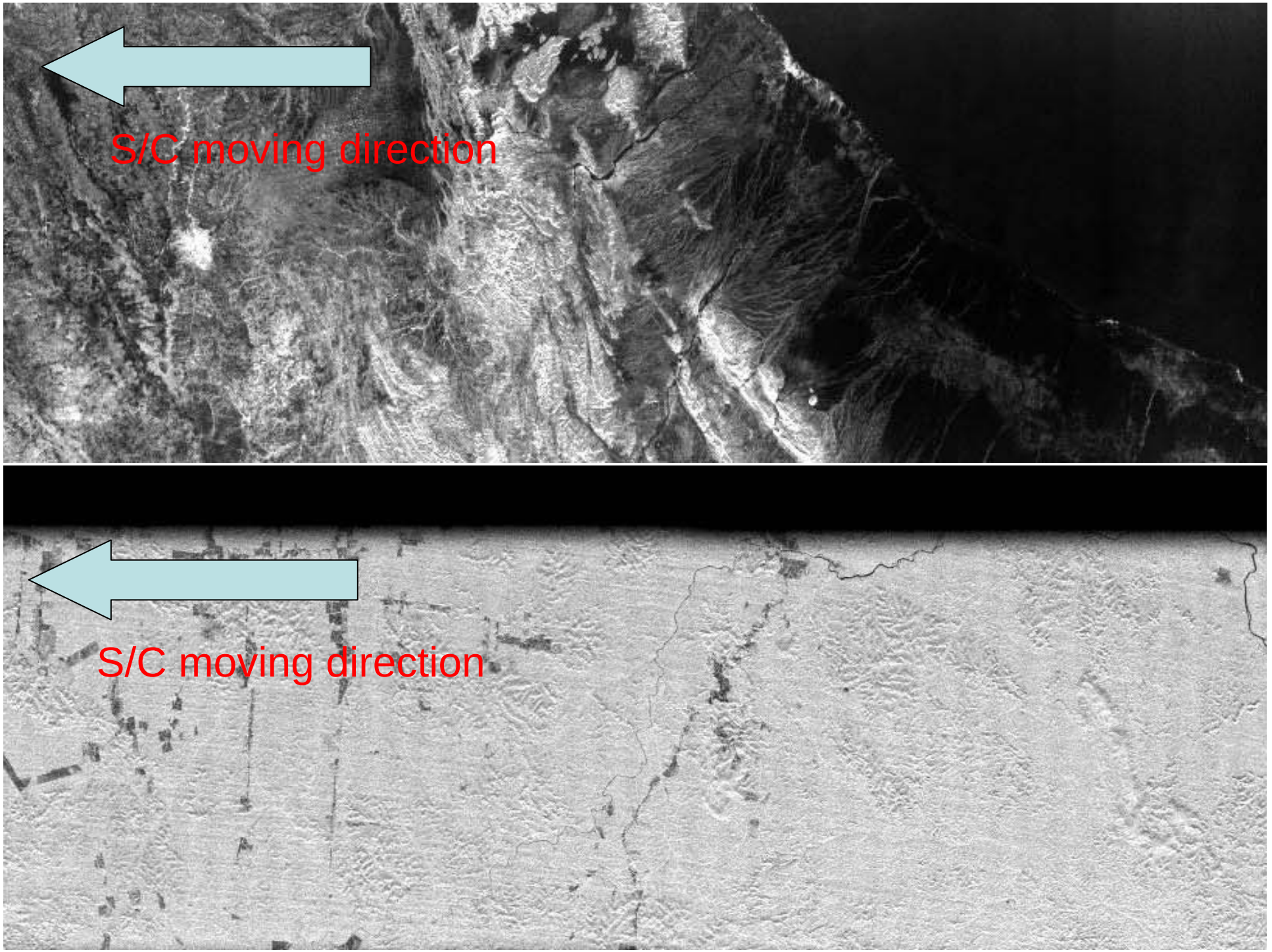
Questions are

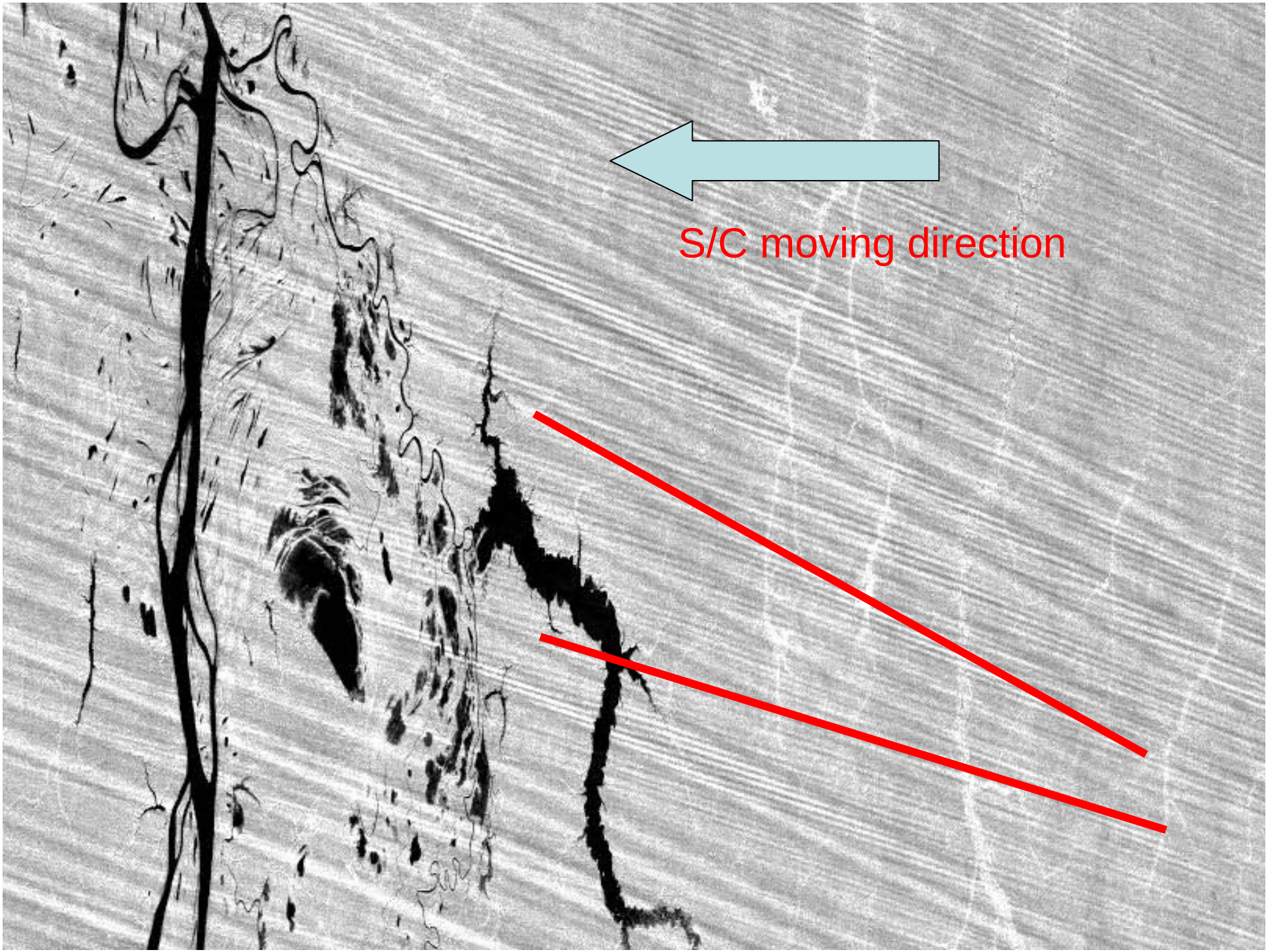
Q1: What are the causes for their appearance in range and azimuth?

Q2: Are they increased or decreased in time?

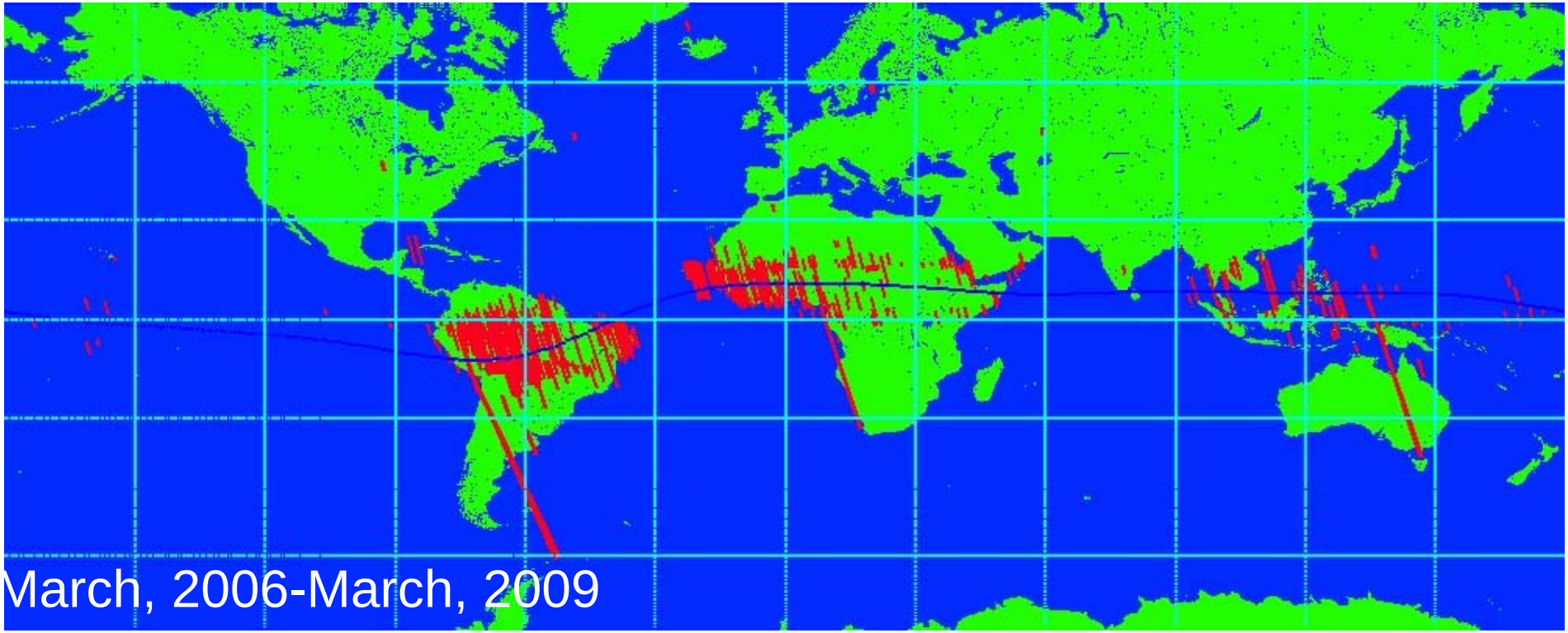
Q3: The possibility for the correction?


