Results of the IMO Video Meteor Network – November 2013

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November 2013 was a month with poor weather – not as bad as in November 2012, but much worse than in November 2011. Observers in Germany, Italy and at the Iberian peninsula were still in a comfortable position, but in particular in Hungary and Slovenia observation was no fun. Only 19 out of 70 cameras obtained twenty and more observing nights. The effective observing time accumulated to 6,700 hours, roughly one hundred more than in the previous year. The number of meteors increased by 2,000 to over 29,000.

With Thomas Łojek, we could win a second Polish observer for the IMO network. Tomasz operates the station PAV57 of the Polish fireball network, a Tayama camera with f/1.0 zoom lens and a focal length of ~5 mm.

Let's have a look at the highlights of Nove,ber. The golden years of the Leonids are over – the last meteor storm dates back more than ten years. Still, the activity profiles show variations from one year to the next as depicted in figure 1. Whereas the data of the last three years agree perfectly at the ascending branch until 234° solar longitude, there are larger deviations between the individual years thereafter. In 2012, the flux density did not exceed 8 meteoroids per 1,000 km^2 and hour. In 2011 and 2013, however, peak activity was 50% higher.

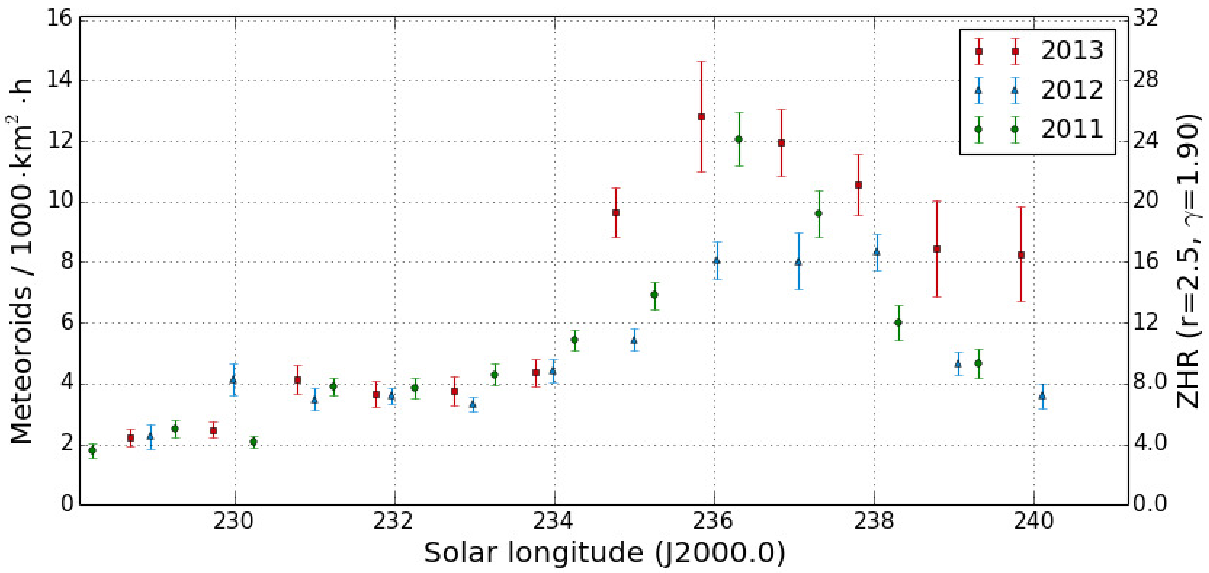

Figure 1: *Flux density profile of the Leonids in the years 2011 till 2013.*

It remains to be checked, if the chosen population index of 2.5 was realistic. To find out, we wanted to apply the same procedure as for the Orionids. However, there are certain situations where the procedure requires further refinement.

Let's go back to the Orionid night of October 20/21, 2013, when a limiting magnitude interval from 1 to 5 mag was covered. (figure 2, left). Most lines show a relatively well-defined intersection point, but the 5 mag line deviates strongly. The reason could be, that the data set was too small (45 min observing time, one meteor), but should that line be completely omitted? And when should we omit such an interval?
The problem can be formulated in a different manner: We want to find the point, where the lines are closest to each other. We do that by handling the lines not and strictly focused, but we blur them mathematically (as depicted schematically in figure 2, right) and choose the r-value, where the overlapping intensity is highest.

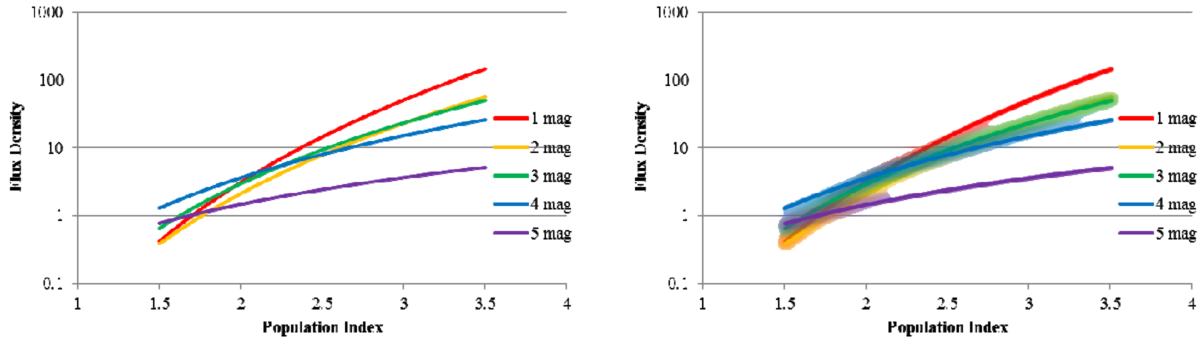

Figure 2: To determine the population index, we plot the dependency of the flux density from the r-value for different limiting magnitudes (left). To determine the best intersection point, the lines are mathematically blurred (right).

But shall all lines be blurred in the same way, or do some lines have to be blurred stronger than others? Instead of omitting the 5 mag line, we could give it a lower weight in the average by blurring it more than other lines.
This approach was implemented by us. Even though the following derivation starts from a different perspective, it yields in the end no more than a probabilistic weighting of lines when the best intersection point is determined.

Now for the mathematical derivation: Let's have a look at the October 20/21 data set as a whole. We observed 170 Orionids with an effective collection area of 18,000 km^2 and hour. The population index describes the brightness distribution, i.e. it defines how many of these 170 meteors below to the first to fifth magnitude. In our example, we do not look at meteors of magnitude x, but rather at meteors with variable magnitudes recorded when the limiting magnitude was x. Still, the distribution is governed by the population index. Given the r-value we know the effective collection area of each limiting magnitude interval. Thus we know, how many meteors out of the 170 should fall into each class. This is depicted in figure 3 with solid lines. Expectedly, intervals with poor limiting magnitude (red and yellow lines) perform much better at low r-values (i.e. when there are many bright meteors) than at large r-values (many faint meteors).
In addition, the figure shows with dashed lines the real number of meteors that were observed in each limiting magnitude interval. Again, they sum up to 170.

