New SpW Data Products and Accessibility in the TSRS Coronal Radio Surveillance

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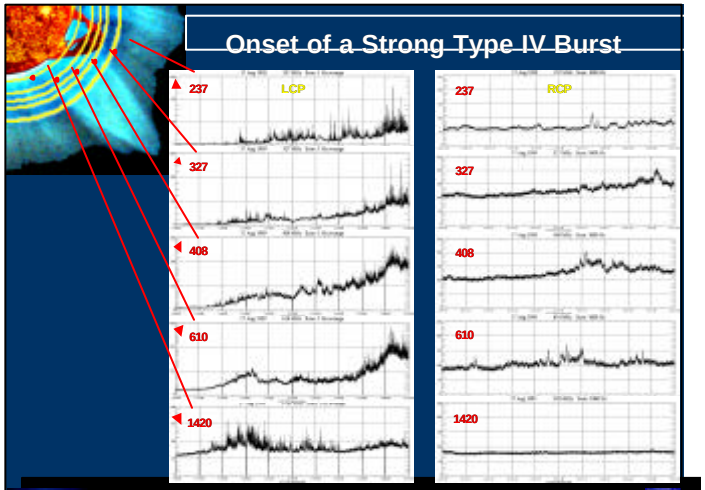
Scheme of the Talk

- Relevance of Solar Radio Emission to Space Weather
- TSRS – The Trieste Solar Radio System
- TSRS Data Products
- TSRS Data Access
- The TSRS WWW Site
- Conclusions

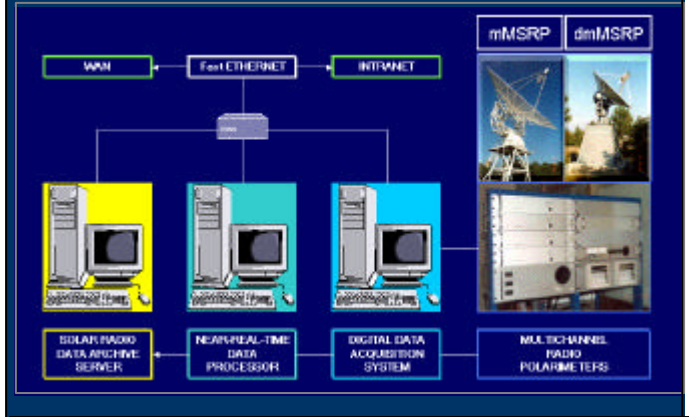
The Trieste Solar Radio System at a Glance

- TSRS (Trieste Solar Radio System)
  - MMSRP (237, 327, 408, 610 MHz)
  - DMMSRP (1420, 2695 MHz)
  - Flux density + Circular polarization
  - High time resolution (1 ms – 0.1 ms)
- Continuous coronal radio surveillance
- Radio indices published on the net in NRT
- SOLRA (SOLar Radio Archive) updated in NRT

