



Using the ionosphere as a standardized measure for cross-calibration of energetic protons

D.W, Danskin and R. Fiori

Donald.Danskin@Canada.ca
Natural Resources Canada





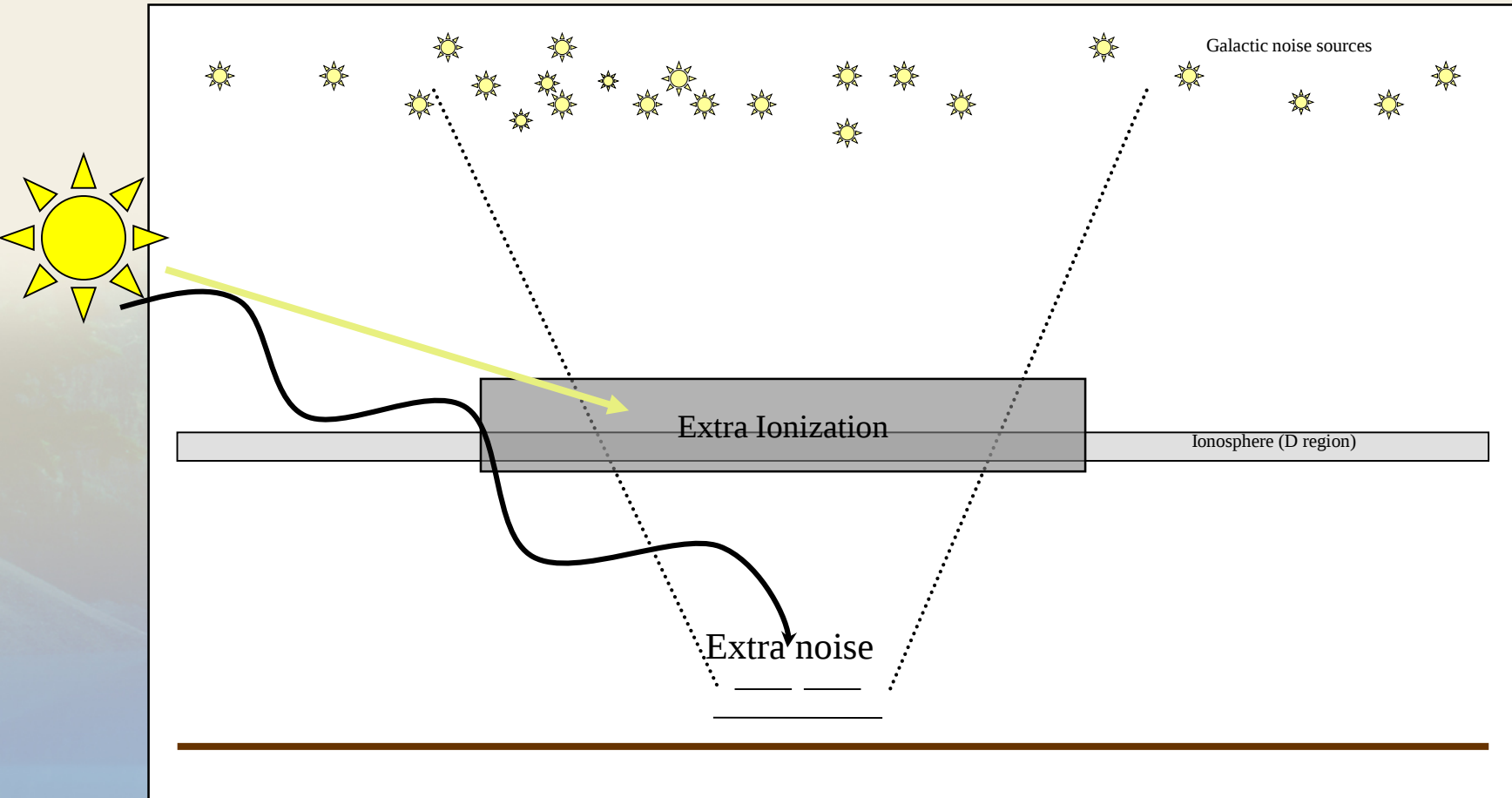
Introduction

- The Canadian Riometer array is a partnership between the University of Calgary and Natural Resources Canada with funding from the Canadian Space Agency.
- Enhanced levels of ~ 10 MeV protons can cause absorption of radio waves in the D region ($\sim 60 - 90$ km) of the ionosphere.
- Absorption levels caused by protons are highly asymmetric, with an intensification in the sunlit ionosphere as compared with dark period.
- Data from the Canadian riometer network and GOES satellites are used to investigate the relationship between radio wave absorption and proton flux.





