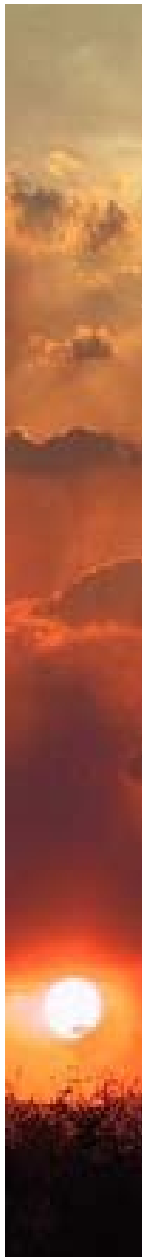
Australian Government
Bureau of Meteorology

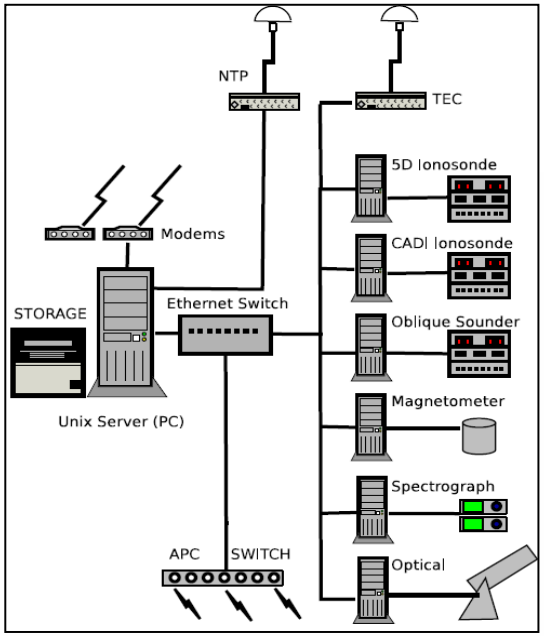


The Australian region space weather network

Richard Marshall

IPS Radio and Space Services
Bureau of Meteorology

IPSNET - space weather sensor network



Cocos Island

Solar Observatory
Ionosonde
Magnetometer
Riometer
TEC
Scintillation
Pulsation
Spectrograph
Internet Access
Dialup
Direct link
Station Closed

Vanimo
Port Moresby
Darwin
Weipa
Townsville
Learmonth
Brisbane
Perth
Culgoora
Canberra
Sydney
Hobart

Niue Is

Norfolk Is

Lord Howe Is

Christchurch

Mawson
Davis
Casey

Macquarie Island

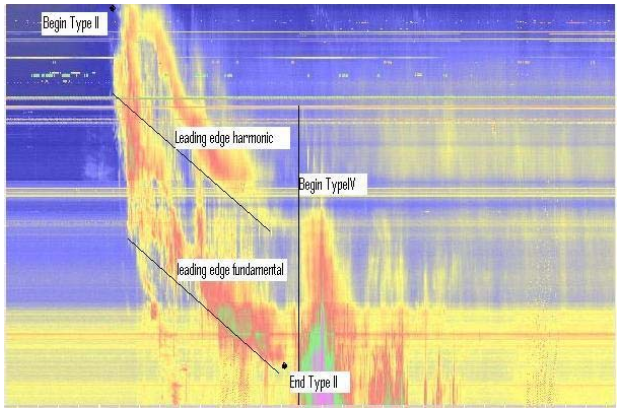
Scott Base

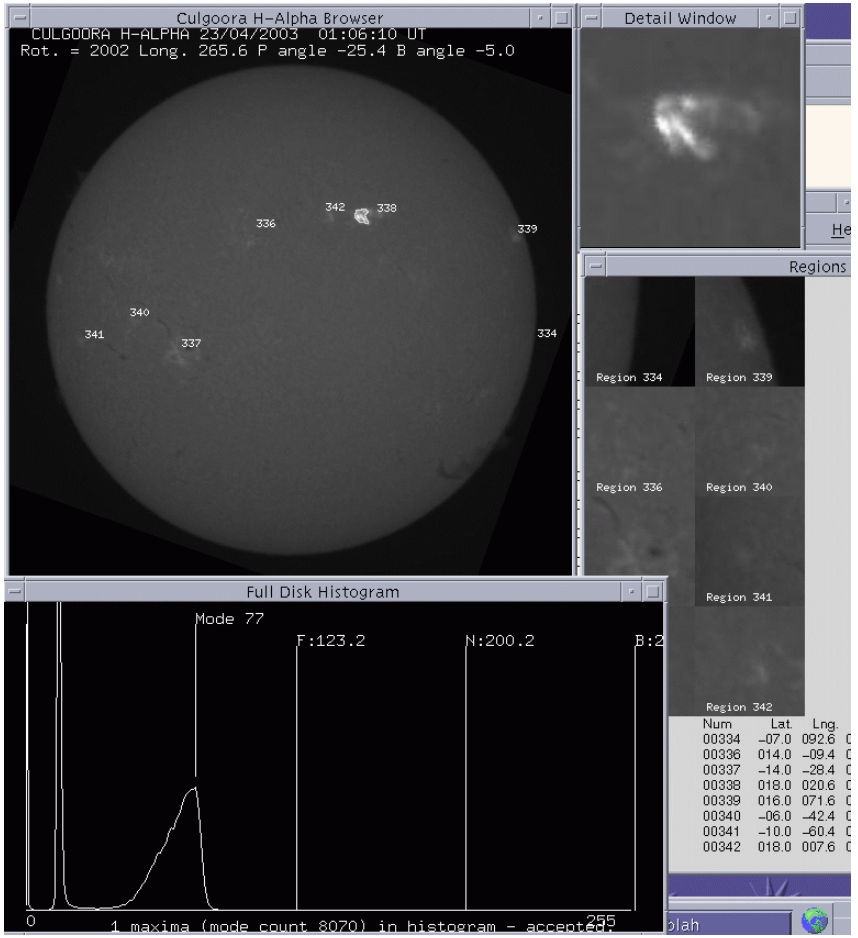
Culgoora Solar Observatory

Culgoora
Radio quiet zone Next to CSIRO ATNF.
No transmissions. Excellent radio reception site.

Solar radio and optical
Magnetometers (IPS & MAGDAS)
Oblique HF radio Rx from NZ and TVL

Spectrograph 18-1800MHz





Learmonth Solar Observatory

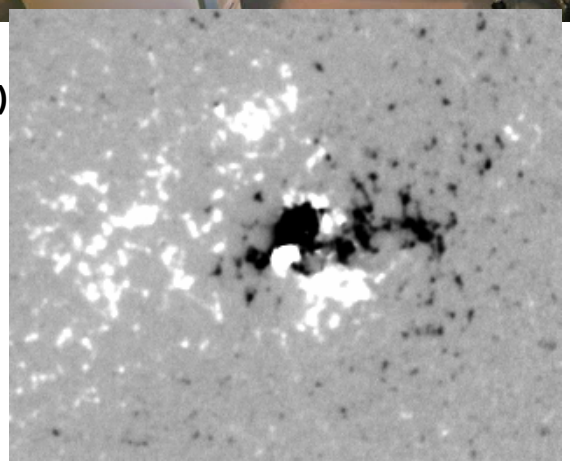
Learmonth

RSTN – Radio Solar Telescope Network

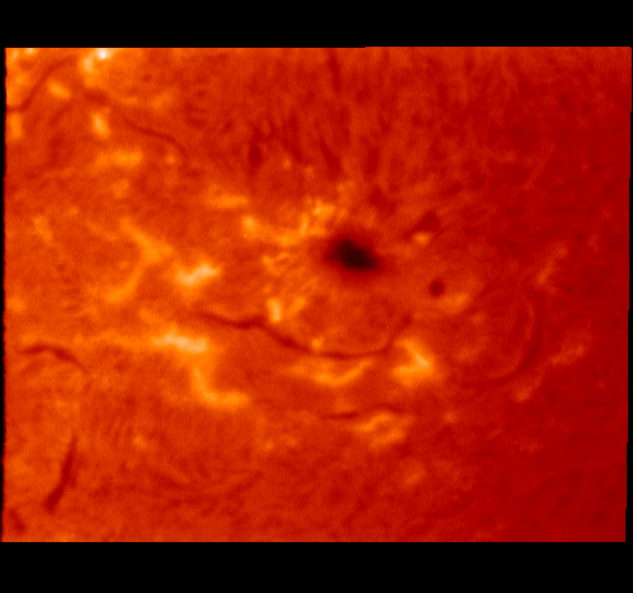
Cover from 25 MHz to 15.4 GHz
3 parabolic antennae
8 fixed frequencies (245, 410, 610, 1415, 2695, 4995, 8800, 15400 MHz)

Solar Radio Spectrograph (designed by IPS) sweeps from 25 to 180 MHz – fed by semi-bicone (low band) and tracking log periodic (high band) antennae.

Operation from sunrise to sunset



IPSNET Observatories



Flare Forecast

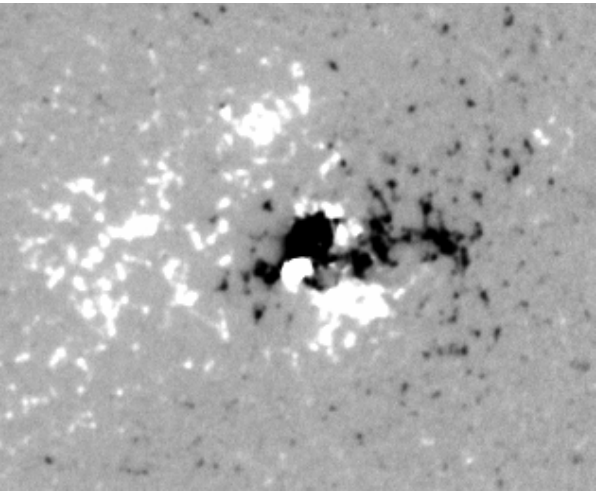
SOLAR DAILY FLARE FORECAST (>= M class) from LEARMONTH SPOTS SUMMARY 0120 UT ON 22/06/04

RGN#	Class	Rate	Prob
0632	HAX	0.11	10.0%
0634	FAO	1.48	77.3%
0635	FAI	1.56	78.9%
0636	BXO	0.01	1.0%
0637	AXX	0.02	1.8%

Total regions = 5, Flare Rate = 3.2/day

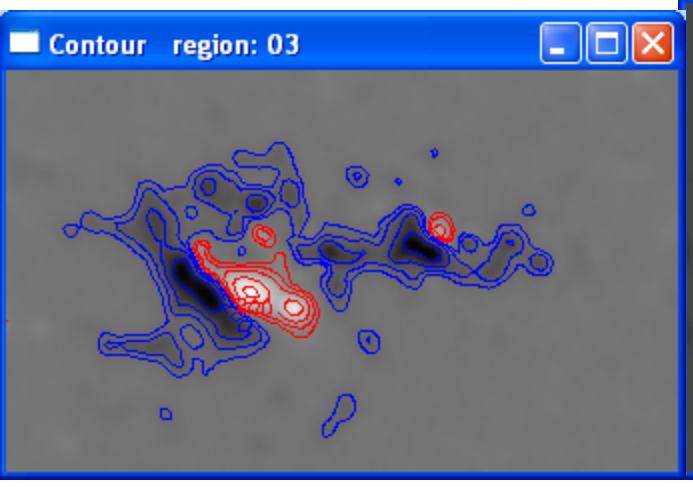
Daily flare probability = 95.8%

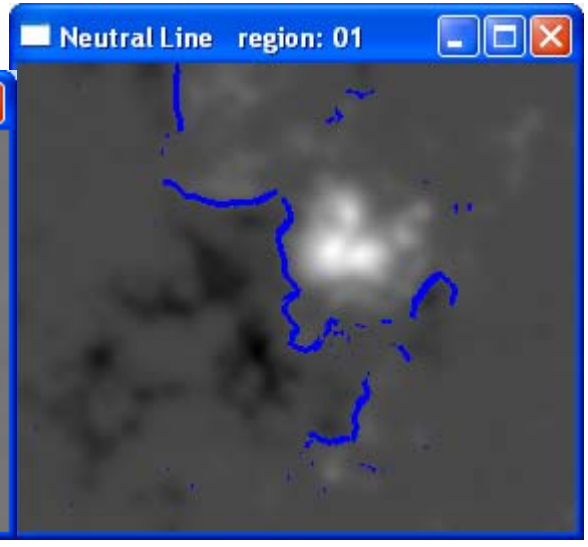
(McIntosh, P.S. 1990, Sol Phys., 125,251)

