ISBN 978-2-87355-024-4

Proceedings of the International Meteor Conference

La Palma, Canary Islands, Spain
20–23 September, 2012

Published by the International Meteor Organization 2013

Edited by Marc Gyssens and Paul Roggemans

Proceedings of the International Meteor Conference
La Palma, Canary Islands, Spain, 20–23 September, 2012
International Meteor Organization
ISBN 978-2-87355-024-4

Copyright notices

© 2013 The International Meteor Organization
The copyright of papers in this publication remains with the authors.

It is the aim of the IMO to increase the spread of scientific information, not to restrict it. When material is submitted to the IMO for publication, this is taken as indicating that the author(s) grant(s) permission for the IMO to publish this material any number of times, in any format(s), without payment. This permission is taken as covering rights to reproduce both the content of the material and its form and appearance, including images and typesetting. Formats may include paper and electronically readable storage media. Other than these conditions, all rights remain with the author(s). When material is submitted for publication, this is also taken as indicating that the author(s) claim(s) the right to grant the permissions described above. The reader is granted permission to make unaltered copies of any part of the document for personal use, as well as for non-commercial and unpaid sharing of the information with third parties, provided the source and publisher are mentioned. For any other type of copying or distribution, prior written permission from the publisher is mandatory.

Editing team and Organization

Publisher: The International Meteor Organization
Editors: Marc Gyssens and Paul Roggemans
Typesetting: LaTeX 2_ε (with styles from Imolate 2.4 by Chris Trayner)

Printed in Belgium

Legal address: International Meteor Organization, Mattheessensstraat 60, 2540 Hove, Belgium

Distribution

Further copies of this publication may be ordered from the Treasurer of the International Meteor Organization, Marc Gyssens, Mattheessensstraat 60, 2540 Hove, Belgium, or through the IMO website (`http://www.imo.net`).

Radio observations and evaluation of the meteor showers between May 4 and August 25, 2012

Kerem O. Çubuk[1,2,4], **Can Terzioğlu**[1,2,4], **H. Aziz Kayıhan**[1,2,4], **Mehmet İ. Selmanoğlu**[1,2,4], **Sara Bulut**[1,2,4], **and Ferhat F. Özeren**[1,2,3]

[1] **Erciyes University Astronomy Club (ASTER)**

[2] **Erciyes University, Faculty of Science, Astronomy and Space Sciences Department**

[3] **Erciyes University, Astronomy and Space Sciences Observatory, Applications and Research Center (UZAYBİMER)**

[4] **Radio Wave Hunters**

info@radiowavehunters.com

In this poster, we present the observational data of the meteor showers which occurred between May 4 and August 25, 2012, using two 4-element Yagi antennas with optimum frequencies at 92 MHz and 100 MHz.

1 Tools

1.1 Hardware

For the observations, we had at our disposal two 4-element Yagi antennas with optimum frequencies at 92 and 100 MHz, a 30 m 75 Ω coaxial cable, two car radios, two interfaces, and two computers.

Figure 1 – The RWH-Y100 (*left*) and RWH-YX (*right*) antennas.

The Yagi antennas (Figure 1) were our own product. The reason for adjusting the optimum frequencies to the specified values is to work in the FM band (87.50–108.00 MHz). The scheme used to build these antennas is shown in Figure 2. Our first antenna, the RWH-Y100, has aluminium elements and a wooden frame. The second antenna, the RWH-YX, was designed taking into consideration the logistic problems caused by an antenna measuring 2 m × 1.5 m. The antenna is composed of element sliders, aluminium elements, and a frame. As element sliders, we took pipe holders which are normally used for natural gas piping systems in apartments. All elements and the frame of the RWH-YX antenna can be disassembled, and reassembled before each observations. Additionally, the antenna can be adjusted to the desired frequency by using the proper elements and element sliders.

