	Heliophysics Integrated Observatory

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Feature description
Type III Solar Radio Bursts
Draft

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Editor:	**Xavier Bonnin**, Paris-Meudon Observatory (OBSPARIS)
Contributors:	Jean Aboudarham, Nicolas Fuller, Christian Renié, Baptiste Cecconi
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Revision History

Version	Date	Released by	Detail
Draft	2011-03-09	Xavier Bonnin	

Note: Any notes here.

Contents

List of acronyms

CSV: Comma-Separated Values
HELIO : Heliophysics Integrated Observatory
HFC : Heliospheric Feature Catalogue
FRC : Feature Recognition Code
IDL : Interactive Data Language
TBC : To Be Confirmed
TBD : To Be Defined

Relevant Documents

1. HELIO_HFC_V2.0 Description of the HFC
2. G. A. Dulk. Type III Solar Radio Bursts at Long Wavelengths. Dans R. G. Stone, K. W. Weiler, M. L. Goldstein, et J.-L. Bougeret, éditeurs, Radio Astronomy at Long Wavelengths, page 115, 2000.
3. P. A. Robinson et I. H. Cairns. Theory of Type III And Type II Solar Radio Emissions. Dans R. G. Stone, K. W. Weiler, M. L. Goldstein, et J.-L. Bougeret, éditeurs, Radio Astronomy at Long Wavelengths, page 37, 2000.
4. Lobzin, V. V., I. H. Cairns, P. A. Robinson, G. Steward, and G. Patterson (2009), Automatic Recognition of Type III Solar Radio Bursts: Automated Radio Burst Identification System Method and First Observations, Space Weather, 7, S04002, doi: 10.1029/2008SW000425.

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Feature Description

This document presents the products of the Radio Burst Automated Tracking software (RABAT) dedicated to the type III (and type II) solar radio bursts recognition. The type III bursts are fast drifting radio emissions that can be observed between ~10 kHz and ~ 1 GHz (see Fig.1). They are generated by supra-thermal electrons (v~c/3) accelerated in the vicinity of active regions in the low corona, and traveling outward along open magnetic field lines into the interplanetary medium. Along their path, these electrons develop "bump-on-tail" distribution unstable to the production of Langmuir waves at the local plasma frequency fp $(kHz) \simeq 9n^{1/2}$, where n is the plasma density in $cm{-}3$. Some of the Langmuir wave energy is then converted through nonlinear wave-wave interactions into electromagnetic waves at the fundamental and/or second harmonic of fp (see ref[2] and ref[3] for more information).