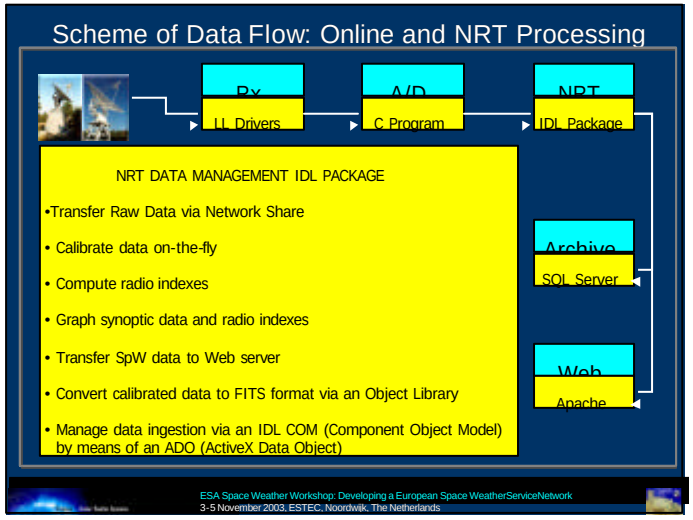
Onset of a Strong Type IV Burst



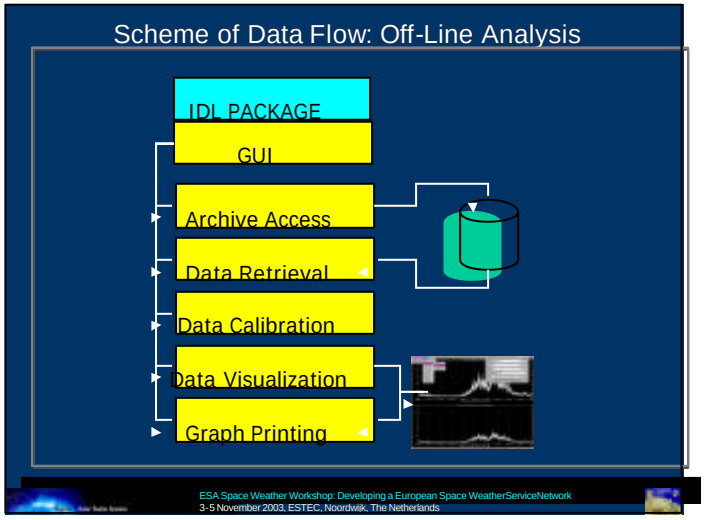
Architecture of TSRS



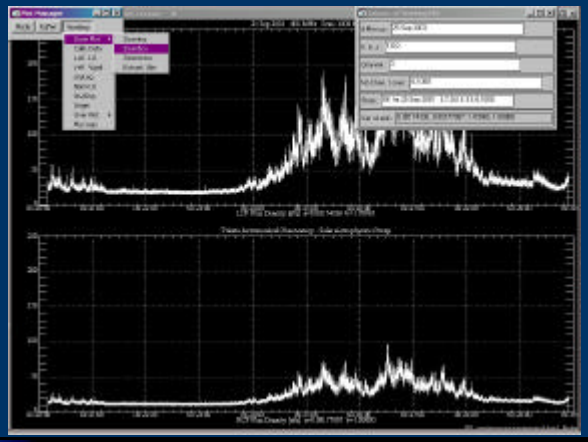
Scheme of Data Flow: Online and NRT Processing



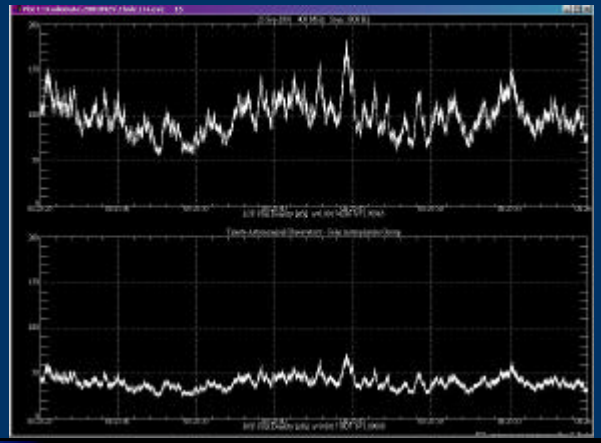
Scheme of Data Flow: Off-Line Analysis



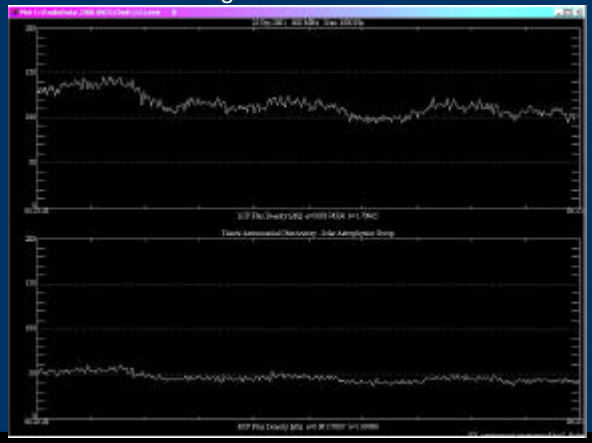
GUI of the Radio Data Processing Package