S/C moving direction
S/C moving direction

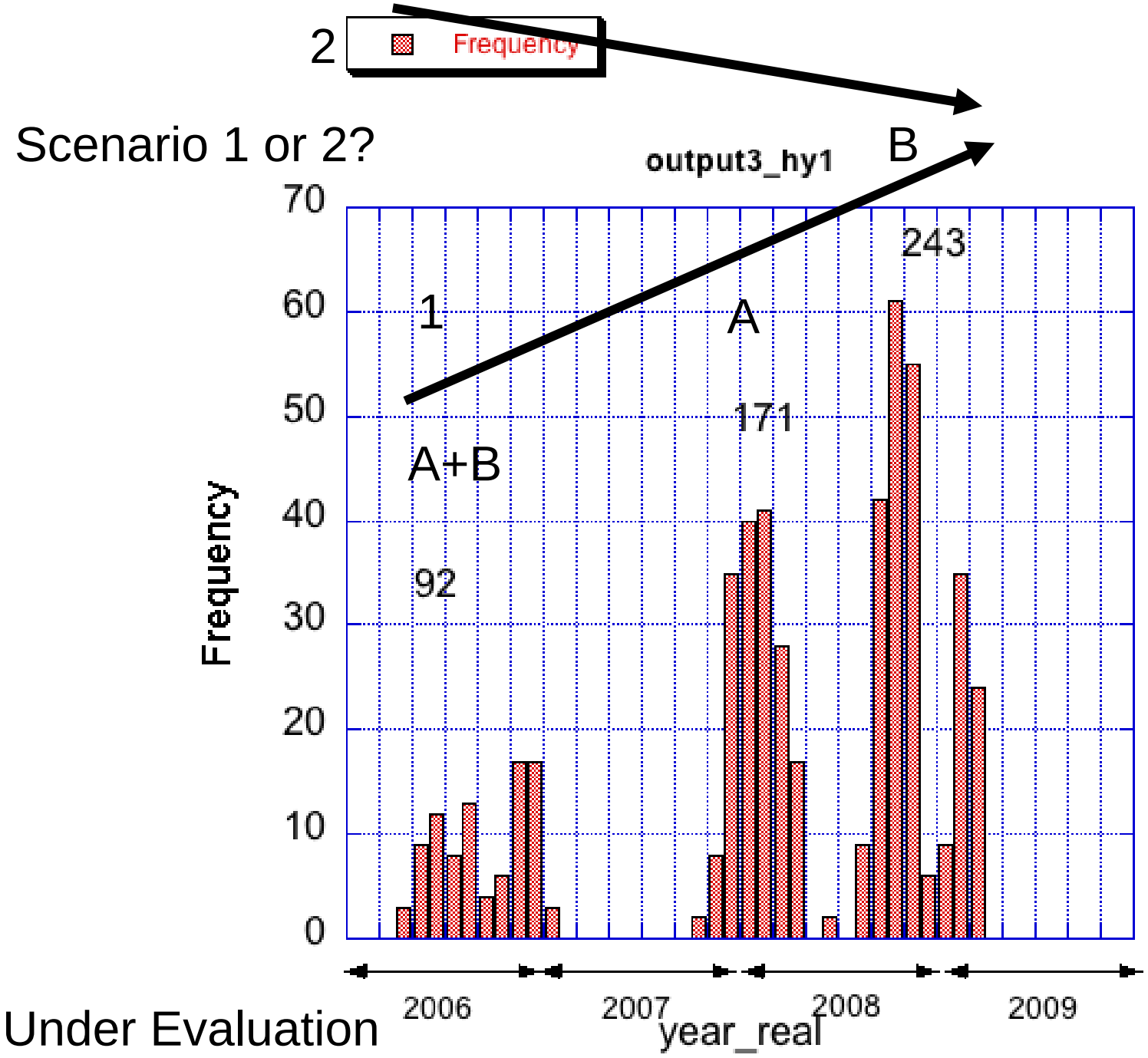

S/C moving direction
S/C moving direction

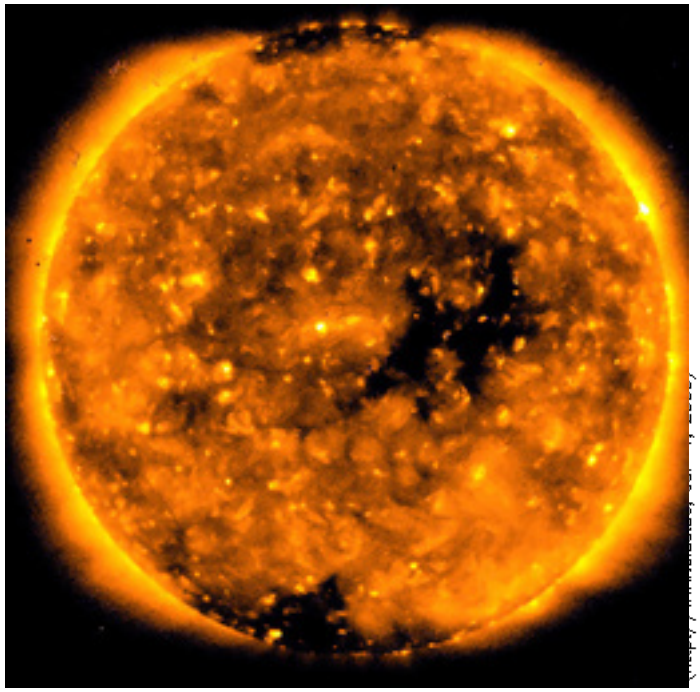

S/C moving direction

ea of PALSAR streaks appearance



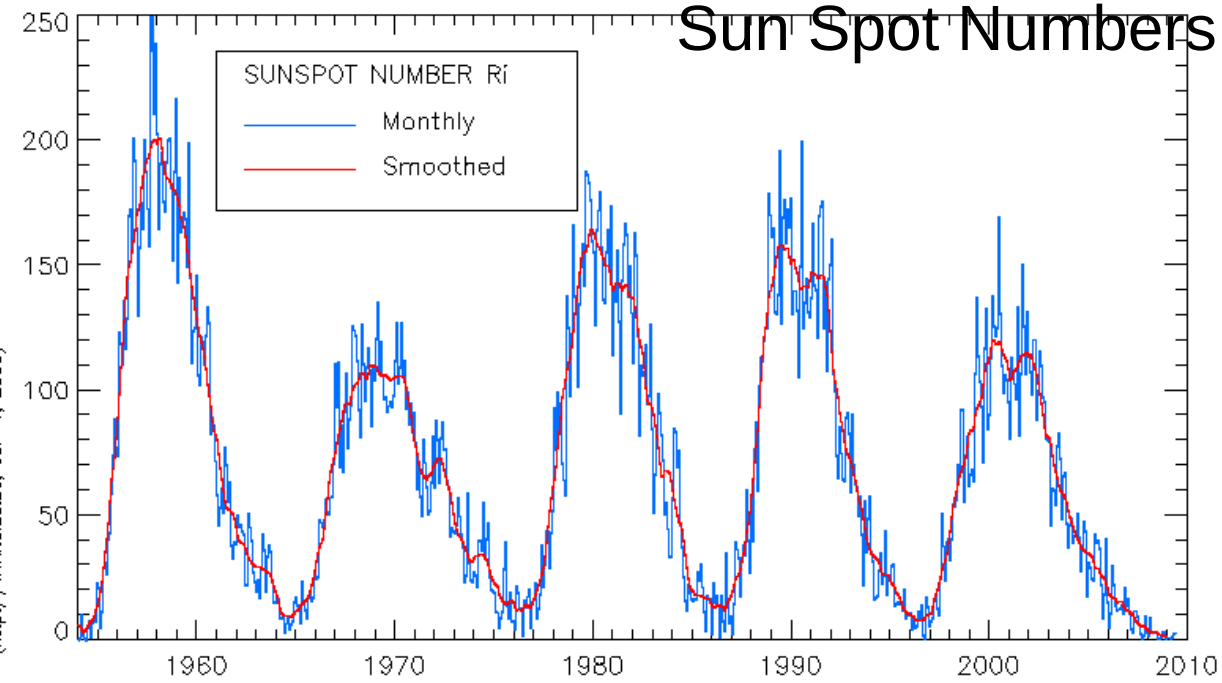
Total number of appearance : 506 : June 2