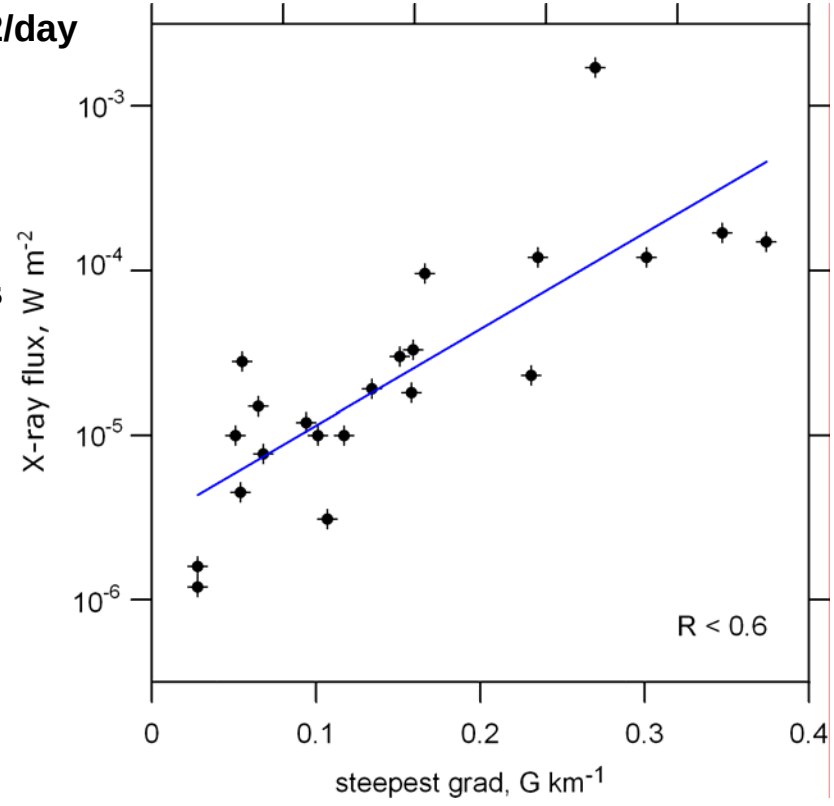


Max Gradient

- **0.025 - 0.09 – possible C-flares**
- **0.09 - 0.25 – possible C and M-flares**
- **> 0.25 – possible C, M, and X-flares**

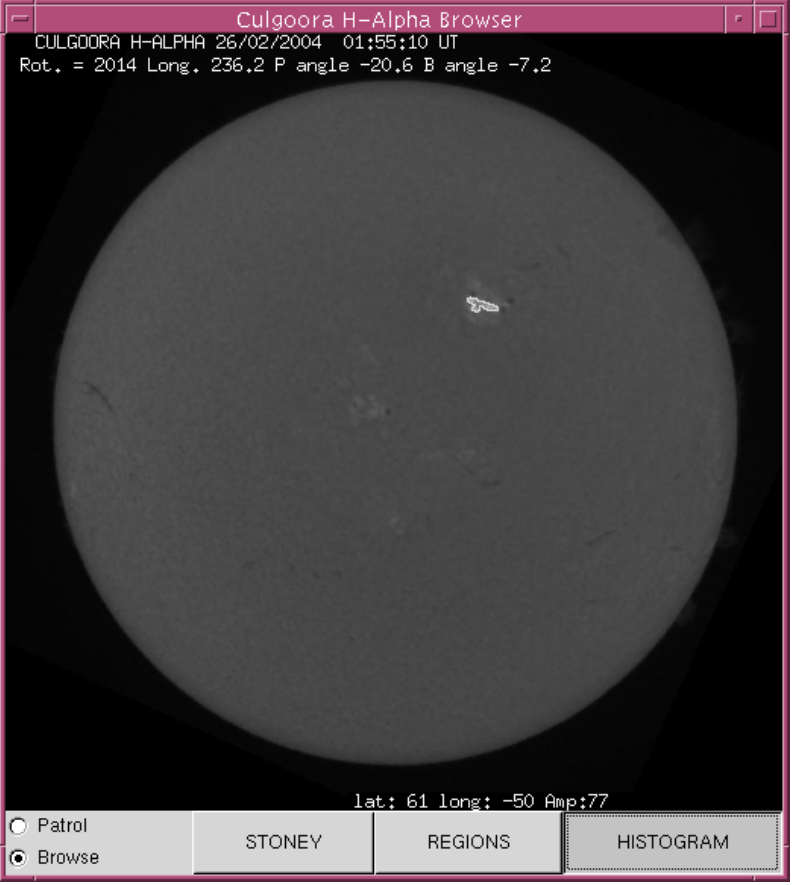


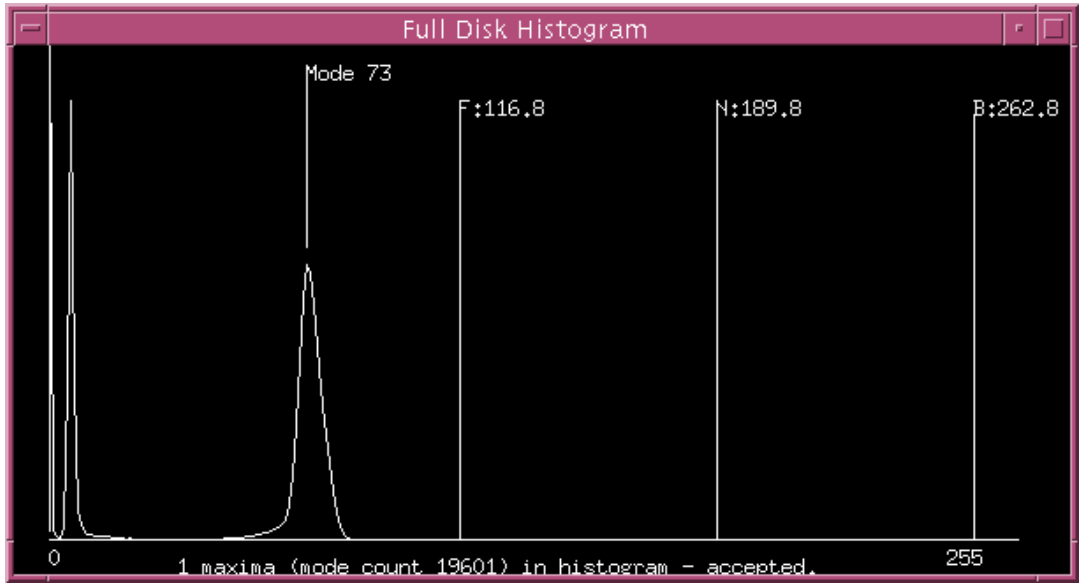




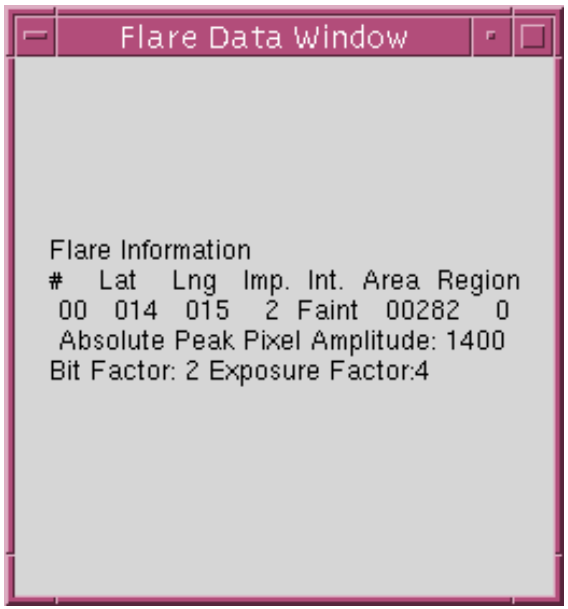
Steward et al., (to be published)

Flare Alert





(G.Patterson)



IPS XRAY AND OPTICAL FLARE CORRELATION –PART D ISSUED AT 0245 UT on 26 Feb 2004 BY IPS RADIO AND SPACE SERVICES FROM THE AUSTRALIAN SPACE FORECAST CENTRE

Optical flares with maximum within 10 minutes of X-ray maximum are correlated.

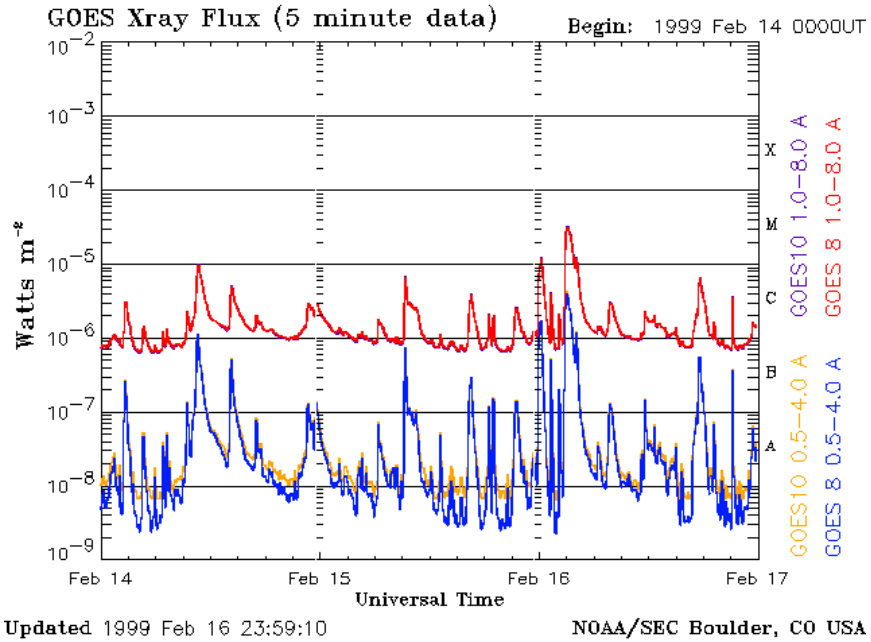
Approximate xray flare maximum 26 2 2004 0204 UT at Flux X1.1

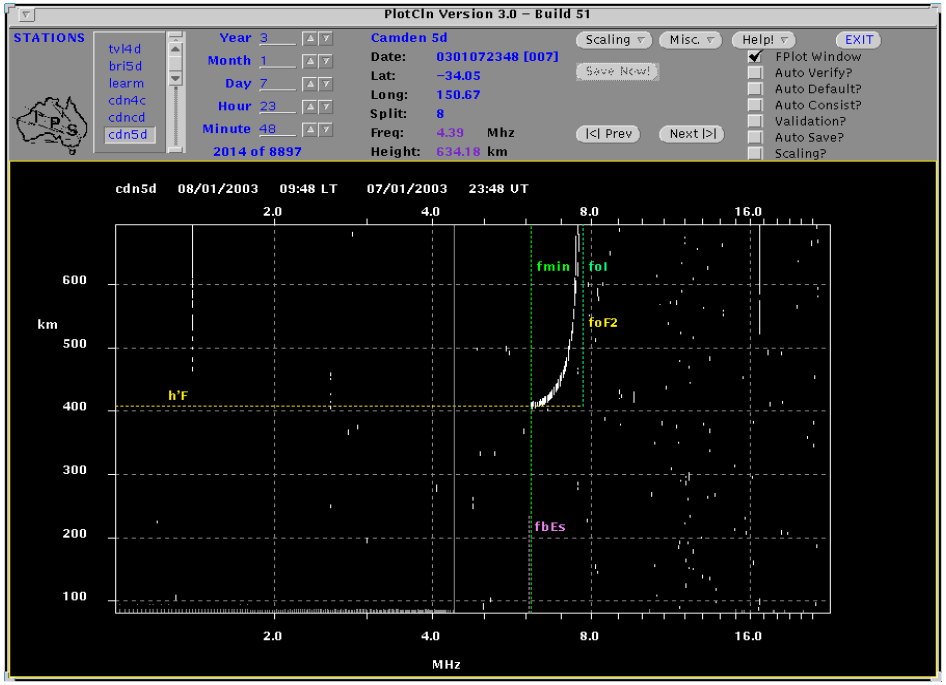
Xray flare possibly optically correlated with the following H-alpha flare auto-detected at IPS Culgoora Solar Observatory:

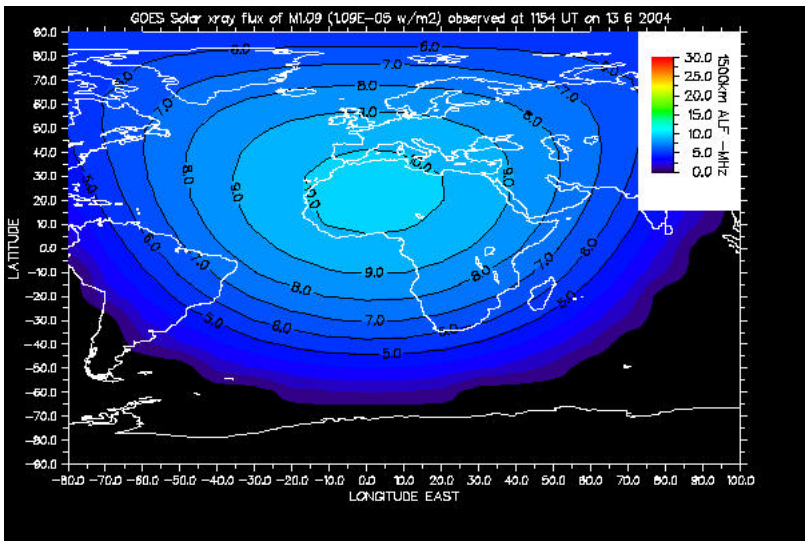
Start date/time	Max date/time	End date/time
26 02 2004 01:55UT	26 02 2004 01:59UT	26 02 2004 02:41UT

Lat	Long	Imp.	Bright.	Area	SEC Region Num
014	014	2	Bright	00485	564

HF SWF Alert







IPS FADEOUT ALERT - PART A FOR HF FADEOUTS AFFECTING THE AUSTRALIAN REGION ISSUE TIME: Thu Feb 26 13:00:24 EST 2004

++

A HF FADEOUT IS NOW UNDERWAY IN PART OF THE AUSTRALIAN REGION. MORE DETAILS OF THE TIMING AND EXTENT OF THIS EVENT WILL BE ISSUED JUST AFTER IT ENDS.

