Results of the IMO Video Meteor Network – August 2013

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August 2012 was a truly record-breaking month. Thanks to perfect observing conditions we recorded over 75,000 meteors in more than 10,500 hours of effective observing time – far more than in any month before. But also August 2013 was not bad. The weather was co-operative with most observers. 53 out of 71 operated cameras were successful in twenty and still 40 cameras in twenty-five and more observing nights. The number of cameras that did not miss a single night grew to six, distributed all over Europe: BILBO and STG38 (Italy), TEMPLAR1 and TEMPLAR3 (Portugal) as well as REMO1 and REMO3 (Germany).
If there weren't three cameras less than last year, we probably had obtained the same result. With over 72,000 meteors from 9,100 hours of effective observing time, it was just a few percent less.

Wolfgang Hinz has finished his relocation and his camera ACR resumed operation after a break of a few months just in time for the Perseids. It is observing now from Schwarzenberg / Saxony in the northern direction, so that the field of view is overlapping with the three southward facing cameras ARMEFA, LUDWIG1 and REMO2 in the Berlin area.
Furthermore, we can welcome the third lady in the IMO network. Jenni Donati from Italy is operating the camera JENNI. Even though her Mintron camera is equipped with a wide-angle lens of "only" f/1.2, Jenni could play in the "premier league" right from the start and contribute almost 2,000 meteor records in August. We keep our fingers crossed that she will be equally successful in the months to come.

Highlight of August were the Perseids just as every year. Figure 1 shows the flux density profile from the week around the maximum, composed from observations between 2011 and 2013. We are looking at a unique data set, because hardly any other shower can provide up to 10,000 meteor records in a single night. In total, almost 50,000 Perseids contributed to figure 1. Each data point represents at least two hours, hence it contains so many meteors that there is almost no scatter. At a zenith exponent of 1.9, the profiles of the individual years fit seamlessly to one another and yield a smooth graph, if we forget about a few outliers at the begin or end of a night. The activity profile teaches us that we missed the primary peak at 140° solar longitude in all three years. Whereas observation stopped just before the peak in 2011, it started right after the peak in 2013. Thus, the main peak should be within the European night time hours of 2014.

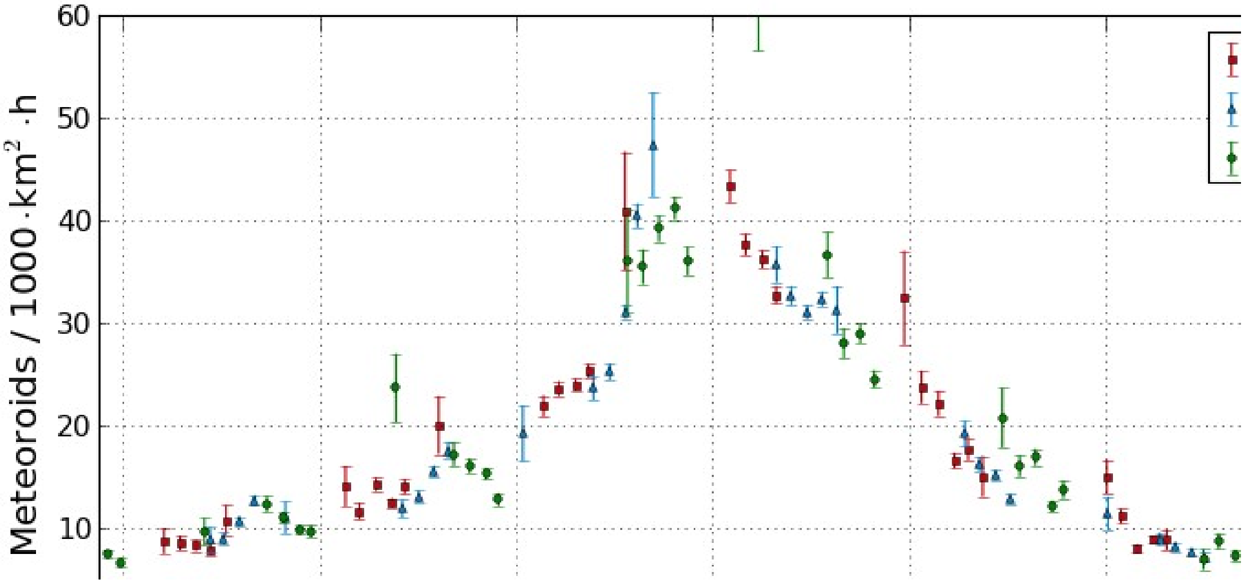

Figure 1: *Flux density profile of the Perseid peak in the years 2011 till 2013, obtained from almost 50,000 Perseids.*

Now to something completely different ...

