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# Improved Modelling of Shortwave Fadeout with 30 MHz riometer data

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**Canadian Hazard Information Service**
**Natural Resources Canada**

**spaceweather.gc.ca**

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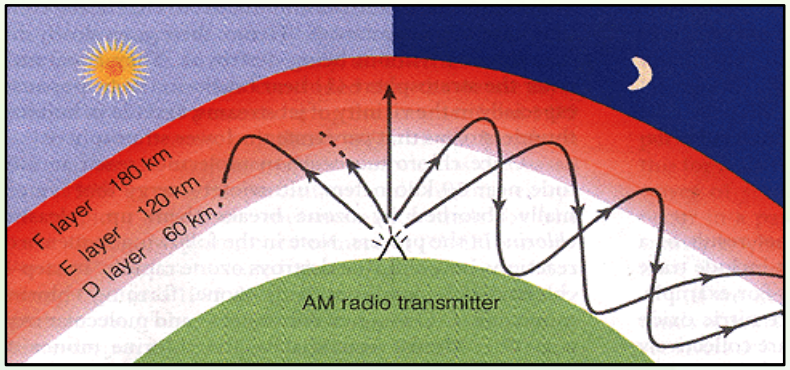
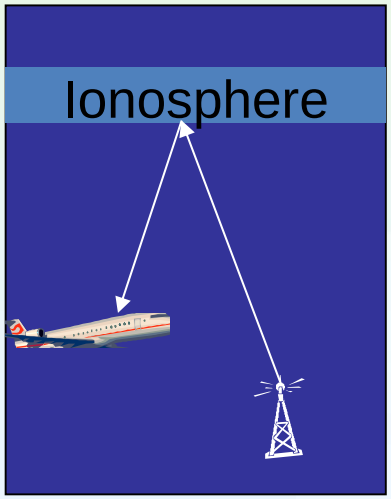
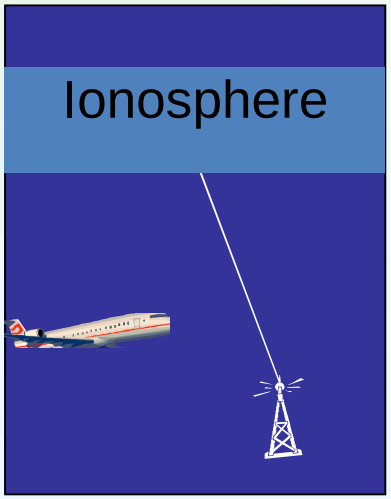
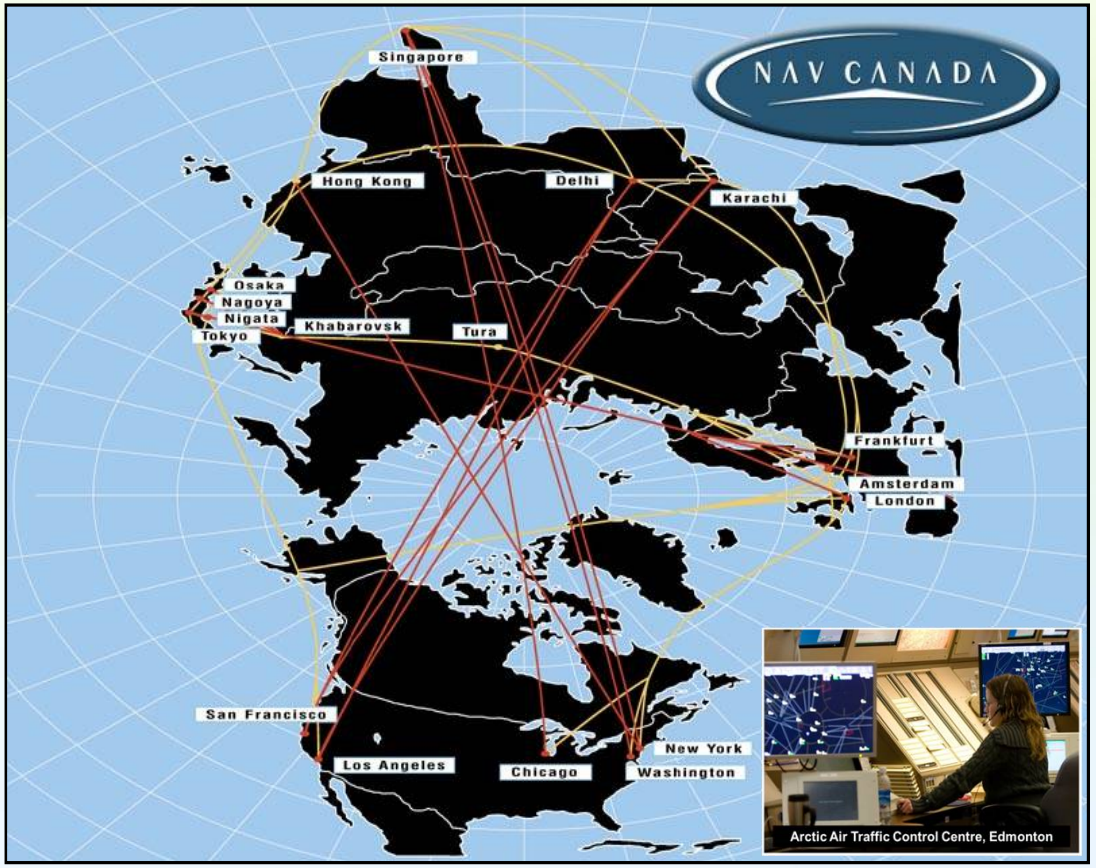
# HF Radio Communication