++

Follow the progress of this event on the IPS Web site http://www.ips.gov.au Click "Space Weather" Click "X-Ray Flux"

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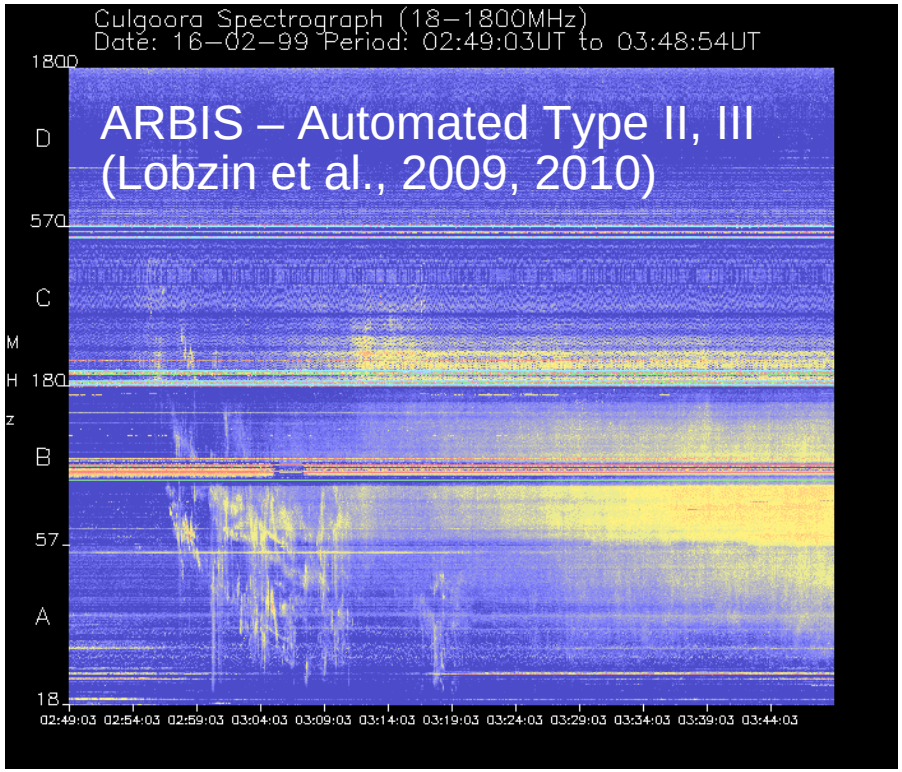
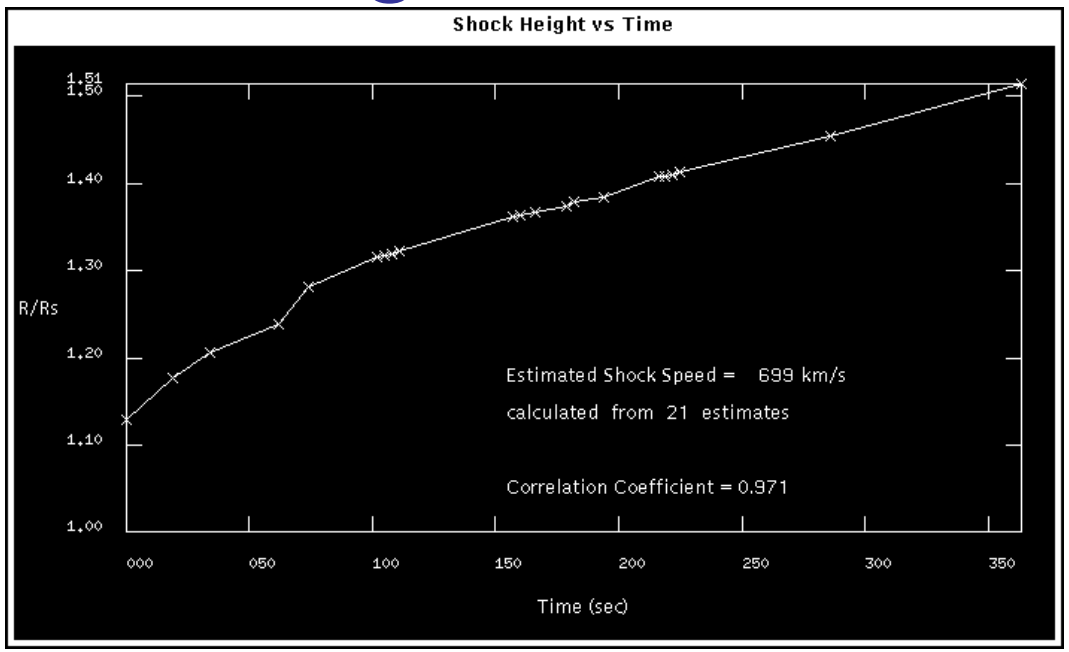
Australian Space Forecast Centre IPS Radio and Space Services (61)(2)9213 8010 (phone) (61)(2)9213 8061 (fax) asfc@ips.gov.au

++

CME Warning





PLAIN PRESTO CULGOORA 03/0131UT NOV 2003

Shock Details

Type II Radio Burst Type
Fundamental

#	Time sec	Freq MHz	Ne	Height Rsun
0	0	159	2.820	1.13
1	19	133	1.964	1.18
2	34	120	1.604	1.21
3	62	108	1.298	1.24
4	74	94	0.993	1.28
5	102	85	0.811	1.32
6	105	85	0.801	1.32
7	108	85	0.797	1.32
8	111	84	0.778	1.32
9	157	75	0.626	1.36
10	160	74	0.618	1.36
11	166	74	0.610	1.37
12	179	72	0.586	1.37
13	182	72	0.574	1.38
14	194	71	0.554	1.38

SOLAR RADIO EVENT 1: DRIFTING: 200 - 30 MHZ

START TIME: 0124 UT

END TIME: 0129 UT

SPECTRAL TYPE: TYPE II BURST

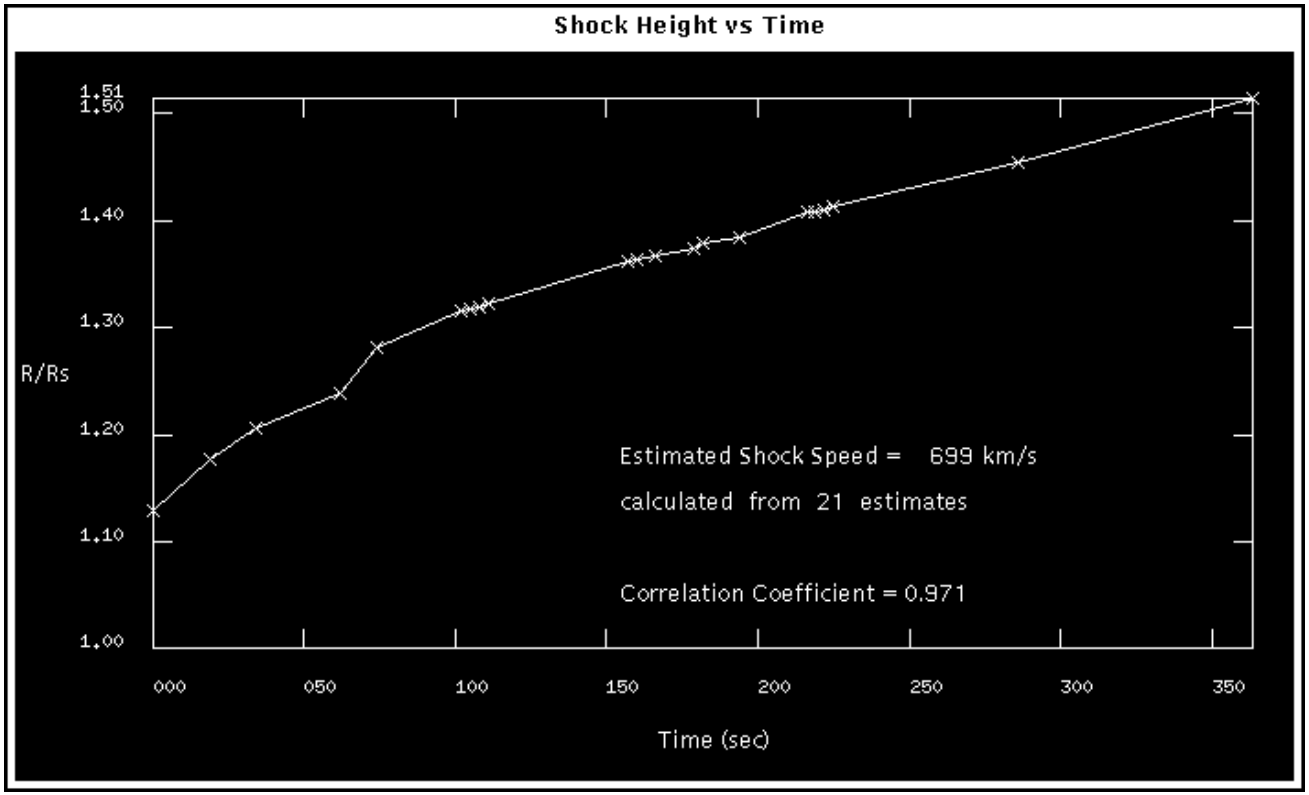
IMPORTANCE: STRONG

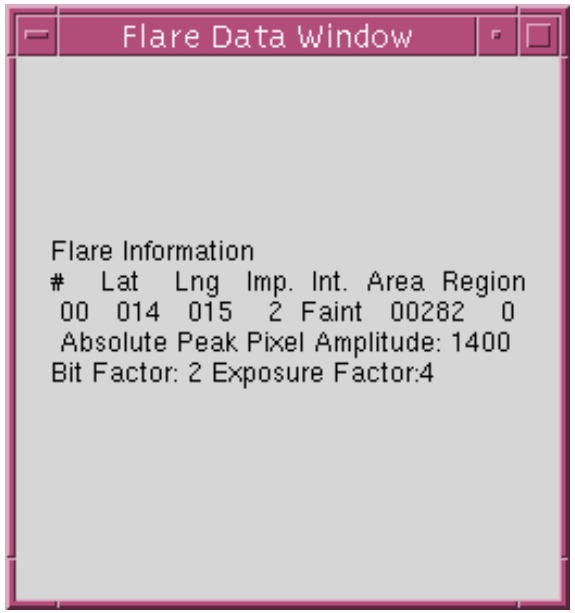
FUNDAMENTAL AND HARMONIC VISIBLE

ESTIMATED SHOCK SPEED 699 KM/S

FLARE OBSERVED IN REGION 10488 SHORTWAVE FADEOUT OBSERVED

Geomagnetic Storm Warning





SUBJ: IPS GEOMAGNETIC DISTURBANCE WARNING 02/46 ISSUED AT 23/0107Z DECEMBER 2002 BY THE AUSTRALIAN SPACE FORECAST CENTRE.

