No Sign of the 2014 Daytime Sextantids and Mass Indexes Determination from Radio Observations

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Introduction

The invitation to observe DSX 221 in the period 30 September – 05 October 2014 by any possible means was made by Rendtel[2] at the IMC 2014 in Giron, France (Rendtel J., 2014, I). Because the position of the DSX 221 radiant was close to the Sun, radio observations by the EurAstro Radio Station (EARS) located in Munich (48° 7' 58,0" N, 11° 34' 47.3" E) immediately appeared particularly suitable.

EARS, based on the forward scattering principle and adopted the following configuration: radio beacon from the GRAVES radar (emitter at Broyes-les-Pesmaes, 47° 20' 51.72" N, 5° 30' 58.68" E, about 500 km from Munich), vertical antenna J-Pole 144, receiver ICOM 1500 (USB mode, 143.049 MHz), computer Pavillion dv6 (processor Intel Core Duo T2500) and SpecLab V26 b10 as recording software. EARS radio observations in the recording period from 30/09/2014, 07:00 UT – 05/10/2014, 16:00 UT proceeded without problems.

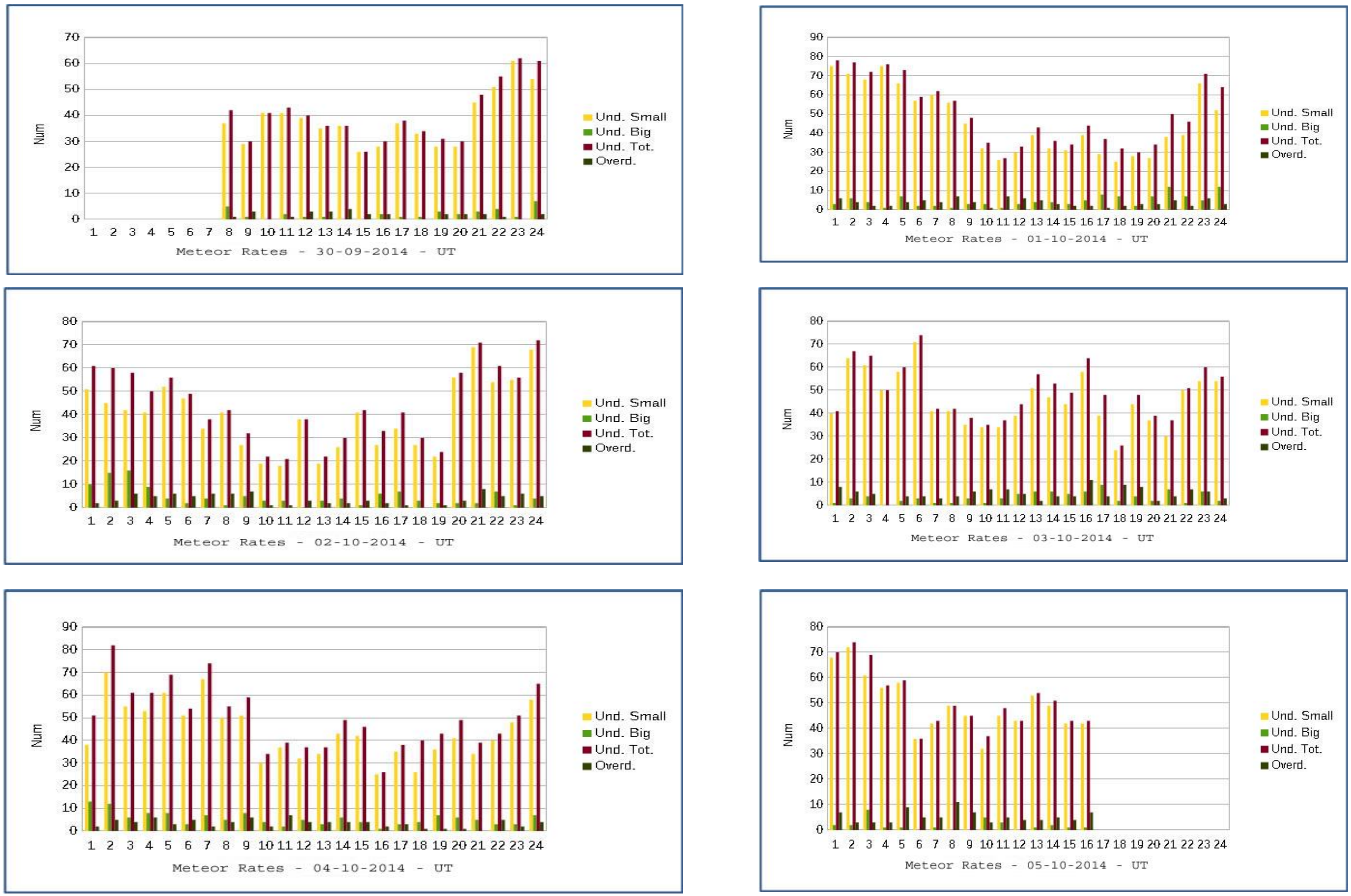
Meteor echoes were counted visually by looking at the JPG images recorded by SpecLab every 5 minutes.

