Statistical analysis of radio type III bursts from the NRH (1998-2007)

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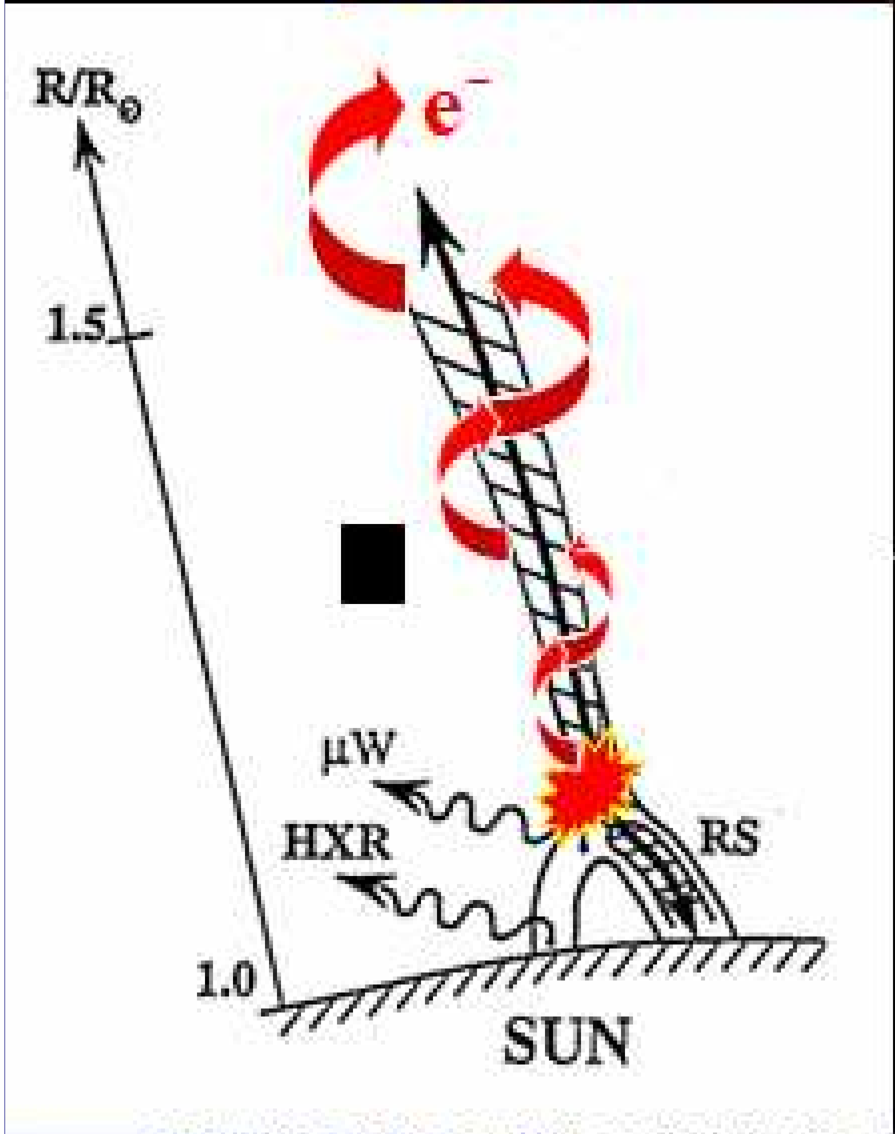
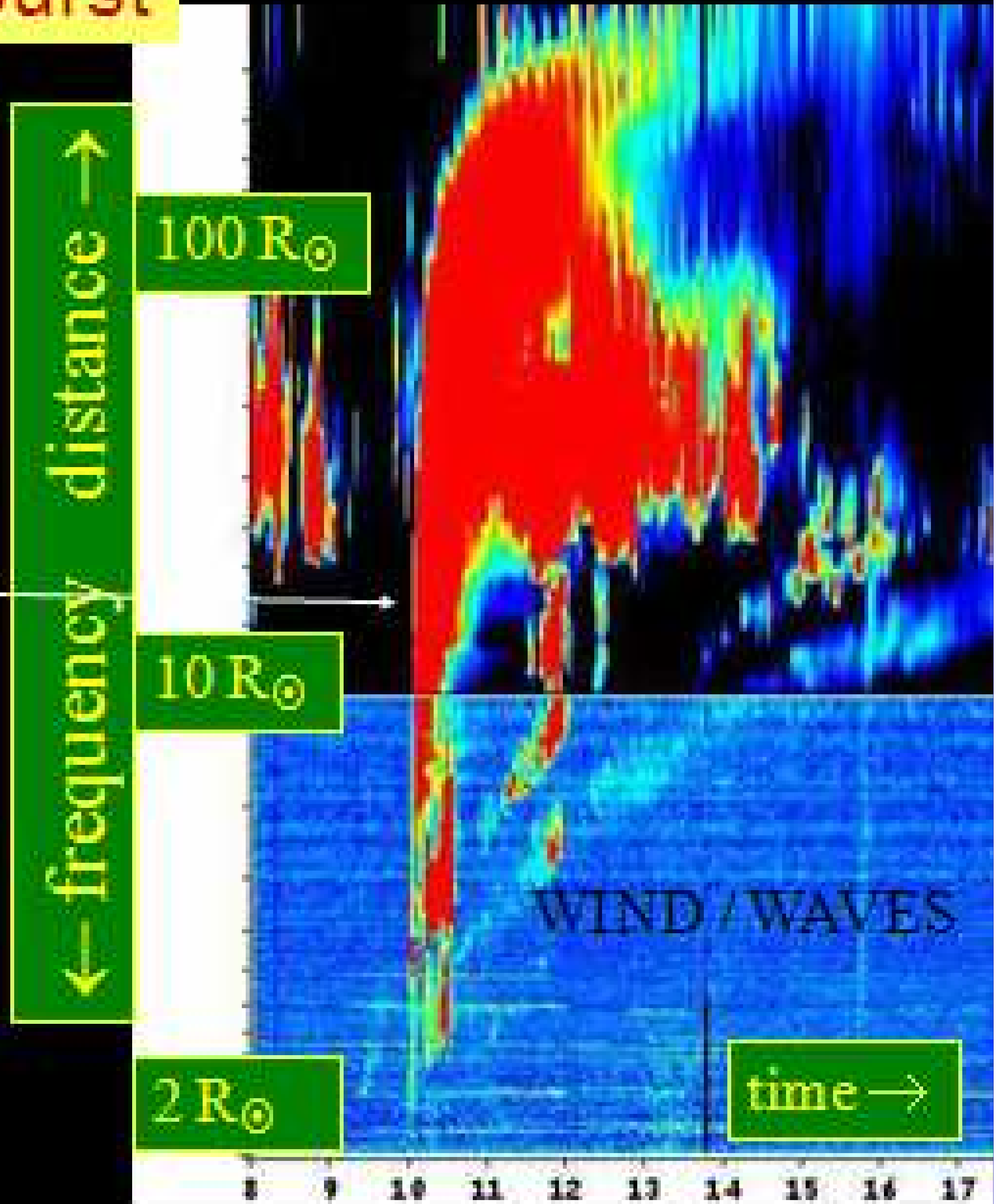
Alliance workshop Meudon 18-21 May 2010

