HF waves observed by DEMETER above the SAA

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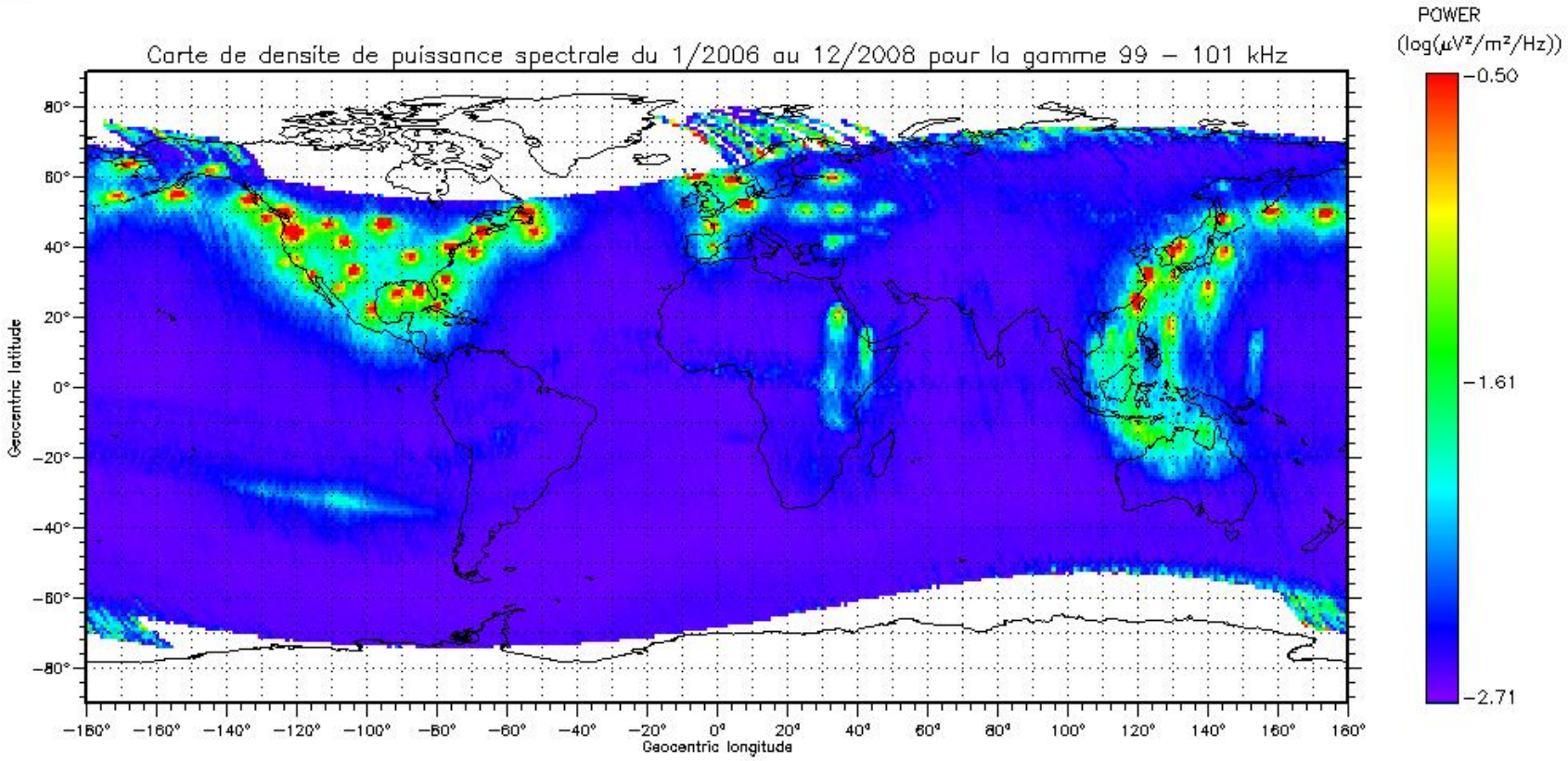
The HF range

In burst or in survey, one electric component is always connected and digitized in the HF range (0 – 3.3 MHz) to produce a power spectrum with $\Delta t = 2$ s and $\Delta f = 3.25$ kHz.

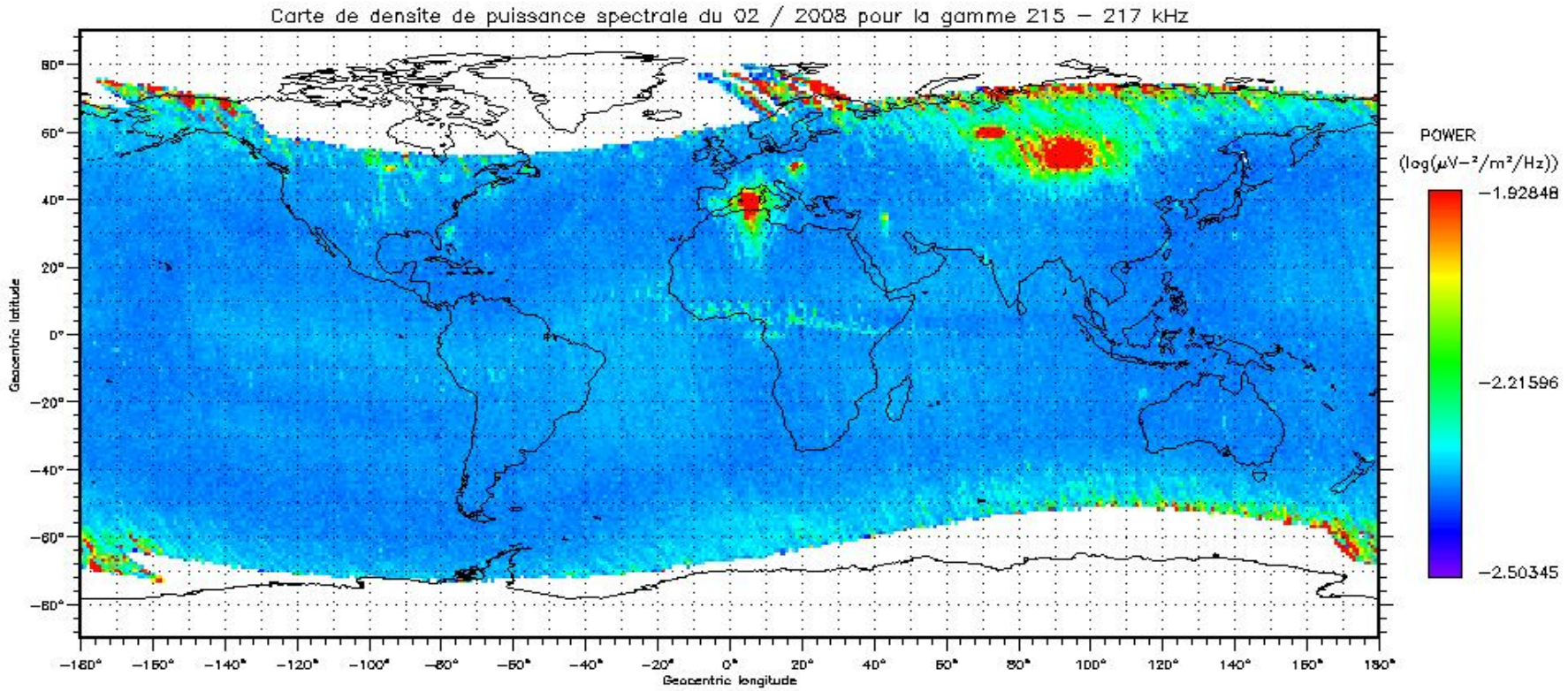
Data have been only used during night time.

