

Some initial results from the Falkland Islands Radar:

Sub-auroral ion drifts, gravity waves, and the Weddell Sea Anomaly

Adrian Grocott

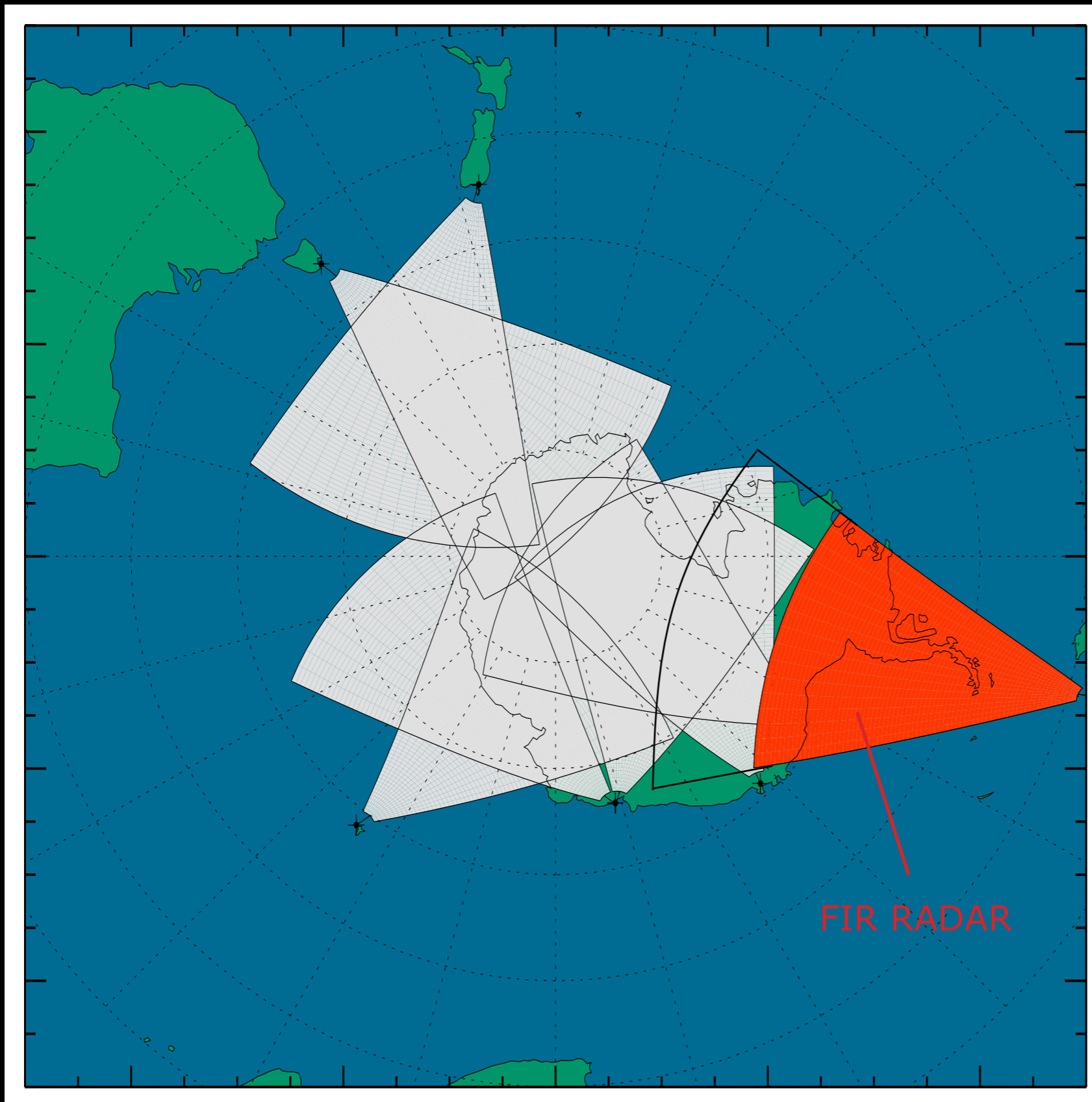
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National Institute of Polar Research, Tokyo, Japan

SuperDARN: Southern Hemisphere



Falkland Islands Radar (FIR)
deployed February 2010

Ceased operations mid-
October 2011

Lowest magnetic latitude
SuperDARN radar enabling
unique studies:

1. Auroral electrodynamics during 'extreme' events (expanded polar cap)
2. Sub-auroral electrodynamics
3. Mid-latitude gravity wave activity
4. Weddell Sea Anomaly

SUPERDARN PARAMETER PLOT

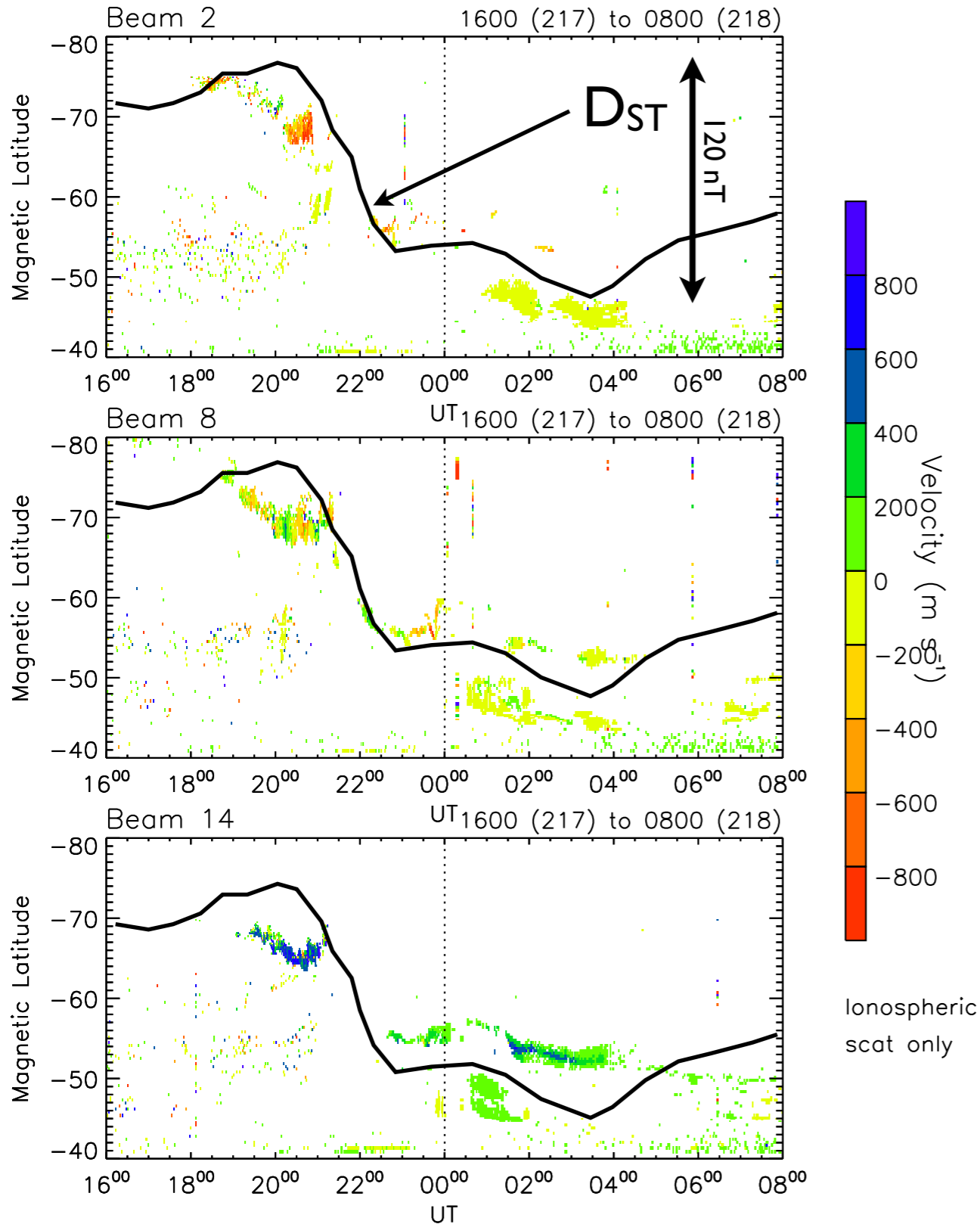
Falkland Islands: vel

5 Aug 2011 ⁽²¹⁷⁾

to

6 Aug 2011 ⁽²¹⁸⁾

fast normal (cw) scan mode (151)



1. Auroral electrodynamics during 'extreme' events

Doppler velocity data from 3 beams of the FIR from 1600 UT on 5th 0800 UT on 6th August 2011