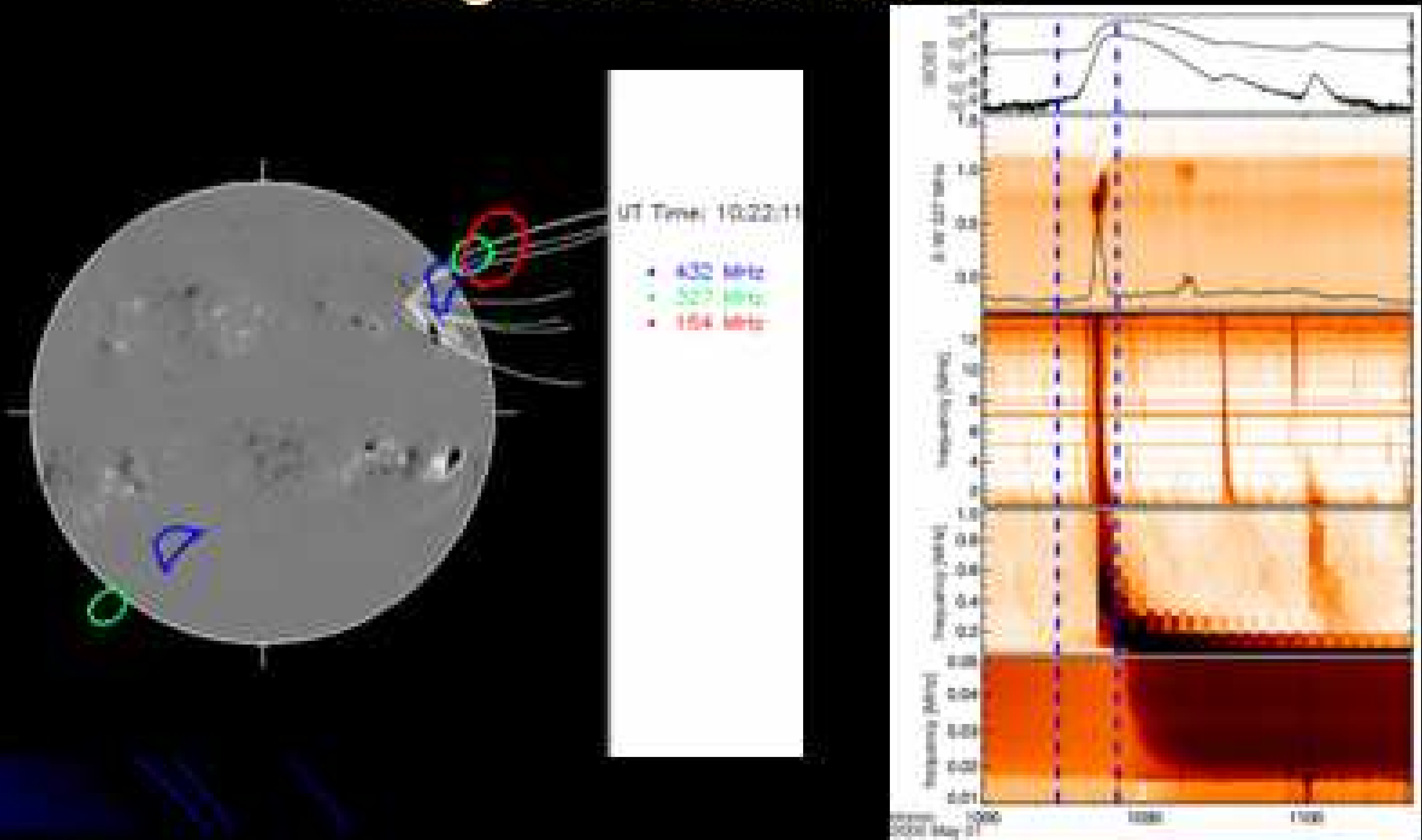
Type III radio burst



(adapted from Marcus Aschwanden)



Propagation of electron beams in coronal magnetic flux tubes



Electron beams in open magnetic flux tube inferred from PFSS model (Schrijver & DeRosa 2002, Solar Phys.; model available within SolarSoft). Electrons reach the *Wind* spacecraft (Langmuir waves).

From Klein et al

- Start from list of solar radio bursts from NOAA: January 1998 to July 2008

Stations Reporting: CULG = Culgoora IZMI = Izmiran LEAR = Learmonth ONDR = Ondrejov PALE = Palehua POTS = Potsdam SGMR = Sagamore Hill SVTO = San Vito

Includes:

Start and end frequencies

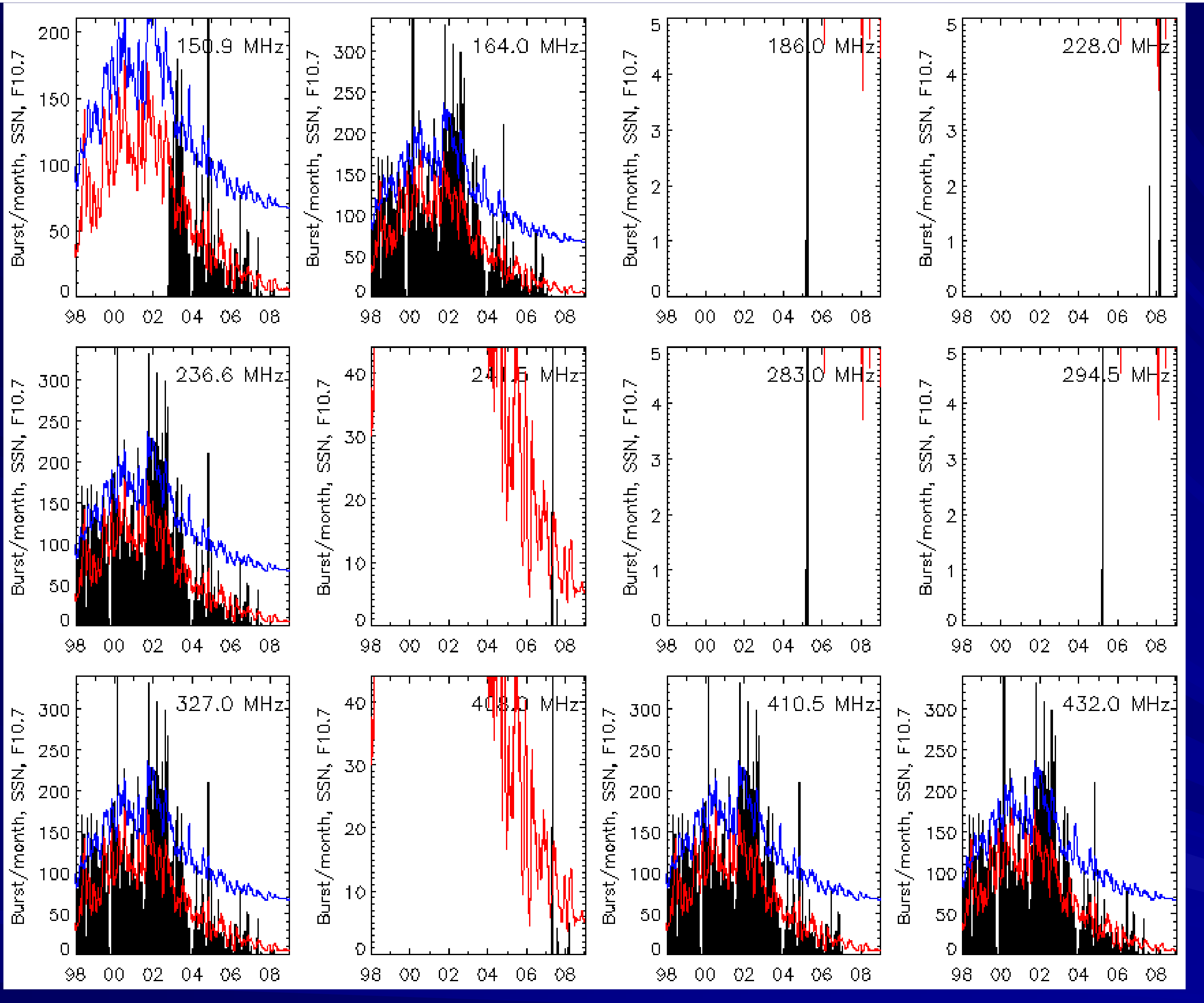
Burst intensity

Spectral type …. But may vary from observer to observer, instrument to instrument…

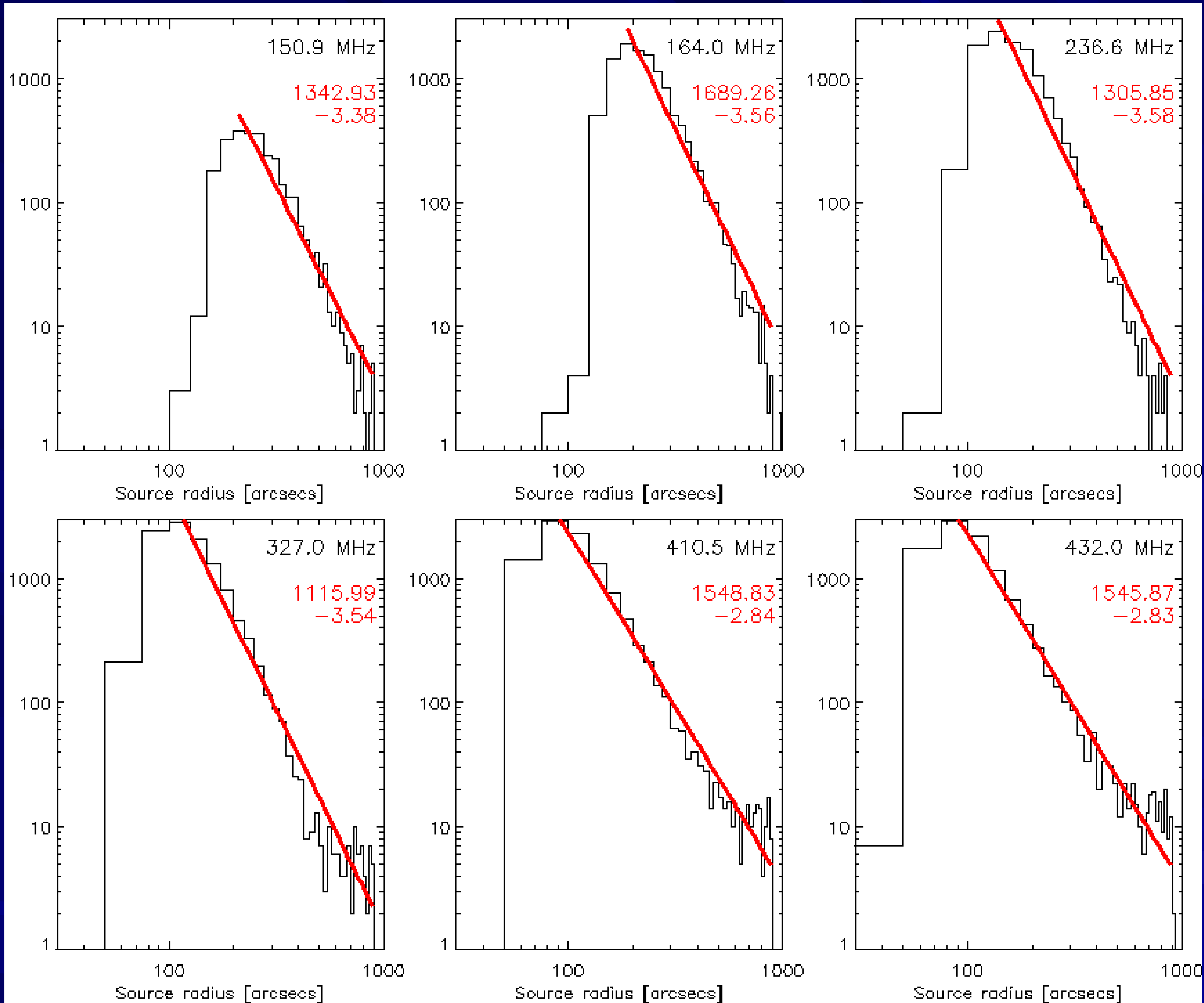
Select events between 08:30 and 15h30 UT and in the 150-432 MHz range (i.e. observed by the NRH).

