

Wind/WAVES Calibration

Scaling of Type II Bursts with Flare Flux

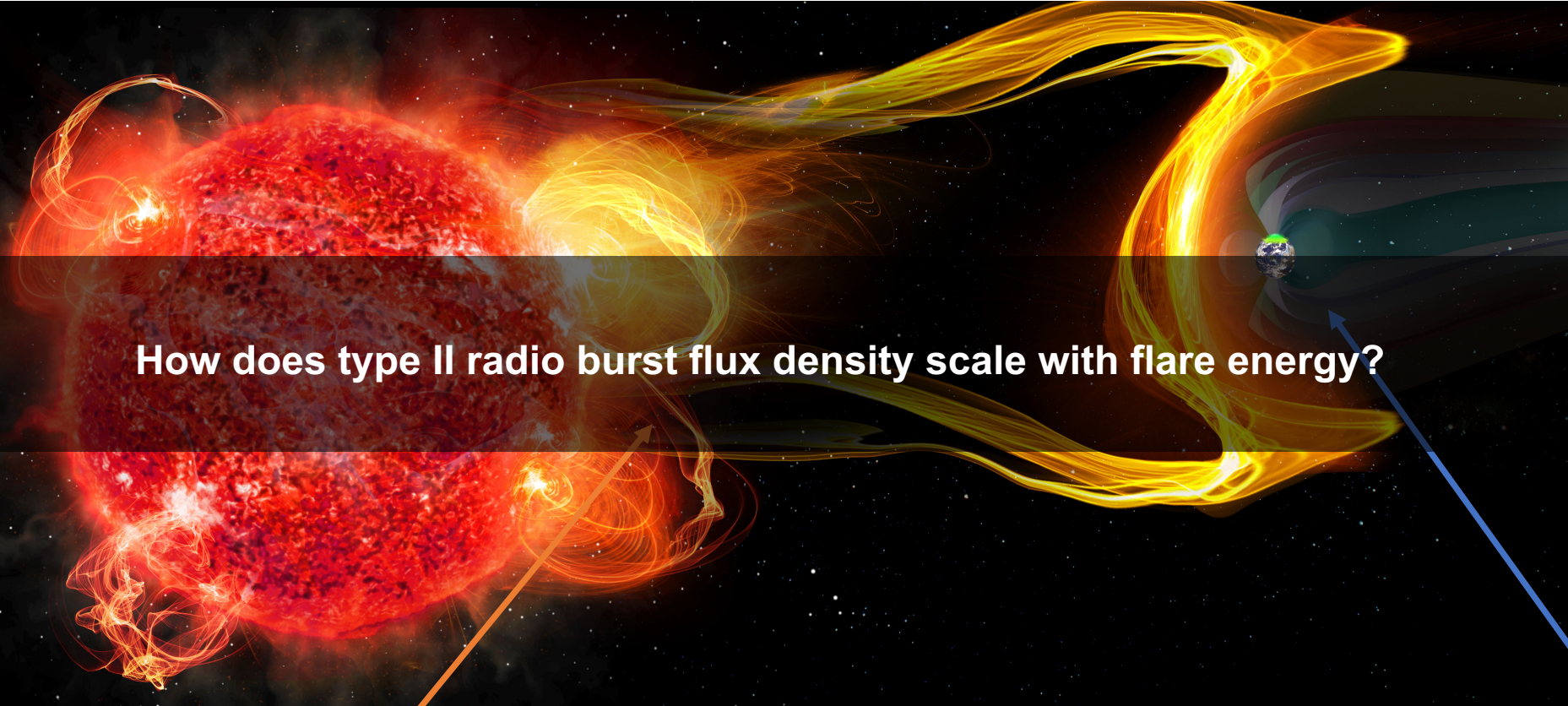
Marin Anderson (JPL)

March 11, 2021

SunRISE Science Team Telecon



Measuring stellar (and exoplanetary) radio emission is critical for understanding the role of extrasolar space weather in habitability.



