Meteoroids 2013, Proceedings of the Astronomical Conference,
held at A.M. University, Poznań, Poland, Aug. 26-30, 2013,
eds Jopek T.J., Rietmeijer F.J.M., Watanabe J., Williams I.P.,
Adam Mickiewicz University Press in Poznań, pp 353–364

Current status of the IAU MDC Meteor Showers Database

Jopek T.J.[1]**, and Kaňuchová Z.**[2]

[1]Astronomical Observatory, Faculty of Physics, A.M. University, Poznań, Poland
[2]Astronomical Institute, Slovak Academy of Sciences, 05960 Tatranská Lomnica, Slovakia

Abstract. During the General Assembly of the IAU in Beijing in 2012, at the business meeting of Commission 22 the list of 31 newly established showers was approved and next officially accepted by the IAU. As a result, at the end of2013, the list of all established showers contained 95 items. The IAU MDC Working List included 460 meteor showers, among them 95 had *pro tempore* status. The List of Shower Groups contained 24 complexes, three of them had established status. Jointly, the IAU MDC shower database contained data of 579 showers.

Keywords: established meteor showers, IAU MDC, meteor database, meteor showers nomenclature

1. Introduction

Since its establishing, the activity of the Task Group of Meteor Shower Nomenclature (later transformed into the Working Group on Meteor Shower Nomenclature, hereafter WG) proved to be advisable.† As results of this activity, several practical principles (rules) have been adopted:

- the meteor shower codes and naming conventions (Jenniskens 2006a, 2007, 2008; Jopek and Jenniskens 2011),
- a two-step process was established, where all new showers discussed in literature are first added to the Working List of Meteor Showers, each being assigned a unique name, a number, and a three letter code,
- all showers which satisfy the verification criterion will be included in the List of Established Showers and then officially accepted during next GA IAU.

The naming rules as well as the Established and Working Shower Lists are posted on the IAU MDC website (Jopek and Kaňuchová 2013).

In 2009, during the GA IAU held in Rio de Janeiro, for the first time in history of Meteor Astronomy 64 showers were officially named by the IAU. Their names and geocentric parameters were given in Jopek and Jenniskens (2011), and were posted on the IAU MDC website (Jopek and Kaňuchová 2013).

Three years later, in Beijing, next 31 showers obtained their official names (see Table 1, 2). During the business meeting of the Commission 22 held in Beijing, the members attending this meeting further agreed that the Working Group on

† The Task Group of Meteor Shower Nomenclature was established during the GA IAU held in Prague in 2006.

Meteor Shower Nomenclature should continue its activity during the next triennium (2012-15). The members of the new WG are: T.J. Jopek (chair), P.G. Brown (v-chair), J. Baggaley, D. Janches, P. Jenniskens (C22 president), J. Kac, Z. Kaňuchová, G.I. Kokhirova, P. Koten, J.M. Trigo-Rodriguez and J. Watanabe.

Shortly before the GA IAU in Beijing the authors of this paper started an upgrade of the MDC shower database. Mainly it consisted in: adding the orbital elements, adding the literature references and additional parameters to already known meteor showers. During this upgrade we found that for some meteor showers the data given in the MDC are incorrect. Partly, such data were corrected, but in some cases deeper studies are needed, and such corrections should be clinched by all members of the WG.

In this study we describe the results of our work. First we remark new utility options implemented on the IAU MDC shower database. Next we point out the need of polishing the rules of meteor shower nomenclature, and propose some standardization for such nomenclature.

2. Upgrade of the IAU meteor shower database

The MDC database upgrading encompassed correction of erroneous data (typos, mistakes), but also complement of the orbital data and bibliographic information. Correction of the erroneous data was an easy task because we have been supported by users who wrote to us about many particular errors. We appreciate their initiative very much.

Next stages of the database upgrade procedure were more labour consuming, sometimes they were tedious and needed computer software implementation.