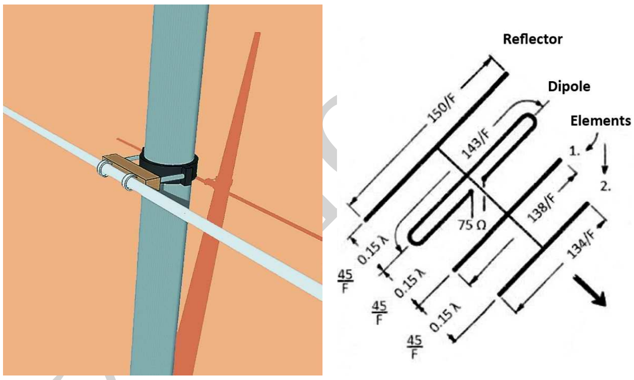

Figure 2 – *Left*: Design of the element sliders used on the RWH-XY antenna. *Right*: Scheme of a 4-element Yagi antenna. F is expressed as 1 unit per 100 MHz and the results are in centimeters.

1.2 Software

The following software was used during the observations: Radio SkyPipe 2.3.22, Colorgramme v3.2, and Audacity 2.0.0. Radio SkyPipe shows the incoming radio signal on a graph; Colorgramme counts meteors automatically by converting sound signals to COM signals by using an interface; and the Audacity software records sound signals. All these softwares have both advantages and disadvantages. For instance, Colorgramme is stable on Windows 98, but causes problems on newer versions of Windows. Radio SkyPipe and Audacity have problems with recordings of over 24 hours. Because of this, some observational data were lost.

2 Principle of meteor reflections in the radio spectrum

A radio station transmits in the FM band. The Earth's atmosphere is transparent for these frequencies; a transmission from a radio station is not reflected by the Earth's atmosphere and can normally not be received