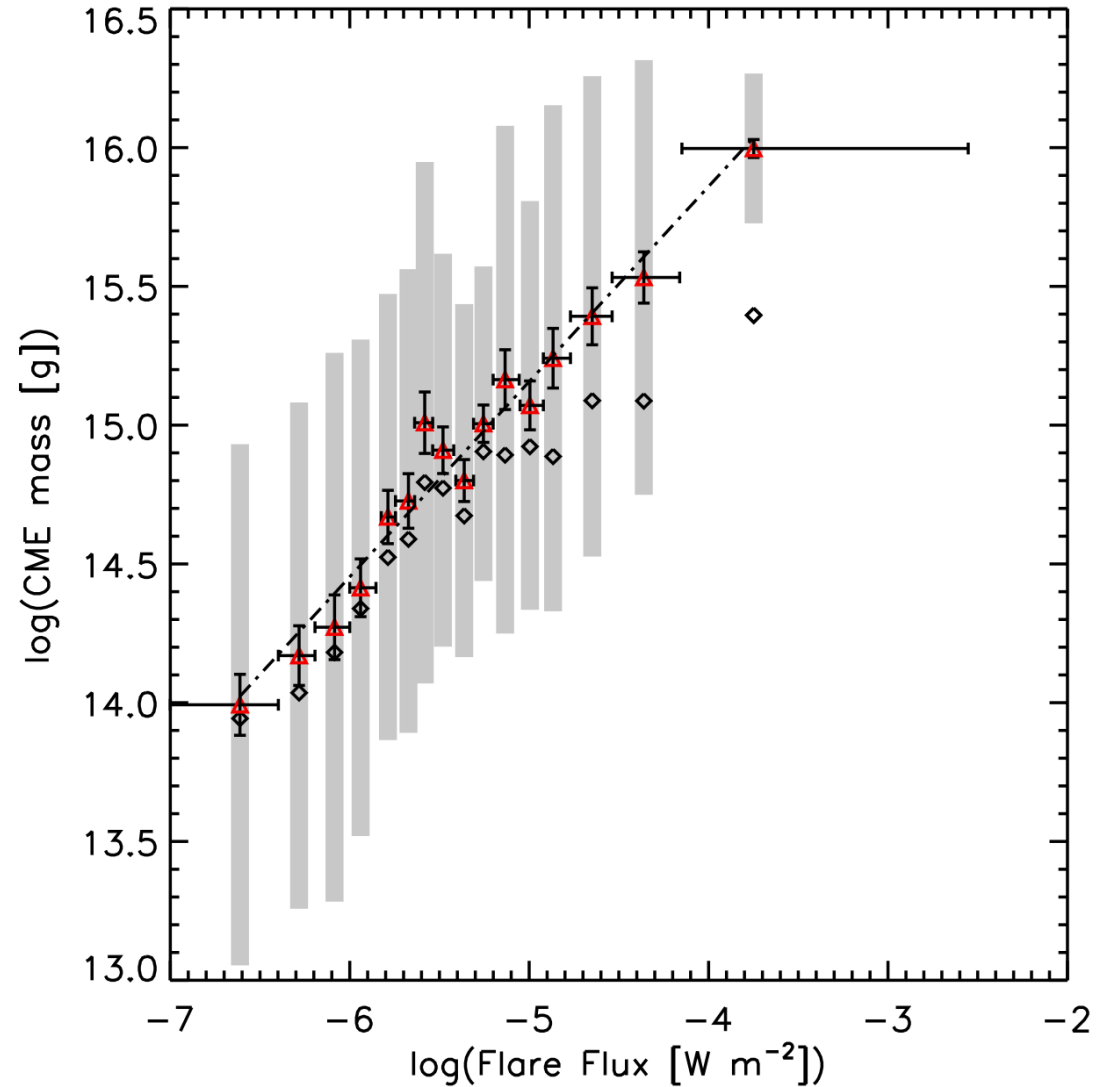
How does type II radio burst flux density scale with flare energy?

