The 1994 η-Aquarids: A Tentative Global Analysis

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What may be the first global analysis ever of the η-Aquarid meteor stream is undertaken with respect to the 1994 display. Data relating to 1140 shower meteors reported by 28 observers from all 5 continents is analyzed. This suggests a higher-than-expected maximum earlier than announced, but the absence of meteor magnitude data prevents a more sophisticated analysis.

1. A comparative advantage

In his overview of the *IMO*'s *Visual Meteor Data Base* (*VMDB*), Rainer Arlt comments on the "very heavy contrast between northern and southern latitudes" when it comes to the geographical distribution of observing sites reporting meteor observations to the *VMDB* [1]. Granted, Rainer is correct in claiming that "a lot of new results were possible if a larger number of high-quality observations from southern latitudes were available." The situation, however, is not all tragic for the southerly-placed. Even with the existing distribution of observing sites reporting to the *IMO*, the relatively southerly sited have a strange comparative advantage.

Within just one-eighteenth (some 5.5%) of the world's latitudes—from some 35° N to 45° N—are to be found over 90% of *IMO*-reporting meteor watchers. Moreover, these are also very unequally distributed along longitude. Indeed, practically all of these 90% occupy three discrete longitudinal "windows:" 70° W to 120° W; 10° W to 35° E; and 140° E to 150° E, approximately [2]. Assuming that they are equally active, just a little more than a quarter of the available longitudinal band is being utilized by these observers.

The picture is somewhat different when observers operating from more southerly latitudes are considered. The North-American, European and Japanese windows are still covered, albeit with far less observer density; but added to these are other longitudinal bands, thanks to observers located in Brazil, Hawaii, the Canary Islands, Kazakhstan, South Africa, Jordan, China, Western Australia and New Zealand. This detail on better longitudinal spread implies that, if observers can be counted upon at critical moments, the *IMO*'s southern flank is in a much better position to monitor rapid changes of activity in dynamic showers than the northern counterpart, this apart from the more conventional monitoring of these annual, stable meteor showers whose relatively southerly radiants elude the bulk of observers stationed in unfavorable northern latitudes.

2. The η-Aquarid Meteor Stream

One of the most important of the latter meteor showers is definitely that associated with the η-Aquarid stream. One of the seven strongest annual meteor showers, the η-Aquarid radiant is, however, the one with the lowest declination—0° approximately. The other six (Quadrantids, April Lyrids, Perseids, Orionids, Taurids, and Geminids) have radiant declinations ranging from +14° to +58°.

Therefore, while on the paper the η-Aquarid stream enjoys a predicted maximum activity rate of some 60 meteors per hour [3]—the strongest annual performance quotient after the Quadrantids, Geminids and Perseids—their coverage sadly is not in proportion to their strength.

There was only temporary heightened interest in the shower in the 1980s as part of the *International Halley Watch*, since this shower, as the Orionid stream, is associated with debris emanating from this famous comet which returned within the vicinity of the Sun and the Earth in 1985-86.

Interest has now once again subsided, to the extent that, although favorably placed with respect to moonlight, this shower was not even included in the *IMO* 1994 Observer's Calendar [4]; a slip admitted by the calendar compiler who, from his northern latitude, has few possibilities of seeing its shower members [5].

The *Malta Astronomical Society Meteor Group* had set out to exploit its locational "comparative advantage" by organizing a visual observational project to monitor the η-Aquarid stream during the 1994 display. The results of this project have already been published [6]. We are now going one step further and a preliminary global analysis of the 1994 η-Aquarid display is being presented.

3. Collaboration

This analysis was at all possible thanks to the generous collaboration of like-minded societies, *IMO* colleagues, and the existence of the *IMO*'s VMDB. Maltese colleague Adrian Galea handled most of the necessary correspondence. Neil Bone, Director of the Meteor Section of the *British Astronomical Association*, passed the relevant details of η-Aquarid observations carried out by Colin Henshaw from South Africa and Tim Cooper from Botswana reporting to the *BAAMS*; George Zay from California passed on details of his own watches; Gilberto Klar Renner has published a synoptic account of his group's observational results from Porto Alegre, Brazil [7]; while Rainer Arlt kindly sent the relevant entries from the *IMO*'s *VMDB* [8], including a significant amount of Japanese observations.

