

RadioMeteorDetector (RMD)

Version 1.12



User's manual

Welcome to RadioMeteorDetector (RMD)!

RMD is a **standalone** application capable of detecting meteor falls within the audio signal from a radio receiver, saving them locally on your PC, and sharing your observations on the RMOB website (www.rmob.org).

This documentation provides guidance on installing, configuring, and using RMD for exploring meteor detection via radio waves.

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1. Introduction

1.1. *Radio Observation of Meteor Fall*

Meteors, entering the Earth's atmosphere, create ionized trails that reflect radio waves, making their presence detectable through radio signals. Meteor observations via radio typically occurs within a frequency range of 50 to 150 MHz. The observed Doppler shift in spectrograms remains minimal due to radio wave reflection occurring on the slowly drifting ionized trail, driven by high-altitude winds. Conversely, a reflection from the meteor head, characterized by its extreme velocity, would yield a substantially greater frequency offset. By utilizing this phenomenon, the RMD Windows application allows users to monitor meteor activity through standard SSB or CW radio receivers.

You will find a lot of information about this phenomenon on the Internet.

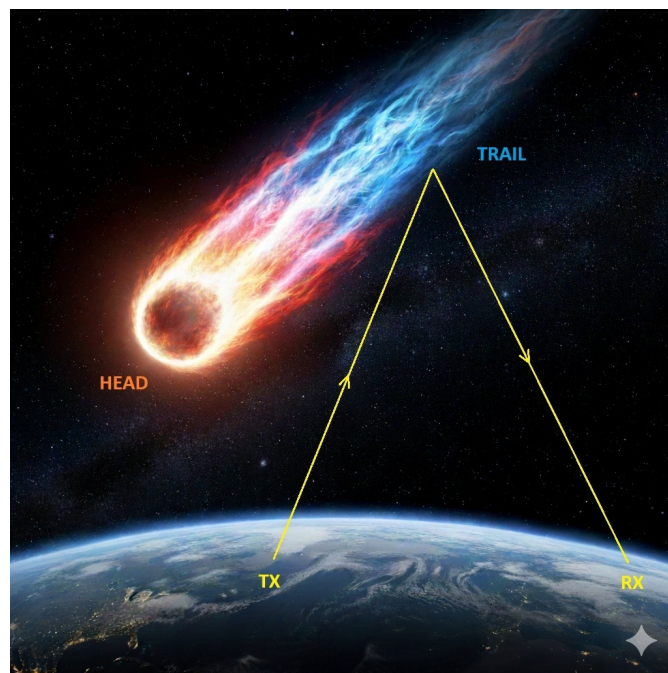


Figure 1: Meteor entering the atmosphere
(Gemini-generated image, edited)

2. **Software Installation**

2.1. *System Requirements*

RadioMeteorDetector (RMD) operates exclusively on Windows. It has been tested on Windows 10 and 11. A modern PC is required due to the real-time nature of audio signal processing. Using a computer that is too slow or heavily burdened with other applications may lead to unexpected restarts of audio components used by RMD and potentially cause the application to crash.

2.2. *Download and Installation Instructions*

RMD is available for download at the following link:

https://www.rmob.org/file/RMD_v110.zip . This compressed file contains the following 3 files: 'RMD.exe' (the RMD application), 'RMD.ini' (its initialization file) and finally 'RMD.pdf' (this document).

2.3. *Setting up RMD for First Time Use*

The software installation is straightforward: simply copy the three files into a directory of your choice, provided that you have read and write access rights in that folder. Administrative privileges are not required for the installation. You can now launch RMD for the first time.

