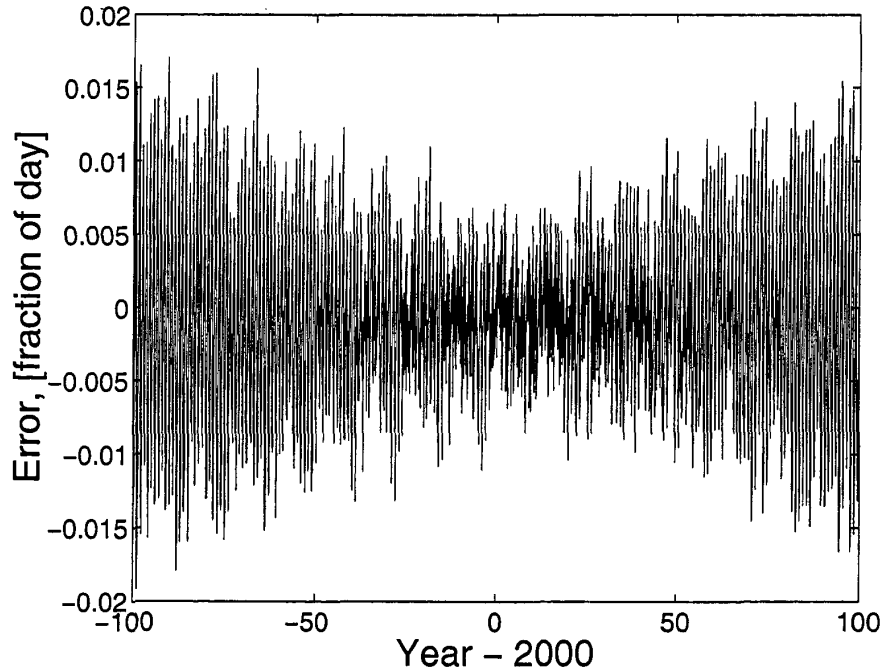

Figure 1 – The algorithm error in days as function of year from 2000

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Observational Results

SPA Meteor Section Results: November–December 1999

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Results and reports submitted to the *SPA Meteor Section* for November and December, 1999, are summarized, except for the Leonid details already discussed [1–3]. The Taurids received some useful coverage in early November, without anything unusual being detected. A brilliant fireball occurred around 22^h10^m UT on November 28 over southeast Ireland, after which about 271 g of L6 chondritic meteorites were recovered near Leighlinbridge, County Carlow, Ireland, the first recovered meteorite fall in the British Isles since 1991. Two other bright fireballs occurred on November 27-28 and 29-30 over Europe as well. December 13-14 saw the highest Geminid ZHRs, 100 ± 10, during a well-observed Geminid epoch. Radio data showed strong echo counts on both December 13 and 14, with the latter date ($\lambda_\odot \approx 263°$, eq. J2000.0) producing the highest counts generally, but with no specific clear maximum time. The Ursid peak was detected by radio only, giving a very weak showing in most datasets especially around $\lambda_\odot = 269°–270°$.

1. Introduction

With the Moon-free parts of both months favoring the expected major shower maxima, as well as the lower-activity Taurid peaks in November, this period was the busiest of the year for the Section, as expected.

Most observations occurred between November 16-17 and 18-19, inclusive, data which have been thoroughly discussed already [1–3]. To avoid needless duplication, the totals in Table 1 exclude the results from this part of November, while the following lists of observers feature only those people who observed away from this spell.

Photographic results came from the *Arbeitskreis Meteore* (*AKM*) members Jürgen Rendtel, Ina Rendtel, and Jörg Strunk, all using fireball cameras in Germany. Along with the other *AKM* data noted here, these reports were extracted from their journal *Meteoros* 2:12 (1999), 3:1 and 3:2 (both 2000), provided by Ina Rendtel. In addition, Morton Henderson in Scotland provided details of his unfortunately unsuccessful Geminid photography in December.

Most of the radio data was submitted by Chris Steyaert in the form of *Radio Meteor Observation Bulletins* (*RMOB*s) 76 and 77, from December 1999 and January 2000 respectively, though R.B. Minton (New Mexico, USA) also provided copies of his data directly in advance of *RMOB* publication. The *RMOB*-only observers were as follows:

Enric Fraile Algeciras (Spain), Mike Boschat (Canada), Maurice de Meyere (Belgium), Ghent University (Belgium), Werfried Kuneth (Austria), Sadao Okamoto (Japan), Ton Schoenmaker (Netherlands), Pierre Terrier (France), and Ilkka Yrjölä (Finland).