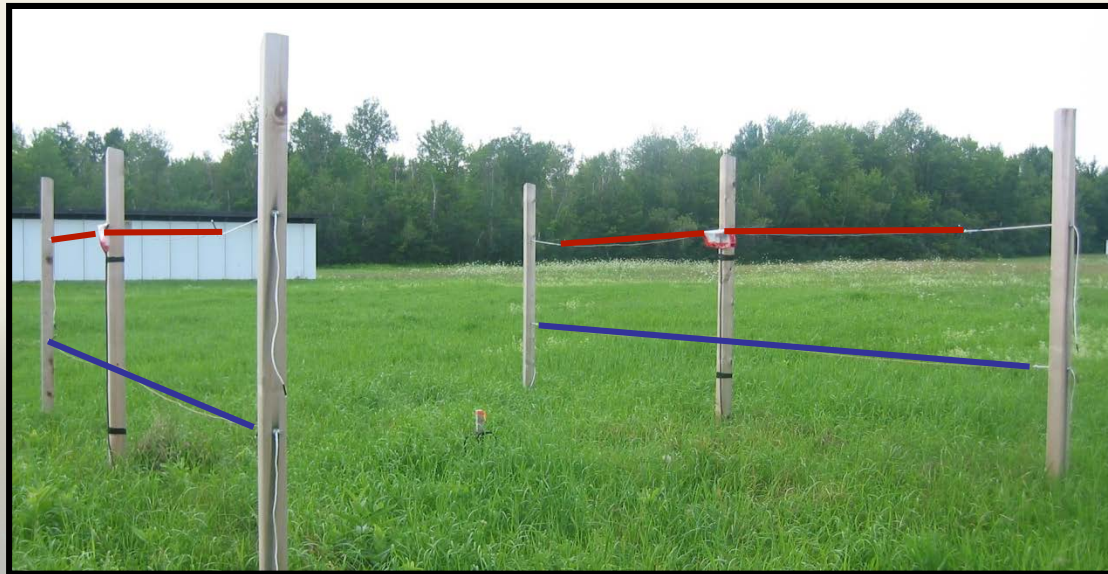
How a riometer works





Riometer Equipment

Data sampler



Antenna

Computer and
Riometer





Saskatoon



Resolute



Ottawa



DRAO - Penticton



Hall Beach





What does a Riometer measure?

Ionospheric absorption (in the D region ~ 90 km)

- Auroral absorption
- Solar radio noise bursts
- X-ray induced absorption
- Polar cap absorption (solar protons)

Typical riometer frequencies are 30.0, 38.2, and ~ 50 MHz.





