



IUGONET

Metadata DB for Upper Atmosphere

超高層大気長期変動の全球地上ネットワーク観測・研究
Inter-university Upper atmosphere Global Observation NETwork

IUGONET 研究集会@February 20, 2015 京大セミナーハウス

TDAS/UDASによる脈動オーロラの研究 ～オメガバンド脈動オーロラの THEMIS衛星・地上同時観測～

佐藤夏雄
国立極地研究所



極地研

IUGONET

THEMIS衛星観測

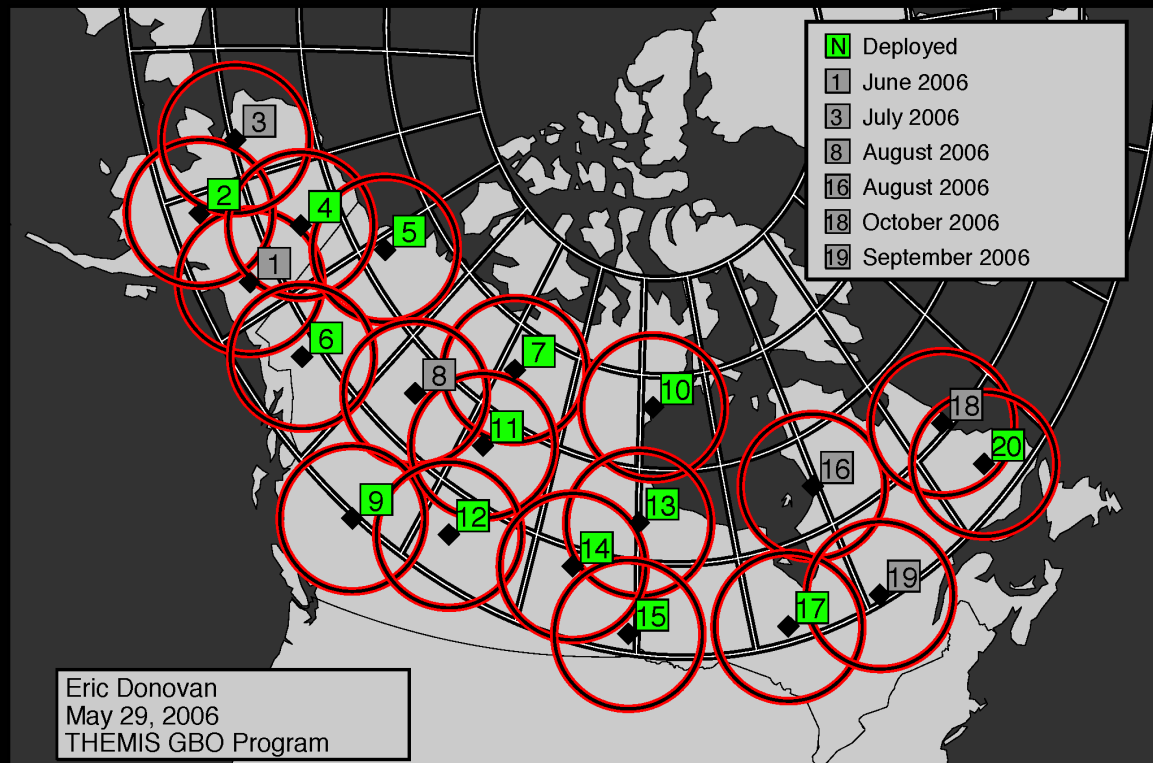
脈動オーロラ観測の
地上・THEMIS衛星同時観測



THEMIS観測プロジェクトはオーロラの衛星-地上同時観測をする上で理想的な配置

THEMIS

Mission Concept – THEMIS GB Program

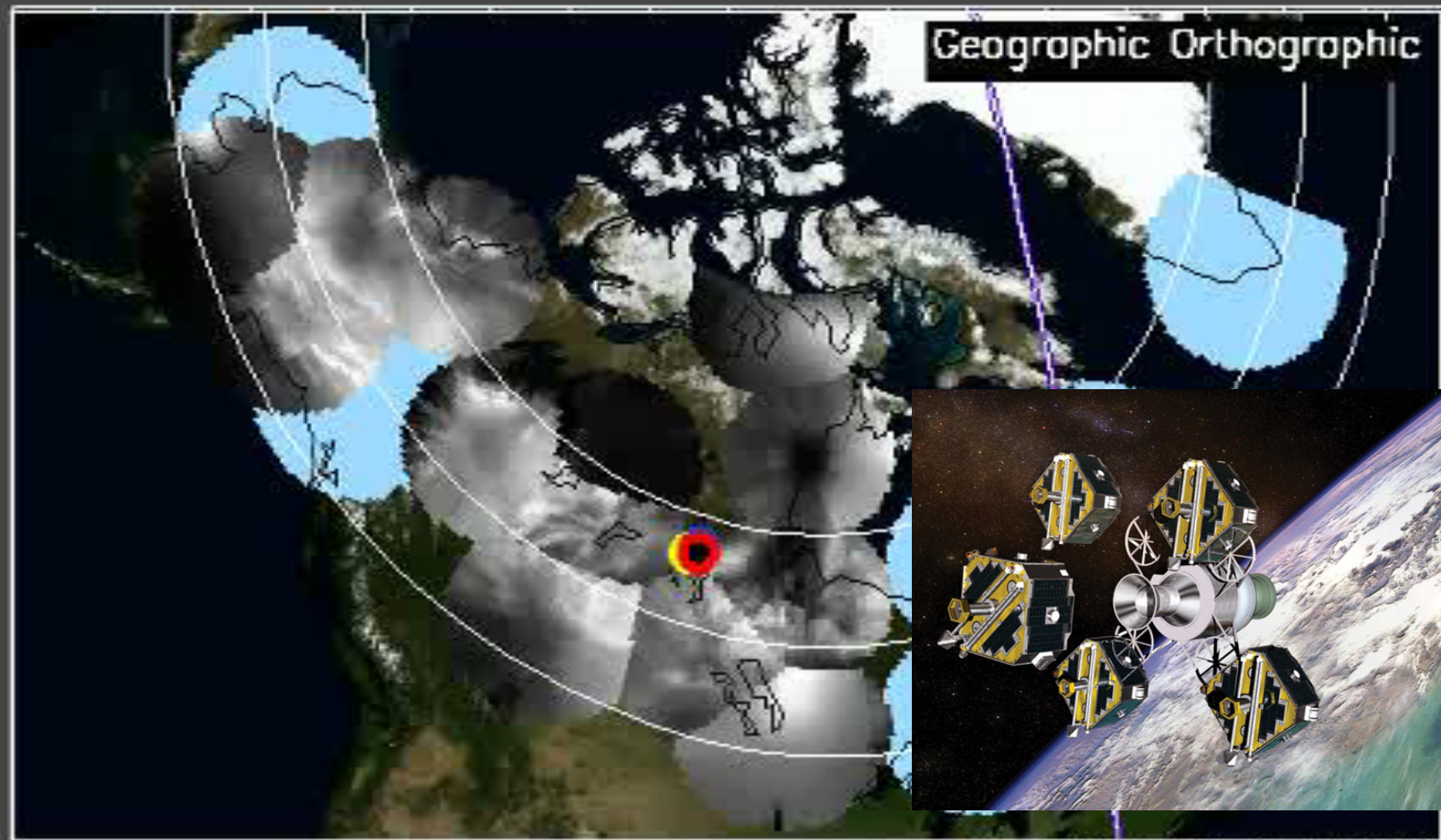


THEMIS

ASI Sites

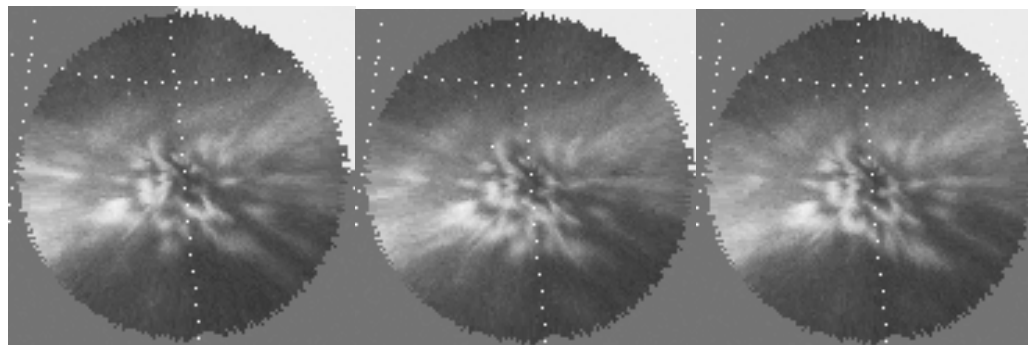
- 1 gakona
- 2 mcgrath
- 3 kiana
- 4 fort yukon
- 5 inuvik
- 6 whitehorse
- 7 ekati
- 8 fort simpson
- 9 prince george
- 10 rankin inlet
- 11 fort smith
- 12 athabasca
- 13 gillam
- 14 the pas
- 15 pinawa
- 16 umiujaq
- 17 kapuskasing
- 18 nain
- 19 chibougamau
- 20 goose bay