4. Observers

In summary, the data from 21 observers from Australia, Botswana, Brazil, Japan, New Zealand, South Africa, and the USA were added to those of 7 other Maltese observers. Note that the longitudinal spread of these observers meant that they could still cover comfortably the activity of the η-Aquarid radiant on a round-the-clock basis. Solar longitude data confirms that this coverage is practically complete at around the predicted maximum—$\lambda_{\odot} = 45^{\circ}\!.5$ (2000.0), around May 6, according to [3]. The full international team of contributors thus comprised the following:

> Anna Baldacchino (BALAN), Godfrey Baldacchino (BALGO), Edwin Camilleri (CAMED), Mark Chamberlain (CHAMA), Maurice Clark (CLAMA), Tim Cooper (COOTI), Luís Antônio da Silva Machado (DA AN), Franco Gatt (GATFR), Antoine Grima (GRIAN), Takashi Hasegawa (HASTA), Colin Henshaw (HENCO), David Holman (HOLDA), Kiyoshi Izumi (IZUKI), Kazuko Kawamura (KAWKA), Peter Knowles (KNOPE), Sandro Lanfranco (LANSA), Robert Lunsford (LUNRO), Hidekatu Mizoguchi (MIZHI); Darlan Moraes (MORDA); Umberto Mule' Stagno (MULUM), Luís Antônio Reck de Araújo (RECLU), Gilberto Klar Renner (RENKL), Roberto Scorbie (SCORB), Richard Taibi (TAIRI), Hiroyuki Tomioka (TOMHI), Graham Wolf (WOLGR), Yasuo Yabu (YABYA), and George Zay (ZAYGE).

5. Analysis

Regretfully, many observations were not accompanied by a magnitude distribution of the shower and/or sporadic meteors observed. As a result, zenithal hourly rate computation using the magnitude ratio technique could not be resorted to. This is a severe blow since much of the potential of a global analysis is immediately lost. Consequently, it was decided to adopt a very approximative technique which assumes a steady sporadic background rate of 12 meteors per hour under standard sky conditions (stellar limiting magnitude of +6.5). I prefer this technique in such situations as an alternative to ZHR formulae which involve a string of computations, each of which are liable to error.

The derived η-Aquarid ZHRs are tabulated in Table 1.

The data in Figure 1 are difficult tot interpret, because no activity trend is discernible. This is mainly because, irrespective of the sophistication of computation, activity rates will ultimately always depend on the actual number of meteors seen. Most of the rates reported in Table 1 are based on a very weak meteor count base.

A clearer activity profile is likely when these data are filtered to comprise only those watches where, in each, at least 20 shower meteors are reported. This shortlists the number of watches from 77 to just 20, bearing some 64% of the total number of shower meteors reported, as listed in Table 2.

Table 1 – ZHR data for the 1994 η-Aquarids. Solar longitudes refer to eq. 2000.0.

$\lambda_\odot$	Obs.	$T_{\rm eff}$	η-Aqr	ZHR	$\lambda_\odot$	Obs.	$T_{\rm eff}$	η-Aqr	ZHR
39°652	BALGO	1.0	1	4 ± 4	45°623	DA AN	1.2	26	29 ± 6
41°576	COOTI	1.0	4	12 ± 6	45°623	MORDA	1.2	21	24 ± 5
42°532	BALGO	1.0	1	21 ± 12	45°623	RENKL	1.2	20	17 ± 4
42°532	BALAN	1.0	1	21 ± 12	45°623	RECLU	1.2	24	39 ± 8
42°872	LUNRO	2.8	7	5 ± 3	45°991	WOLGR	1.5	14	96 ± 26
42°893	ZAYGE	1.9	28	2 ± 2	46°016	WOLGR	0.5	14	28 ± 28
43°230	CLAMA	1.5	39	31 ± 5	46°024	CHAMA	1.0	6	28 ± 6
43°472	MULUM	1.8	24	19 ± 4	46°064	CHAMA	1.0	7	49 ± 7
43°496	COOTI	1.6	28	131 ± 25	46°091	IZUKI	1.2	3	35 ± 20
43°802	ZAYGE	1.0	3	55 ± 24	46°118	CLAMA	0.8	19	5 ± 3
43°842	ZAYGE	1.0	8	41 ± 20	46°158	CLAMA	0.9	24	12 ± 3
43°847	LUNRO	2.0	45	35 ± 8	46°198	CLAMA	0.4	19	20 ± 5
44°073	WOLGR	1.5	21	51 ± 11	46°350	BALGO	1.0	8	22 ± 8
44°086	CHAMA	1.0	5	24 ± 3	46°350	BALAN	1.0	6	17 ± 7
44°113	KNOPE	1.5	13	19 ± 5	46°353	GATFR	1.1	6	11 ± 5
44°238	CLAMA	1.1	39	19 ± 4	46°354	GRIAN	1.1	9	23 ± 8
44°428	CAMED	1.8	7	18 ± 7	46°352	LANSA	1.1	7	10 ± 4
44°430	HENCO	1.0	11	22 ± 7	46°346	MULUM	1.8	39	31 ± 5
44°432	MULUM	1.8	36	29 ± 5	46°591	RENKL	2.3	49	11 ± 2
44°432	BALGO	1.0	6	21 ± 9	46°591	RECLU	2.3	59	18 ± 2
44°434	BALAN	1.0	9	63 ± 19	46°591	MORDA	2.3	49	15 ± 2
44°434	HENCO	1.0	20	31 ± 7	46°633	TAIRI	1.4	6	8 ± 3
44°438	HENCO	1.0	23	32 ± 7	46°967	WOLGR	1.5	24	28 ± 8
44°441	HENCO	1.3	2	100 ± 21	46°994	CHAMA	2.0	13	19 ± 7
44°778	ZAYGE	1.0	7	8 ± 3	47°022	KNOPE	1.5	9	20 ± 5
44°818	ZAYGE	1.6	3	48 ± 9	47°037	YABYA	1.7	9	8 ± 3
45°042	CHAMA	1.0	5	23 ± 10	47°057	MIZHI	0.8	11	77 ± 23
45°045	WOLGR	1.5	11	16 ± 4	47°116	CLAMA	0.8	16	6 ± 2
45°055	TOMHI	2.4	10	15 ± 5	47°136	CLAMA	0.9	20	14 ± 3
45°065	KAWKA	0.9	2	7 ± 4	47°156	CLAMA	0.8	26	24 ± 5
45°075	HASTA	1.5	11	7 ± 2	47°306	BALGO	1.0	5	10 ± 4
45°100	IZUKI	1.2	11	16 ± 5	47°306	BALAN	1.0	2	4 ± 3
45°105	MIZHI	0.8	12	37 ± 11	47°946	TOMHI	1.4	2	5 ± 4
45°125	CLAMA	0.9	22	18 ± 4	47°950	SCORB	1.5	13	31 ± 9
45°165	CLAMA	0.8	32	30 ± 5	47°967	YABYA	2.3	1	1 ± 1
45°205	CLAMA	0.6	19	36 ± 8	47°973	MIZHI	0.9	5	9 ± 4
45°390	BALGO	1.0	3	11 ± 6	48°538	TAIRI	2.0	5	4 ± 2
45°390	BALAN	1.0	2	6 ± 4	49°891	WOLGR	1.5	9	21 ± 7
45°416	COOTI	1.0	7	39 ± 10					