At the last IMC, Jürgen Rendtel reminded us in his lecture to the importance of the population index r. The r-value describes the ratio between bright and faint meteors, or more specifically: How many more meteors there are up to magnitude class m+1, compared to magnitude class m. If the limiting magnitude of the observer (or video system) is close to 6.5 mag, the population index can be neglected, as it has virtually no impact on the ZHR or flux density. The stronger the limiting magnitude deviates from 6.5 mag, however, the more important becomes the use of the proper r-value.

Video observations have one disadvantage and one advantage: The disadvantage is, that they cover a broad spectrum of limiting magnitudes. Due to different camera sensitivities and objective lenses, we obtain limiting magnitudes between roughly 2 and 7 mag in the IMO network. So the chosen population index has a major influence on the calculated flux density. The advantage of video observations is, that they cover a broad spectrum of limiting magnitudes. ☺ This allows us to determine the population index with a completely new approach. Whereas current methods rely on the brightness distribution of meteors or at least their average brightness (relative to the limiting magnitude), our new approach does not need any meteor brightness measurements at all (which is good, because the photometry of meteors in MetRec is known to be quite inaccurate). But more about this new approach later on.

At first we shall analyze, how the population index impacts the flux density. Similar to visual quick look analyses, the MetRec Flux Viewer uses for each shower an average population index. The formula to calculate the flux density FD looks simplified as follows:

$$FD = MC * \cos(ZD^{\gamma}) / T_{eff} / \Sigma_{pix} (CA / r^{6.5-MLM})$$

with MC ... meteor count
ZD ... zenith distance of the radiant
γ ... zenith exponent
T_{eff} …effective observing time (in h)
CA … collection area of a pixel (in km^2 at the meteor layer)
r … population index
MLM … meteor limiting magnitude

The formula contains two ingredients: There are the „global“ parameters zenith distance, zenith exponent, meteor count and effective observing time, which are valid for the full field of view, and there are the „local“ parameters collection area and meteor limiting magnitude, which vary from pixel to pixel. The last two parameters have to be calculated for each pixel individually and accumulated later on. The closer a pixel lies at the horizon, for example, the larger is the collection area at the meteor layer (roughly at 100 km altitude depending on the meteor shower velocity), but the more distant is the meteor layer.

Unfortunately, the population index is part of the term that has to be accumulated pixel-wise. Since the r-value is unknown at the time of observation, we would need to store the meteor limiting magnitude for each pixel at each minute to be able to adjust the flux density once the correct population index is known later on. As the cameras are unguided, the collection area of each pixel remains nearly constant in the course of the night, but the distance to the meteor shower radiant changes, and thereby the apparent meteor velocity and the resulting loss in limiting magnitude, too.

We have checked whether we find an approximation that requires the storage of fewer parameters. As first order approximation we assumed, that the meteor limiting magnitude would be constant in the field of view (AVGMLM). Then we can take this fixed term out of the sum and obtain:

$$FD \approx MC * \cos(ZD^{\gamma}) / T_{eff} / r^{6.5-AVGMLM} / \Sigma_{pix} (CA)$$

If during the calculation of the flux density a population index x was assumed, and later on the correct value y was determined, the correction factor for the flux density CF_{xy} can be expressed as:

$$CF_{xy} = x^{6.5\text{-}AVGMLM} / y^{6.5\text{-}AVGMLM}$$

To evaluate how good or bad this approximation is, we used real observing data from REMO1 obtained on August 12/13 and 13/14, 2013. The first night was partly clouded and the limiting magnitude was changing heavily in the course of the night, whereas the second night was almost completely cloud-free. Figure 2 shows the effective collection area for active meteor showers in those two nights depending on the population index. A range of r between 1.5 and 3.5 was chosen. That is, for every minute, every pixel and every population index between 1.5 and 3.5 (in steps of 0.1), the collection area of the camera was calculated and accumulated over time. We see that the collection area varies up to a factor of ten if the population index changes strongly.