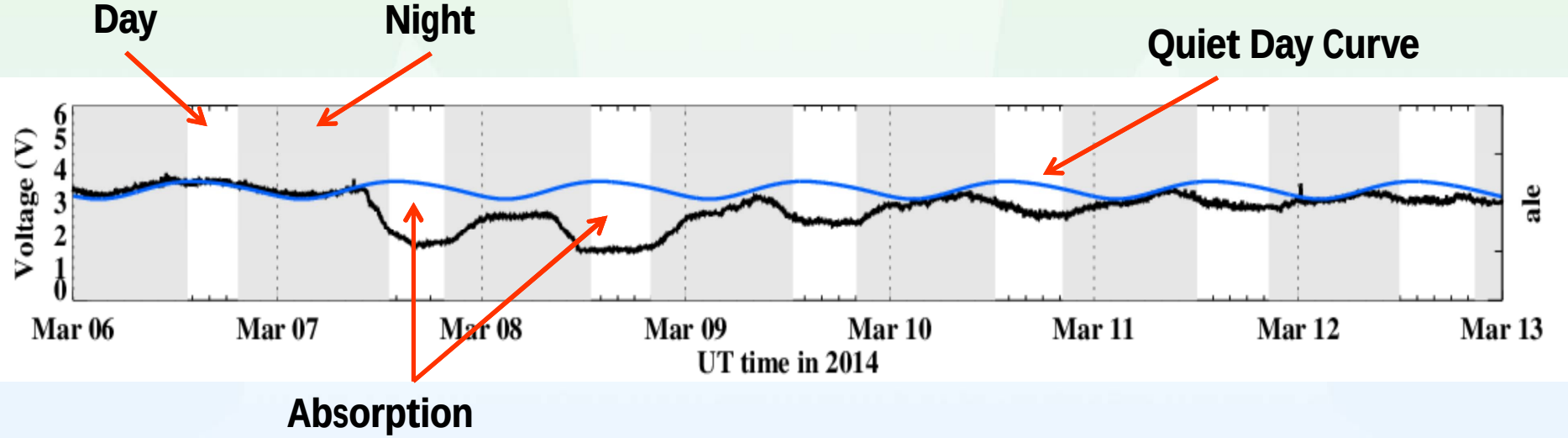


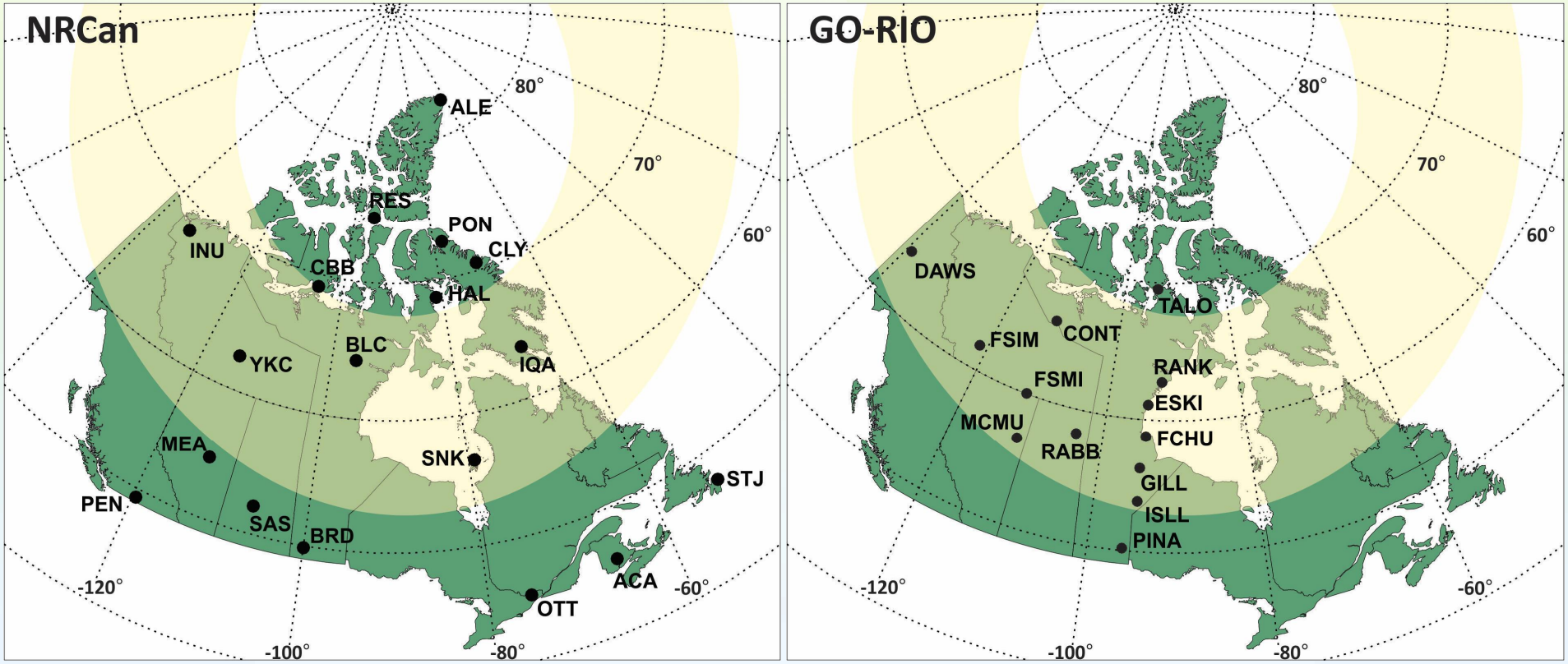



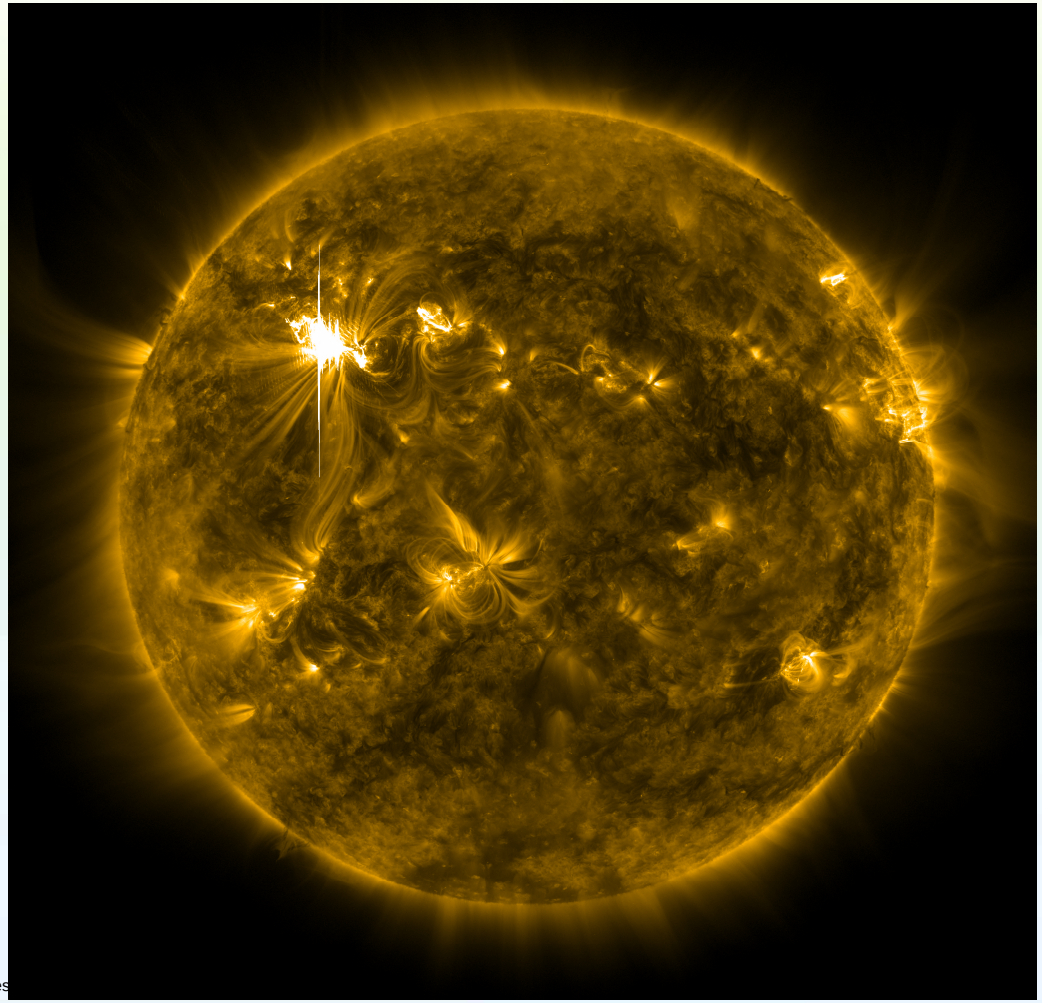
# Riometer Instrument



# Riometer network

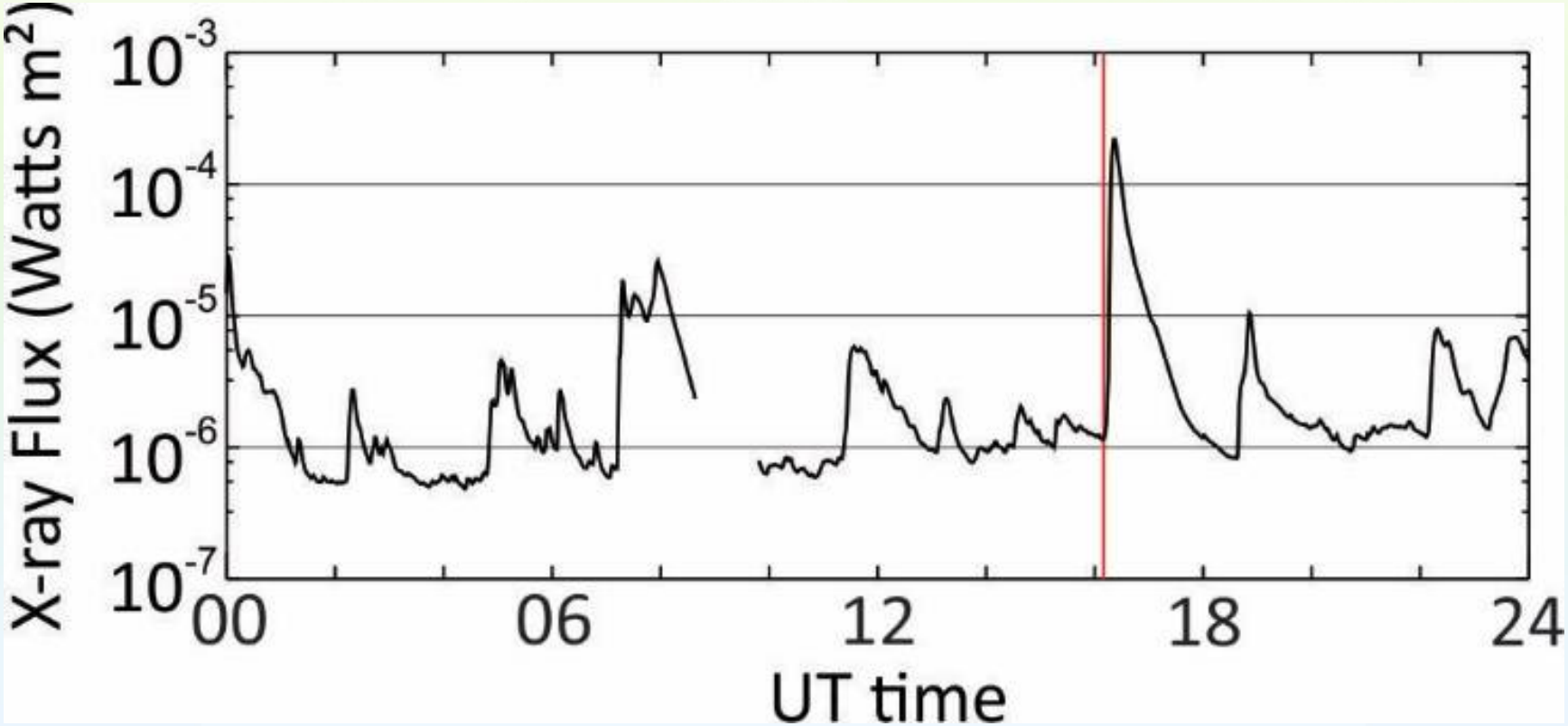