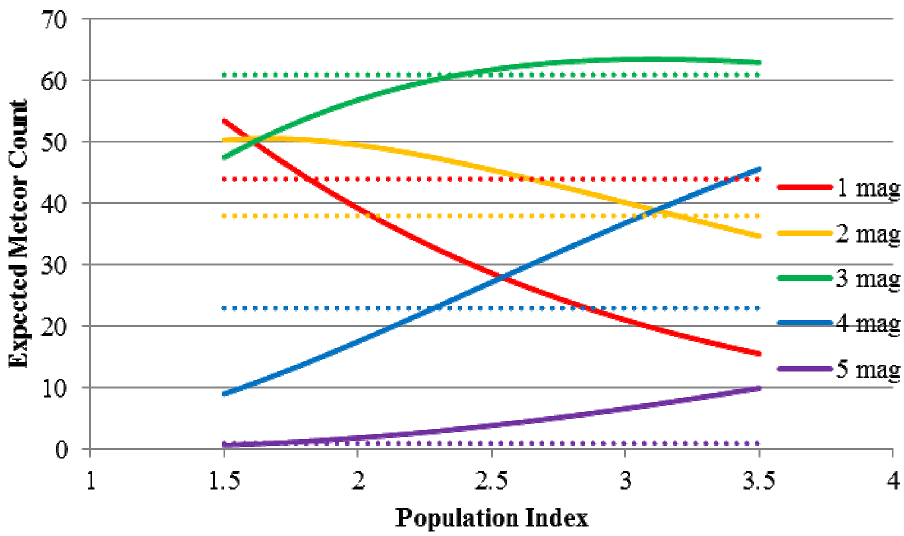

Figure 3: Comparison oft he expected (solid line) and the observed (dashed line) number of Orionids at different limiting magnitudes.

So far it seems we did not win a lot, since again we have different intersection points between the corresponding lines, but now we can introduce a well-established stochastic model. Here we are dealing with a classical Poisson distribution.

So what is a Poisson distribution? Let's look at random events, which occur independently of each other with a constant rate of λ, e.g. how many persons enter a department store on a Saturday afternoon. The average λ may be 600 persons per hour. That does not mean, of course, that every minute exactly 10 persons enter the front door. The number is fluctuating from one minute to the next, because they are independent stochastic events. The Poisson distribution $P_\lambda(k) = \lambda^k / k! * e^{-\lambda}$ describes the probability, that exactly k persons enter the department store in one minute. With a 12.5% chance it will be ten persons, but it may also happen that only two (0.2%) or even 15 customer (3.5%) enter the store. The probability of such outliers is low, but not zero.
The same Poisson distribution holds for the number of meteors observed per unit time at a constant meteor activity. Let's assume that an average of λ = 60 Orionids per hour show up. The probability, that no meteor is seen at one minute is as high as the chance so see one meteor (37%). Five meteors a minute are unlikely (0.3%), but still it happens sometimes.

Back to the meteor count per brightness class: We can calculate for each limiting magnitude and each population index the expected meteor count λ, and we know the truly observed meteor count k. The Poission distribution tells us, how probable that pair is.
The Poisson distribution reflects two important properties. On the one hand, it automatically incorporates the size of the data set: If only one meteor is expected, the probability of observing 0, 1 or 2 meteors is nearly the same. Hence, this limiting magnitude interval will play an underpart in the determination of the population index. If at an interval with plenty of data 50 meteors are expected, then the probability to observe 40 or 60 meteors is much smaller. This interval will define the r-value much better.
On the other hand we see, that the meteor count alone is not the only criterion. At an average limiting magnitude of 3 mag, for example, the number of expected meteors is relatively independent of the population index. We can vary the r-value, but the number of meteors observed at a limiting magnitude of 3 will differ only little. Hence, this interval is less valuable to determine the population index.

Figure 4 shows the dependency of the observed meteor count from the population index using the example data set of October 20/21. Probabilities are presented as logarithmic values, because they easily become very small. The lower black line is the product of the individual probabilities resp. the sum of the log probabilities. It represents the resulting probability for each population index and yields the best r-value. Beyond that, is defines also the quality of the estimate: If the overall log probability is relatively large (close to 0), then the maxima of different curves agree well. If it is smaller, then each of the individual limiting magnitude intervals yields a different picture. If the peak is spiky (independent of the absolute value), then the data set is discriminative and the r-value can be determined quite precisely. If it is shallow, then the observed brightness range was too small to yield a precise r-value.

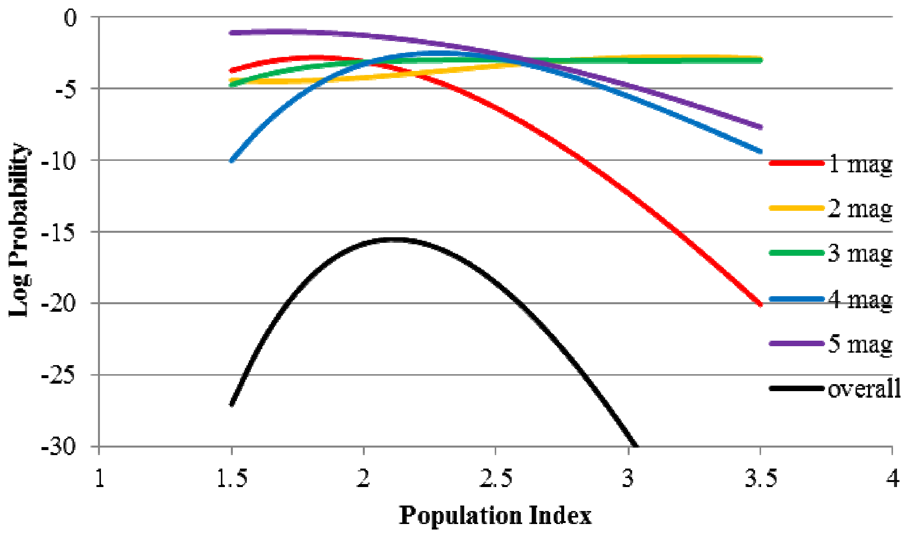

Figure 4: *With the Poisson distribution we can calculate the probability of the observed number of meteors given the expected number of meteors. The lower line represents the combined probability over all limiting magnitude intervals.*

The calculation is done in discrete r-value steps of 0.1. To increase the resolution, we fit a quadractic function ax^2+bx+c to the five values centered at the peak. That can be easily differentiated and the zero crossing of the derivative (= r-value with highest probability) is given by b/2a. In addition we can calculate a confidence interval, e.g. which r-values have still at least 50% of the peak probability. In the example of figure 4, the best population index is 2.12, and all values between 1.96 and 2.29 are in the 50% range.