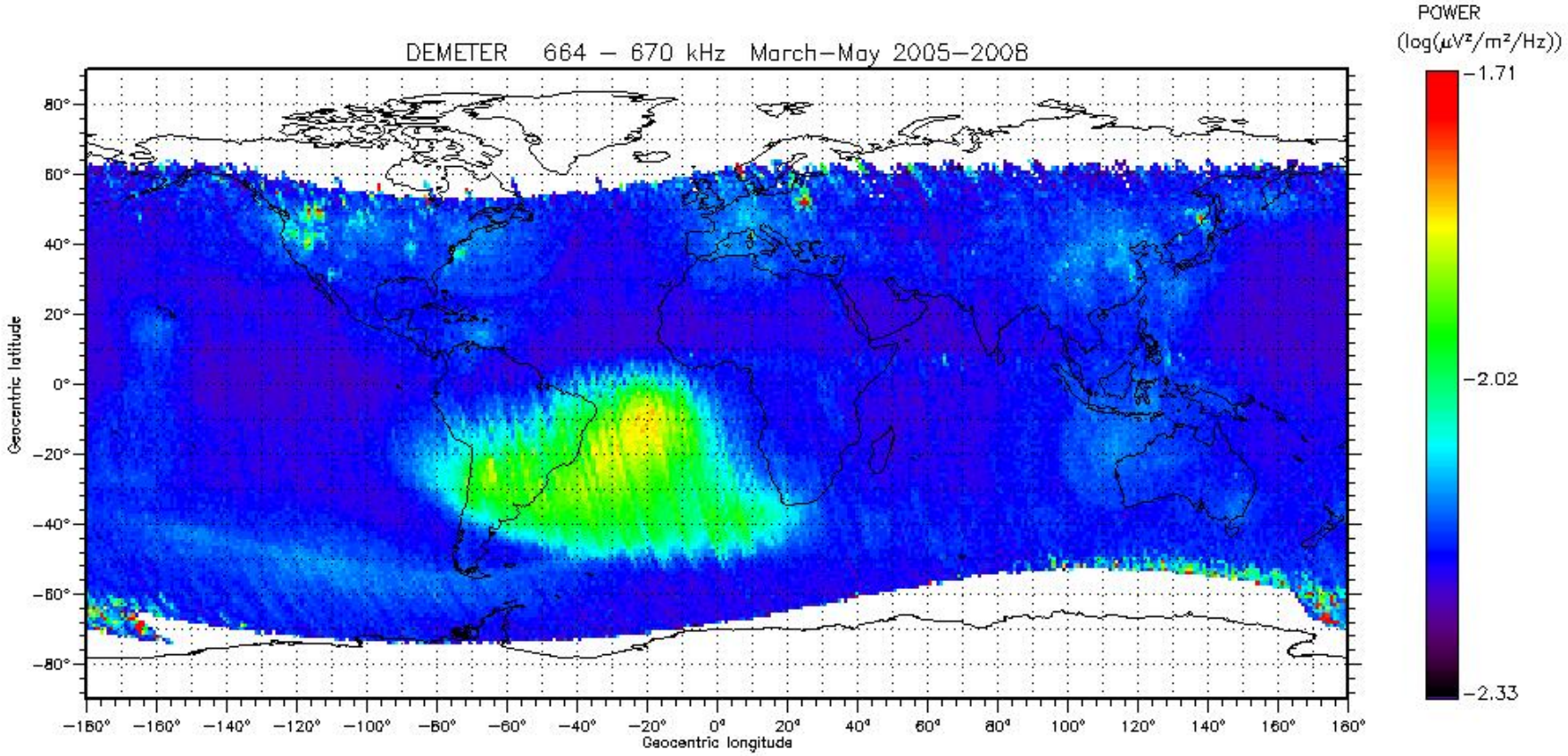
Loran – 100 kHz

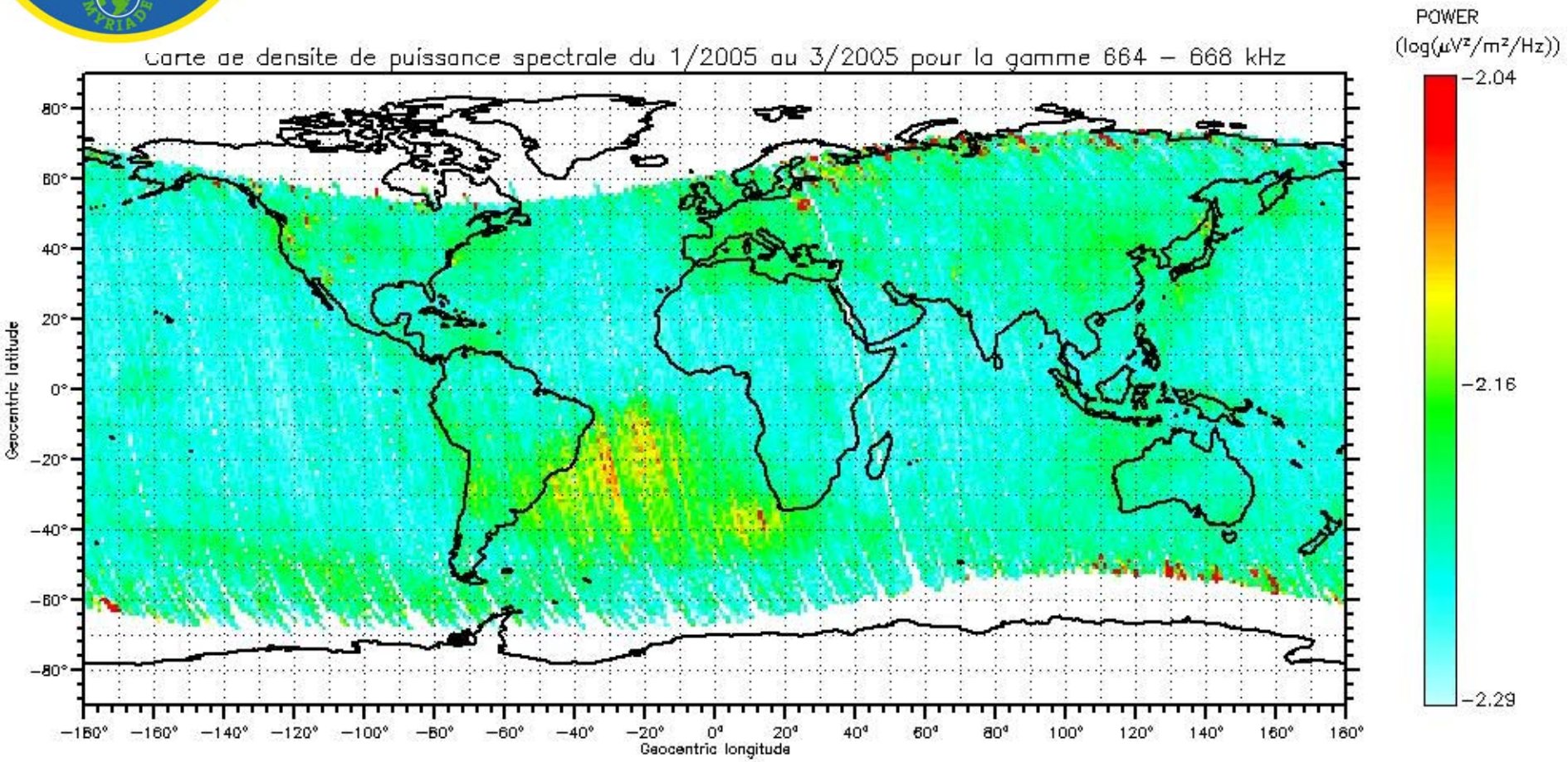


Fullekrug et al., GRL, 2009.