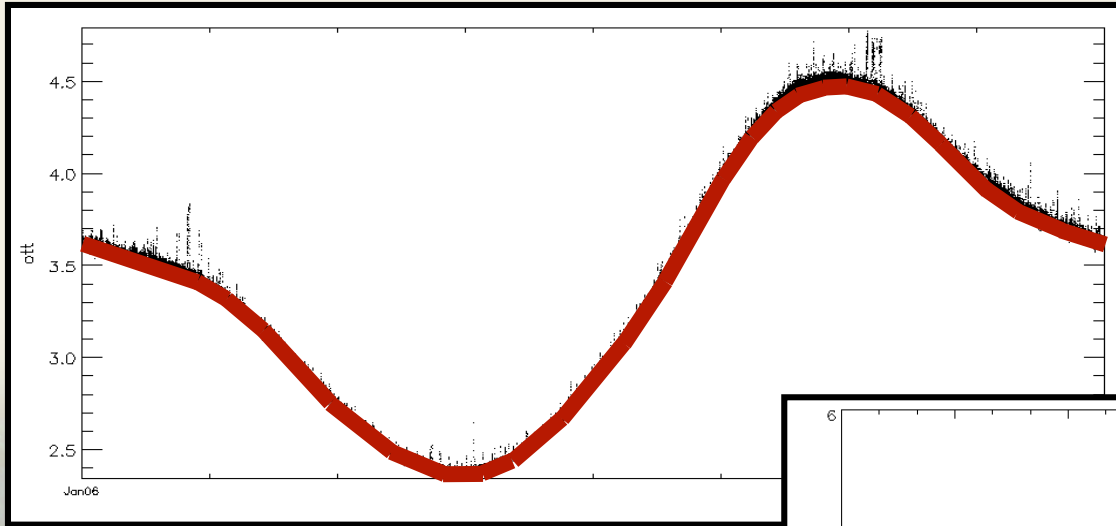
Canadian Riometer Array



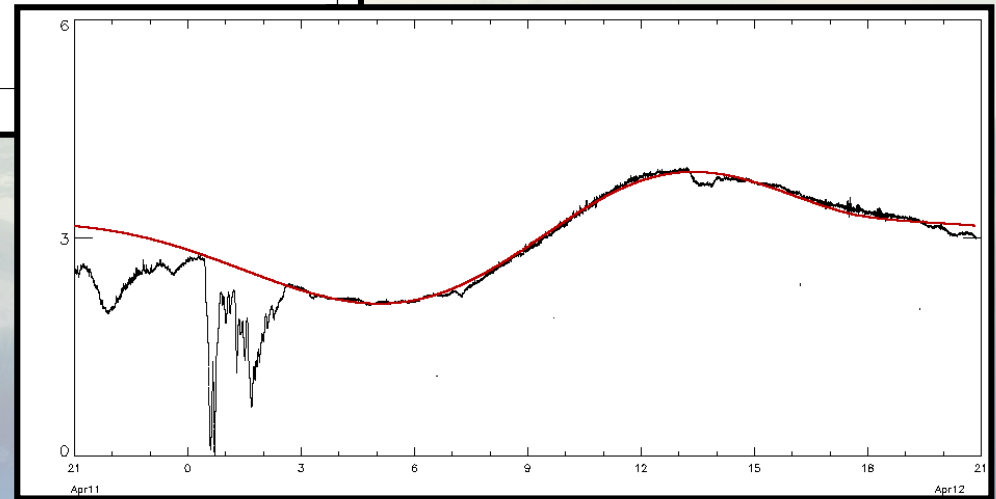


Quiet day curve

Volt



Volt

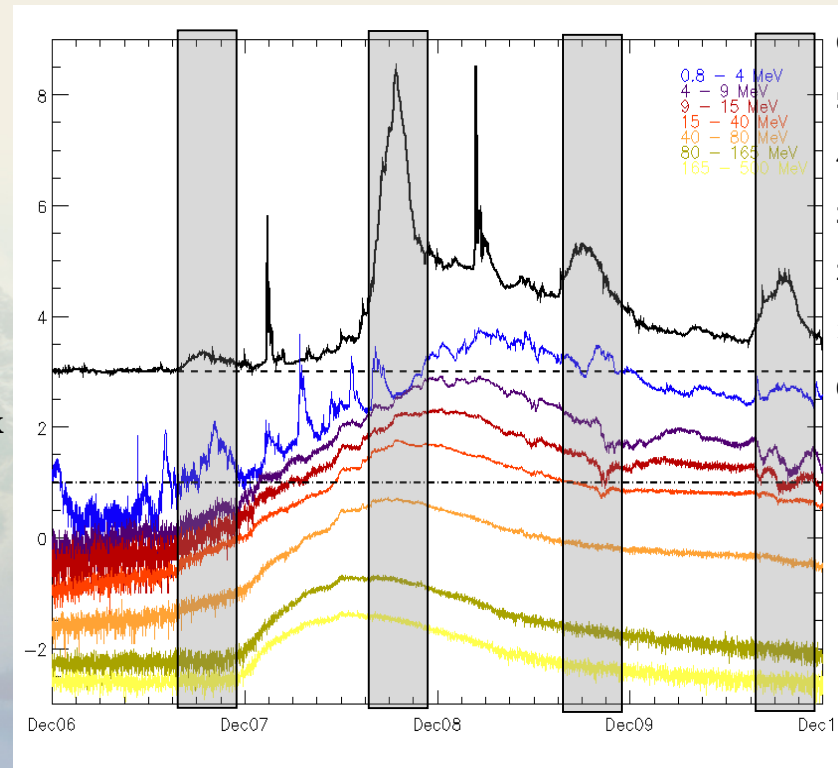


Galactic noise variation over a sidereal day





PCA monitoring



Abs, dB

Taloyoak