2.1. Supplementation of the meteor showers orbits and bibliographic references

Until August 2012, the IAU MDC shower database contained only shower codes, shower names, mean geocentric parameters and the name of the possible parent body. No orbital information i.e. no mean values of the orbital elements were given and no literature references to the data sources were available. To cure the situation

Leonids					Single Shower - Status - Established							Next Previou
RA	DE	dRA	dDE	VG	a	q	e	Peri	Node	Incl	N	References
[deg] J2000				[km/s]	[AU]	[AU]		[deg] J2000				
154.24	21.60	0.659	-0.325	70.66	10.1	0.9853		173.50	236.15	162.36	-	H.Betlem ??
153.0	+22.0	+0.70	-0.42	70.7	11.5	0.985		172.5	235.2	162.6	-	Cook, 1973
153.6	+22.1	+0.60	-0.45	70.26	10.3	0.984	0.904	172.4	235.0	162.1	0009	Kresak and Porubca
153.9	+21.6	+0.944	-0.603	70.92	15.2	0.984		172.36	235.7	162.53	0029	Lindblad et al., 1
55P/Temple-Tuttle												

Figure 1. A fragment of the IAU MDC website screen-shot. An example of the shower upgraded with the orbital elements and the literature ADS references. Currently, for many showers several sets of the geocentric and heliocentric parameters are given.

we added orbital and literature information for over 200 showers using different data sources. Furthermore, for several dozen of showers, the additional sets of mean geocentric and heliocentric parameters determined by different authors have been included into the database. In the main part, we copied data published by

Table 1. Geocentric data of 31 showers (streams) officially named during the IAU XXVIIIth GA held in Beijing in 2012. The solar ecliptic longitude λ_S , the geocentric radiant right ascension and declination α_g, δ_g are given for the epoch J2000.0.

No	IAU No & code		Shower (stream) name	λ_S (°)	α_g (°)	δ_g (°)	V_g (km/s)
1	11	EVI	eta Virginids	354	182.1	2.6	29.2
2	23	EGE	epsilon Geminids	206	101.6	26.7	68.8
3	26	NDA	Northern delta Aquariids	123.4	344.7	0.4	40.5
4	100	XSA	Daytime xi Sagittariids	304.9	284.8	–18.6	26.3
5	128	MKA	Daytime kappa Aquariids	354	338.7	–7.7	33.2
6	151	EAU	epsilon Aquilids	59	284.9	15.6	30.8
7	175	JPE	July Pegasids	107.5	340	15	61.3
8	184	GDR	July Gamma Draconids	125.3	280.1	51.1	27.4
9	197	AUD	August Draconids	142	272.5	65.1	17.3
10	202	ZCA	Daytime zeta Cancrids	147	119.7	19	43.8
11	242	XDR	xi Draconids	210.8	170.3	73.3	35.8
12	252	ALY	alpha Lyncids	268.9	138.8	43.8	50.4
13	257	ORS	Southern chi Orionids	260	78.7	15.7	21.5
14	333	OCU	October Ursae Majorids	202	144.8	64.5	54.1
15	334	DAD	December alpha Draconids	256.5	207.9	60.6	41.6
16	335	XVI	December chi Virginids	256.7	186.8	–7.9	67.8
17	336	DKD	December kappa Draconids	250.2	186.0	70.1	43.4
18	337	NUE	nu Eridanids	167.9	68.70	1.1	65.9
19	338	OER	omicron Eridanids	234.7	60.70	–1.5	26.9
20	339	PSU	psi Ursae Majorids	252.9	167.8	44.5	60.7
21	341	XUM	January xi Ursae Majorids	300.6	169.0	33.0	40.2
22	346	XHE	x Herculids	352	254	48	36
23	348	ARC	April rho Cygnids	37.0	324.5	45.9	41.8
24	372	PPS	phi Piscids	106.0	20.1	24.1	62.9
25	388	CTA	chi Taurids	220.0	63.2	24.7	42.1
26	390	THA	November theta Aurigids	237.0	89	34.7	33.8
27	404	GUM	gamma Ursae Minorids	299.0	231.8	66.8	31.8
38	411	CAN	c Andromedids	110	32.4	48.4	59
39	427	FED	February eta Draconids	315.11	239.92	62.49	35.6
30	445	KUM	kappa Ursae Majorids	223.21	144.46	45.44	65.30
31	446	DPC	December phi Cassiopeiids	252.48	19.8	58.0	16.4

Jenniskens (2006, Table 7), but in the future we intend to take full advantage of the original data sources. Such approach will facilitate removing internal data inconsistency, a problem that we have been noticed during upgrading procedure. In our opinion, the inconsistency of meteor shower data needs thorough solution.