CMEs and SEPs

Auroral radio emission

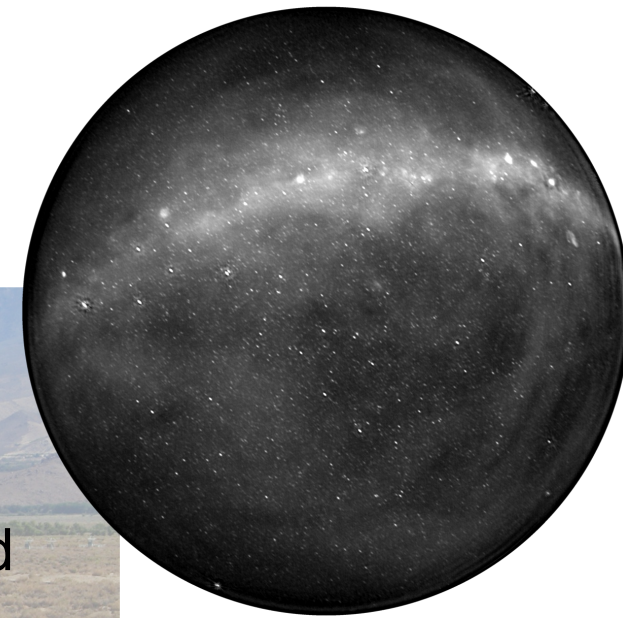
Relationship between X-ray flare flux and CME mass on the Sun

- Sample of temporally and spatially correlated X-ray flares and CMEs from the GOES and LASCO archives, spanning 1996–2006
- Single power-law relationship applicable over at least 3 dex in flare flux
- Does this relationship extend to other stars and higher flare energies?