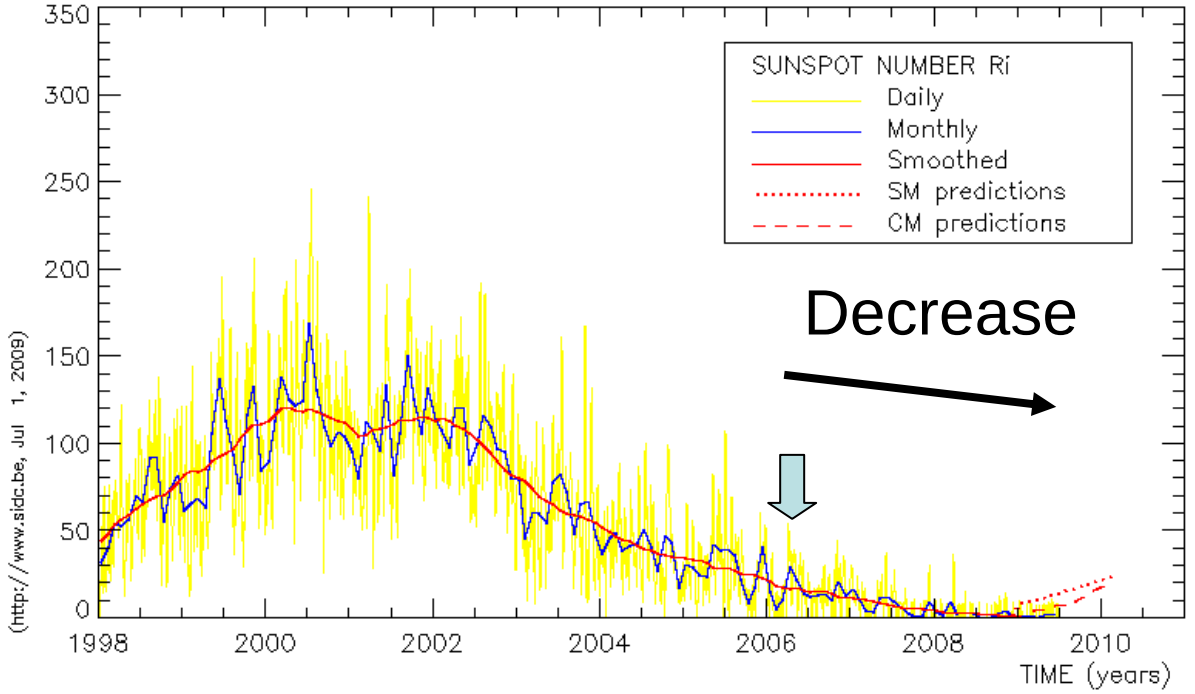

2
Frequency
Scenario 1 or 2?
output3_hy1
B
70
60
50
40
30
20
10
0
Frequency
243
1
A
171
A+B
92
2006
2007
2008
2009
year_real
Under Evaluation