Preliminary version

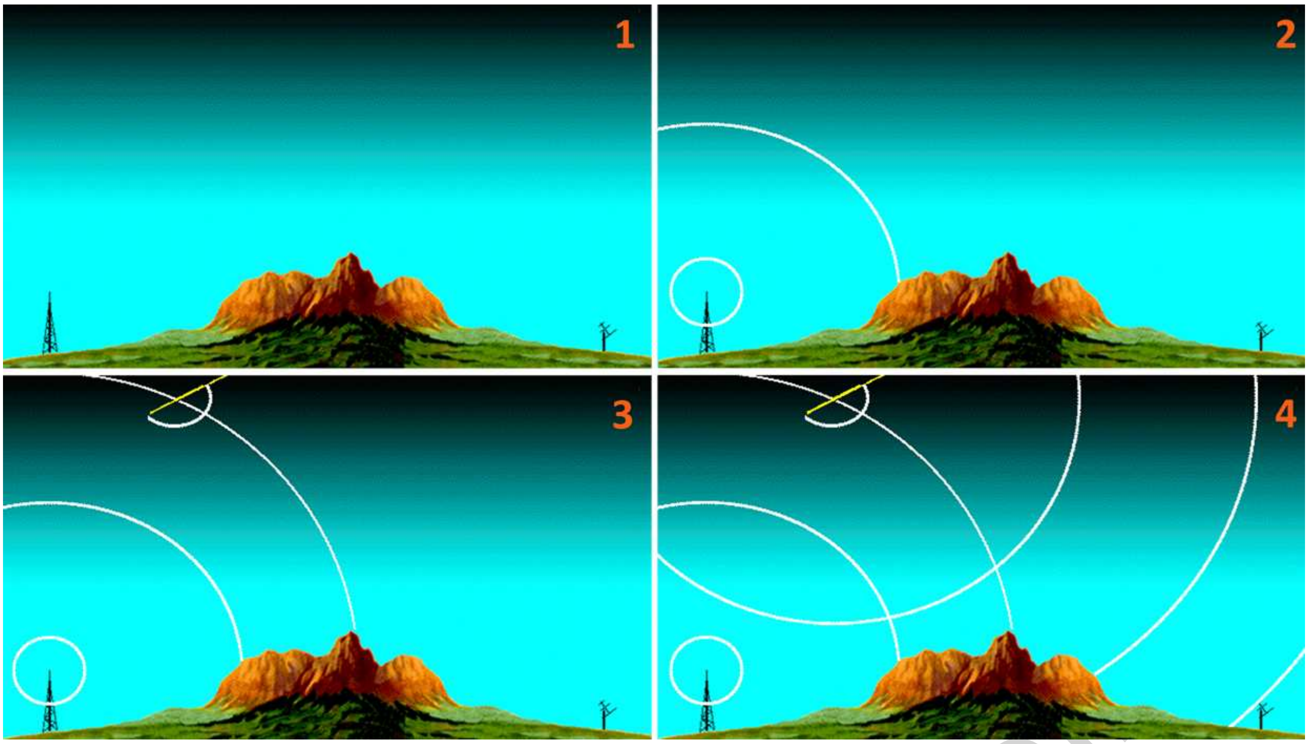

Figure 3 – Principle of meteor reflection. *(Credit: Pierre Terrier.)*

at a large distance. When an outgoing radio signal is reflected by an object on its path, however, it is returned to the Earth where it can be received by a distant antenna. In theory, this requires that there should be between 300 to 2000 km distance between the transmitter and the receiver (Odeh, 2000).

Figure 3 shows how an ionized trail left behind by a meteor reflects radio waves.

3 Observations

According to the theory, 300 to 2000 km distant broadcasts can be received with a hand-made Yagi antenna. Since the observations were made in Kayseri, we directed the antennas towards Ankara-Istanbul to receive more signals (see Section 3.3). Radyo Hacettepe in Ankara and NTV Spor Radyo in Istanbul broadcast at 87.70 MHz. The existance of many major cities on the direction Ankara-Istanbul increases the chance to receive more broadcasts.

Since the signals received during the observations last for a couple of seconds, it was not always possible to understand from which station the broadcasts were aired. However, some larger meteors leave stronger ionized trails behind, making it possible to receive broadcasts of up to a few minutes (up to 20 minutes in theory). Just by chance, one of the captured reflections contained the jingle of Fun Radio, which turned out to be a Slovak radio broadcasting at 87.70 MHz at about 1700 km away from Kayseri. The same station was also recorded by a group from the United Kingdom while doing sporadic meteor observations and proved to be an ideal station to listen for meteor observations.

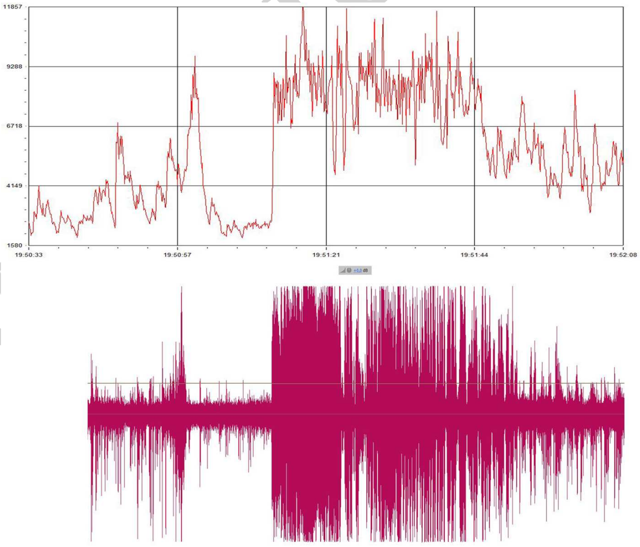

Figure 4 – Underdense and overdense samples taken during observations. The graph at the *top* is Radio Skypipe data, the one at the *bottom* is a Soundbooth sound graph. Both graphs show the change of sound intensity over time. In the Soundboot graph, the short jumps correspond to underdense echoes and the long jumps to overdense echoes.

We next present a few approaches we considered for radio meteor observing and discuss their efficiency.

3.1 Method 1

The observations are carried out after the antenna is directed towards the related scatter area and an empty radio frequency is found.

We found that directing the antenna without checking for a broadcasting station first is a serious mistake, however, and a very inefficient method.