Figure 1 shows an illustrative graph for November–December, which picks out the main features found by most observers. The lack of prominence adopted by the Leonids in the Japanese data allows us to more clearly note other features of interest in the radio results.

Video observations were received from Steve Evans in England (Geminids only; these data also summarized with the *AKM* results in *Meteoros* 3:1 (2000), p. 3), and *AKM* members Michael Gerding, Sirko Molau, Mirko Nitschke, Jürgen Rendtel, and Ulrich Sperberg in Germany. Of the trails identified so far, 484 were Taurids, and 114 Geminids.

The non-Leonid visual watchers included the following:

AKM observers Franziska Böttcher, Frank Enzlein, Christoph Gerber, Matthias Growe, Sven Näther, Jürgen Rendtel (Germany and La Palma), Ulrich Sperberg, Roland Winkler, Nikolai Wünsche (all in Germany only, except where noted); Mary Cook (England), Martin Galea De Giovanni (Malta), Shelagh Godwin (England), Chris Hall (England), Morton Henderson (Scotland), Tony Markham (England), Michael Maunder (England), Alastair McBeath (England), Tom McEwan (Scotland), Alexei Pace (Malta), Trevor Pendleton (England), Ian Rigney (England), George Spalding (England), Umberto Mule' Stagno (Malta), and Joseph Zammit (Malta).

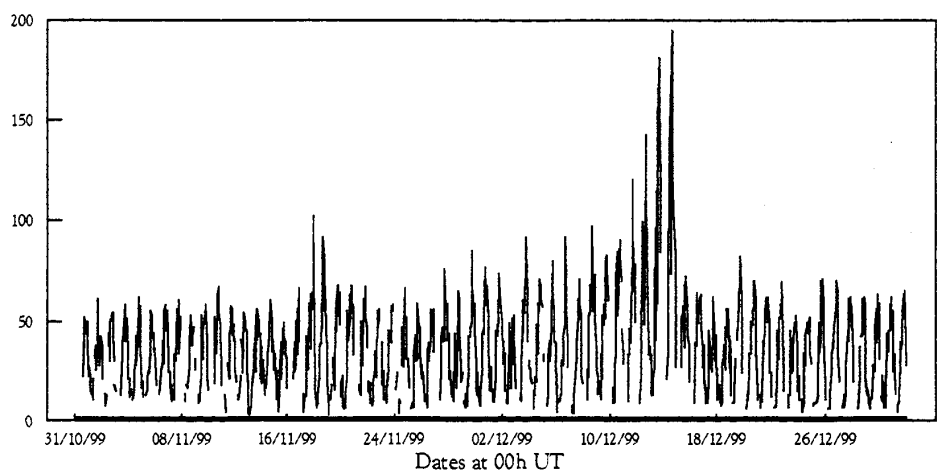

Figure 1 – Raw hourly radio meteor echo counts from November and December, 1999, in data collected by Sadao Okamoto (given in *RMOB* 77, January 2000). Sadao operated his set-up continuously, so the majority of breaks are due to almost daily radio noise interference during the local daytime and evening hours, with very occasional bursts of Sporadic-E. The dominant Geminid peak results from a more favorable observing geometry for this shower than for the Leonid storm.

The Maltese results came courtesy of Martin Galea De Giovanni of the *Astronomical Society of Malta*. In addition, preprint copies of results articles prepared from South-African visual data on the Leonids and Geminids were received from the *Astronomical Society of South Africa*'s Comet and Meteor Section Director, Tim Cooper [4,5].

Table 1 – Visual, photographic, video, and radio hours' totals, plus visual, photographed, and video meteor numbers, recorded in each month (excluding the period from 12^h UT on November 16 to 12^h UT on November 19), with a partial breakdown of visual meteor types.