As the literature references we used the URL addresses of the SAO/NASA Astrophysics Data System (ADS). Figure 1 illustrates an example of a meteor shower data record, now supplemented with a few sets of the dynamical parameters and the literature references.

An upgrade of the MDC shower database will be continued by adding the shower parameters taken directly from the original papers. Also, if relevant data prove to be available, for each shower we will include several sets of additional geocentric and heliocentric parameters.

Table 2. Heliocentric data of 31 showers (streams) officially named during the IAU XXVIIIth GA held in Beijing in 2012. The values of the angular orbital elements are given for the epoch J2000.0. For several showers their mean orbital elements are not given in the source literature.

No	IAU No	Shower (stream) name	a [AU]	q [au]	ω (°)	Ω (°)	i (°)
1	11	eta Virginids	2.562	0.382	349.1	280.5	3.5
2	23	epsilon Geminids	10.0	0.731	241.7	209.0	172.9
3	26	Northern delta Aquariids	2.536	0.071	332.6	1 39.0	23.0
4	100	Daytime xi Sagittariids	1.744	0.383	66.6	296.0	4.3
5	128	Daytime kappa Aquariids	1.7	0.18	42	359.7	1.8
6	151	epsilon Aquilids	0.873	0.354	318.3	59.5	59.6
7	175	July Pegasids	44	0.536	267.2	107.5	131.6
8	184	July Gamma Draconids					
9	197	August Draconids	1.515	1.007	185.6	141.9	30.4
10	202	Daytime zeta Cancrids	5.00	0.05	206.5	326.9	21.1
11	242	xi Draconids	1.279	0.988	175.3	210.8	69.0
12	252	alpha Lyncids	25.4	0.281	295.9	268.8	84.4
13	257	Southern chi Orionids	2.23	0.594	86.4	80.1	5.2
14	333	October Ursae Majorids	5.9	0.979	163.7	202.1	99.7
15	334	December alpha Draconids					
16	335	December chi Virginids					
17	336	December kappa Draconids					
18	337	nu Eridanids					
19	338	omicron Eridanids					
20	339	psi Ursae Majorids					
21	341	January xi Ursae Majorids					
22	346	x Herculids					
23	348	April rho Cygnids	6.51	0.8099	125.55	37.0	69.9
24	372	phi Piscids	2.09	0.8559	125.02	106.0	152.6
25	388	chi Taurids	4.97	0.0807	328.49	220.0	12.3
26	390	November theta Aurigids	1.13	0.1160	330.07	237.0	27.8
27	404	gamma Ursae Minorids	4.20	0.9593	199.54	299.0	51.1
38	411	c Andromedids					
39	427	February eta Draconids	–250	0.971	194.09	315.07	55.20
30	445	kappa Ursae Majorids					
31	446	December phi Cassiopeiids					

3. Test of meteor shower names correctness

During a normal maintenance of the MDC shower database and during its upgrade we have met several problems related to shower names. Some problems were reported to us by the database users, some we have recognized by ourselves.

To ascertain if a shower name listed in the MDC is formally correct, one has to compare it with the name obtained by applying to this shower the nomenclature rules published e.g. in Jenniskens (2006a, 2007, 2008); Jopek and Jenniskens (2011). For old, well known showers discovered many years ago, no one would expect that their names will pass such name test. But in case of the new showers discovered quite recently it should be different. We just wanted to know to what extend the shower nomenclature rules are respected by shower discoverers, and on the other hand, how well the shower nomenclature WG controls the shower naming procedure.

To ensure the test objectivity and to perform it automatically we developed a software in which the shower nomenclature rules were implemented (Jenniskens 2008; Jopek and Jenniskens 2011):

1) a meteor shower should be named after the constellation of stars that contains the radiant,
2) to distinguish among showers from the same constellation, the shower may be named after the nearest (brightest) star with a Greek or Latin letter assigned.
3) to distinguish among showers from the same constellation one may add the name of the month,
4) for daytime showers, those with a radiant less than 32 degrees from the Sun, it is a custom to add "Daytime".
5) Finally one can add "Southern" or "Northern" to distinguish between the south and north branches of a shower, both originated from the same parent body.