Removal of events reported by several observatories

>10000 bursts

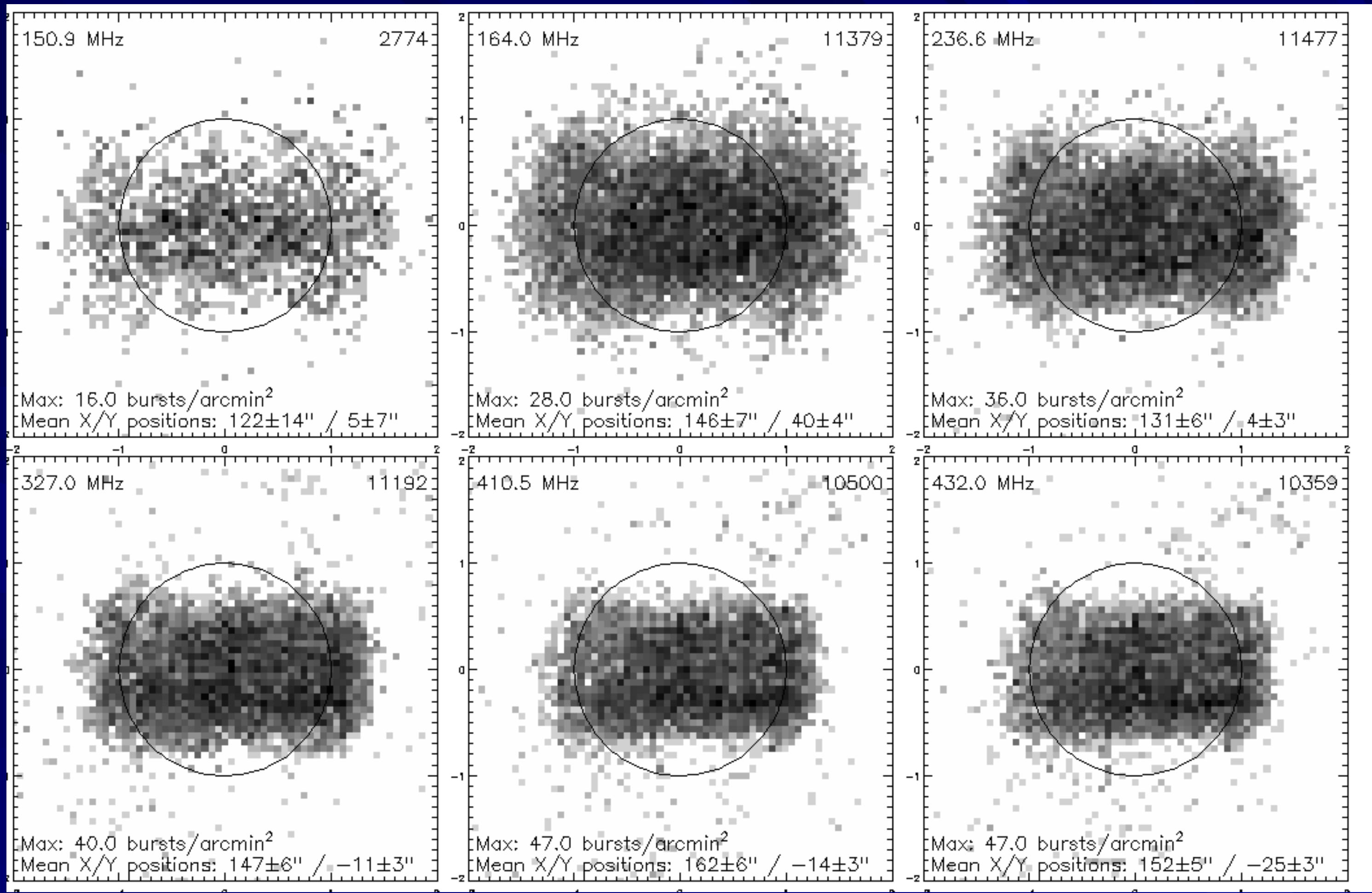


Black: time series of monthly NOAA radio bursts for the NRH period
Red: Sun spot number
Blue: f10.7 (sfu)

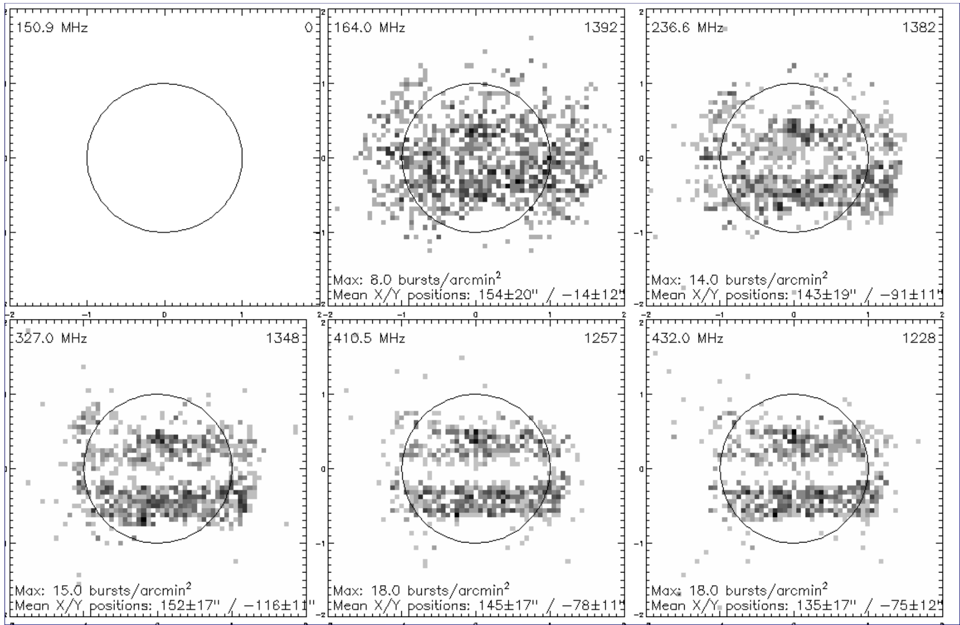


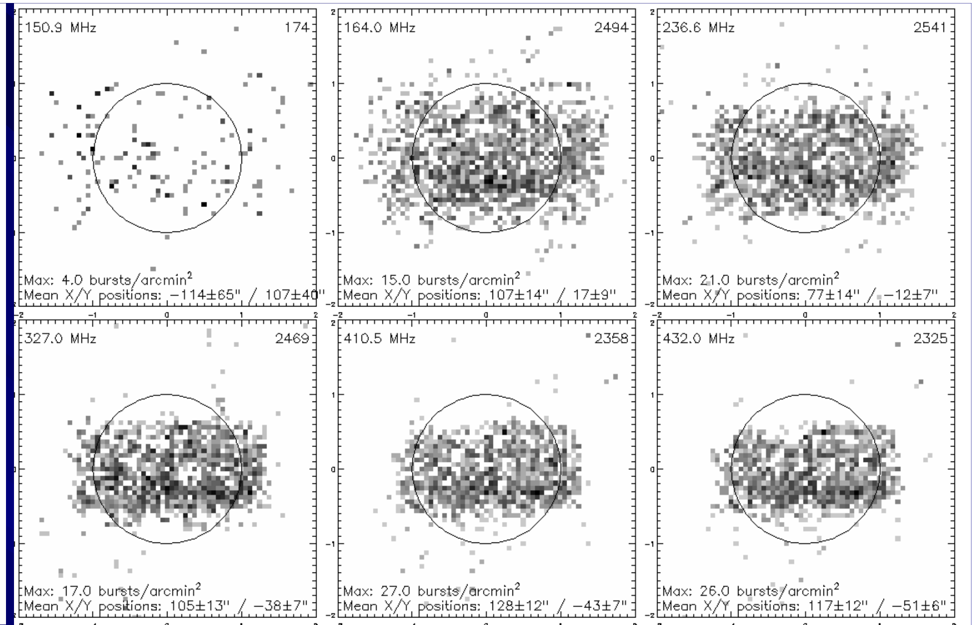
Histograms of mean gaussian radius of radio sources at different frequencies