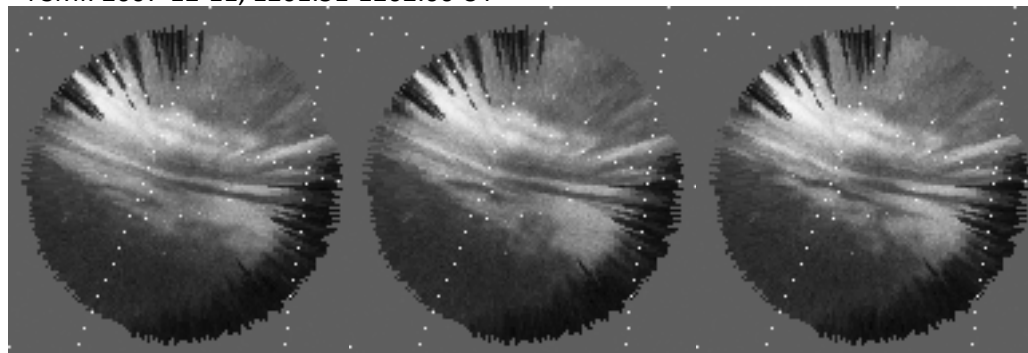
GILL:2008-02-11, 1155.03-1155.09 UT

Patch



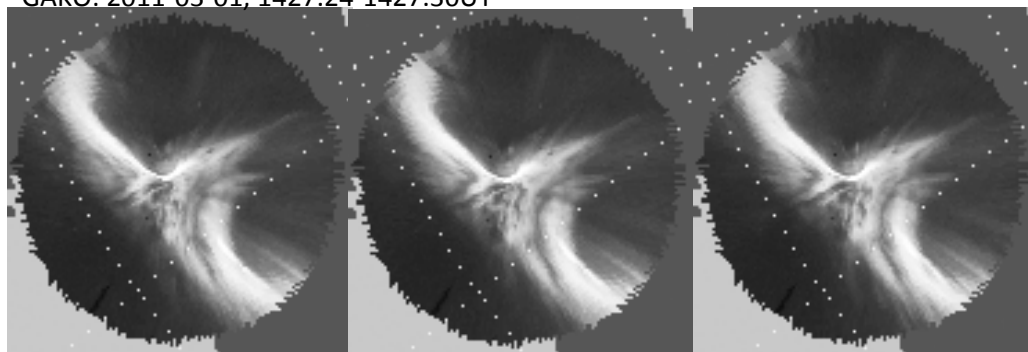
FSMI: 2007-12-11, 1201.51-1202.00 UT

East-west band

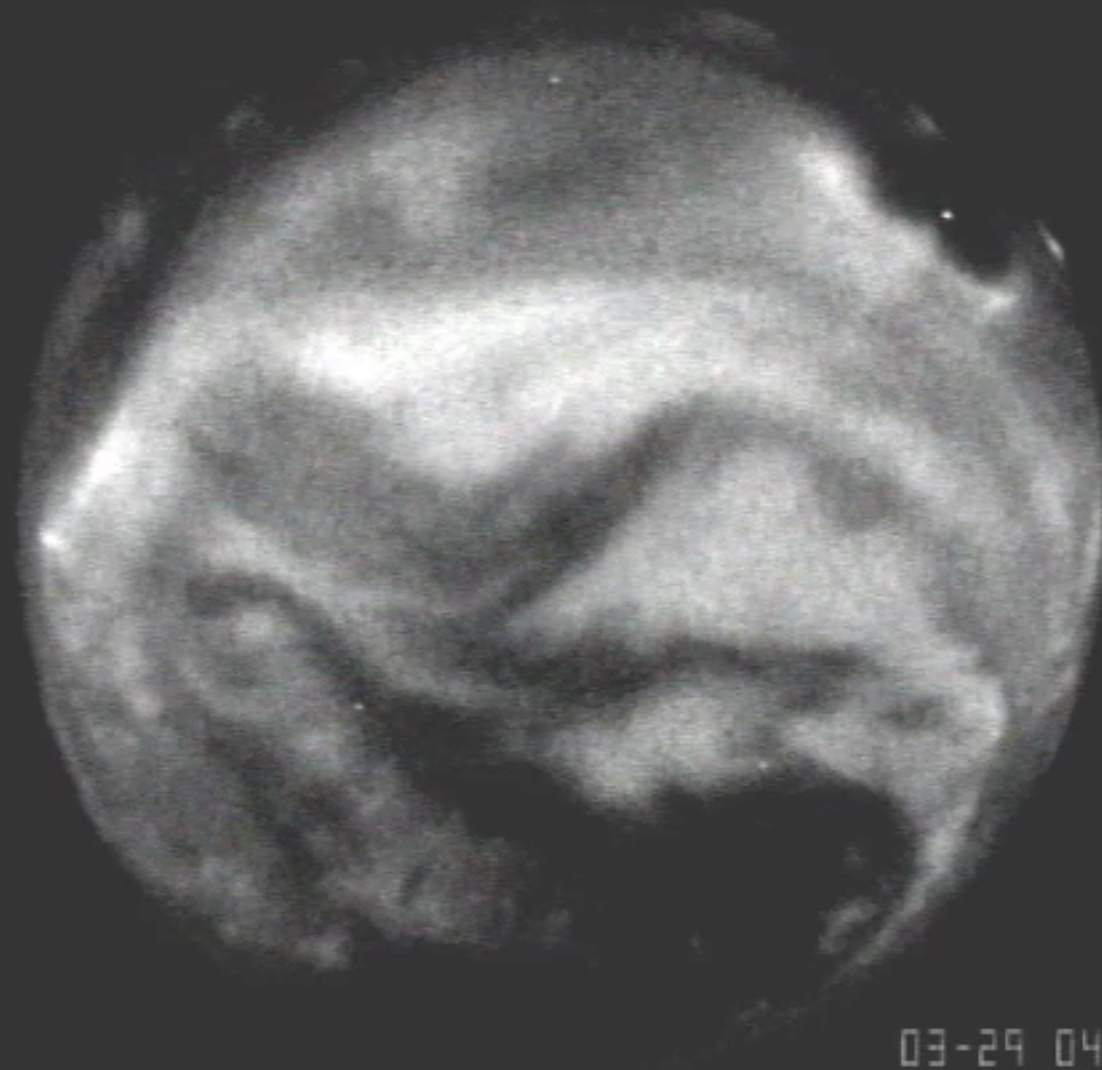


GAKO: 2011-03-01, 1427.24-1427.30UT

Omega band



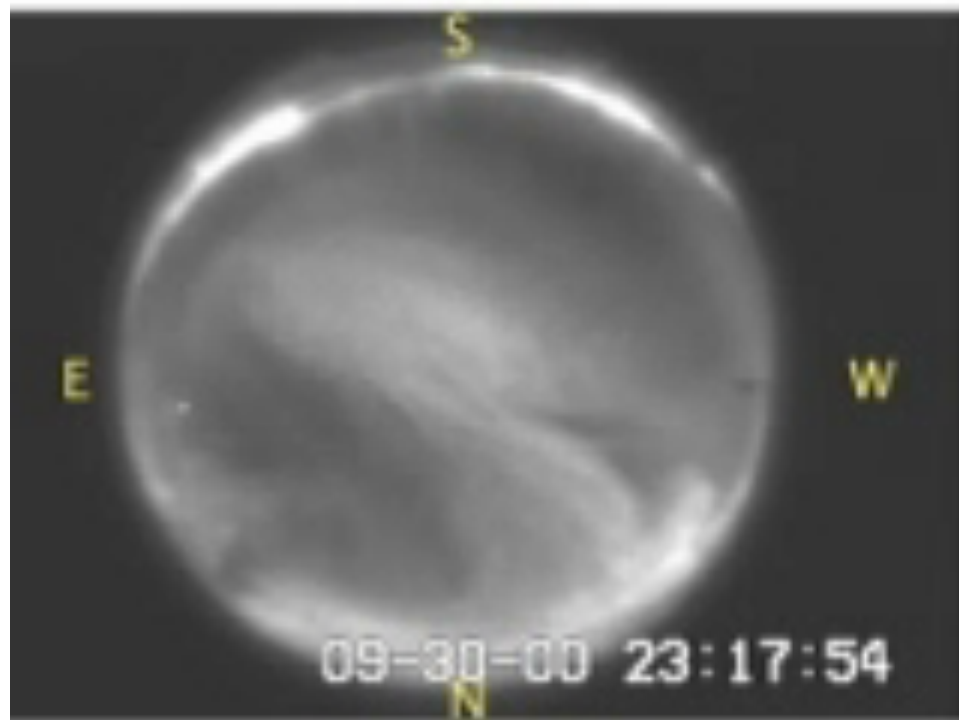
Patch-type Pulsating aurora



03-29 04:07:08

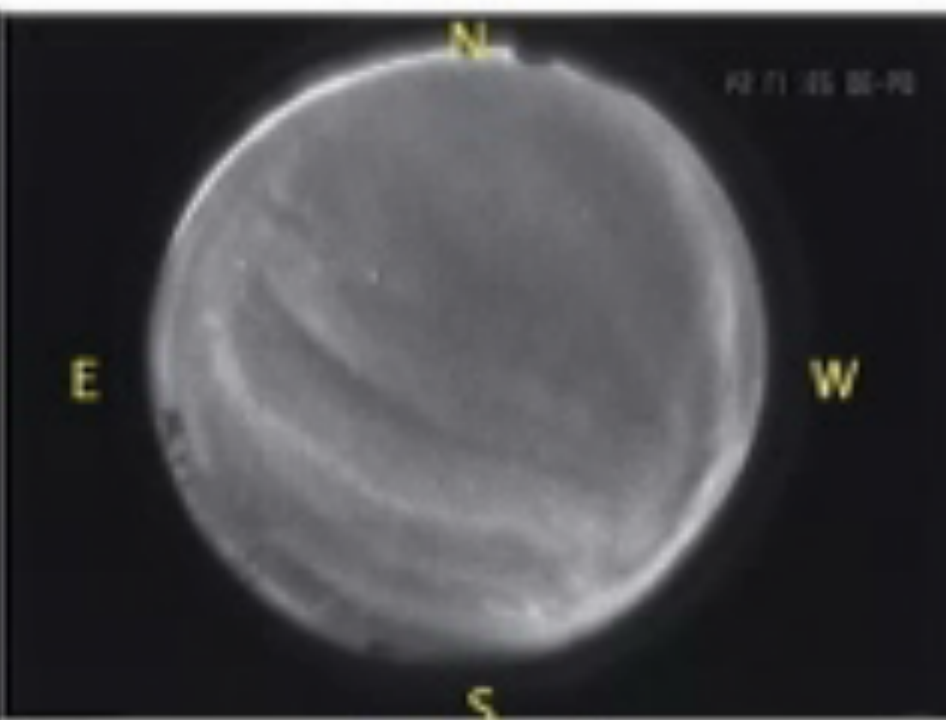


共役点で観測されたオメガバンドとバンド状脈動 オーロラの例



Syowa

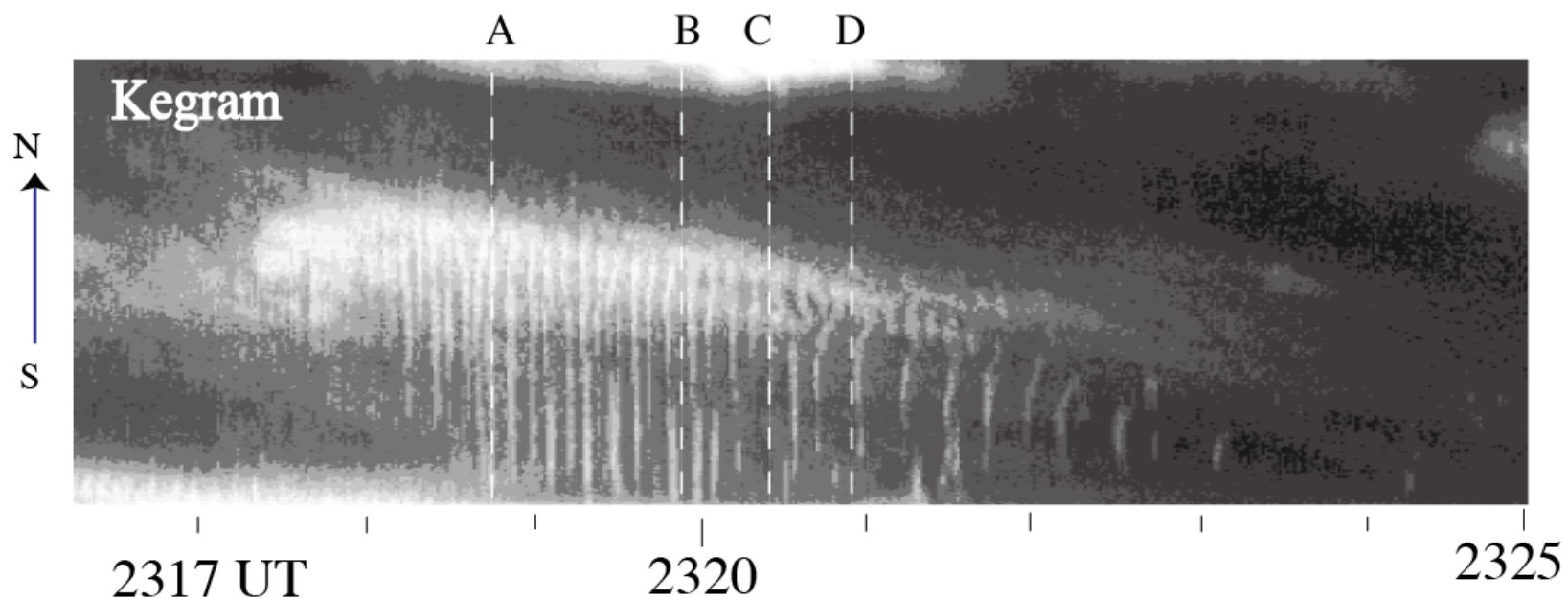
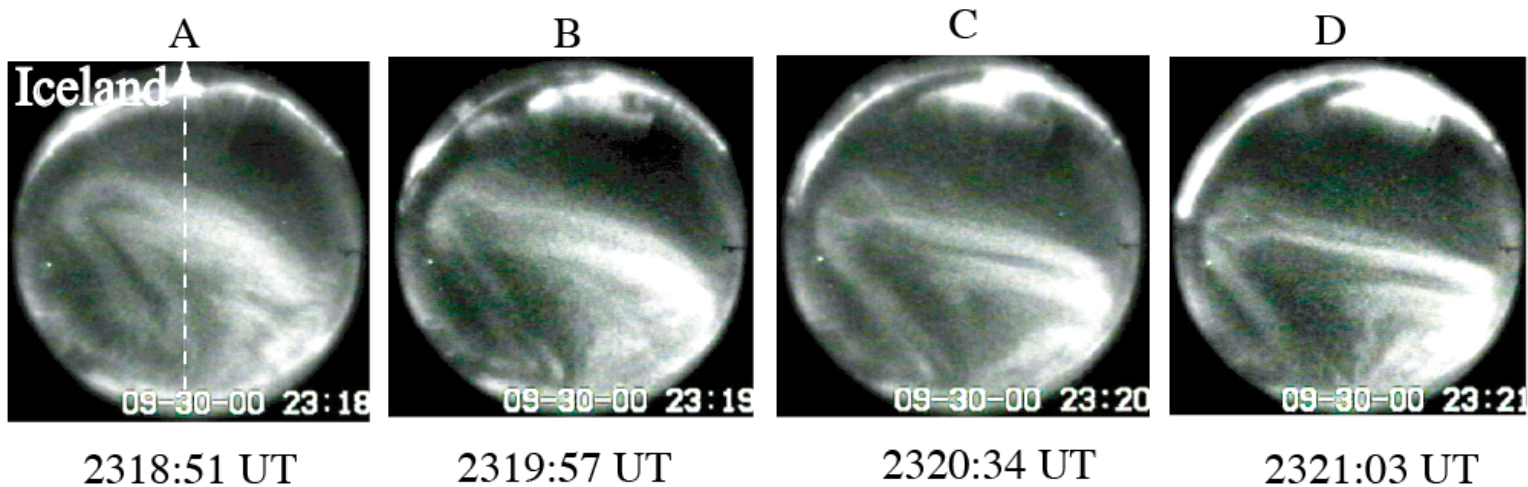
オメガバンド脈動オーロラ

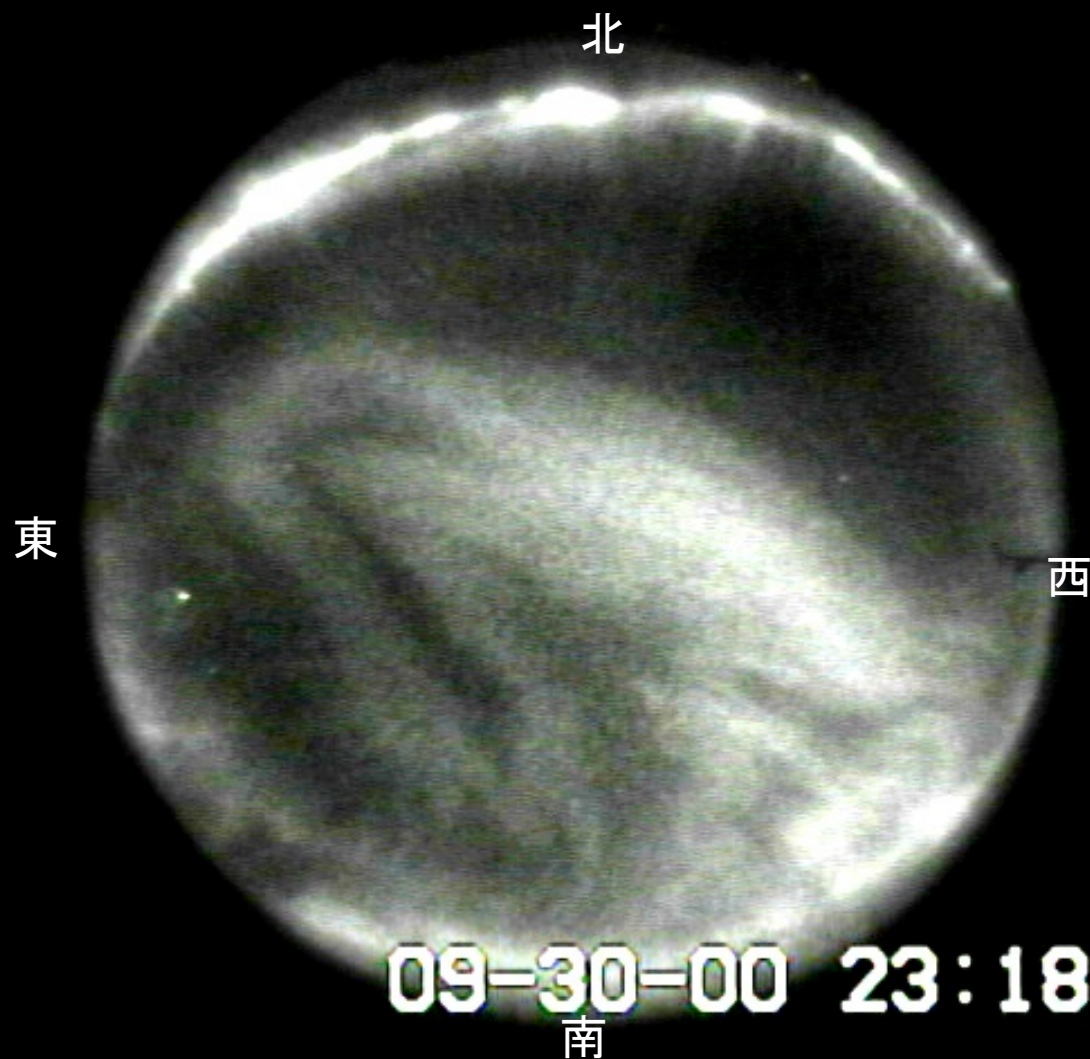


Iceland

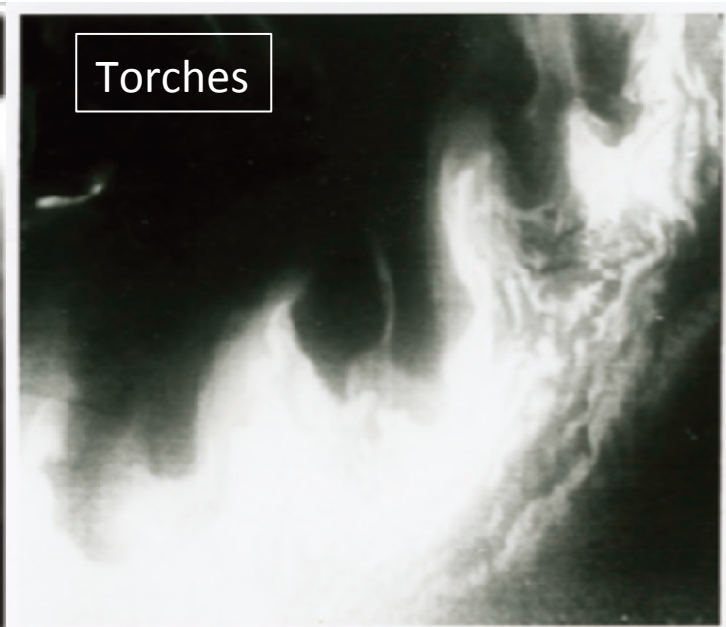
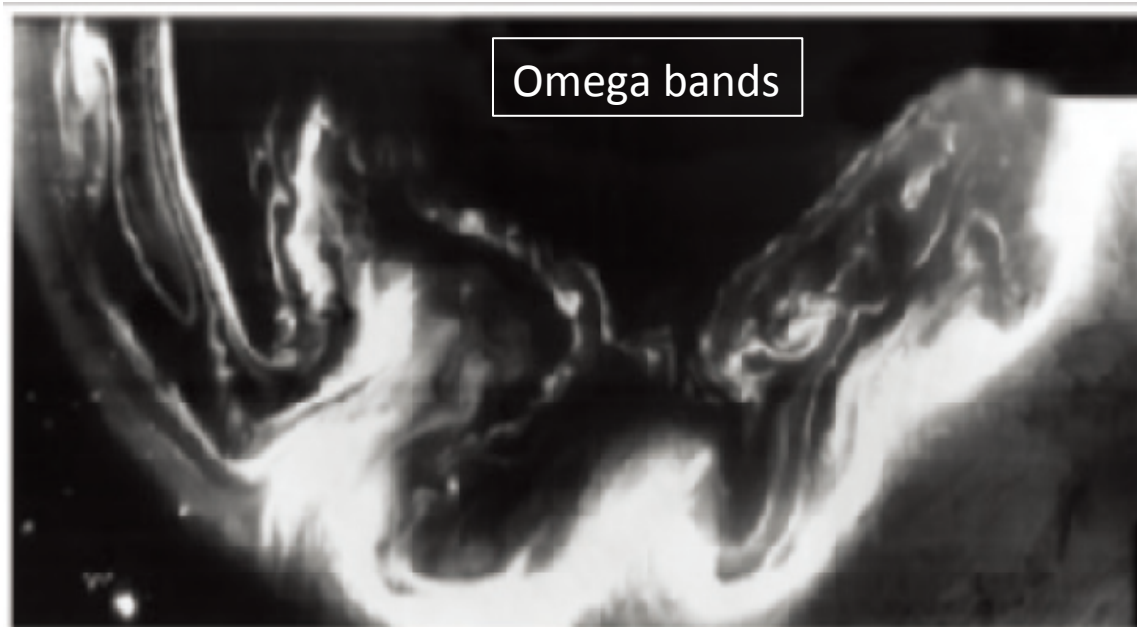
バンド状=>オメガバンド脈動オーロラ

オメガバンド脈動オーロラの例

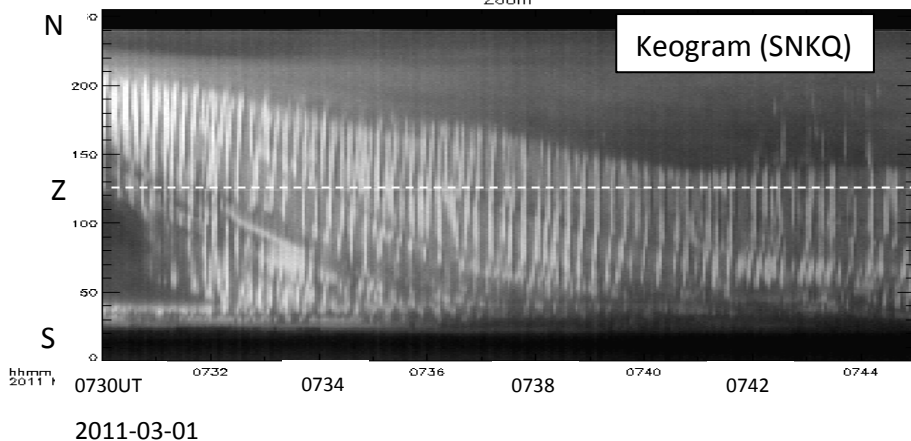
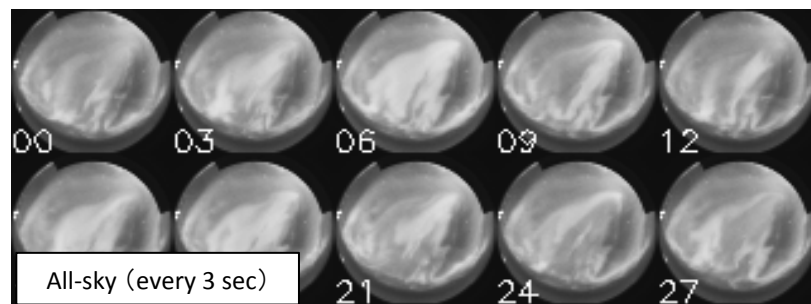
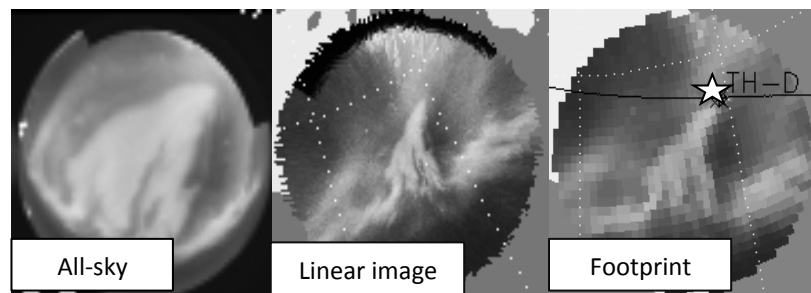