Log Flux

GOES protons

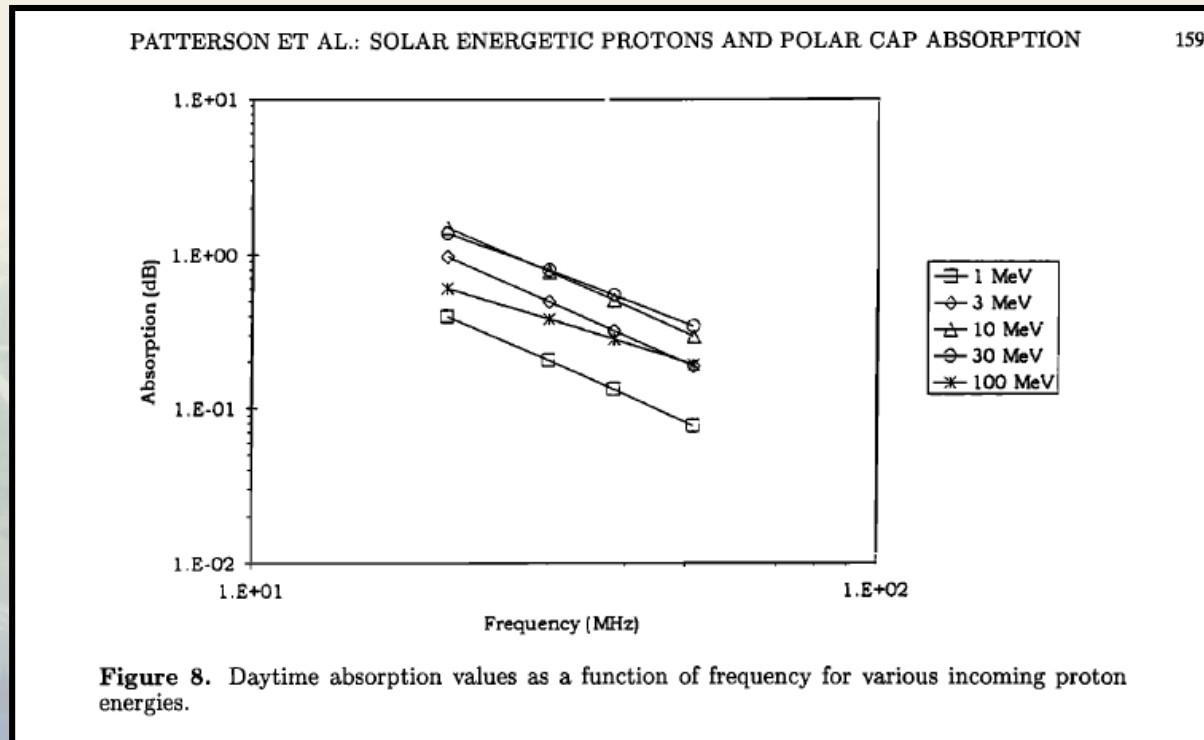
Dec 6, 2006 event

Shaded areas are daytime periods





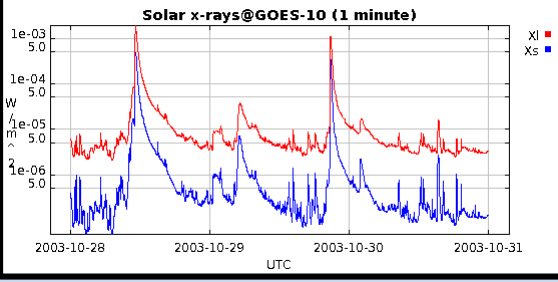
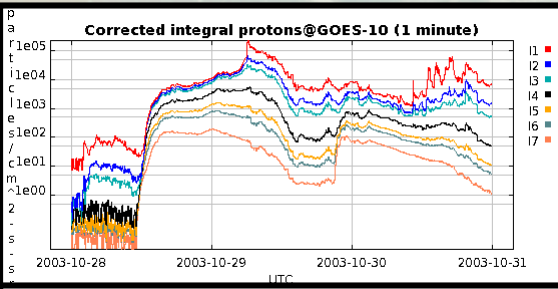
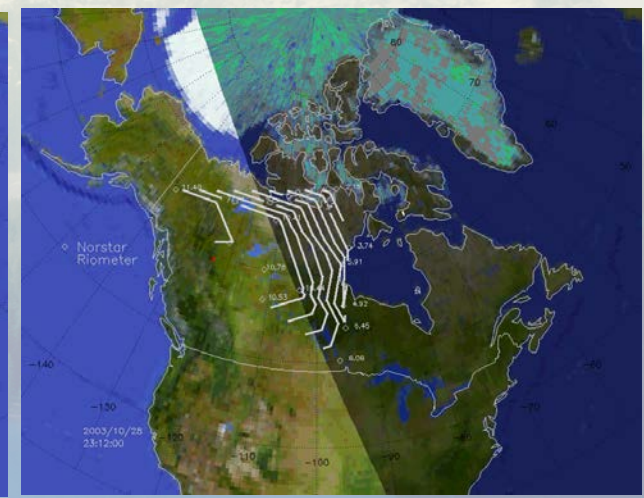
Detection Energies



