

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

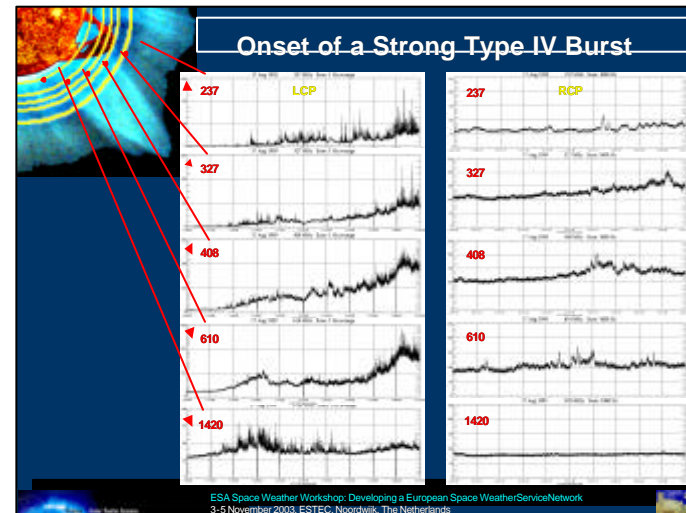
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The Trieste Solar Radio System at a Glance

- 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](#)

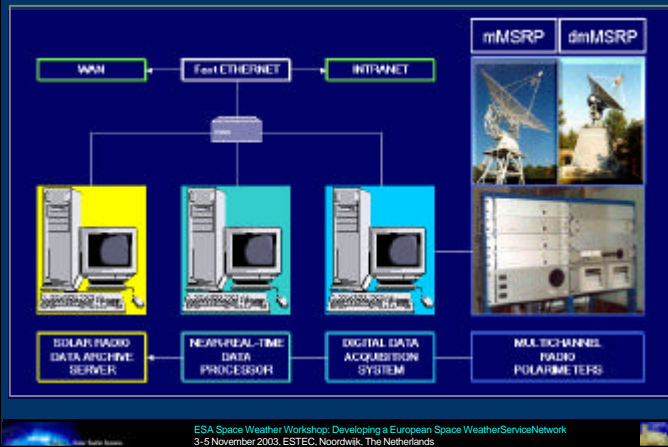
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Onset of a Strong Type IV Burst

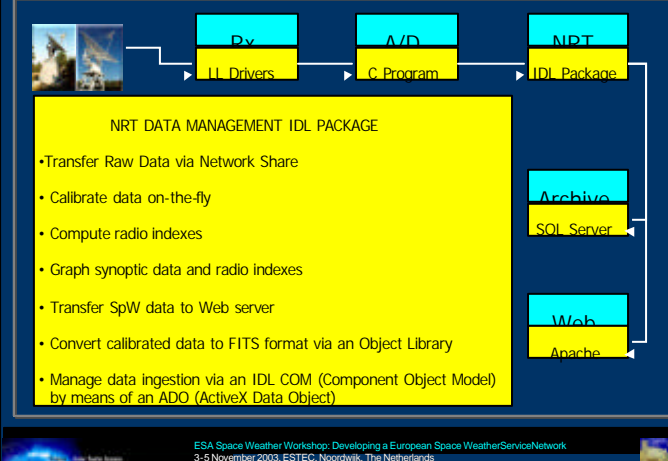


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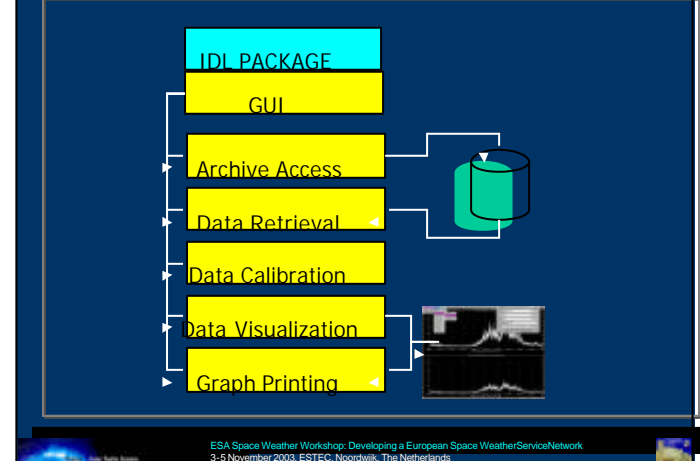
Architecture of TSRS