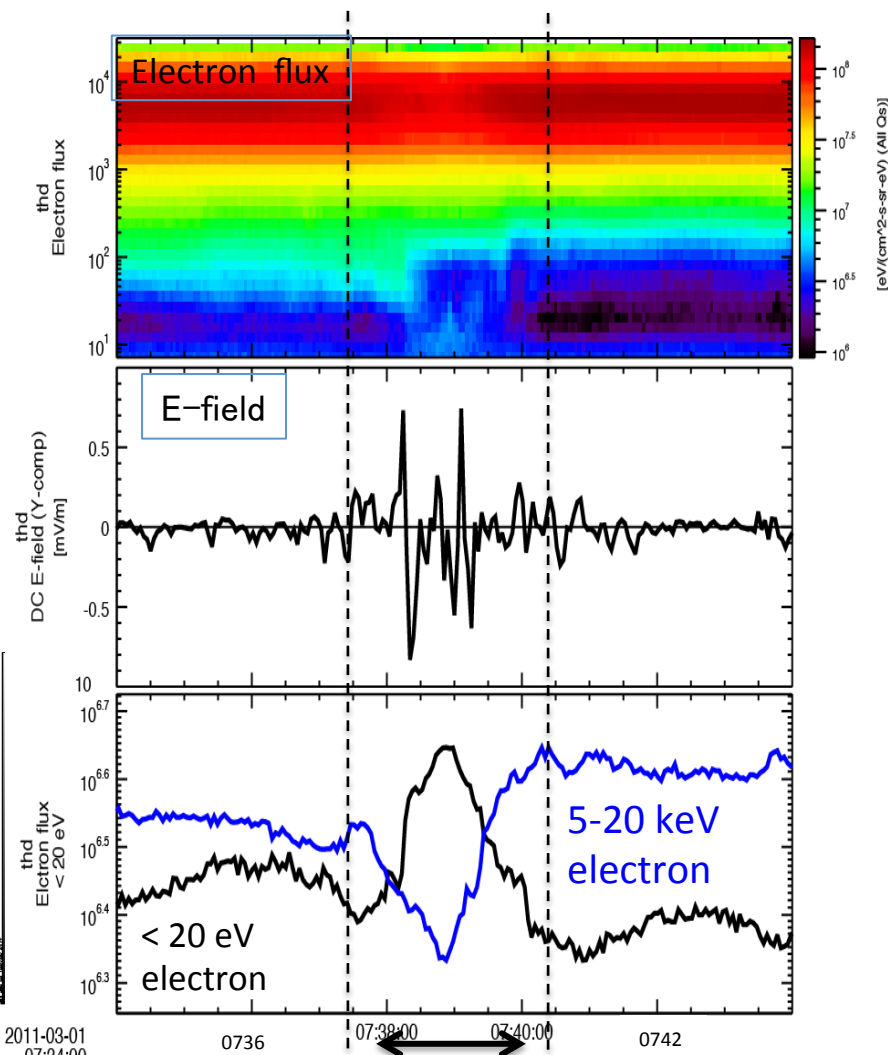
DMDSP衛星で観測されたグローバルスケールのオーロラ



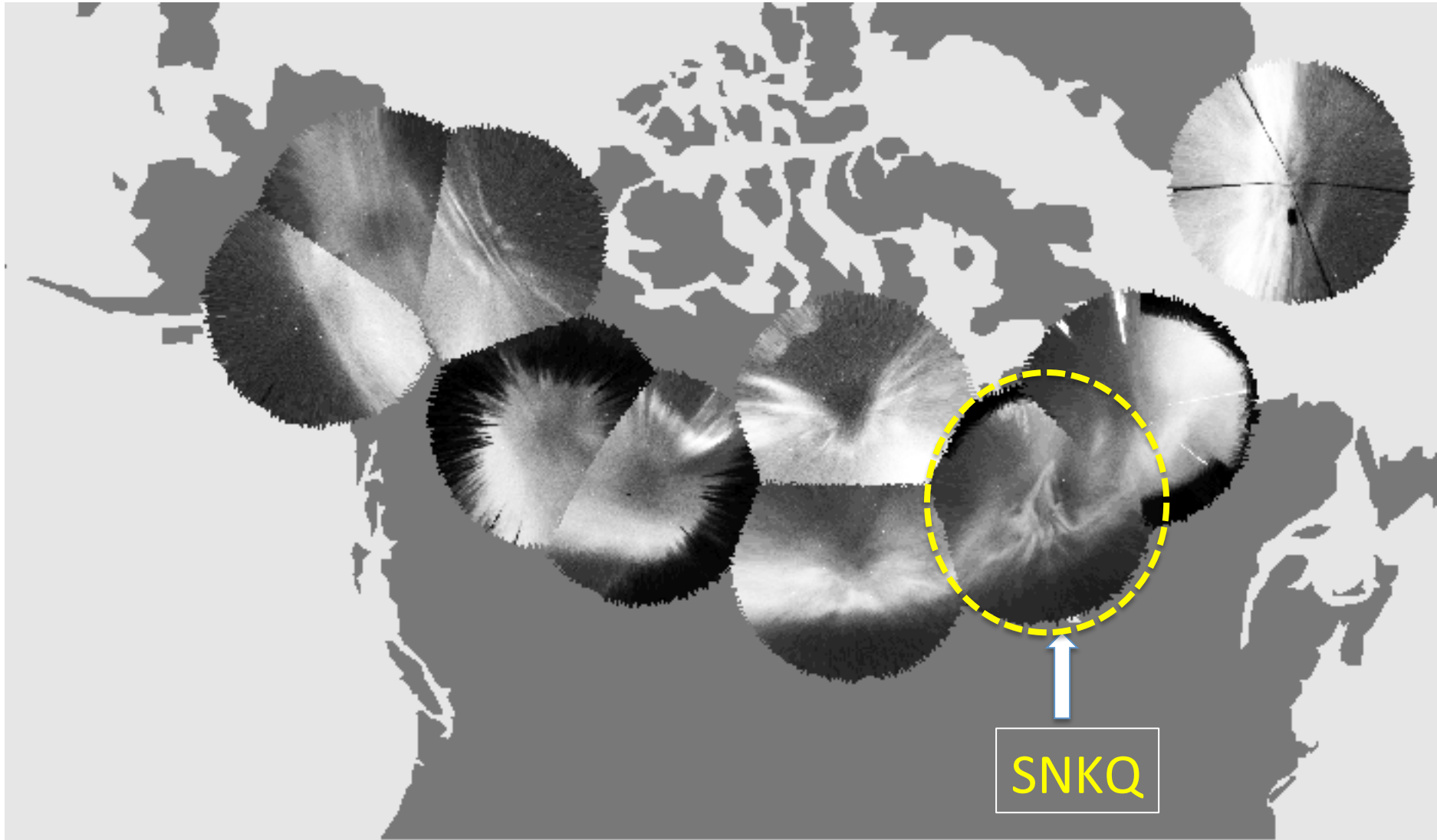
Omega band pulsating aurora

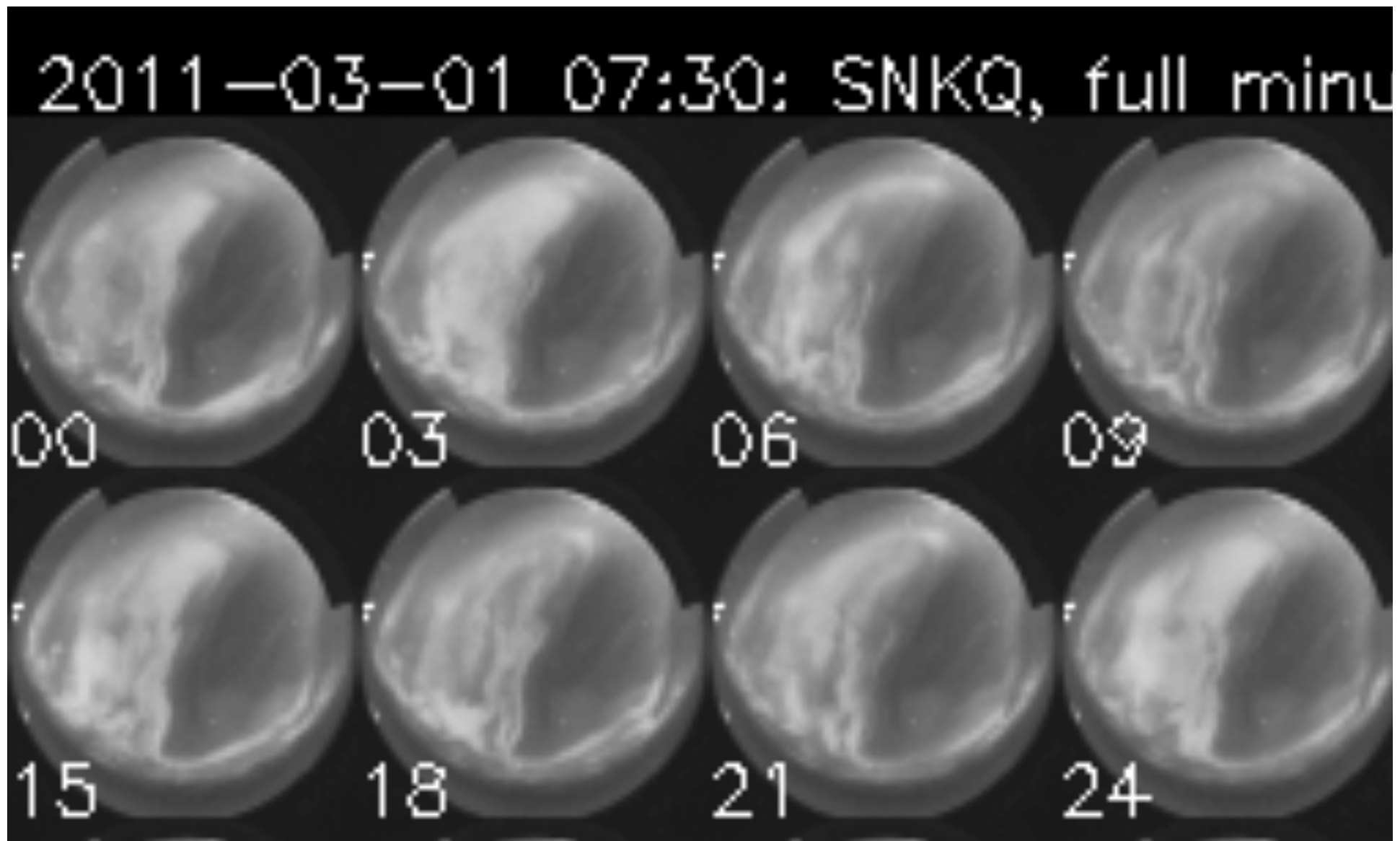


THEMIS-D

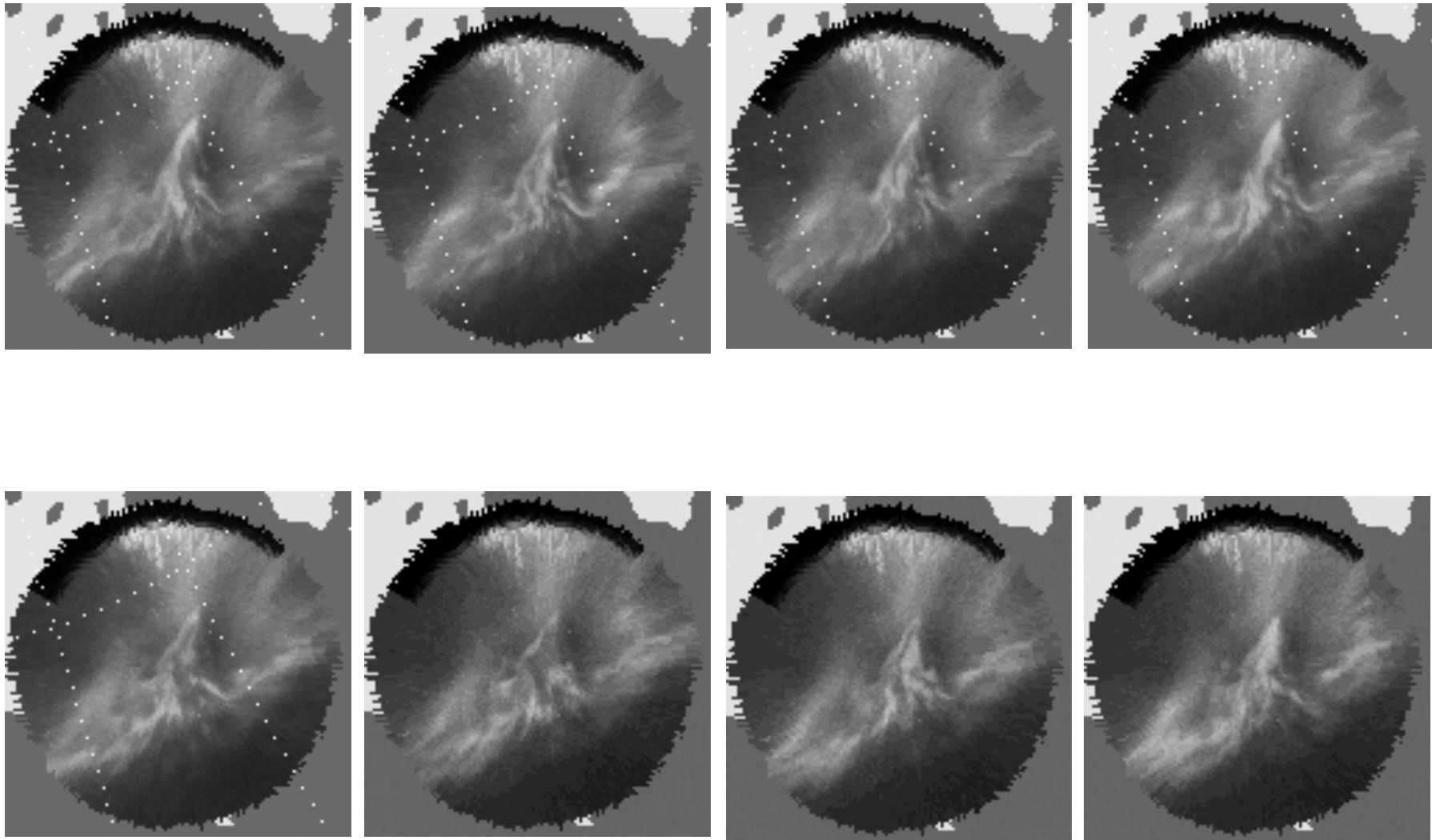


TH-D crossing on Omega band PA aurora

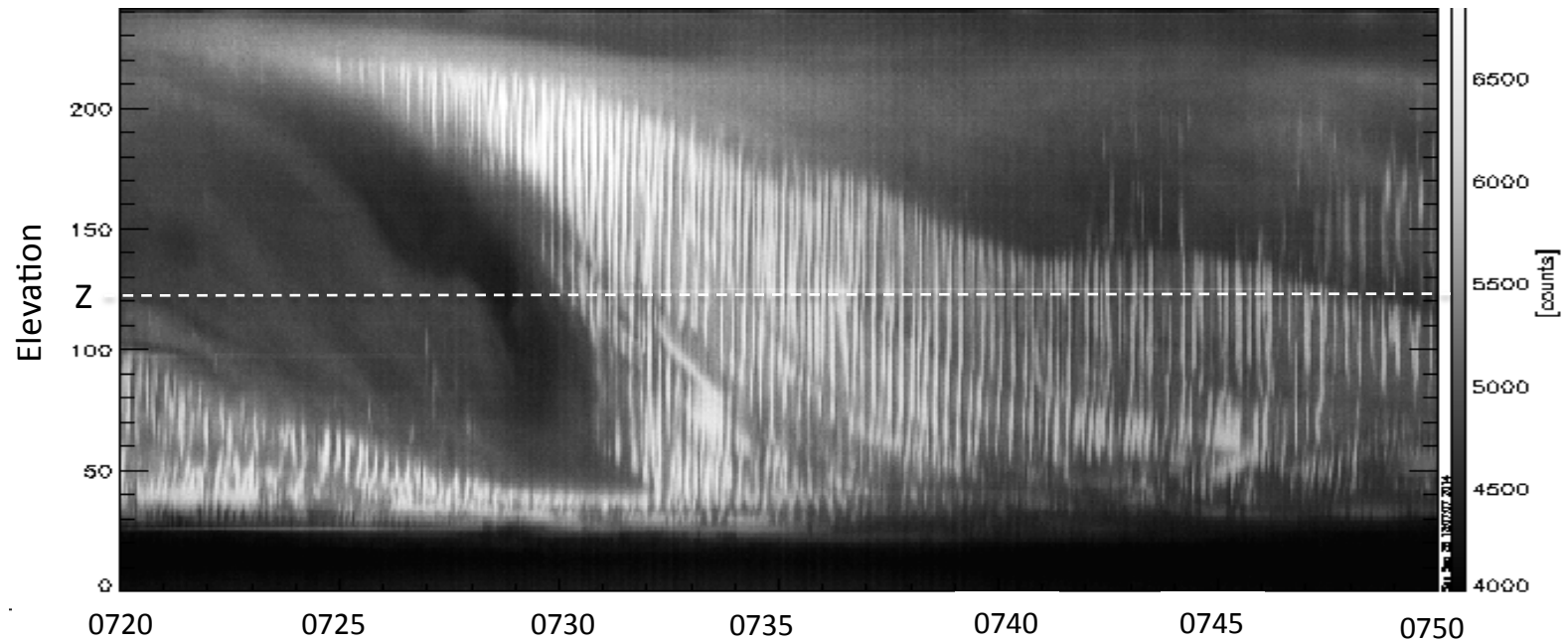




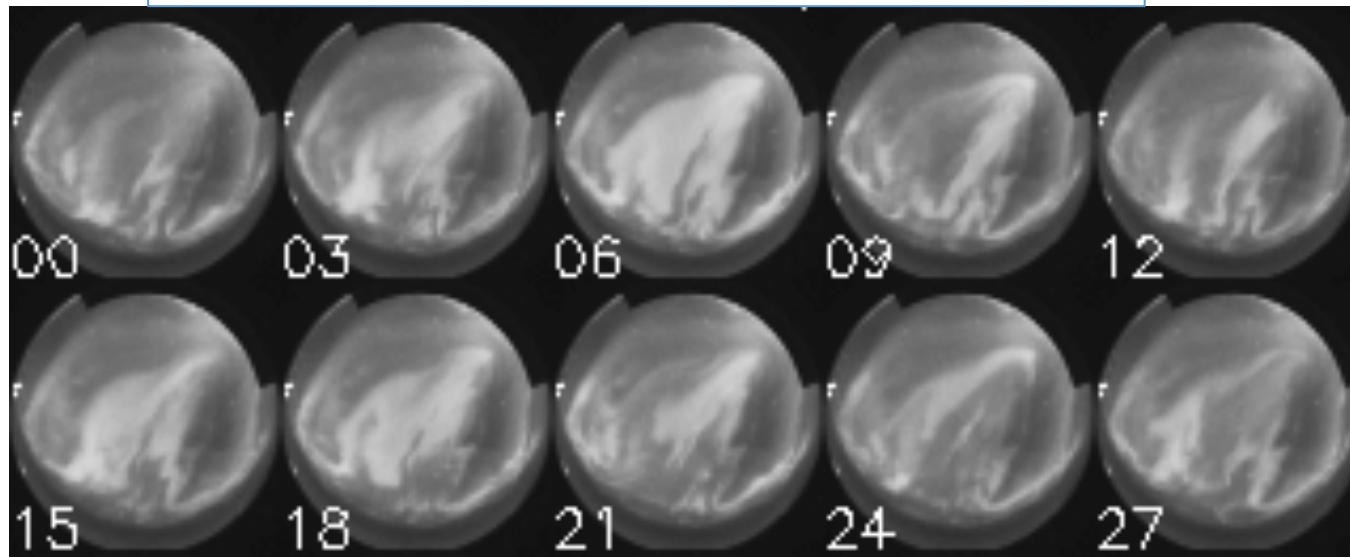
Linear scale images at every 30 sec

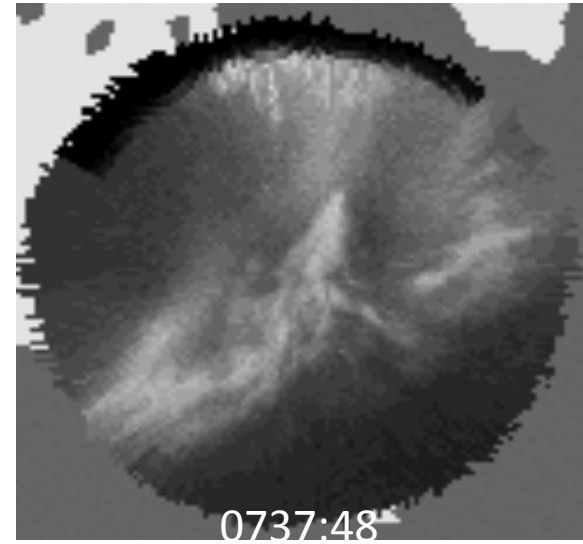
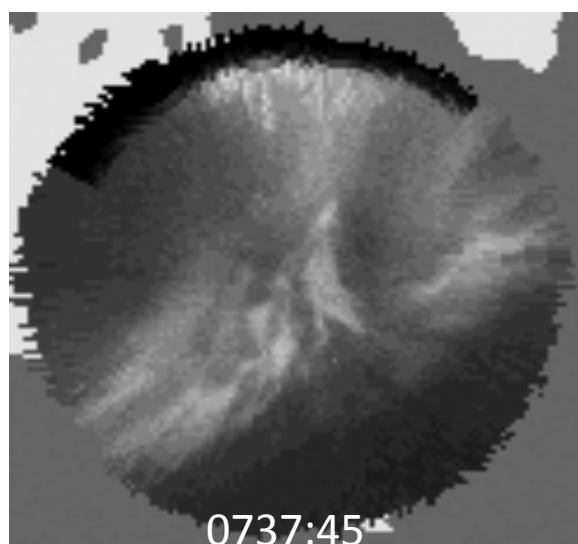
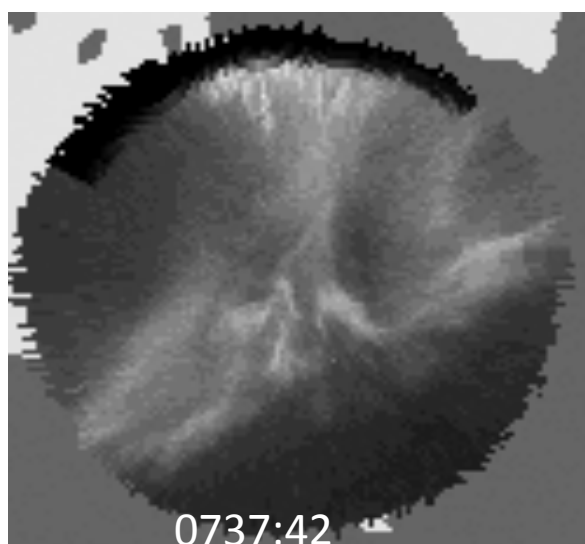
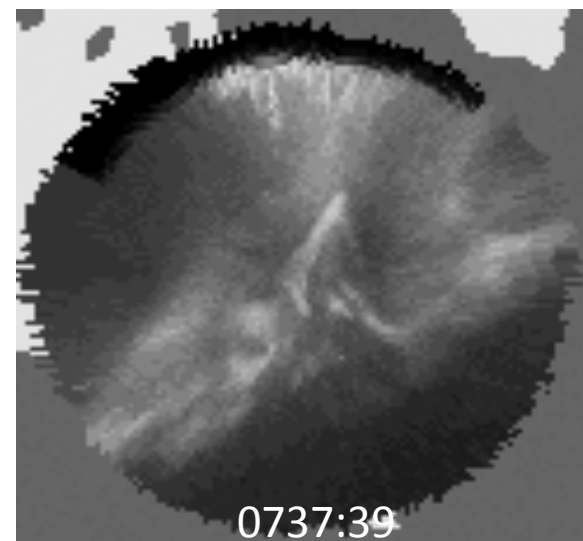
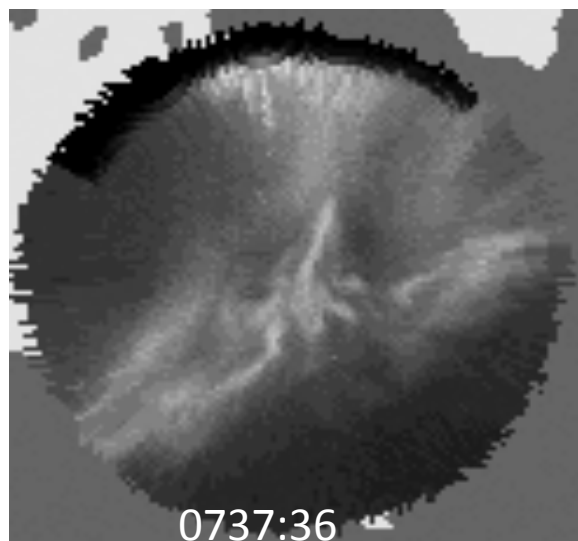
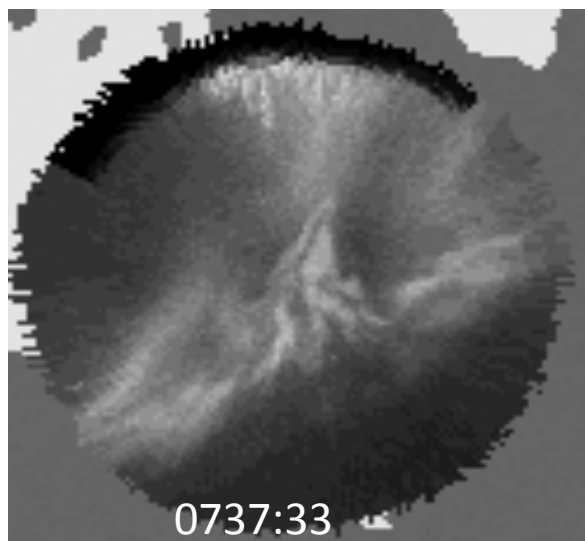