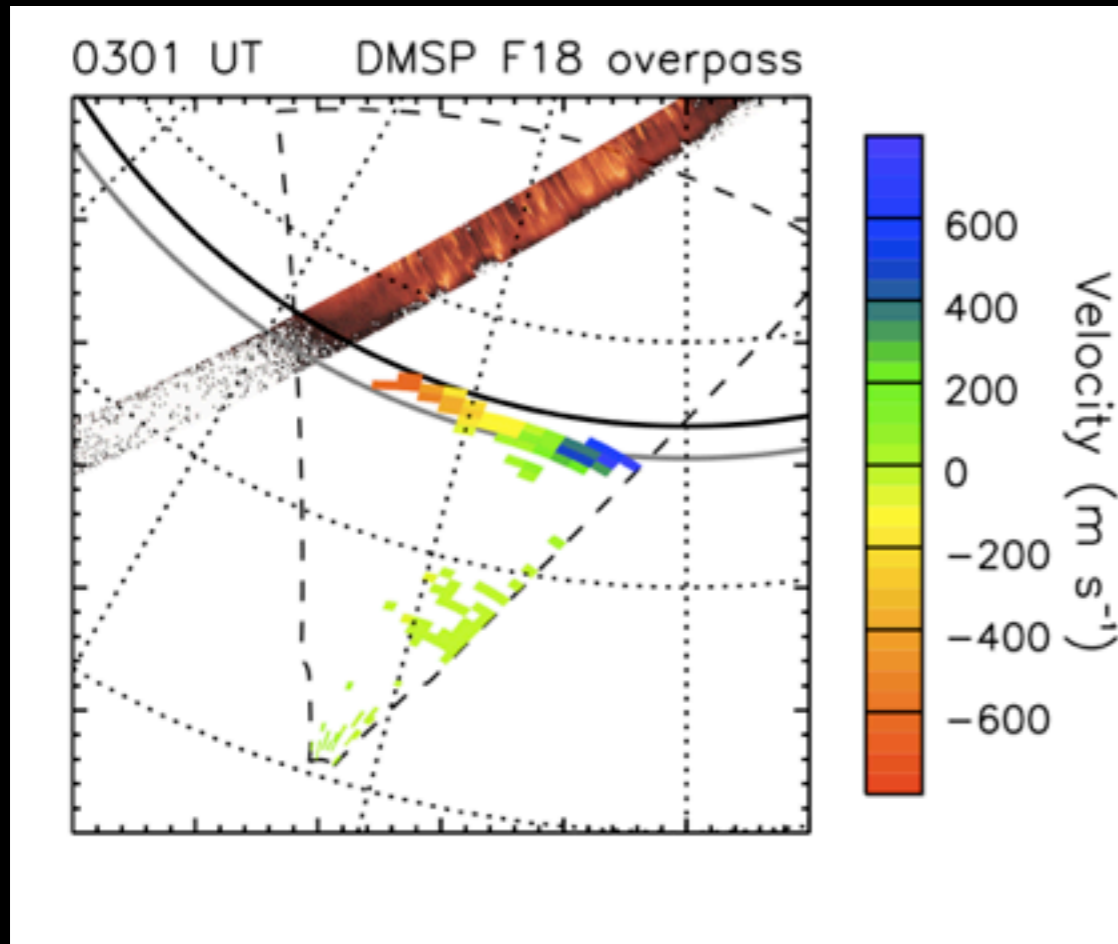
110 range gates enabled FIR to make observations from a high-latitude auroral oval, down to the sub-aural regions

This occurred during the main phase of a rare and recent storm event (D_{ST} superposed on an arbitrary y-axis)

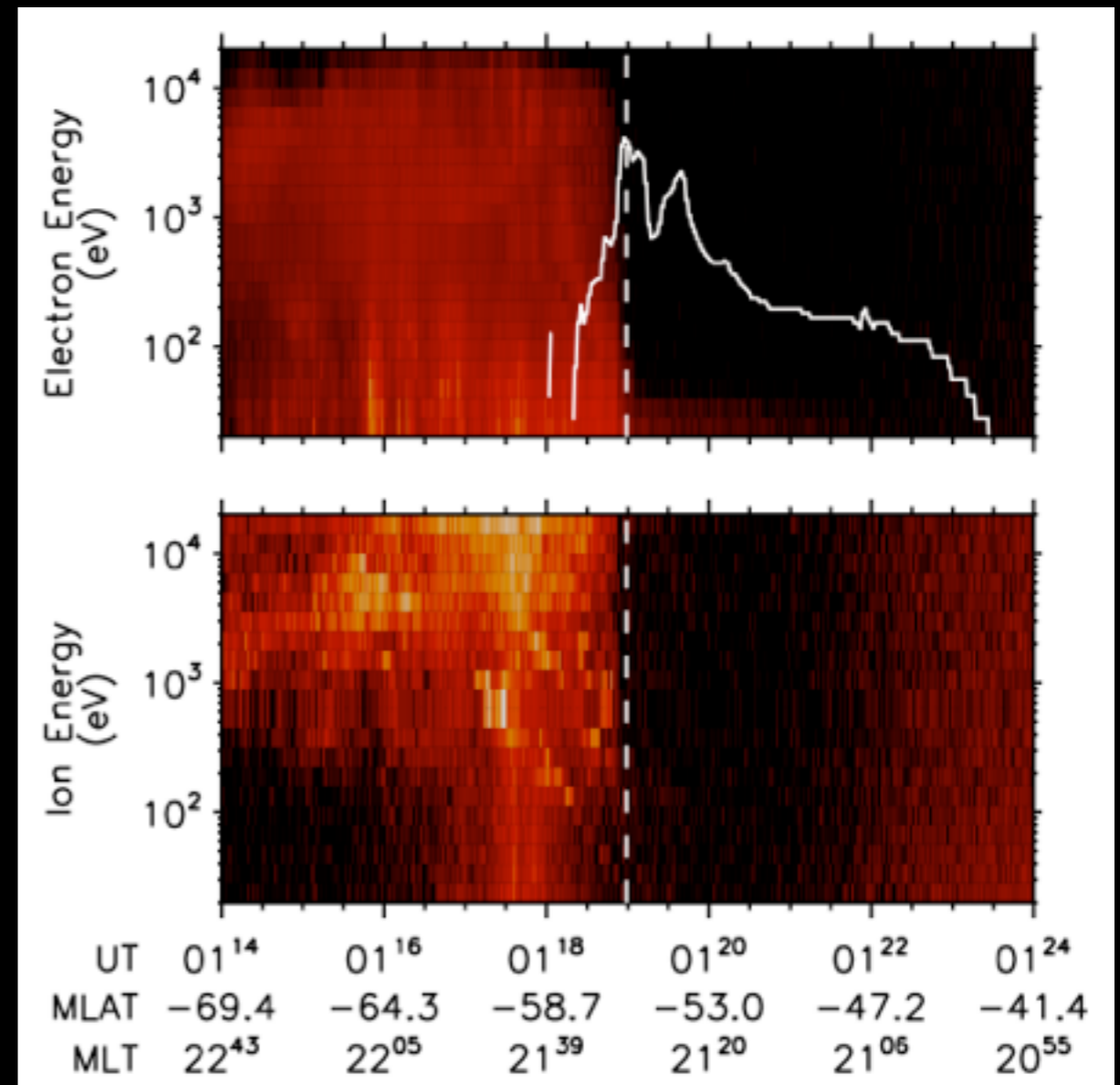
Unfortunately few such events have occurred over the lifetime of FIR

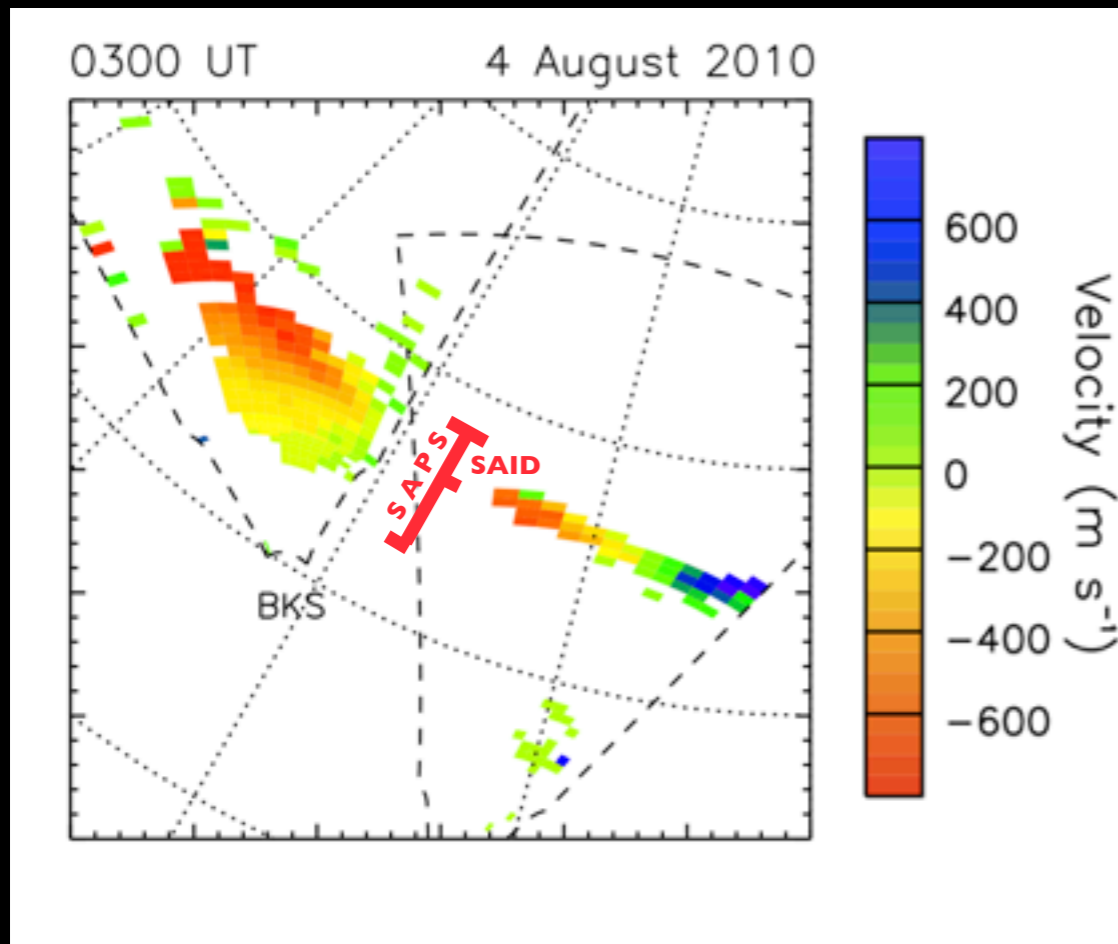
2. Sub-auroral electrodynamics

Doppler velocity data from 4th August 2010 with DMSP electron data superposed indicate a fast, narrow flow channel just equatorward of the electron precipitation boundary



[Grocott et al., JGR, 2011]