Convolved with the instrumental resolution (18’’ to 360’’ depending on frequency and UT)



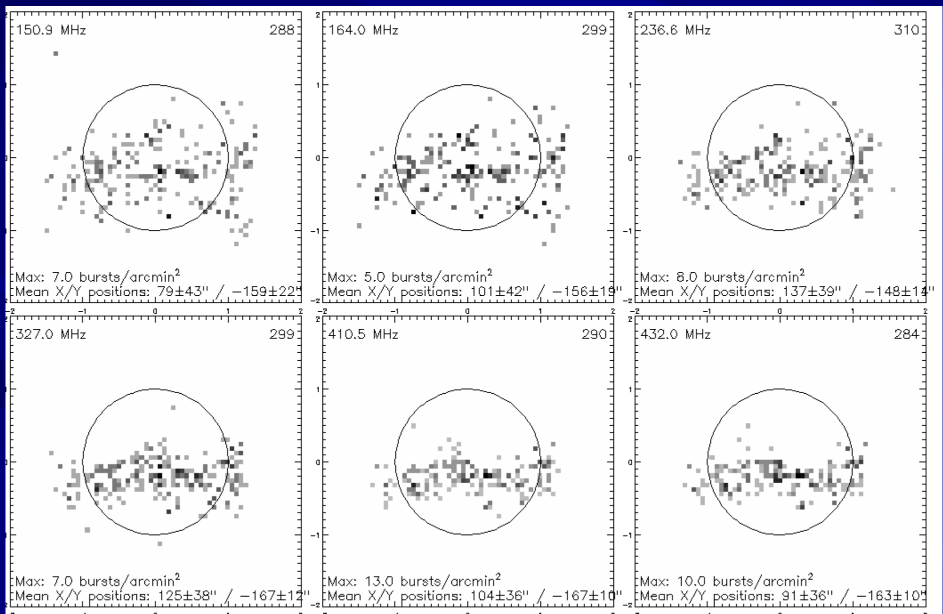
Distribution of radio bursts from 1998 to 2008