Keogram at SNKQ

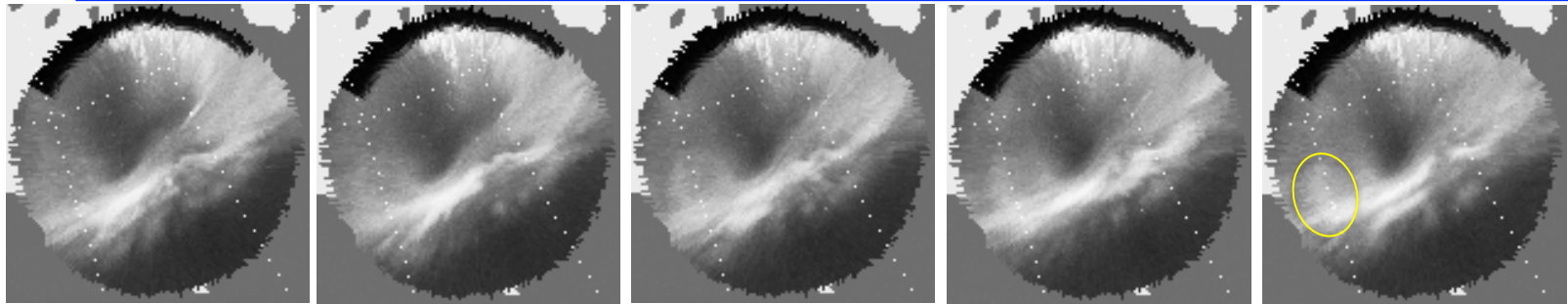


Every 3-sec all-sky images from 0736:00 at SNKQ

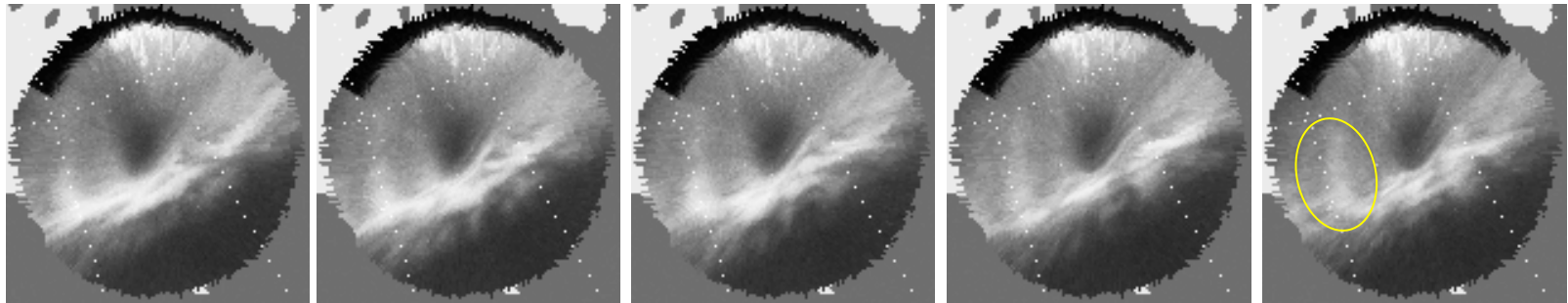




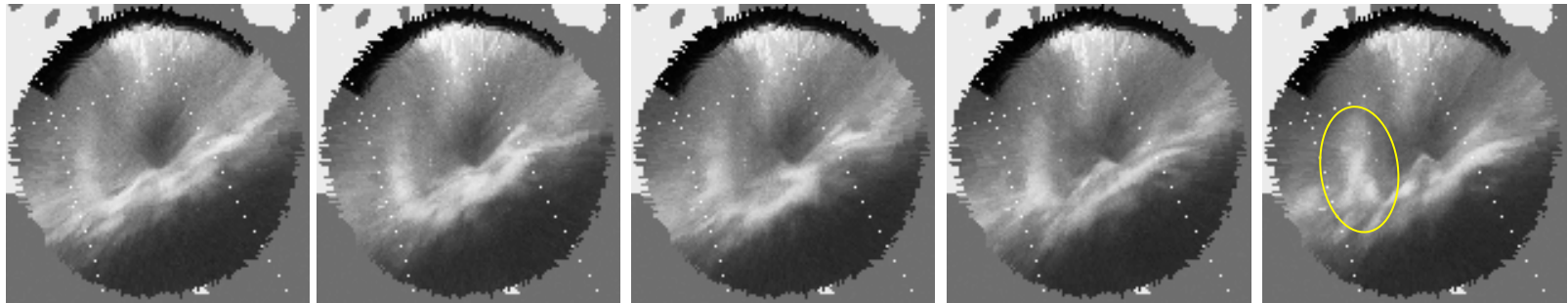
**0706-10
UT**



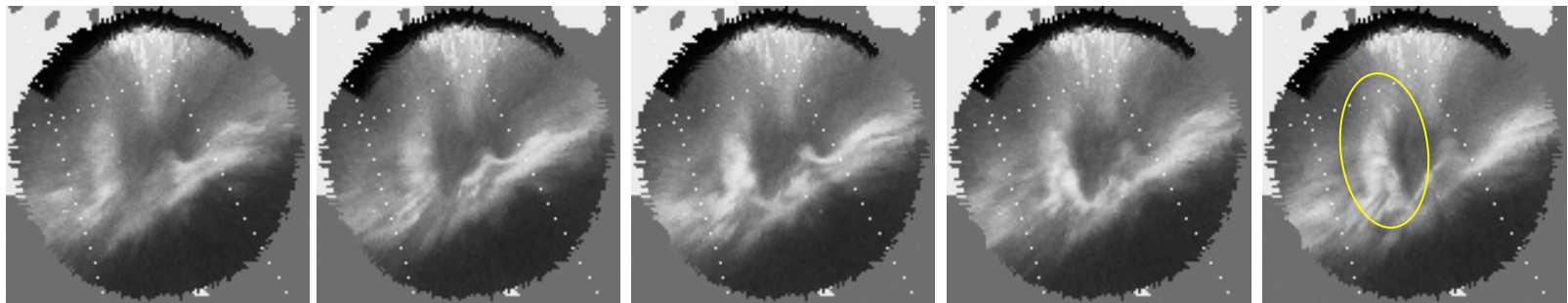
**0711-15
UT**



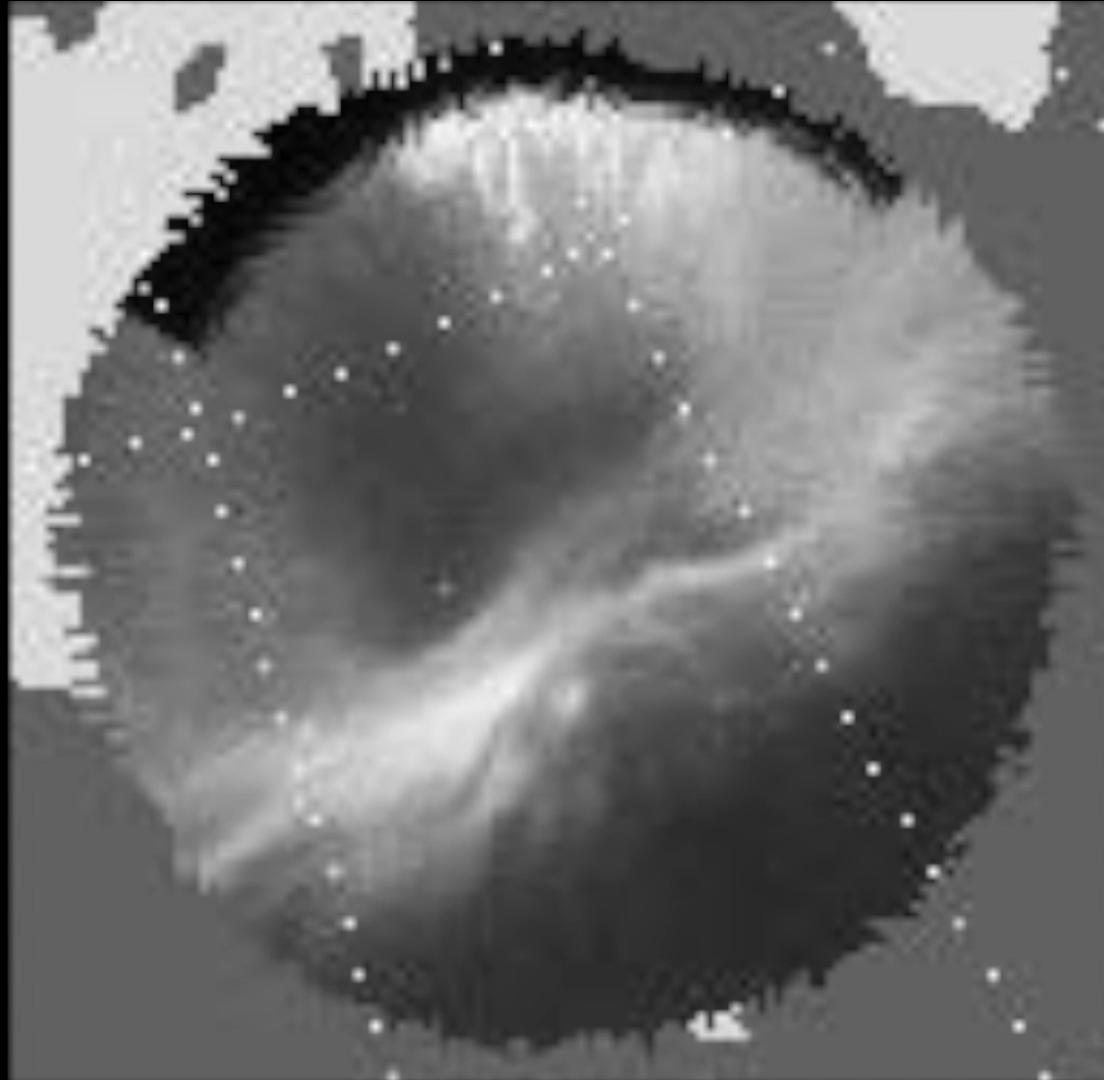
**0716-20
UT**

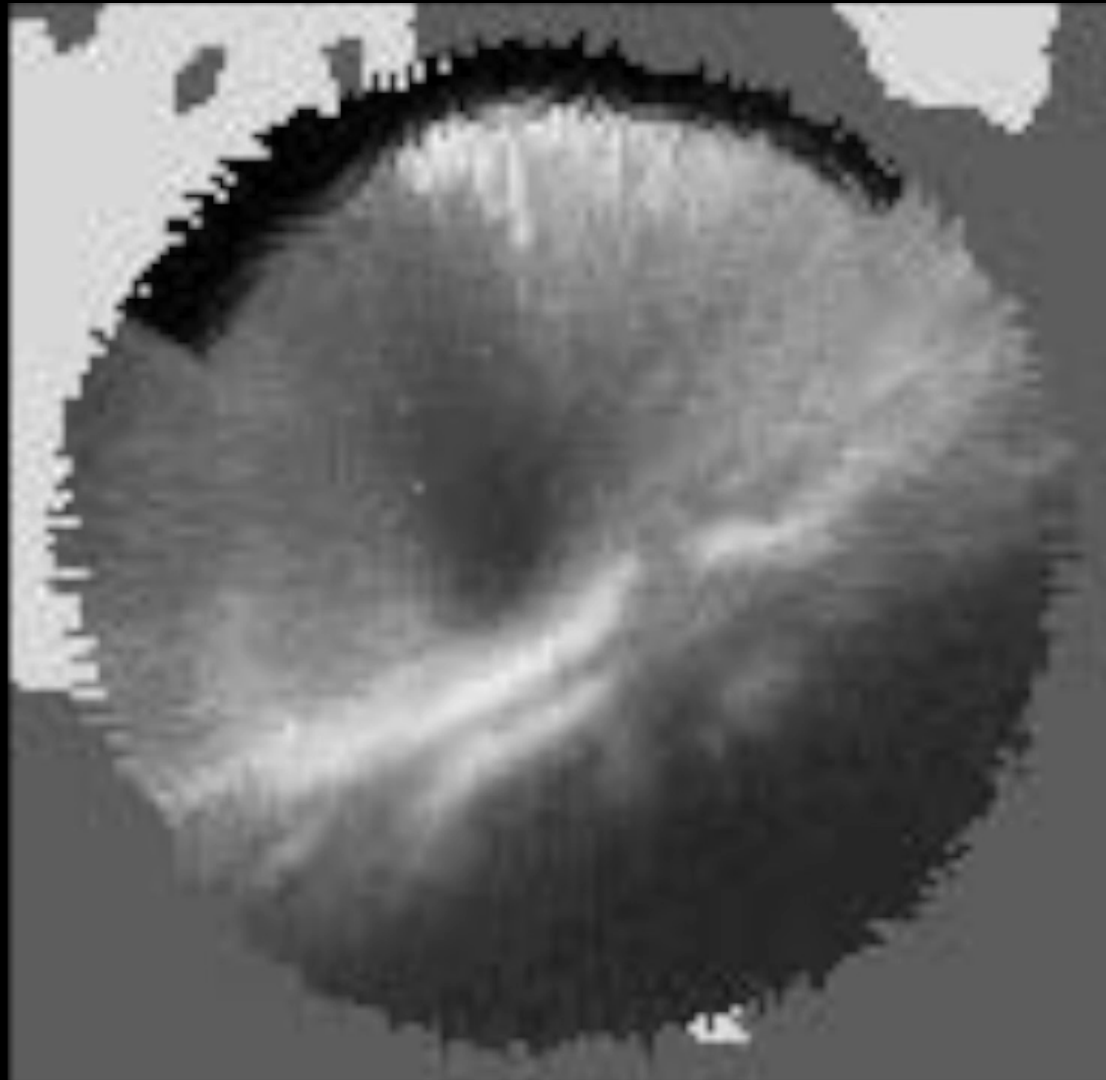


**0721-25
UT**

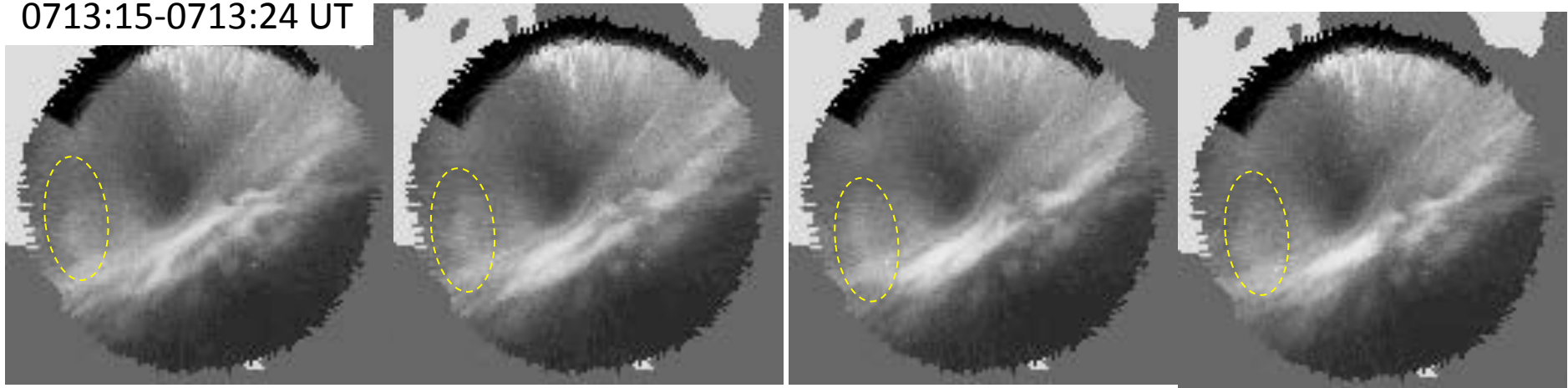


Growth, maximum and declining of Omega band Pulsating Aurora

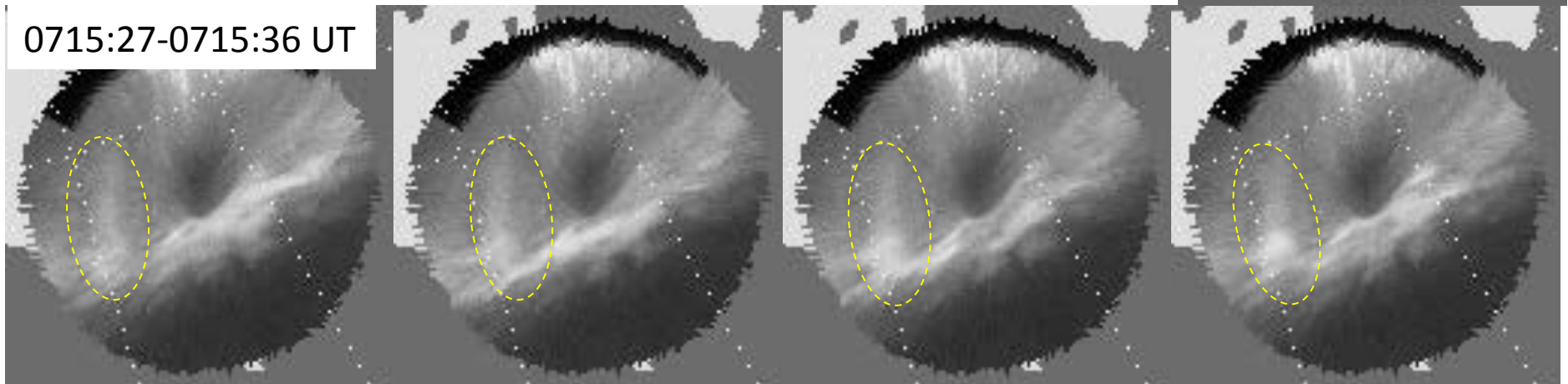




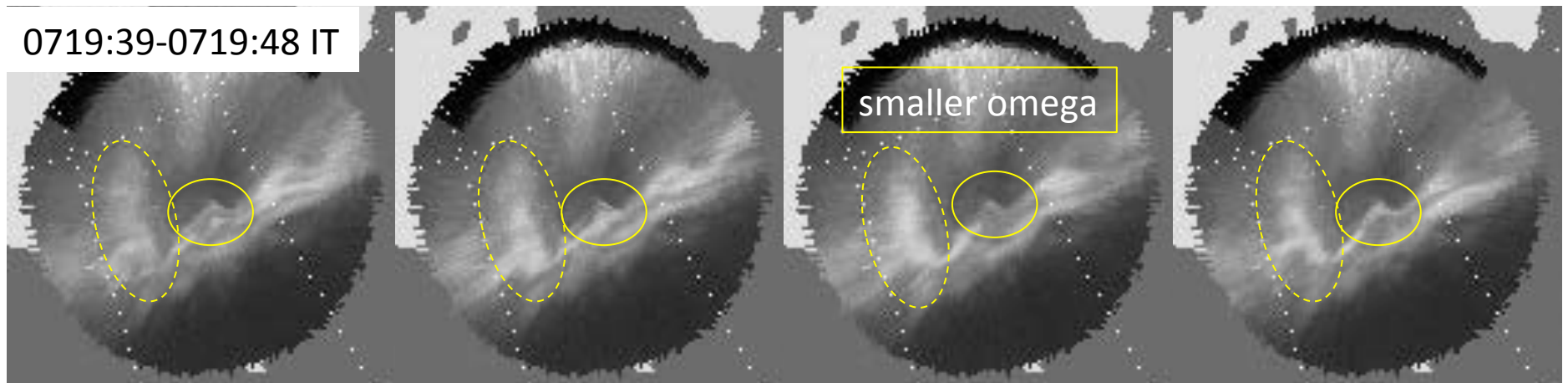
0713:15-0713:24 UT

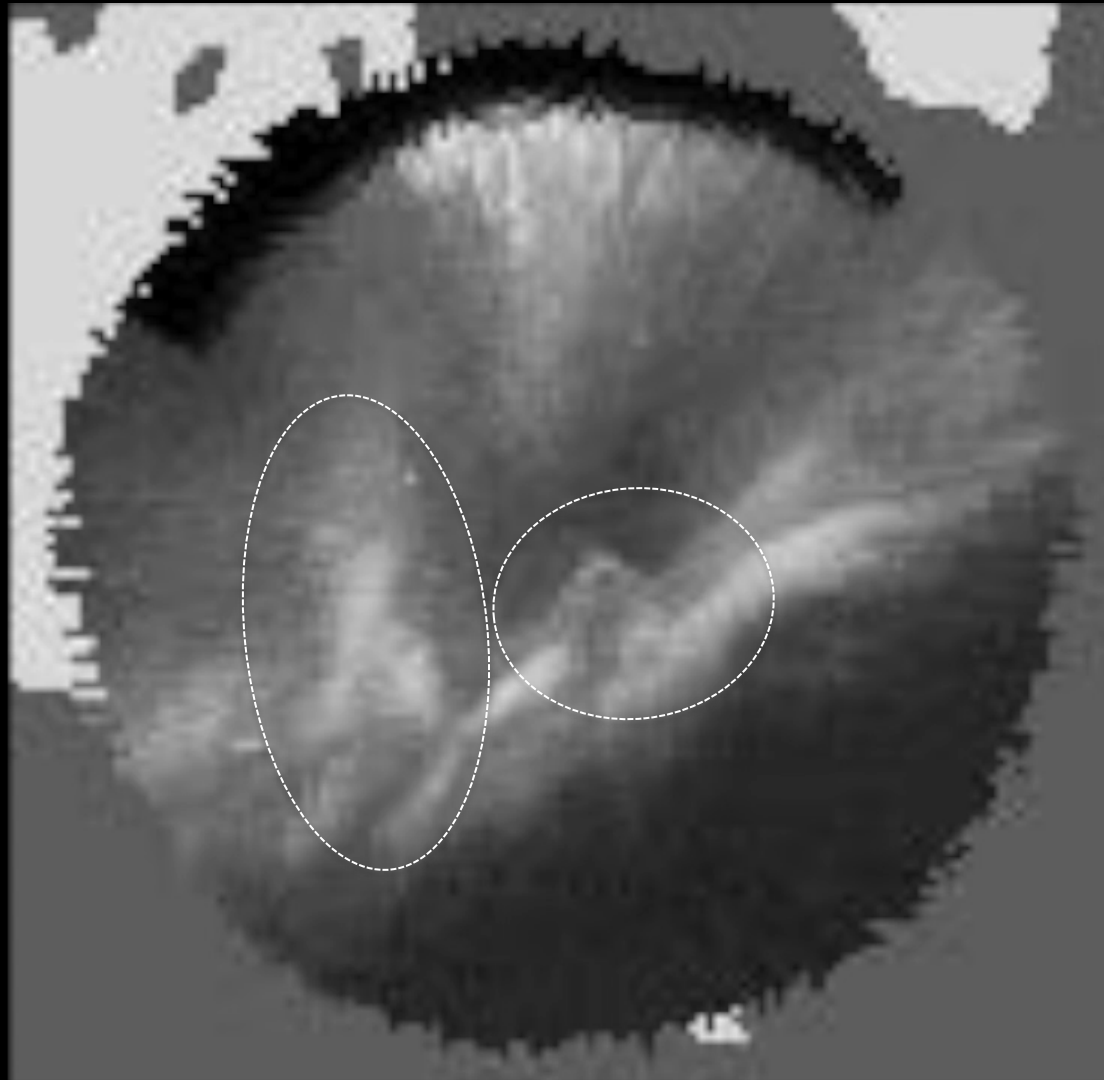


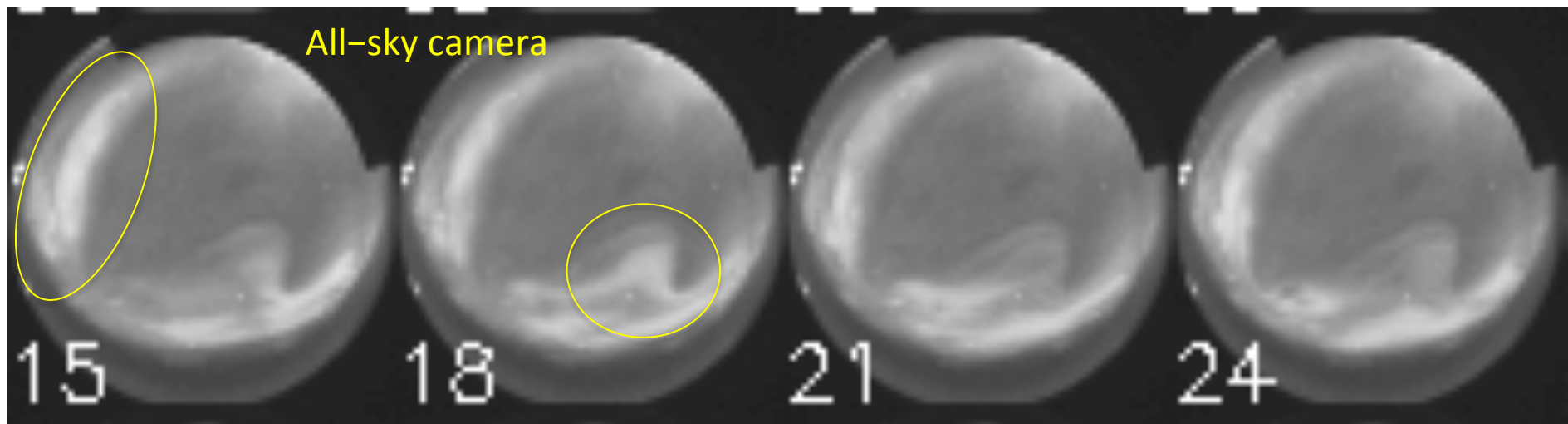
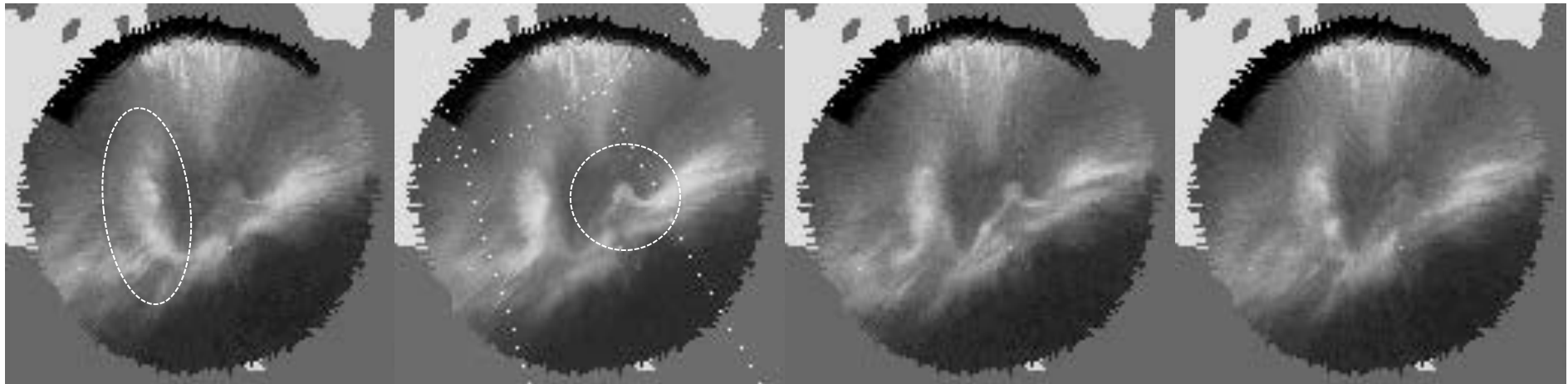
0715:27-0715:36 UT