Preliminary version

Table 1 – Details of the observational data. Meteor showers with ZHRs which have a peak on the specified dates are underlined. The following abbreviations were used: ABoo—α-Bootids, MVir—μ-Virginids, OCap—ω-Capricornids, ASco—α-Scorpiids (May 3), EAqu—η-Aquariids, Hal—Halleyids, EAri—ε-Arietids, ASci—α-Scorpiids (May 16), MAri—May Arietids, BCA—β-Coronae Australids, Sag–Sagittariids, OCet—o-Cetids, LSag—λ-Sagittariids, Ari—Arietids, ZPer—ζ-Perseids, Oph—Ophiuchids, GDra—γ-Draconids, TPer—Taur. Perseids, Scu—Sculptorids, 54Per—54-Perseids, Cor—Corvids, JBoo—June Bootids, TCet—τ-Cetids, BTau—β-Taurids, TAqu—τ-Aquariids, TOph—θ-Ophiuchids, Cap—Capricornids, LGem—λ-Geminids, BCap—β-Capricornids, SCas—σ-Cassiopeiids, ACyg–α-Cygnids, SCap—σ-Capricornids, PAus—Piscis Austrinids, ACap—α-Capricornids, GPeg—γ-Perseids, AqCap—Aquar. Capricornids, NDAqu—N. δ-Aquariids, DCas—δ-Cassiopeiids, Per—Perseids, UPeg—υ-Pegasids, KCyg—κ-Cygnids, NIAqu—N. ι-Aquariids, GLeo—γ-Leonids. (`http://observations.eracnet.org/doc/meteor_shower_calendar.xls`.)

Date	Meteor Showers	Antenna	Frequency(MHz)	Method	Place	Observed Meteor Count
5 May	ABoo, MVir, OCap, ASco, <u>EAqu,</u> Hal, EAri, ASci, MAri, BCA, Sag	RWH-Y100	100.7	1	UZAYBİMER	-
6 May	ABoo, MVir, OCap, ASco, <u>EAqu,</u> Hal, EAri, ASci, MAri, BCA, Sag, Ocet		102.3			-
26 June	LSag, Ari, ZPer, Oph, GDra, TPer, Sag, Scu, <u>54Per, Cor, JBoo,</u> TCet, <u>BTau,</u> TAqu, Toph		101.2	2	Hisarcık	3
27 June	LSag, Ari, ZPer, Oph, GDra, TPer, Sag, Scu, <u>54Per, Cor, JBoo,</u> TCet, <u>BTau,</u> TAqu, Toph					6
28 June	LSag, Ari, ZPer, Oph, GDra, TPer, Sag, <u>54Per, Cor, JBoo,</u> TCet, <u>BTau,</u> TAqu, TOph	RWH-Y100	96.7 - 101.2			3
29 June	LSag, Ari, ZPer, Oph, GDra, TPer, Sag, <u>54Per, Cor, JBoo,</u> TCet, <u>BTau,</u> TAqu, TOph	RWH-YX				4
20 July	Cap, LGem, BCap, SCas, <u>ACyg, SCap,</u> PAus, ACap, GPeg, AqCap, NDAqu, DCas, Per	RWH-YX	87.7	3	ERT-5	9
21 July	Cap, LGem, BCap, SCas, ACyg, <u>SCap,</u> PAus, ACap, GPeg, AqCap, NDAqu, DCas, Per					11
22 July	Cap, LGem, BCap, SCas, ACyg, <u>SCap,</u> PAus, ACap, GPeg, AqCap, NDAqu, DCas, Per					6
23 July	Cap, LGem, BCap, SCas, ACyg, SCap, PAus, ACap, GPeg, AqCap, NDAqu, DCas, Per					12
24 July	Cap, LGem, BCap, SCas, ACyg, SCap, <u>PAus,</u> ACap, GPeg, AqCap, NDAqu, DCas, Per					10
5 August	SCas, SCap, PAus, ACap, <u>GPeg, AqCap,</u> NDAqu, DCas, Per, UPeg, KCyg		87.5			8
6 August	SCas, SCap, PAus, ACap, <u>GPeg, AqCap,</u> NDAqu, DCas, Per, UPeg, KCyg					7
7 August	SCas, SCap, PAus, ACap, <u>GPeg, AqCap,</u> NDAqu, DCas, Per, UPeg, KCyg					5
8 August	SCas, SCap, PAus, ACap, <u>GPeg,</u> AqCap, <u>NDAqu,</u> DCas, Per, UPeg, KCyg		106.4			73
9 August	SCas, SCap, PAus, ACap, GPeg, AqCap, <u>NDAqu, DCas,</u> Per, UPeg, KCyg					-
12 August	SCas, ACap, GPeg, AqCap, NDAqu, DCas, <u>Per, UPeg,</u> KCyg, NIAqu		87.7			64
13 August	SCas, ACap, GPeg, AqCap, NDAqu, <u>Per, UPeg,</u> KCyg, NIAqu					116
14 August	SCas, ACap, GPeg, AqCap, NDAqu, <u>Per,</u> UPeg, KCyg, NIAqu, GLeo					72
15 August	SCas, ACap, GPeg, AqCap, NDAqu, <u>Per,</u> UPeg, KCyg, NIAqu, GLeo					53
16 August	SCas, GPeg, NDAqu, Per, UPeg, <u>KCyg,</u> NIAqu, GLeo					-