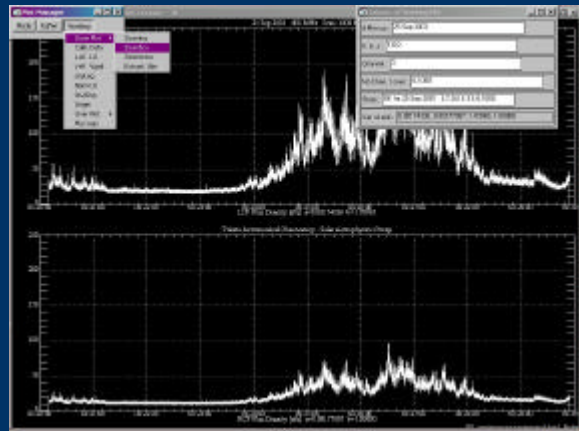
Scheme of Data Flow: Online and NRT Processing



Scheme of Data Flow: Off-Line Analysis

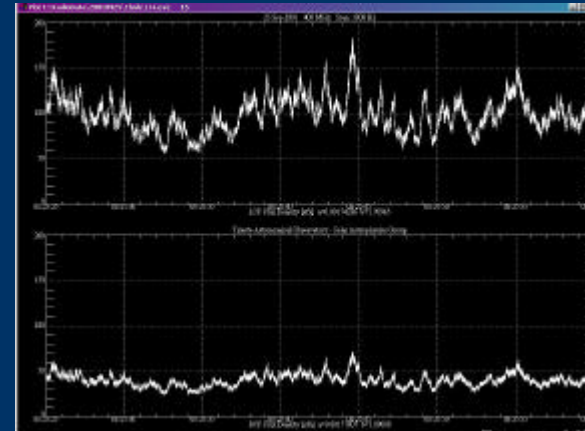


GUI of the Radio Data Processing Package



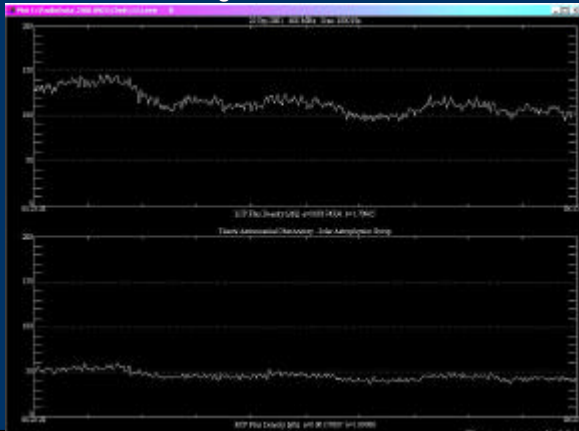
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Interactive Selection and Zoom



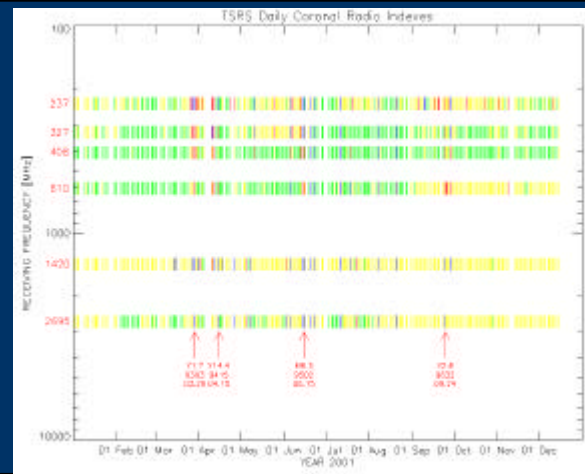
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High Zoom Factor



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ESRS Daily Coronal Radio Indices



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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)

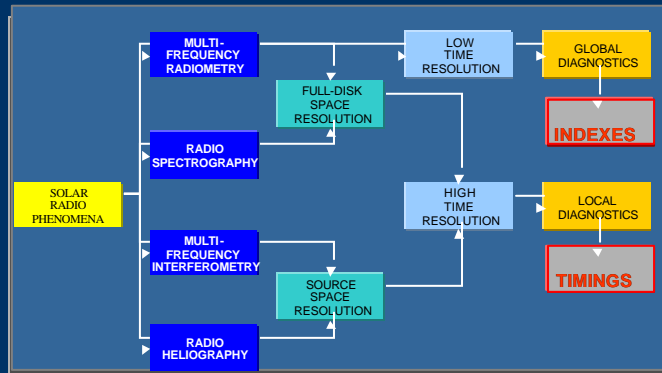
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The Sun as a Radio Noise Source