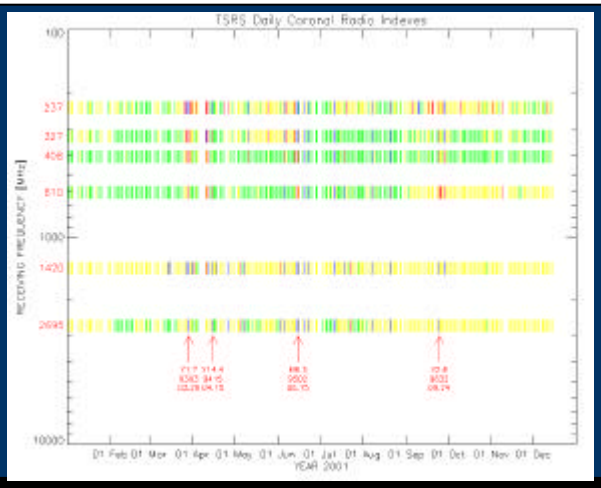


Interactive Selection and Zoom



High Zoom Factor





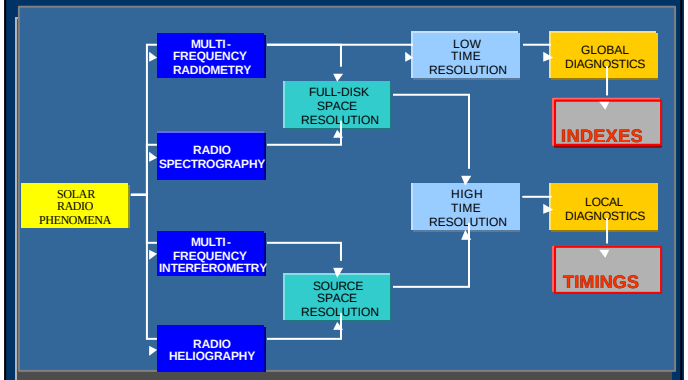
Relevance of Solar Radio Emission to SpW

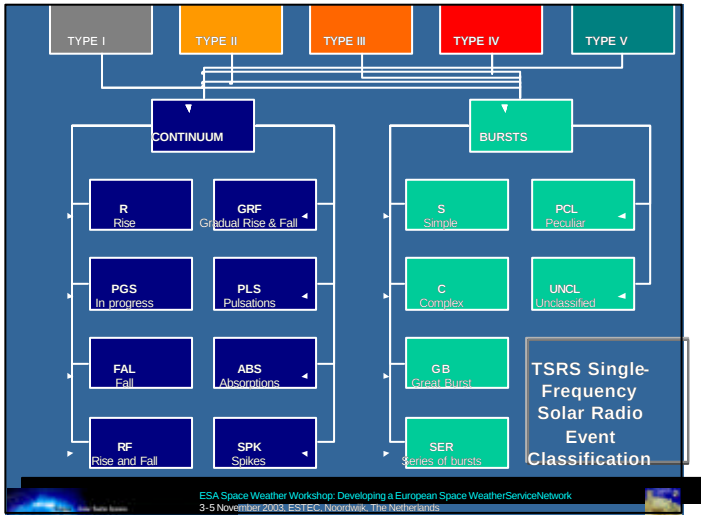
- PROXIES OF SOLAR DRIVERS
  - Type I Bursts (magnetic topology changes)
  - Type II Bursts (propagating shocks; particle beams)
  - Type III Bursts (particle acceleration; particle beams)
  - Type IV Bursts (magnetic reconnection; acceleration)
  - Spikes (energy release fragmentation; acceleration)
  - Precursors (radio signatures preceding flares)
  - 10 cm / 2800 MHz (EUV enhancements)
- DIRECT SOURCE OF GEOEFFECTS
  - Radio Flares (Very Intense Broad Band Radio Noise)

The Sun as a Radio Noise Source

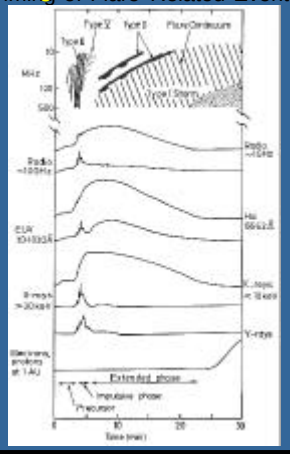
- The Sun is a radio source
  - non-directional
  - broad band
- Solar radio noise can
  - increase by several orders of magnitude during outbursts
  - persist at high levels for minutes to hours
- Enhanced solar radio noise can perturb
  - HF communications (MIL)
  - Mobile communications (GSM, GPRS, UMTS)

RADIO DIAGNOSTICS RELEVANT TO SPACE WEATHER APPLICATIONS





Timing of Flare-Related Events



McLean & Labrum (1985)