Let's summarize: With the modified procedure we find the best intersection point between the lines of different limiting magnitude (figure 2). It incorporates the size of the data set and how well the limiting magnitude class suits at all to determine the population index. If the data set is small or if the expected meteor number changes only little for different r-values, then the class has a smaller weight in the calculation then other. We do not have to arbitrarily omit limiting magnitude intervals, which makes this method quite reliable from the stochastic point of view.

It remains to be clarified, if all data sets should be used for the determination of the r-value or not. It could be that cloudy intervals distort the result systematically, since the limiting magnitude is averaged over the full field of view. Equally we may introduce errors with cameras that show a systematic deviation in the limiting magnitude calculation (e.g. because of poor reference stars). Last but not least, the choice of the brightness intervals was arbitrary. Maybe we get better precision if we do not use fixed one mag intervals but rather adapt the interval boundaries dynamically to the available data set? All these aspects require further investigations in the future.

After so much theory, let's have finally a look at the outcome when the modified approach is applied to the Leonid 2013 data set (figure 5). The values from November 16/17 to 18/19 and on November 20/21 have a small variance, for all other nights the data set was simply too small to determine the r-value precisely. Overall the population index is smaller than two, but there is still no independent confirmation from visual observations.

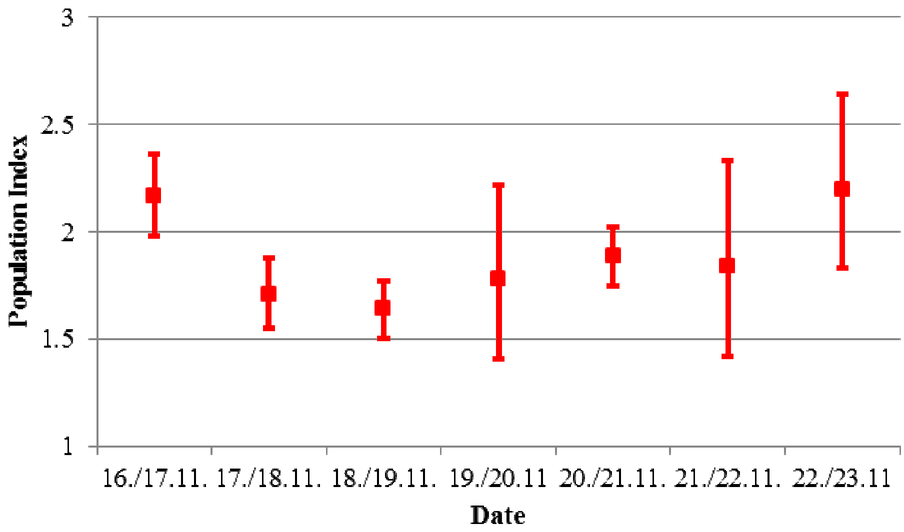

Figure 5: *Population index profile of the Leonids 2013.*

1. Observers

Code	Name	Place	Camera	FOV [$^{\circ 2}$]	St.LM [mag]	Eff.CA [km^2]	Nights	Time [h]	Meteors
ARLRA	Arlt	Ludwigsfelde/DE	LUDWIG1 (0.8/8)	1488	4.8	726	6	56.4	63
BANPE	Bánfalvi	Zalaegerszeg/HU	HUVCSE01 (0.95/5)	2423	3.4	361	8	48.9	155
BERER	Berkó	Ludanyhalaszi/HU	HULUD1 (0.8/3.8)	5542	4.8	3847	6	47.2	244
			HULUD2 (0.95/4)	3398	3.8	671	6	43.4	93
			HULUD3 (0.95/4)	4357	3.8	876	6	45.0	59
BOMMA	Bombardini	Faenza/IT	MARIO (1.2/4.0)	5794	3.3	739	18	84.7	414
BREMA	Breukers	Hengelo/NL	MBB3 (0.75/6)	2399	4.2	699	14	45.0	141
BRIBE	Klemt	Herne/DE	HERMINE (0.8/6)	2374	4.2	678	2	11.4	48
		Berg. Gladbach/DE	KLEMOI (0.8/6)	2286	4.6	1080	14	52.2	208
CRIST	Crivello	Valbrevenna/IT	BILBO (0.8/3.8)	5458	4.2	1772	25	162.5	808
			C3P8 (0.8/3.8)	5455	4.2	1586	23	166.8	619
			STG38 (0.8/3.8)	5614	4.4	2007	23	166.6	855
DONJE	Donati	Faenza/IT	JENNI (1.2/4)	5886	3.9	1222	16	97.6	400
ELTMA	Eltri	Venezia/IT	MET38 (0.8/3.8)	5631	4.3	2151	8	67.4	284
GONRU	Goncalves	Tomar/PT	TEMPLAR1 (0.8/6)	2179	5.3	1842	23	226.9	1047
			TEMPLAR2 (0.8/6)	2080	5.0	1508	23	239.4	1045
			TEMPLAR3 (0.8/8)	1438	4.3	571	26	255.7	967
			TEMPLAR4 (0.8/3.8)	4475	3.0	442	23	232.5	908
GOVMI	Govedic	Sredisce ob Dr./SI	ORION2 (0.8/8)	1447	5.5	1841	14	63.4	210