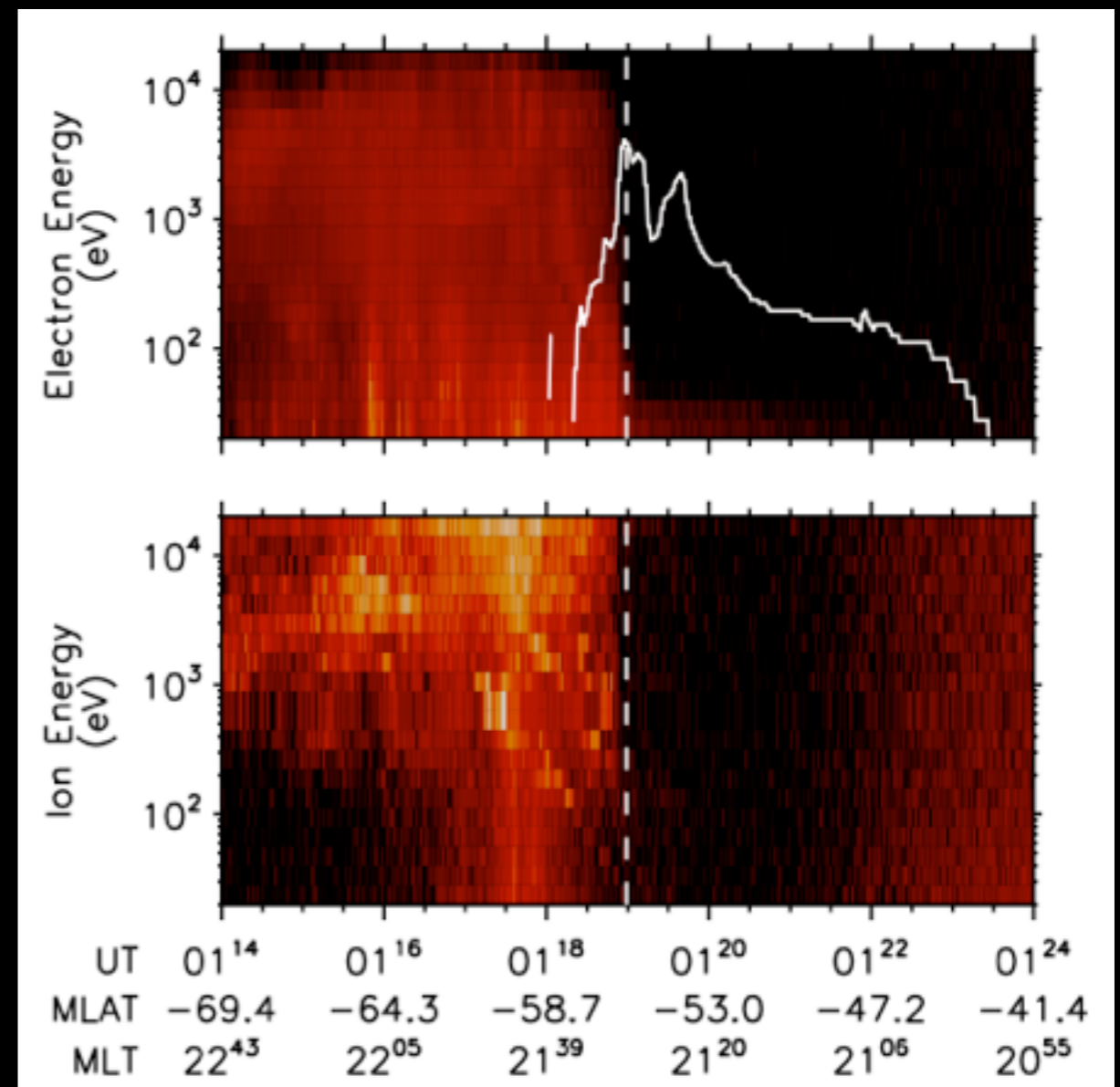


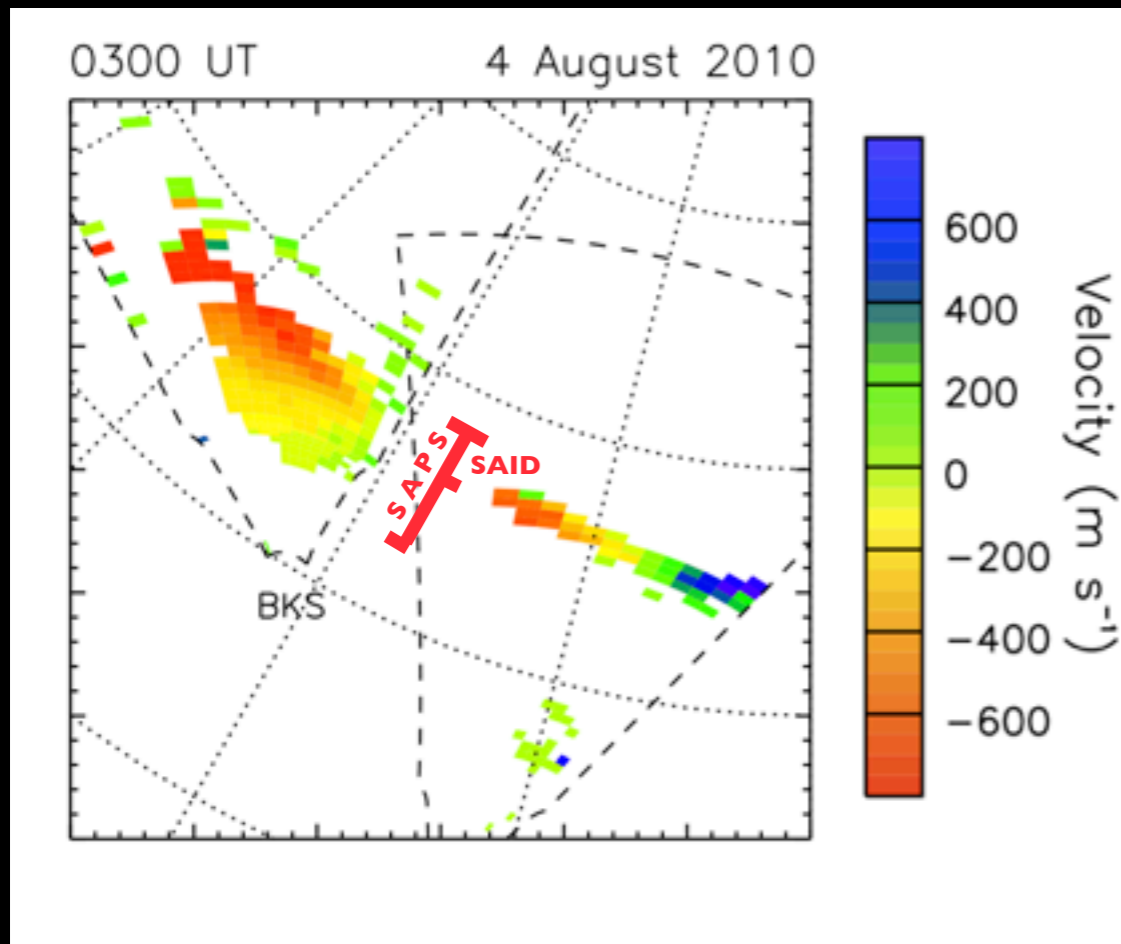


[Grocott et al., JGR, 2011]

2. Sub-auroral electrodynamics

Conjugate northern hemisphere data indicate that the SAID was embedded within the broader SAPS region, confirmed by DMSP drift meter data





[Grocott et al., JGR, 2011]

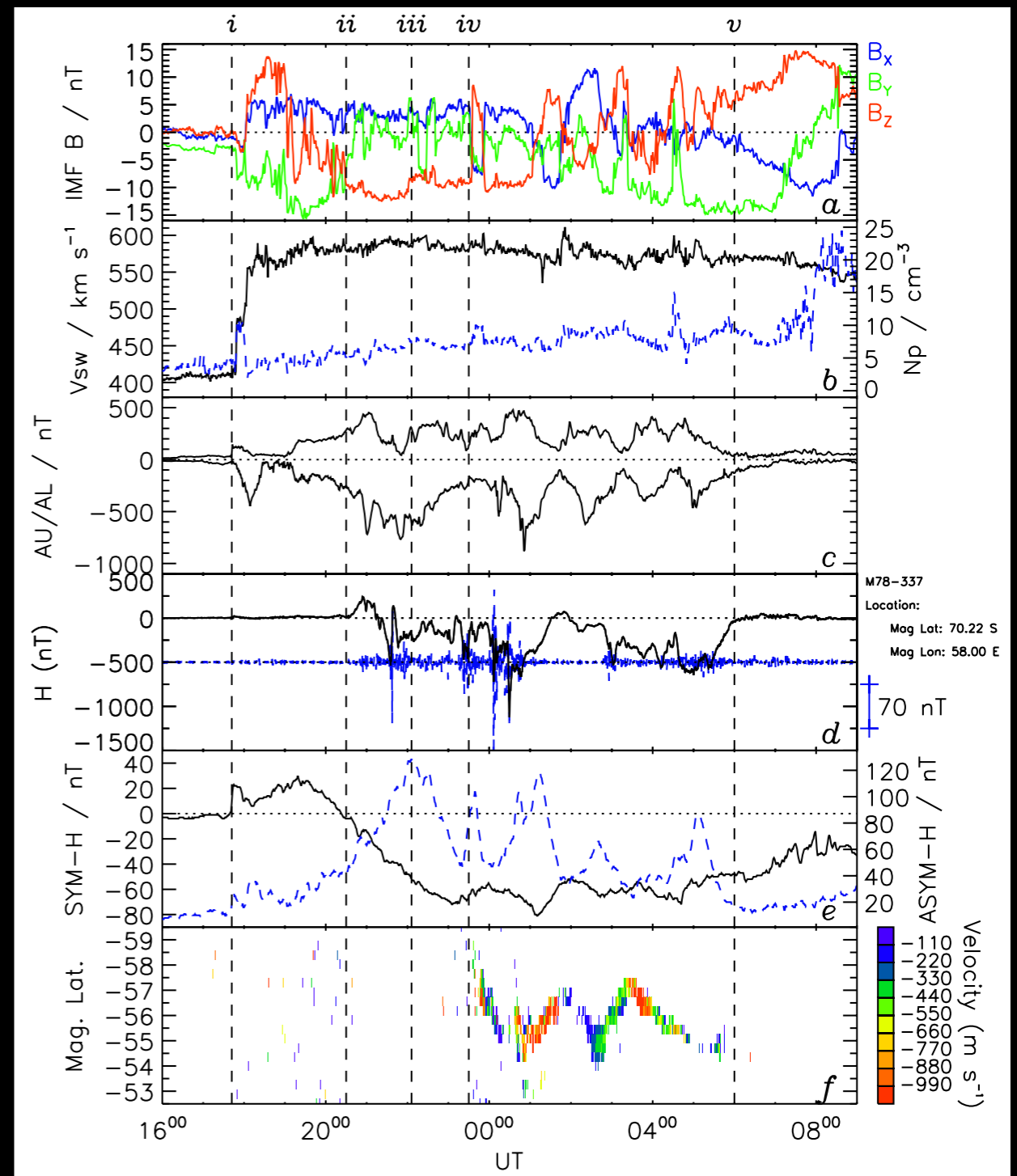
The event followed an interval of substorm activity during the early part of a magnetic storm