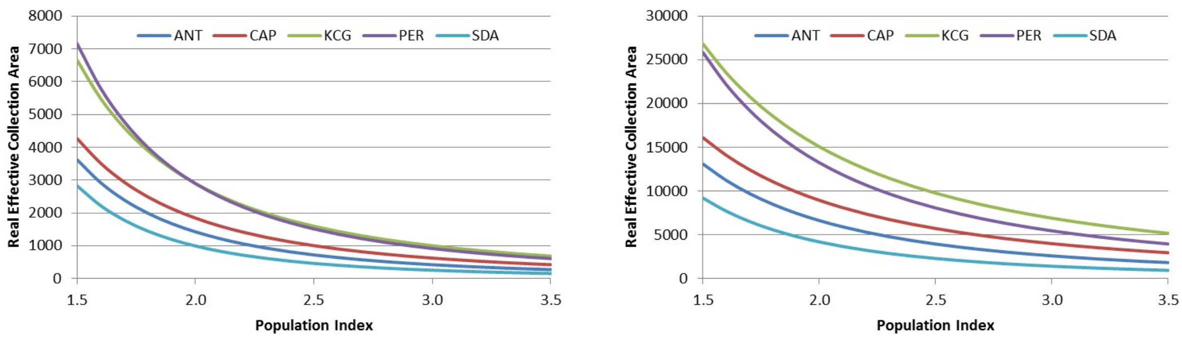

Figure 2: *Effective collection area of REMO1 for different meteor showers on August 12/13 (left) and 13/14, 2013 (right) depending on the population index.*

If the described approximation is applied, the graphs look similar. Thus, we do not present the absolute values in figure 3, but rather the relative errors between the approximated and the original values from figure 2.

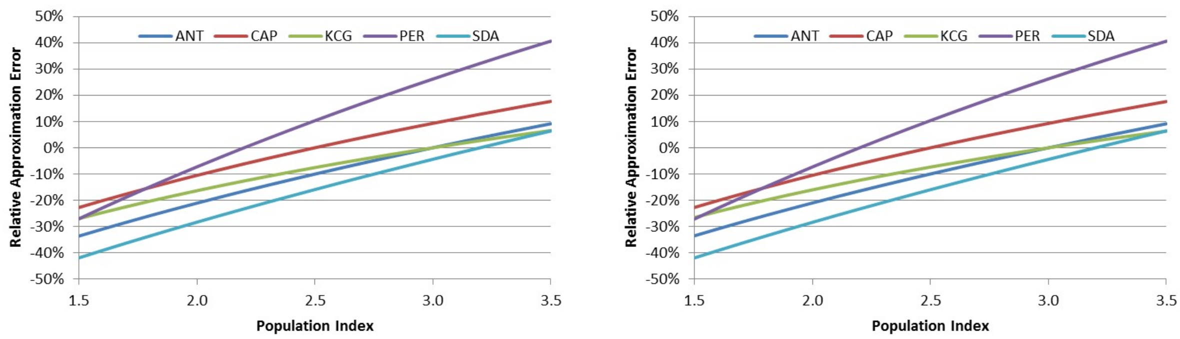

Figure 3: *Relative approximation error, if the pixel-wise limiting meteor magnitude is replaced by an averaged value. Calculated for the data of REMO1 on August 12/13 (left) and 13/4, 2013 (right).*

For each shower, the relative error becomes zero at a different population index, as there were different initial r-values chosen. In the typical range for r-values, the error is less than 15% but in extreme cases it may become as big as 50%. The error is nearly independent of the observing conditions as can be seen when comparing both nights.

In the second order approximation we used the fact that the dependency between the collection area and the r-value (figure 2) can be expressed by a power law function of the type:

$$CA = a * r^b$$

If the collection area is summed up independently for each r-value in the course of the night, we can later estimate the parameters a and b of a power law function that describes the dependency of the collection area (resp. flux density) from the population index. In figure 4, we compare the values derived by this improved approximation with the original values from figure 2. The error has reduced by one order of magnitude in this example. In extreme cases (poor observing conditions, strong deviation of the population index) it may reach 5% - under real conditions it is hardly ever larger than 2%.