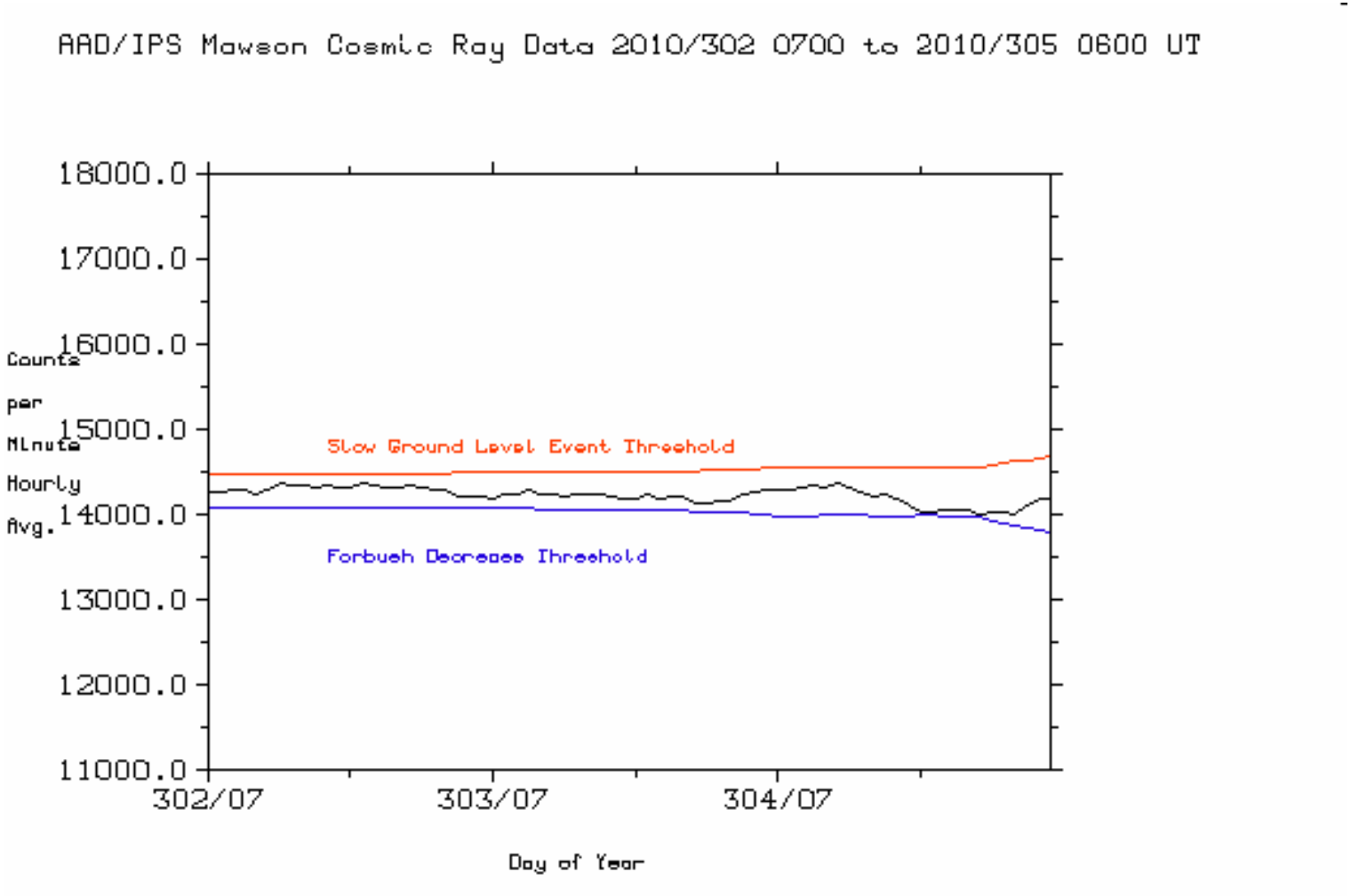
INCREASED GEOMAGNETIC ACTIVITY EXPECTED DUE TO CORONAL MASS EJECTION FROM 23-24 DECEMBER 2002

GEOMAGNETIC ACTIVITY FORECAST

23 Dec: Active to minor storm periods.

24 Dec: Active

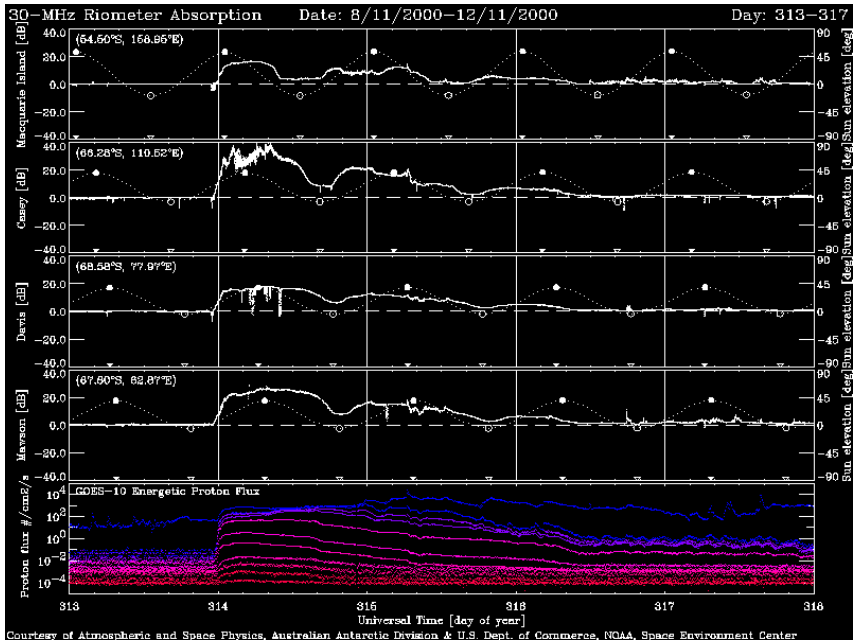
CME Alert



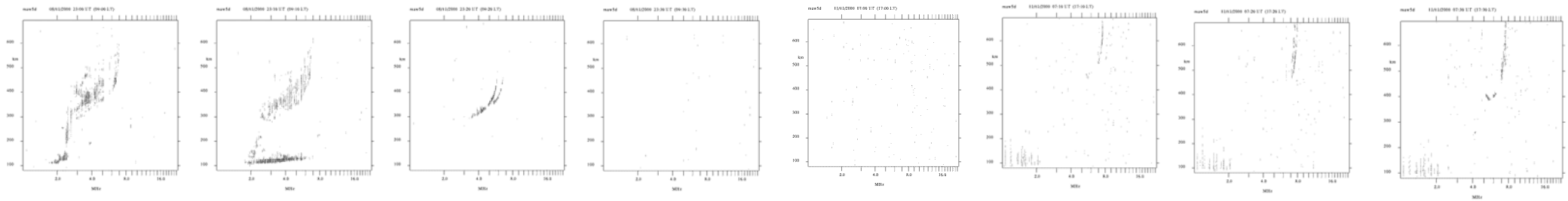
Last updated 01 Nov 2010 07:30 UT

Forbush Decrease Observed (3%) at MAW 05/04/2010 DOY: 95 Hour: 17UT
Forbush Decrease Observed (3%) at MAW 04/08/2010 DOY: 216 Hour: 04UT

PCA Alert



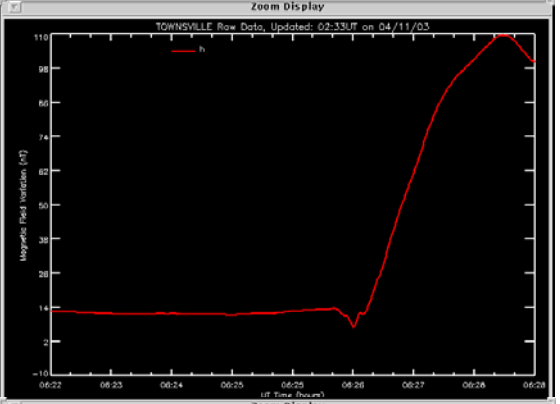
$$A(dB) = 10\log_{10}(A_{qdc}/A_{day})$$

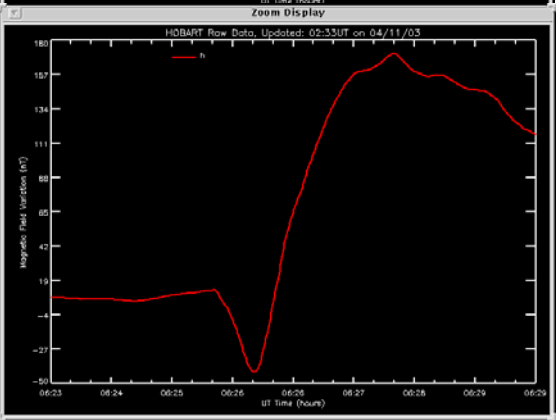


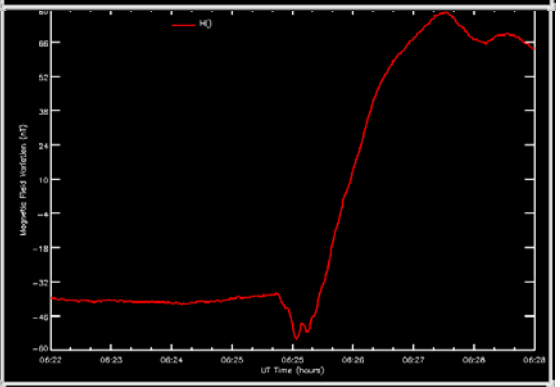
10Mev Proton/PCA Event Began 31 05 2003 0505UT and is in progress

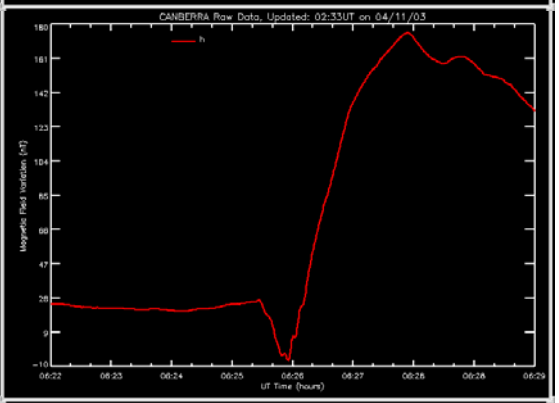
Casey 30Mhz Riometer Data at time of Issue: Casey 1.9 dB

IPS Radio and Space Services | **email: asfc@ips.gov.au**
PO Box 1386 | **WWW: http://www.ips.gov.au**
Haymarket NSW 1240 AUSTRALIA | **FTP: ftp://ftp.ips.gov.au**
tel: +61 2 9213 8010 | **fax: +61 2 9213 8060**









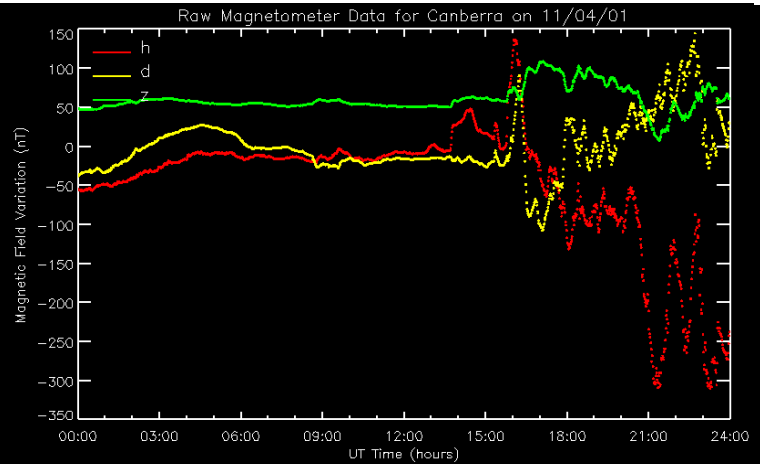
SSC/SI Alert

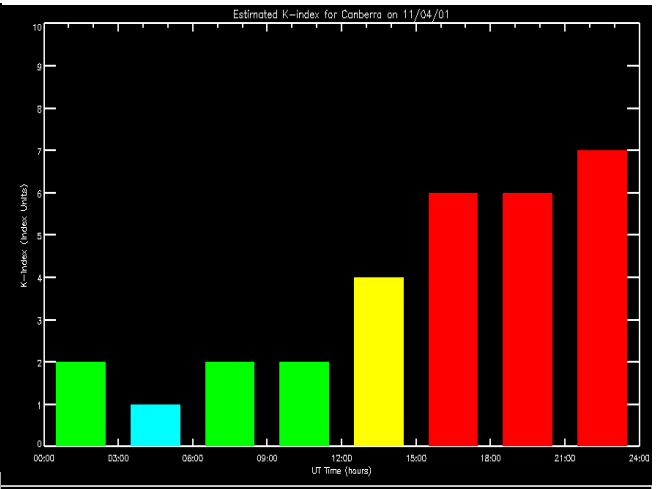
MODERATE SUDDEN IMPULSE DETECTED (87nT)
IN IPS MAG DATA 04 11 03 0626UT

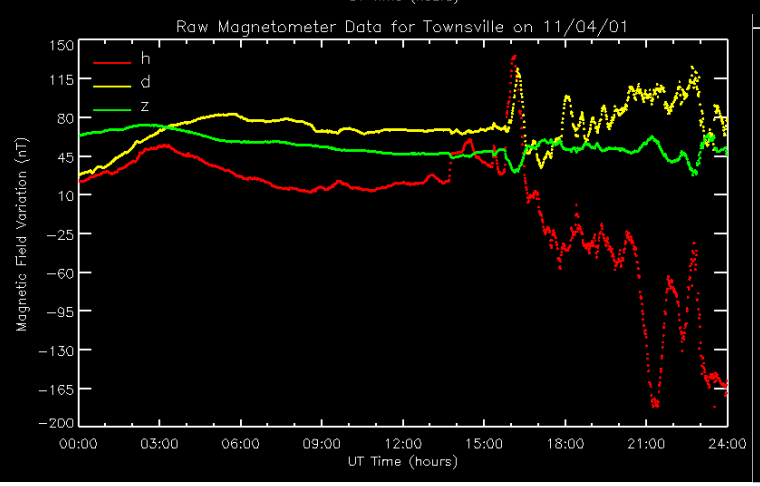
Mean Mag Parameters Pre/Post Impulse:

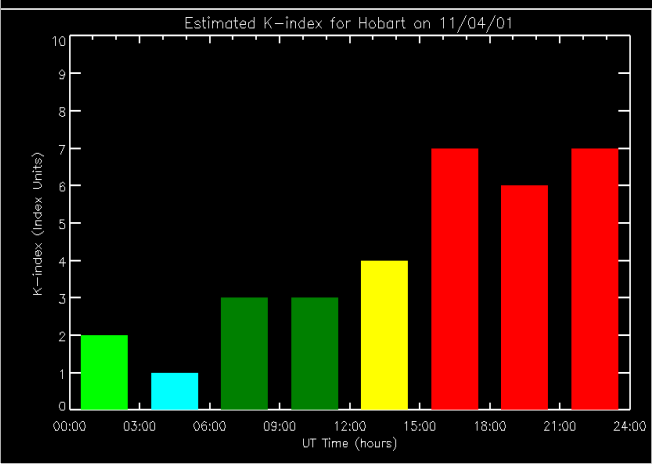
Stn	Unit	Pre Impulse	Post Impulse	Change
Hbt	nT	15.0	118.9	103.9
cbr	nT	29.1	131.7	102.5
tvl	nT	17.0	69.6	52.6
lem	nT	43.2	130.4	87.2
clg	nT	-34.4	54.7	89.1

Geomagnetic Storm Alert









Estimated Indices 05 Jun :

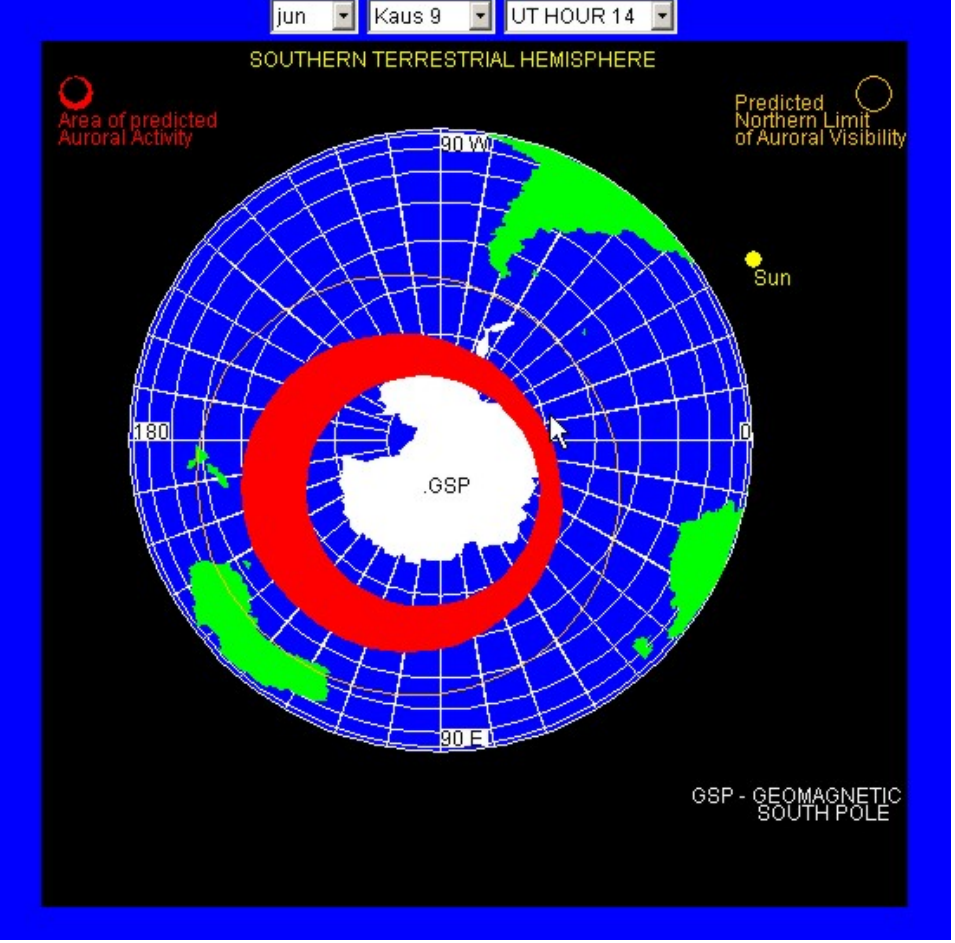
Darwin	**2222 1222**
Townsville	**1222 2222**
Learmonth	**1212 2332**
Culgoora	**2211 2222**
Canberra	**-311 2223**
Hobart	**1211 2222**

Australian Region 2212 2222

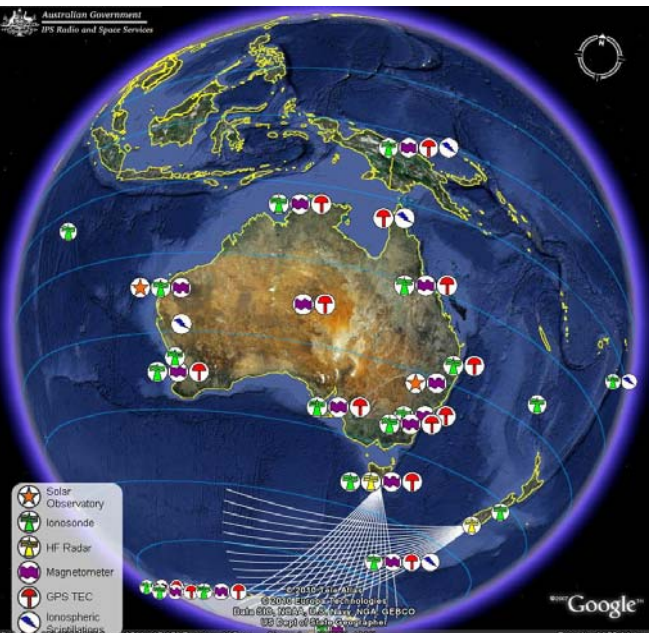
SUBJ: IPS GEOMAGNETIC DISTURBANCE ALERT

ISSUED AT 1716 UT ON 11 APR 2001 BY IPS RADIO AND SPACE SERVICES FROM THE AUSTRALIAN SPACE FORECAST CENTRE

SEVERE GEOMAGNETIC DISTURBANCE IN PROGRESS (K OF 7 REACHED)
PRELIMINARY AUSTRALIAN REGION K INDICES FOR 11 04 01: 2122 47--



Aurora Alert

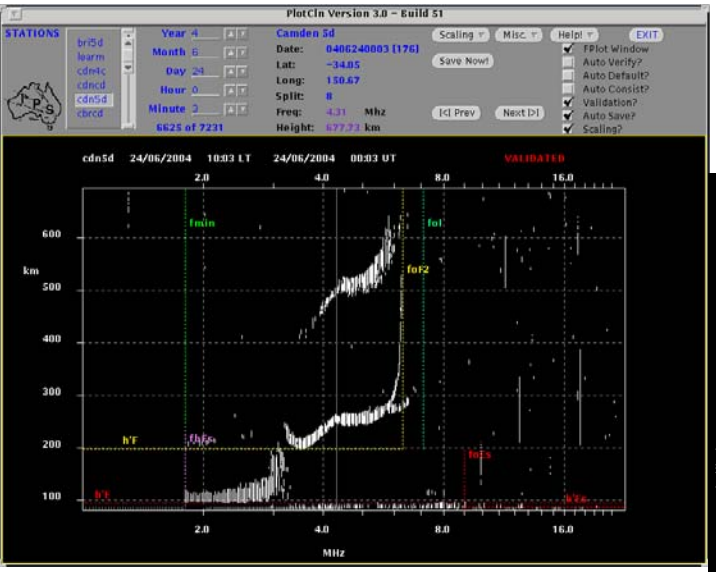


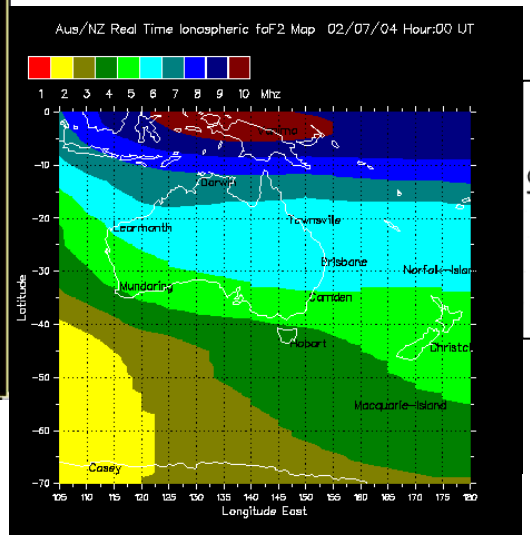
SUBJ: IPS AURORA ALERT ISSUED AT 1818 UT on 31 Mar 2001 BY IPS RADIO AND SPACE SERVICES FROM THE AUSTRALIAN SPACE FORECAST CENTRE

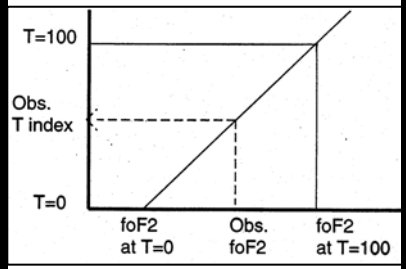
SEVERE GEOMAGNETIC STORM IN PROGRESS.

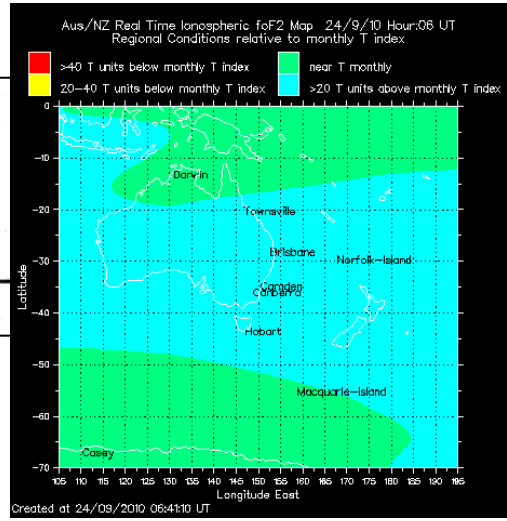
AURORA MAY BE OBSERVED DURING LOCAL NIGHT TIME HOURS IN GOOD OBSERVING CONDITIONS AT REGIONS AS FAR EQUATORWARD AS MIDDLE LATITUDES.

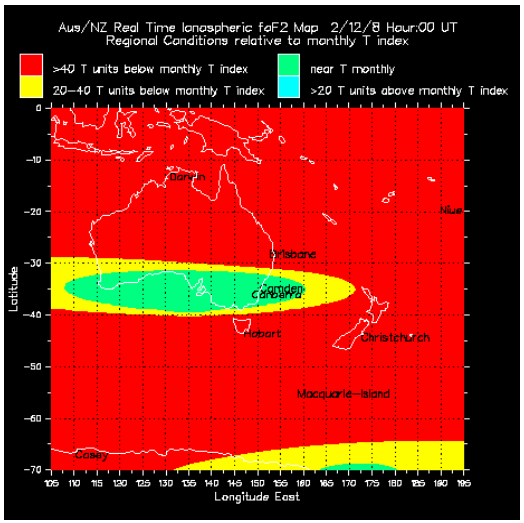
HF COMMS Warning

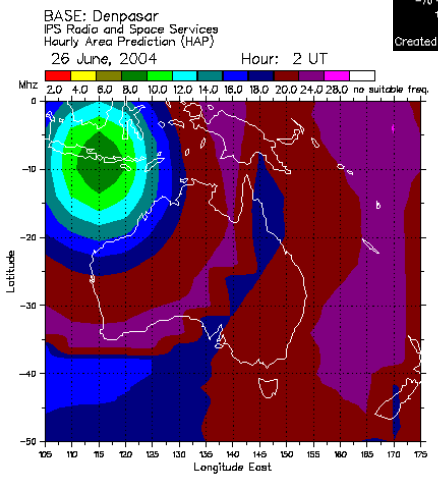










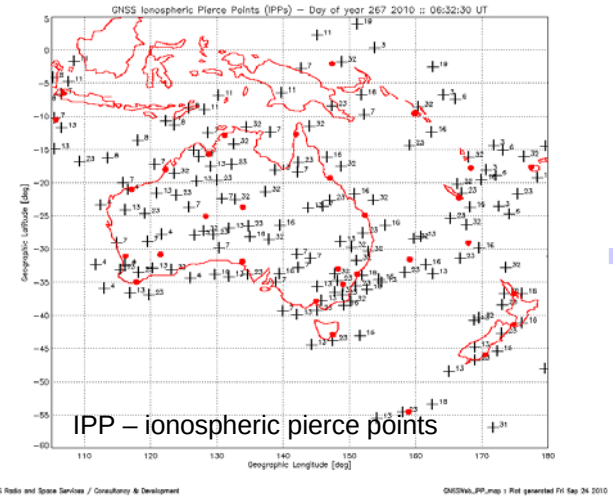


SUBJ: IPS HF RADIO COMMUNICATIONS WARNING 10/21 ISSUED AT 23/2354Z OCTOBER 2010 BY THE AUSTRALIAN SPACE FORECAST CENTRE. DEGRADED HF PROPAGATION CONDITIONS EXPECTED FOR 24 OCTOBER 2010
IF COMMS DIFFICULTIES EXPERIENCED TRY A LOWER FREQUENCY BAND