This is consistent with substorm injections driving polarisation electric fields responsible for the SAID

However, the location of the SAID appears to be related to the large-scale solar wind driven dynamics

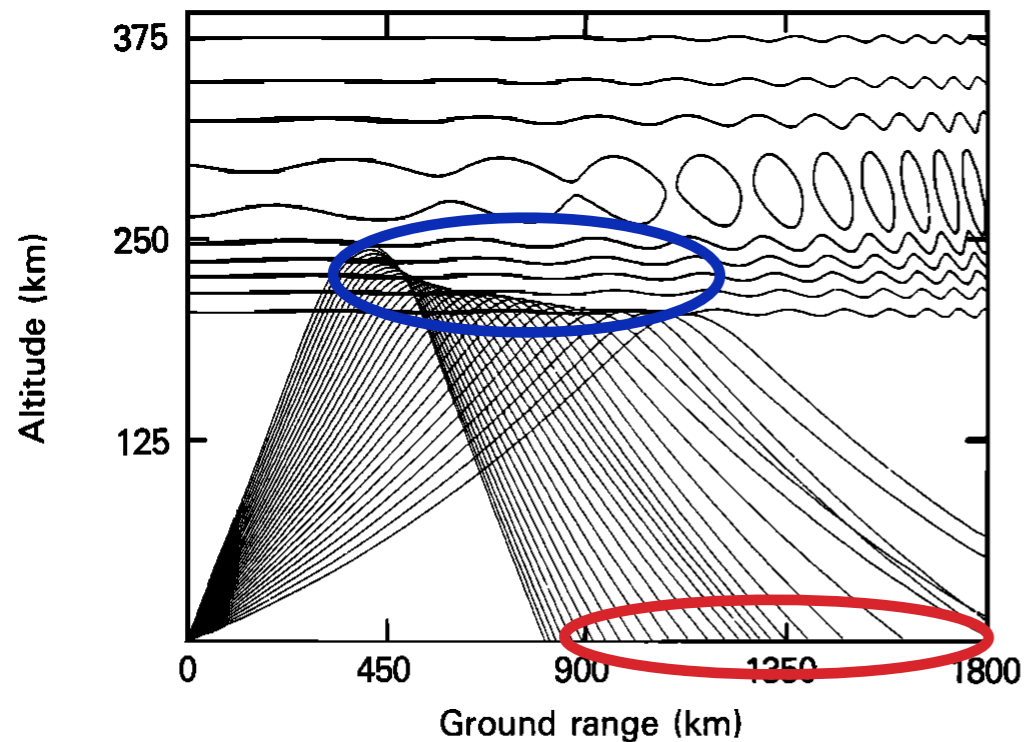
2. Sub-auroral electrodynamics

Conjugate northern hemisphere data indicate that the SAID was embedded within the broader SAPS region, confirmed by DMSP drift meter data



3. Mid-latitude gravity waves

Neutral atmosphere pressure variations due to AGWs couple to the bottomside ionosphere, causing a corrugated structuring of the electron isodensity surfaces. These propagate as what are known as travelling ionospheric disturbances (TIDs) [Samson et al., 1990]

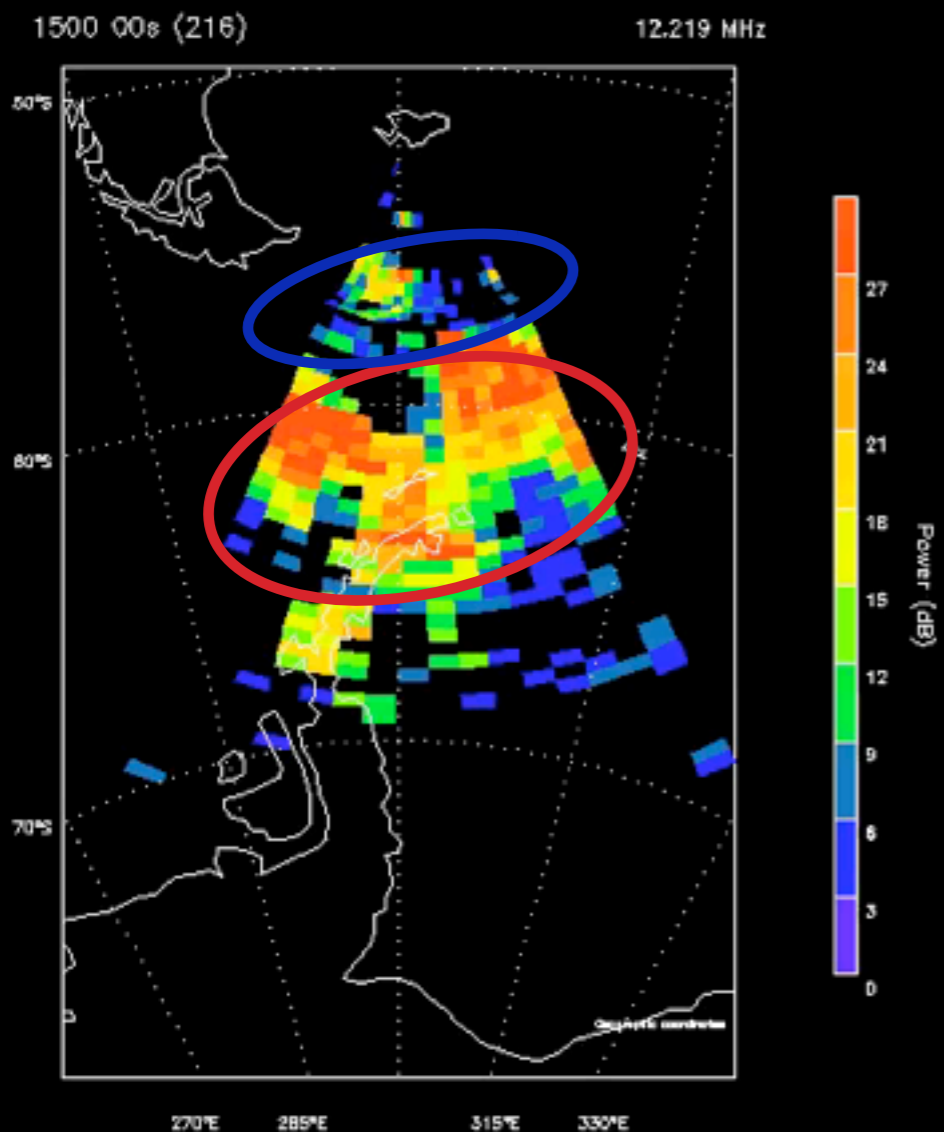
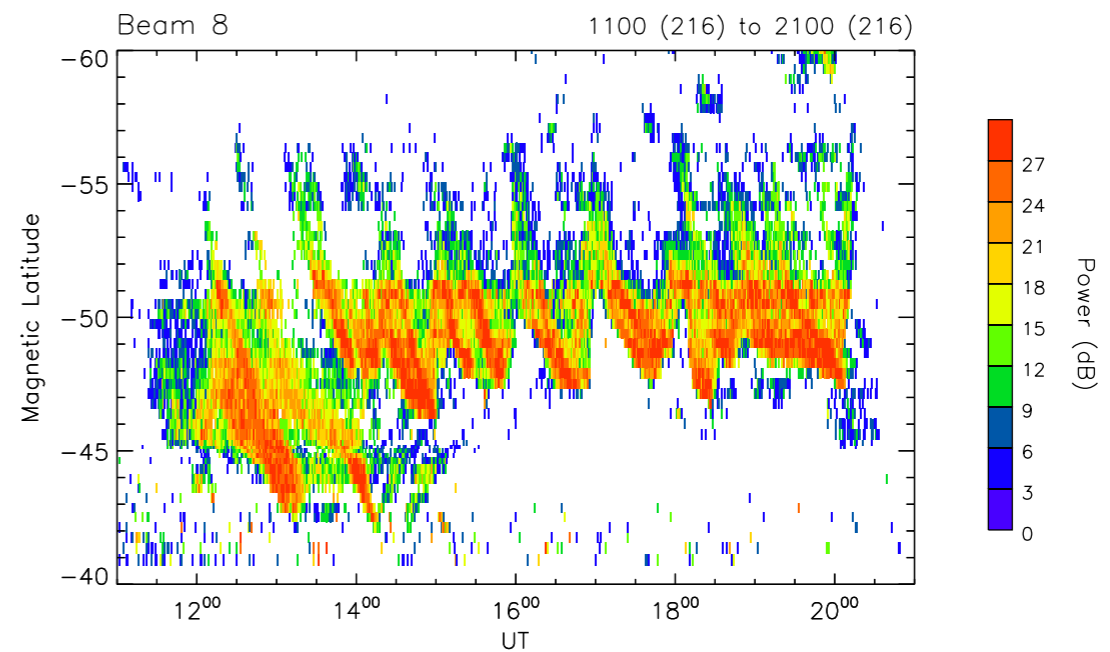