By default, the points 3) and 4) relate to the shower activity period.

Our test consisted of two parts. In the first part, using the shower radiant coordinates, we have found in which constellation this point is located.
The constellation borders were established by Delporte (1930) on behalf of the IAU Commission 3 (Astronomical Notations). Delporte drew the constellation boundaries along vertical lines of right ascension and horizontal parallels of declination, on the epoch pf 1875. For a different epoch, due to precession phenomena, the net of the spherical coordinates do not overlap with the constellation boundaries. Hence, Delporte's publication is not convenient for determining a constellation from the radiant position. For this purpose an approach described by Roman (1987) is excellent. We have implemented it in our testing software, and to take into account an influence of the precession we have used the formulae taken from the Explanatory Supplement to the Astronomical Almanac (Seidelmann et al. 1992, ed.).

In the second part of our test, we have found the star nearest to the radiant position. Corresponding minimum distance along a great circle was calculated between the radiant and the nearest star, both located in the same constellation. Also we have verified if we deal with the "Daytime", "Southern" or "Northern" radiant, as well on which month the shower activity period falls. To find the month of the shower activity we found the date of the shower activity corresponding to the Sun ecliptic longitude given in the MDC. We used the formulae for the Sun ecliptic longitude given in Meuss (1991); Astronomical Almanac (1994). Throughout all test the Sun ecliptic latitude was set to zero, the year of the shower activity was assumed to be 2000 AD.

3.1. Choice of the star catalogue

At the end of AD 2013 the IAU MDC comprised of 95 established showers, 460 working list showers and 24 groups – shower complexes. Inclusively the IAU MDC list (including complexes) contained 579 meteor showers. We have posed a question – are the names of these showers correct from the point of view of the meteor shower nomenclature rules?