Aarnio et al. 2011

Extrasolar space weather monitoring with the OVRO-LWA

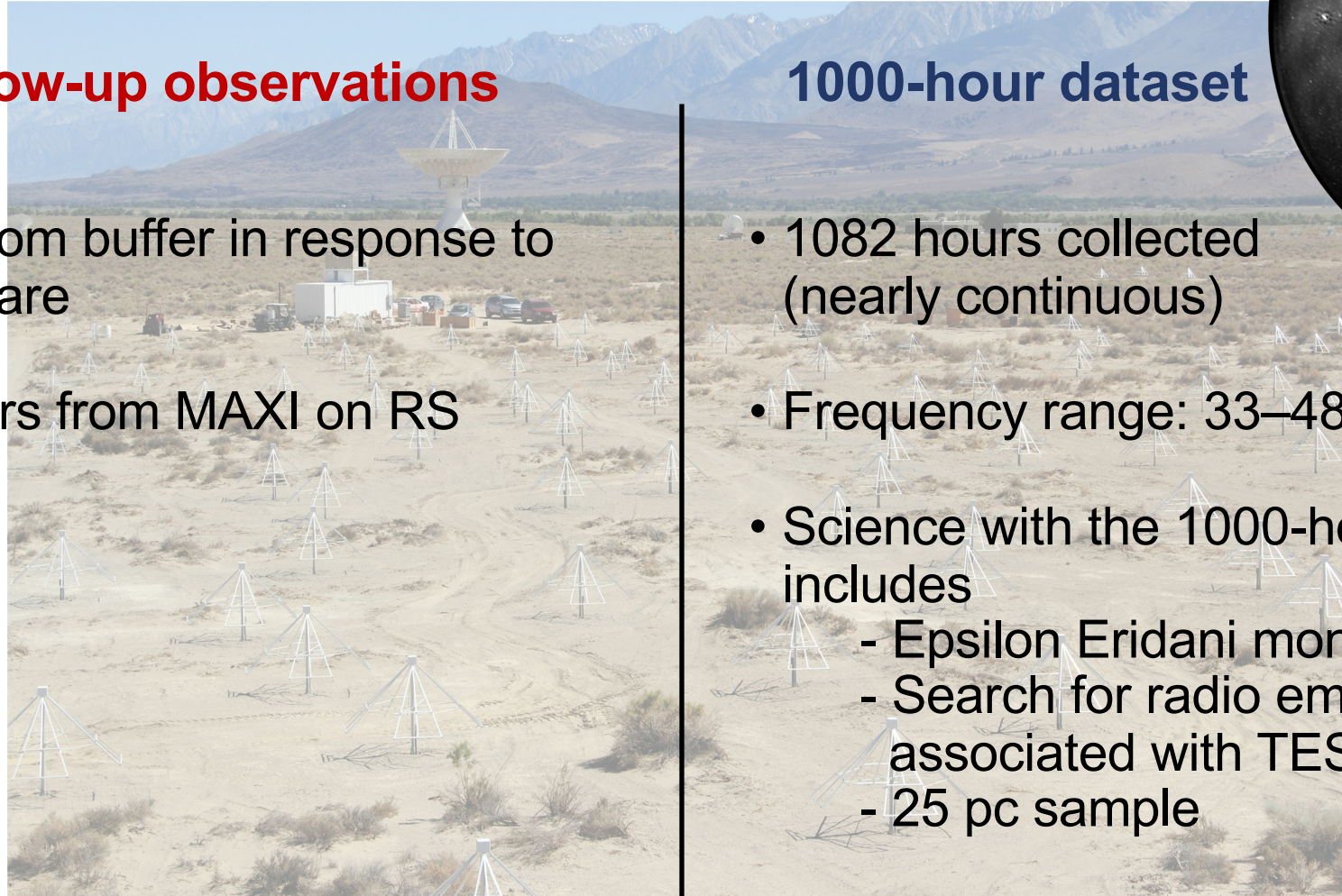


Triggered follow-up observations

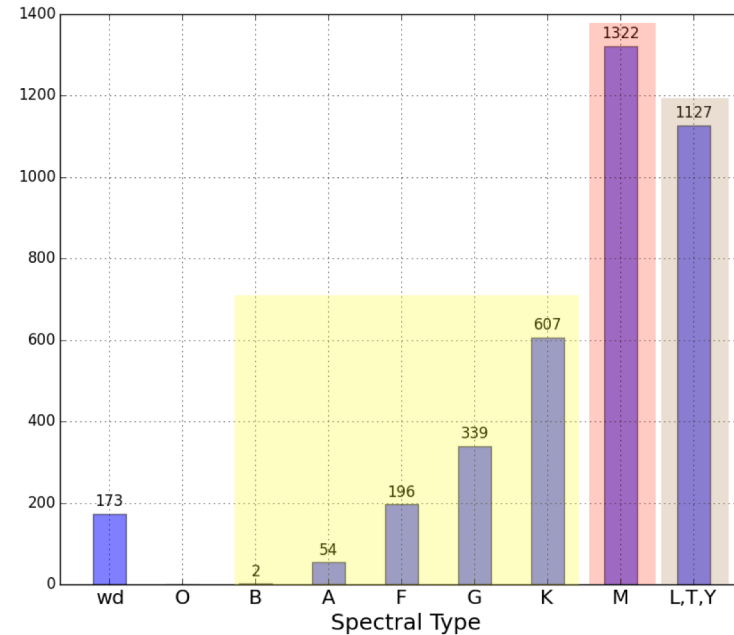
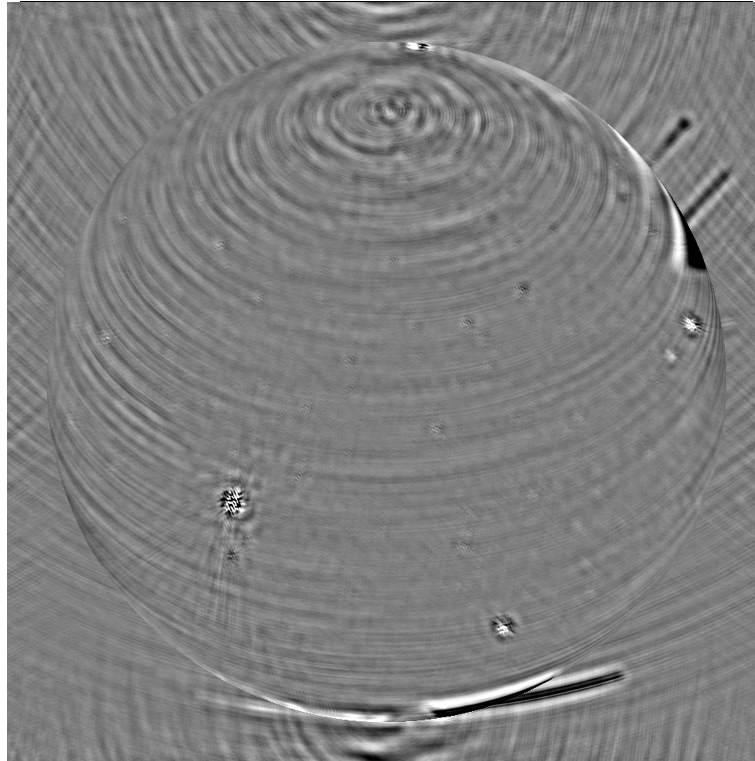
- Data pulled from buffer in response to detection of flare
- 2 X-ray triggers from MAXI on RS CVns