HF COMMUNICATIONS FORECAST (AUSTRALIAN/NEW ZEALAND REGION) FREQUENCY BANDS

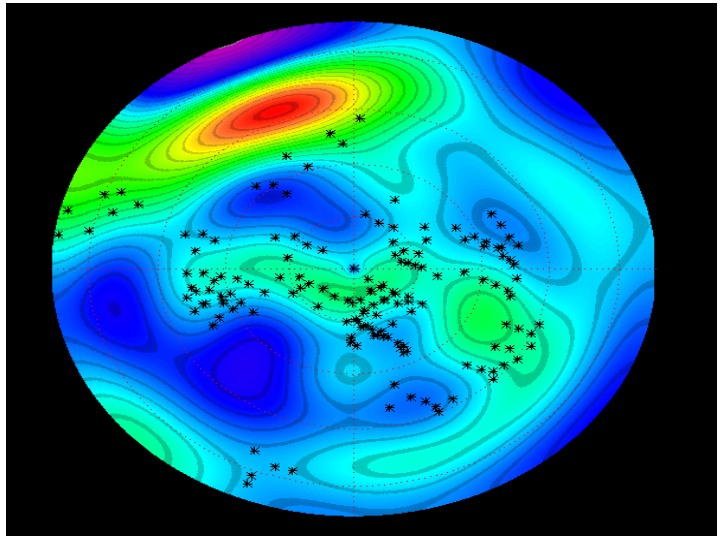
T-index	MUFs	2	4	6	8	12	16	22	26
-10	-22%	2	4	6	8	8	12	16	16

TEC Ionospheric Model



IPP – ionospheric pierce points

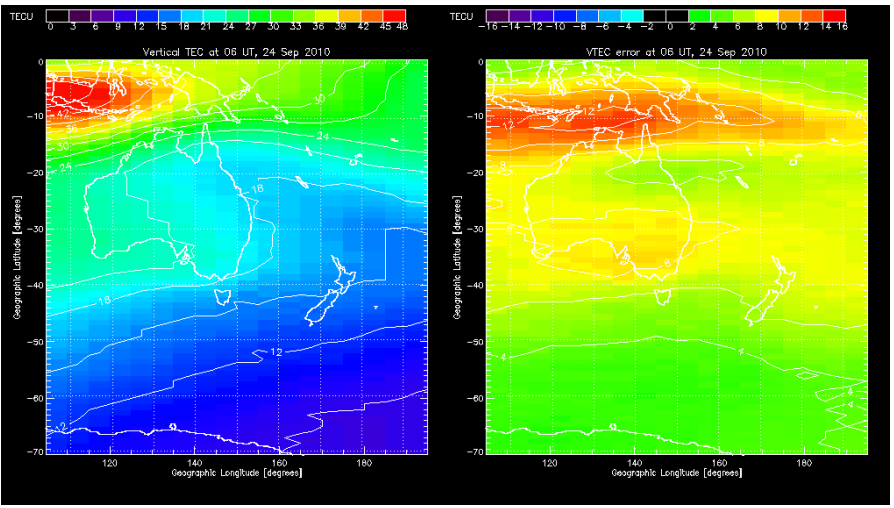
Input data QC
Kalman filtering



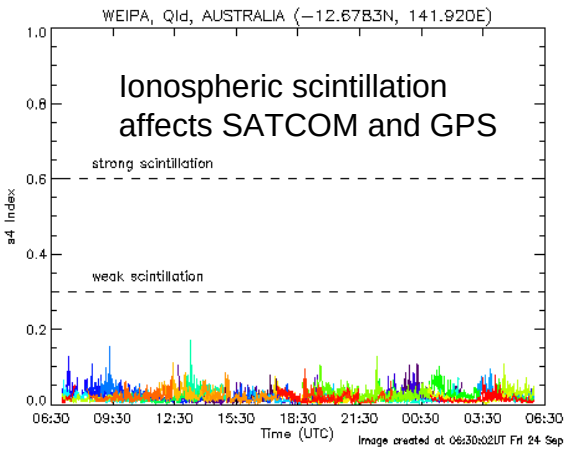
(M.Terkildsen, Z.Bouya and M.Francis)

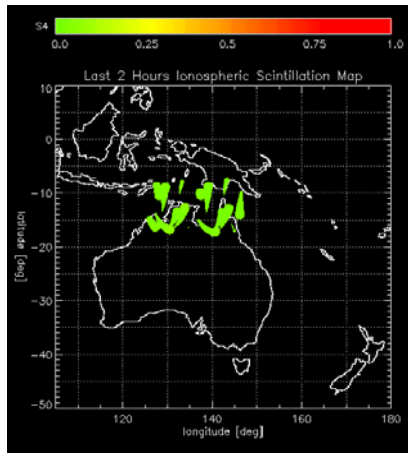
SCHA – spherical cap harmonic analysis of TEC
Legendre polynomial basis functions

$$TEC(\vartheta,\varphi) = \sum_{k=0}^{K\max}\sum_{m=0}^{k} P^{m}_{nk(m)_{(}}(\cos(\vartheta)[g^{m}_{k}\cos(m\varphi) \quad + h^{m}_{k}\sin(m\varphi)$$