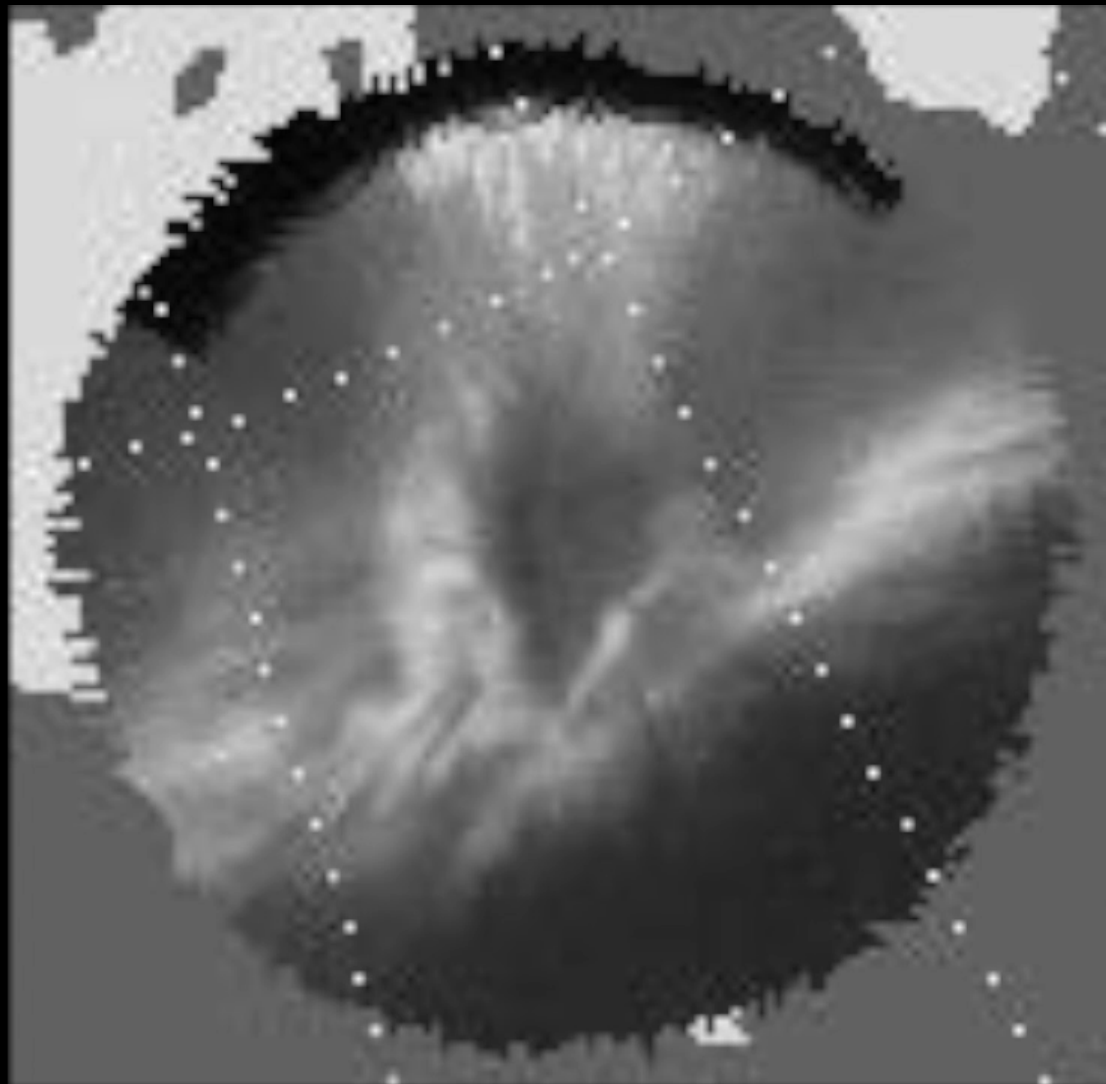


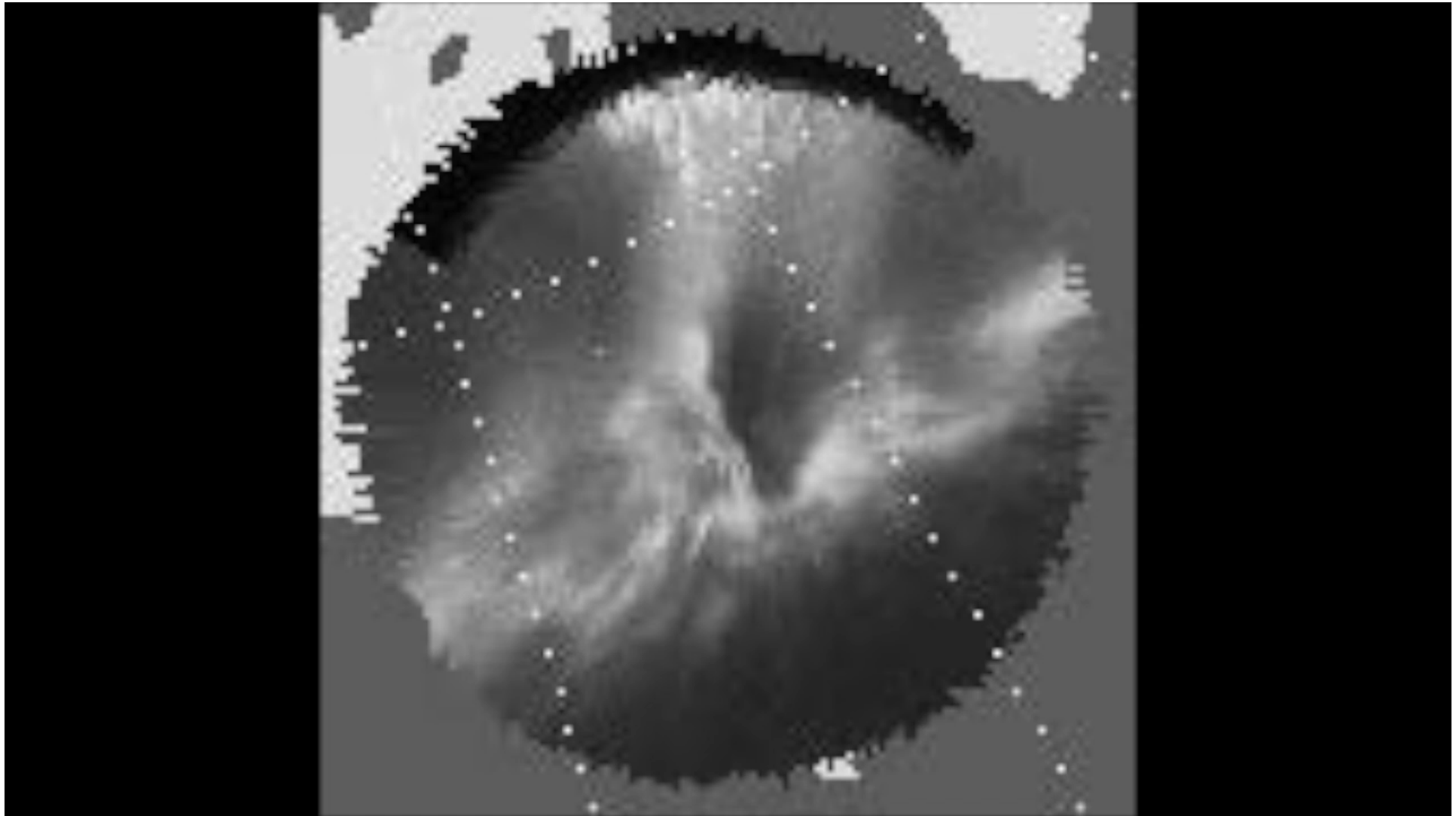
0719:39-0719:48 IT

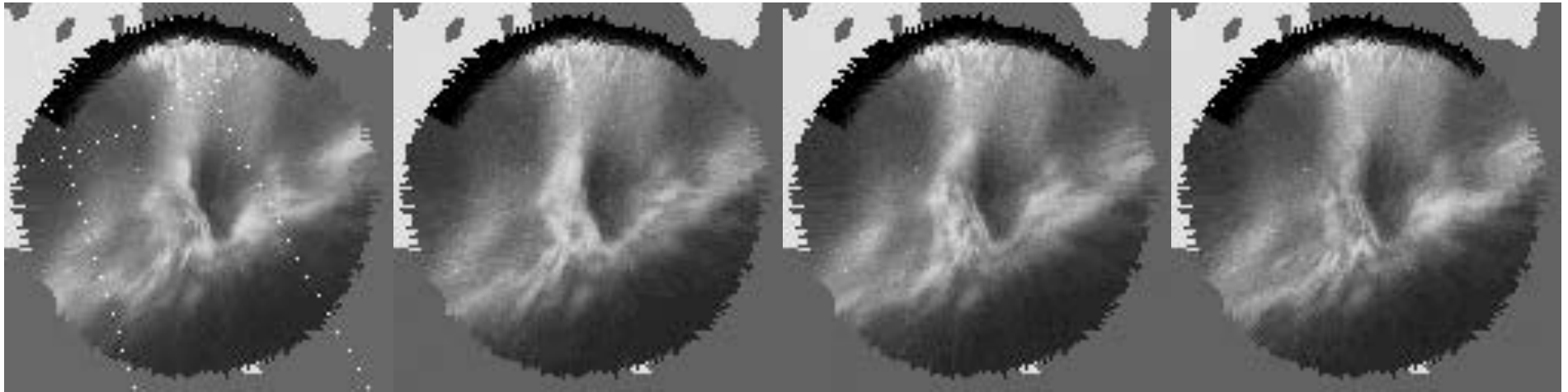










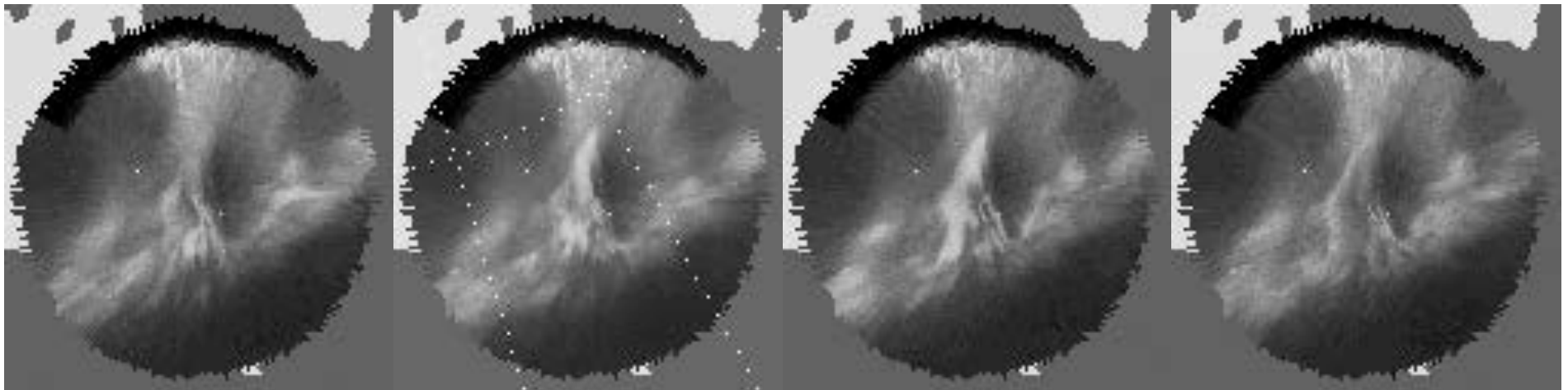


0730:00 UT

0730:03 UT

0730:06 UT

0730:09 UT



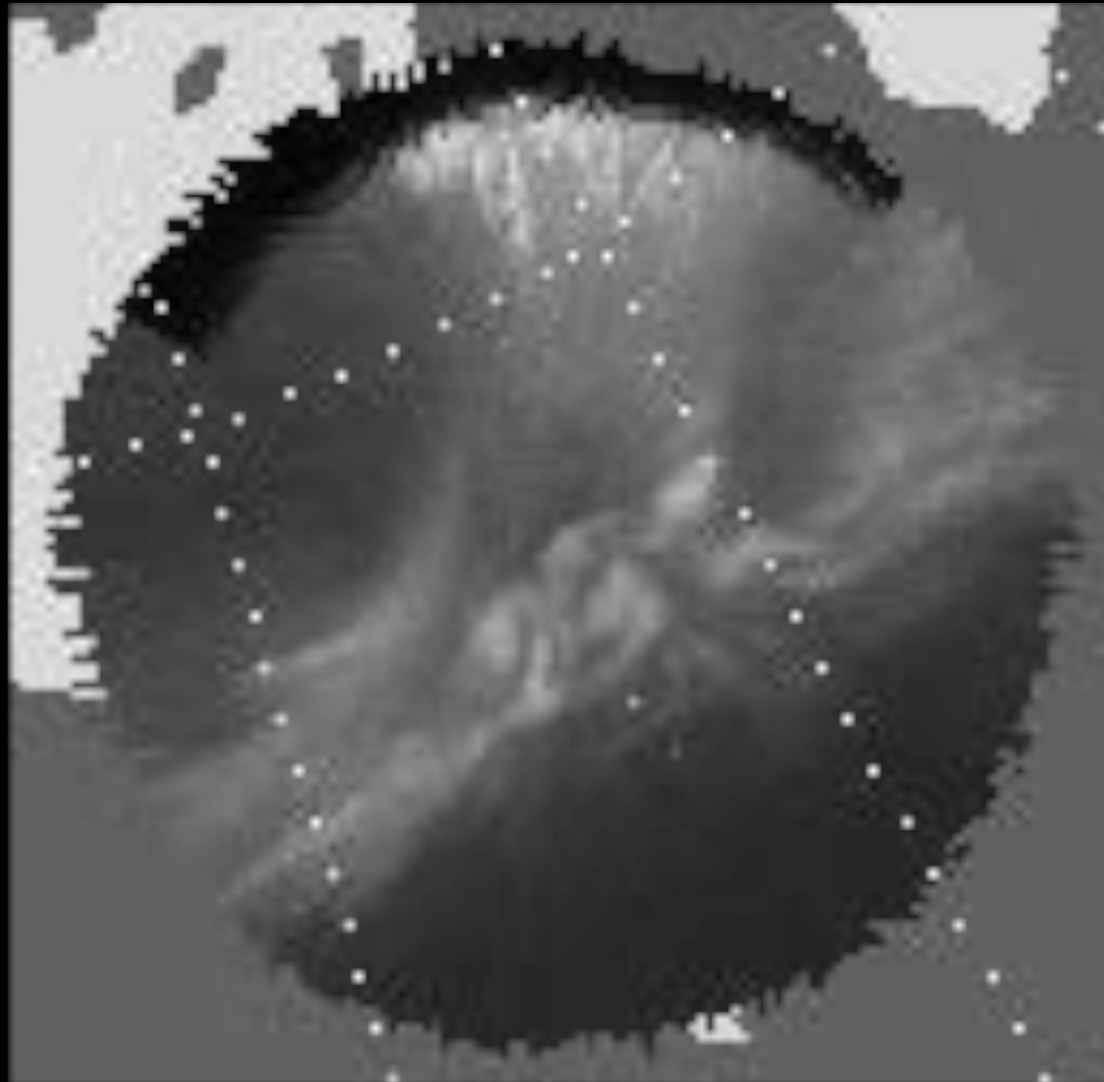
0732:24 UT

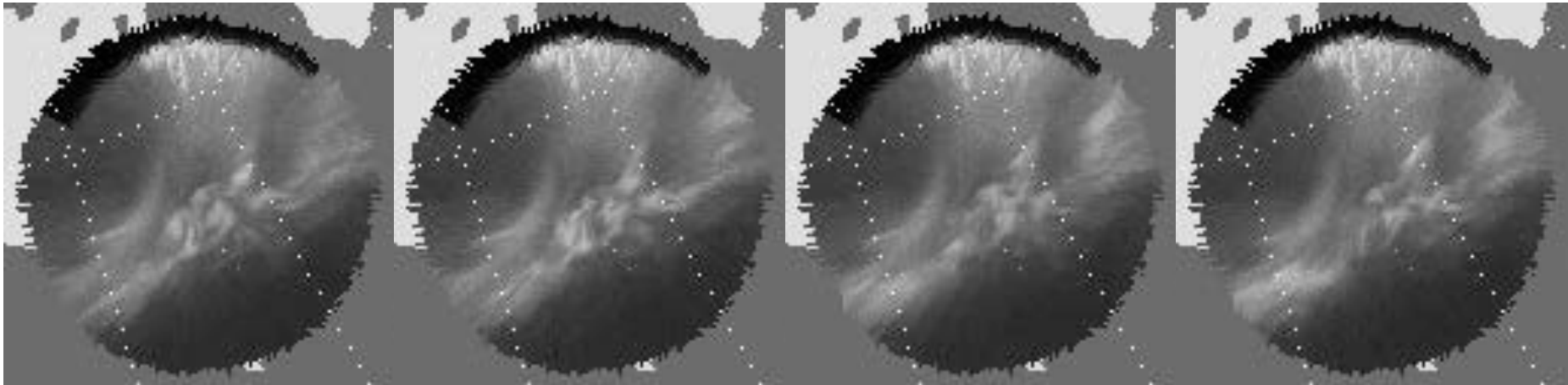
0732:27 UT

0732:30 UT

0732:33 UT

Declining phase



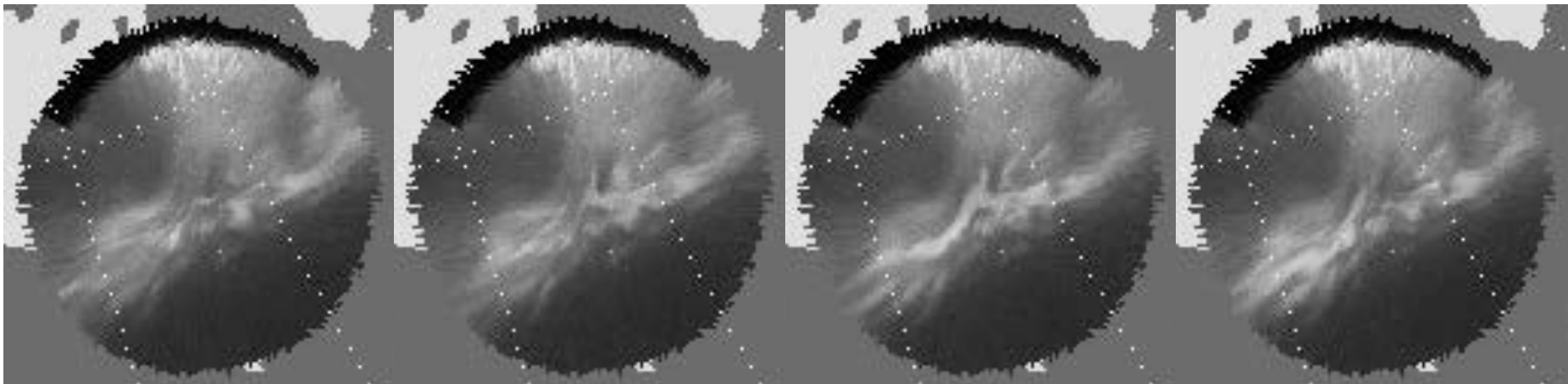


0745:03 UT

0745:06 UT

0745:09 UT