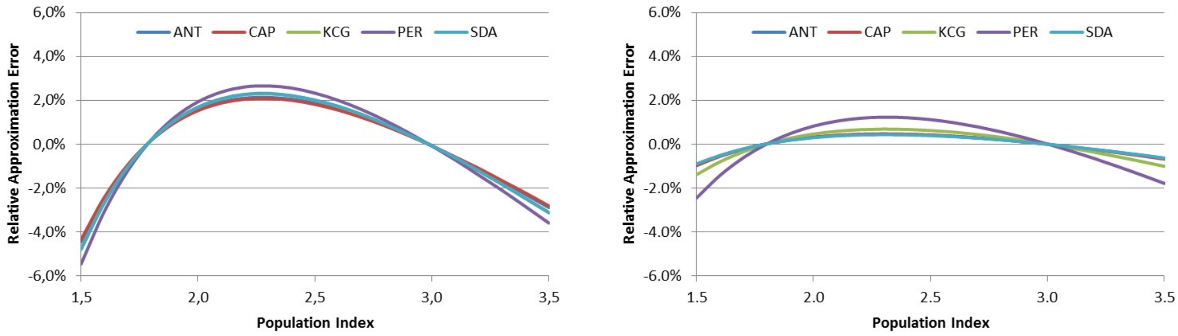

Figure 4: *Relative approximation error, when the dependency of the collection area from the population index is approximated by a power law function. Calculated for the data of REMO1 on August 12/13 (left) and 13/4, 2013 (right).*

Finally the approach was improved once more by computing the power law function not from the collection area accumulated over the full night, but individually for each minute of observation (figure 5). This way, the relative error can be reduced by roughly a factor of three again. In the example of REMO1, it was 1.5% at most (independent of the observing conditions, because the fit is calculated for each minute individually), and less than half a percent for typical deviations of the population index. This error is clearly smaller than other rounding and systematic errors which are introduced during the calculation of the flux density (e.g. when the stellar limiting magnitude is calculated over the full field of view).

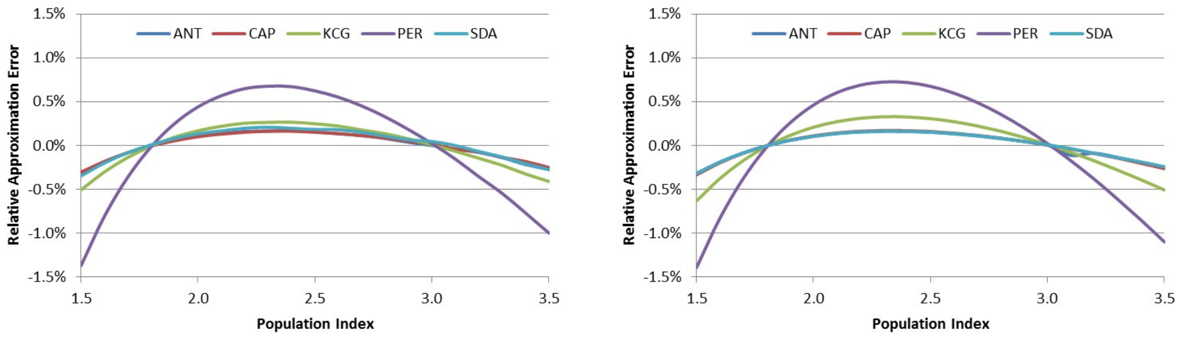

Figure 5: *Relative approximation error,when the dependency of the collection area from the population index is approximated by a power law function every minute. Calculated for the data of REMO1 on August 12/13 (left) and 13/14, 2013 (right).*

What does that mean in practice: As before, MetRec calculates for every minute the limiting magnitude and the effective collection area of all pixels, however, not just for the average shower-dependent population index, but rather for different r-values between 1.5 and 3.5. With a least squares algorithm, the parameters a and b of a power law function are determined such that the dependency of the collection area (and thereby also flux density) is approximated. If the flux density was determined with the initial population index x, but shall be adjusted later for the correct r-value y, the correction factor CF_{xy} becomes:

$$CF_{xy} = x^b / y^b$$

The scaling factor a of the power law function can even be omitted, because it can be derived easily when both the collection area and the exponent b are stored. So every minute, MetRec computes beside the current parameters like the limiting magnitude, collection area and radiant altitude an additional exponent b. It allows for the precise correction of the collection area resp. flux density once the proper population index is known.