Month	Visual	STA	NTA	LEO	Meteors	Photo	Trails	Video	Trails	Radio
November	82^h	68	80	38	713	139^h	8	132^h	259	3243^h
Month	Visual	GEM	URS	COM	Meteors	Photo	Trails	Video	Trails	Radio
December	116^h	1591	7	1	2559	2^h	0	58^h	476	4175^h

2. November

The expected minor radio peaks in pre-Leonid November from [6] were all recovered again in 1999, around $\lambda_\odot = 219°$, $\lambda_\odot = 224°$, and $\lambda_\odot = 227°$ (November 2, 7, and 10, respectively), and, in 40% of the available data sets, the $\lambda_\odot \approx 229°$ peak (November 12) was also found, which was not the case in 1997 or 1998 at this time (though minor peaks around $\lambda_\odot = 230°$–$231°$ were detected then).

Visually, most nights between November 2-3 and 16-17 received some coverage, and low Taurid rates were found throughout. The Northern Taurids seemed somewhat more dominant on November 2-3 and 8-9, the Southern branch more prevalent on November 6-7 and 9-10, but the meteor numbers were low enough to make the reliability of these results questionable. Combined Taurid rates were at their best (ZHRs of 9–12 ± 5–6) on November 2-3 and 8-9 to 9-10 in our data. A handful of late Orionids was also picked up.

Using data from October and November on 30 Southern and 49 Northern Taurids seen by reliable watchers in good conditions (limiting magnitude at least +5.5, cloud cover less than 20%), corrected mean magnitudes of +3.53 and +3.08, respectively, were computed. The November sporadics' value (270 meteors) was +3.25, for contrast. From reported train details, the two Taurid branches showed 6% (1.5/25 meteors) and 3% (1.5/44 meteors) trains, respectively, as opposed to 6% (11/170 meteors) of sporadics. Some further details on the November sporadic magnitude and train distributions were given in [2].

Messages posted to the *IMO-News* e-mailing list between October 20 and November 11 concerned the possibility that Comet C/1999 J3 LINEAR might produce activity of swift meteors from a radiant near γ Ursae Majoris around November 11. Notices were also e-mailed to regular *SPAMS* observers and via the *SPA* Website on October 30, highlighting this possibility, and several useful visual reports from the November 8–12 period were subsequently received. No definite visual rates of meteors from this source could be identified, as also found in the more detailed visual data presented in [7]. Interestingly, [7] also drew attention to enhanced radar activity found in the Ondřejov, Czech Republic, data from 21^h–3^h UT on November 11-12. The center of this period was at $\lambda_\odot = 229\overset{\circ}{.}16$, coincident with the date highlighted as weakly detected in the radio results above, which was not found in 1997 or 1998. The radio data provide only slight possible confirmation of the suggested radar maximum time, however, and it should be noted that, as a minor peak had been found in radio data from 1993–1996 at $\lambda_\odot = 229°$ anyway, the 1999 event may not be at all significant.

Very few visual reports were received after the Leonids, and even the expected minor radio peaks in the latter part of November were generally found less easily than in past years, around $\lambda_\odot = 238°$ and $\lambda_\odot = 240°$–$248°$ (November 21 and November 23–December 1), almost as if meteor activity were recovering after the Leonid storm. There was no indication in the radio signatures around $\lambda_\odot = 239°$ that any unusual α-Monocerotid activity had taken place then (expected peak around 1^h UT on November 22). The strongest, and best-detected, non-Leonid radio peak, found in all the available data sets, occurred at $\lambda_\odot \approx 247°$ (November 30), not a timing noted quite as well before. Roughly coincident with this was a loose "cluster" of three magnitude −10 to −15 fireballs seen from European sites, one each on November 27-28, 28-29, and 29-30. The first occurred around 21^h30^m UT on November 27, and was later identified from Spanish data as most probably being the re-entry of the Chinese Shenzhou Long March rocket [8].

The November 28-29 event was a definite natural meteor. This brilliant bolide occurred at about 22^h10^m UT moving roughly northeast to southwest over the southern Irish Sea, but mostly over southeastern Ireland, from where sonic booms were reported near the town of Carlow, around 60 km southwest of Dublin. James Martin on the Isle of Man, some 175 km northeast of the meteor's end point, estimated the object as being magnitude −12 at least, low in his southwestern sky. Reports from the Carlow vicinity indicated the final brightness lit up the countryside like daylight, however, and houses were shaken as if a bomb had exploded nearby. This information, plus the object's probable trajectory, quickly suggested meteorites might have fallen, and a reward of up to 20 000 GBP was offered by a private meteorite collector in Scotland for any objects recovered. Despite this, it was only in mid-December that the first meteorites were found near the town of Leighlinbridge, County Carlow, and mid-January 2000 before they were identified as such. Four meteorites have now been confirmed, totaling about 271 g in weight, and classified by the Natural History Museum in London as being of L6 chondritic composition.