# Solar flares

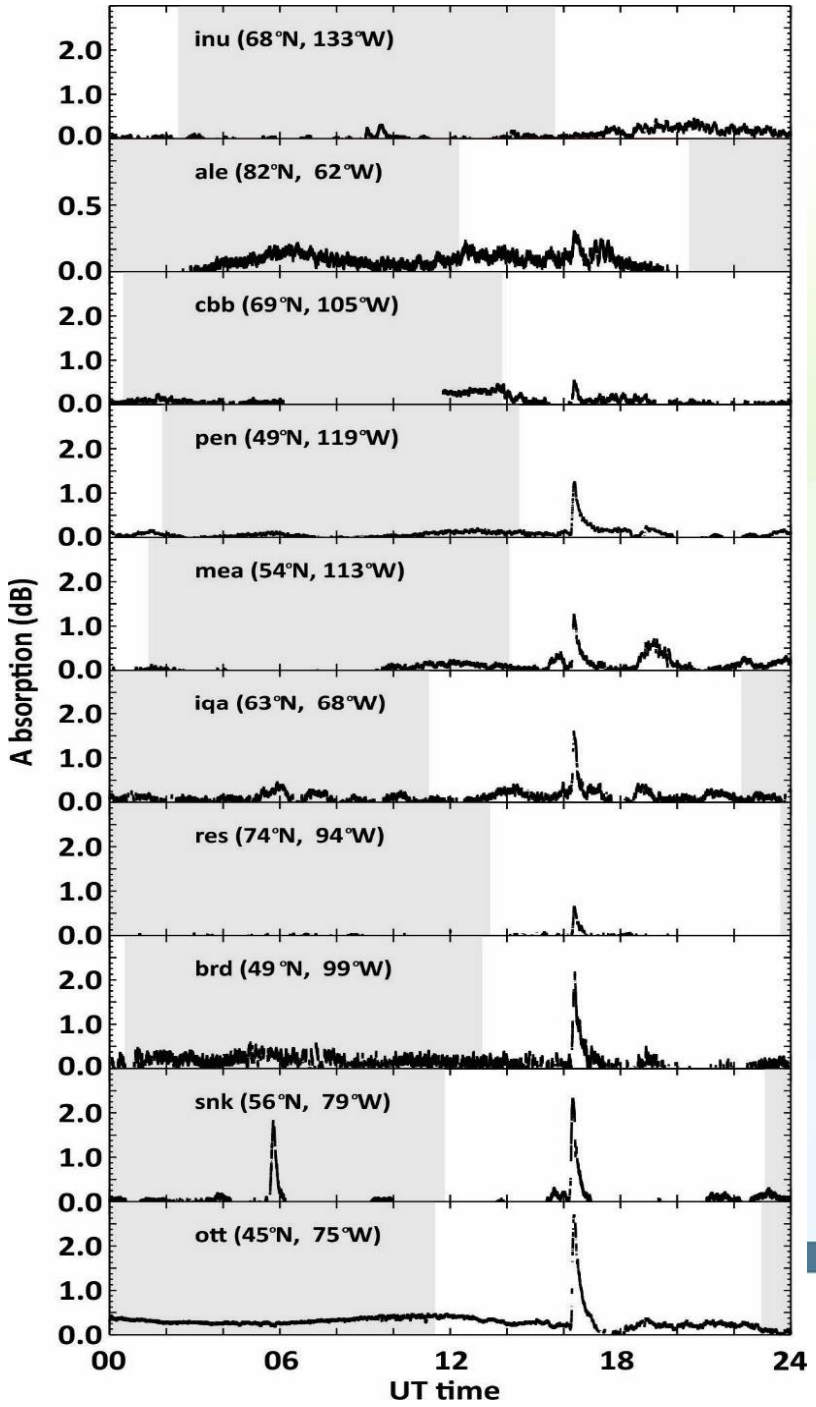


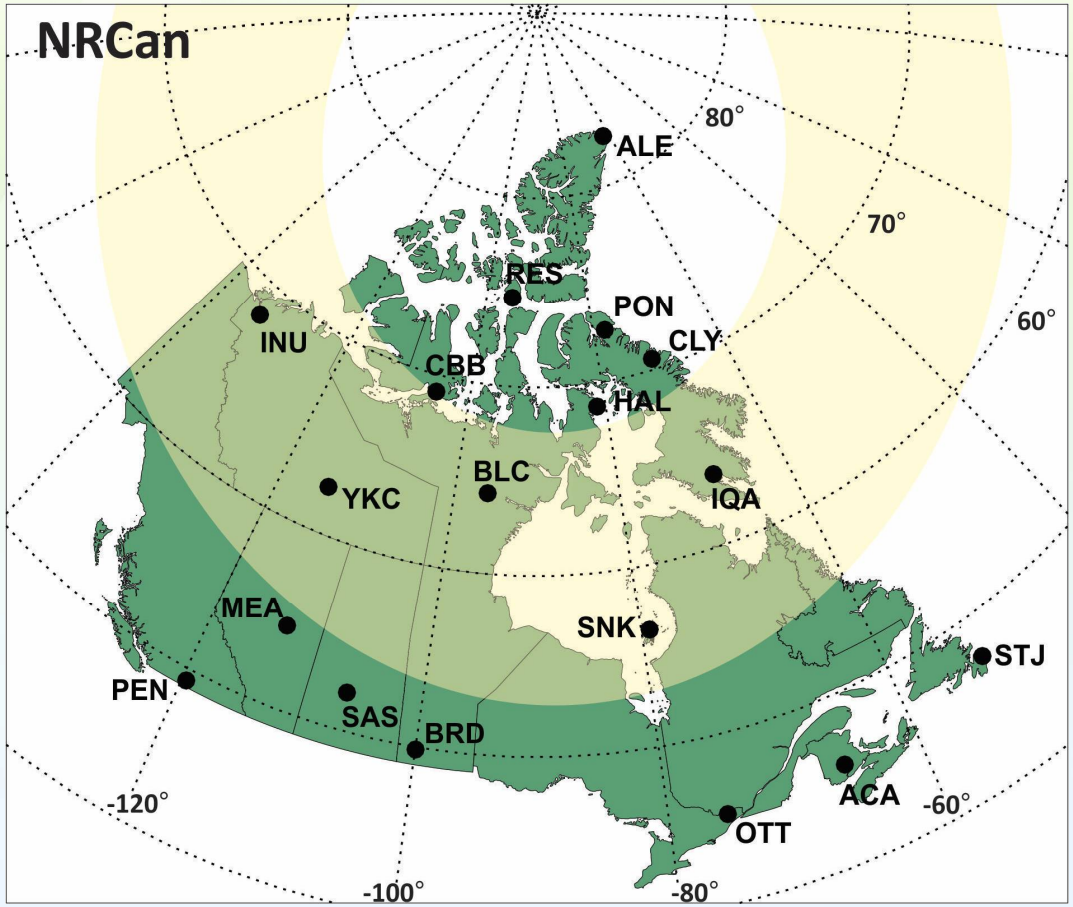
# Event Study
# 11 March 2015

# GOES x-ray flux



# Riometer observations