EARS radio observation of DSX 221

According to the Meteor Shower Workbook 2014 (Rendtel J., 2014, II), there were two other showers active (apart from DSX 221, non-DSX and sporadics) at the time of the observations: 2 STA (Southern Taurids, ZHR_{max} = 5 on October 10), and ORI (Orionids, ZHR = 2 around October 1). This indicates that we may neglect these two minor showers with respect to non-DSX, sporadics and possible DSX 221 meteors.

The observed hourly meteor rates are summarized in the diagrams of Fig. 1. Evidently the meteors of DSX 221 were superposed on the ever present non-DSX and sporadic meteors.

Figure 1 – Observed hourly meteor echo rates during the recording period



Analysis of observed meteor rates

The fact that during the recording period the radiant of DSX 221 descended below the horizon for periods of about 12 hours, allowed to directly acquire in said periods information about non-DSX and sporadic meteors alone as opposed to information about DSX 221 plus non-DSX and sporadic meteors in the periods of about 12 hours in which the radiant was above the horizon (Tab. 1).

Table 1 – **Underd. and overd. meteors for DSX 221 plus non-DSX and sporadic meteors (in the periods in which the radiant was above the horizon) and underd. and overd. meteors for non-DSX and sporadic meteors alone (in the periods in which the radiant was below the horizon) for Munich (Germany).[4]**

1	30/09/14	2h52m	14h56m UTC	DSX 221 radiant above horizon
und.:		min 30 m/h	max 43 m/h	average 38.28 m/h
ove.:		min 0 m/h	max 4 m/h	average 2.14 m/h
30/09/14		14h57m – 01/10/14	2h47m UTC	DSX 221 radiant below horizon
und.spor:		min 30 m/h	max 78 m/h	average 49.45 m/h
ove.spor:		min 0 m/h	max 6 m/h	average 1.90 m/h
2	01/10/14	2h48m	14h52m UTC	DSX 221 radiant above horizon
und.:		min 27 m/h	max 76 m/h	average 49.90 m/h
ove.:		min 1 m/h	max 7m/h	average 4.36 m/h
01/10/14		14h53m – 02/10/14	2h43m UTC	DSX 221 radiant below horizon
und.spor:		min 30 m/h	max 71 m/h	average 48.09 m/h
ove.spor:		min 1 m/h	max 6 m/h	average 2.90 m/h

Table 1 (continuation)

3	02/10/14	2h44m	14h49m UTC	DSX 221 radiant above horizon
und.:		min 21 m/h	max 56 m/h	average 36.36 m/h
ove.:		min 1 m/h	max 7 m/h	average 4.00 m/h
02/01/14		14h50m – 03/10/14	2h39m UTC	DSX 221 radiant below horizon
und.spor:		min 33 m/h	max 71 m/h	average 50.36 m/h
ove.spor:		min 0 m/h	max 8 m/h	average 4.09 m/h
4	03/10/14	2h40m	14h45m UTC	DSX 221 radiant above horizon
und.:		min 35 m/h	max 60 m/h	average 48.36 m/h
ove.:		min 0 m/h	max 7 m/h	average 4.18 m/h
03/10/14		14h46m – 04/10/14	2h36m UTC	DSX 221 radiant below horizon
und.spor:		min 26 m/h	max 82 m/h	average 51.09 m/h
ove.spor:		min 2 m/h	max 11 m/h	average 5.54 m/h

Table 1 (continuation)