1998

2002



2006

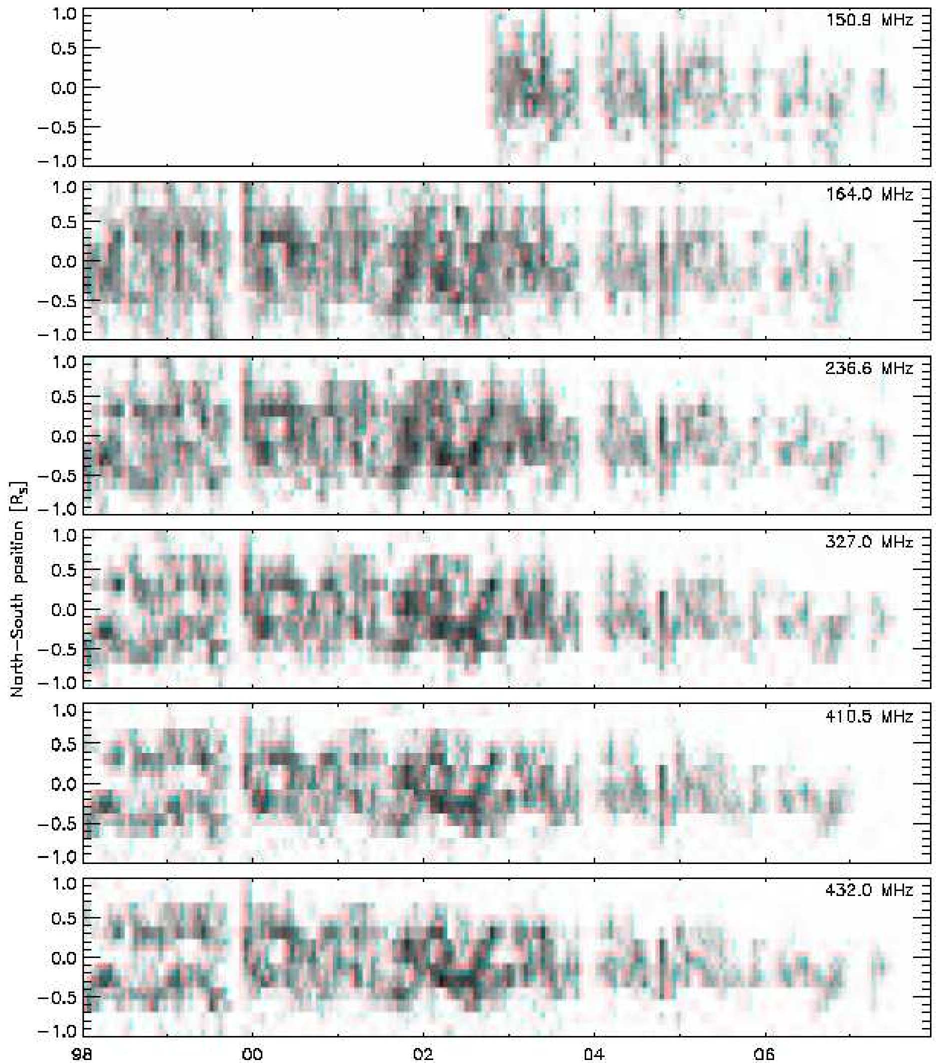
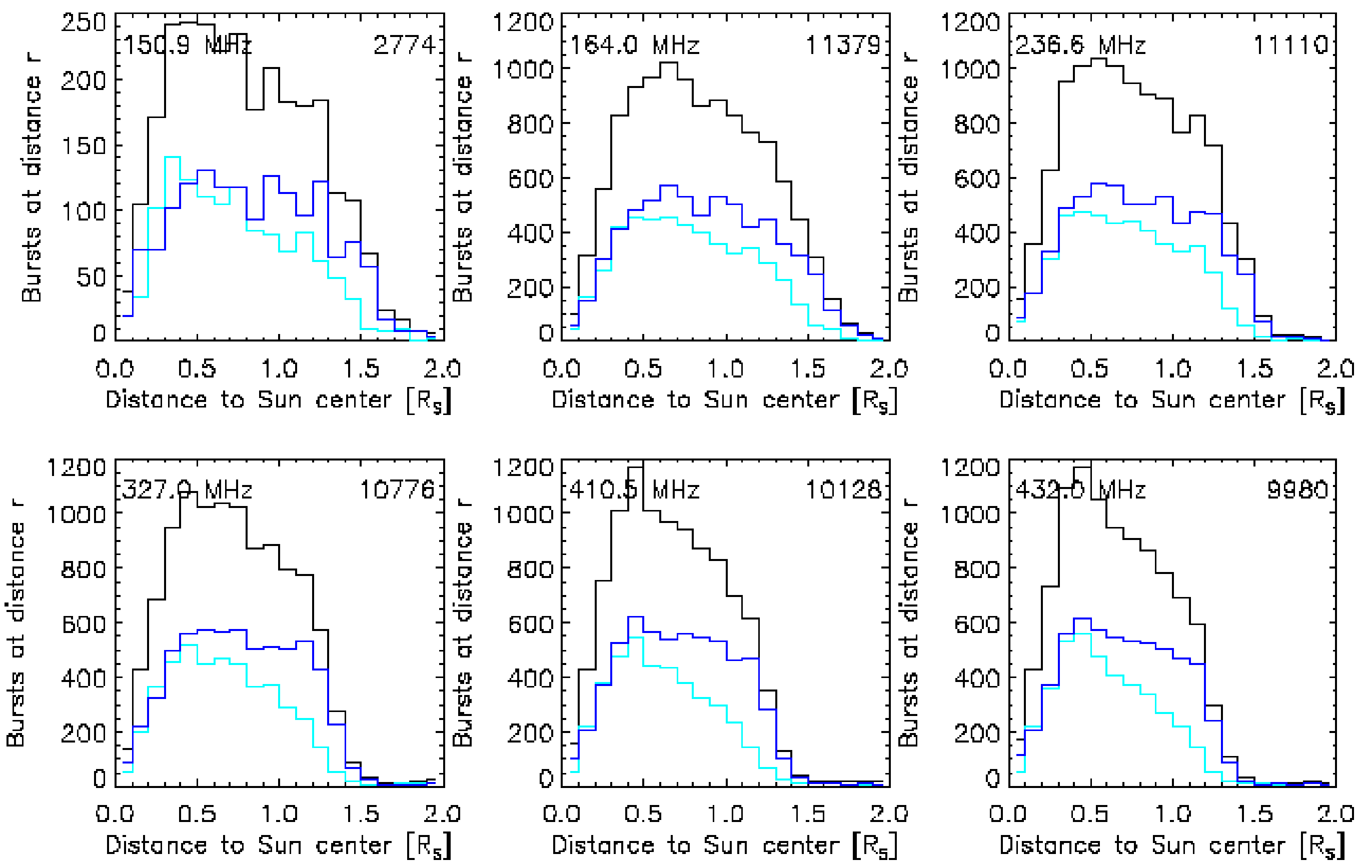
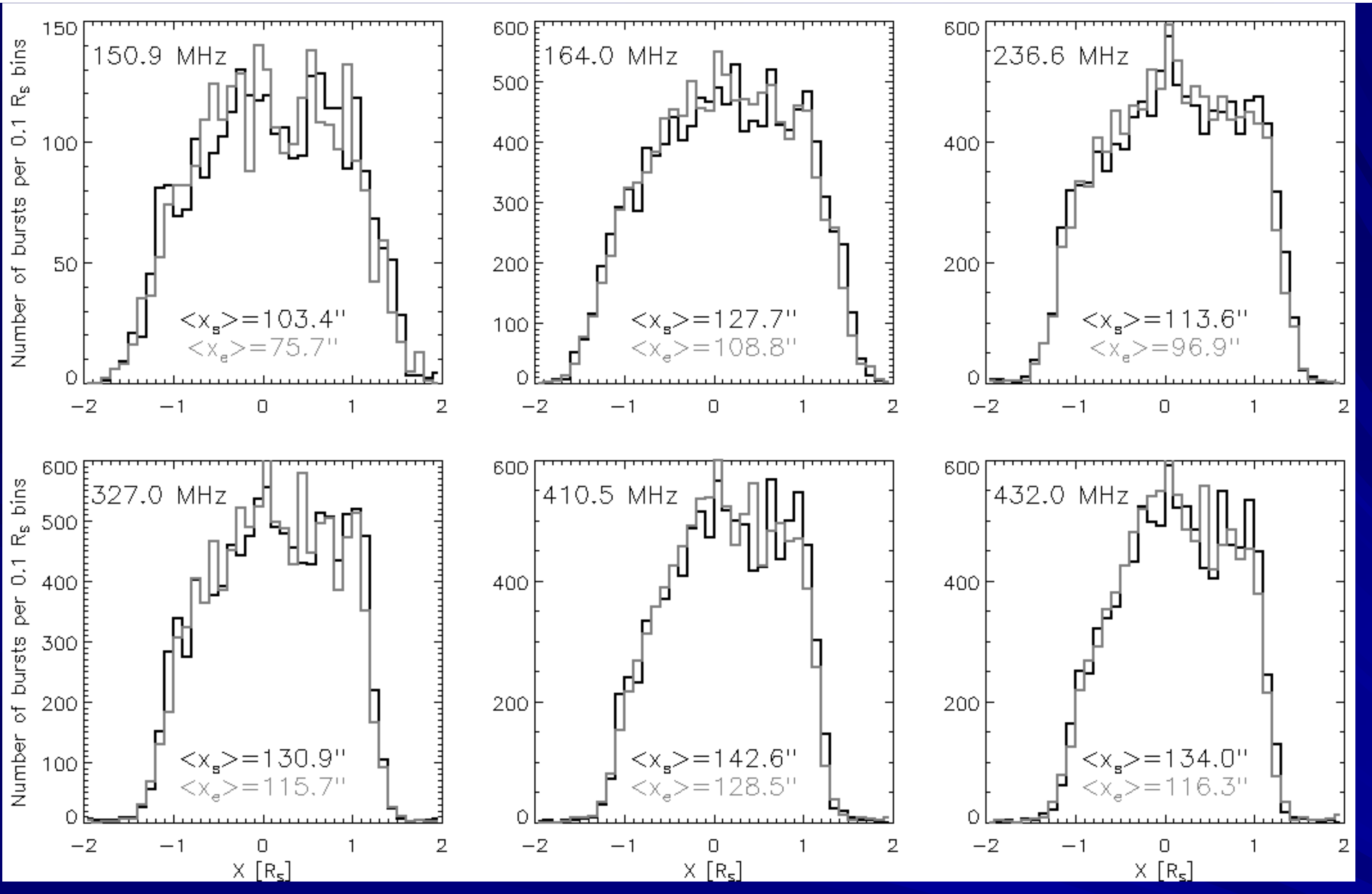


Fig. 7.— "Butterfly diagram" of NOAA-reported solar radio bursts observed by NRH.