6. Discussion

These "refined" data is more instructive, although the time span is compressed relative to the previous table.

They now suggest a heightened activity, with a peak higher than normally expected, and a full day earlier than announced as well. The highest activity reaches a ZHR of 70 at around solar longitude $\lambda_\odot = 43°48$ (2000.0), corresponding to May 4 at $2^{\rm h}$ UT.

This figure and data are both approximate since there are no preceding watches to establish a prior rate and trend. Also, they are based on a single observation, which calls for additional caution.

Table 2 – Filtered 1994 η-Aquarid data (cfr. Table 1).

$\overline{\lambda}_\odot$	Observers	η-Aqr	ZHR
43°48	COOTI-MULUM	52	70 ± 10
43°48	COOTI-MULUM	52	70 ± 10
43°85	LUNRO-ZAYGE	73	41 ± 5
44°15	CLAMA-WOLGR	60	35 ± 5
44°44	HENCO-MULUM	79	38 ± 4
45°16	CLAMA	27	30 ± 5
45°62	RECLU-DA AN-MORDA-RENKL	91	27 ± 3
46°25	CLAMA-MULUM	112	21 ± 2
46°59	RENKL-RECLU-MORDA	157	15 ± 2
46°97	WOLGR	24	28 ± 8
47°14	CLAMA	62	14 ± 3

The activity then subsides, reaching the "normal" and expected level of ZHR = 38 at around May 5 at 2^h UT. The decline continues regularly and steadily, except for a sharp hiccup at solar longitude $\lambda_\odot = 46°79$, corresponding to around May 8 at 17^h UT.

This corresponds to the maximum of the Halleyid stream, active from a practically identical radiant position. However, caution is also called for here, because this higher activity level is shown by a single observation only.

Very soon after, Aquarid/Halleyid activity is down and at par to its sporadic background.

7. Conclusion

The early heightened registration of the reported maximum activity for the 1994 η-Aquarid display needs to be confirmed. One outcome of this preliminary analysis is to highlight the importance of a sufficiently large meteor database to make any activity computation worth its while. Furthermore, the absence of magnitude distributions for shower meteors and their sporadic background renders futile any serious activity assessment.

The southern flank of the *IMO* would contribute much more to the global meteor effort by boosting up its number of observers, these complementing its reports with the expected meteor magnitude distributions per watch.

In this way, it would be able to provide an ever stronger contribution towards the better understanding of the η-Aquarid stream as well as of meteor activity from other low-declination radiants.

References and notes

[1] Arlt, R., "The Present Visual Meteor Database", *WGN* 23:1, February 1995, pp. 4–5.
[2] based on distribution of observing sites reproduced in Figure 1 in reference [1], op. cit.
[3] McBeath, A. (comp.), "1996 IMO Meteor Shower Calendar", IMO, 1995.
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[5] McBeath, A., *personal communications*, 1994.
[6] Baldacchino, G., "1994 η-Aquarids from Malta", *WGN* 22:4, August 1994, pp. 152–154.
[7] Renner, K.G., "The 1994 η-Aquarids in Southern Brazil", *WGN* 23:1, February 1995, p. 17.
[8] Roggemans, P. (comp.), "Observational Report Series 7", IMO, 1995 (VMDB data 1988–1994 is available on an accompanying diskette).