			ORION3 (0.95/5)	2665	4.9	2069	9	40.4	85
			ORION4 (0.95/5)	2662	4.3	1043	13	54.3	108
HINWO	Hinz	Schwarzenberg/DE	ACR (2.0/35)*	557	7.3	5002	13	67.1	356
IGAAN	Igaz	Baja/HU	HUBAJ (0.8/3.8)	5552	2.8	403	12	25.7	89
		Debrecen/HU	HUDEB (0.8/3.8)	5522	3.2	620	17	92.8	210
		Hodmezovasar./HU	HUHOD (0.8/3.8)	5502	3.4	764	17	71.2	157
		Budapest/HU	HUPOL (1.2/4)	3790	3.3	475	14	68.2	55
JONKA	Jonas	Budapest/HU	HUSOR (0.95/4)	2286	3.9	445	14	69.3	151
KACJA	Kac	Kamnik/SI	CVETKA (0.8/3.8)	4914	4.3	1842	6	40.5	265
		Ljubljana/SI	ORION1 (0.8/8)	1402	3.8	331	6	24.5	58
			STEFKA (0.8/3.8)	5471	2.8	379	7	42.9	227
KERST	Kerr	Glenlee/AU	GOCAM1 (0.8/3.8)	5189	4.6	2550	15	81.7	240
KISSZ	Kiss	Sulysap/HU	HUSUL (0.95/5)*	4295	3.0	355	18	56.7	75
KOSDE	Koschny	Izana Obs./ES	ICC7 (0.85/25)*	714	5.9	1464	26	221.2	1846
		La Palma / ES	ICC9 (0.85/25)*	683	6.7	2951	21	144.9	1560
		Noordwijkerhout/NL	LIC4 (1.4/50)*	2027	6.0	4509	15	72.4	209
LOJTO	Łojek	Grabniak/PL	PAV57 (1.0/5)	1631	3.5	269	8	37.9	83
MACMA	Maciejewski	Chelm/PL	PAV35 (0.8/3.8)	5495	4.0	1584	17	77.4	314
			PAV36 (0.8/3.8)*	5668	4.0	1573	18	72.4	274
			PAV43 (0.75/4.5)*	3132	3.1	319	15	56.0	152
			PAV60 (0.75/4.5)	2250	3.1	281	16	38.5	159
MARGR	Maravelias	Lofoupoli/GR	LOOMECON (0.8/12)	738	6.3	2698	19	136.7	377
MASMI	Maslov	Novosimbirsk/RU	NOWATEC (0.8/3.8)	5574	3.6	773	8	39.3	273
MOLSI	Molau	Seysdorf/DE	AVIS2 (1.4/50)*	1230	6.9	6152	17	100.5	1056
			MINCAM1 (0.8/8)	1477	4.9	1084	17	90.1	325
		Ketzür/DE	REMO1 (0.8/8)	1467	6.5	5491	21	117.4	810
			REMO2 (0.8/8)	1478	6.4	4778	22	125.2	622
			REMO3 (0.8/8)	1420	5.6	1967	16	110.7	179
			REMO4 (0.8/8)	1478	6.5	5358	20	125.3	859
MORJO	Morvai	Fülöpszallas/HU	HUFUL (1.4/5)	2522	3.5	532	18	82.1	177
OCHPA	Ochner	Albiano/IT	ALBIANO (1.2/4.5)	2944	3.5	358	13	83.3	240
OTTMI	Otte	Pearl City/US	ORIE1 (1.4/5.7)	3837	3.8	460	24	138.1	628
PERZS	Perkó	Becsehely/HU	HUBEC (0.8/3.8)*	5498	2.9	460	17	95.8	597
ROTEC	Rothenberg	Berlin/DE	ARMEFA (0.8/6)	2366	4.5	911	14	99.7	212
SARAN	Saraiva	Carnaxide/PT	RO1 (0.75/6)	2362	3.7	381	24	225.6	676
			RO2 (0.75/6)	2381	3.8	459	24	216.8	745
			SOFIA (0.8/12)	738	5.3	907	23	224.7	568
SCALE	Scarpa	Alberoni/IT	LEO (1.2/4.5)*	4152	4.5	2052	5	29.3	75
SCHHA	Schremmer	Niederkrüchten/DE	DORAEMON (0.8/3.8)	4900	3.0	409	18	79.9	236
SLAST	Slavec	Ljubljana/SI	KAYAK1 (1.8/28)	563	6.2	1294	8	48.3	108
STOEN	Stomeo	Scorze/IT	MIN38 (0.8/3.8)	5566	4.8	3270	25	142.9	985
			NOA38 (0.8/3.8)	5609	4.2	1911	24	146.3	843
			SCO38 (0.8/3.8)	5598	4.8	3306	23	135.4	1164
STRJO	Strunk	Herford/DE	MINCAM2 (0.8/6)	2354	5.4	2751	15	73.5	311
			MINCAM3 (0.8/12)	2338	5.5	3590	18	82.3	280
			MINCAM4 (1.0/2.6)	9791	2.7	552	17	61.3	132
			MINCAM5 (0.8/6)	2349	5.0	1896	16	72.9	237
TEPIS	Tepliczky	Agostyan/HU	HUAGO (0.75/4.5)	2427	4.4	1036	10	77.9	221
		Budapest/HU	HUMOB (0.8/6)	2388	4.8	1607	17	72.6	369
TRIMI	Triglav	Velenje/SI	SRAKA (0.8/6)*	2222	4.0	546	15	81.7	189
YRJIL	Yrjölä	Kuusankoski/FI	FINEXCAM (0.8/6)	2337	5.5	3574	14	78.0	307
Sum							30	6762.6	29042