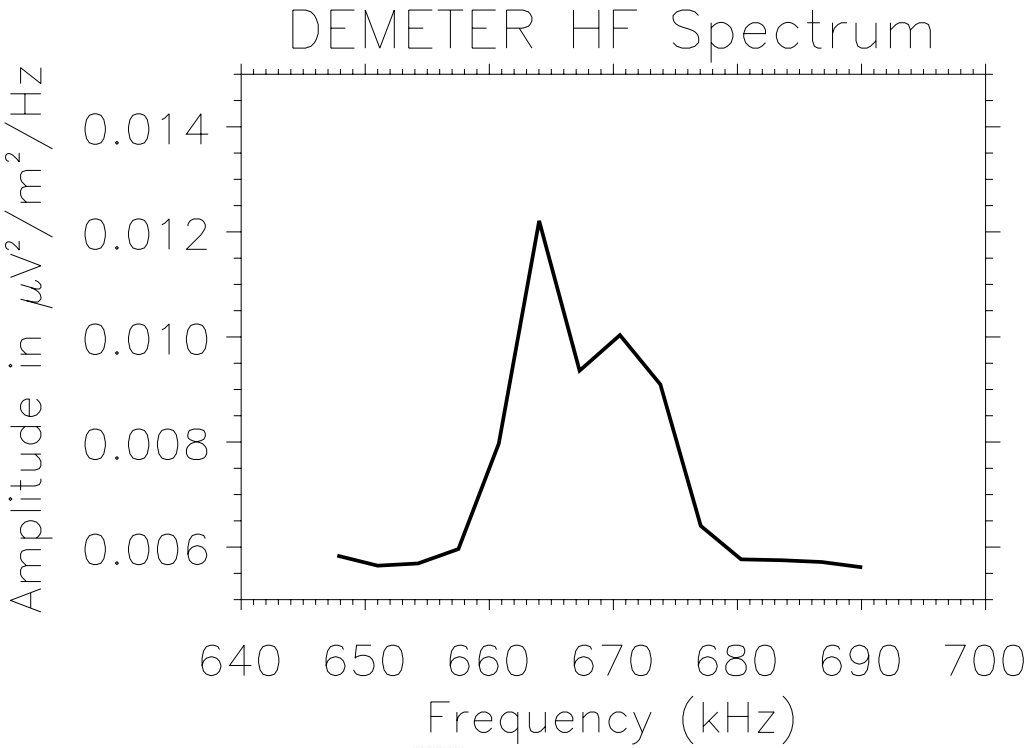
Radio Monte Carlo – 216 kHz

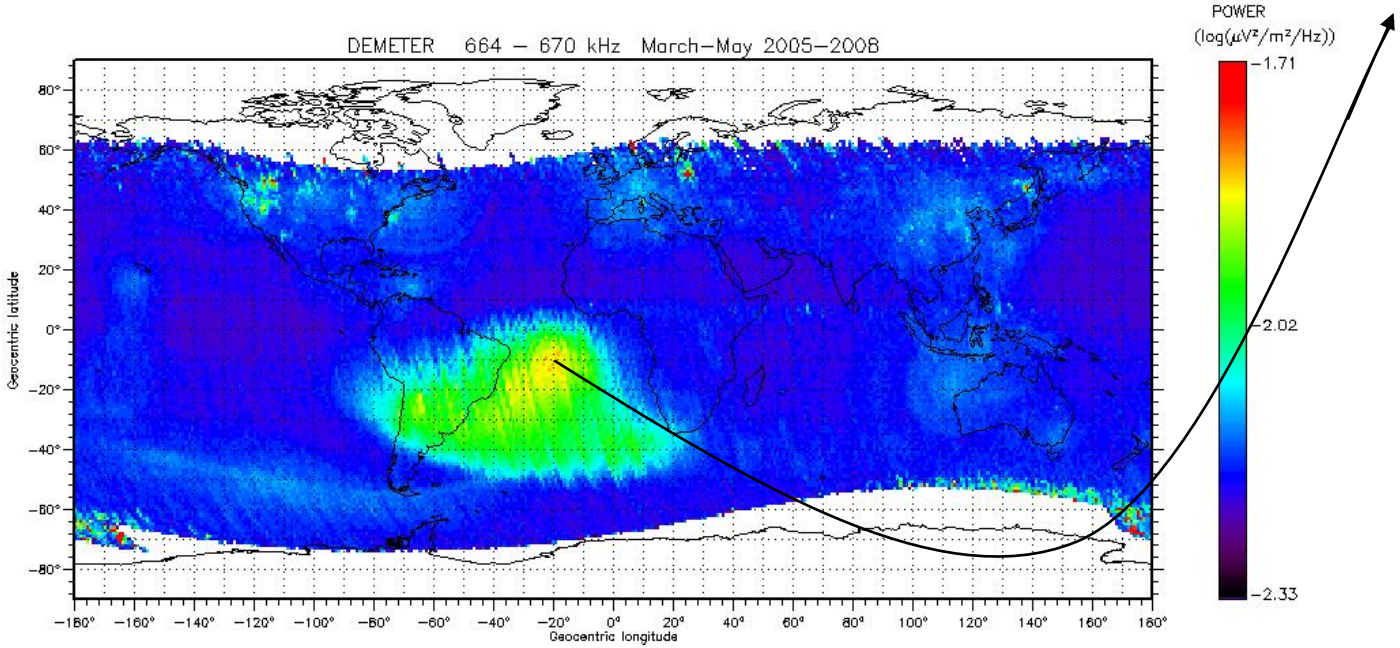


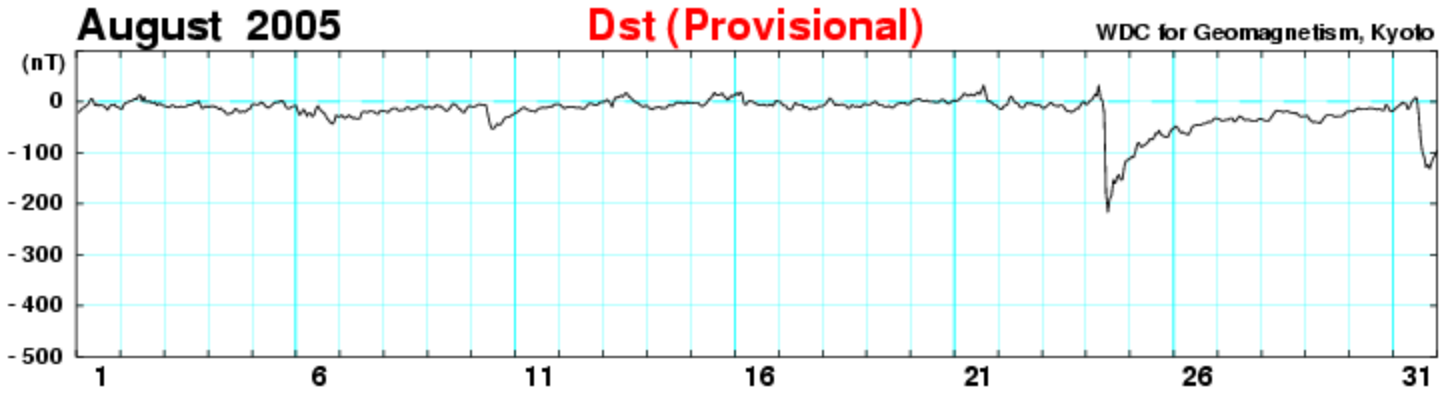

DEMETER 664 – 670 kHz March–May 2005–2008
POWER
(log(μV²/m²/Hz))
-1.71
-2.02
-2.33
Geocentric latitude
80°
60°
40°
20°
0°
-20°
-40°
-60°
-80°
-180° -160° -140° -120° -100° -80° -60° -40° -20° 0° 20° 40° 60° 80° 100° 120° 140° 160° 180°
Geocentric longitude


DNEPR
DEMETER
CNES
CNRS
MYRIADE
Carte de densite de puissance spectrale du 1/2005 au 3/2005 pour la gamme 664 – 668 kHz
POWER
(log(μV²/m²/Hz))
−2.04
−2.16
−2.29
Geocentric latitude
80°
60°
40°
20°
0°
−20°
−40°
−60°
−80°
−180° −160° −140° −120° −100° −80° −60° −40° −20° 0° 20° 40° 60° 80° 100° 120° 140° 160° 180°
Geocentric longitude


DNEPR
DEMETER
CNES
CNRS
MYRIADE


DEMETER HF Spectrum
Amplitude in μV²/m²/Hz
0.014
0.012
0.010
0.008
0.006
640
650
660
670
680
690
700
Frequency (kHz)

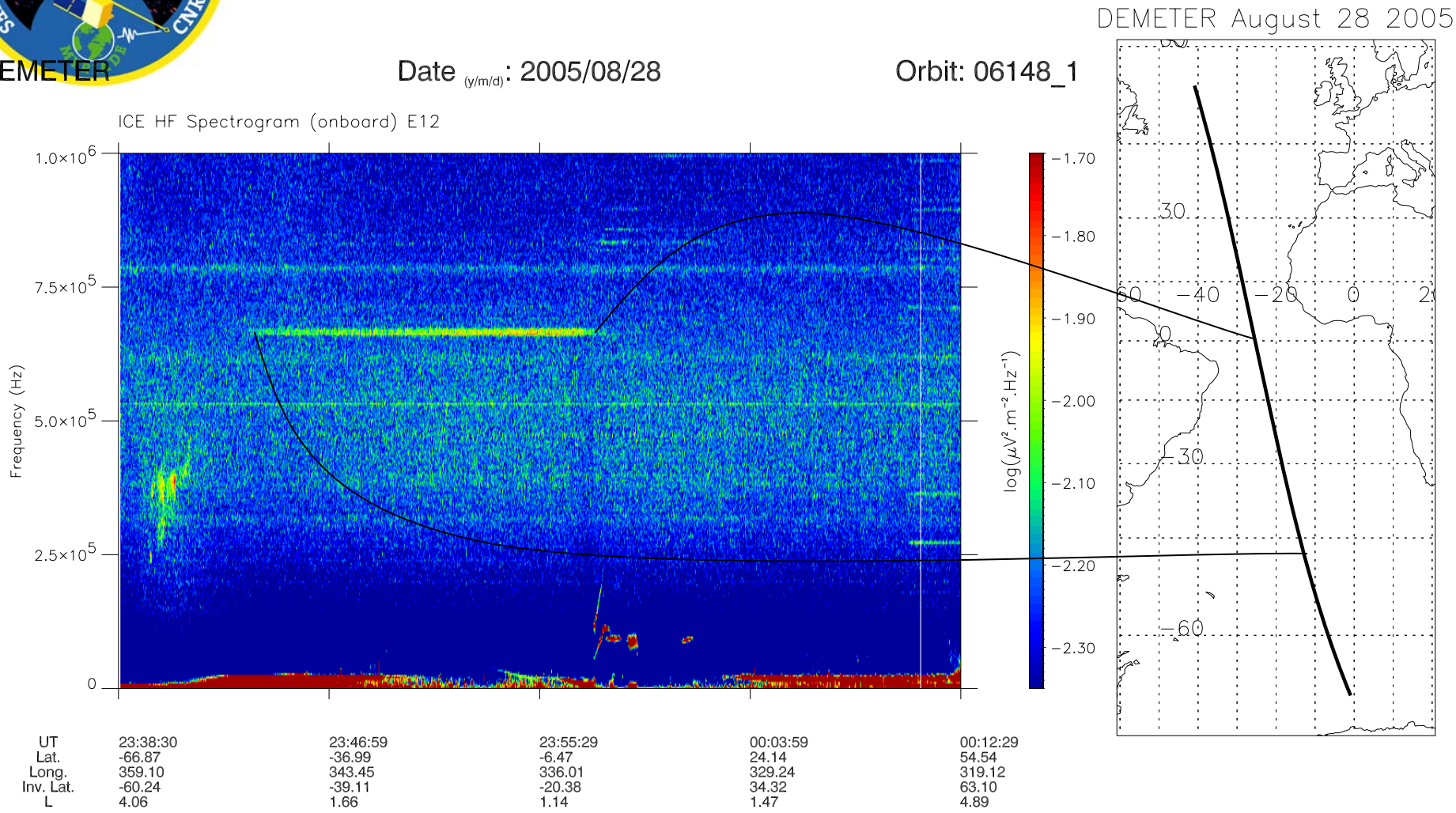

DEMETER 664 – 670 kHz March–May 2005–2008
POWER
(log(μV²/m²/Hz))
-1.71
-2.02
-2.33
Geocentric latitude
Geocentric longitude


August 2005
Dst (Provisional)
WDC for Geomagnetism, Kyoto
(nT)
0
- 100
- 200
- 300
- 400
- 500
1
6
11
16
21
26
31

DEMETER

Date (y/m/d): 2005/08/28

Orbit: 06148_1



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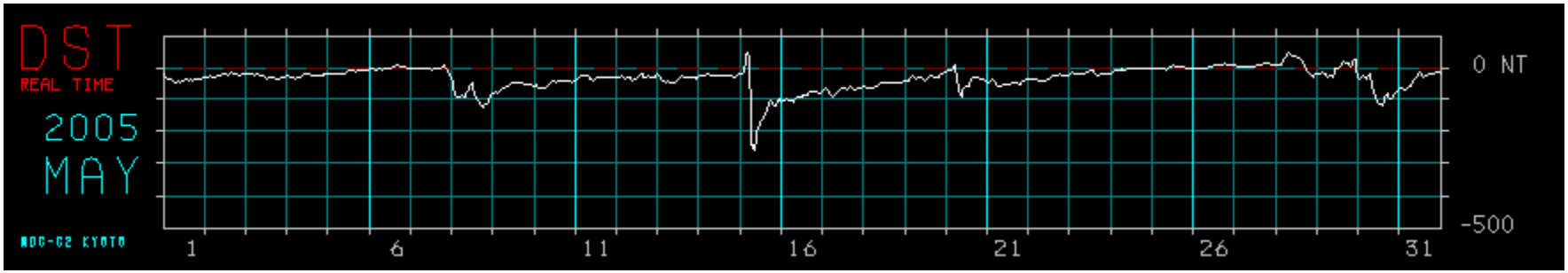
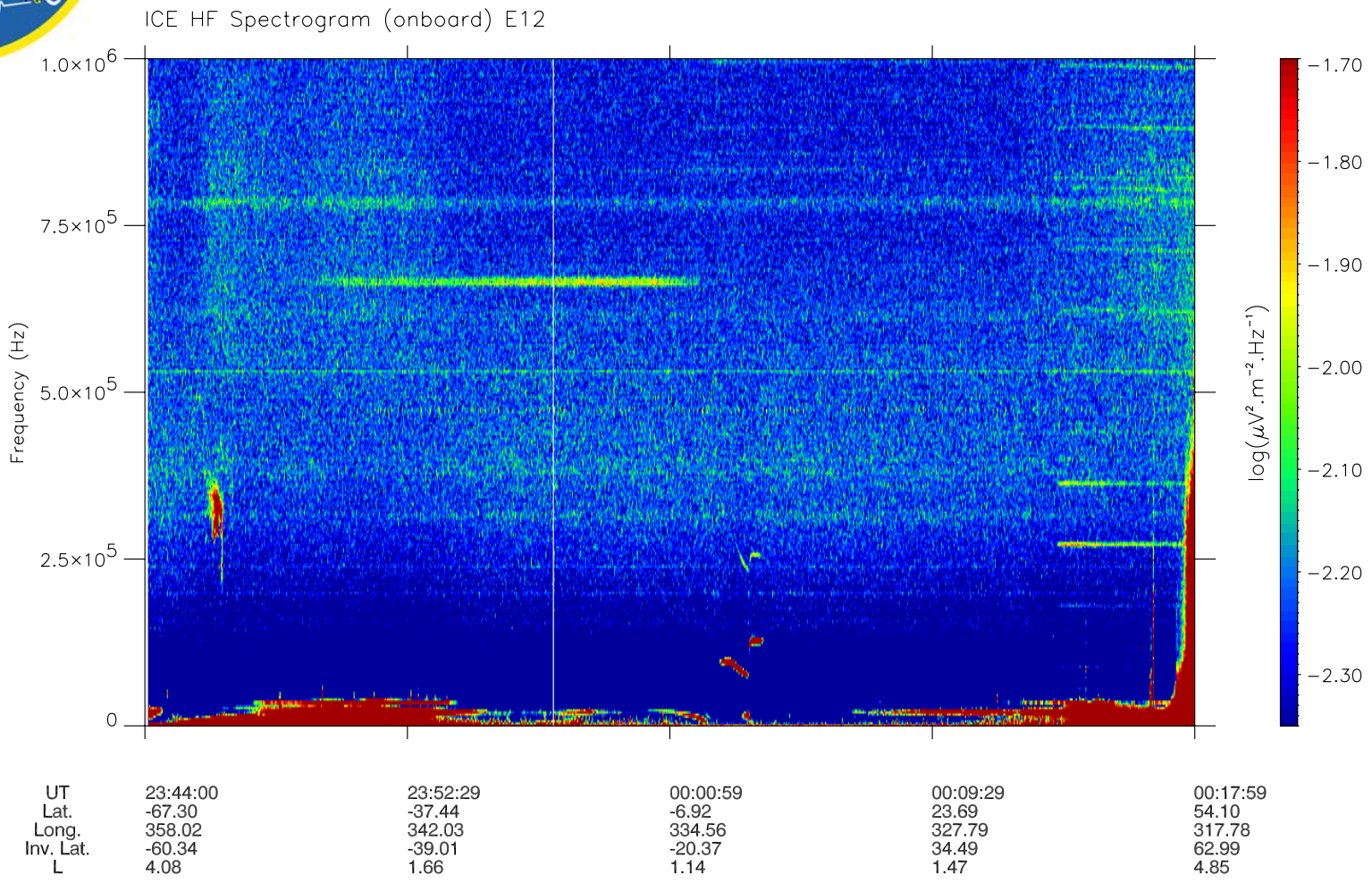
The magnetic storm of May 15, 2005