0745:12 UT



0752:51 UT

0752:54 UT

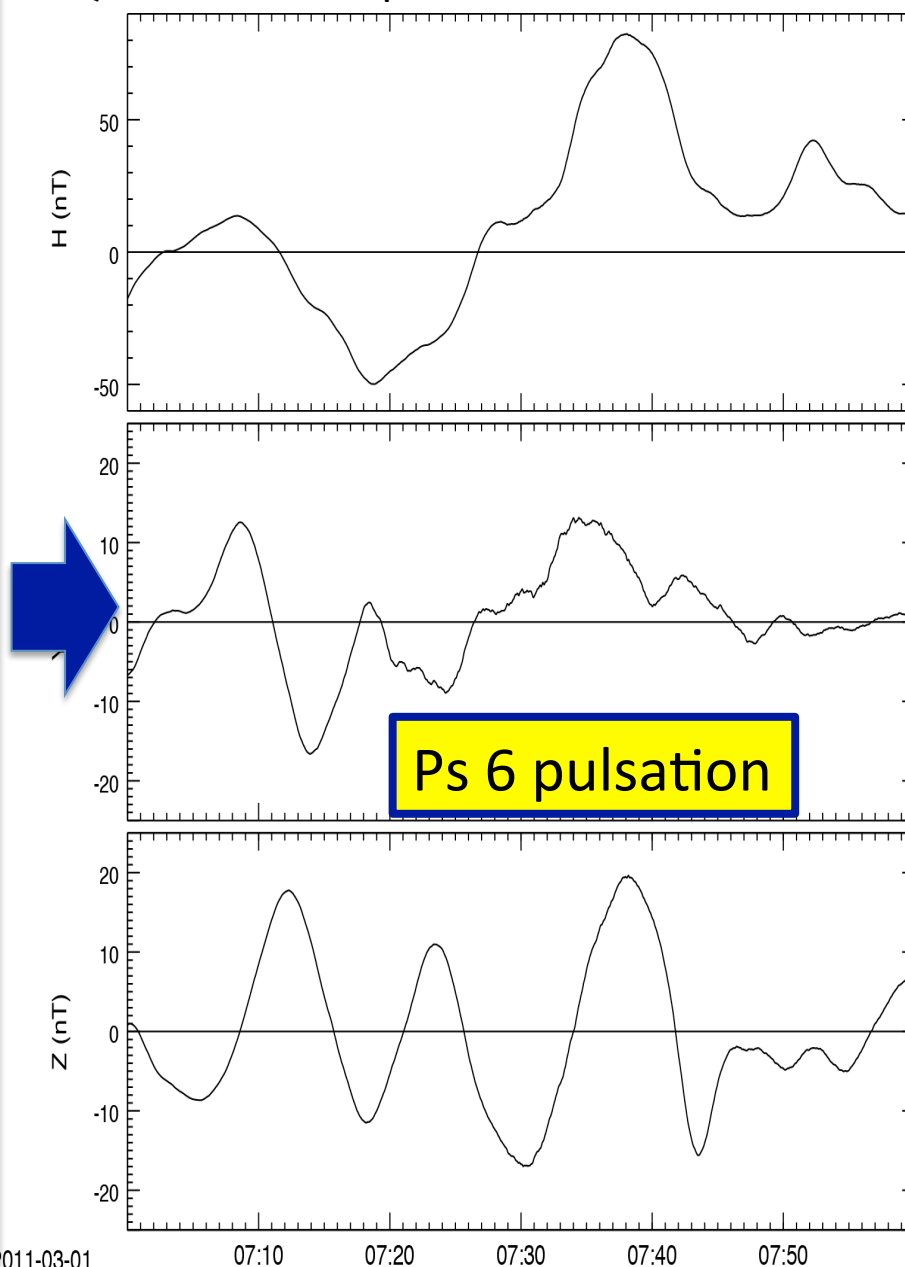
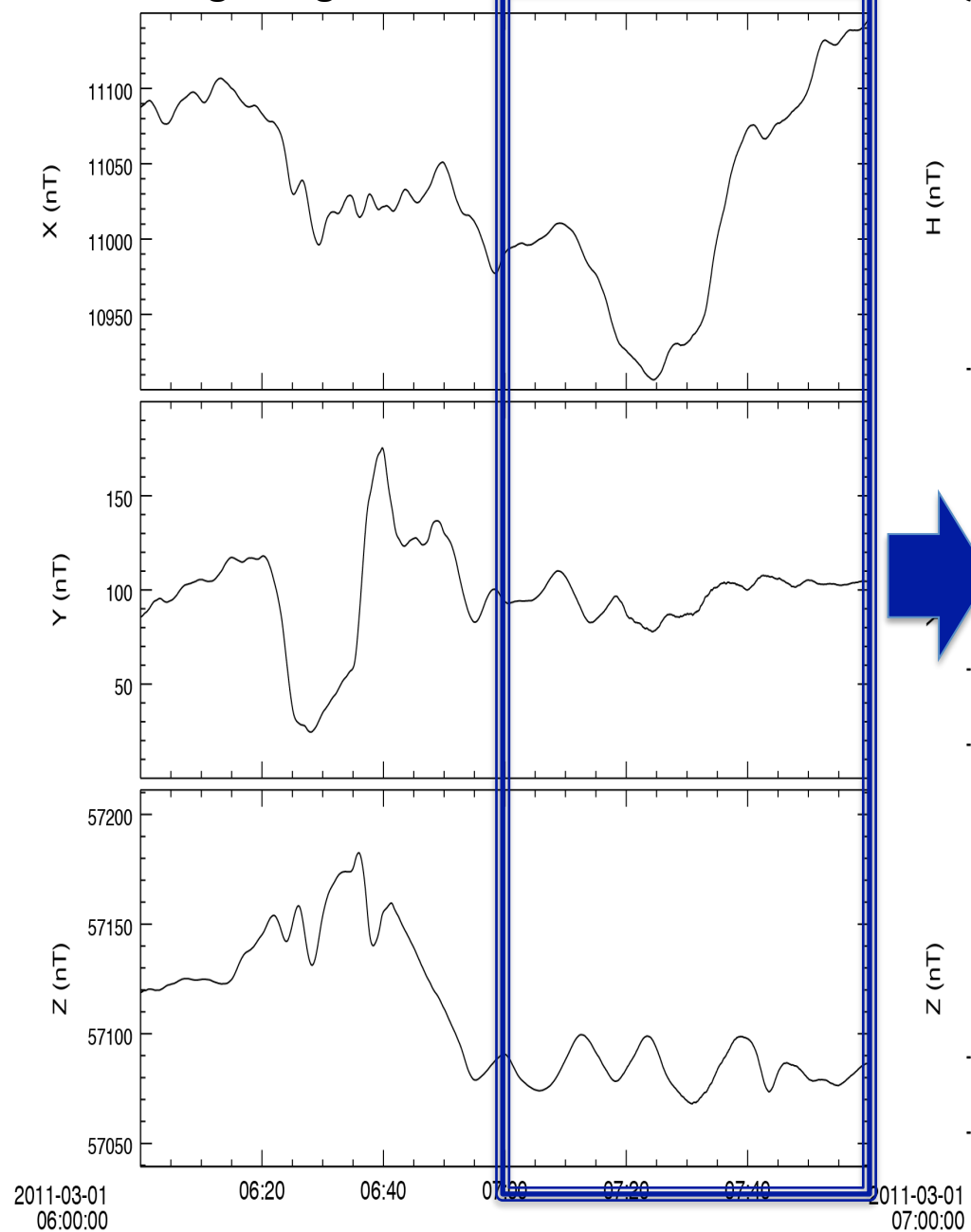
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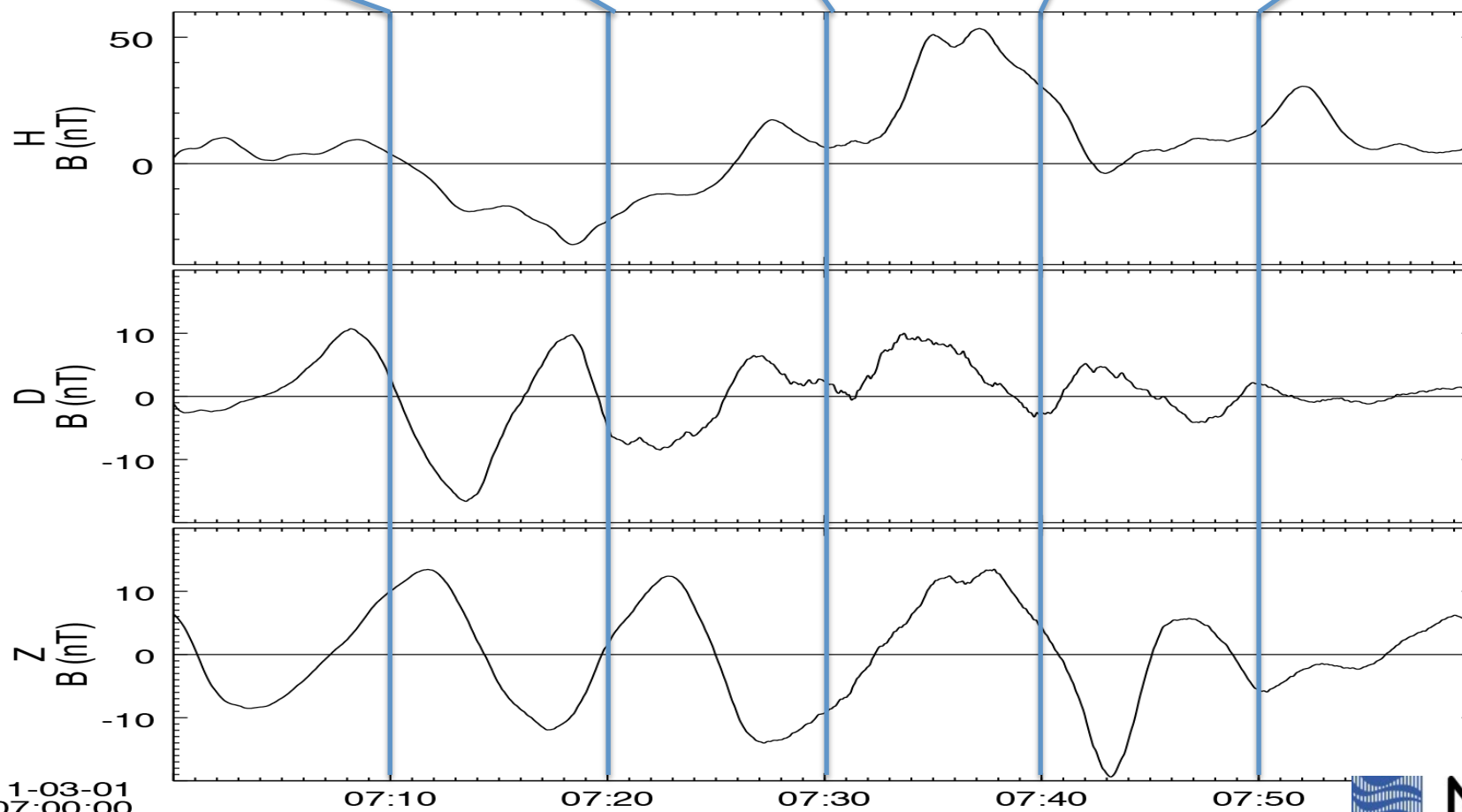
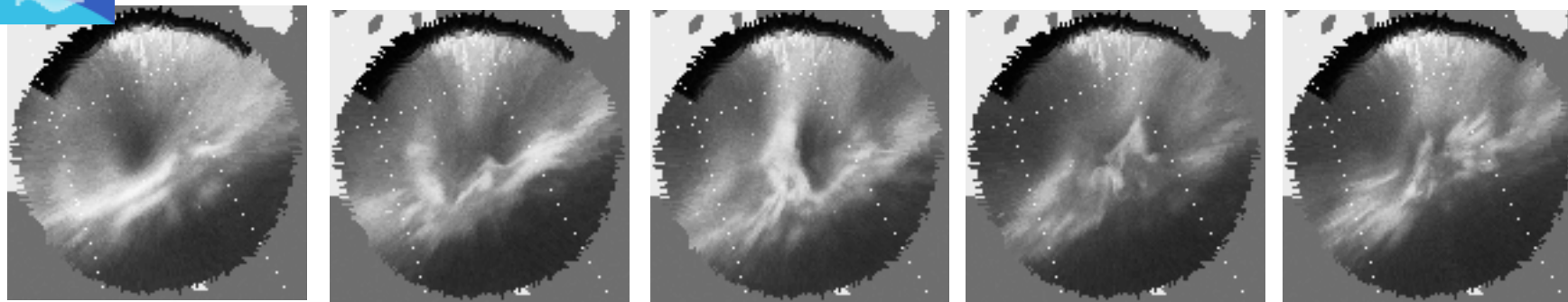
0753:00 UT

Magnetogram

SNKQ

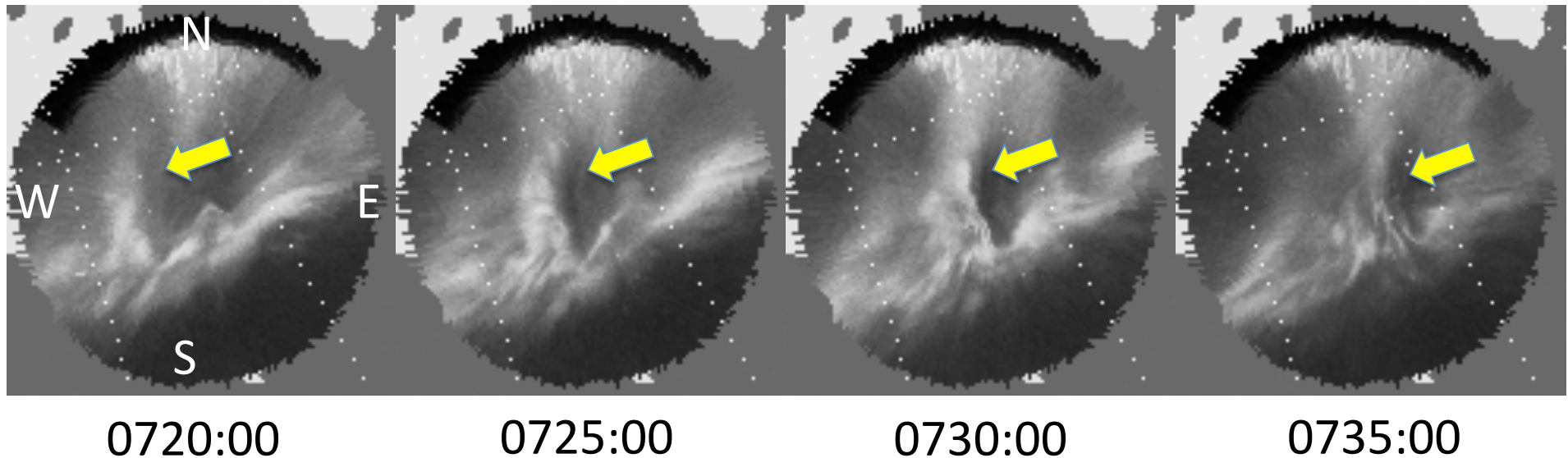
Band-pass filter





2011-03-01
07:00:00

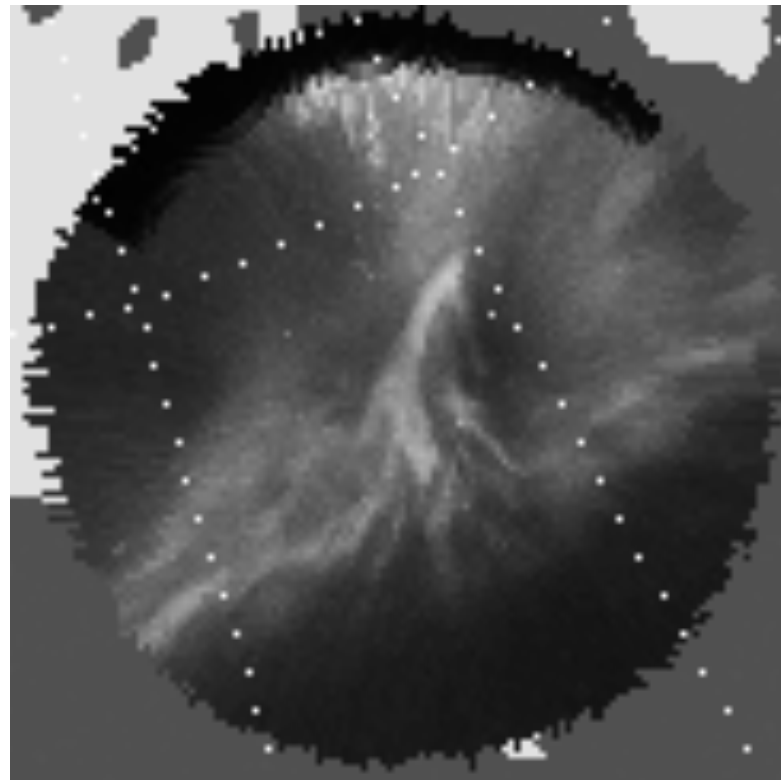
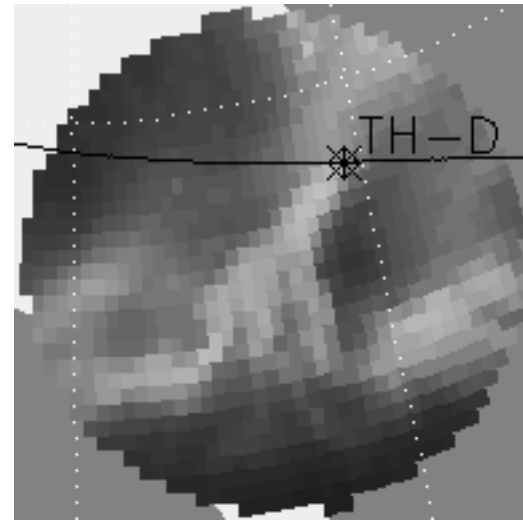
Linear scale images at every 5 min