Sunspot image
By “Hinode” satellite
March 2009

Sun Spot Numbers



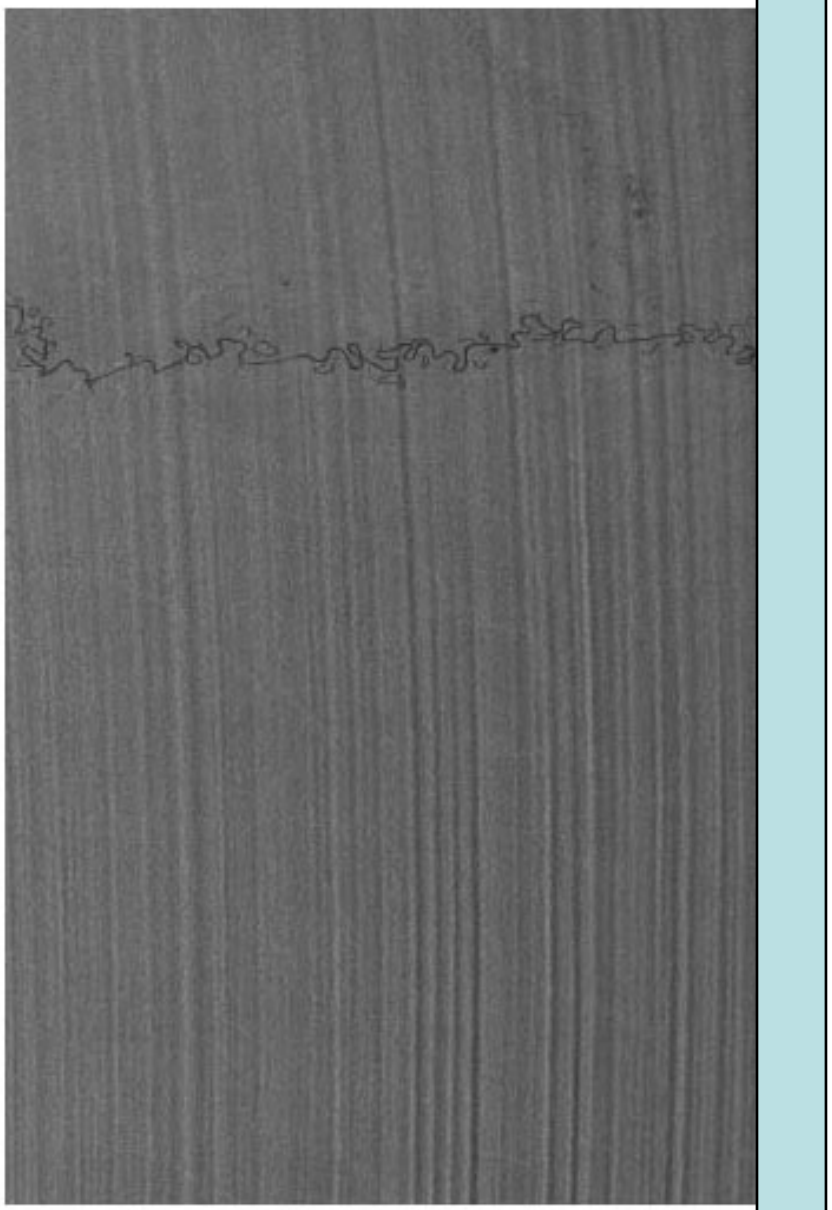


Causes for the stripes

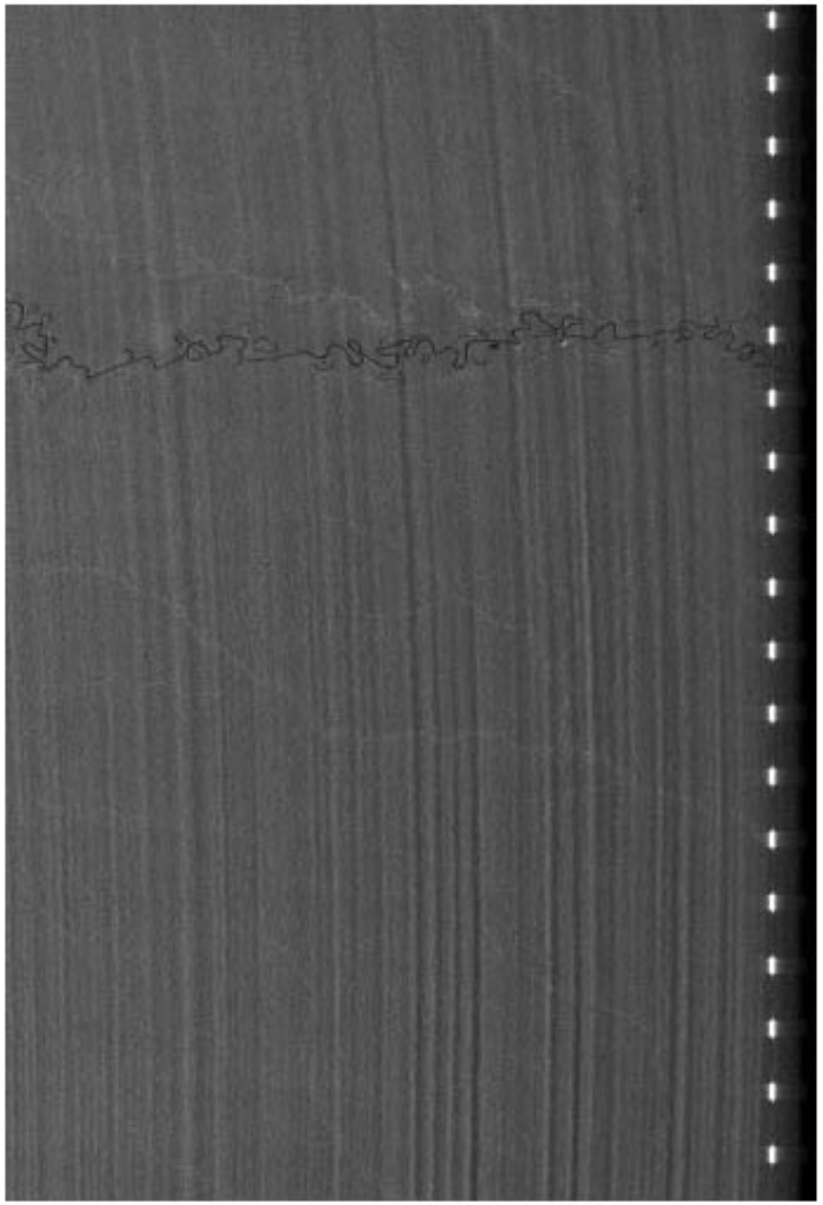
Scintillation in range

Ion Density variation ：Azimuth shift

RSP103_BRS20061126FBD415HV0_W0307149001-03_001



HV

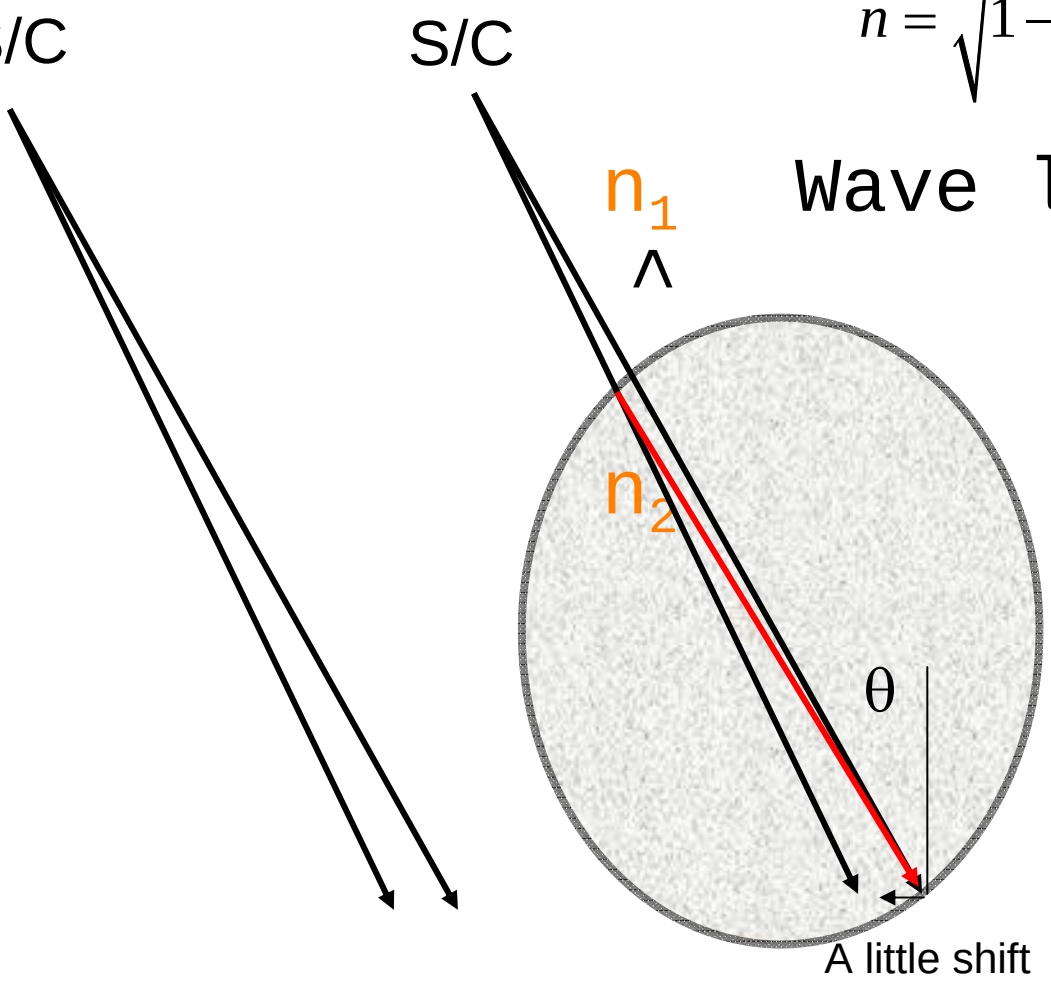


HH

RSP103_BRS20061126FBD415HH0_W0307149001-03_001

.ysis as the scintillation

$$n = \sqrt{1 - \frac{Ne^2}{me_0\omega^2}}$$ n<1.0



Wave length $\sqrt{2\lambda z / \sin\theta}$

Z=300km,
θ=42deg,λ=23.6
e-5km

Without stripes With stripes

Wavelength：
460m

$$df/dT = df/d(-2R/C)\cdot d(-2R/C)/dT$$

$$= f'\left(-\frac{2R'}{C}+\frac{2R}{C^2}\frac{dC}{dT}\right)$$

$$= j\omega f\cdot\left(-\frac{2R'}{nC_0}+\frac{2R}{n^2C}\frac{dn}{dT}\right)$$

$$= j\omega f\cdot\left(-\frac{2R'}{nC_0}+\frac{2R}{n^2C}\frac{dn}{dT}\right)$$

$$= j\omega f\cdot\left(-\frac{2R'}{nC_0}+\frac{2R}{n^2C}\frac{-e^2}{2\varepsilon^0\omega^2 m}\frac{dN}{dT}\right)$$

$$n=\sqrt{1-\frac{Ne^2}{e_0\omega^2 m}}$$

$$D=\frac{40.3N}{f^2}$$

$$f_{de}=f_0\cdot\left(\frac{2R}{n^2C}\frac{-e^2}{2\varepsilon^0\omega^2 m}\frac{dN}{dT}\right)$$

Doppler frequency due to the media variation in azimuth

Representative parameters for the ionosphere:
Electron mass (m): 9.109e-31kg
Electric charge (e): 1.602e-19 Coulomb
Emissivity at space (e_0): 8.854e-12Fm-1
Light speed (c):299792458m-1s-1
Angular speed (ω):2*PAI*1.27e9s-1

If we assume that dN/dT~1.0e9/m^3s-1, f_{de}~0.2Hz at the positive slope and -0.2Hz at the negative slope. It vibrates in azimuth.

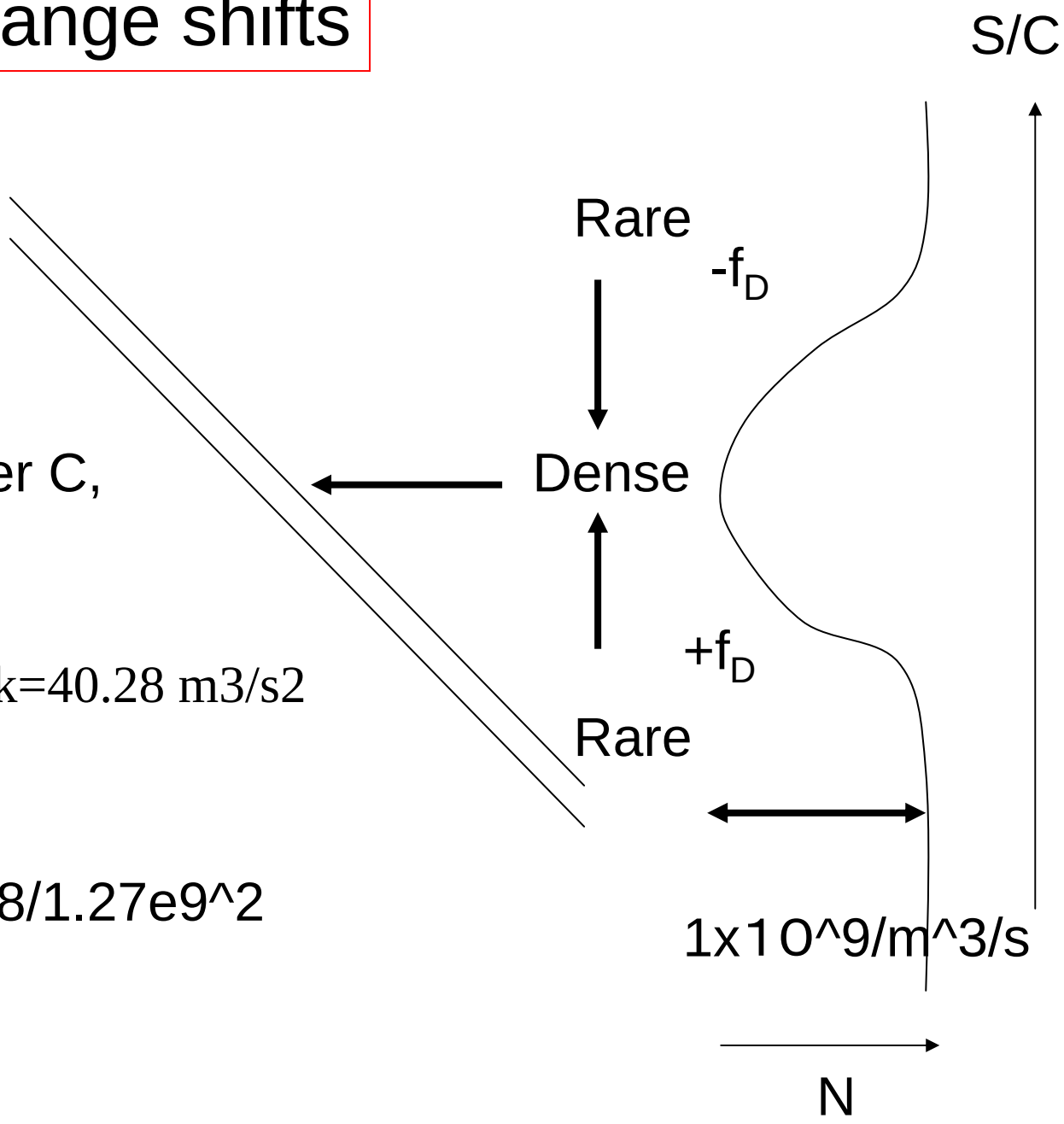
Change in Doppler -> Azimuth shift mainly very slightly in range.

$$\Delta y = \frac{\Delta f_D}{-f_{DD}} v_g$$

Δf	:	Δy
1Hz	:	13m
0.2Hz	:	2.6m

f_{DD}=-500Hz/s
V_g=6.7km/s

Azimuth and Range shifts



Smaller TEC, slower C,
projected nearer

$$\delta r = \frac{k}{f^2}\Delta TEC$$

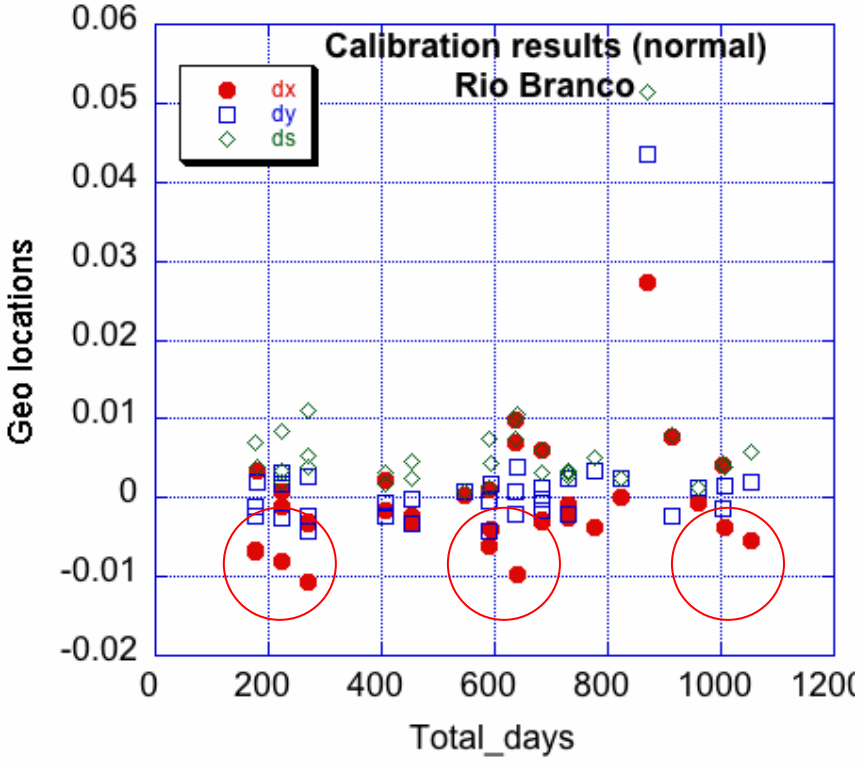
k=40.28 m3/s2

10^9*500000*40.28/1.27e9^2
=12.4m

Geometric evaluation using the corner reflector.