The final brilliant fireball in this spell was caught by the all-sky fireball cameras of *AKM* observers in Germany at five sites, making it the most widely-recorded single meteor in 1999 for the German team. A photograph of its trail appears in *Meteoros* 3:2 (2000), p. 27, captioned as indicating the event had an unusual light curve.

3. December

Early December brought the usual low rates of minor shower meteors for visual observers, with the majority of watching carried out during the first half of the month. The radio observers recorded no untoward events, with the minor $\lambda_\odot = 249°$–$250°$, $\lambda_\odot \approx 254°$, and $\lambda_\odot \approx 256°$ (December 2-3, 7, and 9) peaks from [6] all detected again by most systems. Half the available datasets showed the $\lambda_\odot \approx 256°$ peak extending to $\lambda_\odot \approx 257°$ again, as has been seen before. The $\lambda_\odot \approx 252°$ (December 5) peak first found in 1997 and recovered in 1998 [9] was only seen weakly in 40% of the data sets from 1999, but a comparably weak maximum was found in two other datasets around $\lambda_\odot = 251°$.

With moonlight favoring the Geminid maximum in mid-December, an especial concentration of effort centered around this time came from the visual observers. Reports are available for every night from December 6-7 to 15-16 except 11-12, allowing ZHRs to be computed, with the one missing night fortunately covered by the South-African results [5]. Mean ZHRs for each night are given in Table 2. Individual ZHRs of around or over 100 were recorded throughout the moonless (i.e., after midnight UT) part of December 13-14 through to the first half of December 14-15, but the highest rates were not observed, as these occurred around 17^h UT on December 14 [10]. In the radio data, the strongest echo peaks were found on December 14-15 ($\lambda_\odot \approx 263°$), as Figure 1 shows, but there was no clear evidence supporting a single peak time in the available results. Indeed, counts were almost as high in many reports the previous day as well. Geminid and December sporadic magnitude details are given in Table 3. Around 6% of Geminids (24/372.5 meteors) and 5% of sporadics (4/81.5 meteors) left persistent trains, though the paucity of train reports has prevented a fuller examination of these here.

Table 2 – Mean Geminid ZHRs and standard errors for each indicated night in December 1999, based on data from European and South-African sites. The inflated value for December 7-8 resulted from poor sky conditions, while, on December 11-12, only a single observer's data from South Africa was available (Cliff Turk—data in [5]).

Date	ZHR	Date	ZHR	Date	ZHR	Date	ZHR	Date	ZHR
Dec 6-7	6 ± 4	Dec 8- 9	4 ± 3	Dec 10-11	7 ± 1	Dec 12-13	34 ± 7	Dec 14-15	68 ± 11
Dec 7-8	12 ± 6	Dec 9-10	8 ± 2	Dec 11-12	17 ± 8	Dec 13-14	103 ± 10	Dec 15-16	10 ± 4

Table 3 – Global magnitude distributions, including mean limiting magnitudes and corrected mean magnitudes for the Geminids and December sporadics seen in good sky conditions.

Shower	-3^-	-2	-1	0	$+1$	$+2$	$+3$	$+4$	$+5^+$	Tot	Lm	$\overline{m}_{6.5}$
Geminids	9	6.5	11.5	43	59.5	74.5	98.5	50	20	372.5	5.7	2.81
Sporadics	1	1.5	1.5	3	5.5	11.5	21.5	22	14	81.5	5.7	3.78

Few visual watches were possible after the Geminid maximum, and the moonlit Ursid peak due on December 22-23 passed virtually unobserved except by radio. The weakness of the $\lambda_\odot = 269°–271°$ (December 21–23) period, though recorded at $\lambda_\odot \approx 269°$ in 70% of the radio data sets on-hand, was remarkable compared to past years, and strongly suggests the Ursids produced at best only a low, normal return in 1999. Both minor late-month radio peaks, around $\lambda_\odot = 272°–275°$ and $\lambda_\odot = 278°–279°$ (December 24–27 and 30–31) were detected much as in previous years, the former especially around $\lambda_\odot = 273°$, as last seen in 1997.

Acknowledgments

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