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# Modelling Shortwave Fadeout

Highest Affected Frequency

Solar X-ray flux

Solar Zenith Angle

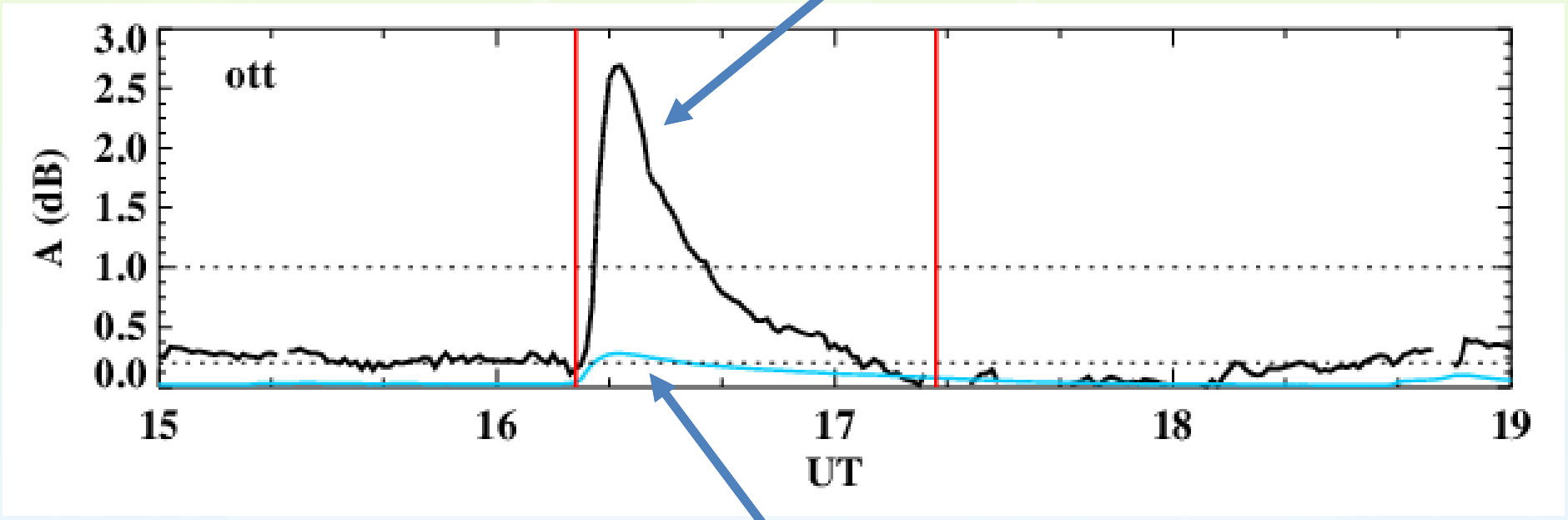
$$HAF = (10 \log F + 65) \cos^{0.75} \chi$$