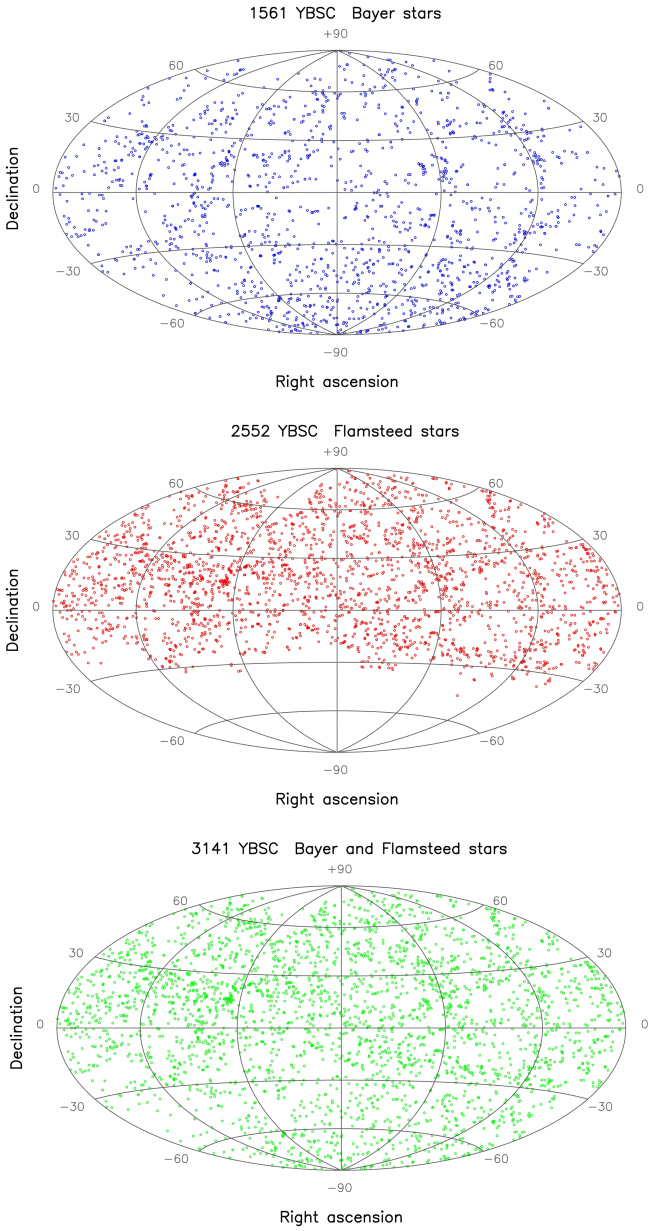

Figure 2. The Hammer-Aitoff diagram of Bayer (top) and Flamsteed (middle) stars taken from the Yale Bright Star Catalogue. The stars designated by Flamsteed are distributed on the sky only visible from Great Britain. The Bayer stars are distributed more uniformly. The bottom diagram contains all 3141 Bayer and/or Flamsteed stars taken from this catalogue. The sky coverage is better on this diagram, still one can see a few regions significantly less populated by stars.

Quickly we have realized that in many cases the shower names can not be verified, and that the main reason of it lies in insufficient precision of 2-nd rule of the meteor shower nomenclature. To apply this rule one has to decide on the star catalogue to use and the limiting magnitude of stars. Such settings were never made by the WG, therefore to address the above issue we have applied the Yale Bright Star Catalogue (BSC), 5th Revised Ed. (Hoffleit and Warren 1991).

The BSC contains 9096 stars† brighter then ∼6.5 magnitude, which is roughly every star visible to the naked eye from the Earth. The catalogue is fixed in number of entries, but its data is being updated. The version of 1991 was the next but four, and it was compiled and edited by Ellen Dorrit Hoffleit of Yale University. Among others, the BSC catalog contains the equatorial positions of stars for J2000, the visual magnitudes, and detailed information on individual entries. This information includes constellation code and a star name — generally Bayer and/or Flamsteed name.

Originally Bayer stars were labelled by Greek and Latin letters e.g. "alpha Centauri", "d Centauri". However, to avoid some confusion, astronomers revised Bayer's system adding several modifications. E.g. in Orion constellation the Greek letter "pi" was supposed to apply to all six stars in the arc forming the lions pelt or shield on Orion left arm. In this case, astronomers added superscripts to Bayers letters (pi^1, pi^2, pi^3,...) to distinguish between the individual stars. In the case of Flamsteed designation system each star is labeled by a number and the Latin genitive of the constellation it lies in, e.g. "51 Pegasi".

From the BSC we have drawn a subset of 3141 stars for which Bayer and/or Flamsteed names were available.‡ Our subset contains 1561 Bayer's stars and 2552 stars designed by Flamsteed. 972 stars have both Bayer and Flamsteed designations. Flamsteed's catalogue covered only the stars visible from Great Britain, and therefore stars of the far southern constellations have no Flamsteed numbers. Bayer stars cover the whole sky more or less uniformly. Figure 2 illustrates distributions of Bayer and Flamsteed stars on the whole celestial sphere.

3.2. Results of the shower name correctness test

After setting the star catalogue, we used a software in which we implemented all the shower nomenclature rules. We wanted to test the name correctness of the meteor showers listed in the IAU MDC. Altogether 554 meteor shower names were initialy tested, but after including the showers for which we had several radiants, we have tested 646 shower names.¶ We compared all components of the shower names given in the MDC database with those yielded by out test-software. We were able to control correctness of the Daytime-Nighttime shower activity, Northern-Southern

† The BSC contains 9110 objects, of which 9096 are stars. Fourteen objects cataloged in the original compilation of 1908 are novae, supernovae or non-stellar objects that have been retained to preserve the numbering.

‡ Three stars from the Trapezoid group in the Orion constellation were omitted to avoid the same star names.

¶ As *a natura rei* — our test was possible only if the solar ecliptic longitude at the moment of the shower activity and the radiant coordinates were given. In the IAU MDC, in case of meteor shower complexes such information is only available for three of them.

branches, the month of the shower activity and the star and constellation names. As was expected, we observed that for some showers more than one name component is incorrectly specified in the IAU MDC database. In Table 3 we collected general results of the test. We made several tests for a few subsets of the whole radiant set (646 radiants) and for different sets of the BSC stars.