SUPERDARN PARAMETER PLOT

Falkland Islands: pwr_L

4 Aug 2010 (216)

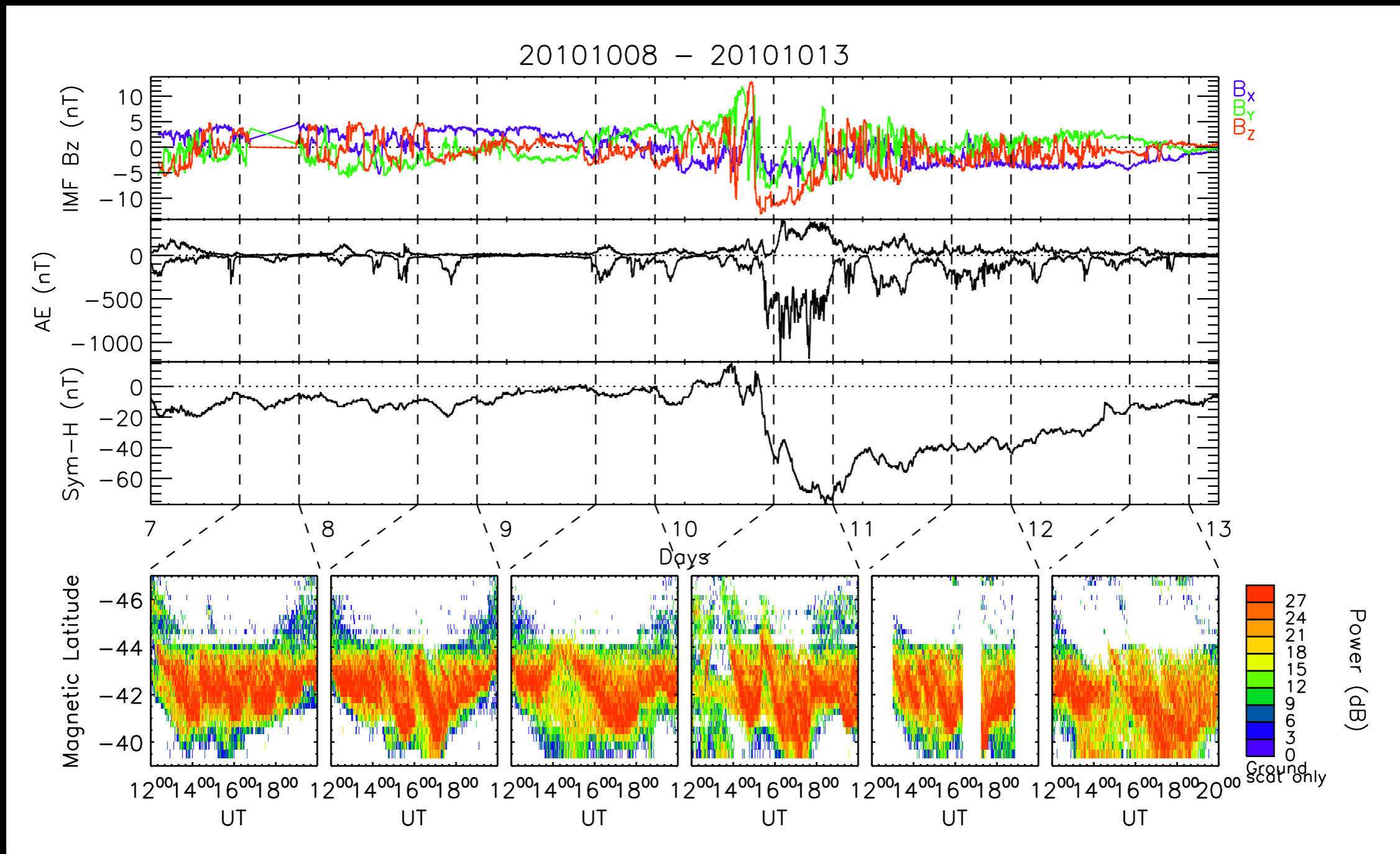
fast normal (cw) scan mode (151)



TIDs are evident in radar data as variations in the power backscattered from the ground or sea caused by focussing and defocussing of the radio wave at its oblique reflection point in the ionosphere

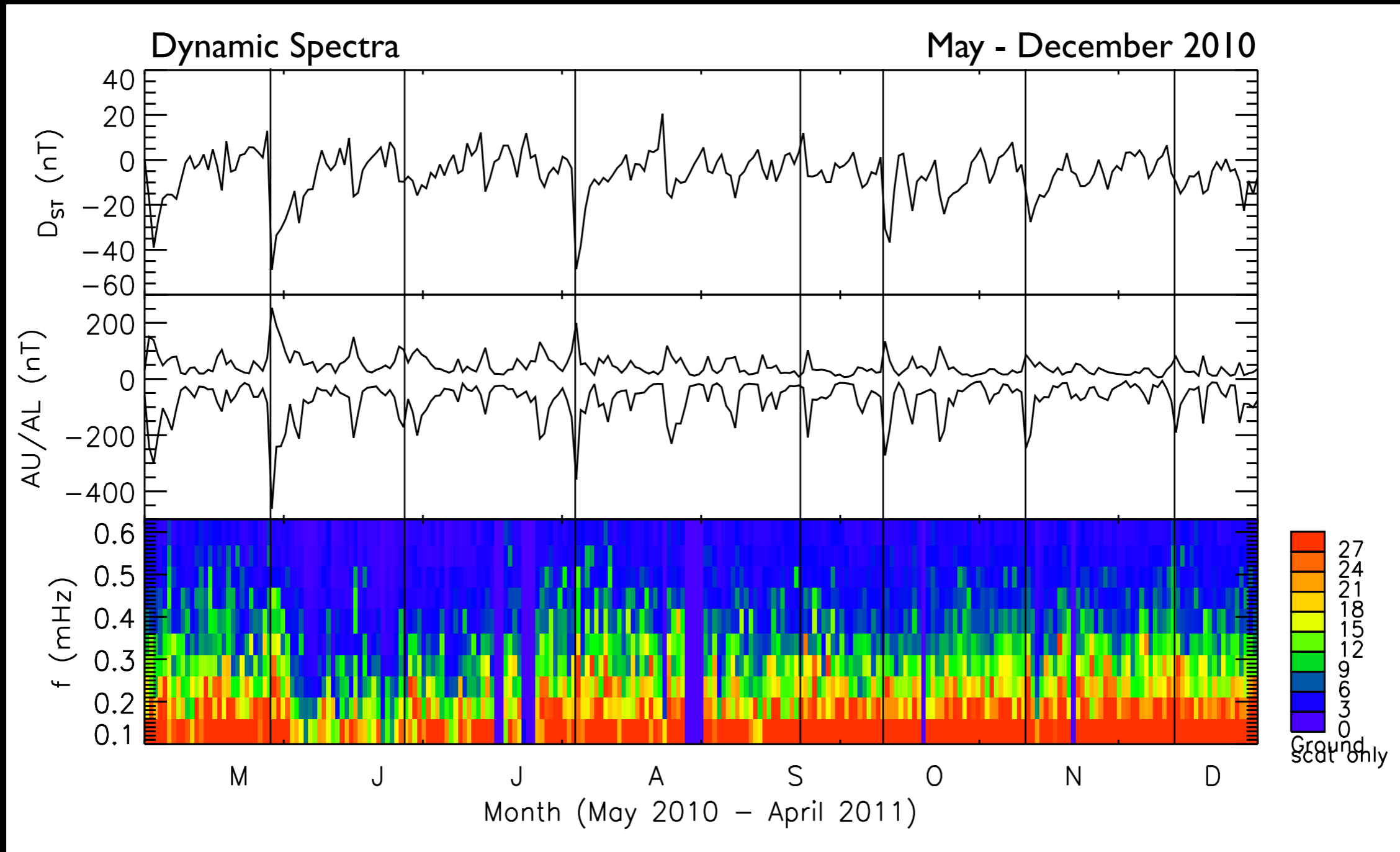
AGWs will be detectable from within the half-hop region of the radar field of view. This region coincides closely with the Antarctic Peninsular

3. Mid-latitude gravity waves



Looking over longer timescales appears to indicate an evolution in TID spectral characteristics associated with the changing geomagnetic conditions