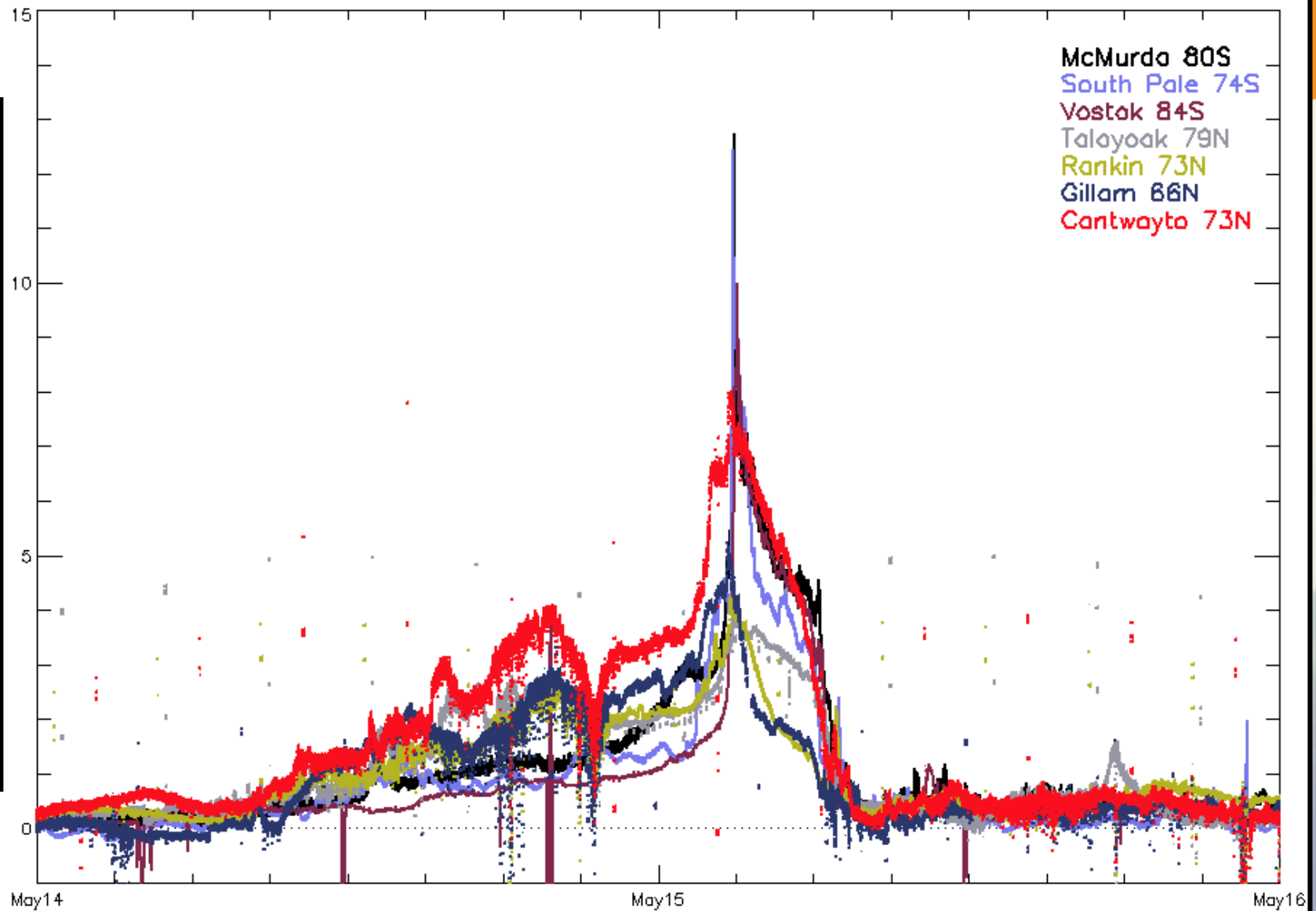
J. D. Patterson, T. P. Armstrong, C. M. Laird, D. L. Detrick and A. T. Weatherwax, Correlation of solar energetic protons and polar cap, Absorption, JGR, V 106, A1, 149-163, 2001