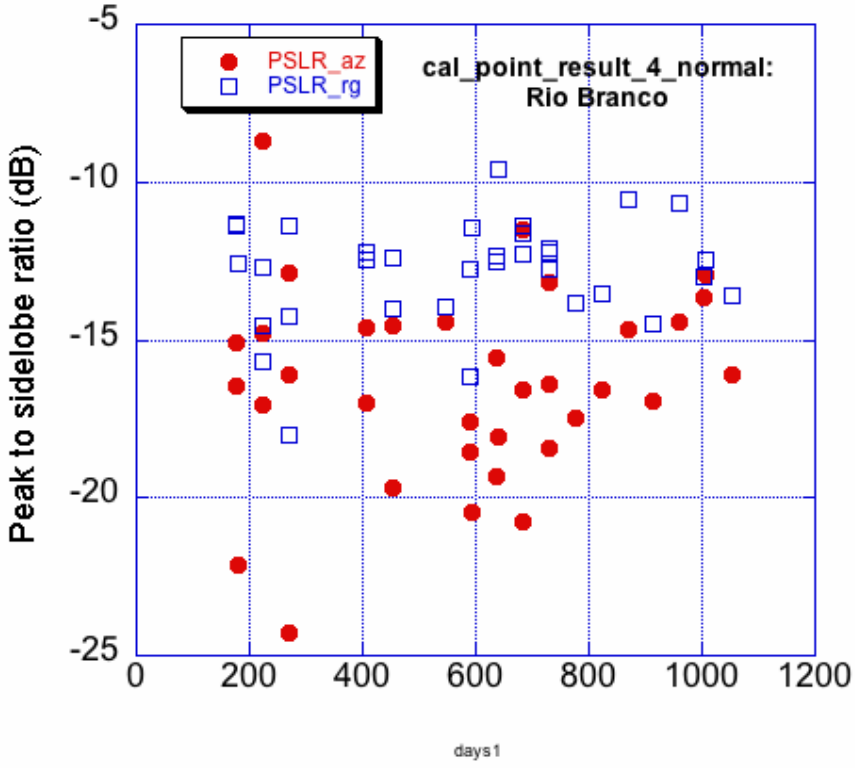
CRs in Amazon are used for the location shift and the resolution.