Table 3. Results of the name correctness test for the IAU MDC meteor showers. The first row refers to all 646 radiants of 554 meteor showers (status for the end of 2013). The second row (350 radiants) refers to "old" showers only, observed before the Working Group on Meteor Shower Nomenclature was organized. The last row involves the showers for which the names were assigned by the Working Group (WG flag in the first column). The letters B and F in the first columns mean that Bayer and Flamsteed stars were used in the test. The second column gives the number of tested shower radiants (NR), the third column (IN) gives the total number of incorrect shower names, the following columns include the number of showers for which the test gave negative results due to incorrect: N-S – Northern-Southern branches, D-N – Daytime and Nighttime activity, M – month of the shower activity, Star – name of the radiant nearest star, Const – constellation name in which the radiant is located. For IN, Star, Cons columns the percentage ratio between quoted values and the NR are given in brackets.

	NR	IN	N-S	D-N	M	Star	Const
BF	646	464 (72%)	5	12	6	415 (64%)	156 (24%)
B	350	257 (73%)	3	10	2	216 (62%)	125 (36%)
BF+WG	296	186 (63%)	2	2	4	175 (59%)	31 (10%)

3.3. Discussion of the results

At first glance, the results given in third column of Table 3 are very discouraging. For majority of meteor showers listed in the MDC, their names do not fulfill the nomenclature rules (see section 3).

In Table 3, the first row presents the most complete result of our test. We used all 3141 Bayer and Flamsteed stars from the BSC catalogue and tested 646 shower radiants included in the MDC database. The names of 73% of meteor showers did not fulfill the nomenclature rules. However one can easily explain significant part of such a result. In this test we made use of Flamsteed stars as well, but these stars were not used when names for ∼500 of the shower radiants collected in the MDC were assigned. Flamsteed stars have been in use quite recently for naming meteor showers.

So we made two additional tests. The first one concerned 350 showers for which the names were assigned outside the WG, and the second test for 296 showers which were named by the WG. In the first test only Bayer stars were used, in the second one, both Bayer and Flamsteed stars. Results of these additional tests are given in the second and third row in Table 3. The numbers of incorrect names are still very high, but the high number of incorrect names for showers fixed before the WG activity time is not a surprise. At that time the shower names were assigned more or less subjectively, using different star maps and possibly applying individual rules developed by shower discoverers.