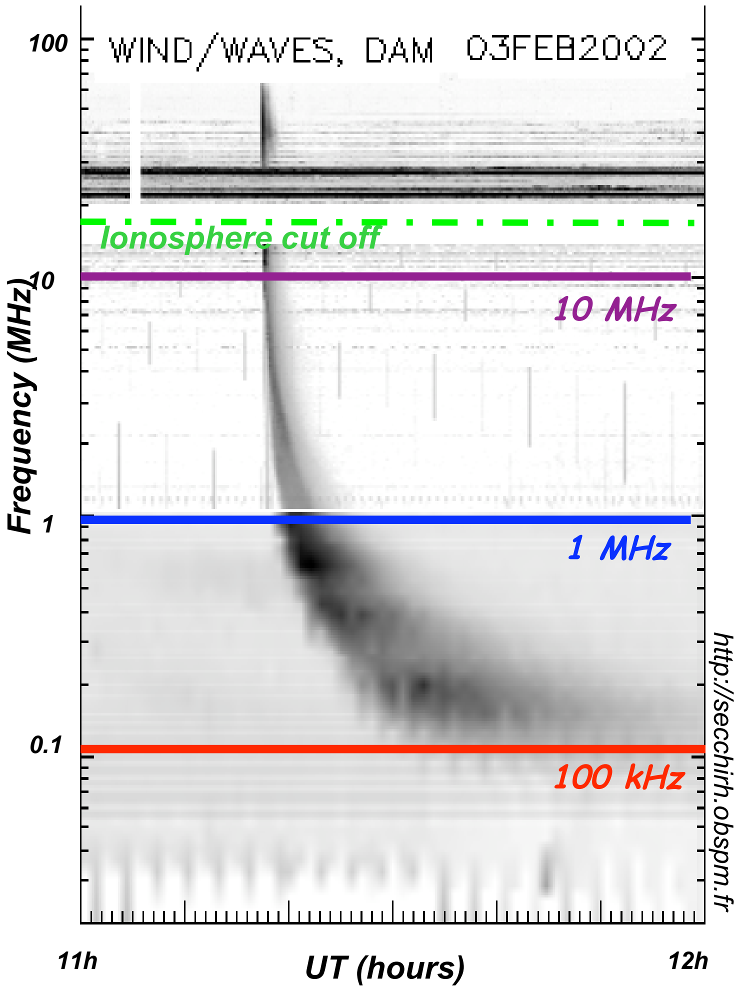

Figure 1: This assembly of dynamical spectra (which represents the radio flux as a function of the time and frequency) shows a type III solar radio burst observed by the Nancay Decametric Array (above 20 MHz) and by the Waves instrument aboard Wind spacecraft (below ~10 MHz). A fast drifting emission from higher to lower frequencies is the typical radio signature of the type III bursts.

Feature Code Characteristics

RABAT is a code written in IDL for the type III solar radio bursts detection. The algorithm is based on the Lobzin et al. 2009 method (see ref[4]), which uses a Radon transform to identify the bursts on a binary mask of the dynamical spectrum. From the radon detection, burst contour is then extracted using chain code technique (since the dynamical spectrum can be seen as an image where time and frequency axis correspond to x and y axis respectively). For now the code can be applied on the Nancay Decametric Array data, and on the Wind/Waves RAD2 and RAD1 data.

Output of the Feature Tracking Code

RABAT produces three ascii files of csv type for each dynamical spectrum processed.
The nomenclatures of the files are:

rabat3_***inst_yyyymmdd_ver_obs.***csv
rabat3_***inst_yyyymmdd_ver_frc***.csv
rabat3_***inst_yyyymmdd_ver_par***.csv

where ***yyyymmdd*** is the date of the corresponding dynamical spectrum (**yyyy** = year, **mm** = month, **dd** = day), and ***inst*** refers to the instrument that made the observation (***inst*** =dam for Nancay Decametric Array observation, ***inst*** =rad2 for Wind/Waves rad2 observations, and ***inst*** =rad1 for Wind/Waves rad1 observations), ***ver*** is the version of the code used to produce files, and ***obs***, ***frc***, and ***par*** refer to type of data contains in the file. The content of each output files is described in more details in the next sub-sections.

Observation file

The observation file (rabat3_***inst_yyyymmdd_ver_obs.***csv) contains main information about the observation used for the detection.

OBSERVATORY;INSTRUMENT;RECEIVER;FLUX_UNITS;WAVEMIN;WAVEMAX;WAVENAME;WAVEUNIT;OBS_TYPE;DATE_OBS;DATE_END;NAXIS1;NAXIS2;CDELT1;CDELT2;PR_LOCFNAME,RUN_DATE;OBS_FILENAME;FRC_FILENAME;PAR_FILENAME

NAME	FORMAT	DESCRIPTION	CURRENT CONTENT
OBSERVATORY	VARCHAR(150)	Name of the observatory/spacecraft that performs observation.	“Nancay”, “Wind”
INSTRUMENT	VARCHAR(150)	Name of the radio instrument that performs observation.	“dam”, “Waves”

RECEIVER	VARCHAR(150)	Name of the receiver that produces the dynamical spectrum used for detection	"ASB", "rad2", "rad1"
FLUX_UNITS	VARCHAR(150)	Units of the radio flux of the spectra	"$W/m^2/Hz$"
WAVEMIN	FLOAT	Minimum frequency of the dynamical spectrum	
WAVEMAX	FLOAT	Maximum frequency of the dynamical spectrum	
WAVENAME	VARCHAR(150)	Name of the domain in the wavelength spectrum	"radio"
WAVEUNIT	VARCHAR(150)	Unit of the frequency for WAVEMAX and WAVEMIN fields	"MHz"
OBS_TYPE	VARCHAR(150)	Type of observation	"remote sensing"
DATE_OBS	DATETIME	Starting time of the dynamical spectrum	"yyyy-mm-ddThh:nn:ss" format
DATE_END	DATETIME	Ending time of the dynamical spectrum	"yyyy-mm-ddThh:nn:ss" format
NAXIS1	LONG	Number of spectra in dynamical spectrum / Number of data points along the X-axis (time-axis)	
NAXIS2	LONG	Number of frequency channels in dynamical spectrum / Number of data points along the Y-axis.	