2.4. *Upgrading from RMD v1.00 to RMD v1.12*

If you're currently using RMD (v1.00) and want to upgrade to RMD (v1.12), here's what to do:

- a. Rename the original (v1.00) files, `RMD.exe`, `RMD.ini` and `RMD.pdf` to `RMD_v100.exe`, `RMD_v100.ini` and `RMD_v100.pdf` respectively.
- b. To be safe, make sure to back up your data files by creating a copy of both the 'data' and 'images' folders.
- c. Finally, unzip the distribution file 'RMD_v112.zip' and copy the three new files—`RMD.exe`, `RMD.ini`, and `RMD.pdf`—into the directory where their counterparts from version 1.00 were installed.

2.5. Upgrading from RMD v1.10 or v1.11 to RMD v1.12

For users of RMD v1.10 or v1.11 looking to update to RMD v1.12, the following steps should be taken:

- a. Rename the only two files, 'RMD.exe' and 'RMD.pdf', in your original installation to 'RMD_v110.exe' and 'RMD_v110.pdf'.
- b. As a precaution, duplicate both the data and images folders to secure your current files.
- c. Unzip the RMD_v112.zip distribution file and copy the new 'RMD.exe' and 'RMD.pdf' into the directory where the previous files were located.
- d. You can now launch your new 'RMD.exe'. Don't forget to update the version information using RMD's main menu:
 - RMOB → Edit User Form (Figure 1)
 - In the form, update the 'Observing Method' content, for example, 'RMD v1.12.'" (Figure 2)
 - Finally, press the button 'Save and Exit (Figure 2)

2.6. First launch

When you first launch the application, it will automatically create three subdirectories named 'data', 'images' and 'RMOB'. These directories are used to store data files and images generated by RMD.

As you use the software, various files will begin to appear in the directory where RMD.exe is installed (referred to as the 'root' directory), as well as in the 'data' (root\data), 'images' (root\images), and 'RMOB' (root\RMOB) directories. A detailed list of these directories' contents is provided in Table 1 of this document.

2.7. Sharing your detection results on RMOB

If you'd like to share your meteor sightings with other enthusiasts, simply go to the *main menu*, select *RMOB > Edit user Form*.

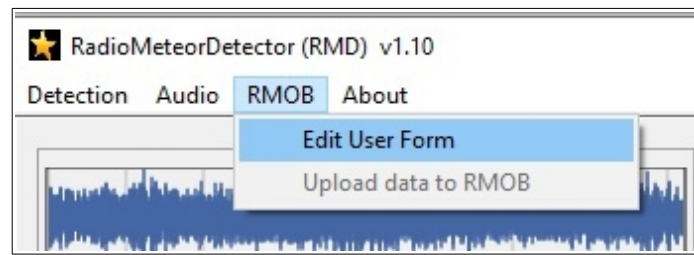


Figure 2: RMOB sub-menu

Fill out the user form completely. As long as all the form fields aren't filled out correctly (until all the checkboxes are checked), you won't be able to activate the submission of your detections to the RMOB website. Save your information by clicking on the 'Save and Exit' button.

RMOB User Information

Before submitting your observations on RMOB (www.rmob.org), please ensure that you complete ALL fields in this form.

Name:	Thibaut	<input checked="" type="checkbox"/>	First Name:	Jean-Claude	<input checked="" type="checkbox"/>
Country:	Luxembourg	<input checked="" type="checkbox"/>	City:	Clemency	<input checked="" type="checkbox"/>
Antenna:	Indoor dipole	<input checked="" type="checkbox"/>	Antenna Elevation (°):	0	<input checked="" type="checkbox"/>
Frequency (MHz):	49.970	<input checked="" type="checkbox"/>	Antenna Azimuth (°):	270	<input checked="" type="checkbox"/>
Preamplifier:	none	<input checked="" type="checkbox"/>	Find your location on Open Street Map Location by clicking here		
Receiver:	SDR dongle	<input checked="" type="checkbox"/>	Longitude (DMS):	005 52 21	<input checked="" type="checkbox"/> East <input type="checkbox"/> West <input checked="" type="checkbox"/>
Observing Method:	RMD (v1.10)	<input checked="" type="checkbox"/>	Latitude (DMS):	049 35 43	<input checked="" type="checkbox"/> North <input type="checkbox"/> South <input checked="" type="checkbox"/>
Computer Type:	Asus	<input checked="" type="checkbox"/>	Long. (°) decimal:	5.872	<input checked="" type="checkbox"/> Latitude (°) decimal:
Your email *:			jc.lx2dx@gmail.com <input checked="" type="checkbox"/>		