DEMETER

Date (y/m/d): 2005/05/15

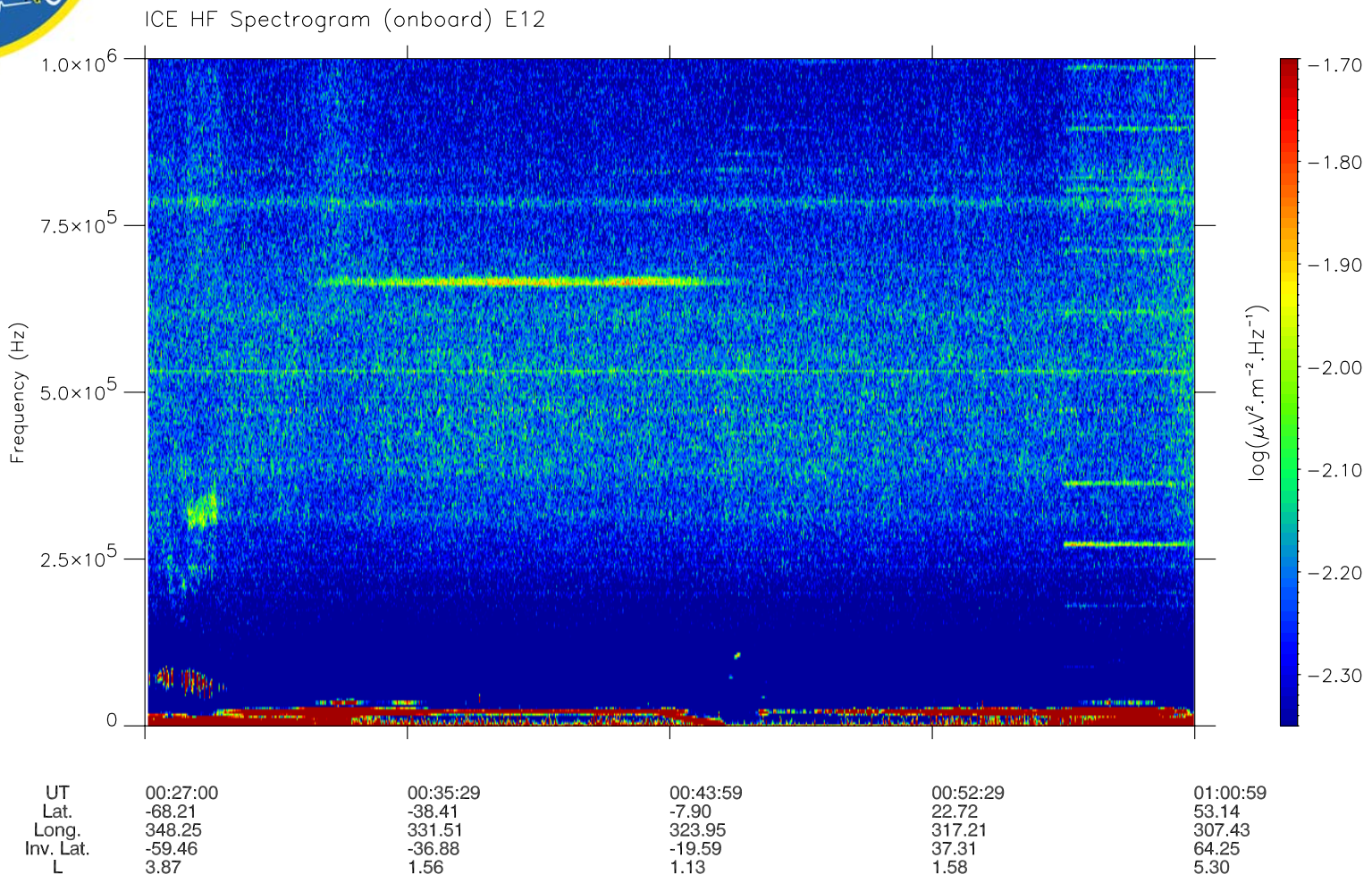
Orbit: 04619_1



UT	23:44:00	23:52:29	00:00:59	00:09:29	00:17:59
Lat.	-67.30	-37.44	-6.92	23.69	54.10
Long.	358.02	342.03	334.56	327.79	317.78
Inv. Lat.	-60.34	-39.01	-20.37	34.49	62.99
L	4.08	1.66	1.14	1.47	4.85

HEPPA- 2009 Boulder

DEMETER Date (y/m/d): 2005/05/17 Orbit: 04634_1



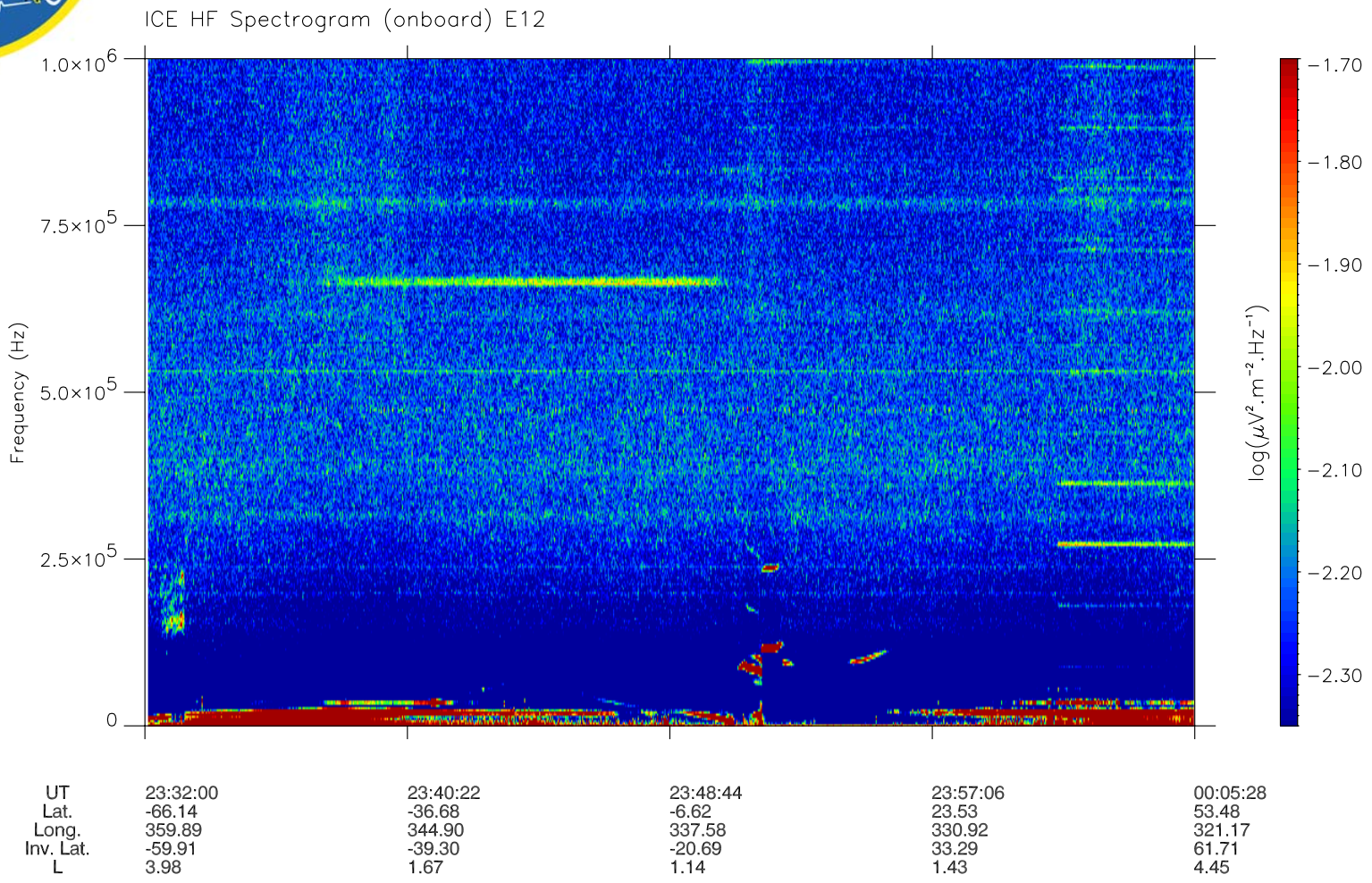
UT	00:27:00	00:35:29	00:43:59	00:52:29	01:00:59
Lat.	-68.21	-38.41	-7.90	22.72	53.14
Long.	348.25	331.51	323.95	317.21	307.43
Inv. Lat.	-59.46	-36.88	-19.59	37.31	64.25
L	3.87	1.56	1.13	1.58	5.30