Eastward drift with speed of ~ 0.15 km/sec

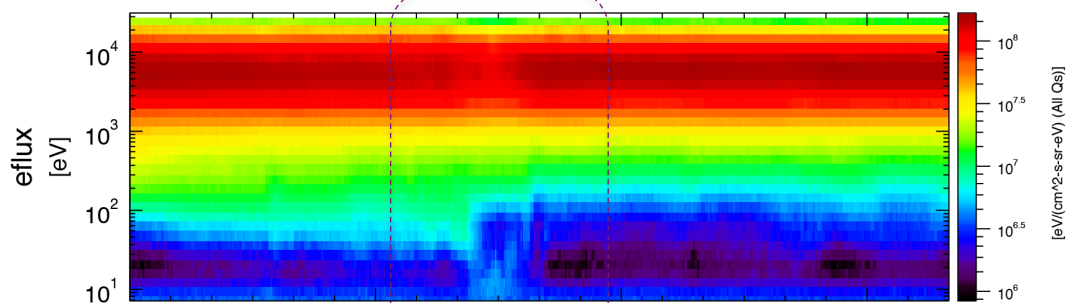
TH-D footprint
時間・空間変化図を作成する

T-89 model

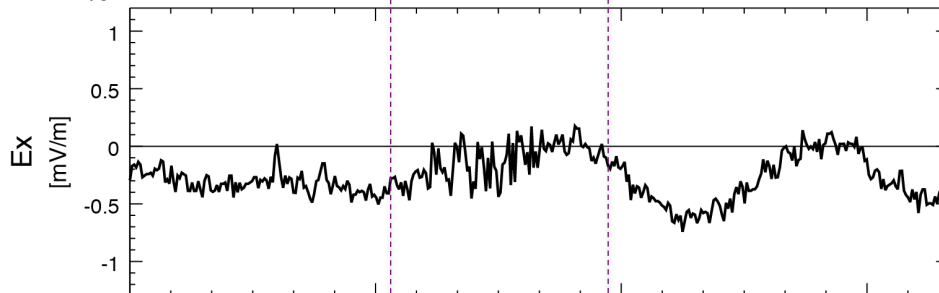


THEMIS-D 2011-03-01

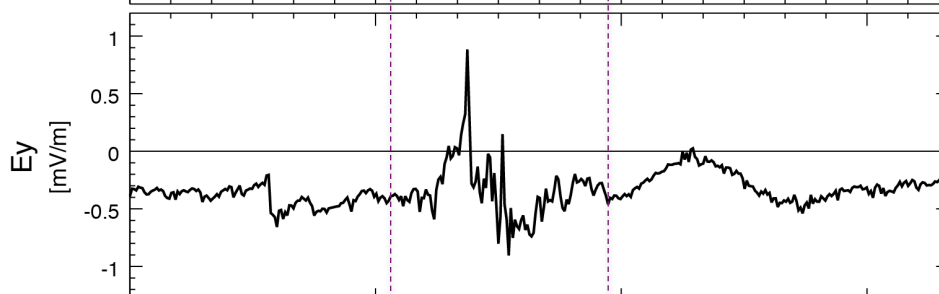
Electron
flux



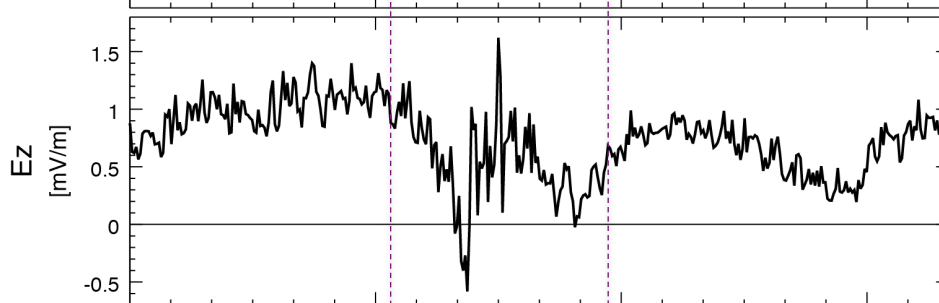
DC Ex



DC Ey



DC Ez



$E_z > E_y > E_x$

07:30:00

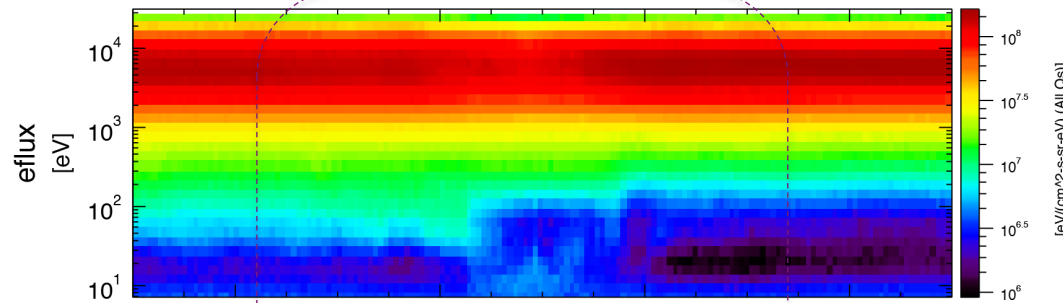
07:36

07:42

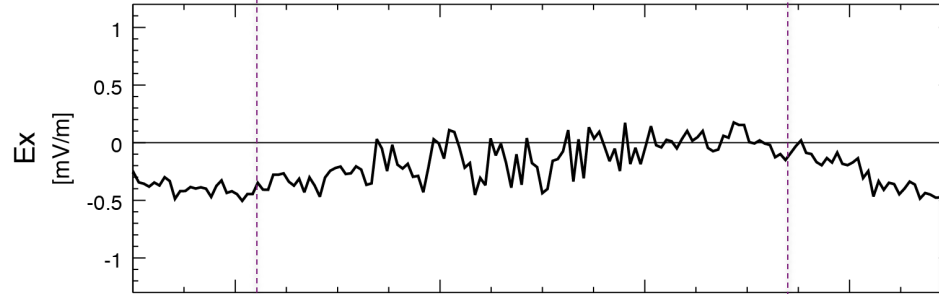
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THEMIS-D 2011-03-01

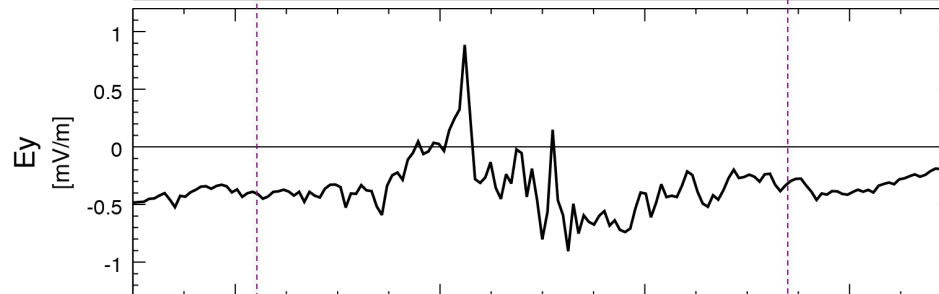
Electron
flux



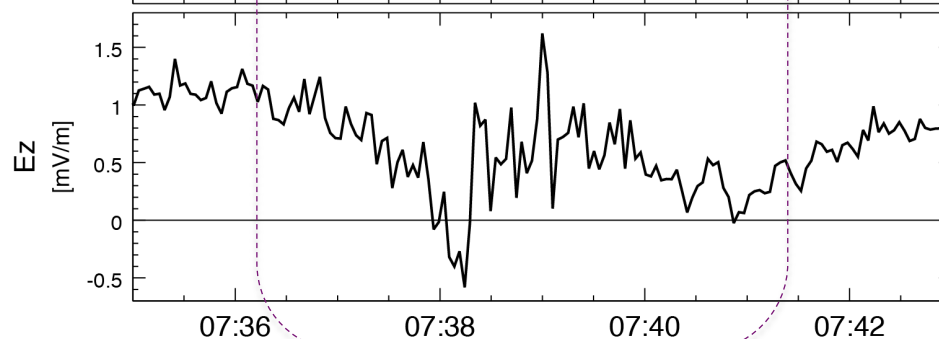
DC Ex



DC Ey



DC Ez



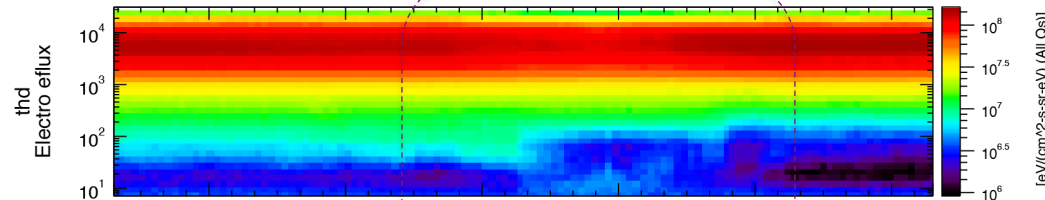
07:35:00

Ez (1.5mV/m pp)
> Ey (1.0 mV/m pp)
> Ex (0.5 mV/m pp)

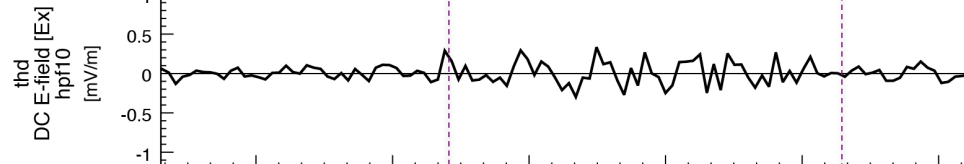
**field-aligned electric
field** may play
important role to
generate Omega band
PAs!!

THEMIS-D 2011-03-01

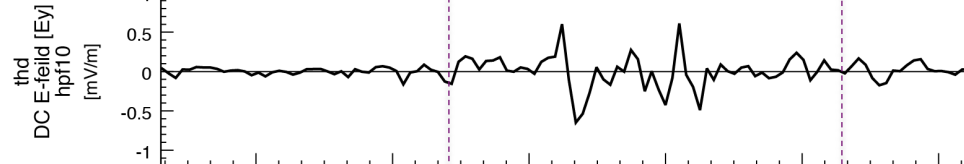
Electron
flux



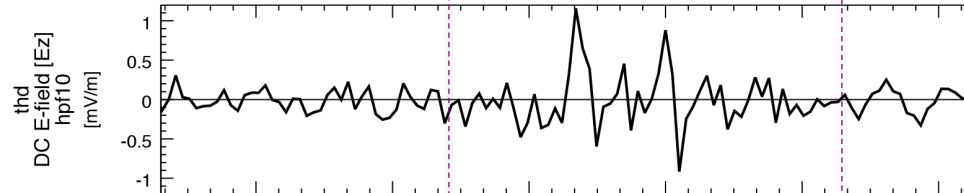
Ex
hpf10



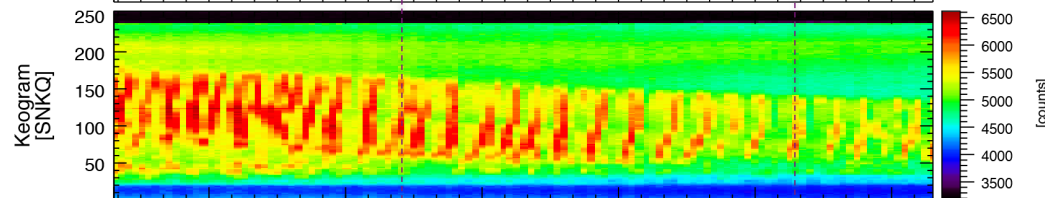
Ey
hpf10



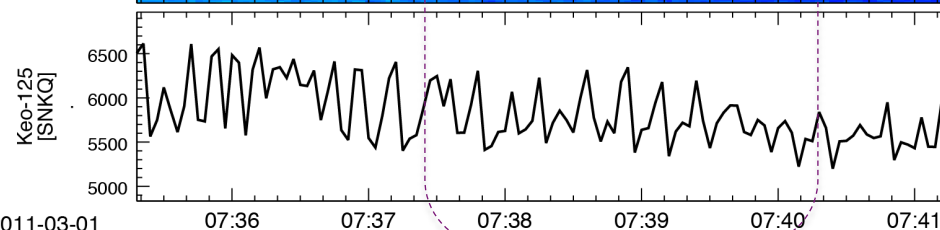
Ez
hpf10



Keogram
[SNKQ]



Keo-int
125

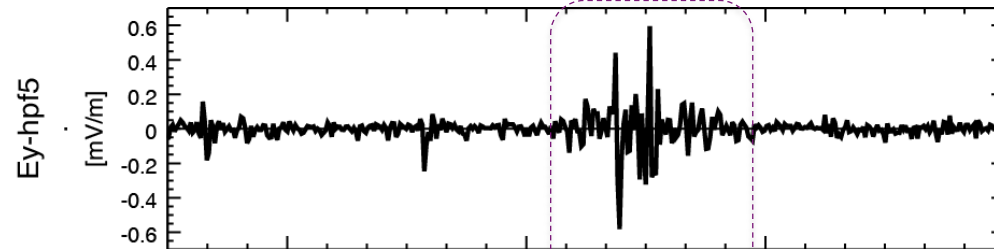


2011-03-01
07:35:18

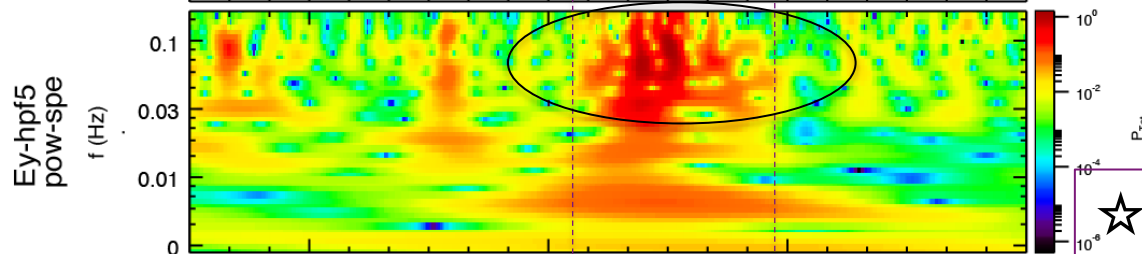
☆ Period of Quasi-
periodic modulation of
electric field and
optical intensity
modulation is almost
the same

THEMIS-D 2011-03-01

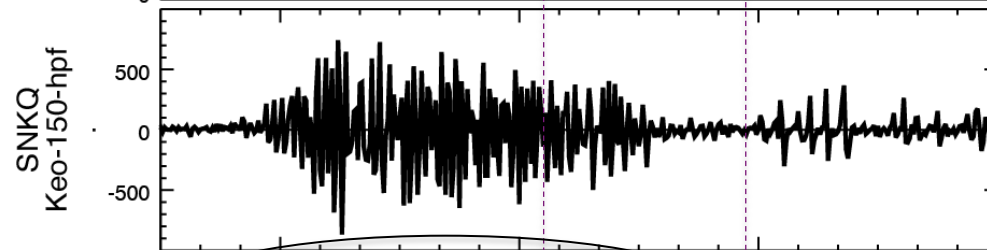
Ey
hpf 5



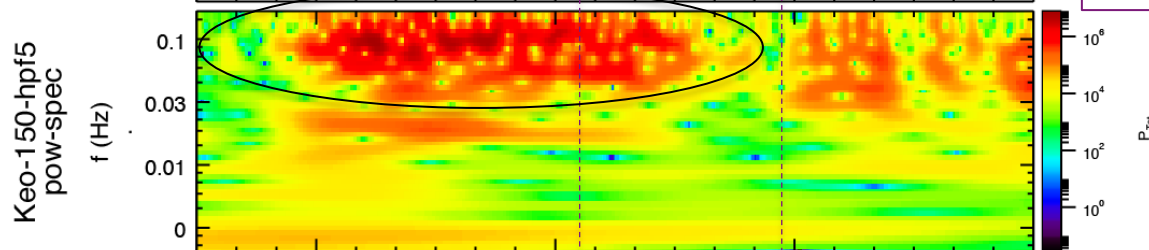
Ey
hpf 5
spectrum



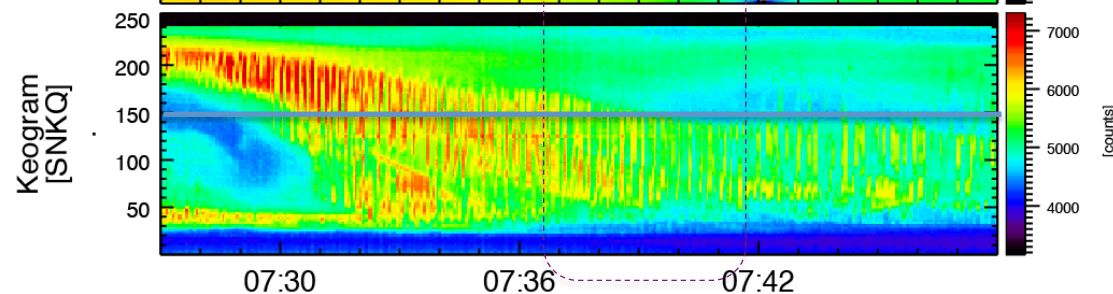
Keo-int
150 hpf 5



Keo-int
150 hpf 5
spectrum



Keogram
[SNKQ]



07:27:00

07:30

07:36

07:42

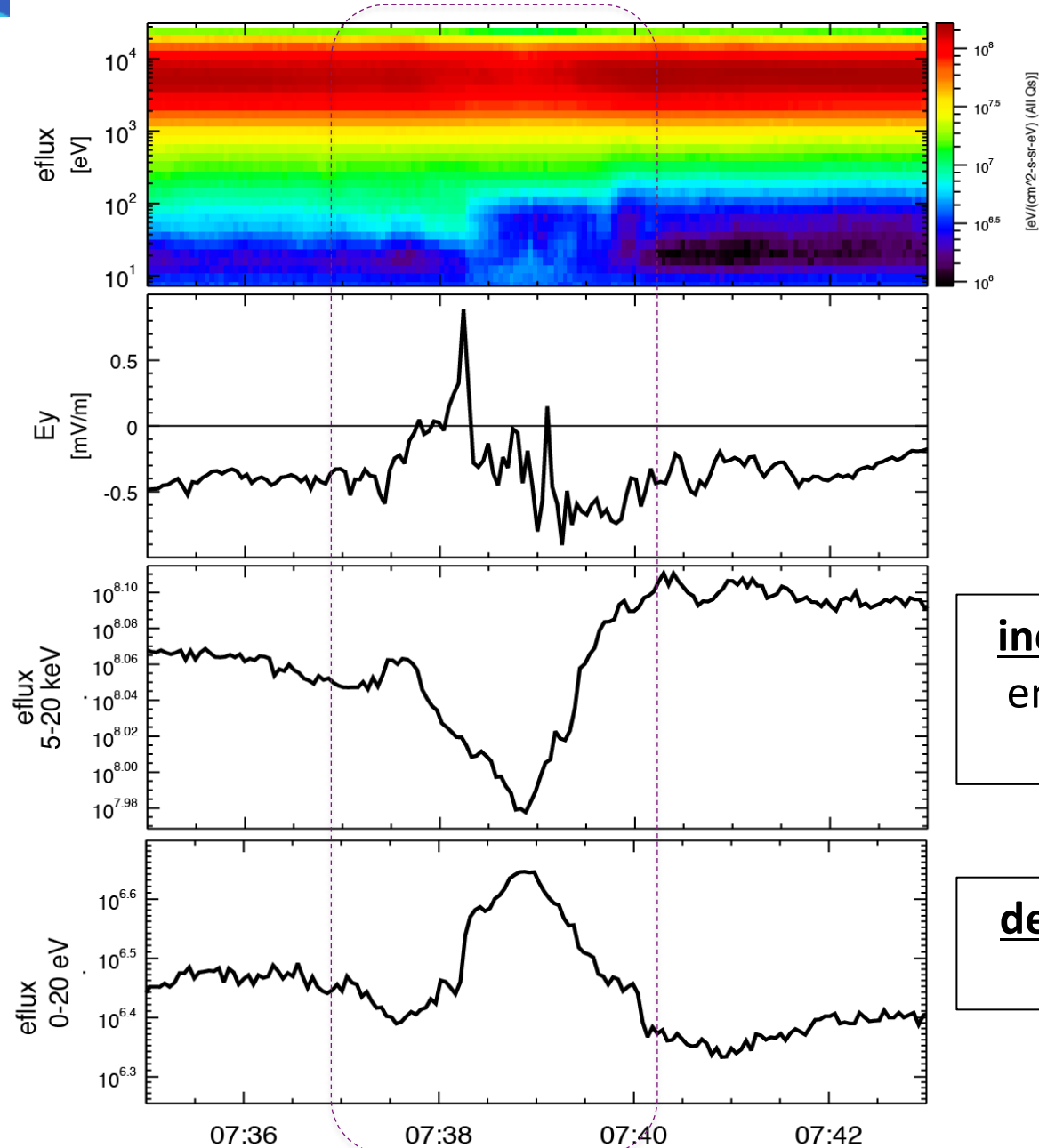
☆ **period** of QP
modulation of electric
field and optical
intensity modulation
is **almost the same**