$$A_x = 0.5 \left[ \frac{HAF}{30\ MHz} \right]^{1.5}$$

Absorption at 30 MHz

# Does the model work?

**Riometer – derived absorption**




**Model – derived absorption**

# What's wrong with the model?

$$HAF = (10 \log F + 65) \cos^{0.75} \chi$$

$$A_x = 0.5 \left[ \frac{HAF}{30\ MHz} \right]^{1.5}$$

# What's wrong with the model?

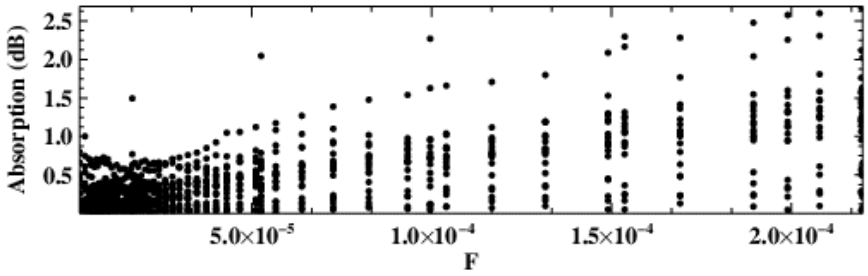
$$HAF = (10 \log F + 65) \cos^{0.75} \chi$$

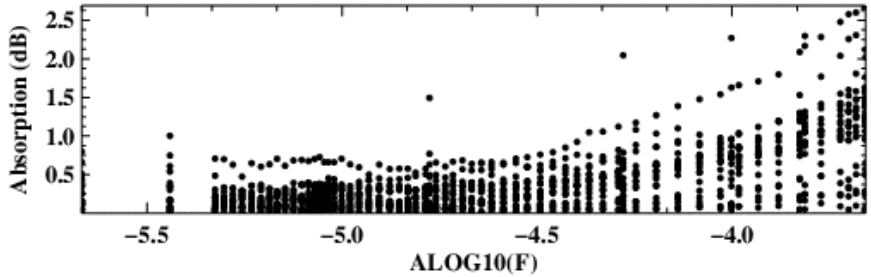
**5MHz data**
**Limited input**
**No X-ray flux!**
**SZA dependence**

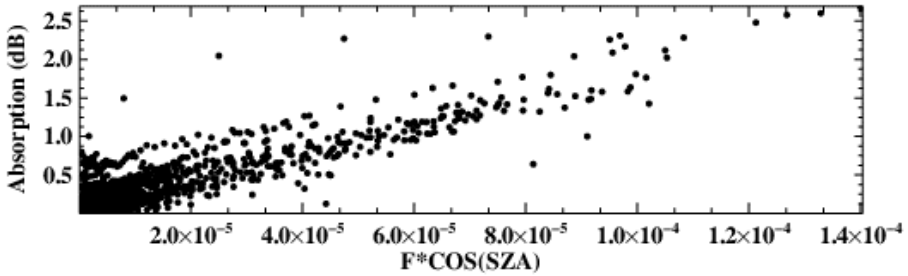
$$A_x = 0.5 \left[ \frac{HAF}{30\ MHz} \right]^{1.5}$$

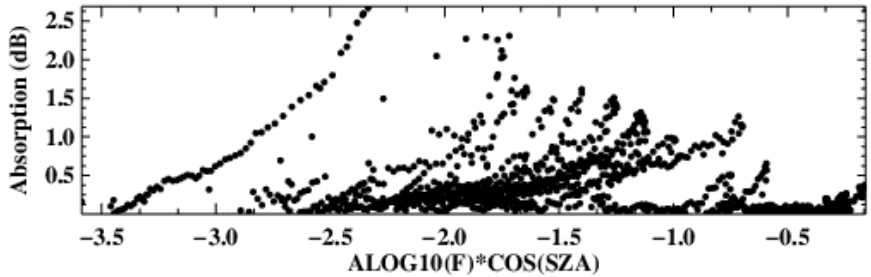
**Scaling doesn't work**
**Varies from 0.2 to 1.0**