SPACE WEATHER
SEC Alerts and Warnings

CATEGORY TYPE	THRESHOLD	ALERT	WARNING
Radio			
245 MHz burst	peak flux ≥ 100 s.f.u.	+	
245 MHz noise storm	peak flux = 5 times background	+	
10 cm burst	peak flux ≥ 100% above background	+	
Type II event	any	+	
Type IV event	any	+	
Particle			
Electron Event	peak flux 10^3 pfu @ > 2 MeV	+	
Suspected Proton Flare	peak flux 10 p.f.u. @ > 10 MeV	+	
P10 Proton event	peak flux 10 p.f.u. @ > 10 MeV	+	+
P100 Proton event	peak flux 100 p.f.u. @ >100 MeV	+	+
SST Radiation Alert	≥ 0.1^{-4} sievert/hour (≥ 10 millirems/hour)	+	+
X-ray			
M5	peak flux ≥ $5*10^{-5}$ W m^{-2}	+	
X1	peak flux ≥ $1*10^{-4}$ W m^{-2}	+	
Geomagnetic			
A Index ≥ 20	running A_R ≥ 20	+	+
A Index ≥ 30	running A_R ≥ 30	+	+
A Index ≥ 50	running A_R ≥ 50	+	+
K Index = 4	K_{fr} = 4	+	
K Index = 5	K_{fr} = 5	+	
K Index ≥ 6	K_{fr} ≥ 6	+	
Atmospheric disturbance			
Stratwarm	stratospheric warming conditions	+	

- Sievert (Sv): effective (equivalent) dose of radiation received by a living organism 1 Sv = 100 rem
- particle flux unit (p.f.u.) [cm^{-2} s^{-1} sr^{-1}]

CONCLUSIONS

- TSRS is now FULLY OPERATIONAL in NRT
- The TSRS archive is now UPDATED in NRT
- Data access is available via HTML and WAP
- TSRS is an EFFECTIVE OBSERVATIONAL TOOL for CORONAL RADIO SURVEILLANCE PURPOSES
- PROJECTS: ESA SWENET, COST Action 724

TSRS Data Products

- High time res. calibrated data files (1kHz; 10min; FITS)
- High time res. uncalibrated data files (1kHz; 10min; BIN)
- 1-sec average calibrated data file (1 Hz; WD; FITS)
- 1-sec average calibrated data file (1 Hz; WD; BIN)
- 1-sec max. calibrated data file (1 Hz; WD; FITS)
- 1-sec max calibrated data file (1 Hz; WD; BIN)
- 1-sec median S+CP multichannel graph (WD; PNG)

TSRS Data Products Specific to Space Weather

- 1-min average radio index
  - whole day index values in text format (WD; TXT)
  - whole day LCP multichannel graph (WD; PNG)
  - whole day RCP multichannel graph (WD; PNG)
  - whole day (LCP+RCP) multichannel graph (WD; PNG)
- 1-min maximum radio index
  - whole day index values in text format (WD; TXT)
  - whole day LCP multichannel graph (WD; PNG)
  - whole day RCP multichannel graph (WD; PNG)
  - whole day (LCP+RCP) multichannel graph (WD; PNG)

TSRS Data Products Specifications

- Radio indices are derived as 1-min average and 1-min maximum values, which are suitable to properly sample flare-associated emissions
- Indices values are expressed both in Solar Flux Units (SFU) and in dBm/Hz as in radio communications
- A 1-min ahead value of radio indices is derived via an autoregressive model to provide indices prediction
- Indices are computed over 1-min but updated every 10 minutes due to hardware constraints!

TSRS Solar Radio Noise (SRN) Level

- The Solar Radio Noise (SRN) level is derived according to a specific thresholding at each receiving frequency, which is based on the respective Quiet Sun levels via a multiplicative factor as

  SRN = (Quiet Sun level) * (Activity Factor)

- SRN is therefore classified as Low, Moderate, High
- Observed and predicted SRN values are published on the web site in NRT

TSRS Data Access

- All Space Weather Data Products are available online
- HTR FITS files of the last 2 months are online
- The archive is updated in NRT at a cadence of 10 mins
- Data access occurs via web through a simplified GUI
- Data are searchable, displayable and downloadable up to a maximum data volume otherwise sent on physical media upon request