Let's finally come back to our new approach on the calculation of the population index without knowing the meteor brightness or brightness distribution. Each camera "samples" the meteor population at a different limiting magnitude. Via the approximation described above we can calculate for each camera, how the flux density depends on the population index. Based on data sets of different cameras we simply have to determine that r-value at which the flux densities of the different cameras match best to one another!

Even though the correction function x^b / y^b looks trivial at the first glimpse, we did not find a closed-form solution for the optimization problem. So in practice we plan to determine the best population index by an iterative approximation. The procedure requires that there are no camera-dependent properties which systematically influence the flux density. So whether the r-values determined by our new approach are really useful has still to be shown in practice.

1. Observers

Code	Name	Place	Camera	FOV [°²]	St.LM [mag]	Eff.CA [km²]	Nights	Time [h]	Meteors
BANPE	Bánfalvi	Zalaegerszeg/HU	HUVCSE01 (0.95/5)	2423	3.4	361	19	97.7	557
BERER	Berkó	Ludanyhalaszi/HU	HULUD1 (0.8/3.8)	5542	4.8	3847	24	143.1	2413
			HULUD2 (0.95/4)	3398	3.8	671	22	140.4	829
			HULUD3 (0.95/4)	4357	3.8	876	24	139.6	518
BIRSZ	Biro	Agostyan/HU	HUAGO (0.75/4.5)	2427	4.4	1036	27	150.3	848
BOMMA	Bombardini	Faenza/IT	MARIO (1.2/4.0)	5794	3.3	739	30	169.0	2155
BREMA	Breukers	Hengelo/NL	MBB3 (0.75/6)	2399	4.2	699	14	74.6	504
			MBB4 (0.8/8)	1470	5.1	1208	25	135.2	566
BRIBE	Klemt	Herne/DE	HERMINE (0.8/6)	2374	4.2	678	27	149.1	744
		Berg. Gladbach/DE	KLEMOI (0.8/6)	2286	4.6	1080	28	135.4	836
CRIST	Crivello	Valbrevenna/IT	BILBO (0.8/3.8)	5458	4.2	1772	31	200.1	1988
			C3P8 (0.8/3.8)	5455	4.2	1586	30	188.0	1499
			STG38 (0.8/3.8)	5614	4.4	2007	31	203.7	2241
DONJE	Donani	Faenza/IT	JENNI (1.2/4)	5886	3.9	1222	24	142.1	1909
ELTMA	Eltri	Venezia/IT	MET38 (0.8/3.8)	5631	4.3	2151	27	172.3	1611
GONRU	Goncalves	Tomar/PT	TEMPLAR1 (0.8/6)	2179	5.3	1842	31	233.5	1165
			TEMPLAR2 (0.8/6)	2080	5.0	1508	30	234.2	1327
			TEMPLAR3 (0.8/8)	1438	4.3	571	31	225.9	967
			TEMPLAR4 (0.8/3.8)	4475	3.0	442	28	220.0	1437
GOVMI	Govedic	Sredisce ob Dr./SI	ORION2 (0.8/8)	1447	5.5	1841	28	153.0	1273
			ORION3 (0.95/5)	2665	4.9	2069	23	124.4	649
			ORION4 (0.95/5)	2662	4.3	1043	27	141.0	852
HINWO	Hinz		ACR (2.0/35)*	557	7.3	5002	19	74.5	571
IGAAN	Igaz	Baja/HU	HUBAJ (0.8/3.8)	5552	2.8	403	26	78.4	321
		Debrecen/HU	HUDEB (0.8/3.8)	5522	3.2	620	27	170.4	1251