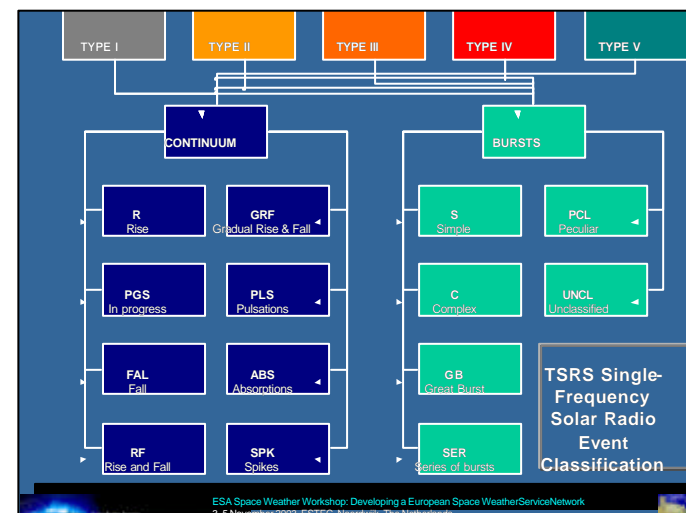
- **The Sun is a radio source**
 - non-directional
 - broad band
- **Solar radio noise can**
 - increase by several orders of magnitude during outbursts
 - persist at high levels for minutes to hours
- **Enhanced solar radio noise can perturb**
 - HF communications (**MIL**)
 - Mobile communications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

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RADIO DIAGNOSTICS RELEVANT TO SPACE WEATHER APPLICATIONS

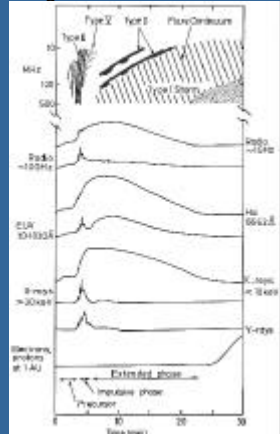


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Timing of Flare-Related Events



McLean & Labrum (1985)

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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 $\geq 100\%$ above background	-	-
	Type II event	any	-	-
Particle	Type IV event	any	-	-
	Electron Event	peak flux 10^3 pfu @ = 2 MeV	-	-
	Suspected Proton Flare	peak flux 10 p.f.u. @ = 10 MeV	-	-
	P100 Proton event	peak flux 100 p.f.u. @ = 10 MeV	-	-
SST Radiation Alert		peak flux 100 p.f.u. @ = 100 MeV	-	-
		$\geq 0.1^m$ sievert/hour (≥ 10 millirems/hour)	-	-
X-ray	M5	peak flux $\geq 5 \cdot 10^{-8}$ W m $^{-2}$	-	-
	X1	peak flux $\geq 1 \cdot 10^{-7}$ W m $^{-2}$	-	-
Geomagnetic	A index ≥ 20	running $A_{\text{av}} \geq 20$	-	-
	A index ≥ 30	running $A_{\text{av}} \geq 30$	-	-
	A index ≥ 50	running $A_{\text{av}} \geq 50$	-	-
	K index = 4	$K_p = 4$	-	-
Atmospheric disturbance	K index = 5	$K_p = 5$	-	-
	K index = 6	$K_p = 6$	-	-
Strawson		stratosphere warning conditions	-	-

• Sievert (Sv): effective (equivalent) dose of radiation received by a living organism 1 Sv = 100 rem

• particle flux unit (p.f.u.) [$\text{cm}^{-2} \text{s}^{-1} \text{sr}^{-1}$]

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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

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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)

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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)

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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!