Light blue: eastern hemisphere
Dark blue: western hemisphere

East-West asymetry
at all frequencies



East- west asymetry: reported for noise storms by Elgaroy in the 60's

Ionospheric effect?? Probably not at highest frequency

Solar effect: inclination of B?
propagation effect in the corona?
radiation pattern of type III bursts?

Link with statistical studies at lower frequencies (see Bonnin et al., 2008)

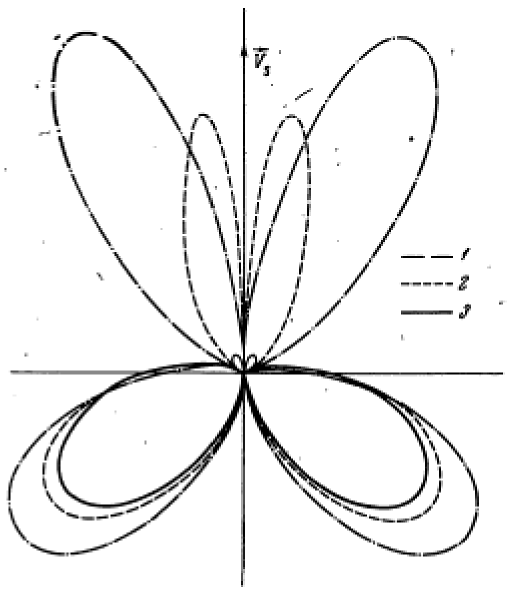
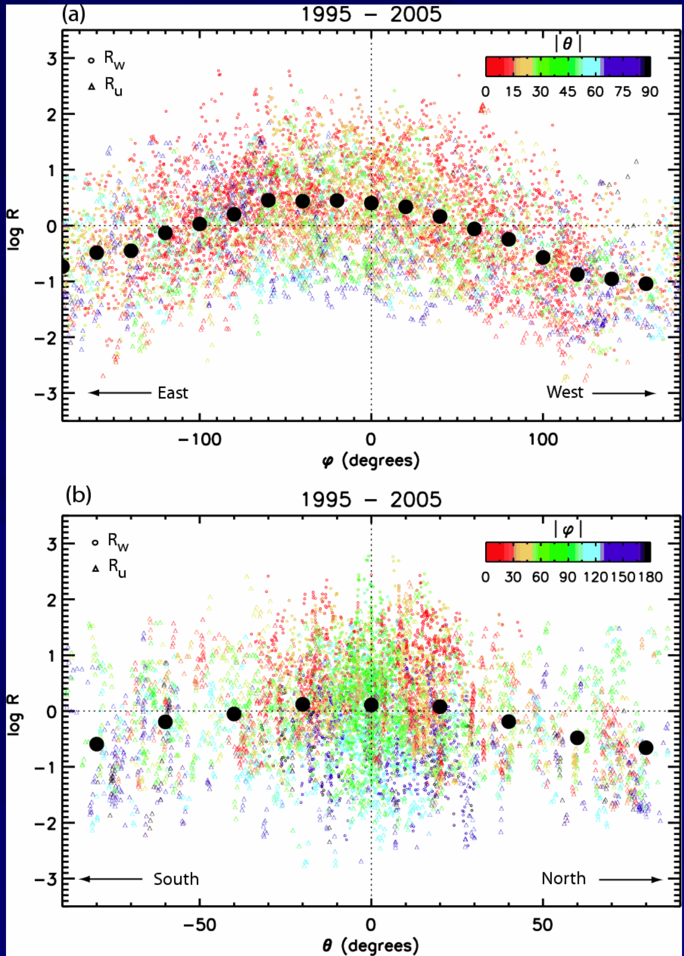


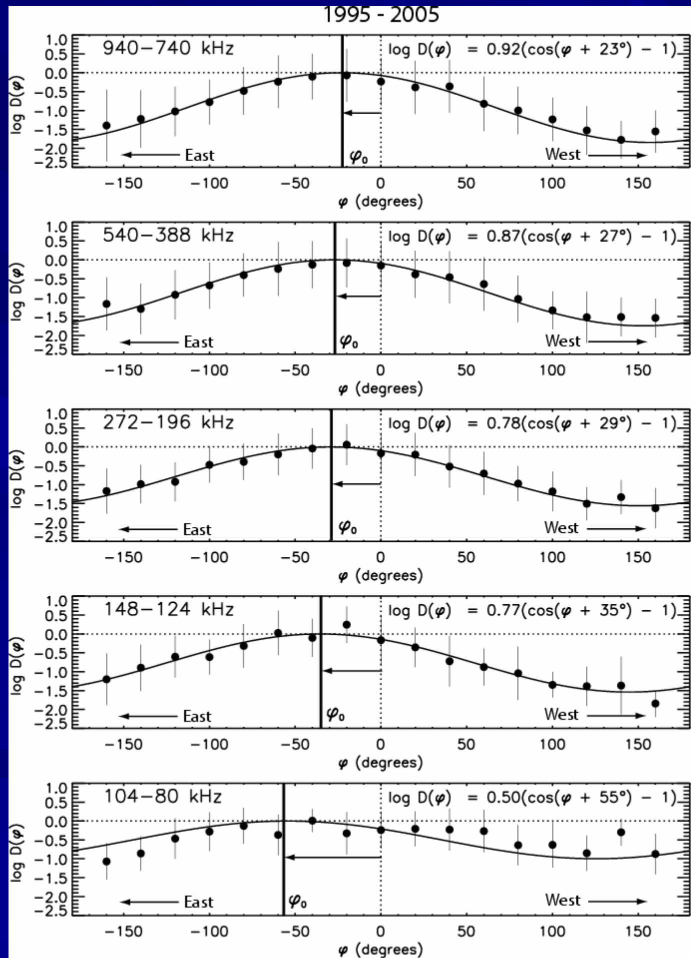
Fig. 1. The directional pattern $\psi(\vartheta)$ for the radiation of the second harmonic in homogeneous plasma. 1) $V_s/c \approx 0.3$; 2) $V_s/c \approx 0.5$; 3) $V_s/c \approx 0.6$.