		Hodmezovasar./HU	HUHOD (0.8/3.8)	5502	3.4	764	29	136.0	828
		Budapest/HU	HUPOL (1.2/4)	3790	3.3	475	25	128.0	378
KACJA	Kac	Kamnik/SI	CVETKA (0.8/3.8)	4914	4.3	1842	15	109.8	1544
		Kostanjevec/SI	METKA (0.8/12)*	715	6.4	640	12	91.1	650
		Ljubljana/SI	ORION1 (0.8/8)	1402	3.8	331	20	82.2	437
		Kamnik/SI	REZIKA (0.8/6)	2270	4.4	840	16	108.0	1654
			STEFKA (0.8/3.8)	5471	2.8	379	16	103.0	1288
KOSDE	Koschny	Izana Obs./ES	ICC7 (0.85/25)*	714	5.9	1464	20	176.7	1484
		La Palma / ES	ICC9 (0.85/25)*	683	6.7	2951	26	177.7	2494
		Noordwijkerhout/NL	LIC4 (1.4/50)*	2027	6.0	4509	20	101.7	810
MACMA	Maciejewski	Chelm/PL	PAV35 (1.2/4)	4383	2.5	253	29	165.2	729
			PAV36 (1.2/4)*	5732	2.2	227	28	177.2	1107
			PAV43 (0.95/3.75)*	2544	2.7	176	27	155.5	528
MARGR	Maravelias	Lofoupoli/GR	LOOMECON (0.8/12)	738	6.3	2698	21	147.3	871
MASMI	Maslov	Novosimbirsk/RU	NOWATEC (0.8/3.8)	5574	3.6	773	4	13.4	111
MOLSI	Molau	Seysdorf/DE	AVIS2 (1.4/50)*	1230	6.9	6152	11	51.2	1059
			MINCAM1 (0.8/8)	1477	4.9	1084	26	134.1	671
		Ketzür/DE	REMO1 (0.8/8)	1467	5.9	2837	31	158.5	1761
			REMO2 (0.8/8)	1478	6.3	4467	30	158.0	1171
			REMO3 (0.8/8)	1420	5.6	1967	31	149.0	442
MORJO	Morvai	Fülöpszallas/HU	HUFUL (1.4/5)	2522	3.5	532	30	167.3	916
OTTMI	Otte	Pearl City/US	ORIE1 (1.4/5.7)	3837	3.8	460	22	89.0	645
PERZS	Perkó	Becsehely/HU	HUBEC (0.8/3.8)*	5498	2.9	460	14	88.4	1336
PUCRC	Pucer	Nova vas nad Dra./SI	MOBCAM1 (0.75/6)	2398	5.3	2976	17	106.7	1213
ROTEC	Rothenberg	Berlin/DE	ARMEFA (0.8/6)	2366	4.5	911	11	46.0	298
SARAN	Saraiva	Carnaxide/PT	RO1 (0.75/6)	2362	3.7	381	26	182.4	762
			RO2 (0.75/6)	2381	3.8	459	28	224.3	1059
			SOFIA (0.8/12)	738	5.3	907	25	194.9	672
SCALE	Scarpa	Alberoni/IT	LEO (1.2/4.5)*	4152	4.5	2052	27	143.6	1185
SCHHA	Schremmer	Niederkrüchten/DE	DORAEMON (0.8/3.8)	4900	3.0	409	28	131.8	860
SLAST	Slavec	Ljubljana/SI	KAYAK1 (1.8/28)	563	6.2	1294	22	130.7	413
STOEN	Stomeo	Scorze/IT	MIN38 (0.8/3.8)	5566	4.8	3270	30	172.0	2337
			NOA38 (0.8/3.8)	5609	4.2	1911	29	172.5	2135
			SCO38 (0.8/3.8)	5598	4.8	3306	29	170.4	2425
STORO	Stork	Kunzak/CZ	KUN1 (1.4/50)*	1913	5.4	2778	4	23.3	821
		Ondrejov/CZ	OND1 (1.4/50)*	2195	5.8	4595	5	31.7	1353
STRJO	Strunk	Herford/DE	MINCAM2 (0.8/6)	2362	4.6	1152	25	110.5	475
			MINCAM3 (0.8/12)	2338	4.5	1199	29	111.1	879
			MINCAM4 (1.0/2.6)	9791	2.7	552	21	57.3	352
			MINCAM5 (0.8/6)	2349	5.0	1896	26	129.6	798
TEPIS	Tepliczky	Budapest/HU	HUMOB (0.8/6)	2388	4.8	1607	26	146.0	1284
YRJIL	Yrjölä	Kuusankoski/FI	FINEXCAM (0.8/6)	2337	5.5	3574	24	94.5	589
Sum							31	9143.5	71855