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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

$$\text{SRN} = (\text{Quiet Sun level}) * (\text{Activity Factor})$$

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

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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

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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>

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The TSRS WWW Site

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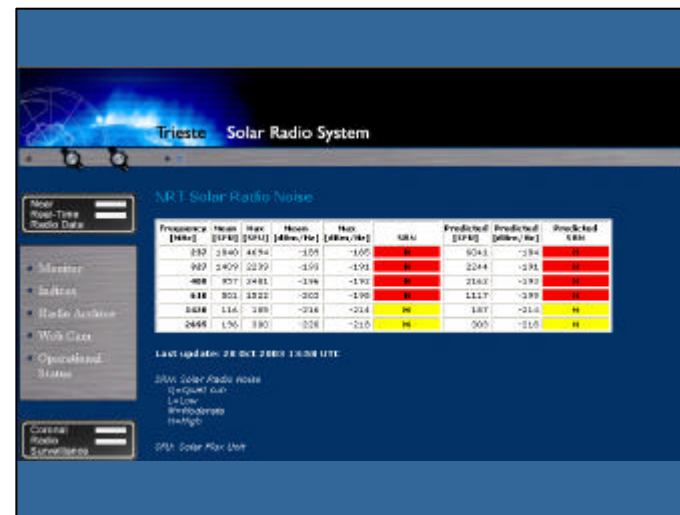
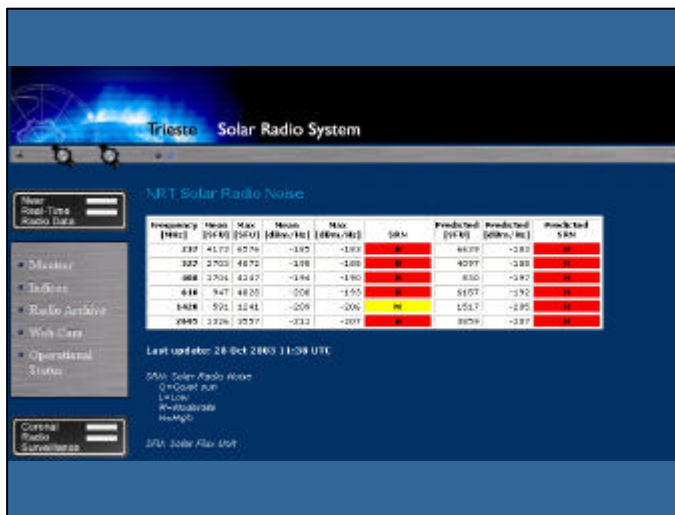
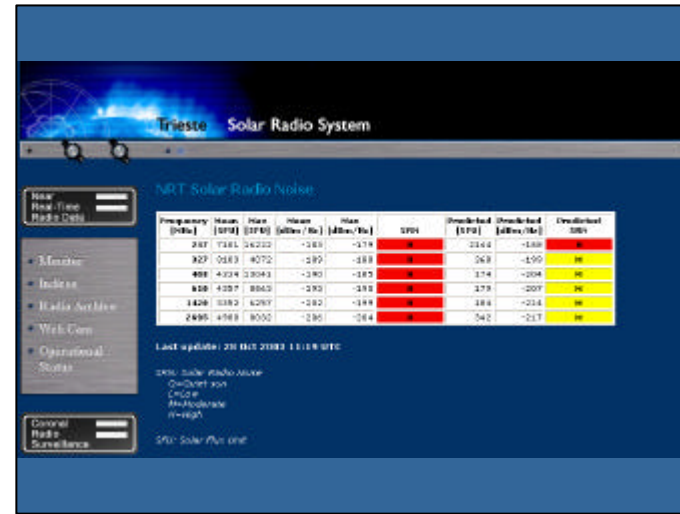
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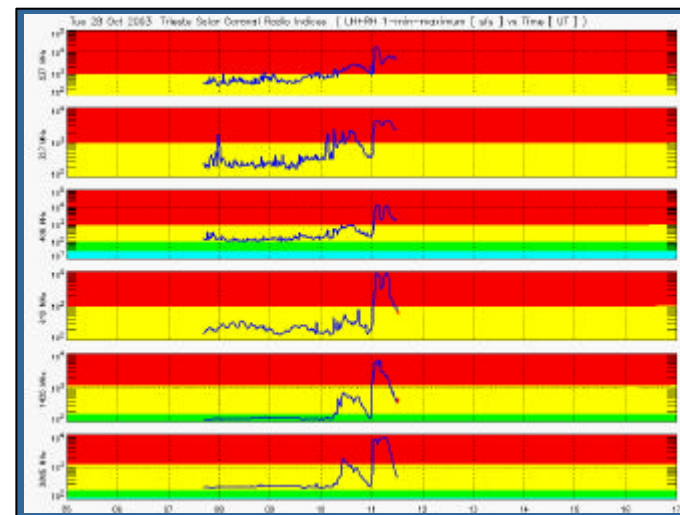
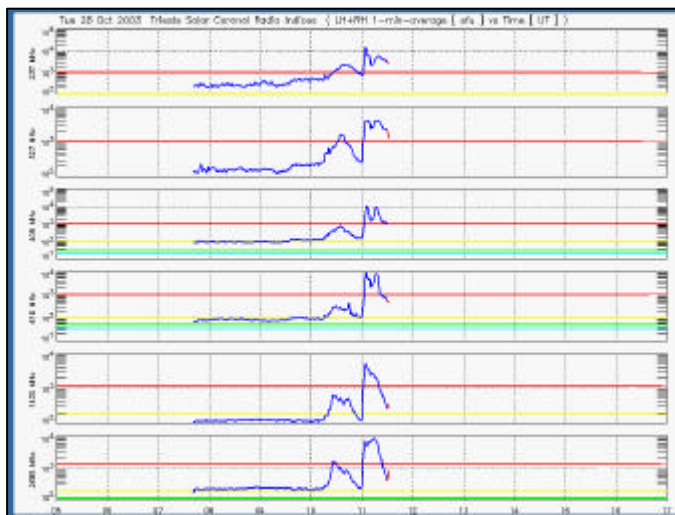
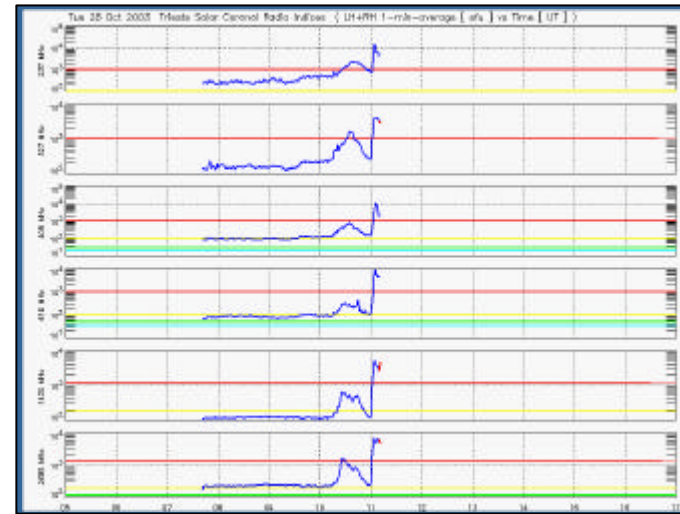
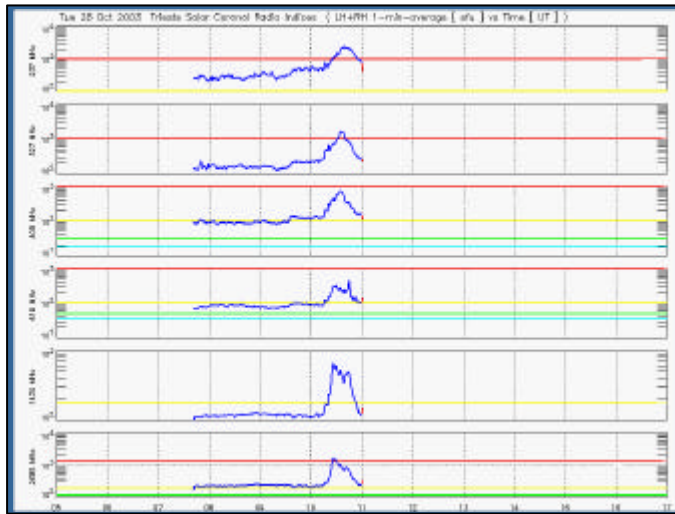
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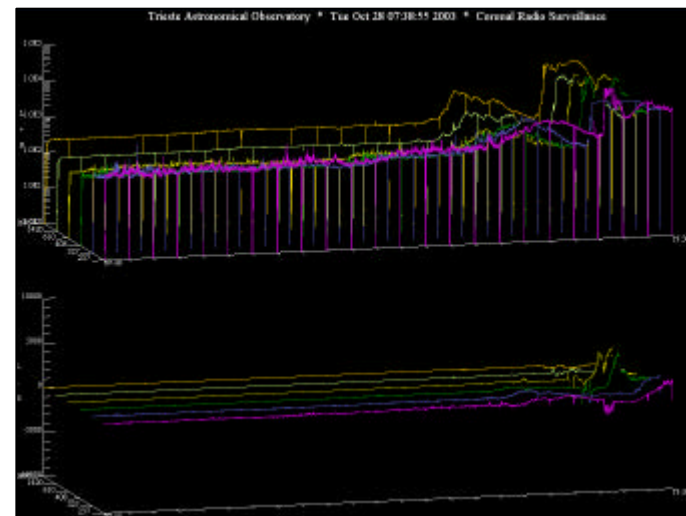
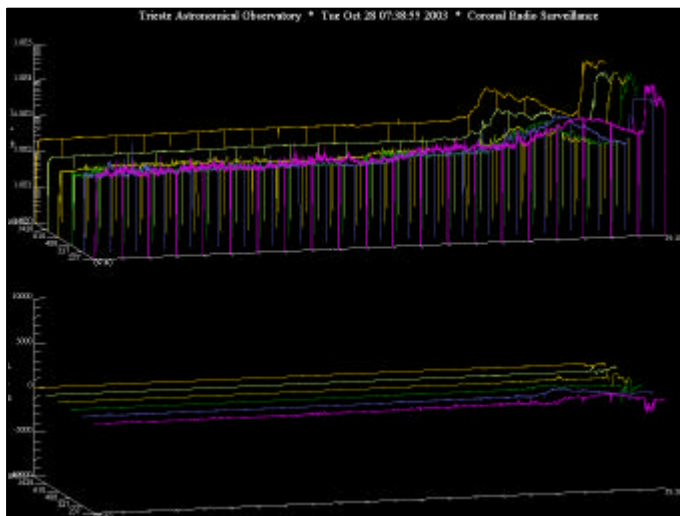
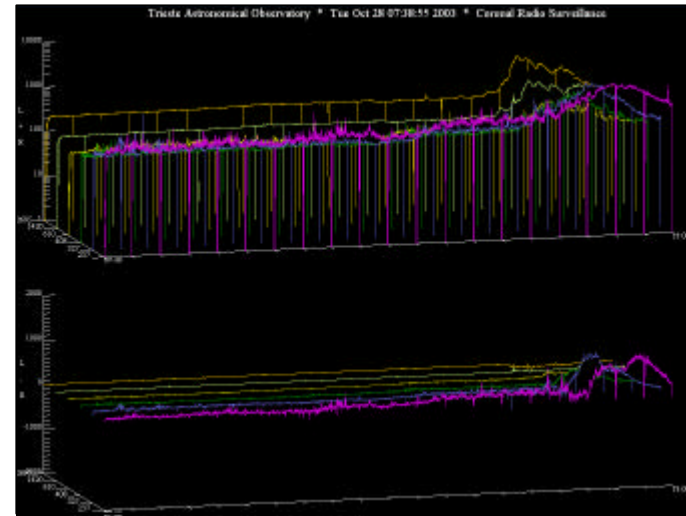