CDELT1	FLOAT	Time resolution between two spectra (in seconds) / X-axis spatial scale	
CDELT2	FLOAT	Frequency resolution (in MHz) between two channels / Y-axis spatial scale	
PR_LOCFNAME	VARCHAR(150)	Name of the input radio data file used for detection	
RUN_DATE	DATETIME	Date at which the code was run	"yyyy-mm-ddThh:nn:ss" format
OBS_FILENAME	VARCHAR(150)	Name of the current file	
FRC_FILENAME	VARCHAR(150)	Name of the corresponding feature recognition code file	
PAR_FILENAME	VARCHAR(150)	Name of the corresponding parameters file	

Feature Recognition Code file

The Feature Recognition Code (FRC) file (rabat3_***inst_yyyymmdd_ver_frc.***csv) contains main information about the detection code running.

INSTITUTE;NAME_CODE;VERSION_CODE;FEATURE,PERSON;THRESHOLD;ENC_MET;RUN_DATE;OBS_FILENAME;FRC_FILENAME;PAR_FILENAME

NAME	FORMAT	DESCRIPTION	CURRENT CONTENT
INSTITUT	VARCHAR(150)	Name of the institute responsible of the feature recognition code.	MEUDON
NAME_CODE	VARCHAR(150)	Name of the FRC.	RABAT

VERSION_CODE	FLOAT	Version of the feature code.	1.0
FEATURE	VARCHAR(150)	Feature concerned by detection.	TYPEIII_BURSTS
PERSON	VARCHAR(150)	Person responsible of the recognition code execution.	XAVIER BONNIN
THRESHOLD	FLOAT	Threshold used on radon transform to detect burst.	
ENC_MET	STRING	Encoding method	e.g., raster, chain code, none, etc.
RUN_DATE	DATETIME	Date at which the code was run	"yyyy-mm-ddThh:nn:ss" format
OBS_FILENAME	VARCHAR(150)	Name of the corresponding observatory file	
FRC_FILENAME	VARCHAR(150)	Name the current file	
PAR_FILENAME	VARCHAR(150)	Name of the corresponding parameters file	

Parameters file

The parameter file (rabat3_***inst_yyyymmdd_ver_par.***csv) contains the products of the automated detection (i.e., extracted bursts parameters).

FEAT_ID;CC_PIX_X;CC_PIX_Y;CC_UTC_X;CC_MHZ_Y;CHAINCODE;LEN_CCODE;
CC_RAD_PIX_X;CC_RAD_PIX_Y;CC_RAD_UTC_X;CC_RAD_MHZ_Y;CHAINCODE_
RAD;LEN_CCODE_RAD;RUN_DATE;OBS_FILENAME;FRC_FILENAME;PAR_FILEN
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NAME	FORMAT	DESCRIPTION	NOTES
FEAT_ID	LONG	Index of the detected burst (value is unique for each burst detected on one dynamical spectrum)	
CC_PIX_X	LONG	Coding 1st position in pixels, X axis	
CC_PIX_Y	LONG	Coding 1st position in pixels, Y axis	

CC_UTC_X	FLOAT	Coding 1st position in utc format, X (time) axis	
CC_MHZ_Y	FLOAT	Coding 1st position in MHz, Y (frequency) axis	
CHAINCODE	VARCHAR(150)	Chain code of the burst boundary	
LEN_CCODE	LONG	Length of the chain code	
CC_RAD_PIX_X	LONG	Radon line Coding 1st position in pixel, X axis	
CC_RAD_PIX_Y	LONG	Radon line Coding 1st position in pixel, Y axis	
CC_RAD_UTC_X	FLOAT	Radon line Coding 1st position in utc format, X (time) axis	
CC_RAD_MHZ_Y	FLOAT	Radon line Coding 1st position in MHz, Y (frequency) axis	
CHAINCODE_RAD	VARCHAR(150)	Chain code of the radon line	
LEN_CCODE_RAD	LONG	Length of the radon line chain code	
FEAT_MAX_INT	FLOAT	Maximum intensity (in flux units)	
FEAT_MEAN_INT	FLOAT	Mean intensity (in flux units)	
LVL_TRUST	INTEGER	Level of confidence of detection	
OVERLAP	INTEGER	Equal to 1 if the burst overlaps with an other one, 0 else.	
RUN_DATE	DATETIME	Date at which the code was run	“yyyy-mm-ddThh:nn:ss” format
OBS_FILENAME	VARCHAR(150)	Name of the corresponding observatory file	
FRC_FILENAME	VARCHAR(150)	Name the current file	
PAR_FILENAME	VARCHAR(150)	Name of the corresponding parameters file	