# Can we do better?



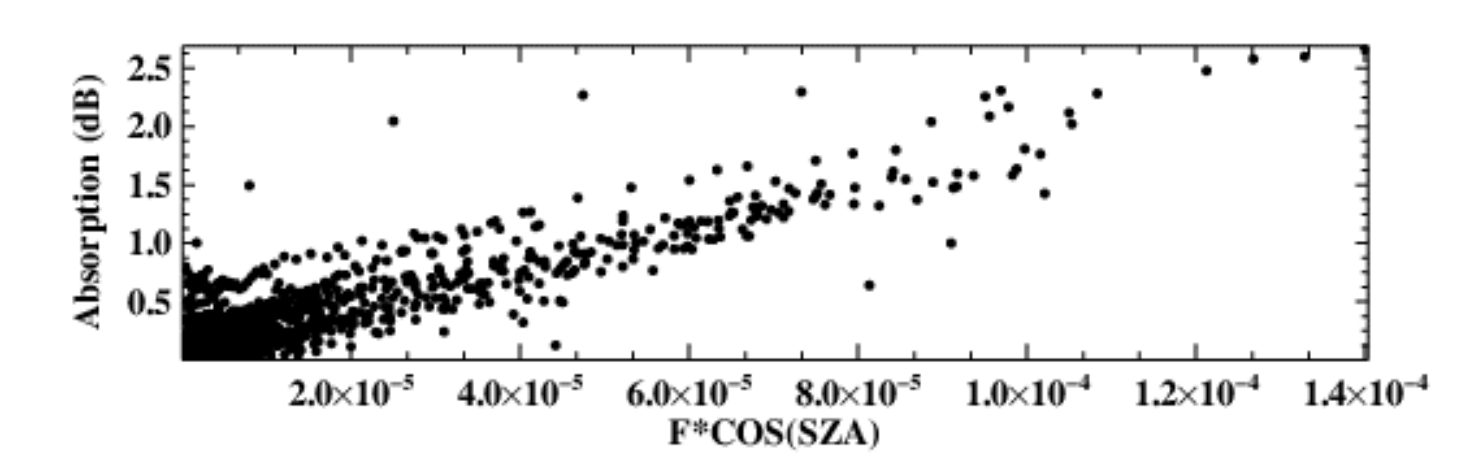




$$A \propto F$$

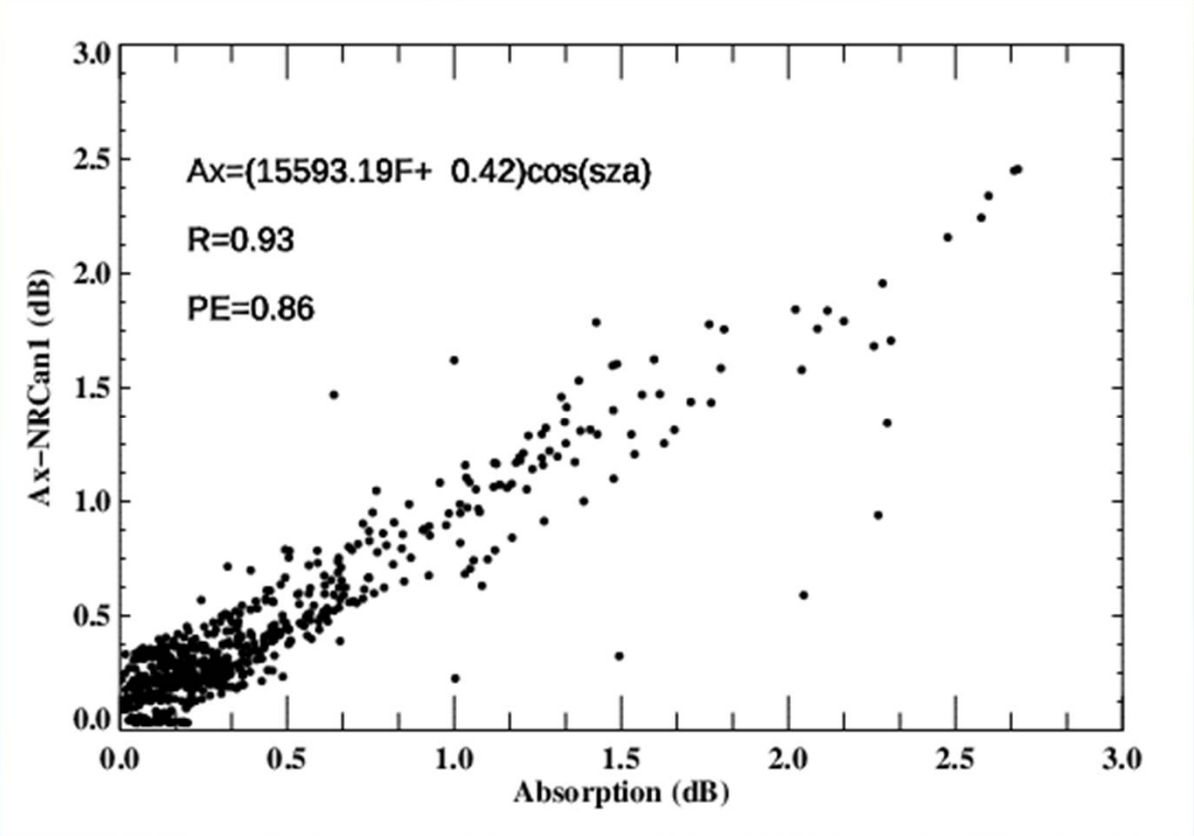
$$A \propto log_{10} F$$

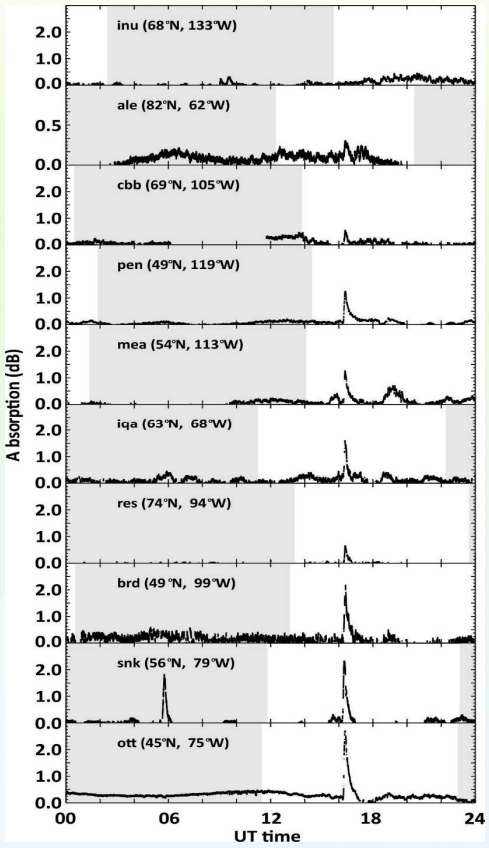
# Starting over – SIMPLIFY!