HEPPA- 2009 Boulder

DEMETER

Date (y/m/d): 2005/05/17

Orbit: 04648_1



UT	23:32:00	23:40:22	23:48:44	23:57:06	00:05:28
Lat.	-66.14	-36.68	-6.62	23.53	53.48
Long.	359.89	344.90	337.58	330.92	321.17
Inv. Lat.	-59.91	-39.30	-20.69	33.29	61.71
L	3.98	1.67	1.14	1.43	4.45

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GENERATION and PROPAGATION

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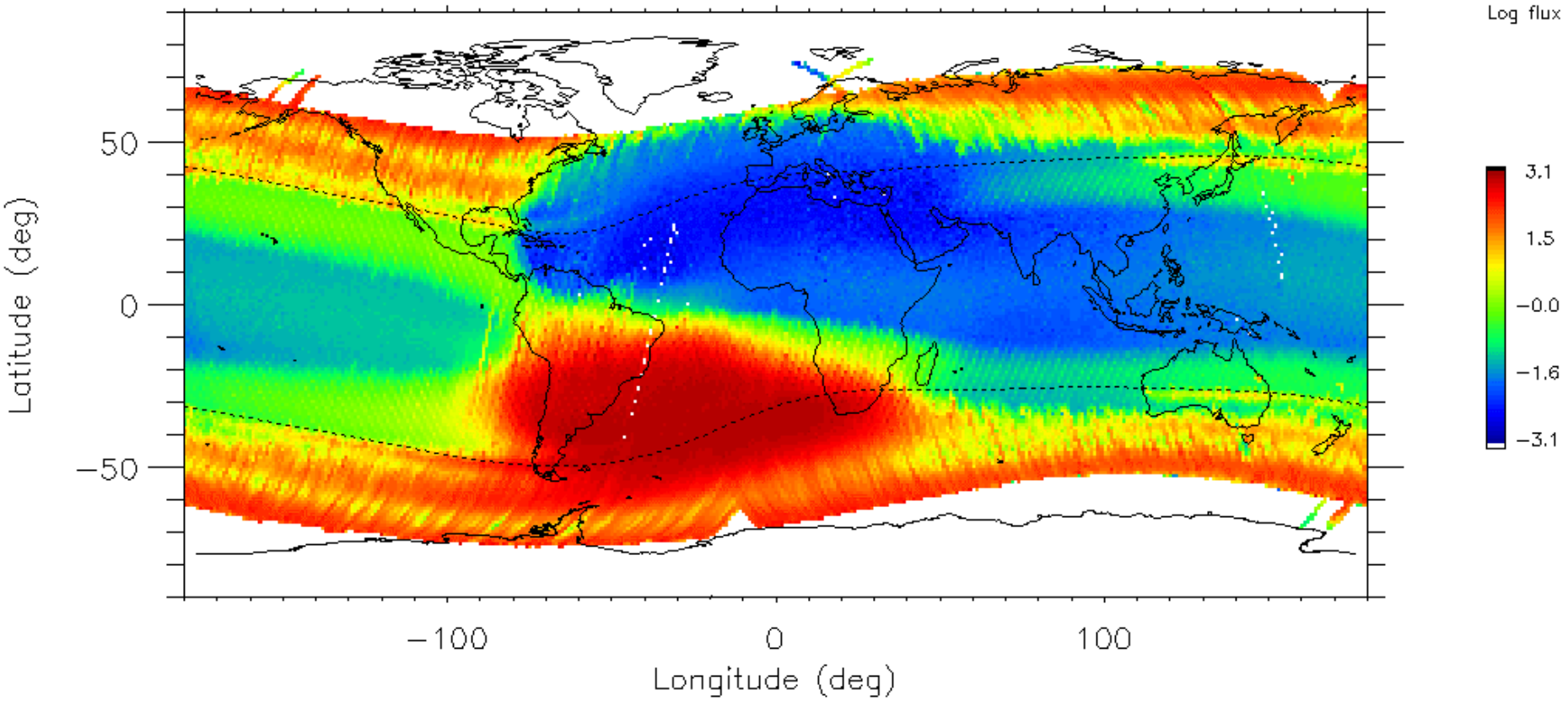
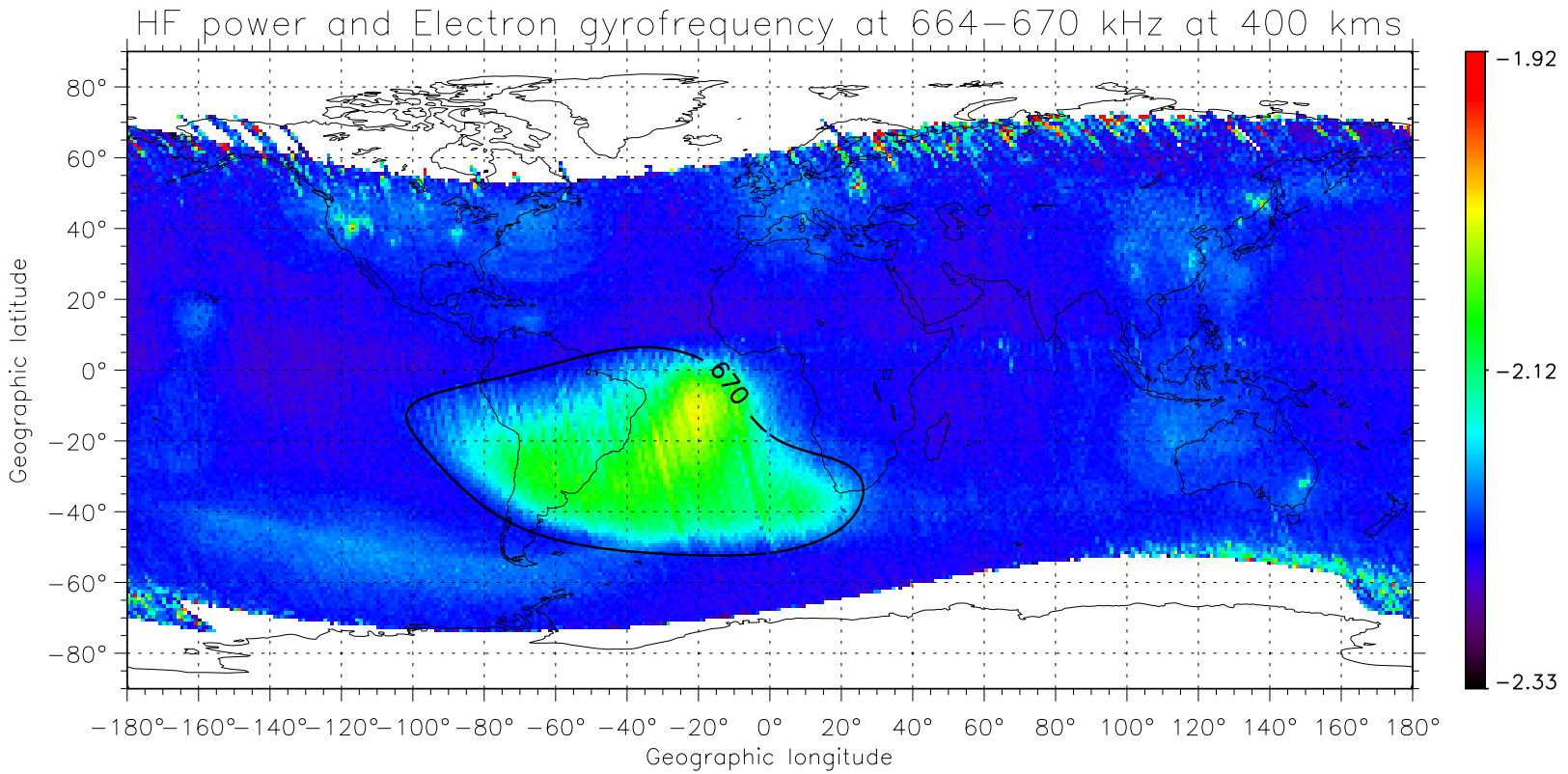
DEMETER