Geolocation



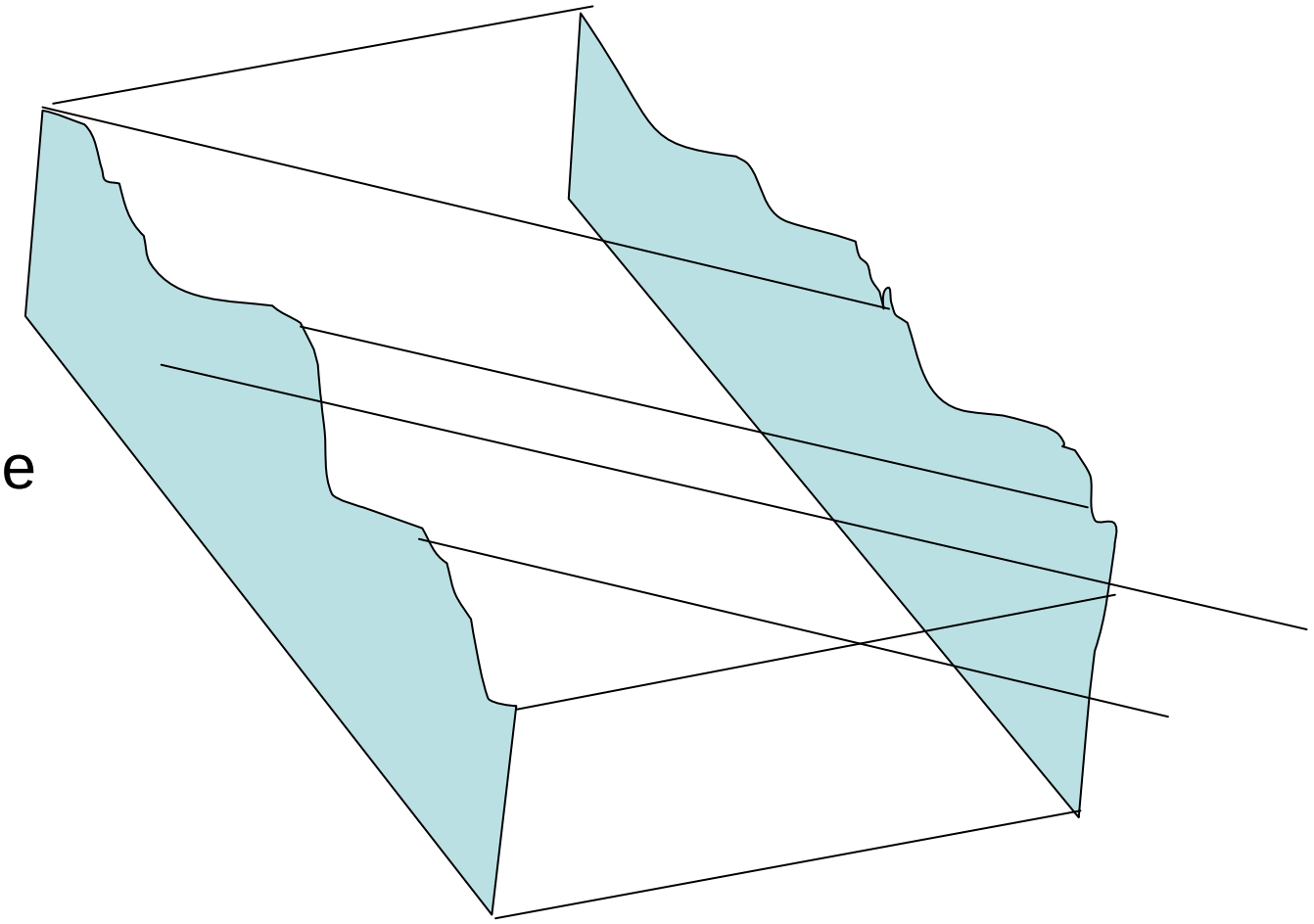
2006/w 2007/w 2008/w

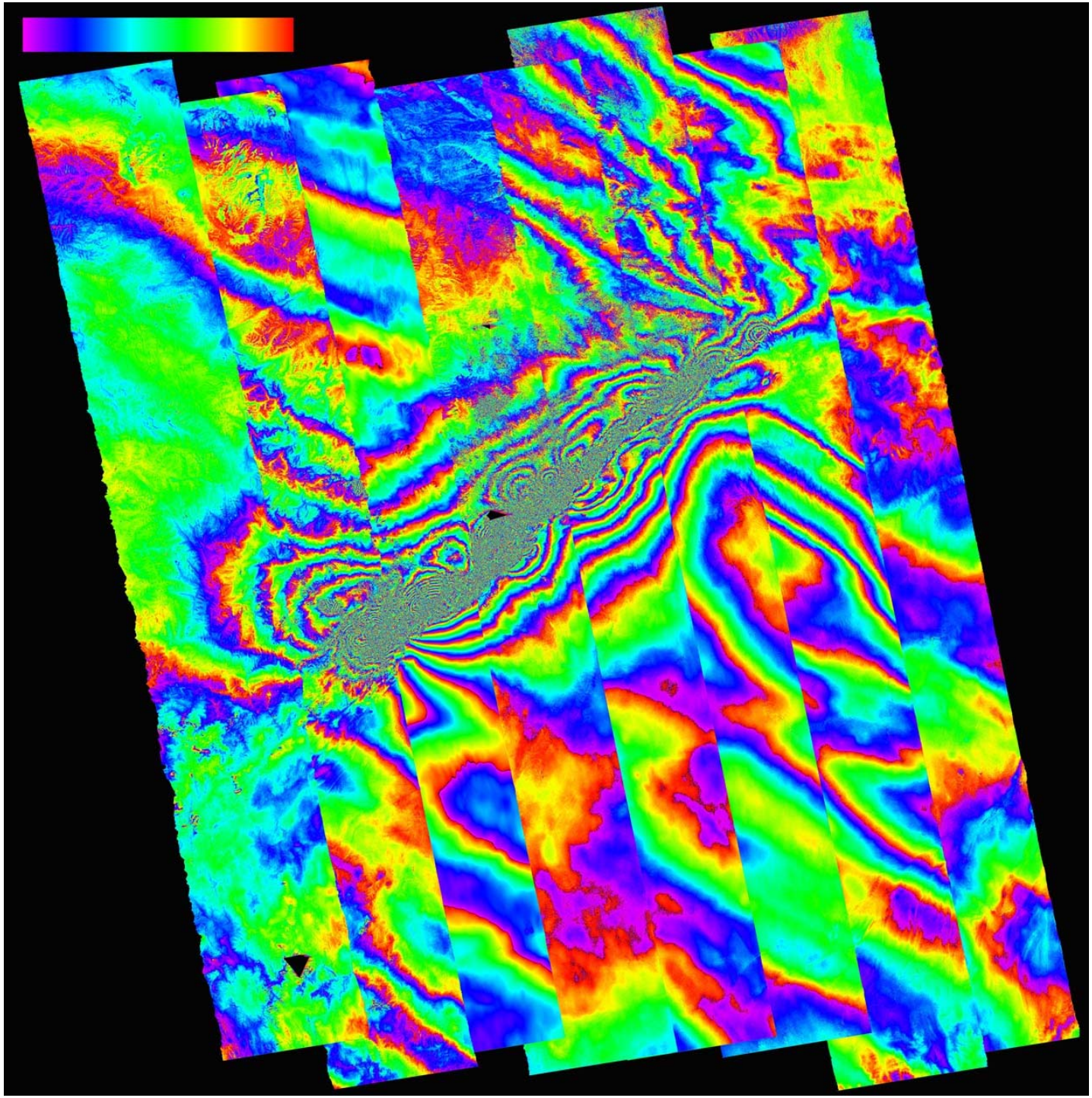
Resolution

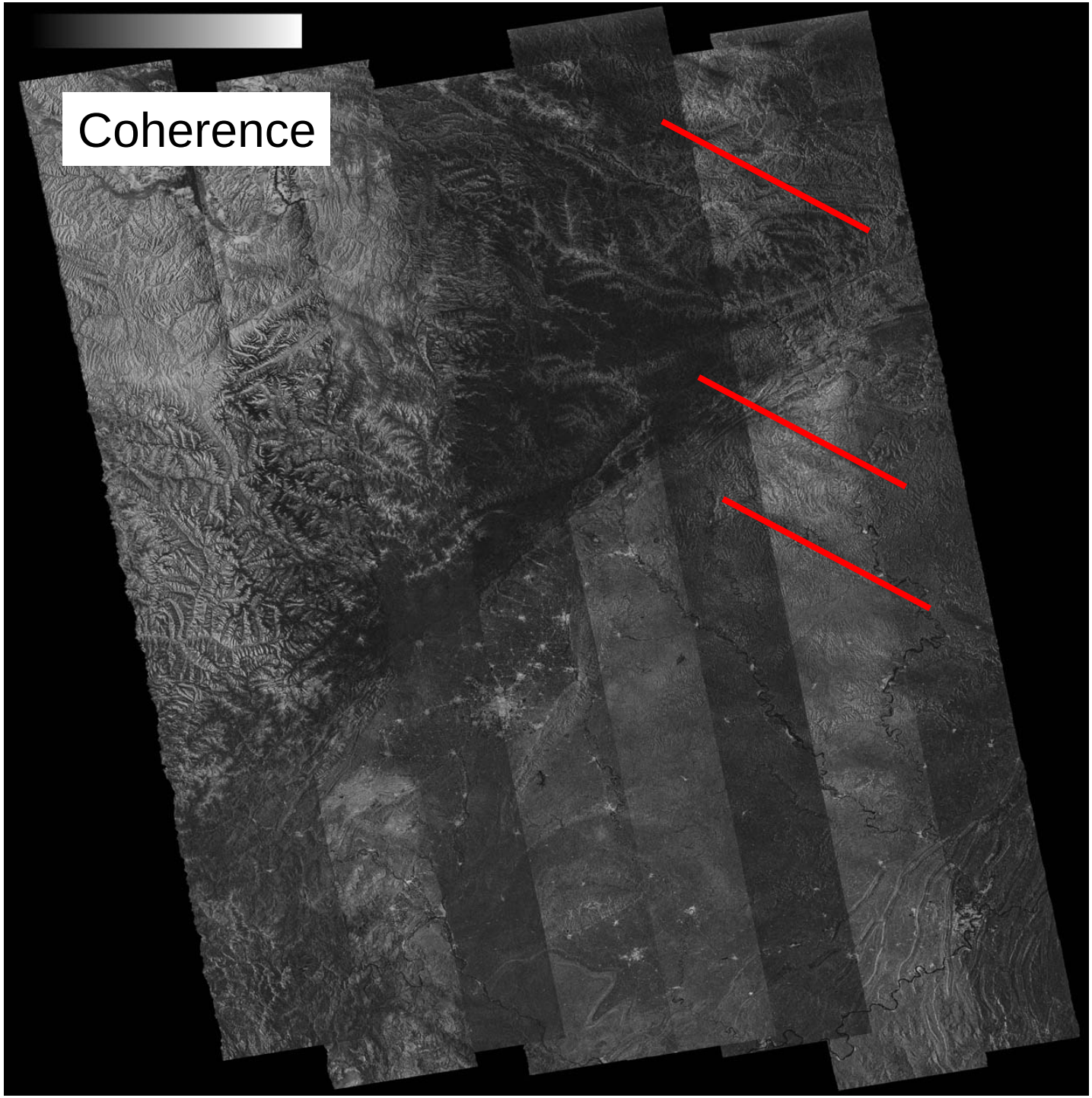


Guess for the Ionospheric structure

Magnetic line






Coherence

10TEC
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From

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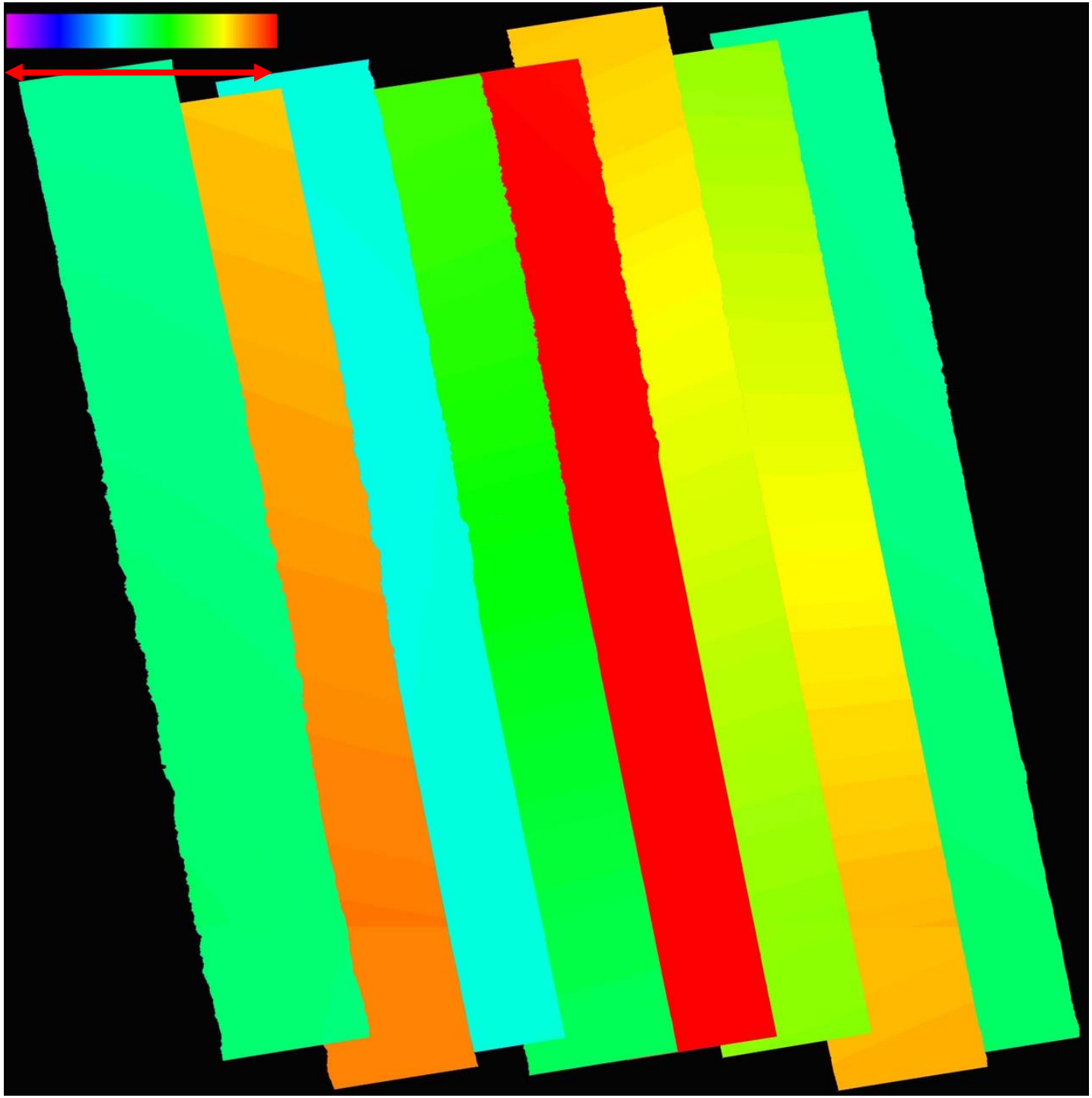
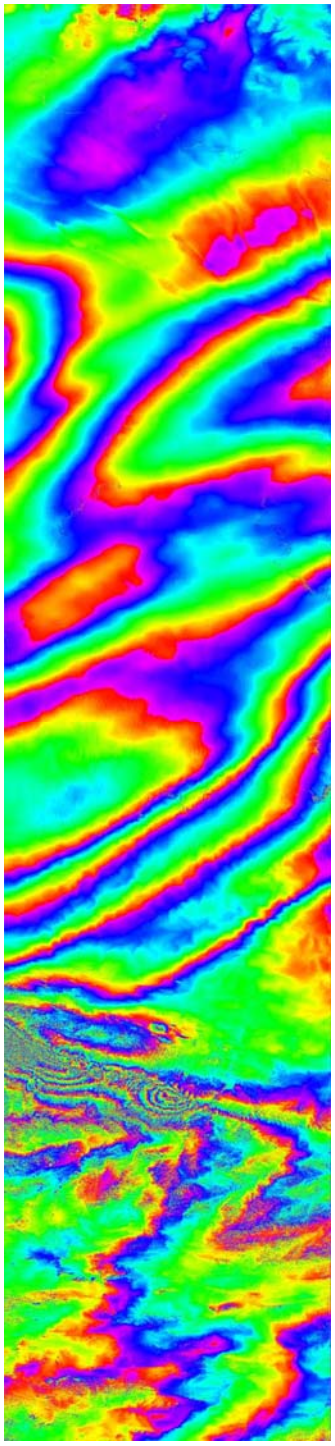
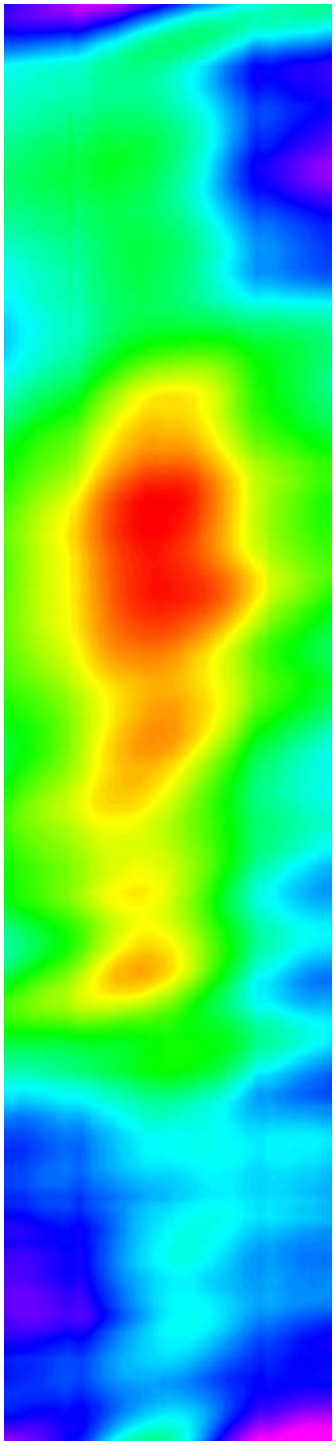
rsity