$$A_x = [AF + B]\cos(\chi)$$

# Modelled Absorption

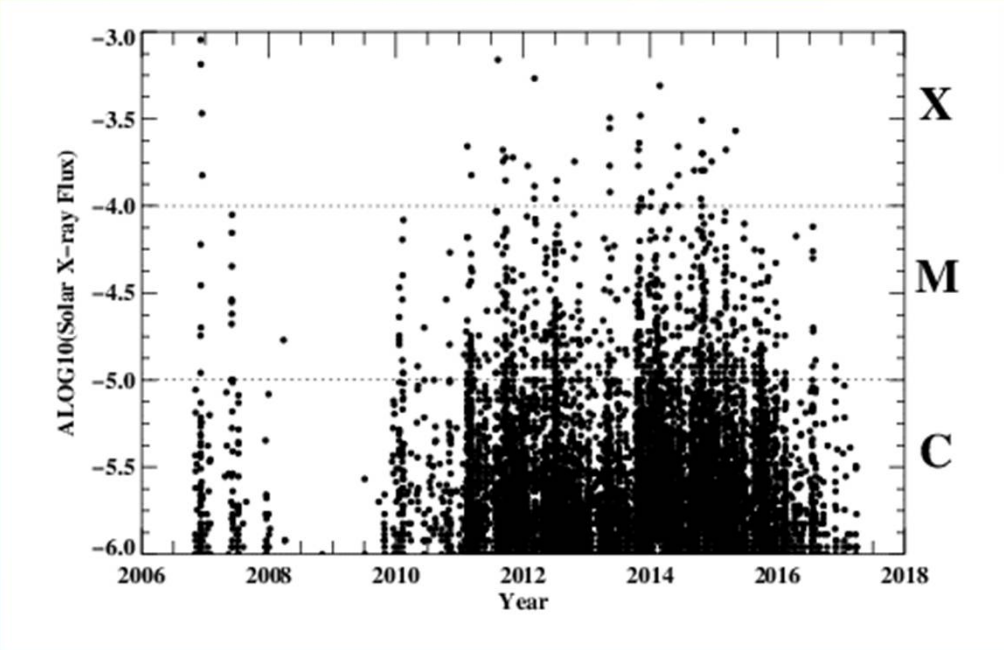


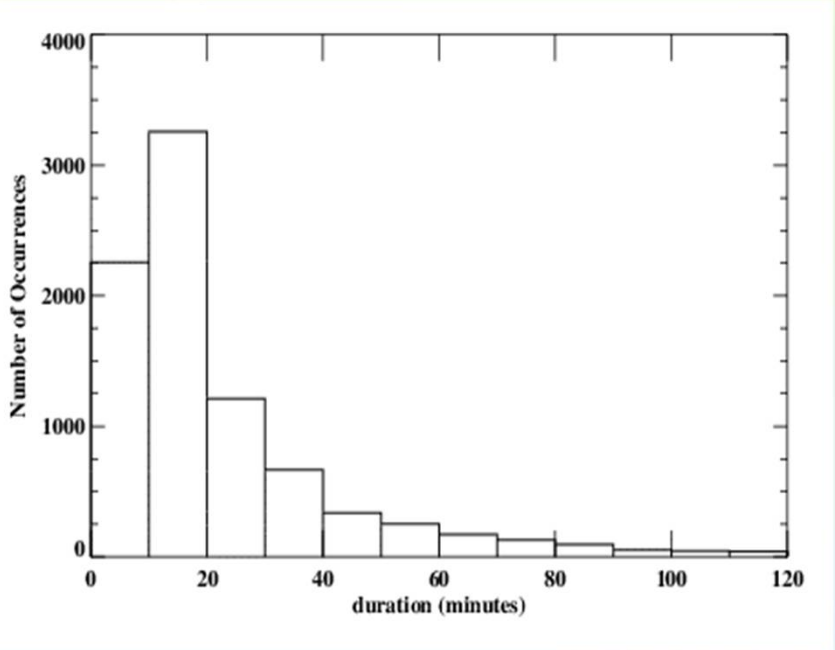




$$A_x = [AF + B]\cos(\chi)$$

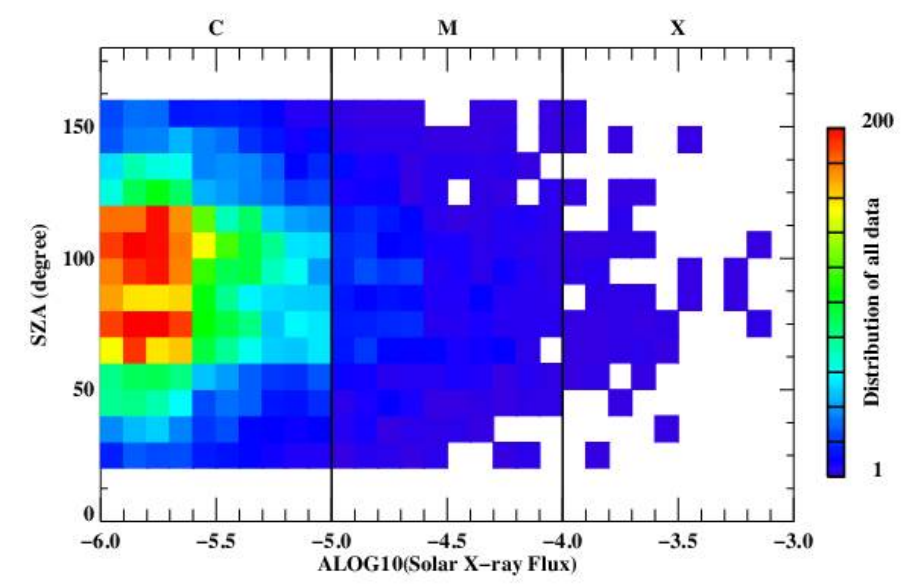
# Multi Event Study

# Solar X-ray flares 2006-2017

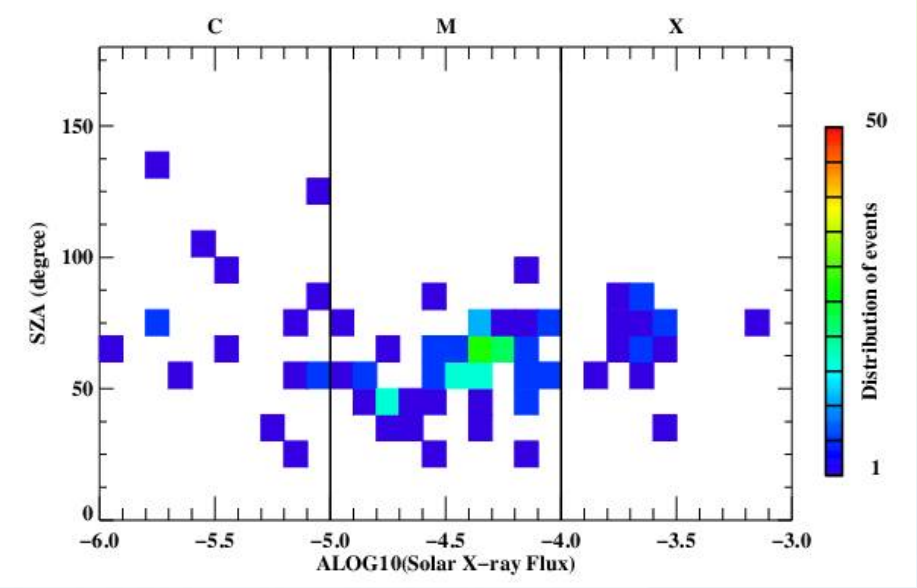


# Solar X-ray flares 2006-2017

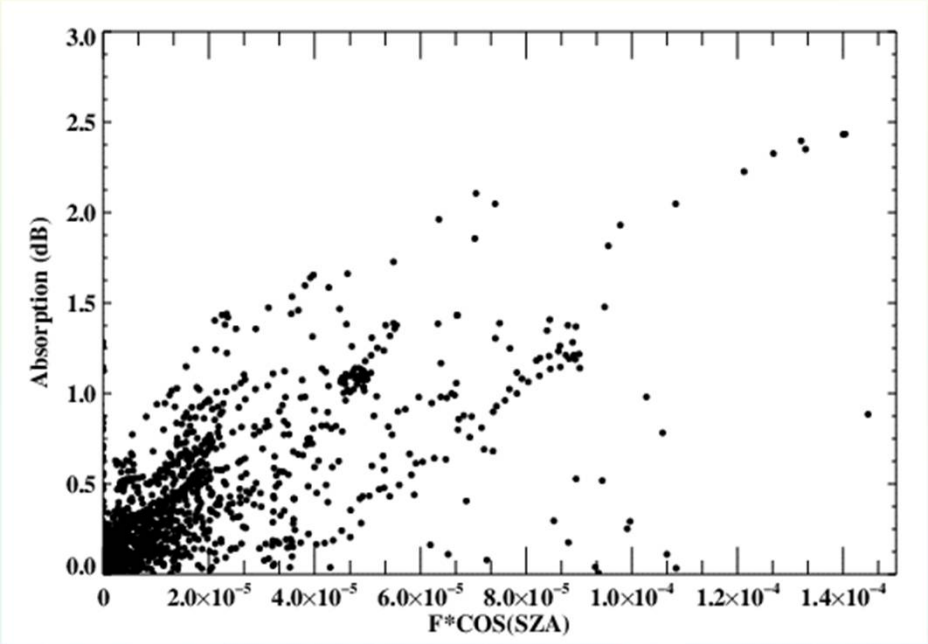


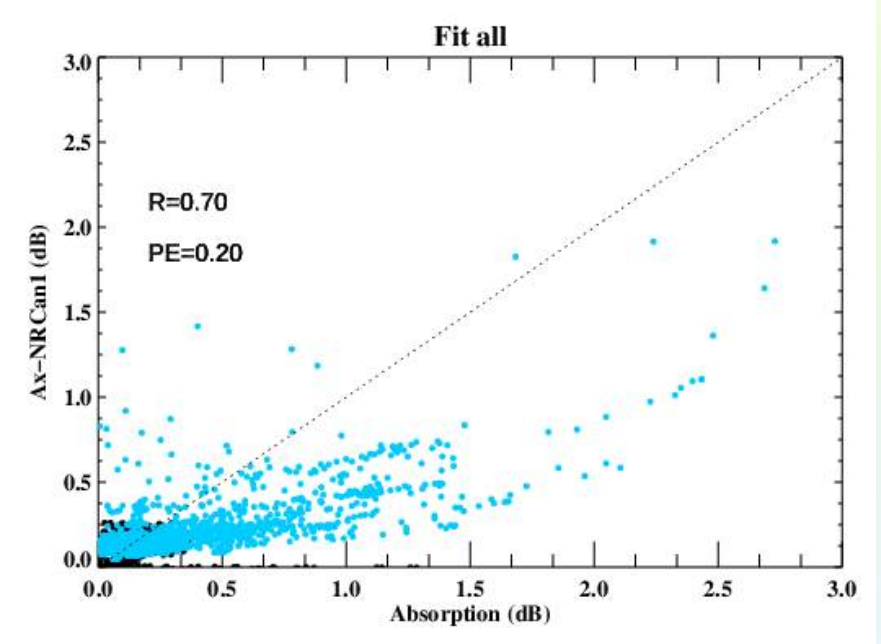

All Flares



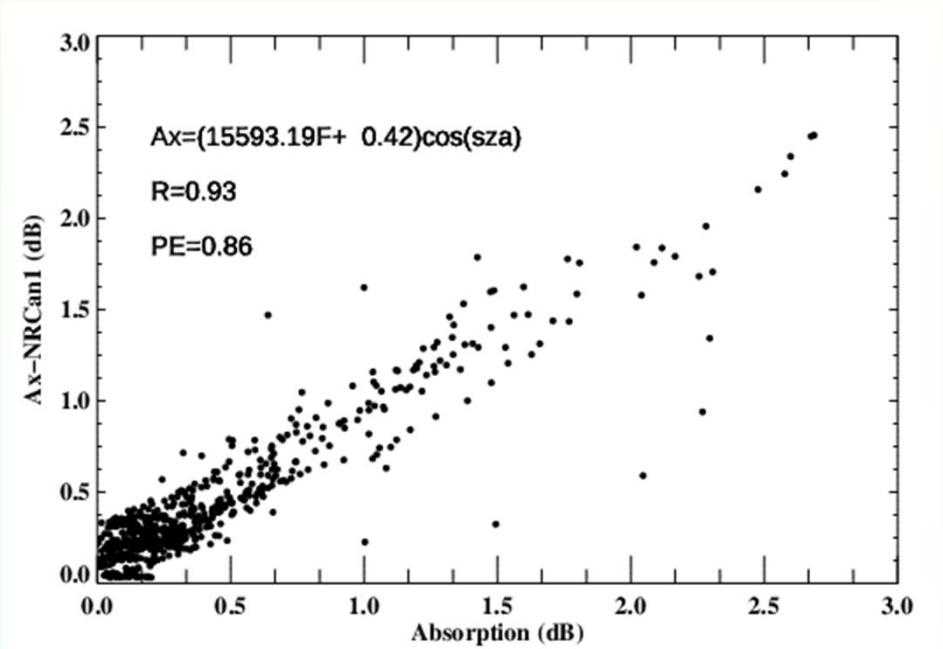

OTT flares