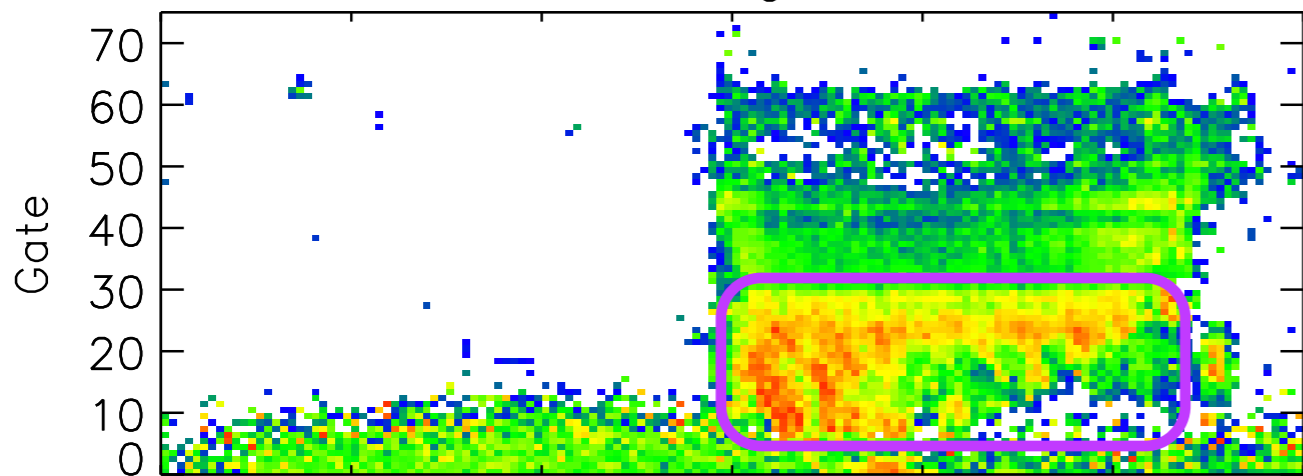
3. Mid-latitude gravity waves



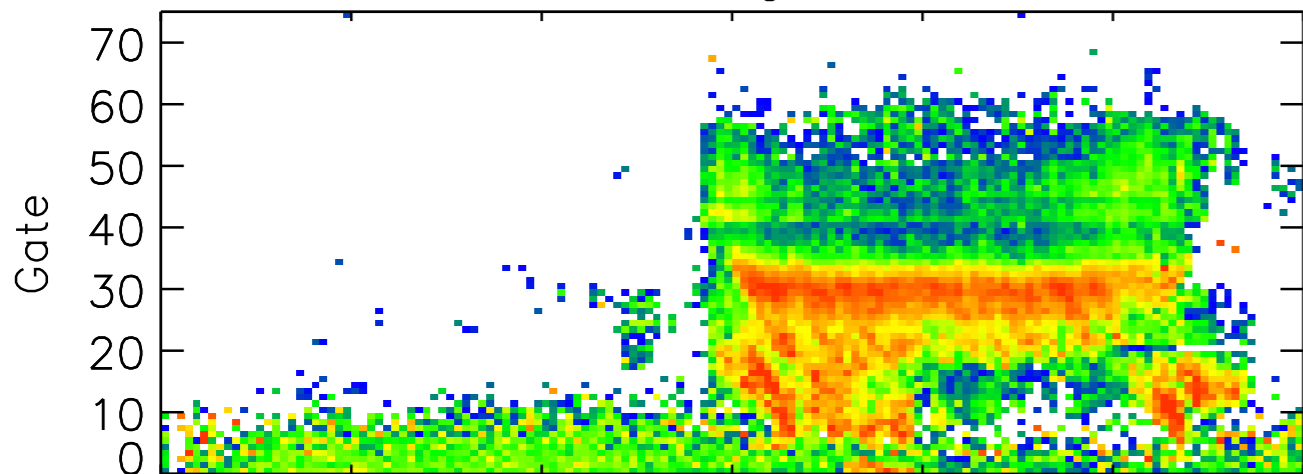
Peak daily spectral power and corresponding AE and SYM-H indices for 8 months in 2011

A seasonal variation is evident (less power in mid-winter) as well as spectral variability associated with geomagnetic activity

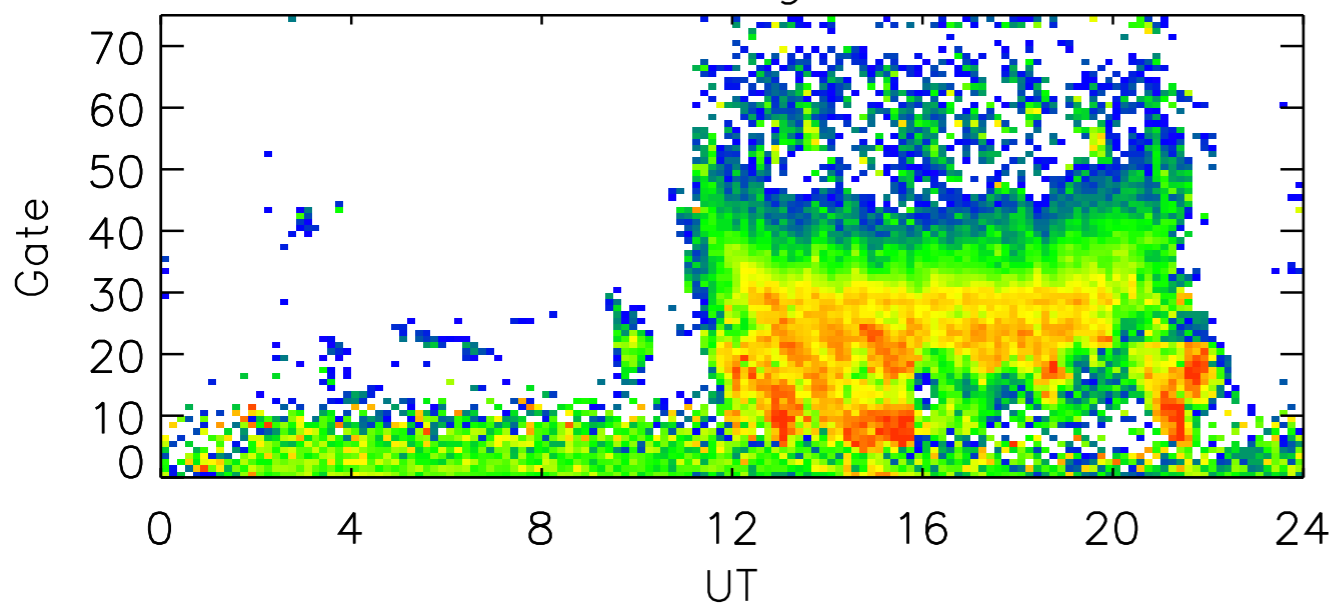
Beam 2, August 2010



Beam 6, August 2010



Beam 10, August 2010



3. Mid-latitude gravity waves

Another interesting result appears if we take monthly averages of the backscatter power

Evidence for persistent TID structures exists - unlikely if they are related to geomagnetic activity since that would not occur at the same UT each day

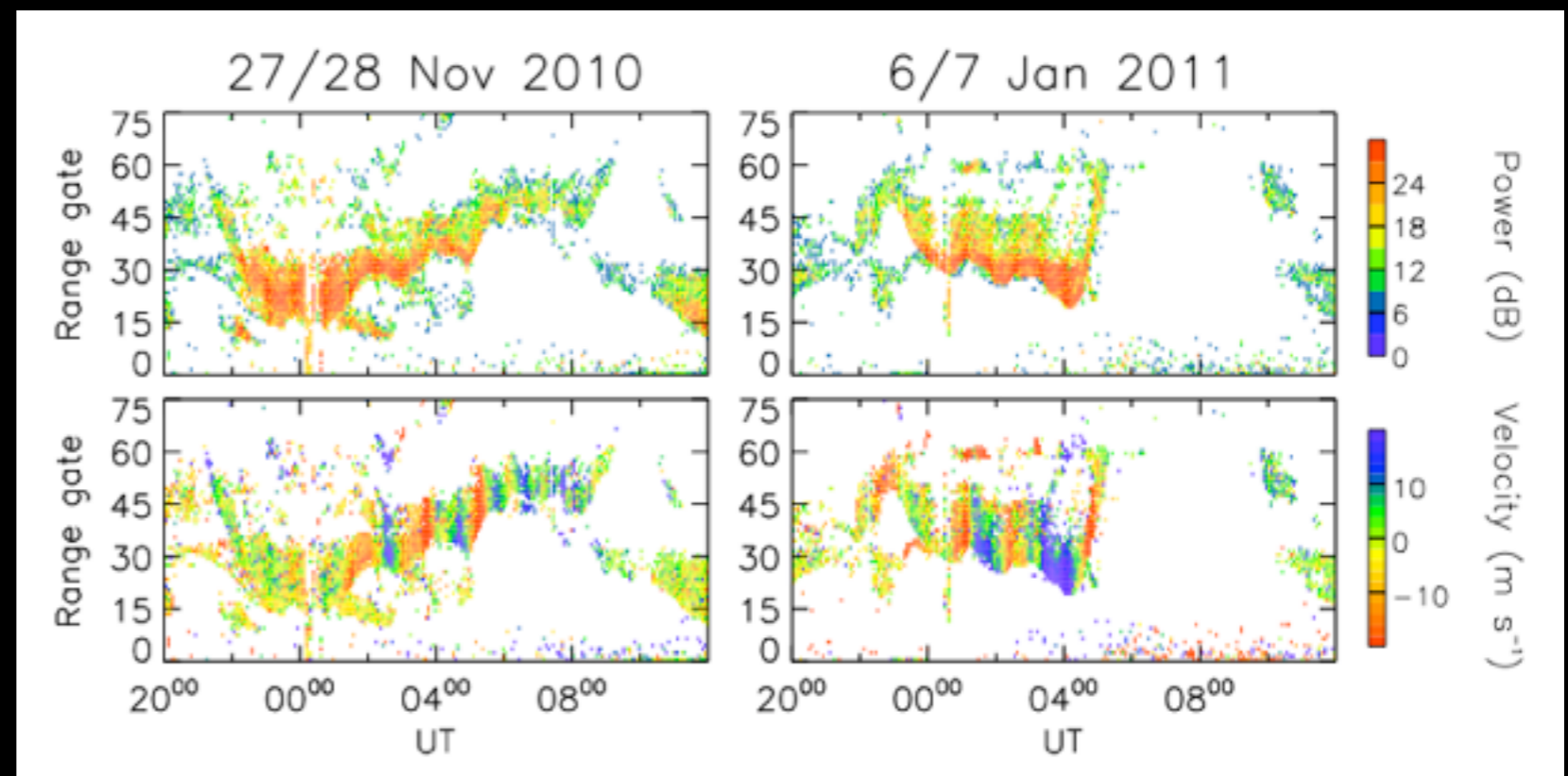
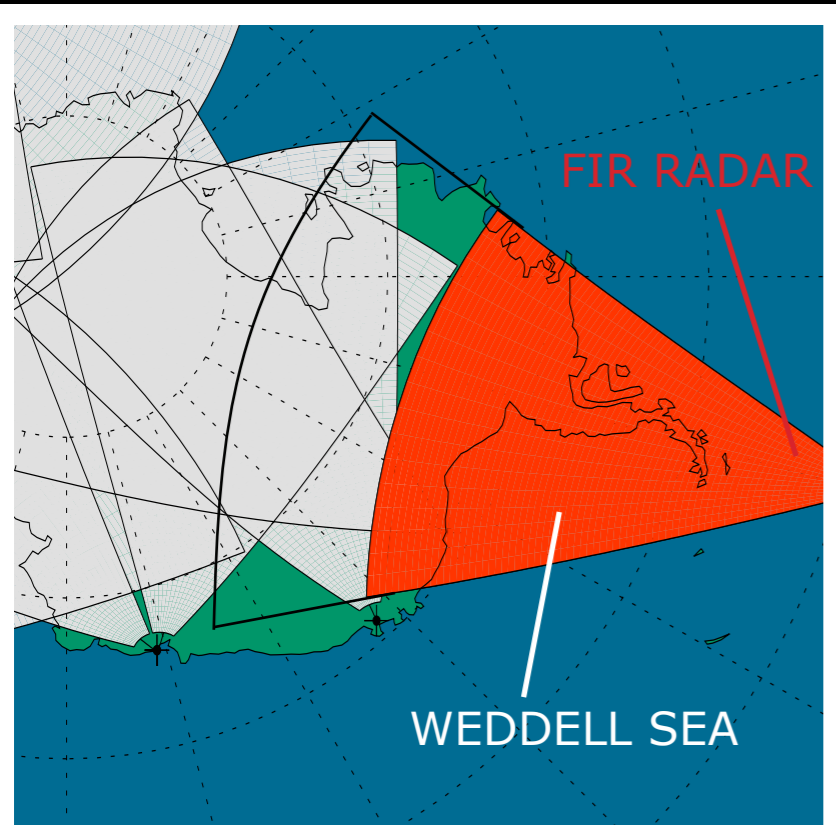
Possibly related to the solar terminator, which can launch gravity waves, and would be relatively constant over just one month