Electron
flux

E_y

e-flux
5-20 keV

e-flux
0-20 eV



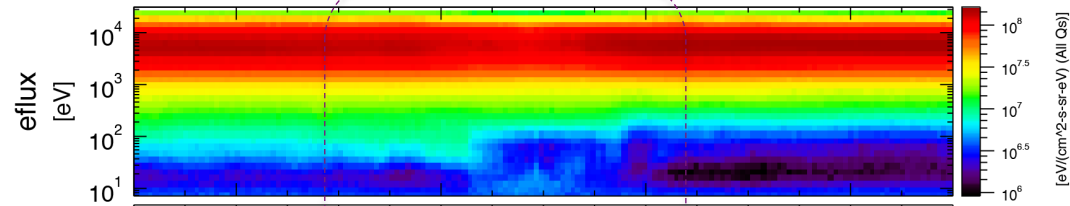
increase of high-
energy electron
flux

decrease of cold
electron flux

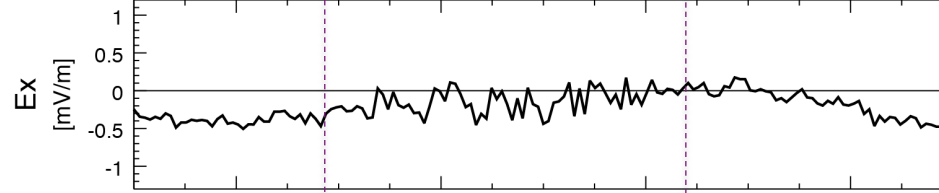
07:35:00

THEMIS-D 2011-03-01

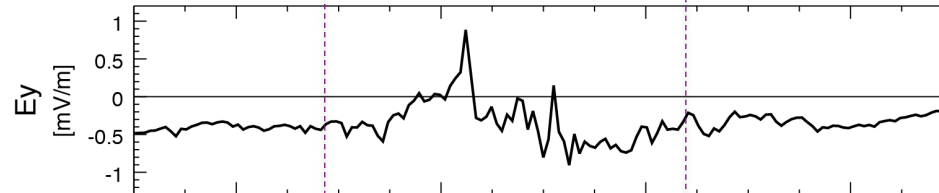
Electron
flux



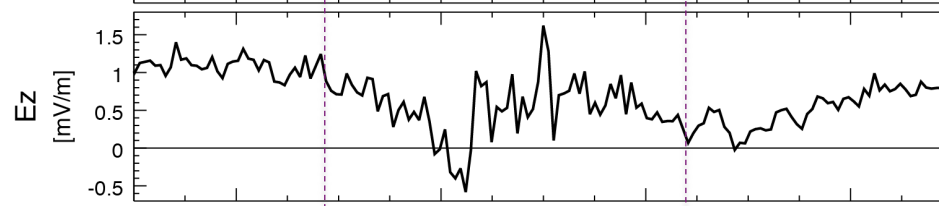
Ex



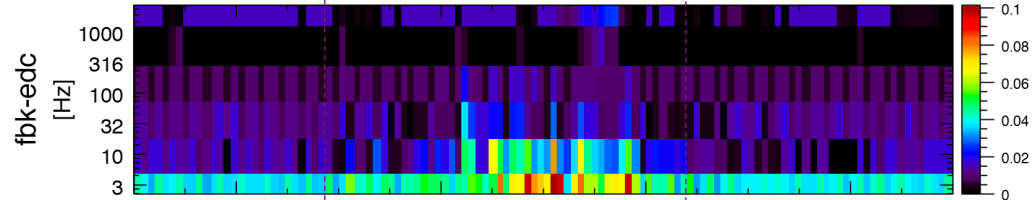
Ey



Ez

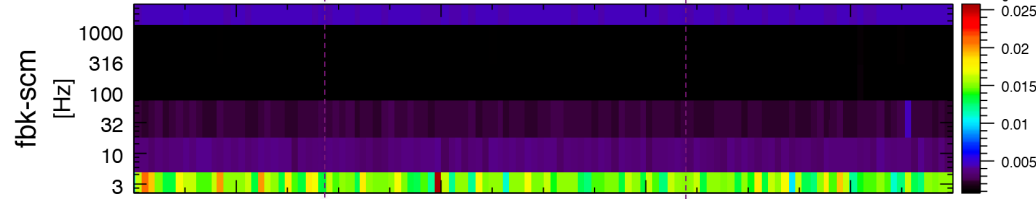


fbk-edc
spec



enhancement on
electro-static wave

fbk-scm
spec



no specific signals on
magnetic wave

07:35:00

07:36

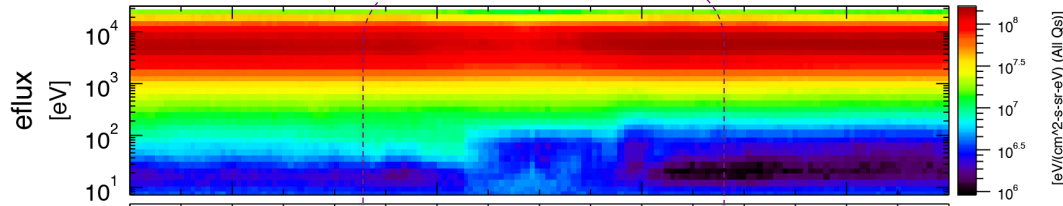
07:38

07:40

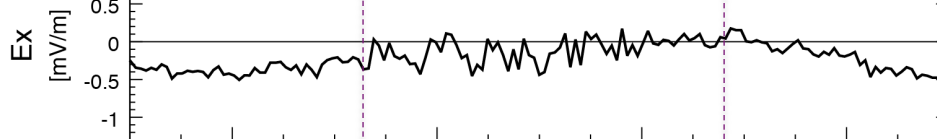
07:42

THEMIS-D 2011-03-01

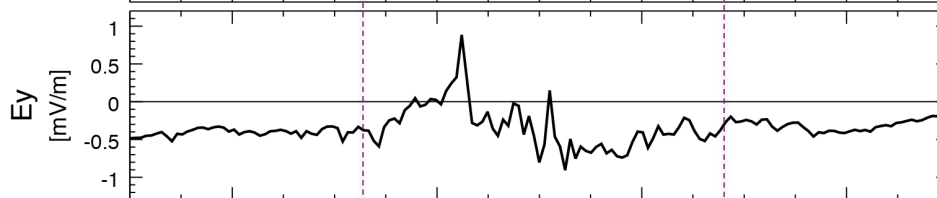
Electron
flux



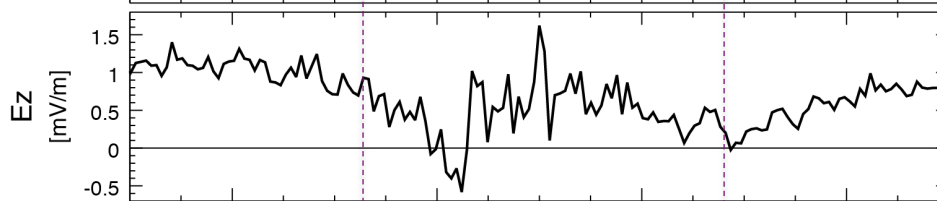
Ex



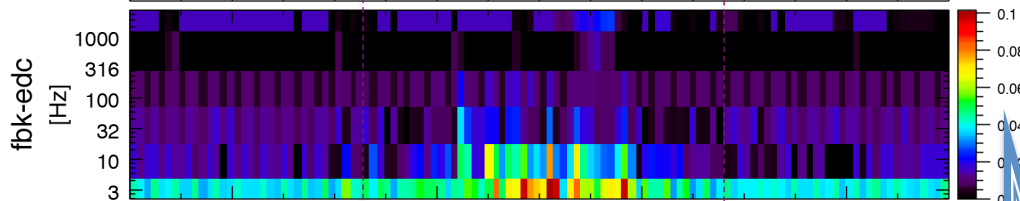
Ey



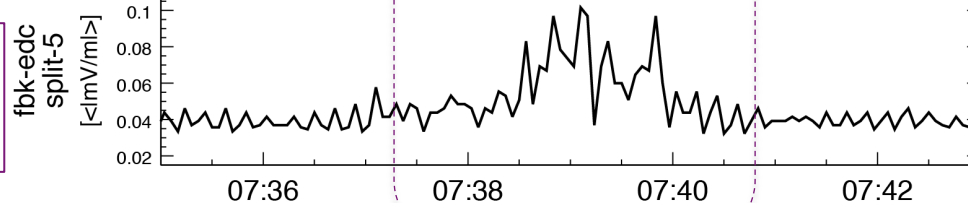
Ez



fbk-edc
spec



fbk-edc
< 5 Hz



low frequency (~ 5 Hz)
electro-static wave
intensity modulation is
the **similar as DC electric
field** modulation

THEMIS-D 2011-03-01

Electron
flux

Ex

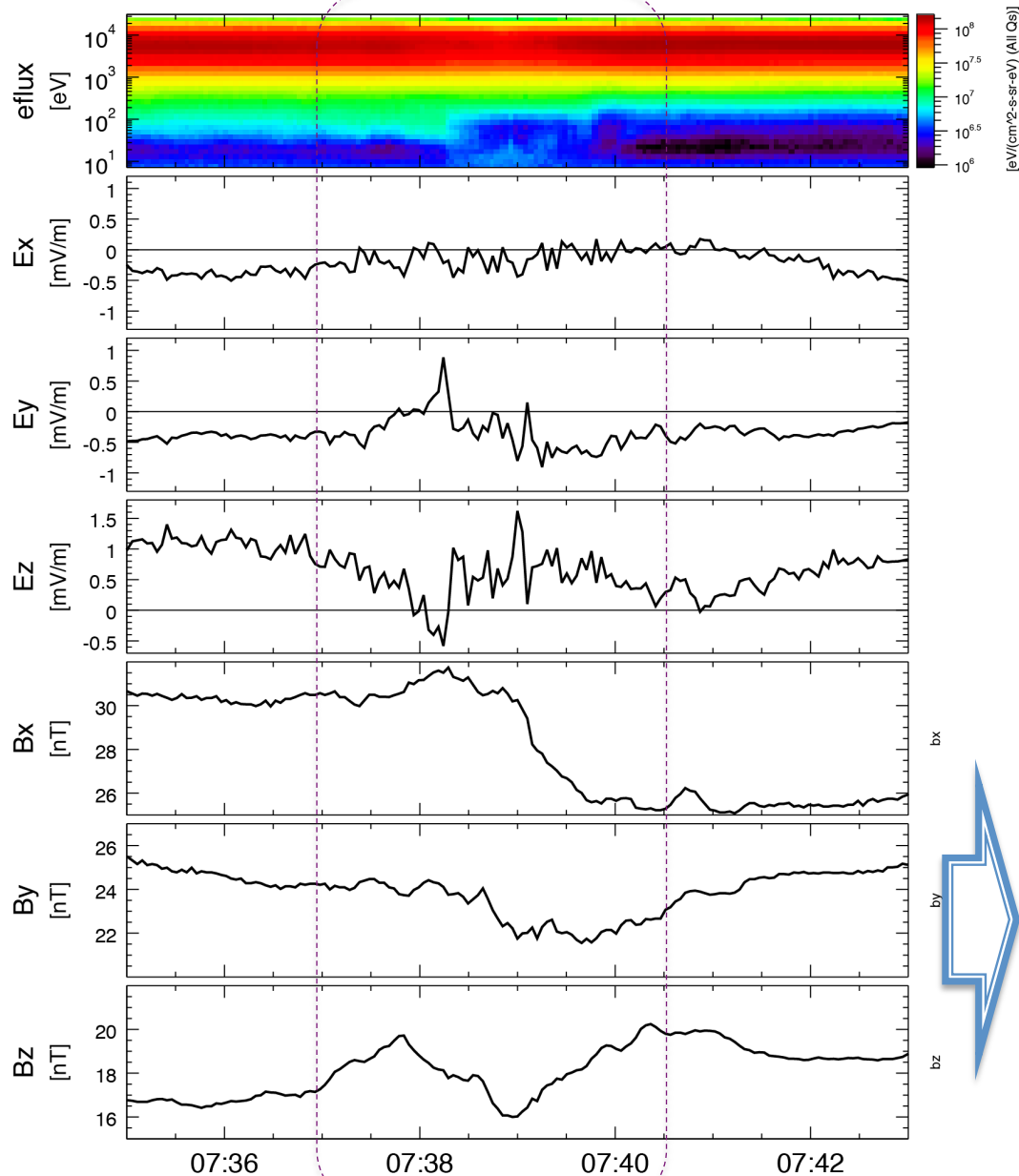
Ey

Ez

Bx

By

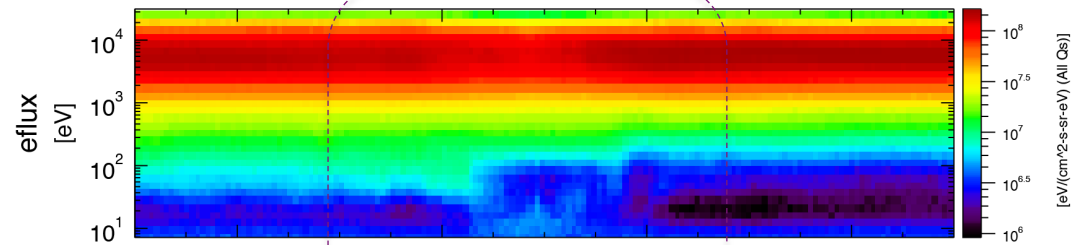
Bz



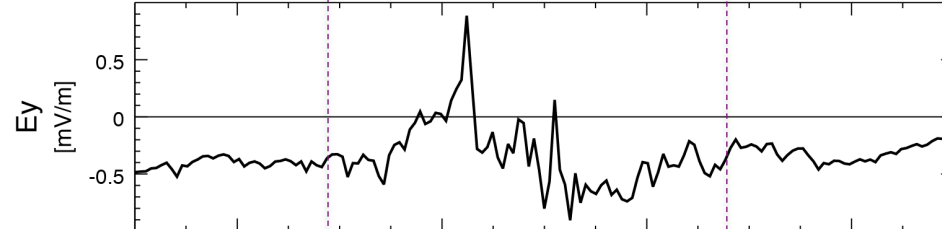
configuration of
magnetic field
changes between
outside and inside of
omega band PA

THEMIS-D 2011-03-01

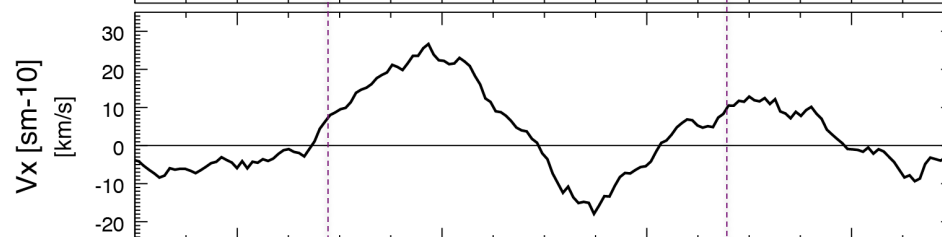
Electron
flux



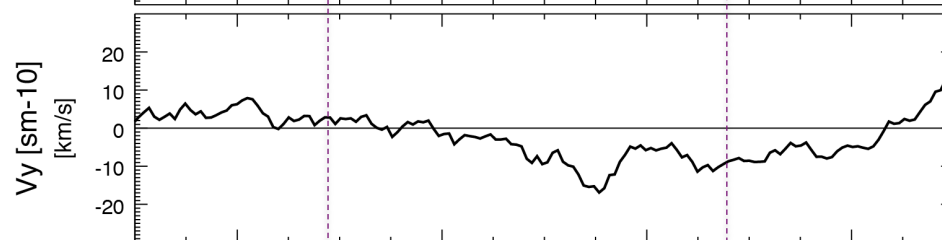
E_y



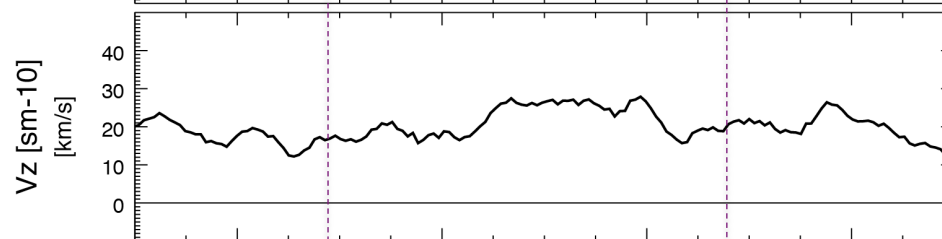
V_x



V_y



V_z

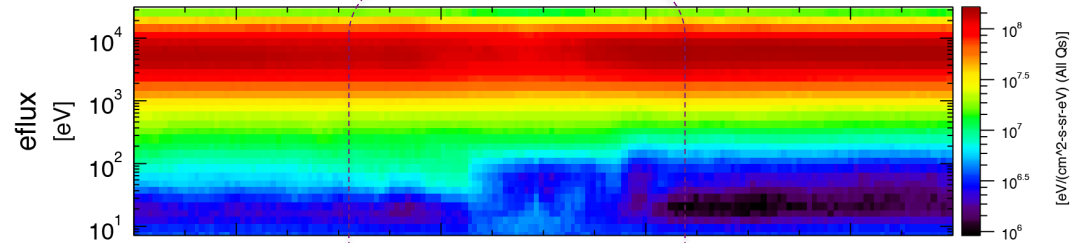


velocity shear
appeared only V_x

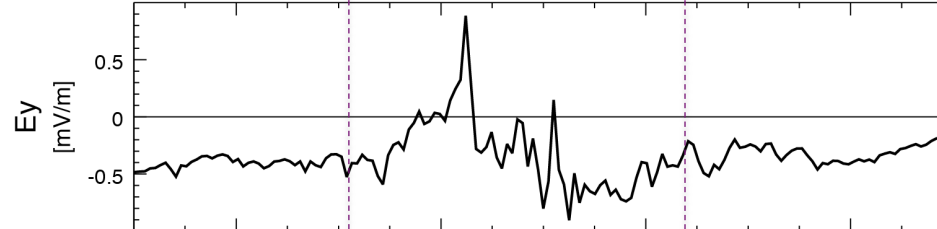
07:35:00

THEMIS-D 2011-03-01

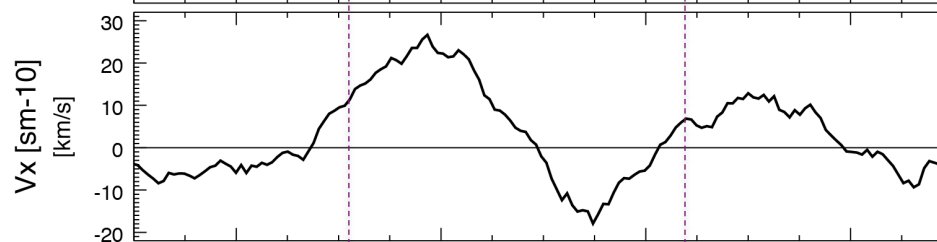
Electron
flux



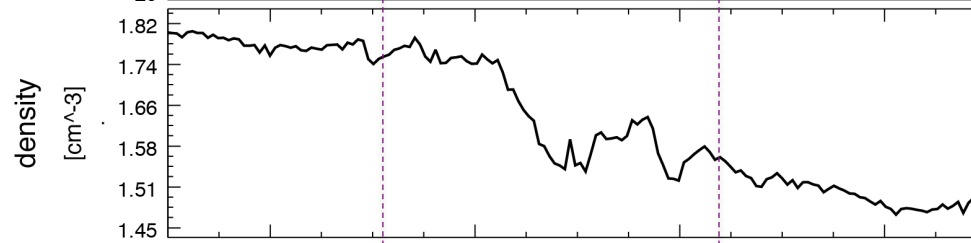
E_y



V_x

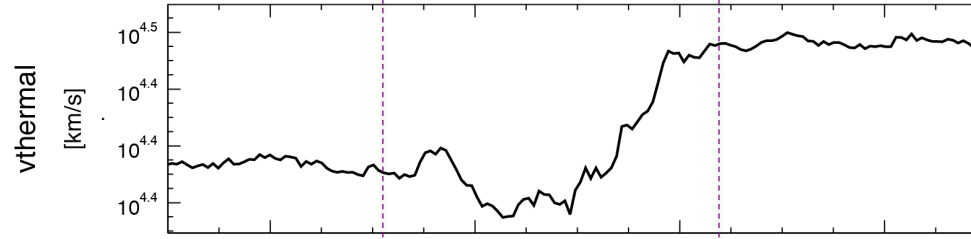


Density



density decreased
after crossing the PA

Thermal
velocity



thermal velocity
increased after
crossing the PA

07:35:00

07:36

07:38

07:40

07:42

Summary

We examined characteristics of omega-band pulsating aurora which observed simultaneously onboard THEMIS spacecraft and on the ground

Ground based optical observation at SNKQ observatory

- MLT is ~0230
- Omega shaped PAs
- ON-OFF period was ~10-20 sec
- Eastward drift with speed of ~ 0.15 km/sec (at 120 km altitude)

THEMIS-D observation

TH-D was located at ~ 03 MLT, ~ -1.0 degree (GSM)

- electric field showed QP modulation (E_z > E_y > E_x)
- period of QP modulation of electric field and optical intensity is almost the same
- high energy (5-20 keV) flux decreased
- low energy (< 20 eV) flux increased
- electro-static wave enhancement, and low frequency (< 3Hz) electro-static wave intensity modulation was the similar as the electric field modulation
- B field configuration changed between outside and inside of omega band PA
- velocity shear appeared only V_x
- density decreased after crossing the PA
- thermal velocity increased after crossing the PA

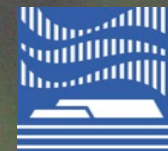
Conclusion

- E-field (especially E_z) is correlating to optical PAs
- Electro-static low frequency wave ($<5\text{Hz}$) also correlating to optical PAs
- Magnetic wave does not correlate of PAs
- High energy electron flux increase and lower energy electron flux decrease inside of PAs

Thanks for your attention

Acknowledgements

- * THEMIS Science Support Team
- * IUGONET Team



NiPR
National Institute of Polar Research