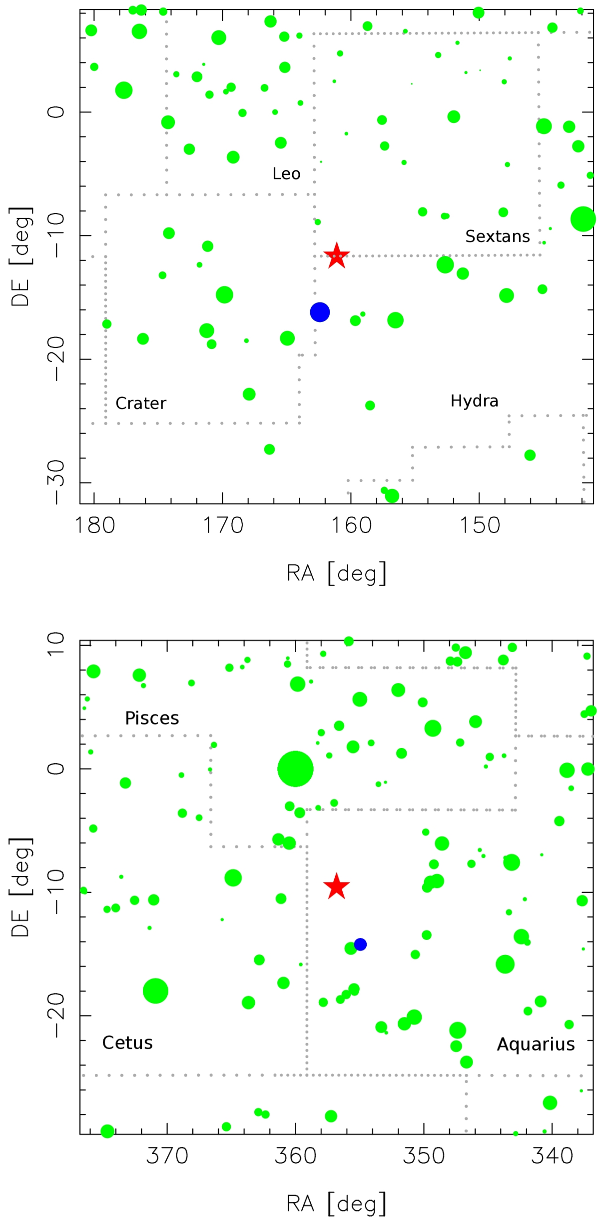

Figure 3. Top — difficult case of the radiant assignement (marked by star symbol) of January ν Hydrids (#544, JNH). It lies almost on the border of two constellations. Bottom — the radiant of the August ι Cetids (#505, AJC) undoubtedly lies in the Aquarius constellation.

The last row in Table 3 enables us to draw a weak conclusion that activity of the WG brought positive results – among 296 showers a fraction of incorrect names is a bit smaller. However, this fraction is disconcertingly high, and after the WG started its activity, one should expect that all fractions in the last row of Table 3 should be close to zero. Again we can explain such result easily. During the seven years of its activity the WG had no access to the standard implemented by our software. Without any commonly used standard, all the work of the WG was subjective.

Without an objective tool (a software plus a star catalogue) it is very difficult to find which star is the closest one to a given point on the celestial sphere. Therefore in Table 3 we see the highest numbers in the seventh column. Additionally these numbers were increased by each incorrect assignment of the constellation name in which the shower radiant lies in. Therefore one can assume that the incorrect star names, for the most cases, resulted just due to mistakes. They were not the results of the willful nomenclature rules violations.

But it seems to be the opposite in case of the incorrect constellation name assignment. Certainly, a few mistakes were also possible here. E.g. on Figure 3 the radiant of January ν Hydrids lies very close to the border between Hydra and Sextans constellations. By "naked eye" it is very difficult to decide in which constellation this radiant lies in. Therefore in case of incorrect constellation names we can have some amount of mistakes, but in most cases, it seems that the shower nomenclature rules were violated, also by the WG. An example of such nomenclature rule violation is shown on the bottom graph of Figure 3. On this graph, the radiant point lies undoubtedly inside the Aquarius constellation, however despite it, the shower was named August ι Cetids.

Our tests have shown that the number of incorrect months, branches and day-night activities assignments are small. They were caused by mistakes like in case of the shower Southern δ Leonids (see Figure 4), or due to inconsistency of the shower parameters. In some cases, data given in the MDC shower database were taken from different sources, e.g. the solar longitude at the peak of the shower activity and the radiant coordinates are taken from different sources. Therefore, probably they are inconsistent. But in our software to find e.g. precise radiant elongation from the Sun at the moment of shower activity one needs consistent data. From our experience, the data inconsistency in the MDC is a serious problem and should be investigated separately.

Several incorrect "Daytime" prefixes can be explained by the choice of the value 32 degrees† for the critical elongation of the daytime radiant from the Sun. In the MDC database we have found the shower (#152, NOC, Northern Daytime ω Cetids) with radiant elongation 47 degrees, labeled by Sekanina in his original paper Sekanina (1976) also as "Daytime" shower. It is clear that the value 32 degrees is just too rigorous.

† This value was taken from Jenniskens (2008); Jopek and Jenniskens (2011).

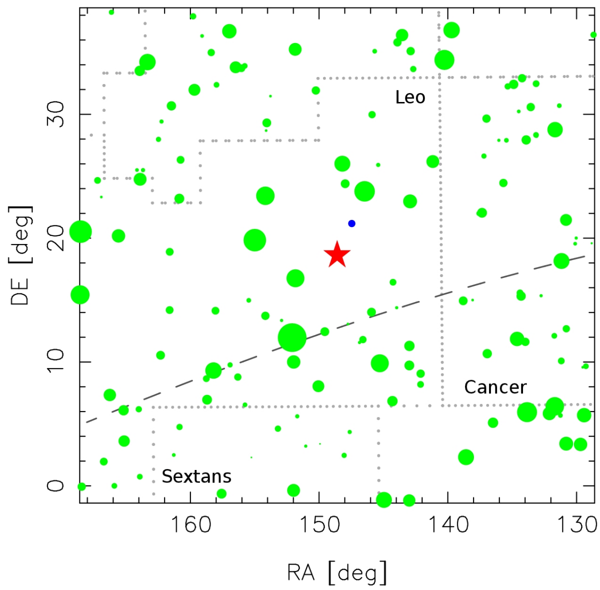

Figure 4. Southern δ Leonids (#113, SDL), the third set of parameters for this shower contains the radiant coordinates RA=148.6, DE=18.6. Its ecliptic latitude is BE=5.5 degrees, what means that this radiant, marked by a star symbol, lies in the northern ecliptic hemisphere not the southern one.