1000-hour dataset

- 1082 hours collected (nearly continuous)
- Frequency range: 33–48 MHz
- Science with the 1000-hour dataset includes
 - Epsilon Eridani monitoring
 - Search for radio emission associated with TESS flares
 - 25 pc sample



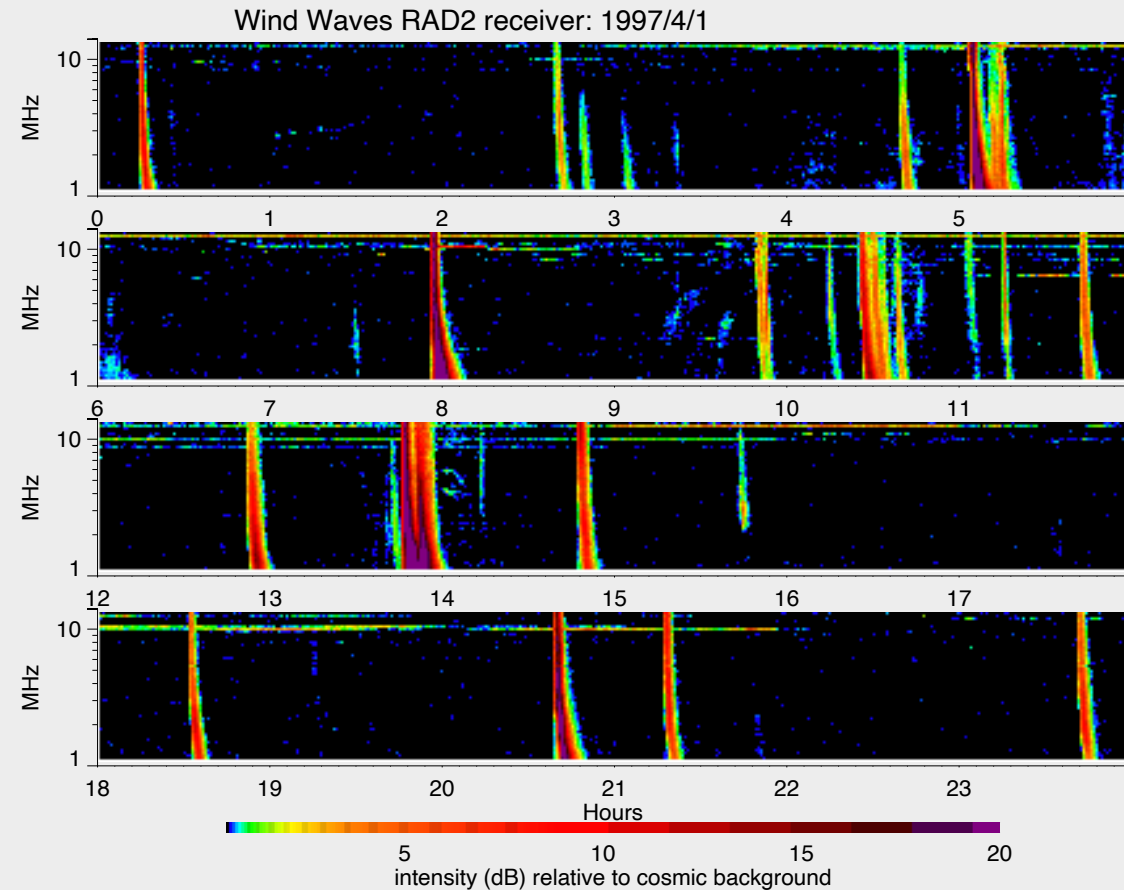
Simultaneous monitoring of all stellar systems out to 25 pc.



- Volume-limited sample of nearly 4000 systems.
- Search for signatures of space weather across a broad range of stellar ages and spectral types.

Wind/WAVES type II burst and CME catalog

- Catalog of manually identified type II bursts observed by Wind/WAVES, spanning April 1997 – September 2017.
- Associated CMEs observed by SOHO/LASCO and flares observed by GOES.
- Order(500) DH type II bursts catalogued here.