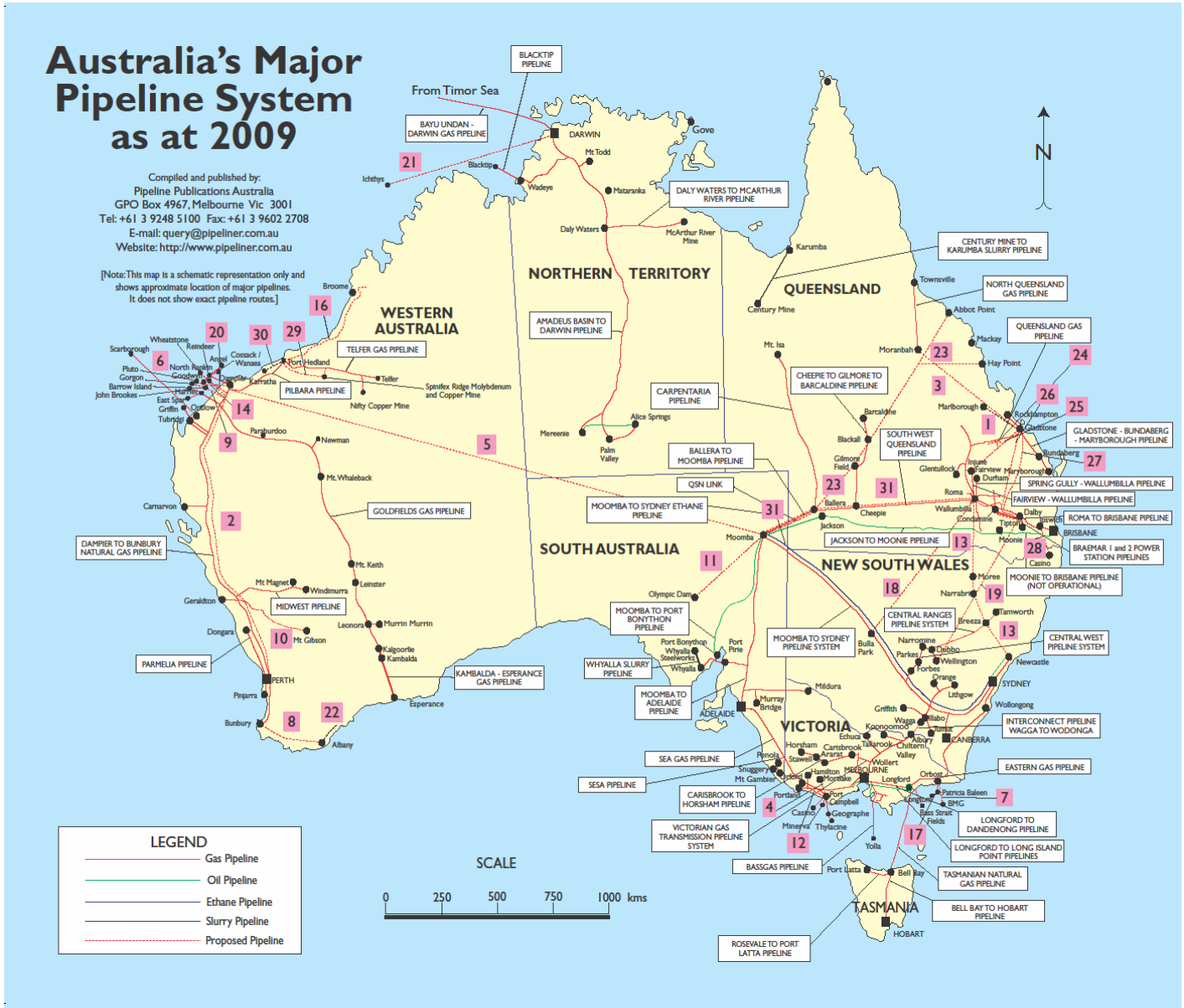


Plasmasphere model
Klobuchar model



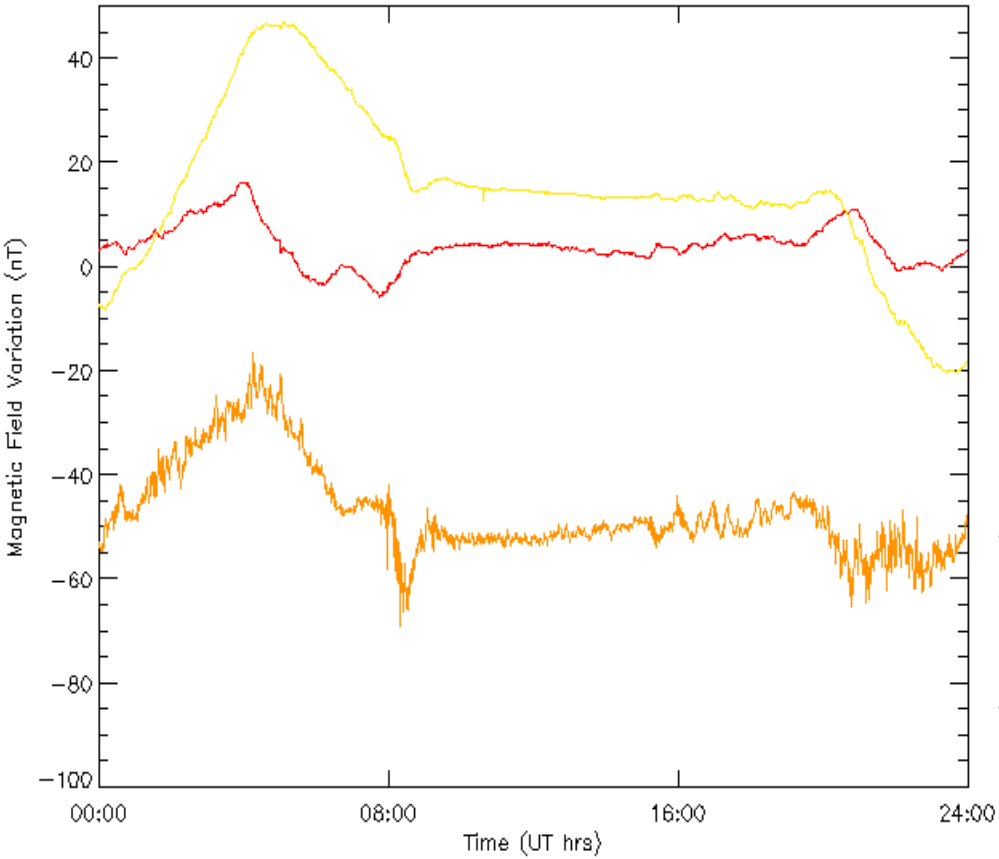


GICs in Pipelines

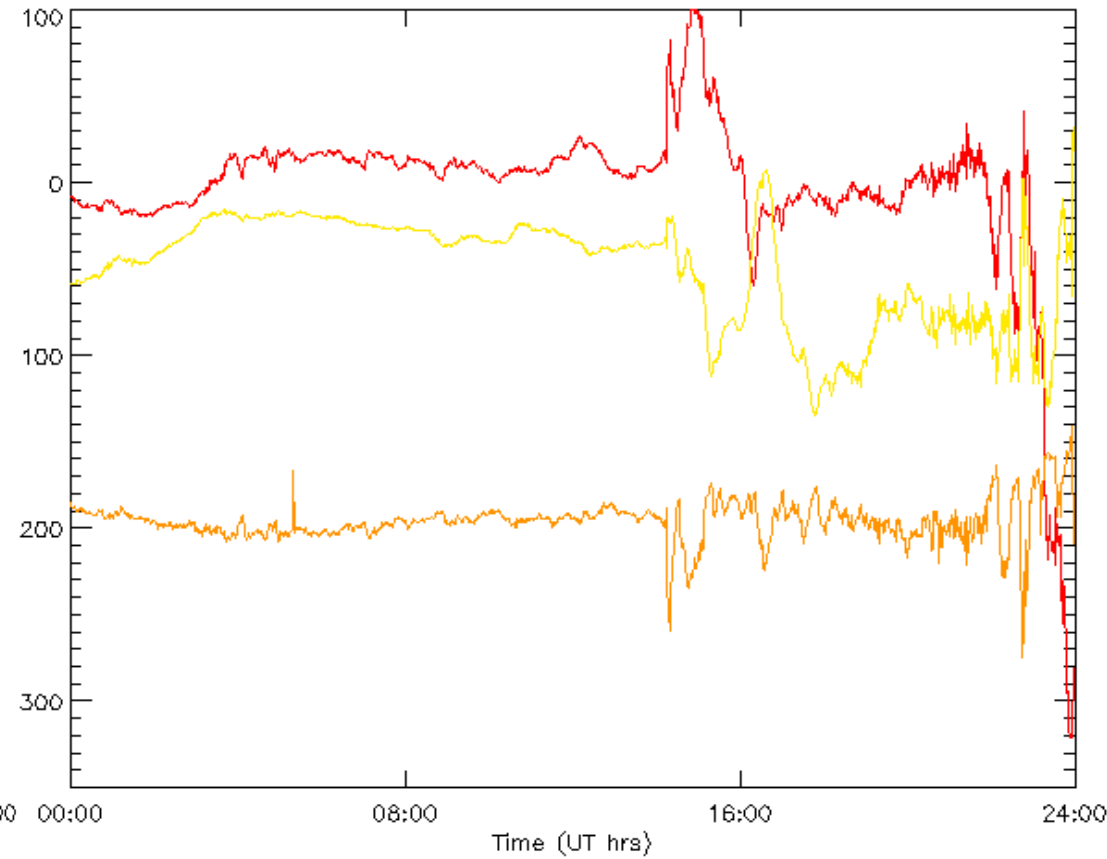


GICs in Pipelines

Geomagnetic Quiet Day

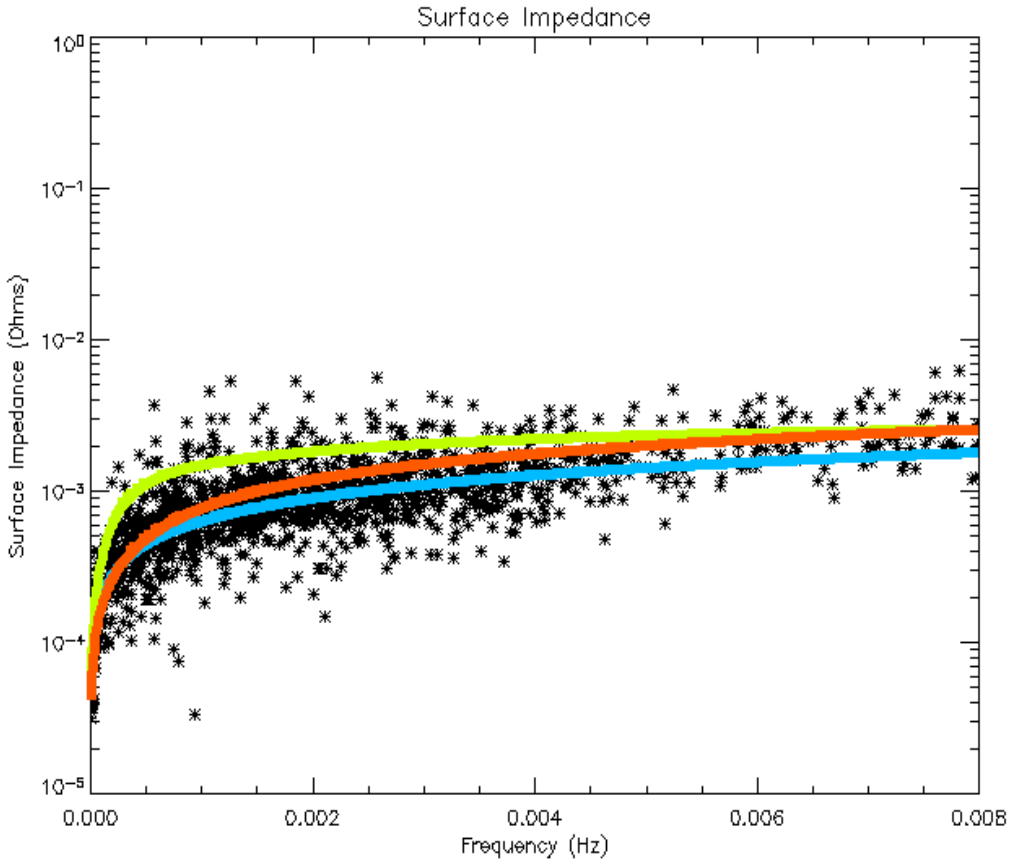


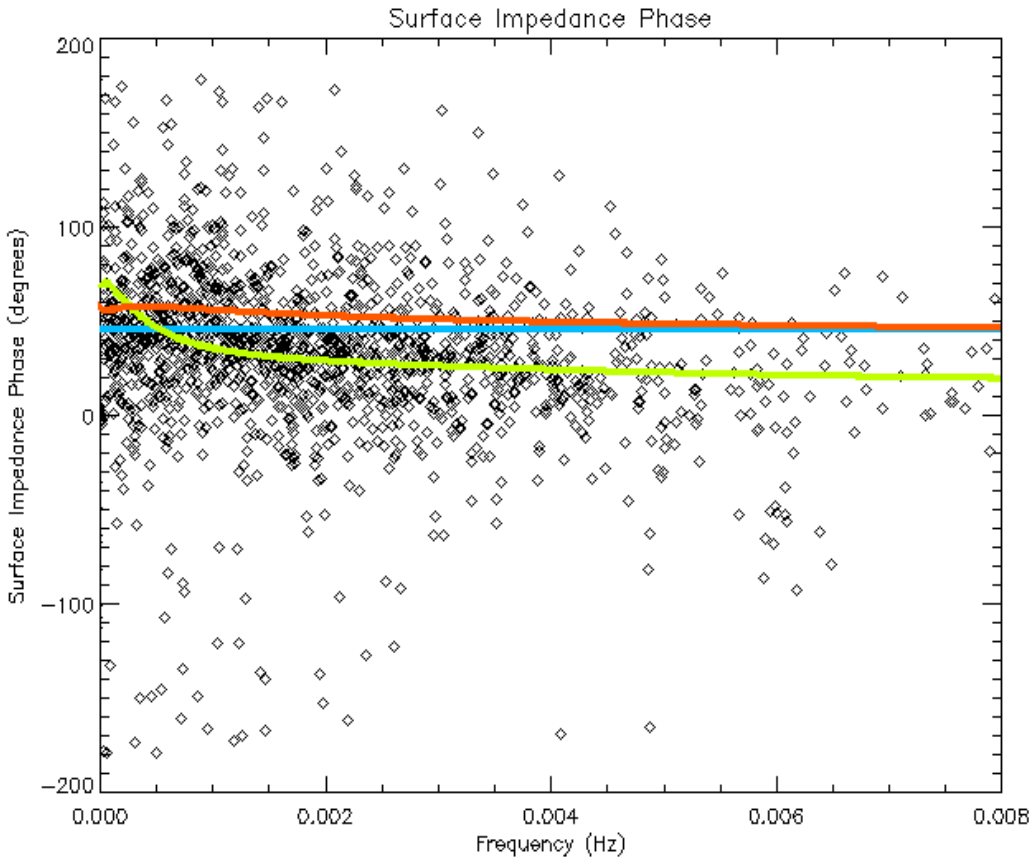
Geomagnetic Storm



GICs in Pipelines

Spectral Analysis: B vs PSP



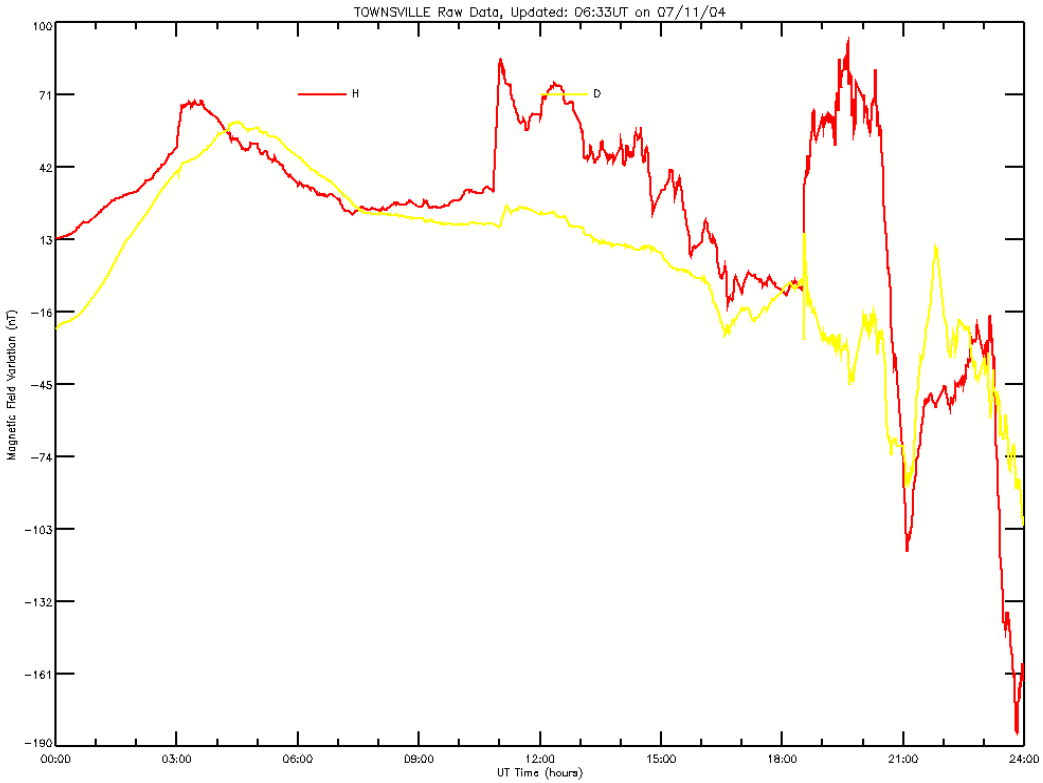


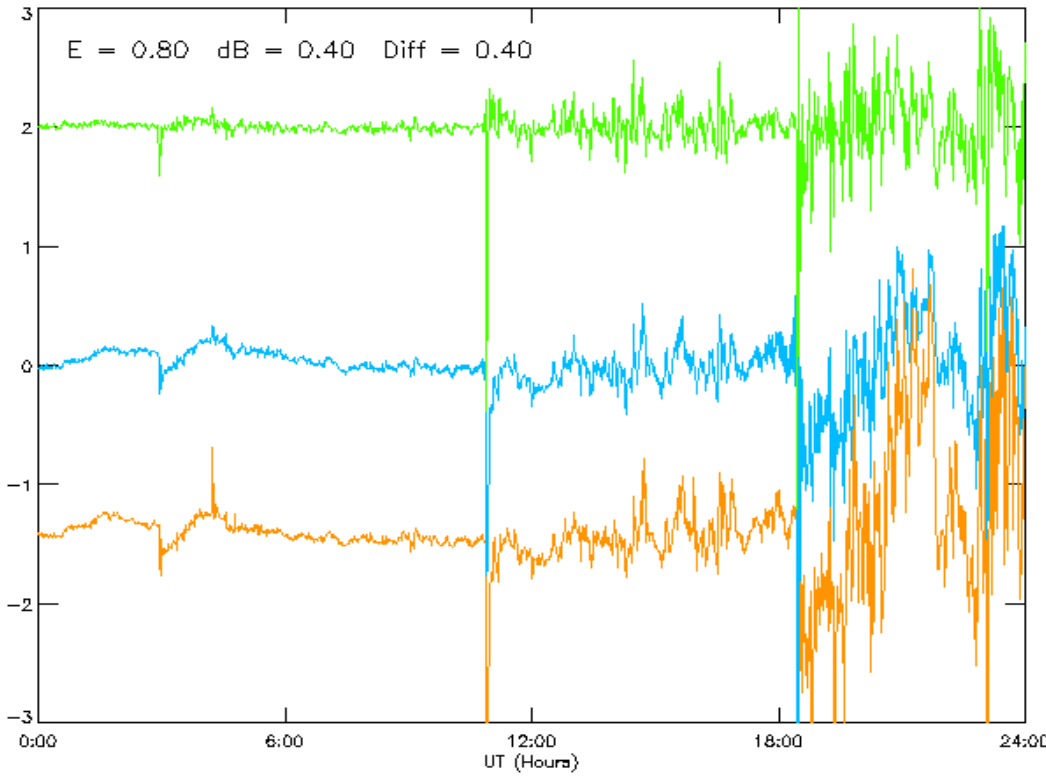
GIC- Index: $Z(f) = \sqrt{\frac{f}{f_N}}\; e^{i\frac{\pi}{4}}$