* active field of view smaller than video frame

2. Observing Times (h)

November	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15
ARLRA	-	-	7.2	-	2.5	-	-	-	9.1	-	-	-	-	-	-
BANPE	5.0	0.3	-	-	-	-	4.7	5.7	-	-	-	-	-	-	-
BERER	-	-	-	-	-	6.9	-	-	-	-	-	-	-	-	-
	-	-	-	-	-	3.7	-	-	-	-	-	-	-	-	-
	-	-	-	-	-	5.4	-	-	-	-	-	-	-	-	-
BOMMA	7.5	4.0	5.1	-	5.6	5.6	-	5.9	7.7	-	-	0.6	0.5	-	-
BREMA	-	1.4	2.1	3.8	-	-	-	-	-	4.3	-	6.4	2.1	-	0.2
BRIBE	-	-	-	-	0.9	-	-	-	-	10.5	-	-	-	-	-
	-	-	3.4	2.7	0.7	-	-	1.4	0.2	8.8	-	-	-	-	12.0
CRIST	0.6	-	7.3	1.7	11.3	11.7	0.4	0.2	9.0	9.3	12.4	7.0	0.2	-	0.6
	-	-	7.5	7.1	9.8	7.5	0.2	-	8.4	8.5	12.2	7.6	0.3	1.5	2.9
	0.7	-	8.6	-	10.9	11.9	0.6	0.3	10.1	9.7	12.4	7.3	0.2	-	-
DINJE	11.7	4.2	9.5	-	10.5	12.3	1.5	-	-	-	-	1.0	0.8	-	-
ELTMA	-	-	7.8	-	11.4	12.5	-	-	-	-	7.4	6.9	-	-	2.0
GONRU	-	2.3	4.5	-	-	-	-	10.3	11.9	12.2	12.3	12.4	12.4	12.2	7.2
	-	4.1	5.5	-	-	-	-	10.2	12.0	12.2	12.3	12.4	12.4	12.4	6.8
	-	3.3	3.7	-	0.7	-	0.3	11.9	8.4	12.3	12.2	12.2	12.2	12.3	7.2
	-	3.5	4.1	-	-	-	-	10.0	10.9	12.2	12.4	12.4	12.4	12.3	6.2
GOVMI	10.3	6.9	-	-	6.7	2.5	11.4	8.3	0.7	-	-	-	0.9	-	-
	9.8	-	-	-	2.9	-	9.0	-	0.5	-	-	-	-	-	-
	8.6	-	-	-	1.4	2.3	10.7	7.0	0.8	-	-	-	0.7	-	-
HINWO	2.1	4.9	8.6	1.3	2.5	-	2.3	-	7.4	-	8.7	5.6	3.0	-	-
IGAAN	-	0.3	-	-	0.5	-	3.4	9.5	-	-	-	-	-	0.2	1.2
	-	3.6	-	-	-	6.2	8.7	-	4.5	4.6	12.6	-	-	-	-
	6.9	0.8	-	-	-	-	8.7	7.8	3.9	3.4	3.8	-	0.1	1.8	1.7
	-	4.7	-	-	3.4	2.2	7.3	4.5	-	0.8	-	-	-	-	2.7
JONKA	0.8	6.8	-	-	1.3	1.4	11.2	4.2	-	2.7	-	-	-	-	3.1
KACJA	6.6	-	-	-	-	5.5	2.8	-	-	-	-	-	-	-	-
	1.5	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	8.8	-	-	-	-	4.3	2.8	-	-	-	-	-	-	-	-
KERST	7.1	7.4	7.5	5.5	3.0	6.0	8.5	7.3	6.6	7.5	2.3	2.4	0.3	-	6.5
KISSZ	-	5.0	0.7	-	1.9	1.2	7.5	0.6	-	2.6	0.2	1.5	-	-	-
KOSDE	10.8	-	4.5	11.2	8.4	4.7	10.9	9.8	11.3	10.1	11.3	11.1	3.8	8.8	7.8
	10.8	-	10.4	10.8	8.7	10.9	10.9	10.9	2.3	9.9	8.9	7.9	1.9	-	3.6
	-	3.2	-	5.6	-	-	2.2	2.8	3.6	9.4	-	8.8	1.6	6.0	4.0
LOJTO	-	-	-	-	-	-	0.6	-	-	4.8	0.4	-	-	-	0.6
MACMA	5.4	2.1	-	1.5	-	-	0.4	11.4	-	-	1.2	-	-	11.7	2.7
	5.7	1.7	2.6	1.0	-	0.4	0.5	5.3	-	-	0.4	-	-	10.6	2.0
	5.3	1.9	2.4	2.4	-	1.0	0.9	11.2	-	-	-	-	-	10.5	3.1
	-	1.6	2.4	-	-	0.6	-	3.6	-	-	0.9	-	-	2.9	-
MARGR	3.3	11.1	10.3	10.9	8.3	3.1	3.3	11.4	11.4	8.5	11.3	8.3	8.8	-	-
MASMI	3.7	0.7	-	-	-	-	-	-	-	11.5	-	-	-	-	1.0
MOLSI	5.4	4.8	11.8	4.8	4.9	2.3	10.8	0.5	6.4	0.8	8.9	-	-	-	-
	3.4	4.6	10.9	2.8	4.5	1.1	10.9	0.4	4.7	0.3	9.0	-	-	-	-
	1.5	2.4	9.4	2.5	4.6	0.6	-	2.4	6.8	5.8	12.7	-	12.2	4.0	2.2
	1.8	2.6	10.2	3.4	4.5	0.7	-	2.7	7.2	5.6	13.1	-	12.4	2.6	2.3
	-	-	8.1	2.5	3.6	-	-	-	6.6	5.6	12.9	-	12.4	5.3	2.0
	1.6	2.6	9.9	3.2	4.7	-	-	3.0	6.9	5.7	13.1	-	12.4	3.8	-
MORJO	5.1	2.3	-	-	2.8	-	12.2	3.6	2.3	3.0	0.9	0.4	-	0.9	3.4
OCHPA	-	-	0.5	-	-	-	-	-	-	3.4	3.7	11.0	7.7	-	4.4
OTTMI	3.7	5.4	1.1	-	-	4.1	4.2	2.3	6.9	-	8.7	8.5	9.4	1.7	5.8
PERZS	12.3	6.9	-	0.6	6.5	1.6	12.6	9.1	2.4	-	-	-	1.6	-	5.3
ROTEC	-	-	8.5	2.2	-	-	-	1.1	8.9	6.7	12.8	-	11.1	-	1.3
SARAN	5.9	5.9	3.4	-	-	-	-	10.8	10.5	12.1	11.9	10.9	10.1	10.9	4.5
	4.0	4.7	2.4	-	-	-	-	8.5	7.6	9.5	9.2	12.0	12.1	12.2	4.4
	4.9	5.9	3.1	-	-	-	-	10.6	8.0	11.4	12.1	12.0	12.2	12.2	-
SCALE	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SCHHA	-	0.9	4.0	3.6	3.9	0.2	-	2.0	0.8	12.1	3.4	3.6	9.9	-	6.2
SLAST	6.5	-	-	-	-	3.1	-	-	-	-	-	-	-	-	-
STOEN	3.8	-	5.2	-	6.2	12.7	2.2	0.2	2.8	0.2	9.7	6.9	4.1	-	3.5
	4.7	-	5.8	-	7.4	12.7	2.5	-	2.0	0.2	10.2	8.7	3.4	-	3.5
	3.5	-	3.7	-	4.6	10.8	1.1	-	1.8	0.4	9.6	5.6	4.6	-	3.5
STRJO	-	-	1.8	2.4	0.8	-	-	-	1.9	7.5	5.4	0.4	6.9	-	-
	-	-	0.9	1.2	0.3	-	-	-	1.5	6.3	5.5	2.5	7.8	-	3.4
	-	-	0.8	1.2	0.4	-	-	-	0.9	5.9	3.3	2.6	4.3	-	0.7
	0.6	-	-	1.6	0.3	-	-	-	0.3	7.0	5.7	2.5	6.9	-	2.5
TEPIS	6.5	7.0	1.8	-	3.0	-	12.0	10.1	-	-	-	-	-	-	-
	7.3	6.6	0.9	-	3.1	-	10.7	8.5	-	1.9	0.6	-	1.4	-	1.1
TRIMI	-	4.6	-	-	2.8	11.7	10.0	2.7	0.2	-	-	-	-	-	-
YRJIL	-	1.2	-	-	1.9	2.5	-	-	-	7.0	9.4	-	5.1	-	-
Sum	215.5	154.2	229.9	97.5	184.1	193.9	220.9	250.0	238.1	294.2	347.4	219.4	242.6	156.8	145.1