200 keV

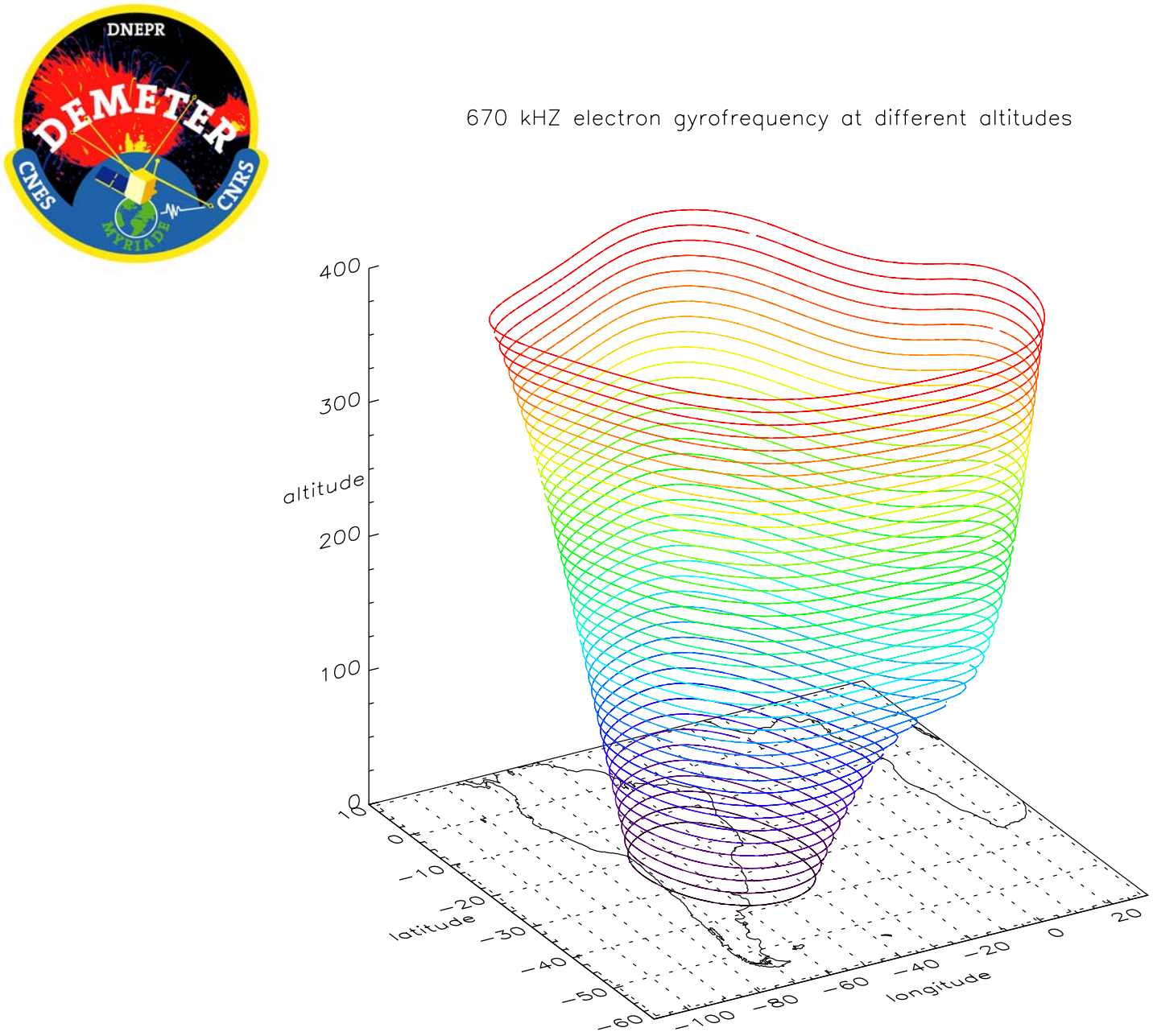
01/Oct/2005



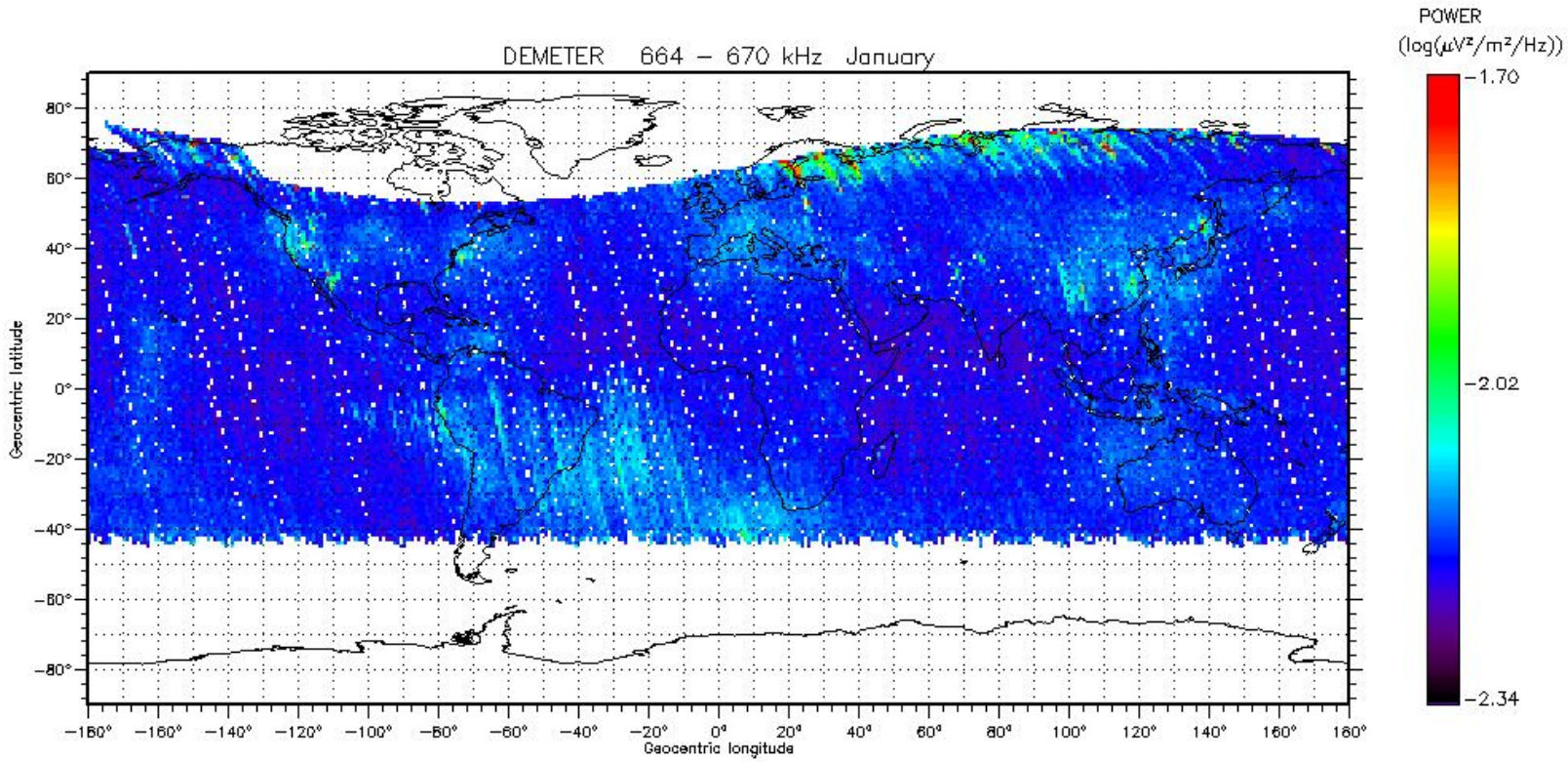
Sauvaud et al., GRL, 2008



HEPPA- 2009 Boulder



HEPPA- 2009 Boulder



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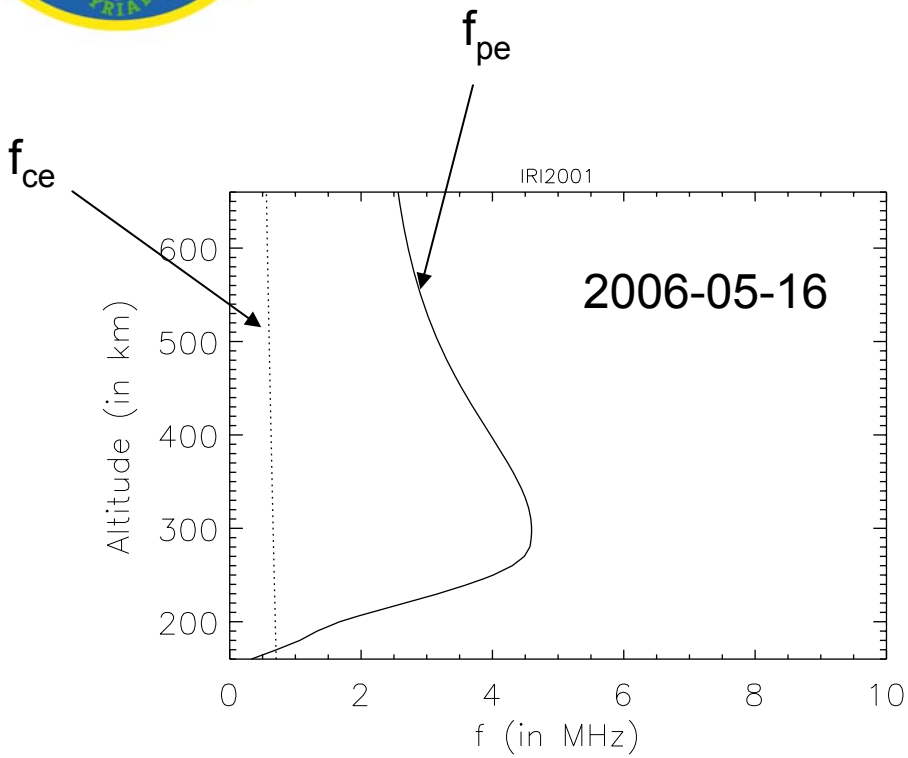