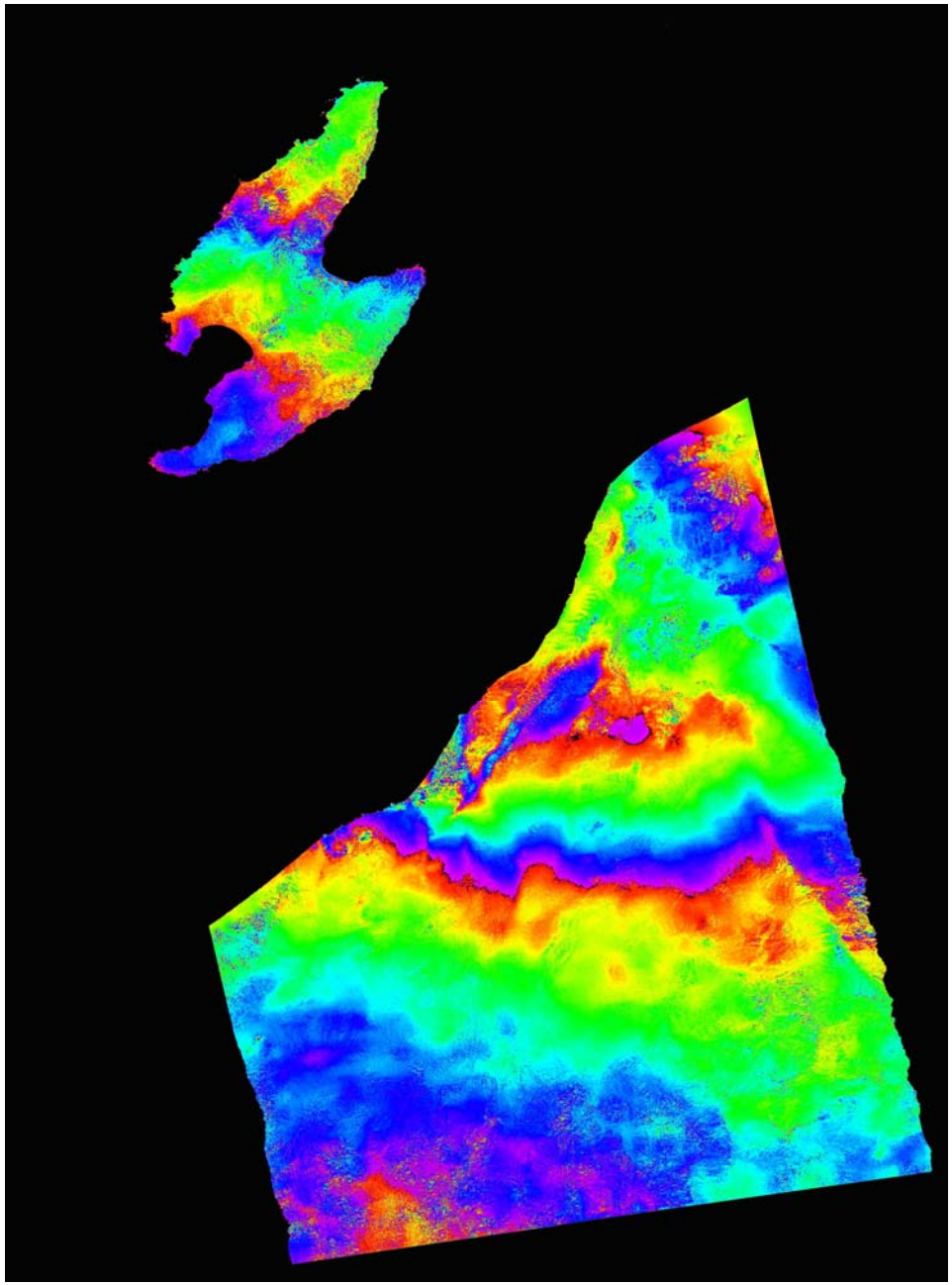


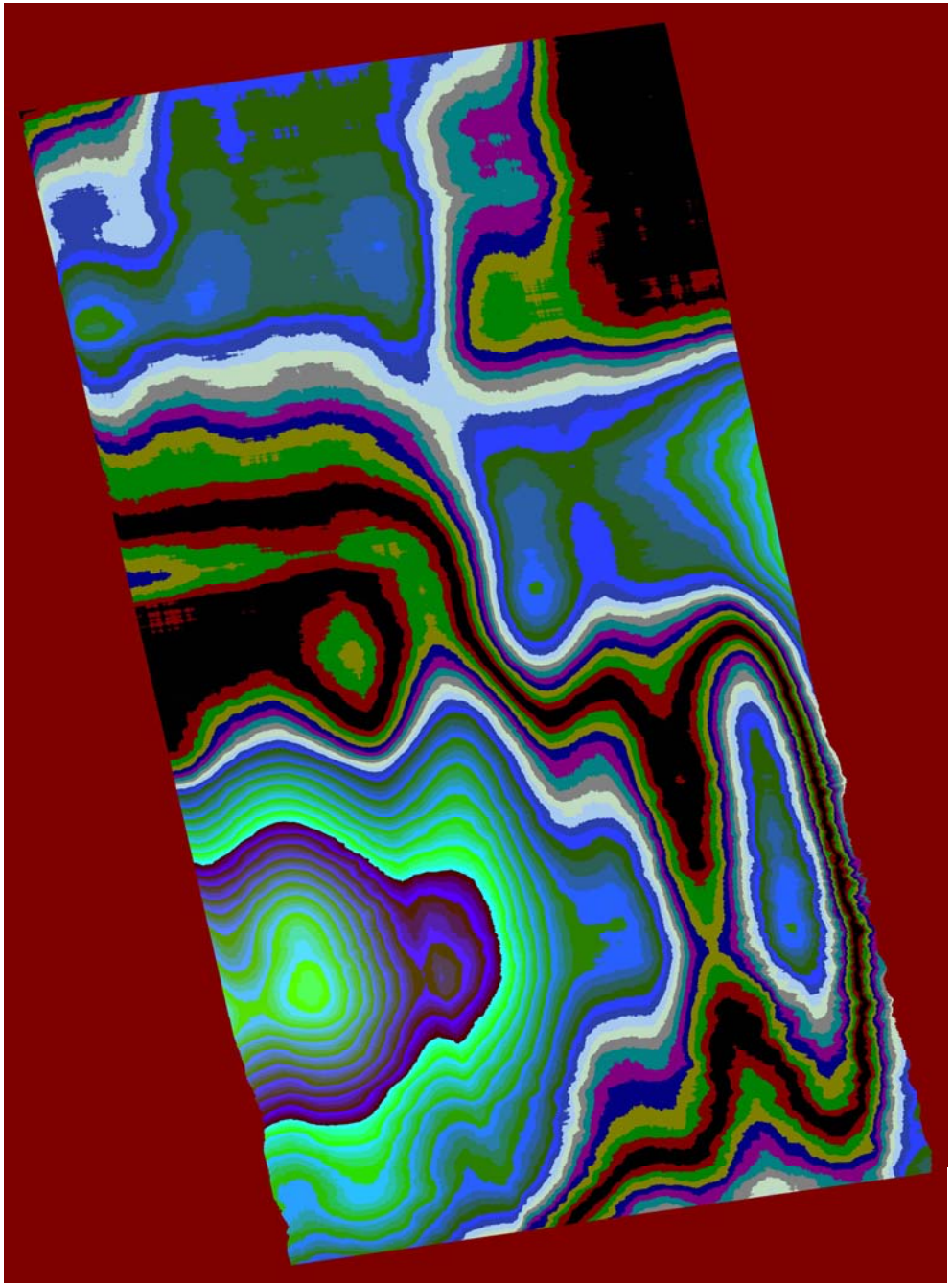
RSP471

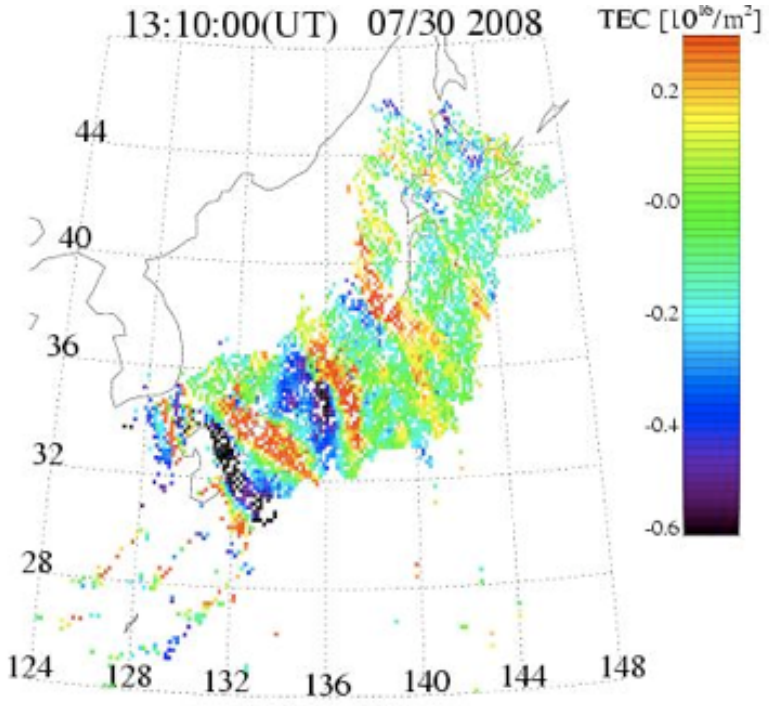




TEC distribution






13:10:00(UT) 07/30 2008
TEC [10^16/m^2]
0.2
-0.0
-0.2
-0.4
-0.6
44
40
36
32
28
124
128
132
136
140
144
148

Conclusions

Appearance of the streaks, which may be related to the ionospheric disturbance, increases as time goes by while the solar activity decreases. -> needs more evaluation.