Or could be related to a geographic feature, if effectively standing waves were present due to, e.g. winds over mountains

4. Weddell Sea Anomaly (WSA)

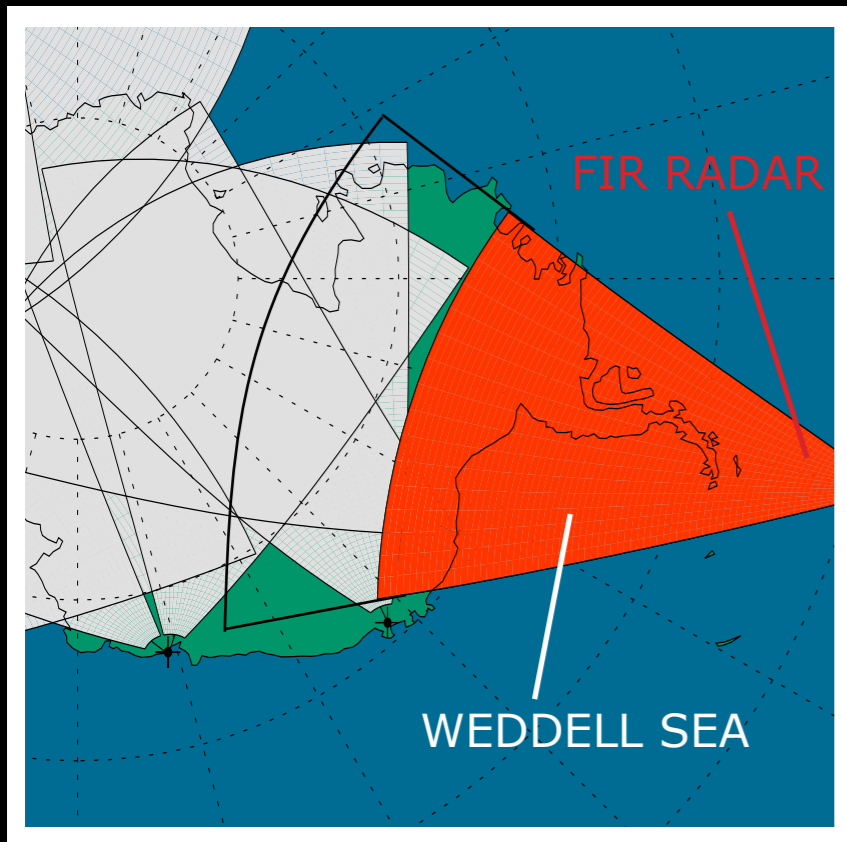
The WSA is an ionospheric structure characterised by a larger nighttime electron density than daytime density.

During the summer months, FIR observed sea scatter at nighttime that suggested curious undulations of the ionosphere



4. Weddell Sea Anomaly (WSA)

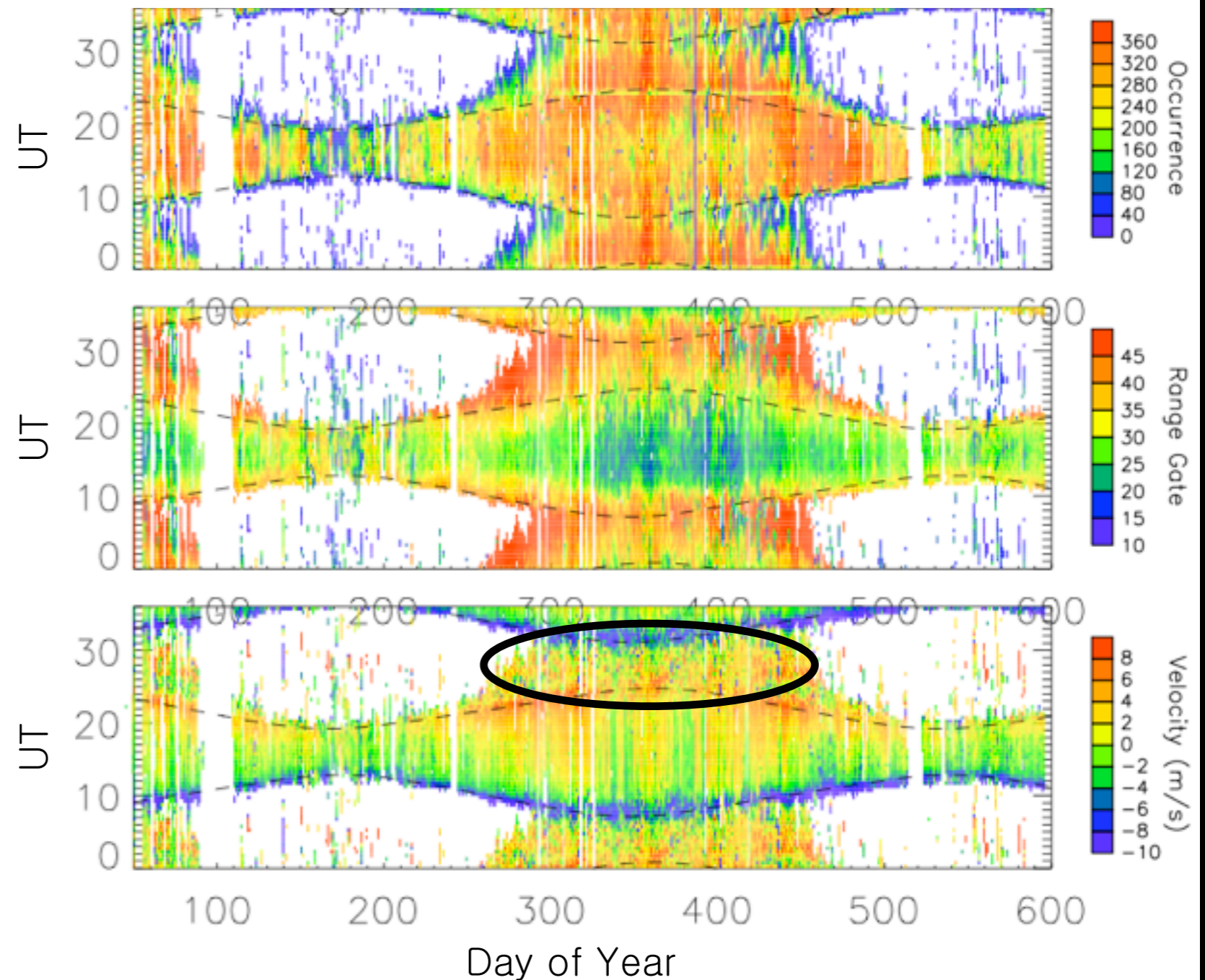
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Median values in 30 bins of the full FIR dataset, hour against day.