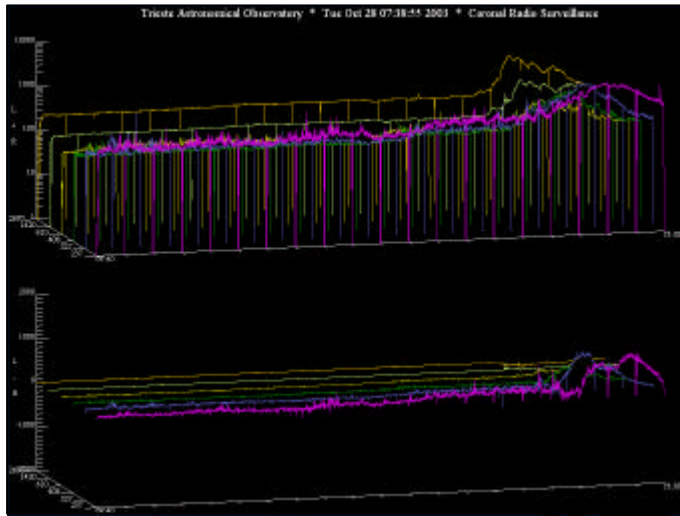
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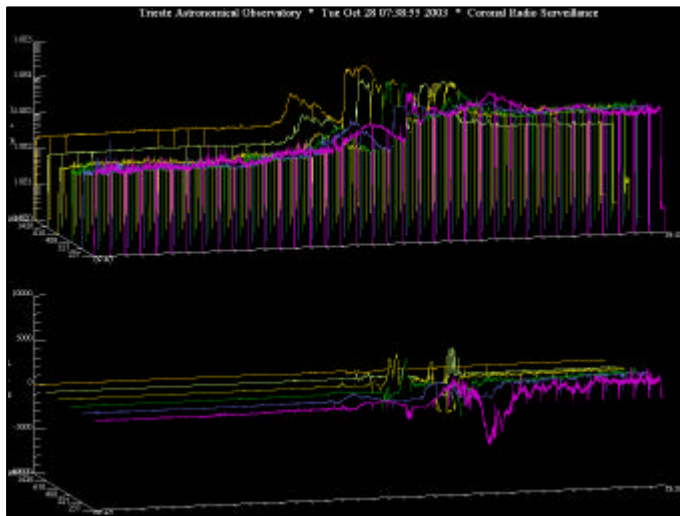
The screenshot shows the 'Trieste Solar Radio System' web page. It features a central solar image with a radio signal overlay. Below the image is a table titled 'MST Solar Radio Noise' with columns for 'Time (UTC)', 'S11', 'S22', 'S16', 'S18', 'S48', and 'S40'. The table contains numerical data and color-coded cells (red, yellow, green). The page also includes a navigation menu on the left and a footer with logos for ESA and SWENET.