* Please enter a valid email address.
 This will enable RMOB to contact you in case of issue when publishing your data on the RMOB website.
 To ensure the confidentiality of your email address, it will not be published on www.rmob.org.
 Furthermore, your email address will be encrypted before being transferred or stored on the RMOB server.

Save and Exit

Figure 3: RMOB user form

Using the *main menu* again, select *RMOB > Upload data to RMOB*. The second row of the submenu RMOB will be checked, and the led at the bottom right of the RMD main screen will turn to green.

From now on, your data will be sent and updated to the RMOB website (www.rmob.org) every hour, on the hour. Please note that all data sent to RMOB is also stored locally in the '\\root\\RMOB' directory.

You can pause sending your detections to the RMOB server at any time by selecting *Main Menu -> RMOB -> Upload data to RMOB* again. This will uncheck

the second row in the RMOB submenu, and the LED at the bottom right of the RMD main screen will turn red.

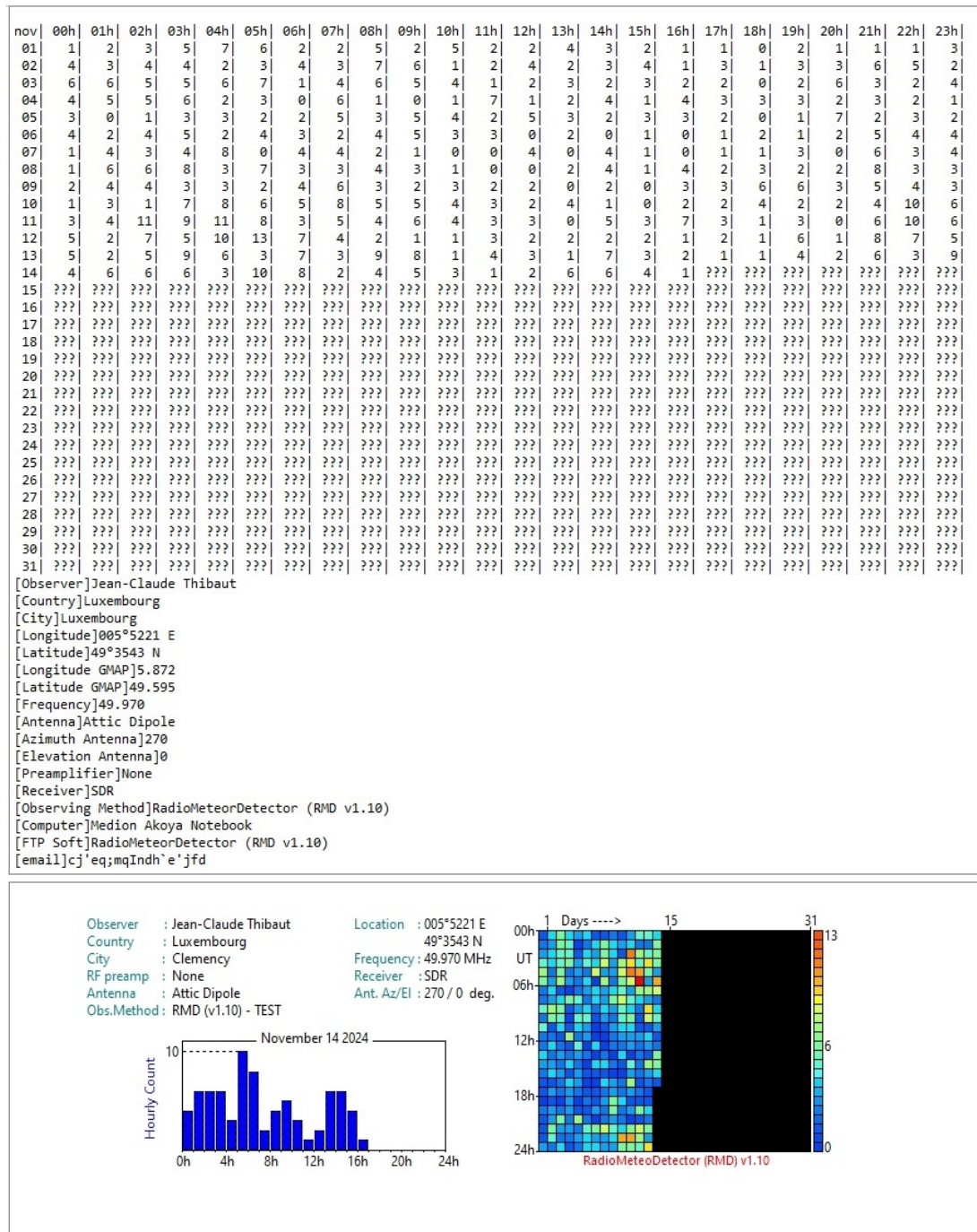


Figure 4: Text File and JPG Image Created for Publication on the RMOB Website

3. Software

3.1. Software overview

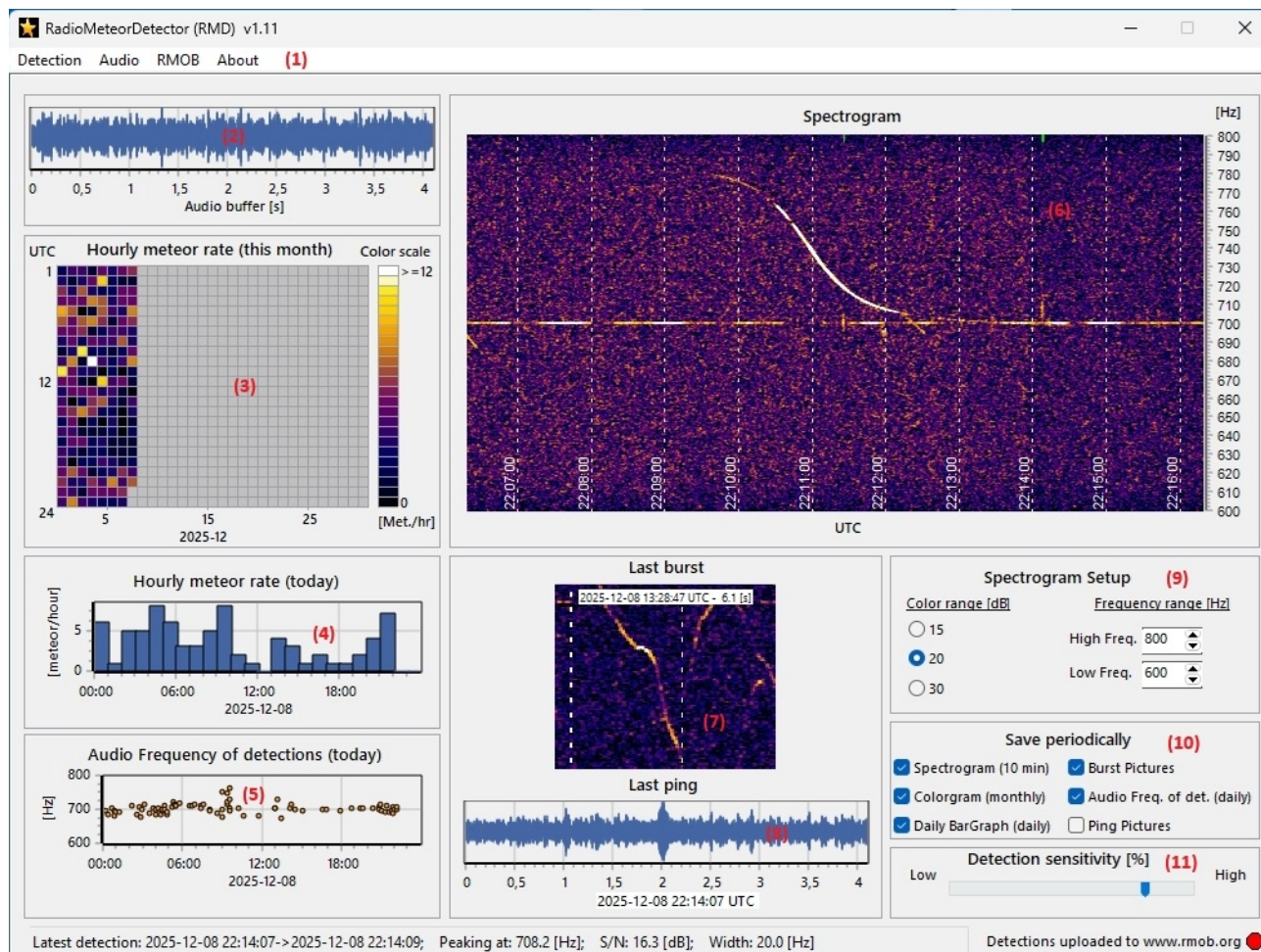


Figure 3: RadioMeteorDetector (RMD) Main Screen

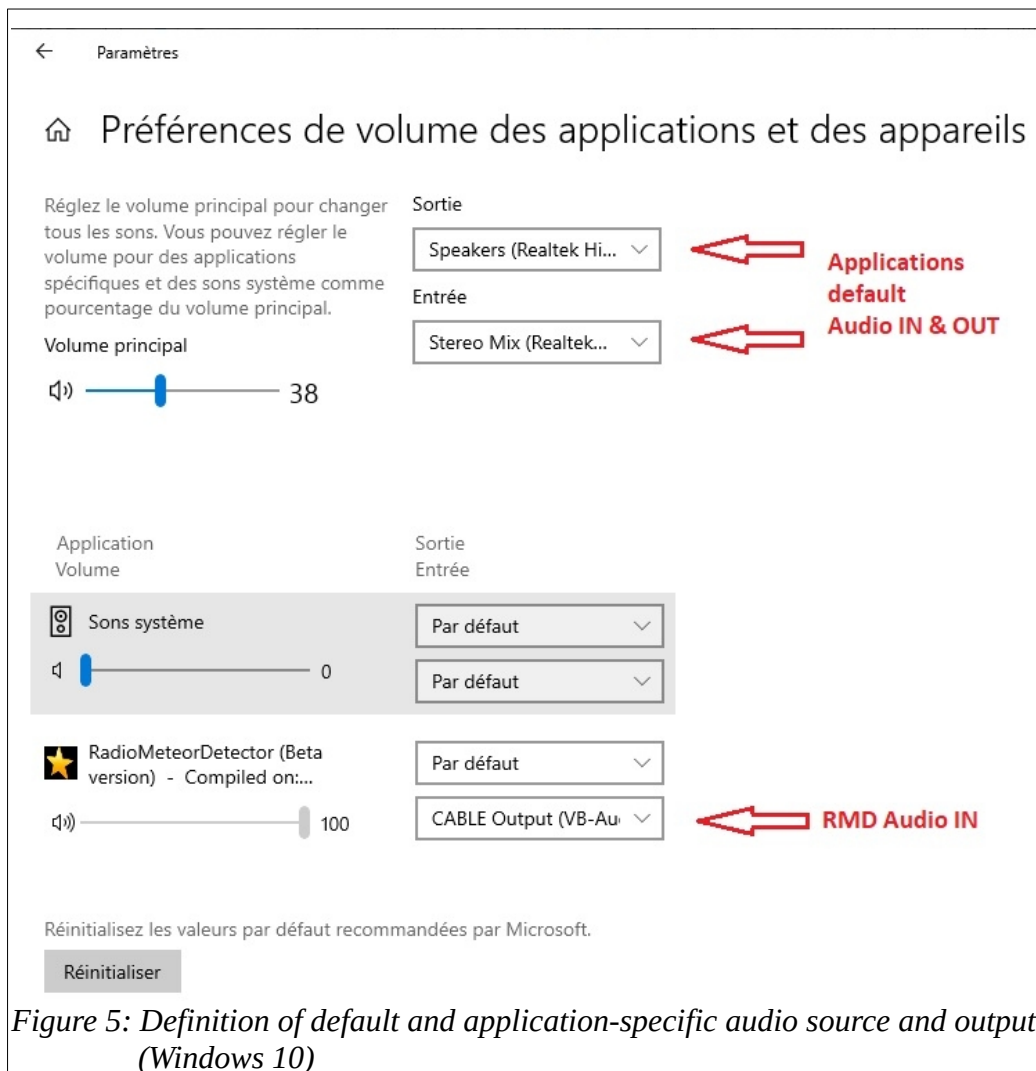
Using RMD is simple and intuitive. Let's quickly review the contents of the main window of this application.