Calibration of Wind/WAVES RAD2 (1.075 – 13.8 MHz)

$$S_B(\nu) = S_{\nu,gal} \frac{P_{\nu,B}}{P_{\nu,gal}} \quad [\text{Jy}]$$

where

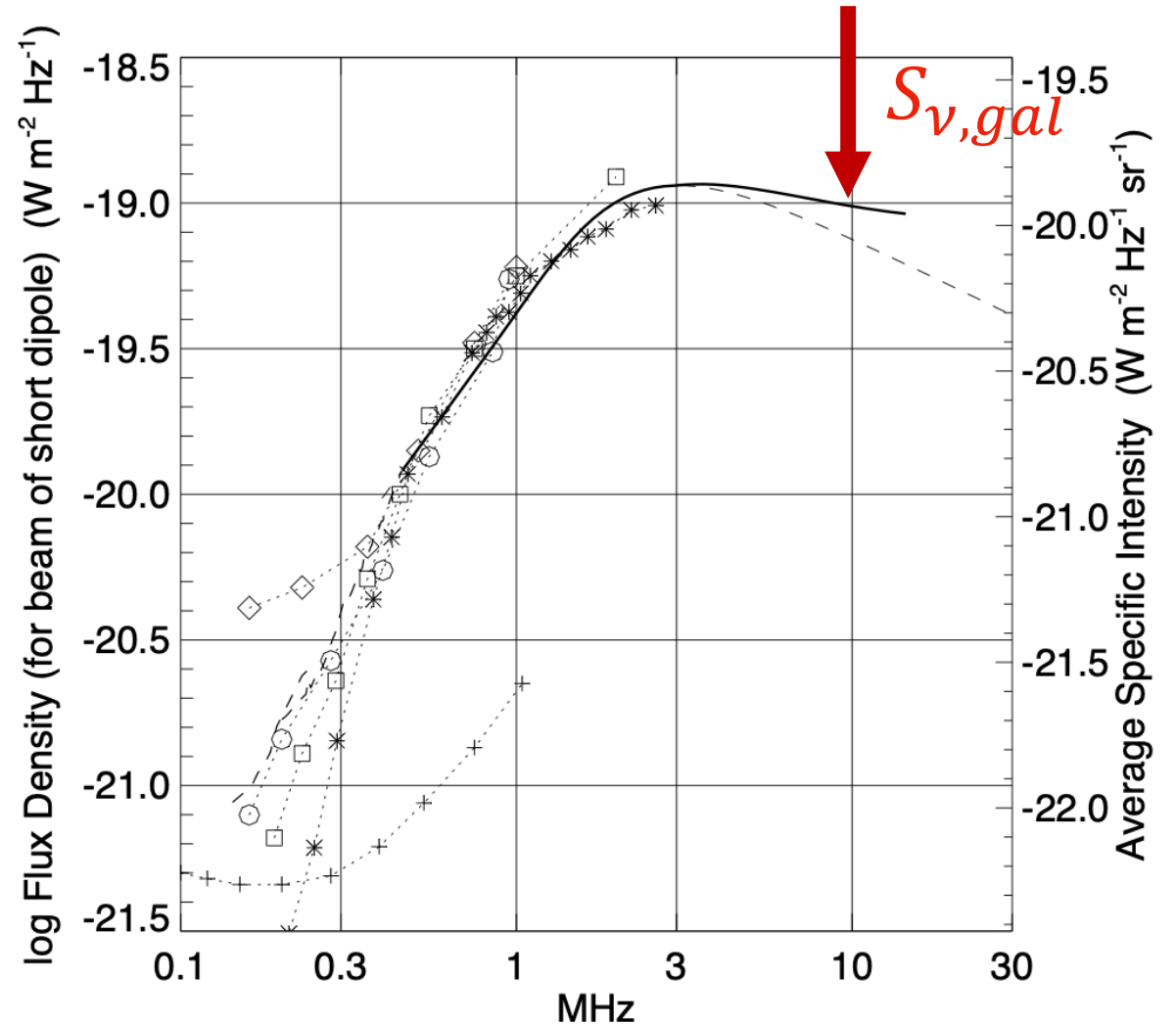
$$P_{\nu,B} = P_{\nu,BRG} - P_{\nu,gal} - P_{\nu,receiver} \quad [\mu\text{V}^2/\text{Hz}]$$

$$P_{\nu,background} = P_{\nu,receiver} + P_{\nu,gal}$$

Applicable where galactic background radiation is the principal contribution to T_{sys} .