The screenshot shows the 'Trieste Solar Radio System' web page, which is identical to the one above. It features a central solar image with a radio signal overlay. Below the image is a table titled 'MST Solar Radio Noise' with columns for 'Time (UTC)', 'S11', 'S22', 'S16', 'S18', 'S48', and 'S40'. The table contains numerical data and color-coded cells (red, yellow, green). The page also includes a navigation menu on the left and a footer with logos for ESA and SWENET.









Trieste Solar Radio System

Real Time Radio Data

Monitor
 Tables
 Radio Archive
 Web Cam
 Operational Status

Coronal Radio Surveillance
 Tables
 Pages
 Documentation
 Sample Data
 Space Weather
 Home

The Trieste Near-Real-Time Solar Radio Indices

Solar radio indices are derived separately for each of emission channel (LH and RH flux density) at each receiving frequency (207, 227, 239, 413, 2046, 2496 MHz) and for the sum of the two (low channel (LH + RH) (SOLR) flux density), by averaging the related radio flux density over 10-minute intervals.

The relevant graphs are automatically generated and automatically updated in real-time with a time cadence of 10 minutes during the whole day, observing runs, which spans from 02:30 UT to 27:30 UT at maximum.

In the graphs **Real-time** indicate observed values and **Old-time** indicate **10-minutes** forward predicted values.

Click on the following links to open independent indexes with the relevant graphs for the data:

- Multi-channel LDC 1-min-averages index-graph (PHG)
- Multi-channel LDC 1-min-averages index-graph (PHG)
- Multi-channel LDC 1-min-averages index-graph (PHG)

Click on the following links to open the FITS files:

- Trieste-real-time-radio-indices-FITS
- Trieste-real-time-radio-indices-FITS
- Trieste-real-time-radio-indices-FITS

Solar Radio Indices graphs and numerical values in ASCII format for the previous days can be retrieved from the relevant [Data Table Archive](#).

Trieste Solar Radio System

SOLRA - SOLAR Radio Archive
Trieste Solar Radio Archive

any time
 selected time interval

starting date: 2003-10-26 14:00:00
 ending date: 2003-10-26 14:00:00

This interval can be used for FITS reference system.

Data type: ALL

The data type depends on the contents, sampling rate, compression and preparation of the observed data, etc.

The format: ALL

The file format depends on the file type, it is generally stored in compressed FITS files, except in graphic files, etc.

File name: (updating search)

Search a string or search on matching the labels, usually in paths.

Trieste Solar Radio System

SOLRA - SOLAR Radio Archive
Trieste Solar Radio Archive

any time
 selected time interval

starting date: 2003-10-26 14:00:00
 ending date: 2003-10-26 14:00:00

This interval can be used for FITS reference system.

Data type: ALL

The data type depends on the contents, sampling rate, compression and preparation of the observed data, etc.

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