- ____
- 5 04/10/14 2h37m 14h41m UTC DSX 221 radiant above horizon
- und.: min 34 m/h max 74 m/h average 51.63 m/h
- ove.: min 2 m/h max 6 m/h average 4.27m/h
- 04/10/14 14h42m – 05/10/14 2h32m UTC DSX 221 radiant below horizon
- und.spor: min 26 m/h max 74 m/h average 48.90 m/h
- ove.spor: min 0 m/h max 7 m/h average 2.63 m/h
- ____
- 6 05/10/14 2h37m 14h41m UTC DSX 221 radiant above horizon
- und.: min 36 m/h max 59 m/h average 47.45 m/h
- ove.: min 3 m/h max 11 m/h average 5.54 m/h
- ____

The average number of underdense meteors per hour when the radiant was above (45.3) and below the horizon (49.5), suggests that the observed meteor activity corresponds mainly to fluctuations of the non-DSX and sporadic background.

There is no single period with the radiant above the horizon where the number of <u>underdenses</u> meteors was significantly higher than the number of underdense meteors with the radiant below the horizon in the previous or next period. This leads to the same conclusion.

The average number of overdense meteors when the radiant was above the horizon (4.0) was higher than when the radiant was below the horizon (3.4). But a simple statistical analysis revealed that the number of overdense meteors per hour when the radiant is above the horizon is not significantly larger than the number of overdense meteors per hour when the radiant is below the horizon (assuming Gaussian distributions and testing at a confidence level of 95%). Hence, we can assume that we did not observe any DSX 221 activity that exceeds the standard deviation of the non-DSX and sporadic rates

We conclude that the activity of the DSX 221 meteors, if any, was at a much lower level than the non-DSX and sporadic activity.

The mass index of a meteoroid stream or non-stream and sporadics

The mass index s describes the meteoroid mass distribution within a meteoroid stream which is governed by a power law. The larger the mass index, the larger the relative number of small particles. Exploiting the relationship between meteoroid mass and magnitude of the corresponding visual meteor, the mass index s can be expressed in terms of the population index r as follows: $s = 1 + 2.5\, b \log r = 1 + 2.3 \log r$, where $b = 0.92$ (Koschack R., 1990, I), (Koschack R., 1990, II).

Employing the power law and the fact that the duration of an overdense reflection is roughly proportional to the mass of the meteoroid, we find that the relation between the logarithm of the duration T of the overdense meteors and the logarithm of the cumulative number N(T) of overdense meteors with duration at least T is a straight line with slope $1 – s$.

More detailed explanations regarding the meaning of the mass index and how to calculate it can be found in (Belkovich O.I., 2006), (Verbeeck C., 2014). In particular, it is explained in (Verbeeck C., 2014) how to obtain the mass index from the amplitude distribution of all meteor reflections.

Calculation of non-DSX and sporadic mass indexes from radio observations

Tab. 2 and Fig. 2 show the values of the mass index for the non-DSX and sporadic meteors in 10 periods, obtained according to the method sketched above. The log cumulative duration distribution plot for all overdense meteor reflections observed from September 30 till October 5 2014 is in Fig. 3.

Table 2 - Mass index variation for sporadic meteors in the periods 1-10.

Period	From	UT	to	UT	mass index non-DSX and sporadics
• 1	30/09/14	15:00:00	01/10/14	01:00:00	1.74
• 2	01/10/14	03:00:00		13:00:00	2.07
• 3	01/10/14	15:00:00	02/10/14	01:00:00	2.51
• 4	02/10/14	03:00:00		13:00:00	1.87
• 5	02/10/14	15:00:00	03/10/14	01:00:00	2.64
• 6	03/10/14	03:00:00		13:00:00	2.65
• 7	03/10/14	15:00:00	04/10/14	01:00:00	2.41
• 8	04/10/14	03:00:00		13:00:00	2.37
• 9	04/10/14	15:00:00	05/10/14	01:00:00	2.46
• 10	05/10/14	03:00:00		13:00:00	2.26