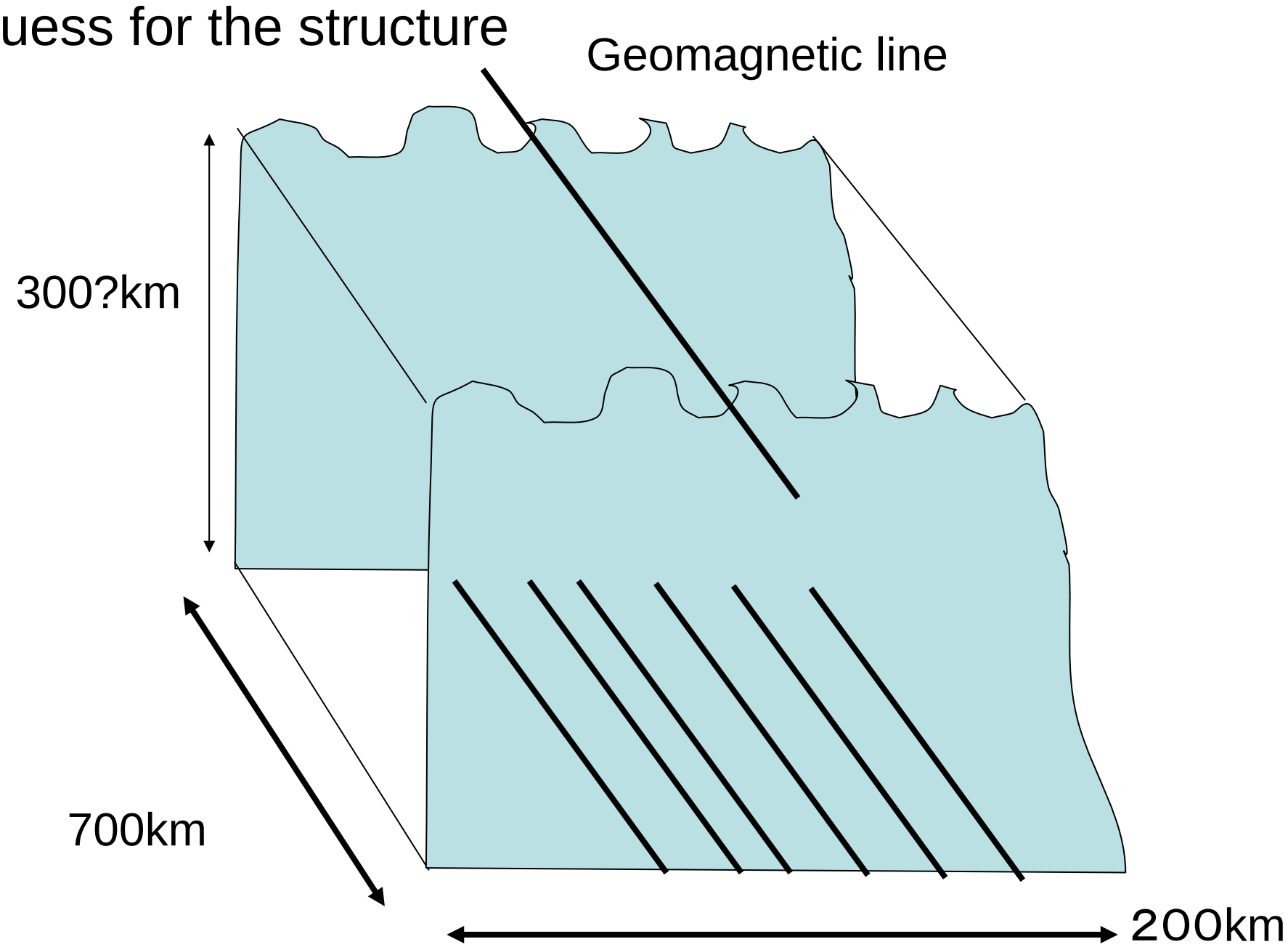
Streaks appear both in amplitude and phase, and making the image interpretation difficult.

Estimated cause of the streaks are that the TEC deviates along the geomagnetic lines and overlaid with the scintillation in range and shift in azimuth (vibration).

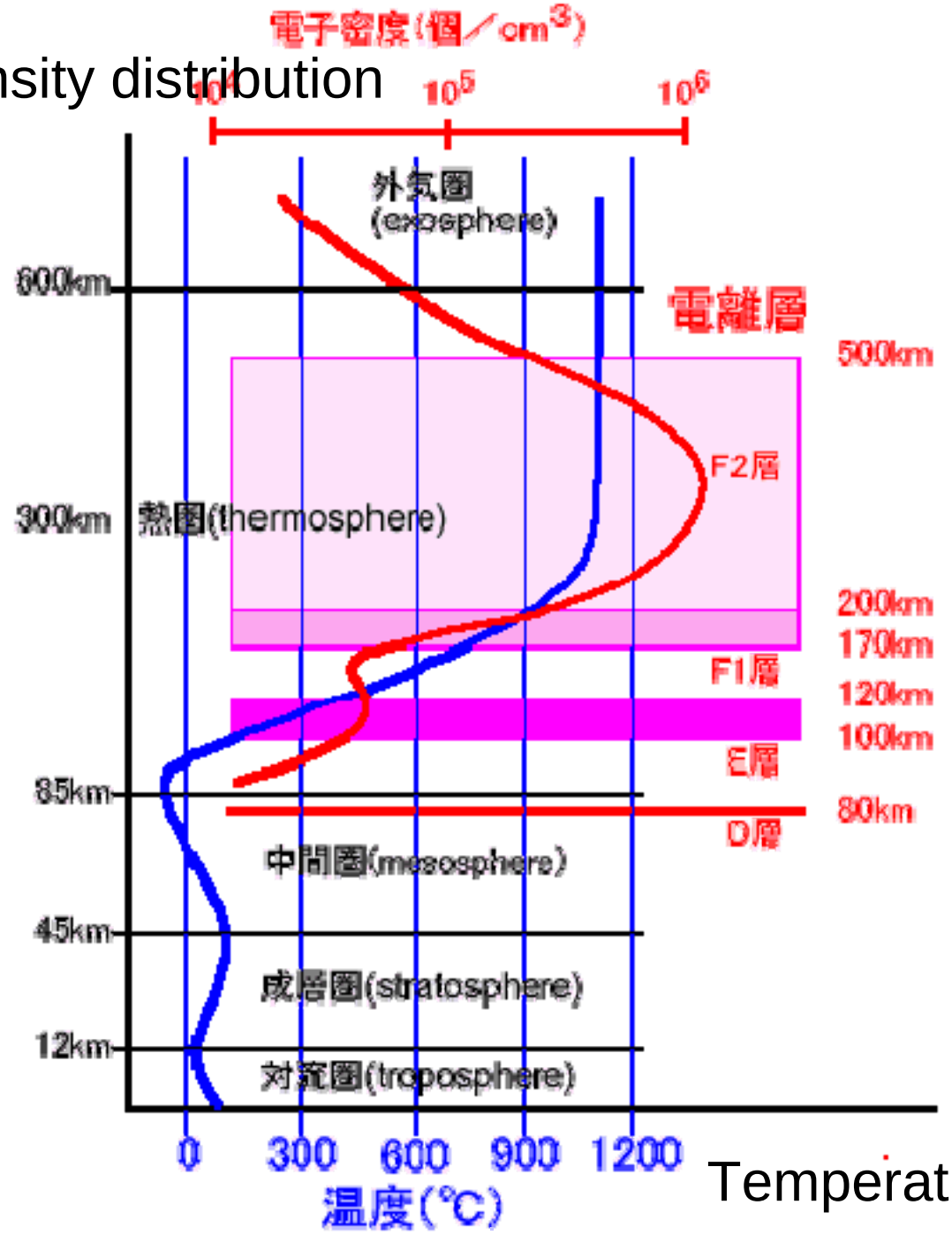
Comparison with the GCP on the ground, range variation appears in 10m and azimuth variation in 3m (+-).

This case shows the electron variation of 1x10^9/m^3/s.

Guess for the structure



Electron density distribution



Temperature

Doppler Frequency：Observation target (ionosphere) changes the Doppler frequency.

SAR received signal at intermediate frequency：

$$f(-\frac{2R}{C})$$

Time variation:

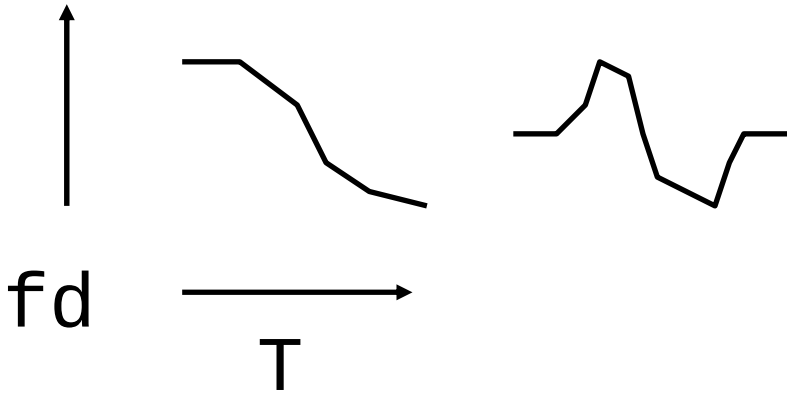
$$\frac{df}{dT} = j\omega f\left(-\frac{2dR/dT}{\frac{C_0}{n}} + \frac{2R}{\left(\frac{C_0}{n}\right)^2}\left(n^2\right)dn/dT\right)$$

Doppler

Doppler by media → Shift in azimuth

$n(T - V_p T)$

n:electron density



Shift in Az and r