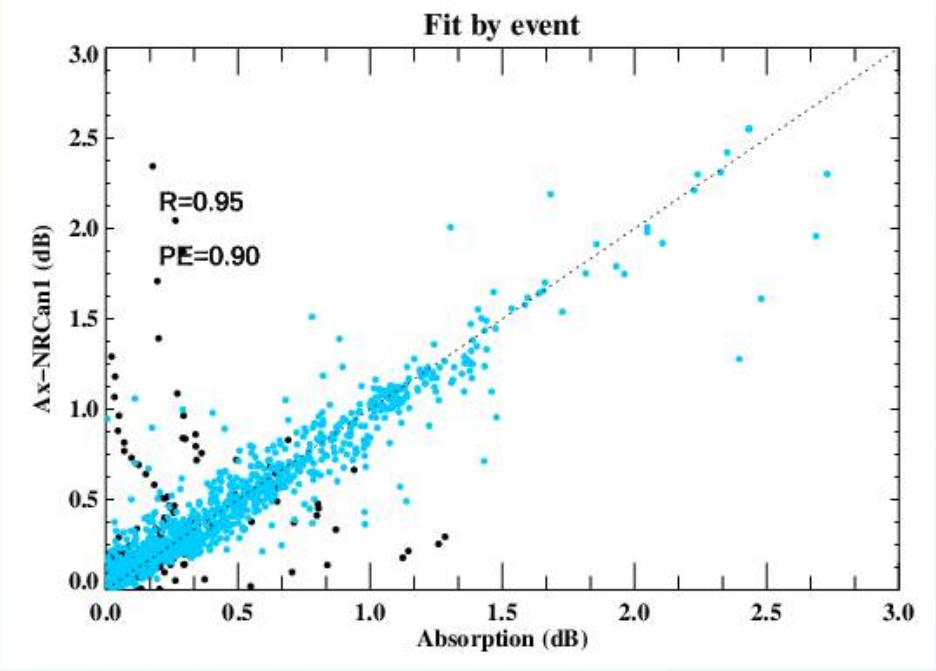
# Modelling the overall data set



# Improved Modelling of Shortwave Fadeout




**11 March 2015**
**multiple riometers**

**2006-2017 flares**
**OTT riometer**

# Summary and Conclusions

- Current methods for modelling absorption due to shortwave fadeout severely underestimate absorption at 30 MHz
- Absorption modelling is significantly improved by adopting a simple relationship

$$A_x = [AF + B]\cos(\chi)$$

- Question: How to parameterize the model?

# Thank you