November	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
ARLRA	-	-	-	-	-	-	-	-	12.8	12.5	12.3	-	-	-	-
BANPE	-	-	-	-	-	-	-	-	-	7.1	-	10.7	7.3	-	8.1
BERER	6.8	-	-	4.4	-	-	5.5	-	-	-	10.7	12.9	-	-	-
	6.4	-	-	4.1	-	-	5.8	-	-	-	10.4	13.0	-	-	-
	6.5	-	-	4.3	-	-	5.5	-	-	-	10.3	13.0	-	-	-
BOMMA	-	-	-	4.1	5.1	3.6	-	1.5	3.4	10.7	-	-	4.5	7.5	1.8
BREMA	-	-	-	4.3	1.9	-	-	1.8	2.8	5.4	-	-	-	5.0	3.5
BRIBE	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	3.9	-	-	0.6	1.4	-	-	2.4	2.5	11.4	-	-	-	0.8	-
CRIST	12.6	-	-	2.0	0.7	2.8	-	0.2	7.3	12.9	12.9	11.5	13.0	5.7	9.2
	12.6	-	-	2.6	1.4	8.0	-	-	7.8	12.9	12.9	5.1	12.9	4.2	12.9
	10.5	-	-	1.5	1.0	2.8	-	0.2	11.6	12.9	12.9	12.3	13.0	6.3	8.9
DINJE	-	-	-	5.1	4.7	3.2	-	-	5.3	10.5	-	-	5.0	9.6	2.7
ELTMA	7.0	-	-	-	-	-	-	-	-	-	-	-	-	-	12.4
GONRU	7.0	6.1	9.9	12.2	8.6	-	0.6	-	11.7	12.5	12.5	12.6	11.9	11.1	12.5
	7.5	12.1	12.3	12.3	8.8	-	0.6	-	11.8	12.7	12.5	12.6	12.1	11.2	12.6
	5.8	9.8	12.3	12.6	10.2	-	7.0	12.6	12.7	12.7	12.8	12.7	12.2	12.8	12.8
	6.3	11.1	12.4	12.3	8.6	-	0.6	-	11.8	12.7	12.6	12.6	11.4	11.1	12.6
GOVMI	6.1	0.2	2.1	-	-	1.7	-	-	0.2	-	-	-	-	-	5.4
	3.3	-	3.3	-	-	-	-	-	-	0.6	-	-	6.0	-	5.0
	2.2	-	4.5	-	-	-	-	-	0.7	2.1	-	-	7.9	-	5.4
HINWO	-	-	9.3	-	-	-	-	-	5.0	-	6.4	-	-	-	-
IGAAN	1.8	-	-	2.6	-	-	0.9	-	-	0.4	-	2.6	2.3	-	-
	0.4	-	-	5.0	-	-	7.6	2.2	3.5	1.1	11.9	12.8	0.7	0.2	7.2
	2.8	-	6.6	1.1	-	5.1	4.7	-	-	-	-	-	-	3.3	8.7
	5.8	-	-	-	5.5	-	1.3	-	-	2.0	7.6	12.7	-	-	7.7
JONKA	6.4	-	-	-	-	-	-	-	-	0.3	3.9	13.3	-	1.8	12.1
KACJA	-	-	-	-	-	-	-	-	-	-	-	10.9	9.2	-	5.5
	-	-	-	-	-	-	-	-	-	3.8	3.5	9.3	2.9	-	3.5
	-	-	-	-	-	-	-	-	-	-	-	9.8	9.5	0.9	6.8
KERST	3.8	-	-	-	-	-	-	-	-	-	-	-	-	-	-
KISSZ	3.6	0.2	-	0.2	-	-	3.0	-	0.6	-	1.9	13.2	1.2	-	11.6
KOSDE	-	2.0	2.5	1.4	10.0	10.5	10.4	10.2	10.4	11.5	6.0	10.2	11.6	-	-
	-	-	-	-	3.0	5.0	5.5	3.4	5.0	5.0	2.7	-	7.4	-	-
	-	-	-	4.7	-	6.8	-	-	-	3.7	-	-	-	6.2	3.8
LOJTO	-	-	11.1	-	-	-	-	-	-	5.2	11.3	-	3.9	-	-
MACMA	-	-	6.9	4.9	3.1	2.0	-	-	-	5.9	6.5	6.2	3.6	-	1.9
	-	-	7.2	9.1	1.8	-	-	-	-	7.0	7.4	6.1	3.4	0.2	-
	-	-	4.8	-	-	-	-	-	-	1.5	3.7	5.2	0.7	-	1.4
	-	-	3.8	3.3	0.3	0.3	-	-	-	1.8	7.3	4.0	4.1	0.2	1.4
MARGR	-	-	4.6	3.9	9.3	0.8	-	-	-	-	-	-	-	6.7	1.4
MASMI	1.0	-	-	-	-	-	-	-	-	-	12.9	6.6	1.9	-	-
MOLSI	-	-	3.5	-	-	0.3	-	-	6.5	7.5	11.9	9.4	-	-	-
	-	-	3.8	-	-	-	-	-	6.4	6.3	12.6	8.2	-	-	0.2
	-	-	-	-	0.6	-	-	0.5	13.6	13.7	13.4	-	3.5	2.6	2.4
	3.0	-	-	-	1.4	-	-	0.7	13.6	13.7	13.3	-	4.3	3.1	3.0
	3.4	-	-	-	-	-	-	-	13.7	13.7	13.0	-	2.8	2.2	2.9
	3.6	-	-	-	1.0	-	-	1.2	13.7	13.7	13.7	-	5.0	3.1	3.4
MORJO	4.3	-	8.3	-	4.6	-	0.6	-	-	-	-	9.7	-	4.3	13.4
OCHPA	-	-	-	-	-	-	-	-	0.2	10.0	11.5	11.1	9.2	0.5	10.1
OTTMI	-	1.1	10.0	5.6	-	-	10.2	8.5	5.4	0.9	8.7	2.0	9.9	9.3	4.7
PERZS	7.8	-	-	-	-	-	-	-	-	2.3	1.6	4.3	10.0	4.3	6.6
ROTEC	2.6	-	-	-	-	-	-	1.4	13.4	13.4	12.5	-	3.8	-	-
SARAN	6.1	6.0	7.9	10.8	8.0	-	-	9.6	12.7	12.7	12.3	12.7	4.4	12.7	12.8
	7.3	6.0	7.6	12.0	8.1	-	-	9.7	12.5	12.5	12.0	12.5	4.8	12.6	12.6
	6.8	7.3	8.2	12.1	8.8	-	-	9.6	12.5	12.5	12.2	12.5	4.6	12.6	12.6
SCALE	-	-	-	-	-	-	-	-	4.5	9.7	6.0	4.2	4.9	-	-
SCHHA	0.2	-	-	-	0.7	-	-	7.6	-	8.3	-	-	-	8.7	3.8
SLAST	-	-	-	-	-	-	-	-	2.0	6.9	5.4	11.3	9.4	-	3.7
STOEN	7.7	0.2	-	0.2	3.5	1.1	4.2	-	8.8	13.3	9.5	6.9	13.2	3.3	13.5
	7.3	0.4	-	0.9	3.9	1.4	3.3	-	8.7	13.2	9.1	7.1	13.2	3.2	13.5
	9.1	-	-	2.1	3.8	1.0	2.2	-	8.9	12.8	8.9	7.4	13.2	3.3	13.5
STRJO	-	-	-	-	8.6	-	-	5.8	9.0	13.2	5.3	-	-	1.7	2.8
	-	0.4	-	3.8	9.8	-	-	7.4	9.4	13.2	4.9	-	-	1.1	2.9
	-	0.4	-	-	6.5	-	-	4.6	8.3	13.2	4.7	-	-	0.8	2.7
	-	-	-	-	7.6	-	-	4.9	9.6	13.2	5.3	-	-	1.7	3.2
TEPIS	-	-	-	-	-	-	-	-	-	2.1	9.6	13.2	-	-	12.6
	-	-	-	0.6	3.0	0.2	-	-	-	3.9	4.8	10.9	-	-	7.1
TRIMI	6.4	-	1.9	-	-	2.0	-	-	2.5	9.3	4.4	9.6	8.7	-	4.9
YRJIL	5.3	8.0	-	-	-	-	-	-	5.6	14.4	1.7	4.3	-	6.6	5.0
Sum	211.0	71.3	164.8	166.7	165.3	58.6	79.5	106.0	328.4	478.4	454.1	409.2	304.5	202.5	372.7