Zhelezniakov & Zaitsev, 1970



(Bonnin et al., 2008)

Between 940 and 80 kHz



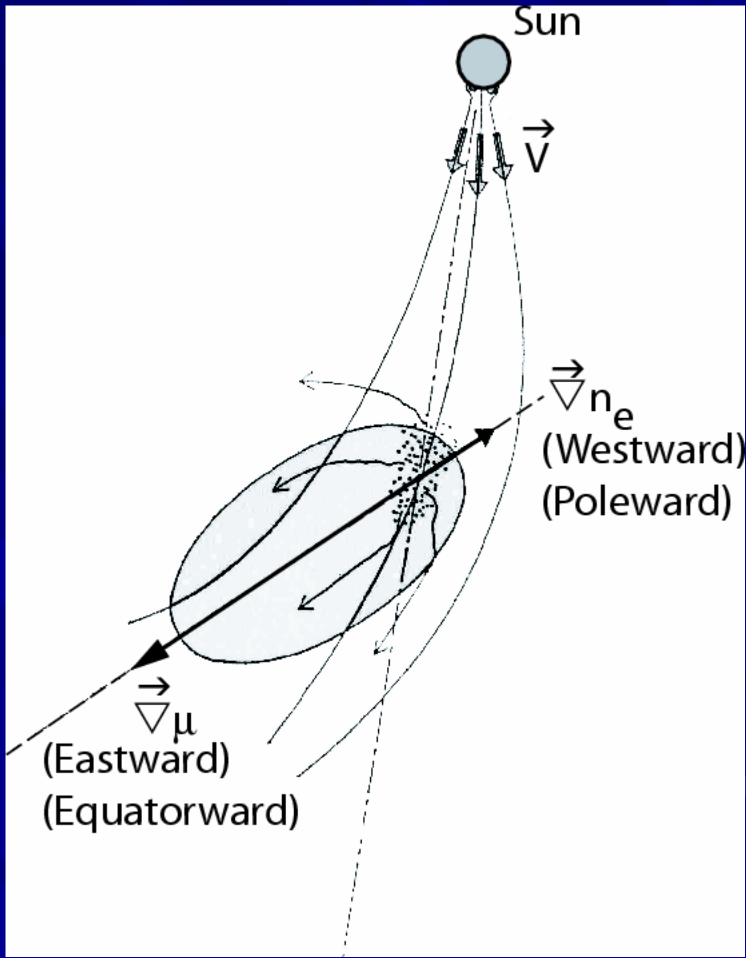
Eastward tilt of the radiation diagram
(see also Poquérusse et al.
Hoang et al.

Interpretation at low frequencies:

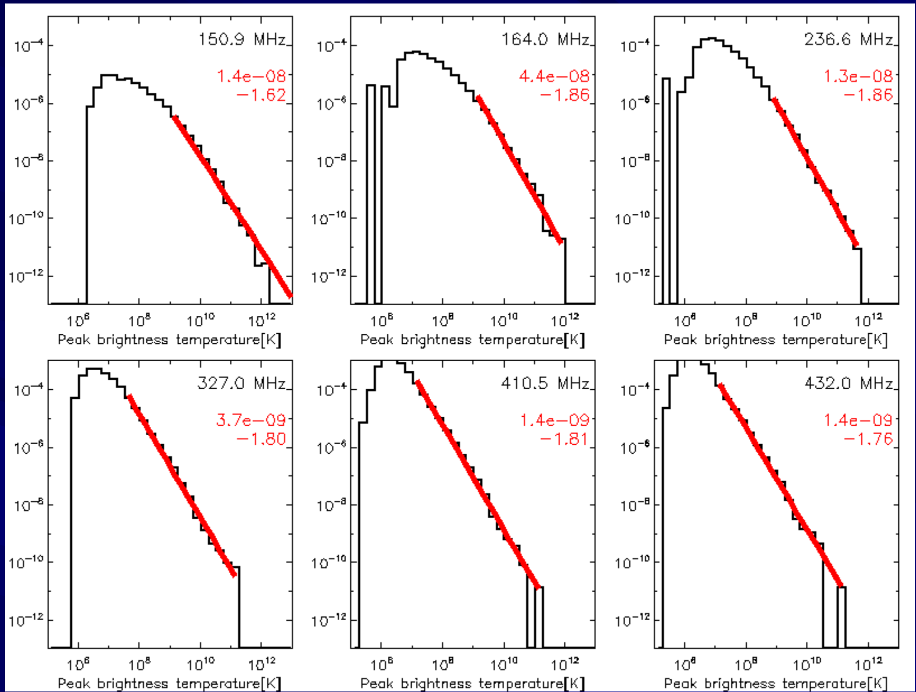
Refraction effects at density gradients

Valid interpretation at high frequencies?

The type III electrons travel outward along spiral open-field lines from the associated flare sites in active regions. Along these paths, the solar wind escapes faster than in the surrounding areas filled with structures of closed-field lines. At some distance farther out, the faster wind catches up with the ambient slower wind and produces a density compression that leads to a transverse density gradient directed westward (poleward) of the open-field direction. This in turn results in a refractive index gradient , oriented eastward (equatorward) in the opposite sense of the density gradient. Radiation is thus bent in the eastward (equatorward) direction as observed. (Bonnin et al. 2008

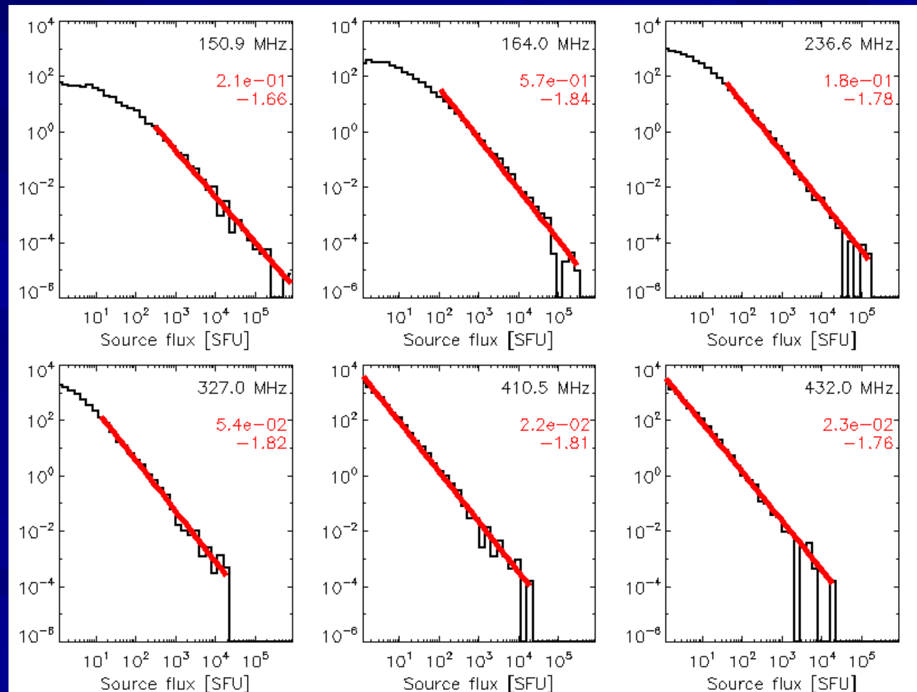


Brightness temperatures and fluxes



Brightness temperatures

Power law distribution : -1.6- -1.8



(see also Nita at al. 2002
for events above 2 GHz)

Different from type I burst intensity
(Mercier and Trottet 1997)

Solar flux

Preliminary conclusions:

- - Distribution of type III radio sources from 450-150 MHz
- -East-West asymetry of the number of bursts : interpretation?
- - Brightness distribution functions