Figure 2 - **Mass index variation for sporadic meteors in the periods 1-10.**

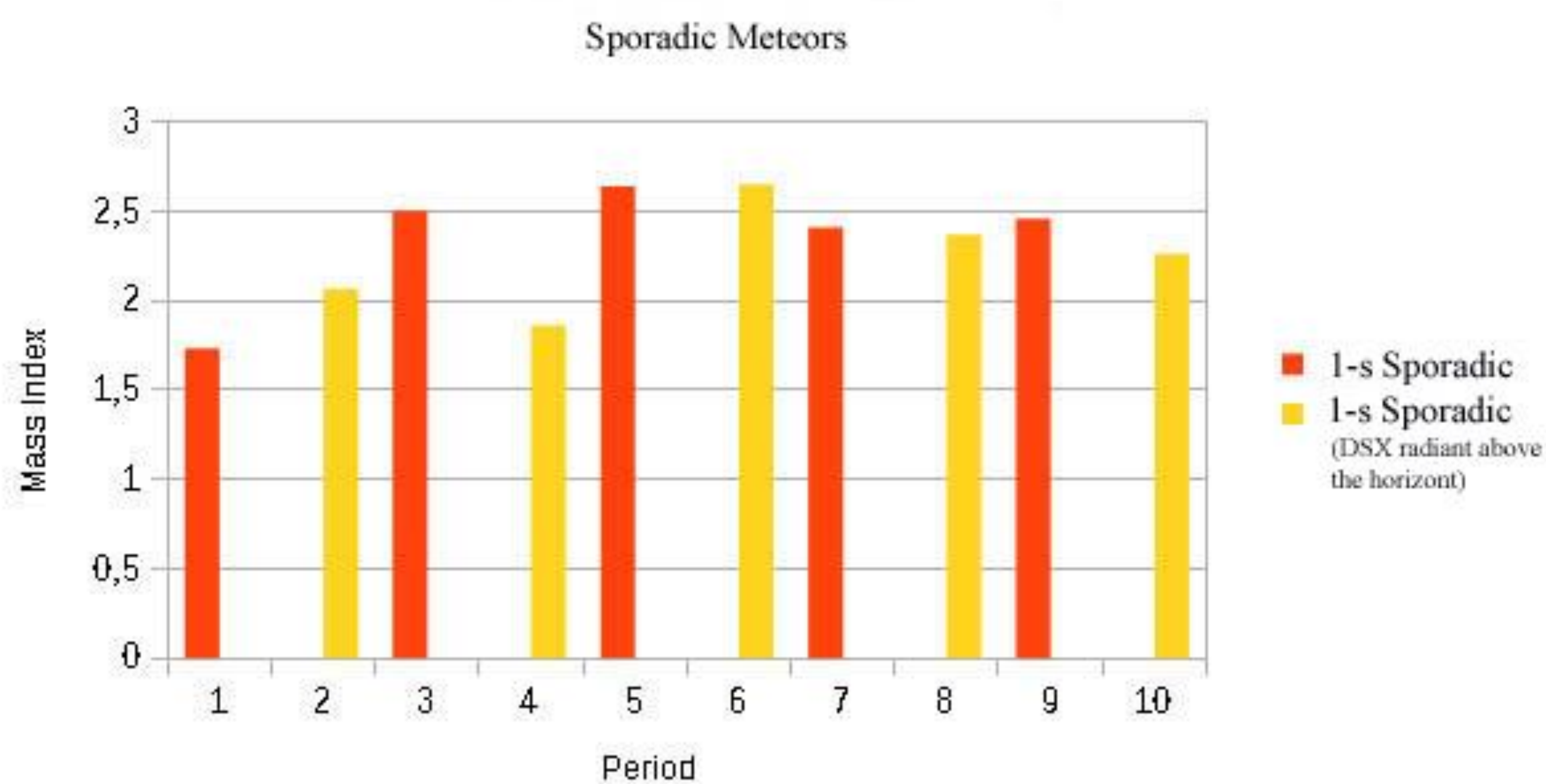
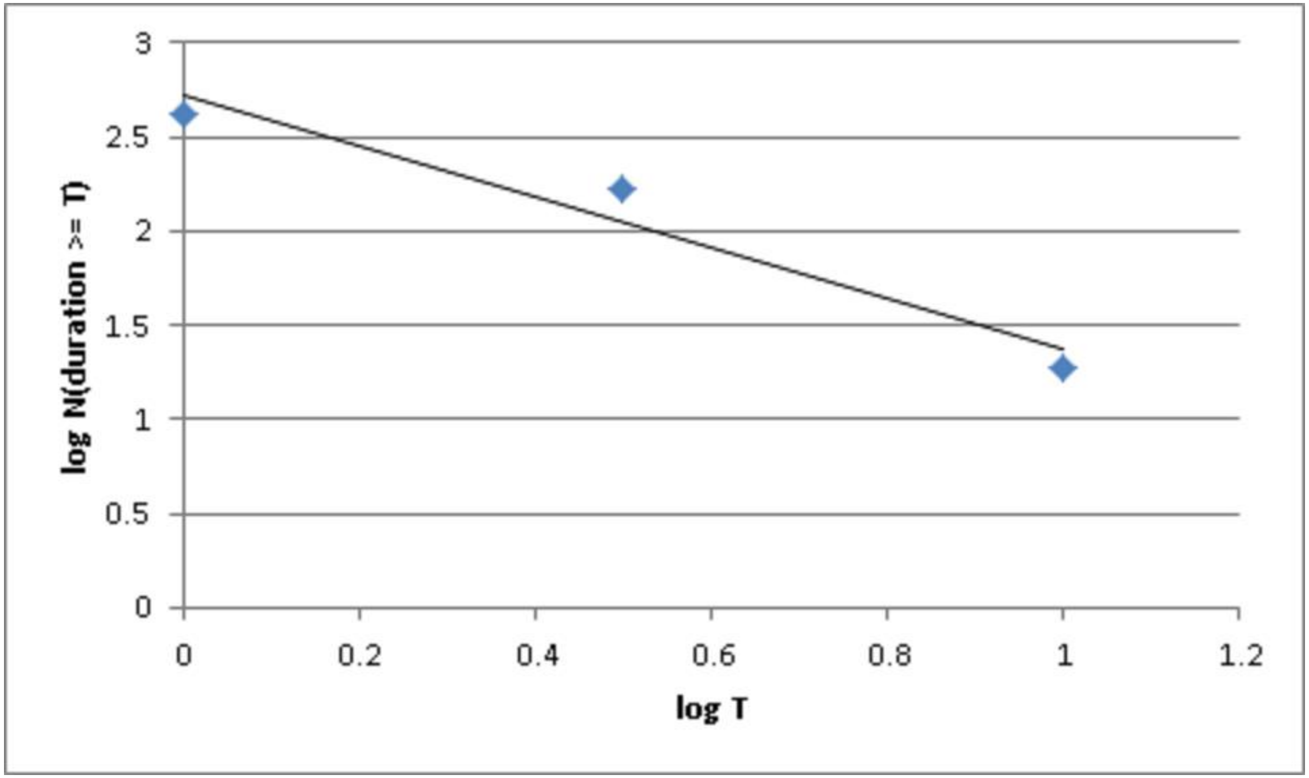