(Marshall et al., 2010)

GICs in Pipelines

GIC Index: 7th November 2004



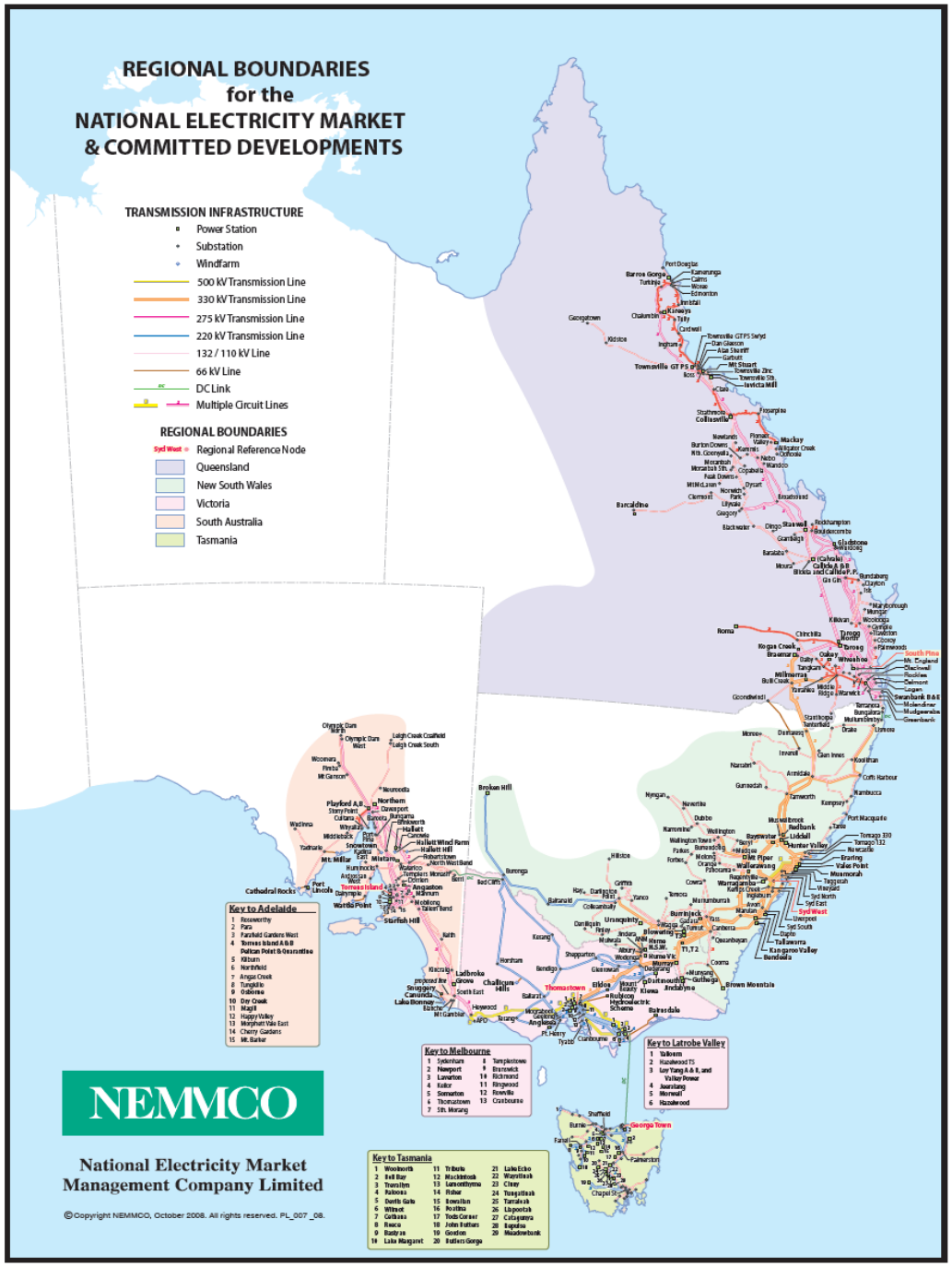


Red – H Comp

Yellow – D Comp

Green – dB/dt
Blue – GIC-index
Orange - PSP

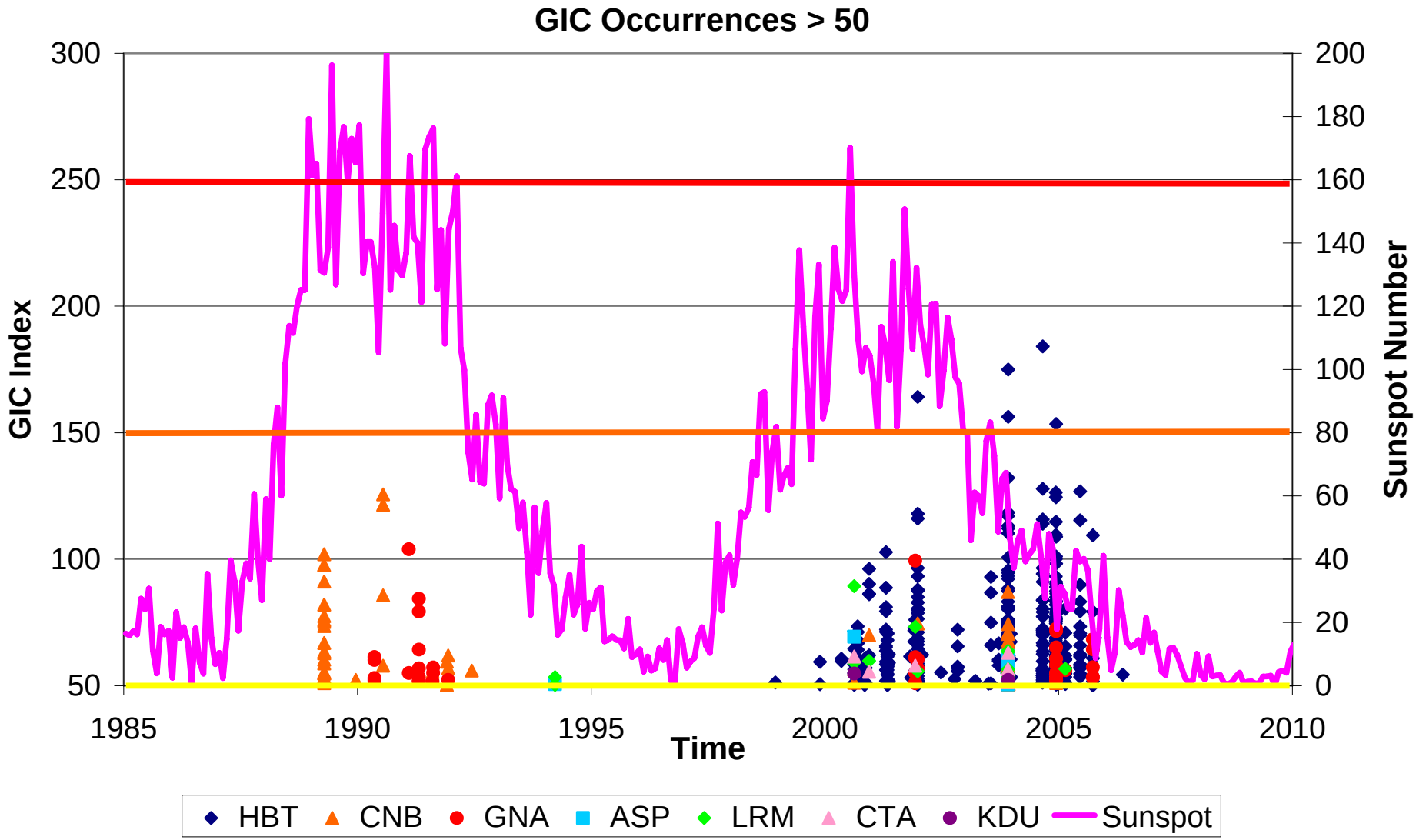
GICs in Power Networks



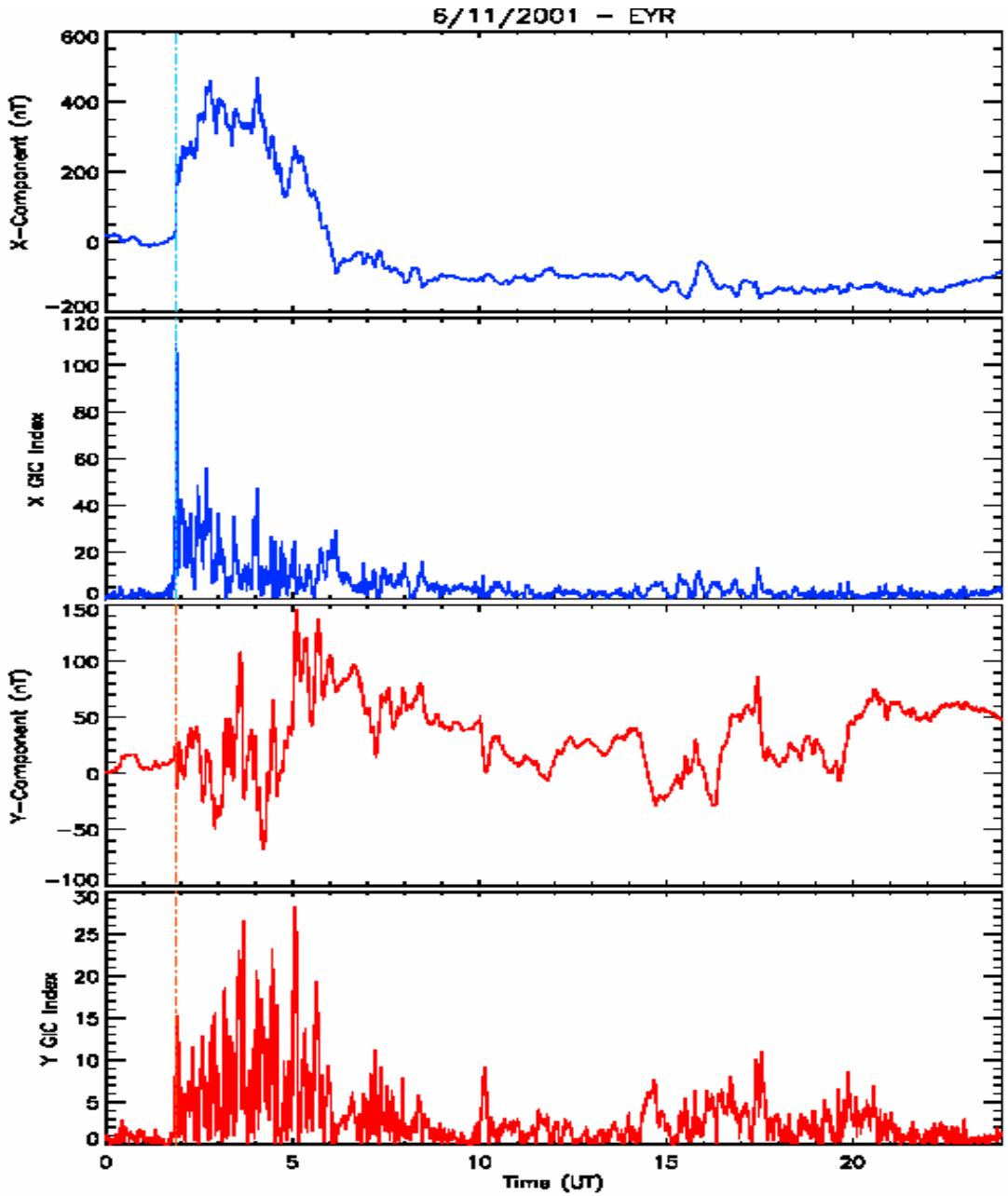
Increased Connectivity eg., HVDC link TAS

- **Market Competition**
- **Robustness to demand**
- **Increased susceptibility to Space weather**

GICs in Power Networks



GICs in Power Networks



- **NZ Previously considered safe due to mid-latitude location**
- **Prior to 2001 no GIC related faults recorded**
- **Fault attributed to premature ageing**
- **Analogous situation between NZ south Island and TAS**

www.ips.gov.au/Space_Weather