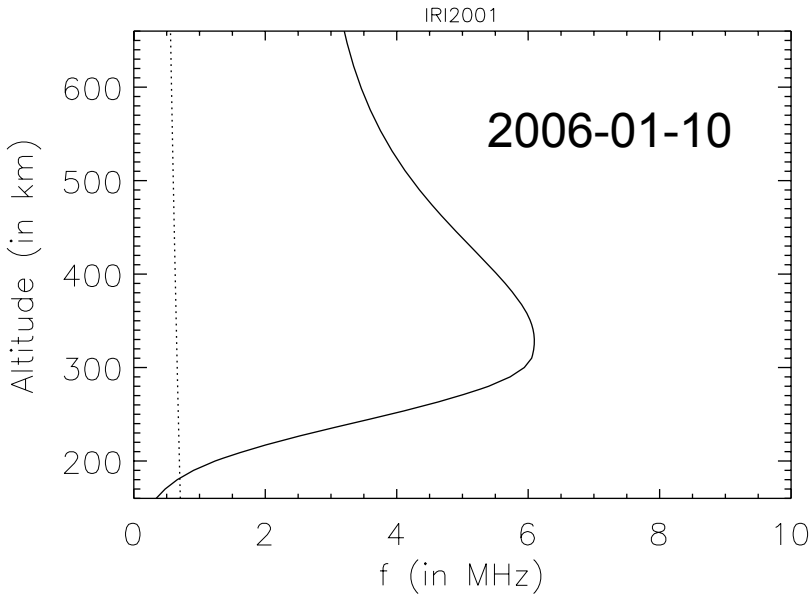
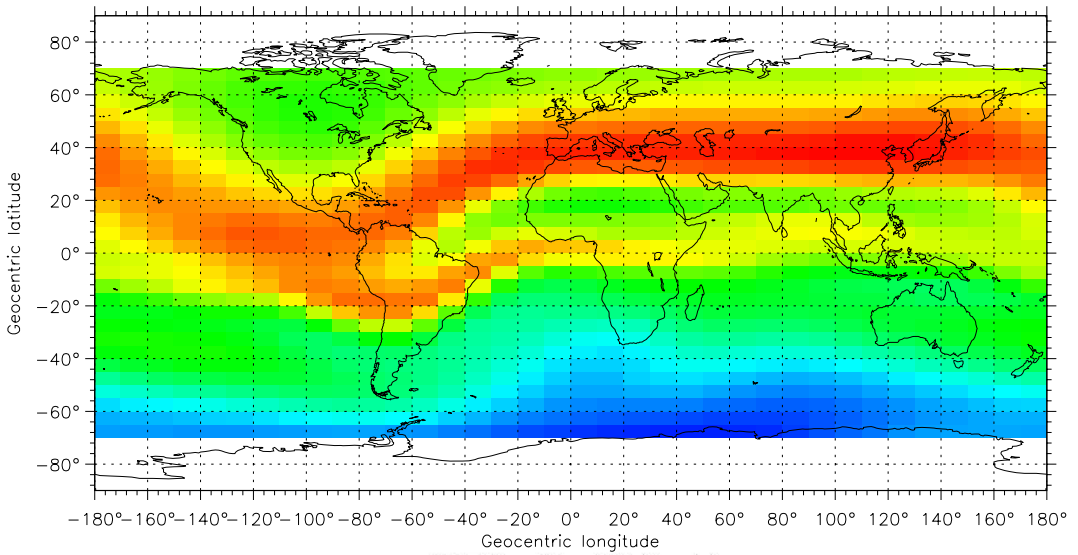
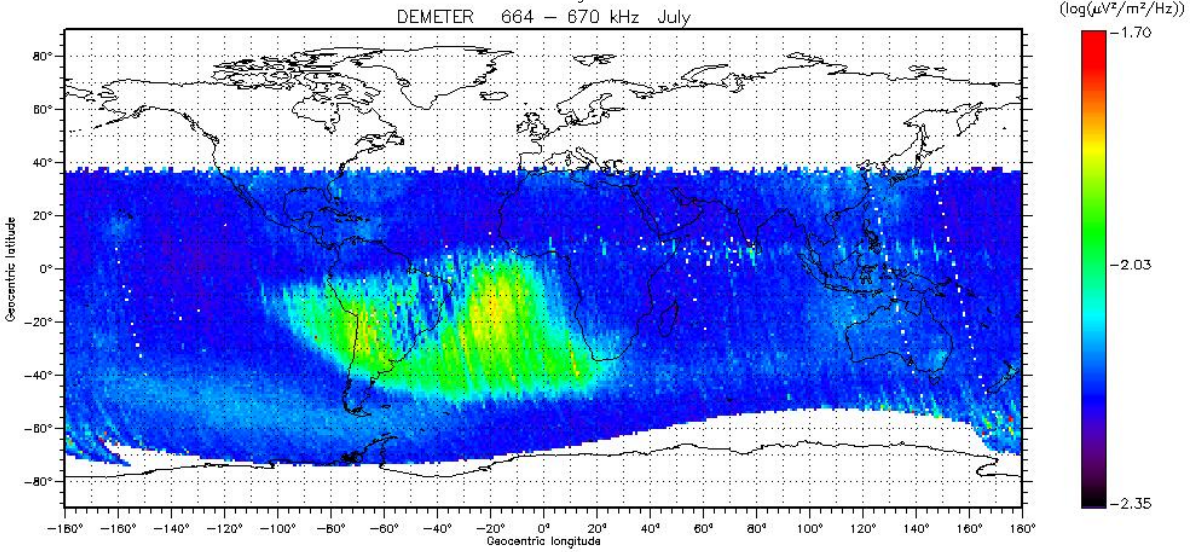
Night time – Position: Lat -10°, Long 340°



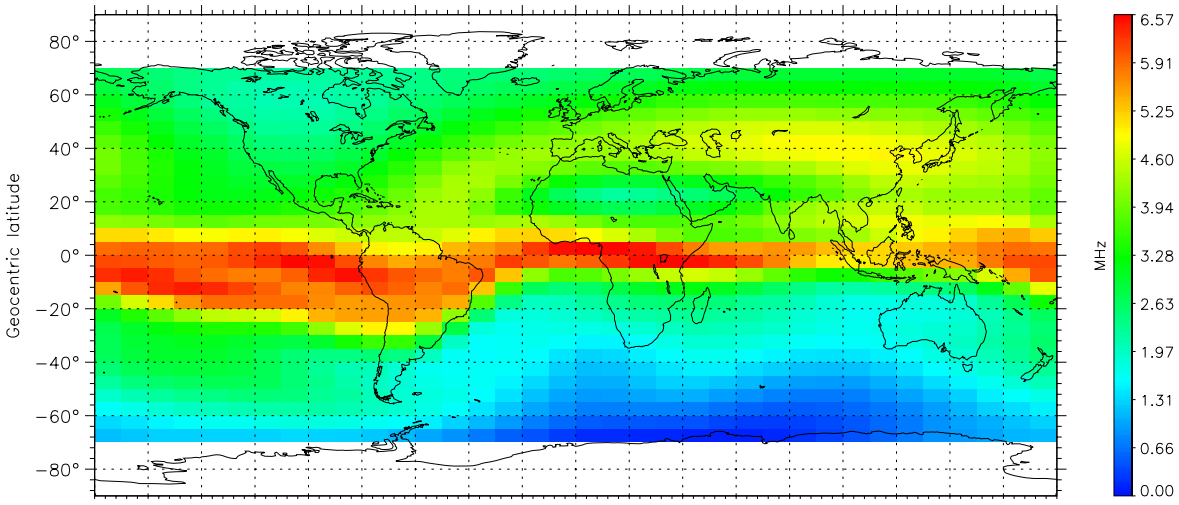


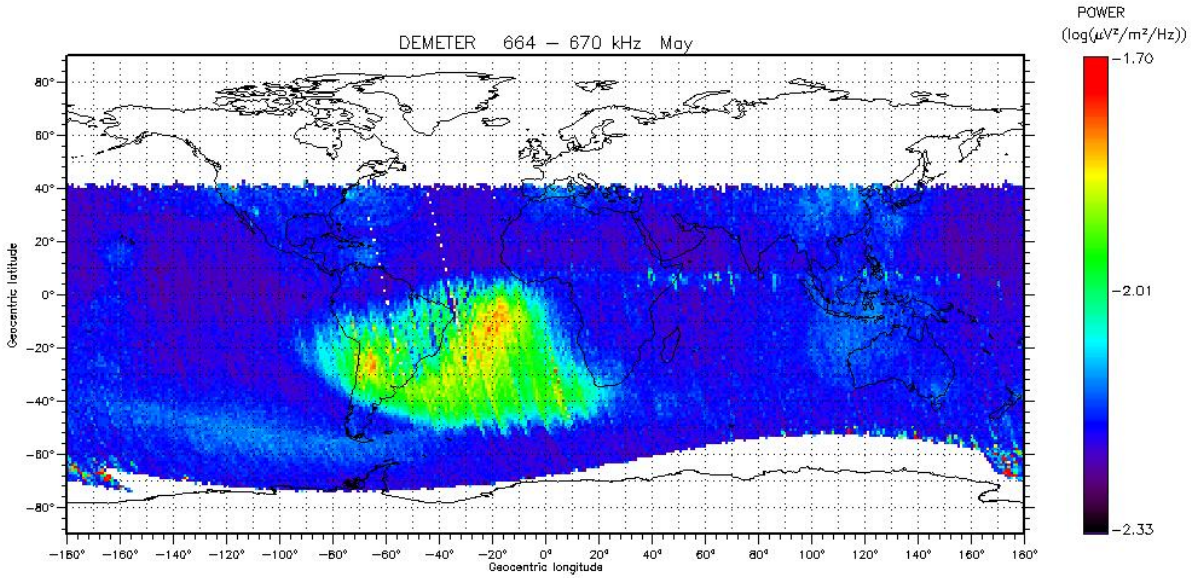
Critical frequency of the F layer at 22.30 LT – July