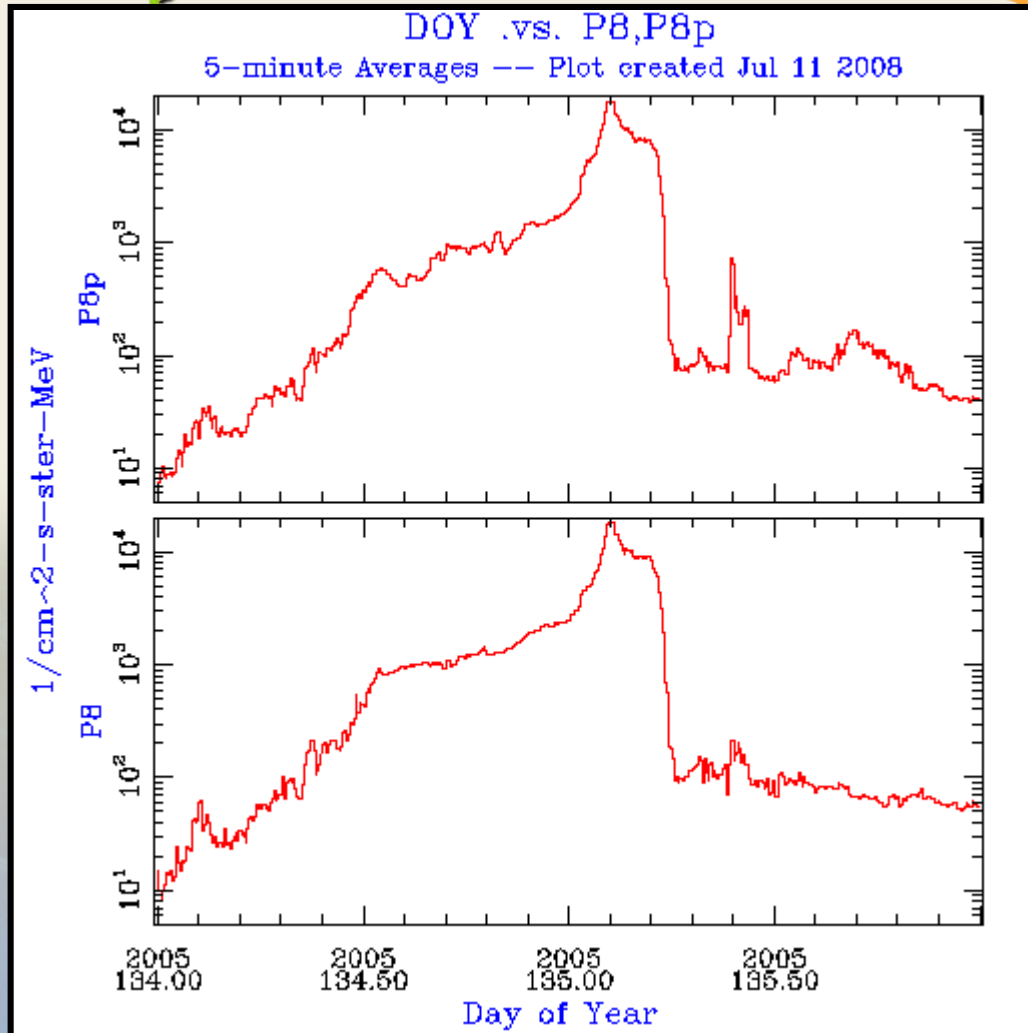


PCA day-night effect Oct 28, 2003



Effective 30 MHz absorption, dB



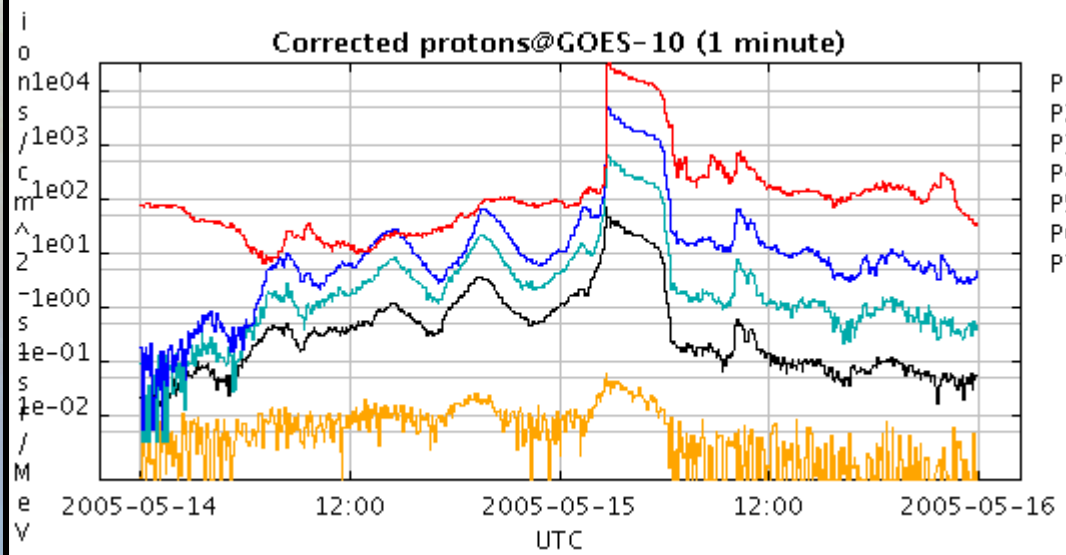