4. Conclusions

In 2012 during the GA IAU in Beijing, 31 new meteor showers were officially named. Thus, at present the list of the established meteor showers contains 95 objects. Including showers placed on the Working list and the List of Showers Groups the MDC contains 579 meteor showers (see Jopek and Kaňuchová 2013).‡

On the IAU website `http://www.iau.org/public/themes/naming/` one can find information on how different astronomical objects and features are named, *inter alia* the minor planets and comets. There is no information about the nomenclature of meteor showers. To include such information on this website, we believe, it is essential to formulate and implement the objective rules of the meteor shower nomenclature. Our study has shown that nomenclature rules published so far are not sufficient for this purpose. They are not sufficiently precise, hence not objective. Such situation is very disadvantageous for the meteor astronomers community.

Existing nomenclature problems can be solved twofold: by keeping tradition as much as possible, or more radically. In the first approach we should transform existing traditional, imprecise rules into a set of objective ones, e.g. by choosing a standard star catalogue which will be used for meteor shower name assignments. More radical approach, perhaps unavoidable, requires more energy and a good will from the meteor astronomers community. Probably, it would require the break up with the tradition.

‡ Status at the end of 2013.

Another important task is an improvement of the IAU MDC shower database. The MDC database needs further improvement, both as to its contents and as to its user friendly interface. Without fail, such improvement will require long-term activity.

Acknowledgements

We would like to acknowledge the users of the IAU MDC who informed us about several erroneous data: Reiner Arlt, Zeljko Andreić, David Asher, Rhiannon Blaauw, Steve Hutcheon, Diego Janches, Sirko Molau, Ned Smith and Francisco Ocaña, Regina Rudawska.

References

Astronomical Almanac 1996, 1994, by Nautical Almanac Office, Washington, DC (USA); p. C24

Delporte E., 1930, Dlimitation scientifique des constellations, Cambridge University Press

Hoffleit D., Warren Jr., W.H., 1991, "The Bright Star Catalog, 5th Revised Edition (Preliminary Version)", `http://tdc-www.harvard.edu/catalogs/bsc5.html`

Jenniskens P., 2006, Meteor Showers and their Parent Bodies, Cambridge UP, UK, pp 790

Jenniskens P., 2006a, WGN, Journal of the International Meteor Organization 34, 127

Jenniskens P., 2007, Div. III, Comm.22, WG Task Group for Meteor Shower Nomenclature, IAU Information Bulletin 99, January 2007, 60

Jenniskens P., 2008, EM&P, 102, 5

Jopek T.J., Jenniskens P.M., 2011, in Proc. Meteoroids 2010 Conf., held in Breckenridge, Colorado USA, May 24-28 2010, eds Cooke W.J., Moser D.E., Hardin B.F., Janches D., NASA/CP-2011-216469, p. 7

Jopek T.J., Kaňuchová Z., 2013, Meteor Data Center, `http://www.astro.amu.edu.pl/~jopek/MDC2007/`, or `http://www.ta3.sk/IAUC22DB/MDC2007`

Jeong-Han Kim, Geonhwa Jee, Changsup Lee, Yong-Ha Kim, 2013, Advances in Polar Science, 24 (4-English), 241

Meuss J., 1991, Astronomical Algorithms, Willmann-Bell, p. 151

Roman N.G., 1987, Publication of the Astronomical Society of Pacific, 99, 695

Seidelmann P.K., et al., 1992, Explanatory Supplement to the Astronomical Almanac, ed. by Seidelmann P.K., University Science Books, Mill Valley, California

Sekanina Z., 1976, Icarus, 27, 265