3. Results (Meteors)

November	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15
ARLRA	-	-	8	-	2	-	-	-	11	-	-	-	-	-	-
BANPE	11	2	-	-	-	-	11	21	-	-	-	-	-	-	-
BERER	-	-	-	-	-	18	-	-	-	-	-	-	-	-	-
	-	-	-	-	-	5	-	-	-	-	-	-	-	-	-
	-	-	-	-	-	9	-	-	-	-	-	-	-	-	-
BOMMA	36	27	20	-	29	28	-	16	43	-	-	3	1	-	-
BREMA	-	4	2	11	-	-	-	-	-	17	-	37	7	-	1
BRIBE	-	-	-	-	2	-	-	-	-	46	-	-	-	-	-
	-	-	7	6	2	-	-	13	1	41	-	-	-	-	47
CRIST	3	-	12	5	63	53	3	1	34	65	74	26	1	-	1
	-	-	17	30	51	14	1	-	19	37	59	17	2	8	13
	5	-	28	-	75	72	3	1	49	66	75	25	1	-	-
DONJE	62	33	31	-	24	26	1	-	-	-	-	3	1	-	-
ELTMA	-	-	13	-	48	52	-	-	-	-	30	15	-	-	19
GONRU	-	2	9	-	-	-	-	56	29	43	70	65	52	59	43
	-	11	12	-	-	-	-	44	42	51	55	65	54	54	42
	-	6	4	-	4	-	2	33	22	42	47	49	60	55	33
	-	7	6	-	-	-	-	39	34	52	49	63	51	44	35
GOVMI	22	11	-	-	19	8	42	29	2	-	-	-	5	-	-
	14	-	-	-	9	-	17	-	3	-	-	-	-	-	-
	16	-	-	-	3	6	22	8	2	-	-	-	1	-	-
HINWO	7	23	63	5	8	-	12	-	40	-	52	18	10	-	-
IGAAN	-	2	-	-	3	-	5	31	-	-	-	-	-	1	2
	-	5	-	-	-	14	40	-	6	3	21	-	-	-	-
	10	1	-	-	-	-	30	24	9	3	4	-	2	4	1
	-	1	-	-	4	1	3	2	-	1	-	-	-	-	1
JONKA	2	16	-	-	4	3	21	7	-	5	-	-	-	-	10
KACJA	18	-	-	-	-	9	6	-	-	-	-	-	-	-	-
	6	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	17	-	-	-	-	4	3	-	-	-	-	-	-	-	-
KERST	26	31	24	10	11	17	25	20	13	28	5	4	1	-	14
KISSZ	-	5	2	-	4	3	10	1	-	3	1	2	-	-	-
KOSDE	100	-	42	95	62	60	104	100	90	101	100	83	39	78	67
	146	-	119	121	79	131	122	106	7	113	107	110	23	-	67
	-	13	-	10	-	-	11	9	12	44	-	38	3	10	7
LOJTO	-	-	-	-	-	-	1	-	-	9	2	-	-	-	2
MACMA	20	11	-	3	-	-	1	32	-	-	1	-	-	54	7
	23	6	14	6	-	3	3	39	-	-	1	-	-	47	6
	12	4	10	4	-	3	2	18	-	-	-	-	-	28	6
	-	5	13	-	-	2	-	9	-	-	2	-	-	20	-
MARGR	7	40	27	37	11	6	11	37	35	36	39	23	22	-	-
MASMI	20	1	-	-	-	-	-	-	-	97	-	-	-	-	4
MOLSI	24	31	105	32	36	16	168	1	49	4	124	-	-	-	-
	4	13	31	10	12	7	34	1	11	2	34	-	-	-	-
	1	5	56	18	18	1	-	1	46	31	94	-	95	12	12
	4	7	38	17	12	1	-	3	37	27	79	-	74	3	8
	-	-	9	6	1	-	-	-	7	8	32	-	22	2	3
	3	7	74	14	16	-	-	5	40	27	104	-	102	4	-
MORJO	7	5	-	-	5	-	33	8	1	6	2	1	-	2	6
OCHPA	-	-	2	-	-	-	-	-	-	4	14	23	24	-	16
OTTMI	23	30	7	-	-	35	39	23	49	-	41	36	39	7	10
PERZS	73	15	-	2	52	17	88	39	32	-	-	-	10	-	46
ROTEC	-	-	10	7	-	-	-	1	17	8	22	-	11	-	2
SARAN	12	18	6	-	-	-	-	39	29	34	39	42	35	33	16
	12	17	5	-	-	-	-	28	21	28	30	51	32	43	20
	7	20	4	-	-	-	-	27	10	37	26	35	39	40	-
SCALE	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SCHHA	-	3	12	6	13	1	-	4	3	47	10	20	23	-	6
SLAST	7	-	-	-	-	3	-	-	-	-	-	-	-	-	-
STOEN	11	-	12	-	45	104	4	1	9	1	84	37	35	-	50
	9	-	13	-	41	74	5	-	5	1	55	27	19	-	25
	14	-	26	-	38	113	6	-	5	3	88	44	46	-	51
STRJO	-	-	4	9	6	-	-	-	4	36	9	3	34	-	-
	-	-	2	3	2	-	-	-	7	21	13	12	41	-	3
	-	-	1	2	2	-	-	-	2	11	3	4	19	-	4
	1	-	-	2	1	-	-	-	3	33	8	13	14	-	3
TEPIS	7	9	8	-	19	-	32	34	-	-	-	-	-	-	-
	12	19	2	-	27	-	66	32	-	3	3	-	6	-	5
TRIMI	-	6	-	-	2	35	24	1	1	-	-	-	-	-	-
YRJIL	-	2	-	-	7	5	-	-	-	30	31	-	28	-	-
Sum	814	474	910	471	872	959	1011	944	891	1305	1739	994	1084	608	714