TSRS Dedicated Web Site

- A dedicated web site is available at the URL:

http://radiosun.ts.astro.it

- The site is available also via WAP at the URL:

http://radiosun.ts.astro.it/wap/en.wml

The TSRS WWW Site

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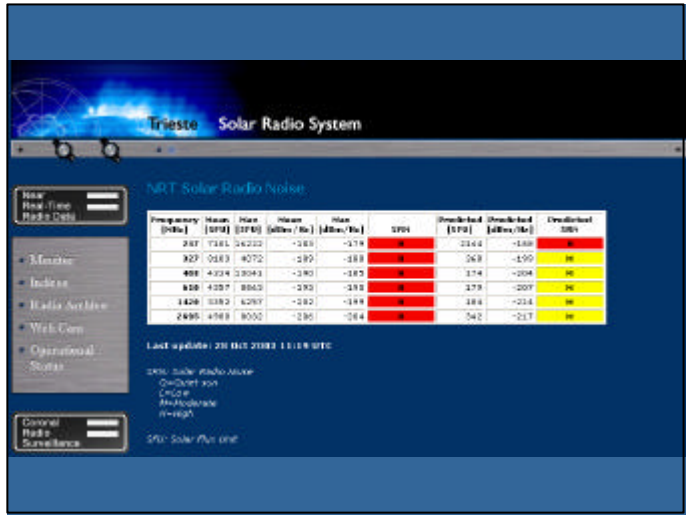
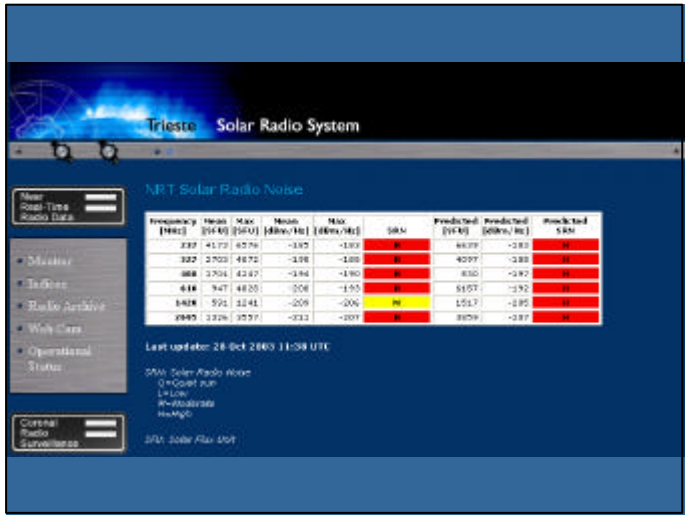
ESA Space Weather Workshop: Developing a European Space WeatherServiceNetwork
3-5 November 2003, ESTEC, Noordwijk, The Netherlands