- (1) Main Menu : The main menu lets you start or stop signal processing (and meteor detection), choose your audio source, set up your station information, and decide if you want to share your detections on the RMOB website.
- (2) Audio Buffer : this graph depicts the evolution of the amplitude of the input audio signal over time.
- (3) Colorgram : a practical way to show the meteor activity during the current month. Don't forget to check the color scale for reference.

- (4) Hourly Rate : evolution hour after hour of the observed meteor rate today.
- (5) AF detections : individual audio frequencies at which meteors were detected today are shown in this chart.
- (6) Spectrogram : a detailed view of the audio input signal frequency content, during the last 10 minutes. The best place to observe meteors pings and bursts.
- (7) Latest burst : here's a spectrogram zoom-in on the latest detected burst. This image displays bursts with a duration of 5 seconds or longer.
- (8) Latest ping : a view on the latest detected ping.
- (9) Spectrogram setup : Here you can define some parameters of the spectrogram. The color scale minimum (black) is always defined as the noise floor level, while the scale maximum (white) can be defined by the user (15, 20 or 30 dB above the noise floor level). The min and max frequencies can be defined by the user as well.
- (10) Save on disk : You can define here which graphs will be saved in the subdirectory 'root\images'.
- (11) Detection sensitivity : here is where you can define the exact threshold of detection sensitivity. To find the right setting, start with an average value (typically 50%) and gradually increase it until you notice the software begins to produce false detections. At that point, slightly decrease the sensitivity. You will then be close to the optimal setting. **Take the time to properly adjust this parameter. The effectiveness of the RMD detection algorithm depends on it.** Each configuration has its own optimal sensitivity setting.
- (12) Status bar : You'll find here some details related to the latest detection.
- (13) Led : Check here at a glance to see if your detections are currently shared on RMOB (www.rmob.org).

3.2. Audio sources

RMD's audio source is the audio signal from your radio receiver. Depending on your setup, it will be necessary to define the audio source in the Windows audio mixer (Figure 2) and/or via the RMD menu.



Examples of feasible audio source configurations: :

- Use a wired connection between you analog receiver's audio output and your PC sound card's audio input.
- You can use a virtual audio cable between the audio output of your favorite SDR software and the RMD's audio source as well
- Another possible configuration would be to play an audio file on your PC and set the input signal for RMD as the PC speaker output signal. .

It's important to note that RMD itself is silent. Indeed, it doesn't have an audio output.

3.3. Output files

RMD locally creates and store locally data files (*.txt) and images files (*.jpg). Tables 1 and 2 enumerate all the files created by RMD and provide some details about them.