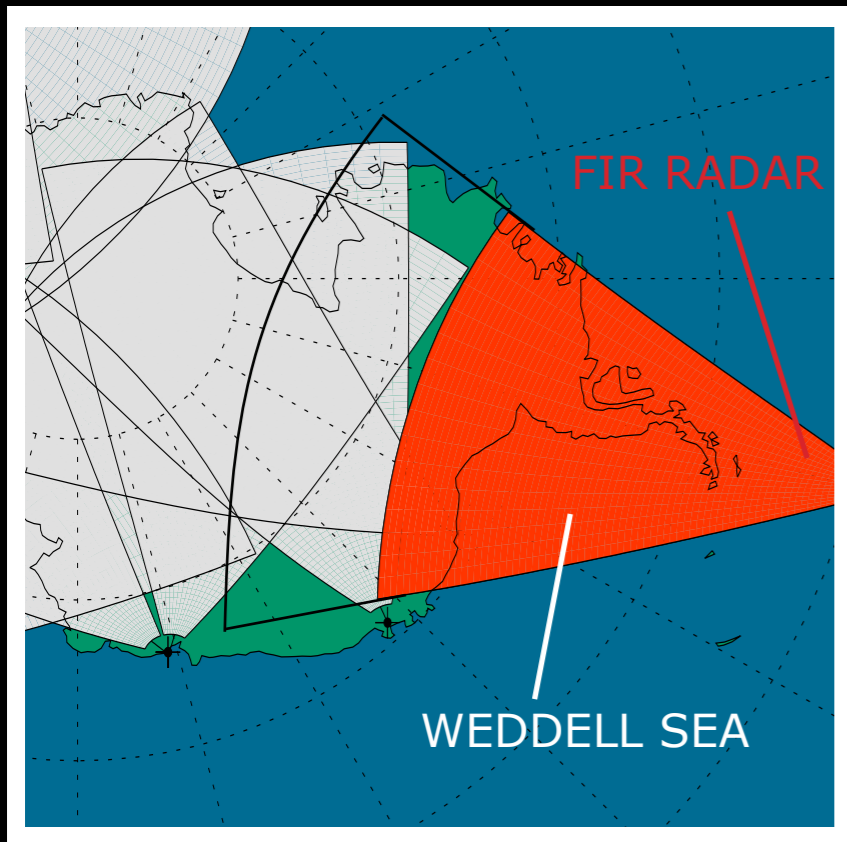
The WSA scatter is that appearing in the summer, after sunset, seen to move to further ranges

The velocity of the scatter is characterised by large variability



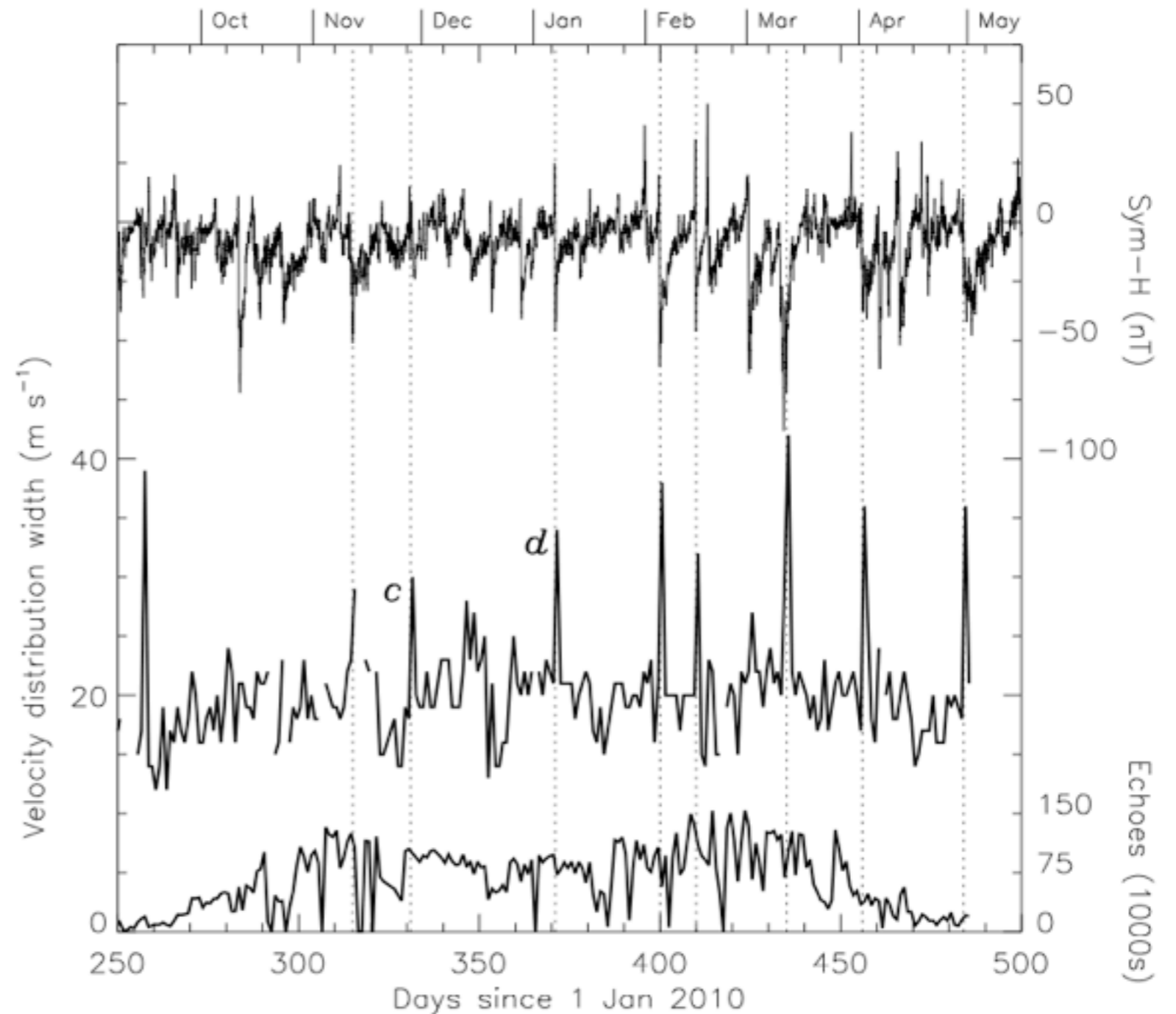
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The width of the velocity distribution within each bin (the 90% decile - 10% decile) provides an estimate of the variability

The highly variable intervals appear to coincide with high geomagnetic activity



4. Weddell Sea Anomaly (WSA)

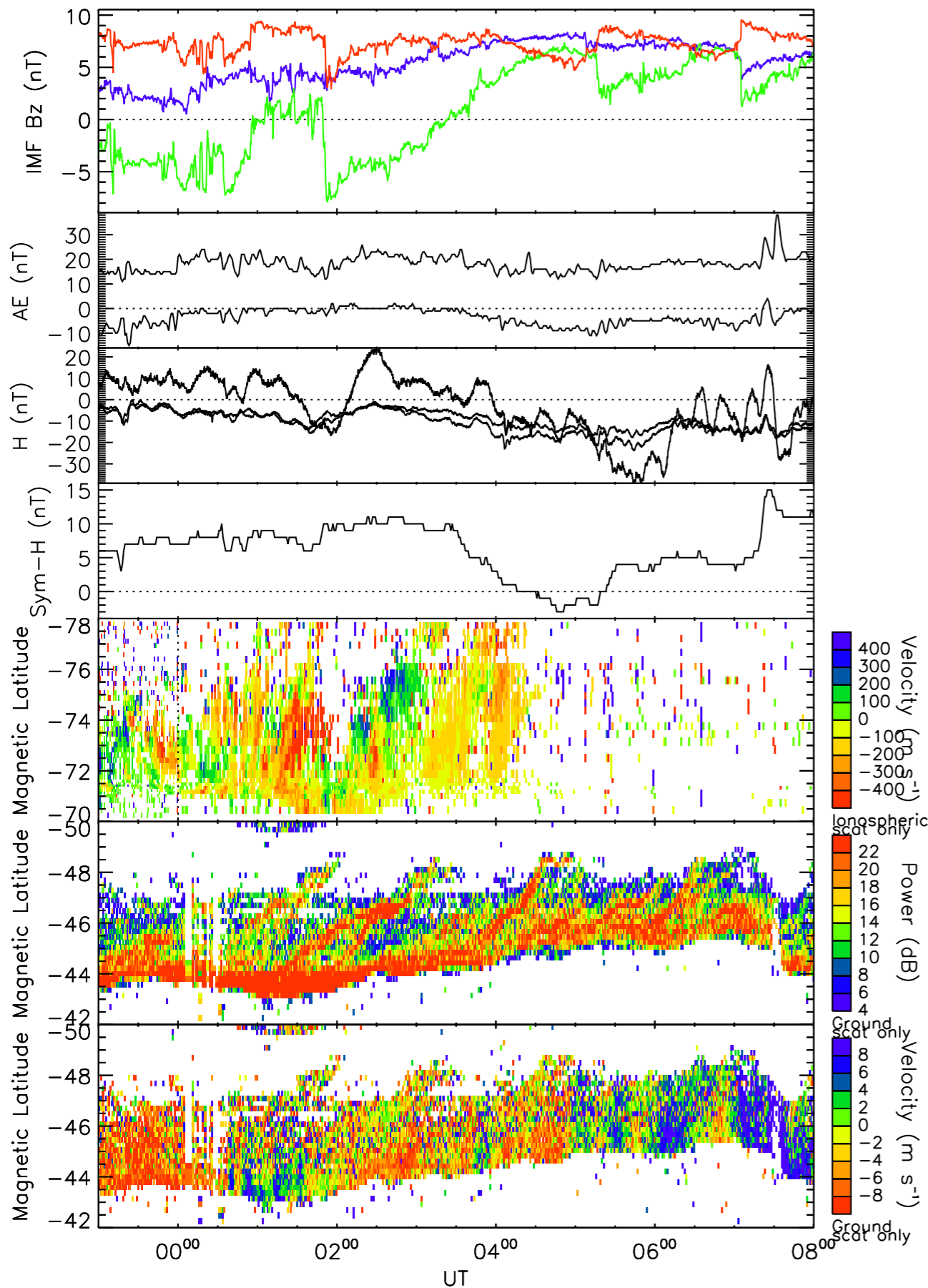
31st October - 1st November 2010

Quiet geomagnetic conditions, during a northward IMF interval

Modest local ground magnetic oscillations accompany auroral electric field variations of many 100s m s^{-1}

WSA shows only modest effect in range and velocity variability

Instead poleward propagating 'tendrils' of enhanced power appear



Falkland Islands Radar

15th Feb 2010 - 5th October 2011

During its short life the F-I radar observed a wide variety of phenomena and showed real potential, especially towards the end, as geomagnetic activity had started to pick up and mid-latitude ionospheric scatter was becoming more commonplace.

The antennae remain at Goose Green, so hope remains that a new set of electronics may become available in the future so that the F-I radar may operate once more...