Trieste Solar Radio System
SWENET


Trieste Solar Radio System
NRT Solar Radio Noise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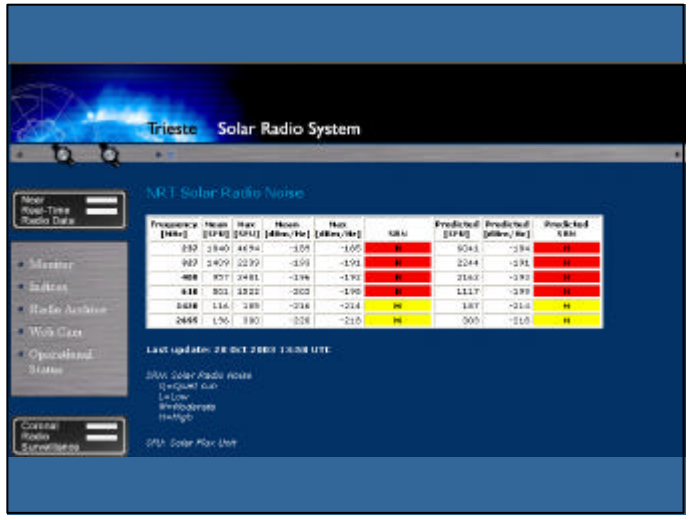
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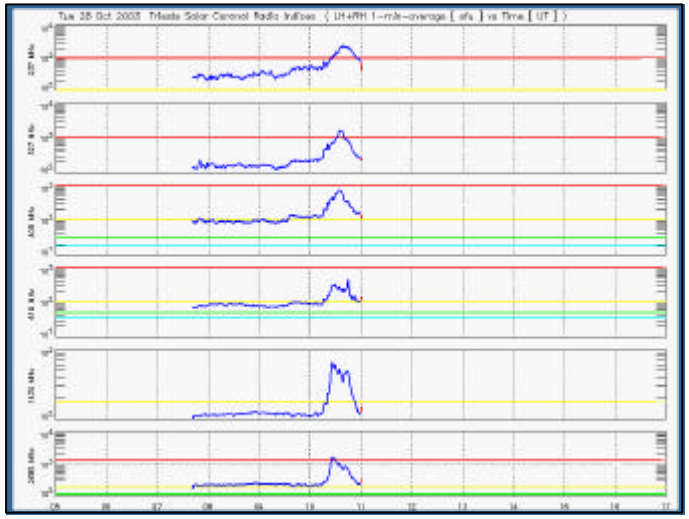
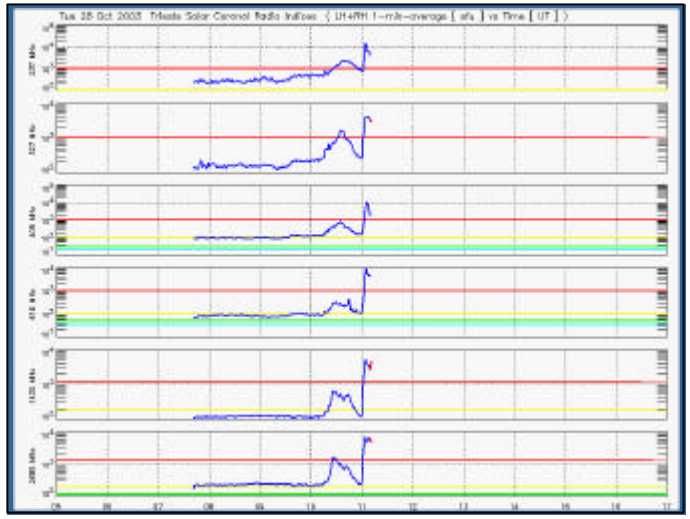
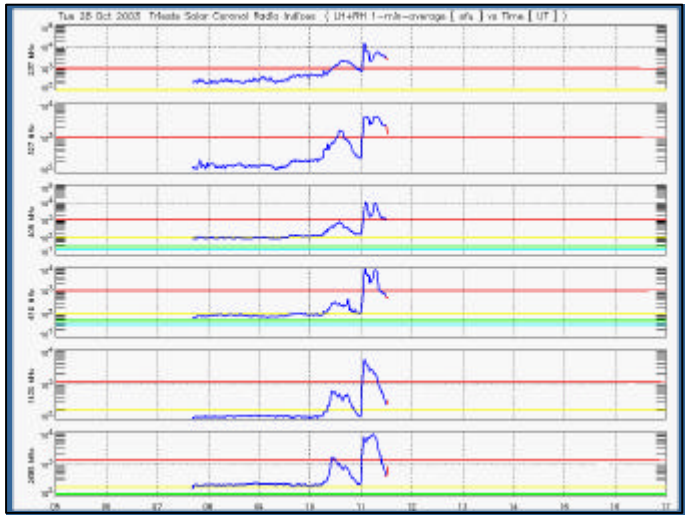
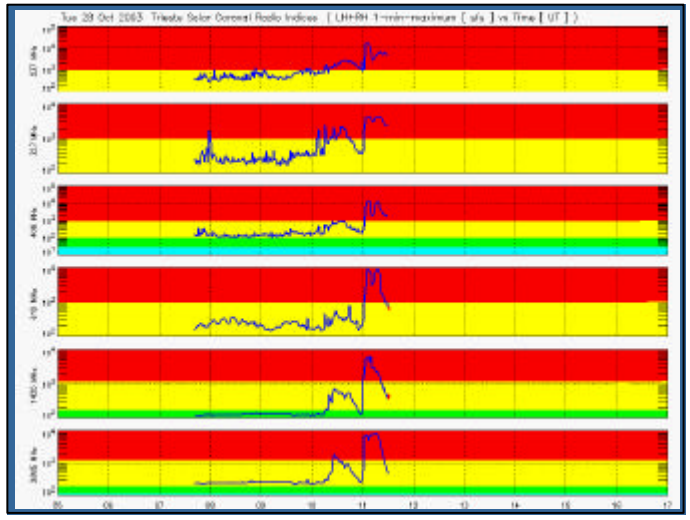
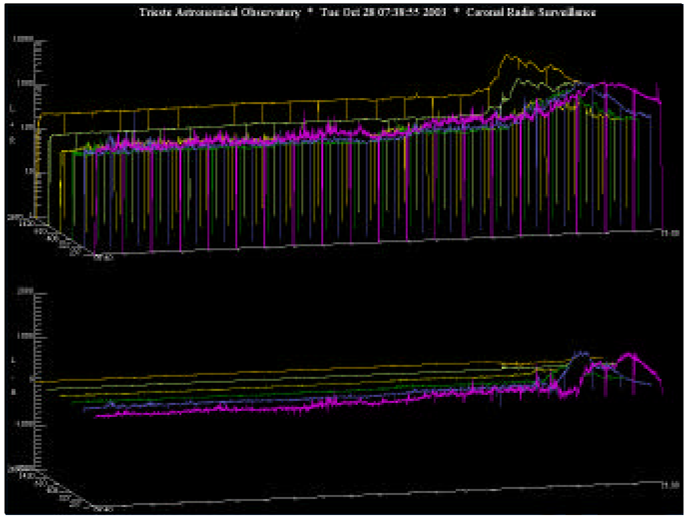
NRT Solar Radio Noise