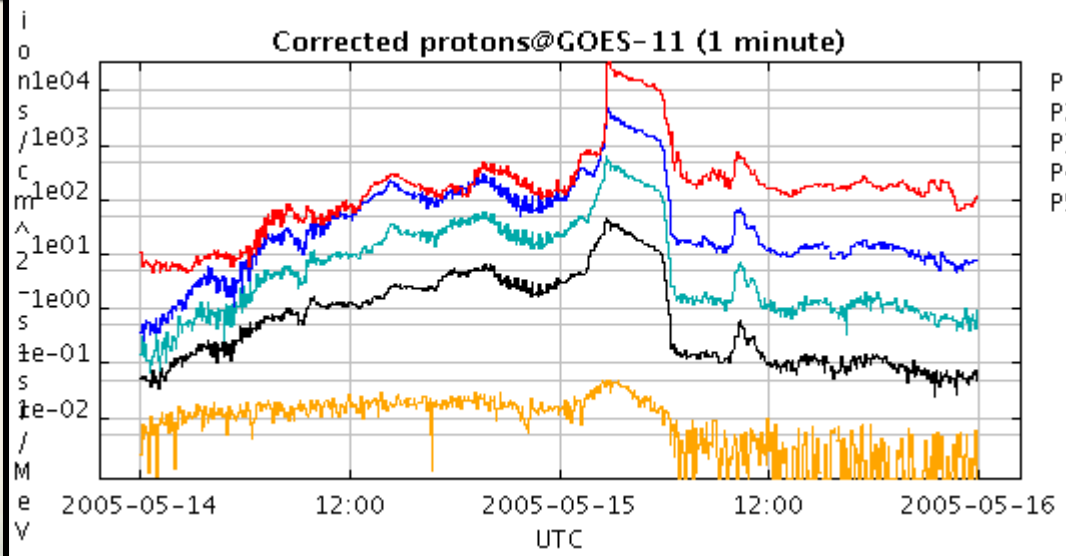


ACE energetic protons

*We thank the ACE
EPAM instrument team
and the ACE Science
Center for providing the
ACE data.*