***Figure 3* – The log cumulative duration distribution plot for all overdense meteor reflections observed from September 30 ti1l October 5, 2014.**



The (base 10) logarithm of the number of overdense meteor reflections with duration longer than T is plotted for log T equal to 0, 0.5, and 1. The resulting mass index is 1 minus the slope of the linear fit.

Discussion

The calculated sporadic mass indexes in Tab. 2 and Fig. 2 vary between 1.74 and 2.65, with an average value of 2.30.

This calculated value is close to the often-cited standard value of 2.35 for the sporadic mass index (e.g., Simek M., 1968), however the origin of this value is based on a different size population (Hawkins G.S., 1958) than the sporadic meteors observed in our current analysis.

More recent investigations of the year-round sporadic mass index have found values closer to 2, e.g. the sporadic mass index range found by Blaauw (Blaauw R.C., 2011) in the period 2007-2010 is 2.17 +/- 0.07.

Hence, most of our mass index values are quite high.

Part of the systematic overestimation in the mass index values obtained by EARS may be linked to the characteristics of the GRAVES radar which transmission beam performs a full rotation every 800 ms. Therefore, EARS would get an average underestimation of meteor durations of 0.4 s. For the long duration meteors, this underestimation error is not important, but we will probably underestimate the number of meteors with duration longer than $\sqrt{10}$ seconds and overestimate the number of meteors of duration lower than $\sqrt{10}$ seconds. This means that we will overestimate the mass index.

Conclusion

We advise fellow radio observers to adopt both our method of separating radiant above horizon and radiant below horizon periods, and our method for calculating the mass index. For meteor showers with a higher ZHR, the overdense shower meteors should stand out better from non-shower and sporadics. For a radio set-up that records the maximum power or amplitude for each individual meteor reflection, an alternative method for determining the mass index is described in (Verbeeck C., 2014). This may well remove the apparent overestimation in calculated mass indexes.