November	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
ARLRA	-	-	-	-	-	-	-	-	16	15	11	-	-	-	-
BANPE	-	-	-	-	-	-	-	-	-	27	-	25	29	-	29
BERER	19	-	-	8	-	-	3	-	-	-	110	86	-	-	-
	3	-	-	2	-	-	4	-	-	-	46	33	-	-	-
	1	-	-	3	-	-	1	-	-	-	23	22	-	-	-
BOMMA	-	-	-	23	21	33	-	2	3	72	-	-	19	25	13
BREMA	-	-	-	28	7	-	-	5	9	4	-	-	-	4	5
BRIBE	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	7	-	-	3	2	-	-	16	12	47	-	-	-	4	-
CRIST	29	-	-	18	6	3	-	2	55	67	65	88	85	9	40
	50	-	-	7	5	36	-	-	30	47	32	41	50	4	49
	33	-	-	6	6	8	-	1	54	70	66	91	82	8	30
DONJE	-	-	-	14	17	42	-	-	7	68	-	-	26	25	20
ELTMA	43	-	-	-	-	-	-	-	-	-	-	-	-	-	64
GONRU	37	35	44	39	22	-	1	-	64	69	57	69	65	48	69
	37	47	52	64	20	-	1	-	51	50	62	68	49	48	66
	29	53	48	52	24	-	9	61	54	43	54	43	35	52	53
	30	47	46	61	20	-	1	-	39	51	49	46	40	44	54
GOVMI	17	1	8	-	-	3	-	-	1	-	-	-	-	-	42
	2	-	1	-	-	-	-	-	-	1	-	-	17	-	21
	1	-	1	-	-	-	-	-	2	5	-	-	22	-	19
HINWO	-	-	37	-	-	-	-	-	35	-	46	-	-	-	-
IGAAN	10	-	-	17	-	-	6	-	-	2	-	8	2	-	-
	2	-	-	7	-	-	7	2	1	4	17	34	2	1	44
	2	-	14	5	-	14	3	-	-	-	-	-	-	3	28
	1	-	-	-	10	-	2	-	-	3	6	14	-	-	6
JONKA	9	-	-	-	-	-	-	-	-	2	9	21	-	2	40
KACJA	-	-	-	-	-	-	-	-	-	-	-	80	79	-	73
	-	-	-	-	-	-	-	-	-	4	6	16	5	-	21
	-	-	-	-	-	-	-	-	-	-	-	67	74	3	59
KERST	11	-	-	-	-	-	-	-	-	-	-	-	-	-	-
KISSZ	8	1	-	1	-	-	5	-	2	-	4	8	2	-	13
KOSDE	-	8	6	21	66	86	74	98	83	106	31	73	73	-	-
	-	-	-	-	20	21	28	34	49	58	20	-	79	-	-
	-	-	-	12	-	11	-	-	-	4	-	-	-	16	9
LOJTO	-	-	22	-	-	-	-	-	-	7	32	-	8	-	-
MACMA	-	-	75	27	1	3	-	-	-	18	26	21	9	-	5
	-	-	37	14	2	-	-	-	-	20	21	12	19	1	-
	-	-	23	-	-	-	-	-	-	13	13	12	1	-	3
	-	-	33	21	2	2	-	-	-	15	13	6	10	1	5
MARGR	-	-	4	5	20	3	-	-	-	-	-	-	-	13	1
MASMI	2	-	-	-	-	-	-	-	-	-	81	55	13	-	-
MOLSI	-	-	3	-	-	1	-	-	151	47	192	72	-	-	-
	-	-	3	-	-	-	-	-	53	19	63	27	-	-	1
	-	-	-	-	1	-	-	2	131	151	99	-	12	13	11
	2	-	-	-	1	-	-	2	98	104	76	-	10	9	10
	1	-	-	-	-	-	-	-	34	25	20	-	3	2	4
	9	-	-	-	1	-	-	2	150	158	101	-	17	9	16
MORJO	6	-	13	-	14	-	1	-	-	-	-	17	-	3	47
OCHPA	-	-	-	-	-	-	-	-	1	22	30	36	34	1	33
OTTMI	-	6	38	10	-	-	45	37	10	1	35	13	41	31	22
PERZS	30	-	-	-	-	-	-	-	-	15	5	6	73	2	92
ROTEC	1	-	-	-	-	-	-	8	45	40	32	-	8	-	-
SARAN	27	8	27	32	9	-	-	33	34	34	33	43	12	32	49
	46	10	24	53	14	-	-	38	40	44	43	40	22	34	50
	17	11	25	32	14	-	-	26	26	28	36	29	11	31	37
SCALE	-	-	-	-	-	-	-	-	10	29	10	16	10	-	-
SCHHA	1	-	-	-	5	-	-	34	-	22	-	-	-	20	6
SLAST	-	-	-	-	-	-	-	-	15	14	10	14	33	-	12
STOEN	61	1	-	1	14	20	7	-	74	115	40	80	71	8	100
	50	3	-	6	21	15	9	-	62	105	28	54	108	6	102
	71	-	-	16	32	10	9	-	87	114	51	101	112	7	120
STRJO	-	-	-	-	35	-	-	13	52	70	10	-	-	6	20
	-	2	-	19	25	-	-	14	26	57	13	-	-	3	17
	-	3	-	-	12	-	-	12	11	26	4	-	-	1	15
	-	-	-	-	28	-	-	10	36	57	8	-	-	6	14
TEPIS	-	-	-	-	-	-	-	-	-	3	29	39	-	-	41
	-	-	-	2	26	1	-	-	-	34	37	52	-	-	42
TRIMI	10	-	2	-	-	4	-	-	6	16	14	20	32	-	16
YRJIL	18	39	-	-	-	-	-	-	23	60	2	16	-	24	22
Sum	733	275	586	629	523	316	216	452	1742	2302	1921	1714	1504	559	1780