GOES protons



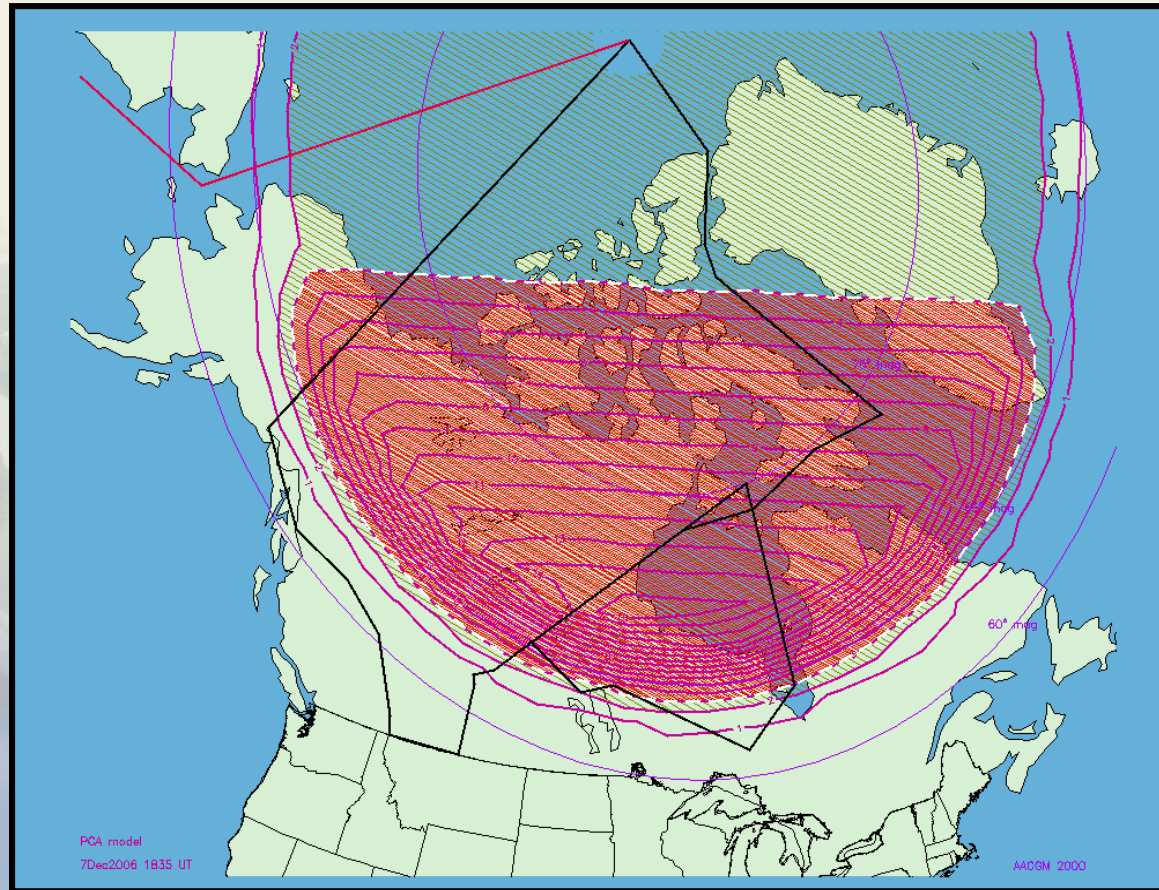
P1	Corrected protons: 0.8 - 4 MeV
P2	Corrected protons: 4 - 9 MeV
P3	Corrected protons: 9 - 15 MeV
P4	Corrected protons: 15 - 40 MeV
P5	Corrected protons: 40 - 80 MeV

We thanks the National Geophysical Data Center for the GOES data.
<http://spidr.ngdc.noaa.gov/spidr/index.jsp>





Polar Cap Absorption





Take-away's

- Riometers are widely distributed and functionally have not changed since 1970's.
- Respond to ~ 10 MeV protons
- Easiest detection of protons during sunlit periods
- Detection time is quick by the ionosphere
- Proton events often occur before magnetic activity.
- Comparison during active periods can be contaminated by Auroral Particles and Energetic Electrons.



Conclusion

- Riometer data has been collected since ~1990 under CANOPUS.
- NRCan riometers were installed after 2006
- A new website will be available for accessing absorption values
- For further information/ clarification / data send email to: Donald.Danskin@Canada.ca

Canadian Riometer Array is funded in part by the Canadian Space Agency through Go-Canada grants. E. Spanswick is the principal investigator for the Go-Riometer part of the array, D. Danskin manages the NRCan riometers.