3.2 Method 2

Antennas are directed towards the city center from outside the city. The observations are carried out by picking a station known to be broadcasting in the city, but which cannot be received from the location.

Being stationed only 15 km away from the city center during the observations, resulted in being outside of the theoretical meteor scattering area (300–2000 km). As a result, also this method is inefficient and unsuitable.

3.3 Method 3

The antenna is directed towards Ankara-Istanbul, and the receiver is adjusted for the frequencies known to be broadcasting in these cities.

This is the method which is the most suitable according to the theory, and it is the one that should be used.

An overview of our observations is given in Table 1.

4 Evaluation and results

In this study, we present 21 days of observation. During observations, we noticed some errors and changed the method accordingly. Due to the low budget of the team, we suffered from problems with the equipment and the logistics. The low quality of the observing equipment adversely affected the number of meteors observed. Despite encountering many errors and problems, and considering the experience and knowledge at the beginning of the study, we achieved significant progress. If meteor observations can be carried out throughout the country with records taken 24/7, a large database can be formed and much greater studies can be performed. This is one of the future plans of the Radio Wave Hunters.

Acknowledgements

We would like to thank İbrahim İsrafil Şenyiğit and Görkem Koray Öz, for their contributions during the team's early developments; Gülay and Ercihan Güney, for providing us with all means of support during our June observations, Ece Gülfem Dağdeviren, for accompanying us during many observations, and for her support, and finally, Ömer Faruk Dağdeviren, for helping us by providing electronics support.

References

Engin M.F., Uğurluoğlu C.B., Topal S., and Başlangıç G. (2005). "Basit radyoastronomi tekniğiyle meteor gözlemi ve analizi". *Journal of Istanbul Kültür University*, Istanbul Kültür University, pages 83–91 (in Turkish).

Jenniskens P. (2006). *Meteor Showers and Their Parent Comets*. Cambridge Univ. Press, Cambridge UK.

Kronk G. W. (1984). *Comets: A Descriptive Catalog*. Enslow Publishers, New Jersey.

IMO (2011). *Radio observations*. `http://www.imo.net/radio`.

Odeh M., Jordanian Astron. Society (2000). *Observing meteors by radio*. `http://www.jas.org.jo/radio.html`.

RMOB (2011). *Radio meteor observing bulletin*. `http://www.rmob.org`.

SkyScan (2011). *Sky scan science outreach program*. `http://www.skyscan.ca`.

Terrier P. (2008). *Colorgramme Lab Software*. `http://radio.meteor.free.fr`.

Preliminary version