Galactic spectrum derived from Cane 1979.

Dulk et al. 2001



Calibration of Wind/WAVES RAD2 (1.075 – 13.8 MHz)

Hillan et al. 2010

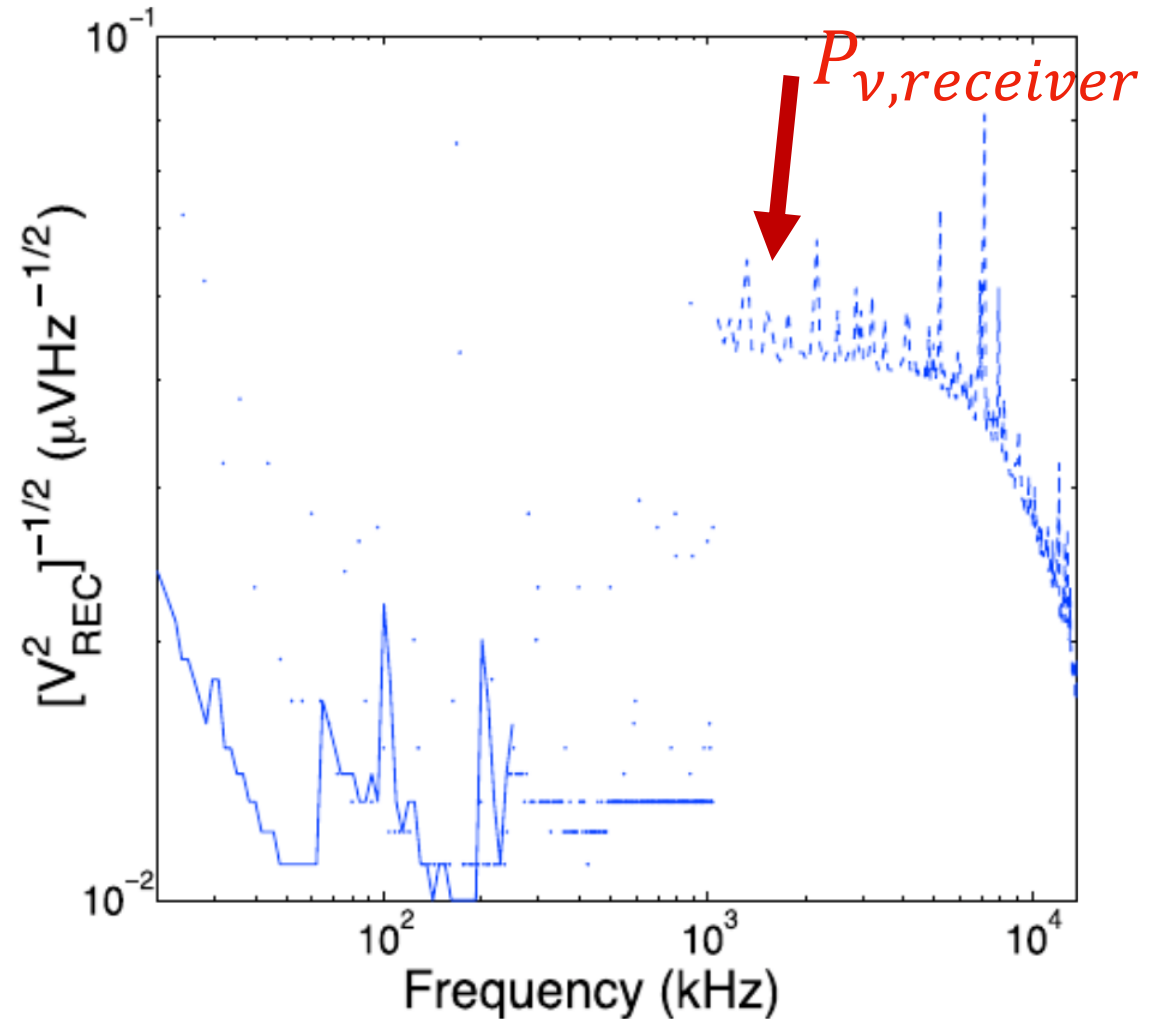
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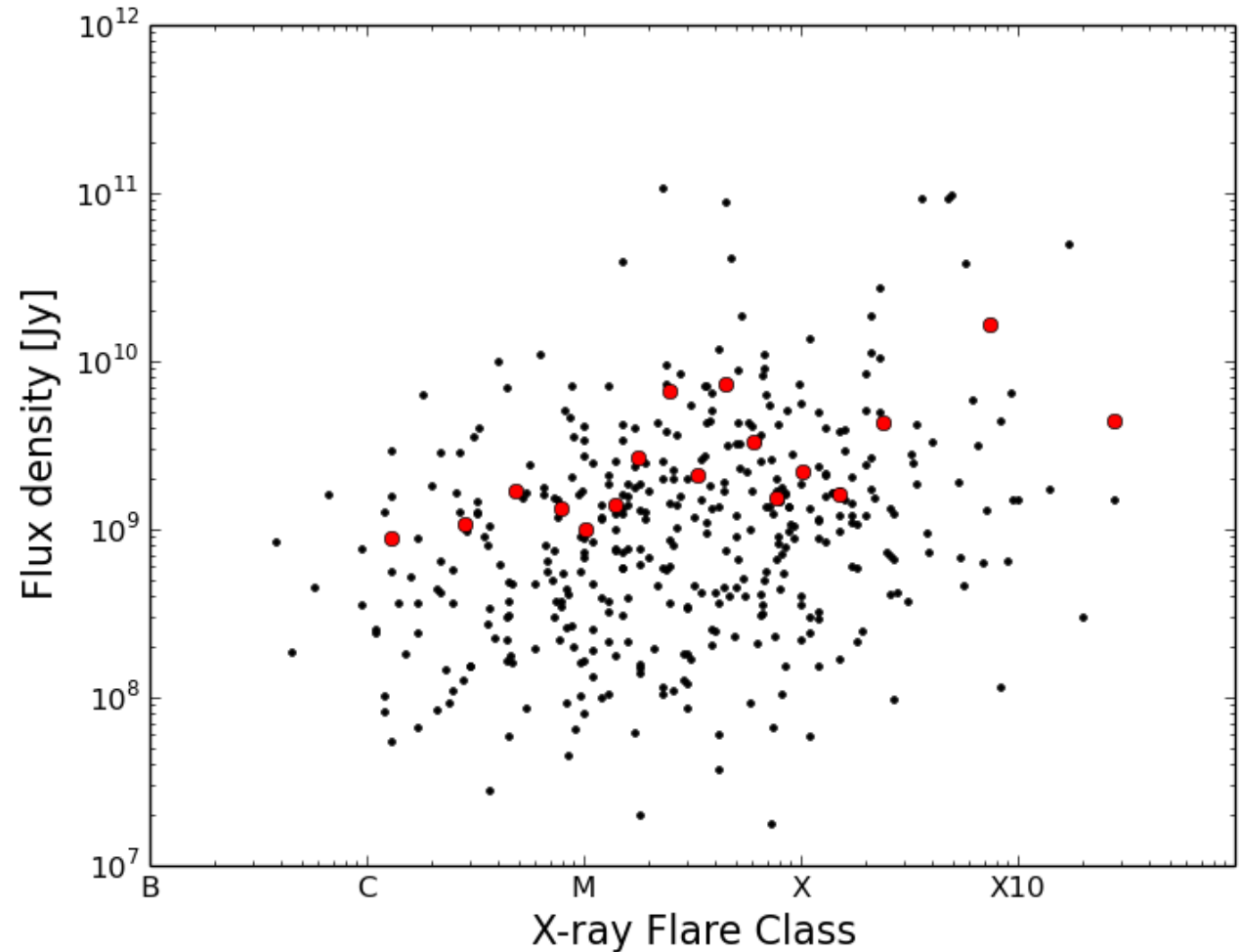
$$P_{\nu,background} = P_{\nu,receiver} + P_{\nu,gal}$$

RAD2 data from 11 Nov 1994, prior to antenna deployment.



Type II radio burst flux density versus X-ray flare flux

- Peak flux density in the RAD2 band during catalogued type II burst versus GOES soft X-ray flare importance.
- Order(400) DH type II bursts with measured GOES 1–8 Å flux.



Type II radio burst flux density versus peak frequency

- Peak flux density in the RAD2 band during catalogued type II burst versus peak frequency.