Name	Directory	Updated	Remarks
debug.txt	root	1 second	Caution : do not edit or delete this file while RMD is running
debug_yyyymmdd_hhmmss.txt	root	10 minutes	Based on debug.txt . This file is created 10 minutes after program start and contains detailed processing data. Note : in version 1.10, RMD deletes the old debug_yyyymmdd_hhmmss.txt files and keeps only the most recent one.
yyyy.dat	root\data	after each detection	Contains informations related to each meteor detection for the current year : Date, Time, Duration, Peak Frequency [Hz], Peak S/N [dB] and Peak Width [Hz]
yyyymm.dat	root\data	after each detection	Same content as yyyy.txt, but for a specific month
yyyymmdd.dat	root\data	after each detection	Same content as yyyy.txt, but for a specific month
Hourly.dat	root\data	Each hour, at hh:00:00	Number of detections per hour, since you started to detect meteors with RMD
username_mmyyyrmob.txt	root\RMOB	Hourly	Can be uploaded and shared on www.rmob.org

Table 1: RMD data files

Note : The information contained in the files yyyy.dat, yyyymm.dat, yyyymmdd.dat is redundant. Under certain circumstances, this helps reduce data access time.

Name	Directory	Updated	Remarks
debug_yyyymmdd_hhmmss.jpg	root	10 minutes	First spectrogram following a program start. To be used with debug_yyyymmdd_hhmmss.txt for debugging reasons only Note : In version 1.10, RMD deletes the old debug_yyyymmdd_hhmmss.txt files and keeps only the most recent one.
Last_BarChart.jpg	root	Each hour, at hh:00:00	Hourly detection rate (See (4) in Figure 3). Cleared at midnight UTC
Last_FreqChart.jpg	root	Each hour, at hh:00:00	Peak audio frequency for each detection (See (5) in Figure 3). Cleared at midnight UTC
Last_Hourly.jpg	root	Each hour, at hh:00:00	Colorgram of the current month (See (5) in Figure 3).
Last_Ping.jpg	root	After each detection	Event shown in the time domain (See (8) in Figure 3).
Last_Spectrogram.jpg	root	10 minutes	(See (8) in Figure 3).
Last_Zoomed_Spectrogram.jpg	root	Each time a burst is detected	(See (7) in Figure 3).
yyyymmddhhmmRMD.jpg	root\images	10 minutes	Similar to Last_Spectrogram.jpg
yyyymmdd_hhmmss_Ping.jpg	root\images	Each detection	Similar to Last_Ping.jpg
yyyymmdd_hhmmss_Burst.jpg	root\images	Each detection	Similar to Last_Zoomed_Spectrogram.jp
yyyymm_col.jpg	root\images	Monthly	Similar to Last_Hourly.jpg
yyyymmdd_Rate.jpg	root\images	Daily	Similar to Last_BarChart.jpg
yyyymmdd_FMax.jpg	root\images	Daily	Similar to Last_FreqChart.jpg
username_mmyyyy.jpg	root\RMOB	Hourly	Can be uploaded and shared on www.rmob.org

Table 2: RMD images files

Note : It is very convenient to transfer via FTP the images whose name starts with 'Last_xxx' to feed your own web site. See an example on my web site:

<http://meteoclemency.myartsonline.com/index.php/meteores>

3.4. Signal Processing Key Parameters

Sampling Frequency : 4000 [Hz]

Audio Buffer Size : 16384 samples (4.096 [s])

Overlap : 75 [%]

Window : Hanning

FFT Size : 8192 bins

FFT Resolution : 0.244 [Hz]

The meteor detection algorithm is mainly implemented in the frequency domain.

4. **Final word and Disclaimer**

I hope you'll enjoy using RMD as much as I do.

Disclaimer:

RMD is offered free of charge and may not be sold.

This application is provided 'AS IS'. Use it at your own risk. The author disclaims any responsibility for issues arising from the use of this software.

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January 05, 2026