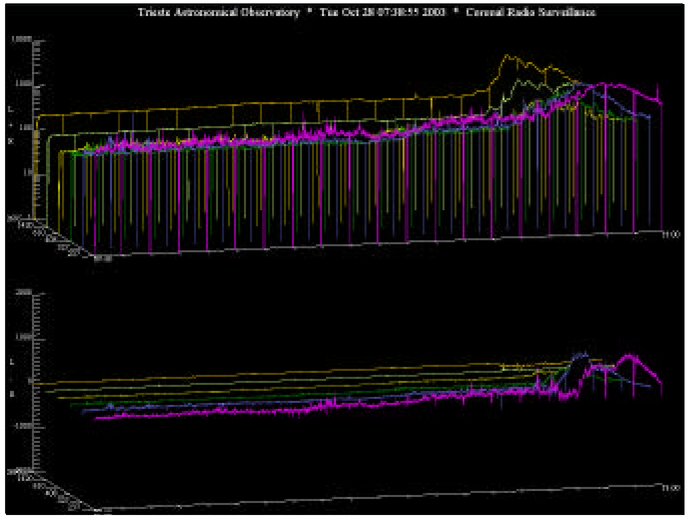









Trieste Astronomical Observatory * Tue Oct 28 07:38:55 2003 * Coronal Radio Surveillance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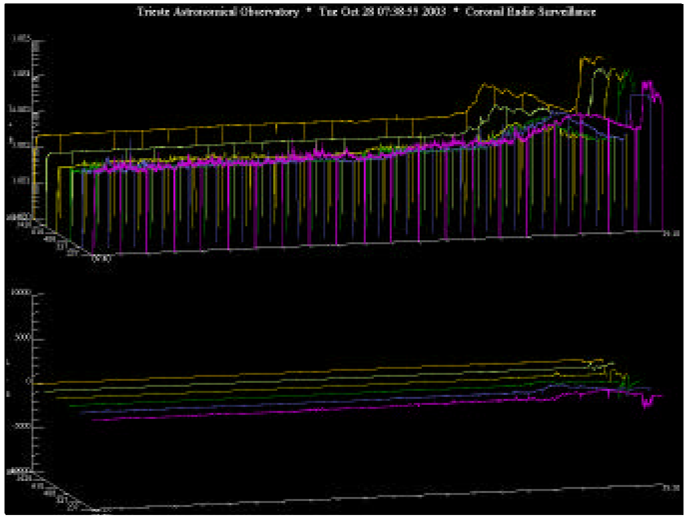
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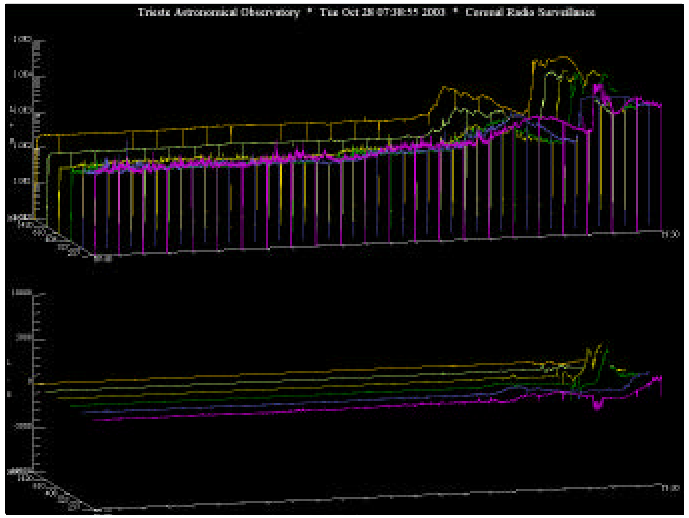
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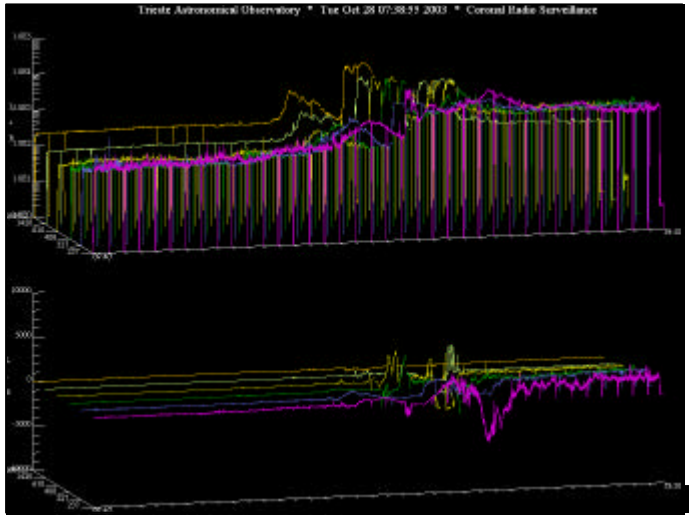
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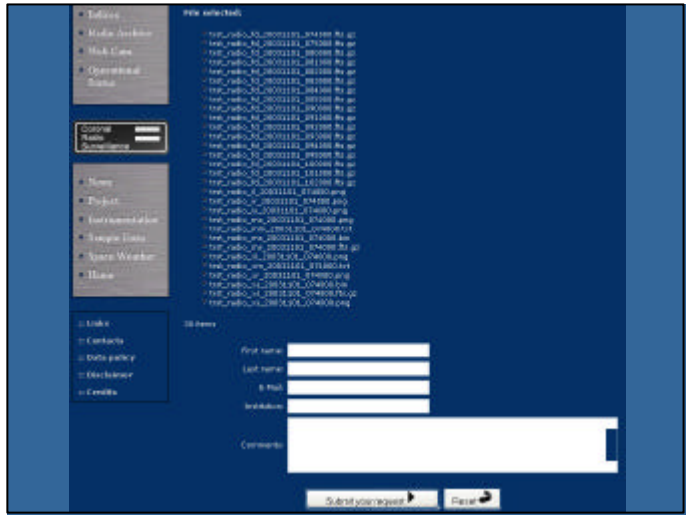
Trieste Solar Radio System


Trieste Solar Radio System


Trieste Solar Radio System


Trieste
Solar Radio System
SOLRA - SOLar Radio Archive




12:35
WAP RadioSun
INAF Trieste
Astronomical
Observatory
Trieste Solar Radio
System
Coronal Radio
Indexes (10 mins
updating)
01 Nov 2003 12:18
摩托羅拉


12:35
WAP RadioSun
freq mean peak SRN
MHz SFU SFU
237 63 253 M
327 77 207 M
408 60 183 M
610 68 188 M
摩托羅拉


12:35
WAP RadioSun
1420 99 110 M
2695 171 191 M
freq mean peak
MHz dBm/Hz dBm/Hz
237 -203 -197
327 -205 -201
摩托羅拉


12:35
WAP RadioSun
408 -208 -204
610 -211 -207
1420 -217 -217
2695 -220 -220
SRN:Solar Radio
Noise
Q=Quiet sun
摩托羅拉


12:35
WAP RadioSun
SRN:Solar Radio
Noise
Q=Quiet sun
L=Low
M=Moderate
H=High
SFU:Solar Flux Unit
摩托羅拉


12:35
WAP RadioSun
237 63 253 M
327 77 207 M
408 60 183 M
610 68 188 M
1420 99 110 M
2695 171 191 M
摩托羅拉


12:35
WAP RadioSun
237 -203 -197
327 -205 -201
408 -208 -204
610 -211 -207
1420 -217 -217
2695 -220 -220
摩托羅拉