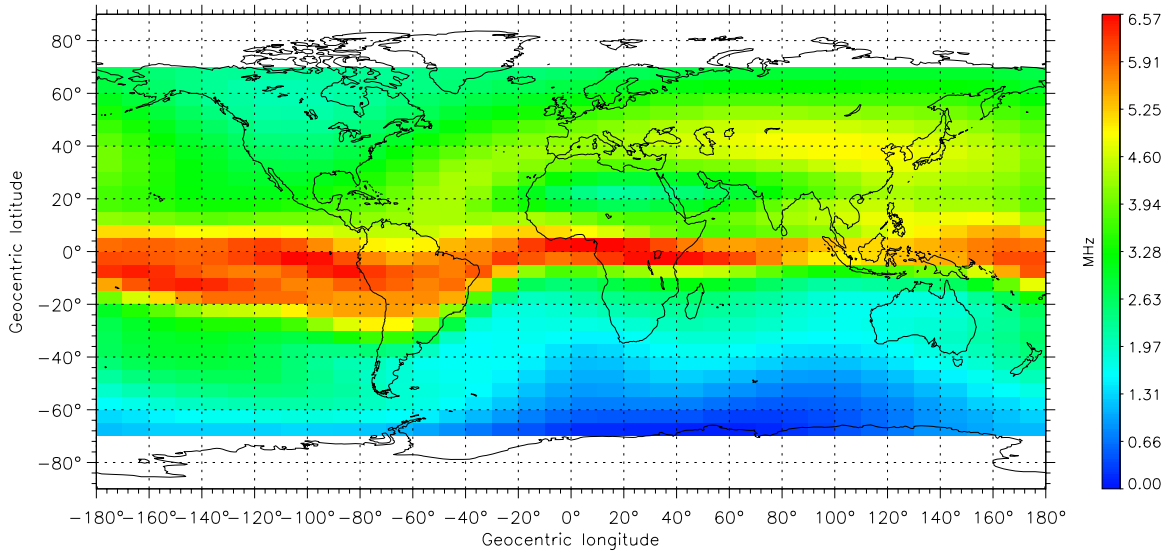


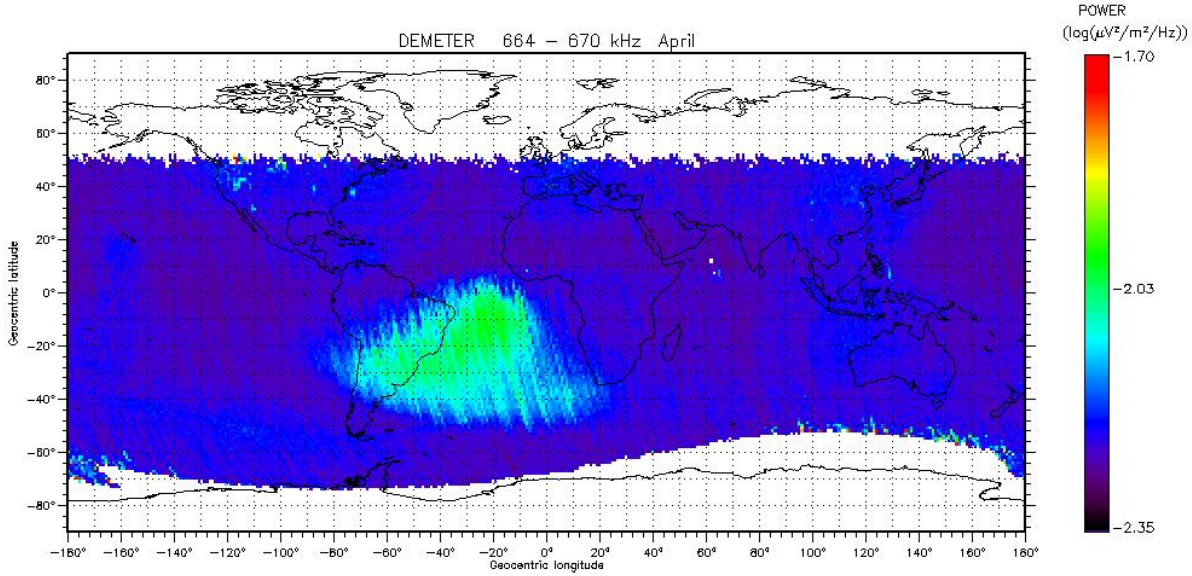
Critical frequency of the F layer at 22.30 LT – May



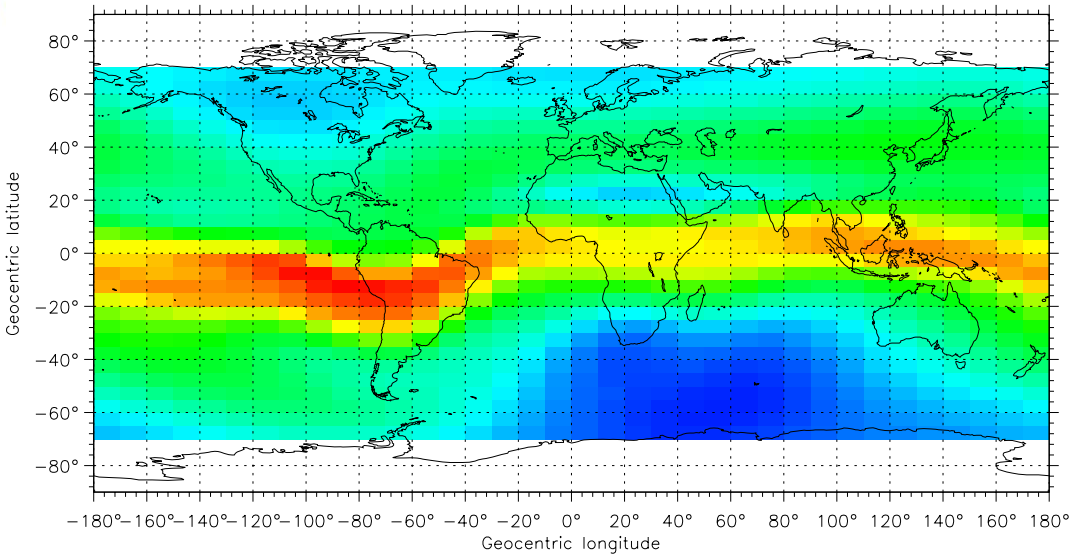


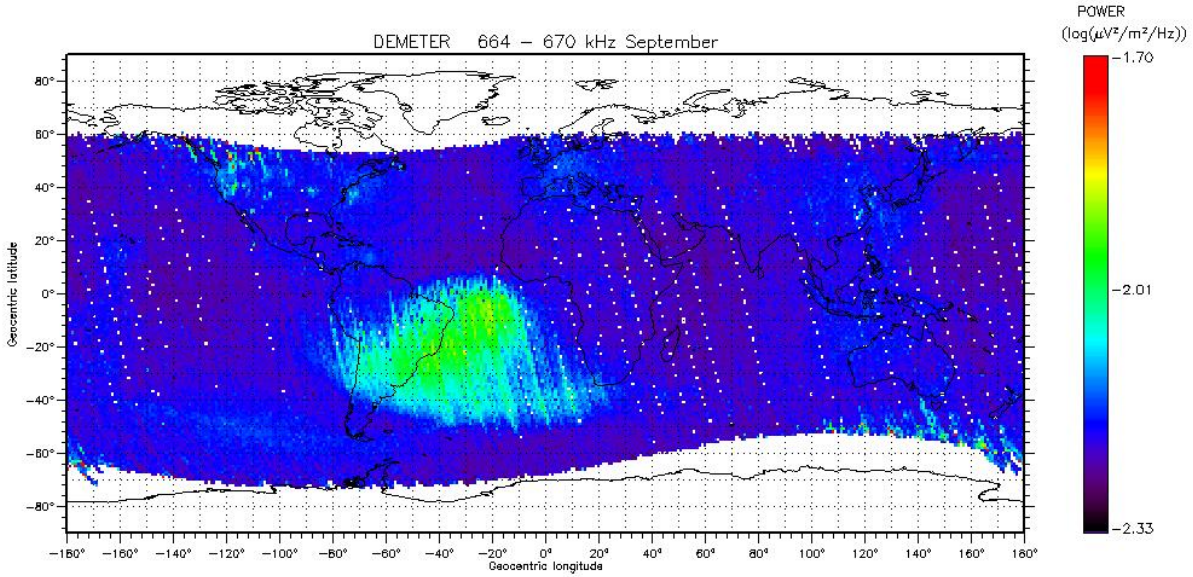
Critical frequency of the F layer at 22.30 LT – April





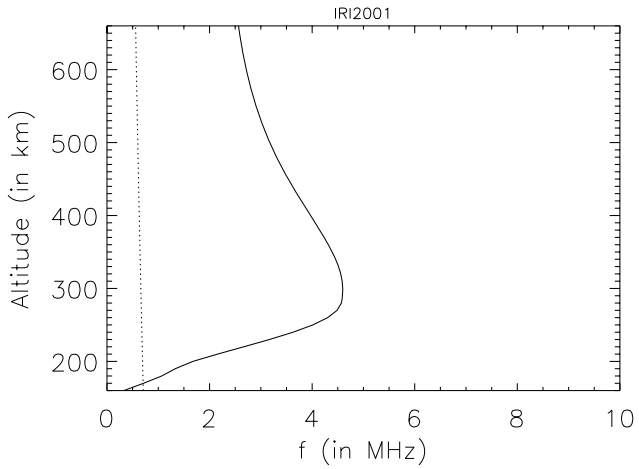
Critical frequency of the F layer at 22.30 LT – Sept





Whistler mode emissions

The whistler mode has an upper frequency limit at f_{ce} or f_{pe} whichever is lower.



Z mode emissions

2 cases:

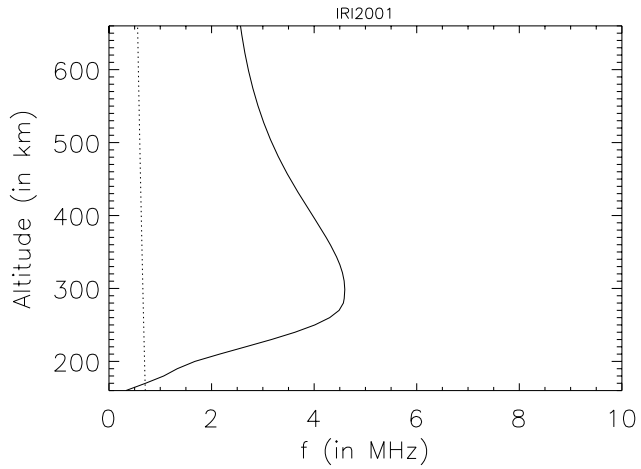
- $f_{pe} > f_{ce}$

The emission is observed in the range $f_{pe} < f < f_{uh}$

- $f_{pe} < f_{ce}$

The emission is observed in the range $f_z < f < f_{ce}$

where $f_z = [(f_{ce}/2)^2 + f^2_{pe}]^{1/2} - f_{ce}/2$



Z mode emissions

- Generation mecanism is generally attributed to Cyclotron Maser Instability which predicts a wave generation close to f_{ce} (see Labelle & Treumann, 2002).
- For example Omidi et al. (1984) find a generation at $f < f_{ce}$ and their mecanism shows that the waves cannot access the region where $f > f_{ce}$.
-If the emission is below the F layer, to reach the satellite the waves are very attenuated. Only the most powerful emission close to f_{ce} could be observed.

Conclusions

- A narrow frequency band (660 – 680 kHz) emission is observed over the SAA at an altitude of 660 km.
-This frequency roughly corresponds to a value <~ f_{ce} below the satellite altitude, and the surface of observation is limited to an area where f_{ce} < 670 kHz.
-The fadding of the emission during summer suggests that the generation occurs below the ionospheric levels where the plasma density is high (i.e. at a location where f_{pe} < f_{ce}).
- It is hypothesized that it is a Z mode emission which is due to drifting energetic particles which continuously precipitate into the SAA ionosphere (the mirror heights over the SAA fall to ~ 100 km in altitude).