* active field of view smaller than video frame

2. Observing Times (h)

August	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15
BANPE	-	-	5.2	2.6	6.3	6.2	6.3	2.3	-	7.1	5.2	7.4	-	-	6.5
BERER	6.9	7.1	7.0	2.9	7.1	7.2	7.3	5.4	3.4	1.0	7.2	7.1	0.3	6.6	7.8
	7.0	7.1	5.6	2.8	7.3	7.3	7.4	5.5	3.9	1.1	7.5	7.4	-	5.9	7.9
	7.0	7.1	5.3	2.8	7.3	7.3	7.4	5.3	3.6	0.9	7.5	7.5	1.1	6.1	7.9
BIRSZ	6.8	6.9	7.0	2.5	7.1	7.1	7.2	7.3	1.0	4.8	1.0	6.6	-	6.2	7.7
BOMMA	0.7	3.5	4.3	3.6	7.7	7.7	3.1	4.4	2.0	8.1	8.3	8.2	8.2	7.8	8.3
BREMA	6.3	6.3	6.4	6.5	5.9	6.6	-	6.2	5.4	1.3	4.4	3.2	-	7.0	6.7
	6.3	6.3	6.4	6.5	5.1	6.4	-	6.1	3.5	1.3	4.1	3.5	-	5.1	6.9
BRIBE	6.4	5.2	5.7	5.8	5.2	6.8	-	6.5	4.6	7.0	2.5	2.2	7.0	6.8	7.2
	6.2	2.6	4.1	6.6	3.2	6.5	-	4.9	4.3	3.7	5.1	2.1	7.2	7.2	3.7
CRIST	7.3	7.4	5.8	7.5	7.5	7.4	5.8	1.3	7.8	7.8	7.8	7.9	3.3	6.5	8.1
	-	7.4	4.9	4.6	5.7	7.4	4.2	0.7	7.8	7.8	7.9	7.9	0.5	8.0	8.1
	7.3	7.4	5.5	7.5	7.5	7.4	6.5	1.0	7.8	7.8	7.8	7.9	3.4	6.9	8.1
DINJE	-	-	-	-	-	5.4	3.5	3.1	2.1	7.5	8.0	8.1	7.5	6.7	7.2
ELTMA	7.7	7.6	7.8	7.8	7.7	7.2	6.0	4.3	-	7.9	8.1	8.1	5.7	6.2	8.4
GONRU	6.0	8.2	8.2	8.3	8.3	7.8	8.3	8.3	8.3	8.5	6.2	4.5	8.4	8.7	3.1
	6.3	6.2	7.6	8.3	8.3	7.2	8.4	8.4	8.5	8.5	6.1	4.5	8.7	8.7	3.4
	4.9	8.1	8.1	8.2	8.2	6.9	8.3	8.3	8.3	8.3	4.6	3.2	8.7	8.6	2.6
	-	-	8.3	8.3	8.1	6.9	8.3	8.4	8.5	8.5	6.2	4.5	8.7	8.7	3.2
GOVMI	6.4	4.8	6.2	6.7	7.3	7.4	7.5	7.4	0.8	7.4	7.8	7.8	-	2.8	5.3
	6.6	1.9	5.3	2.8	6.7	7.5	7.6	5.2	3.3	7.2	7.8	8.0	-	-	-
	6.6	2.4	5.7	6.1	7.3	7.4	7.5	4.9	0.8	7.2	7.7	7.8	-	2.3	7.0
HINWO	4.8	5.3	3.4	2.5	5.4	-	-	-	-	1.5	-	-	-	5.2	4.1
IGAAN	0.4	0.9	0.2	0.3	0.8	1.5	0.8	-	2.0	-	-	-	1.5	0.2	8.0
	4.6	7.1	7.1	7.2	7.2	7.4	7.3	6.6	6.9	4.7	7.7	7.7	6.0	0.4	7.8
	6.3	6.1	6.9	7.0	7.4	7.5	7.6	7.4	2.0	2.7	7.6	7.8	3.4	2.0	7.2
	6.9	7.0	6.9	2.7	7.1	7.1	7.1	7.3	0.9	2.7	7.5	7.5	-	4.4	7.7
KACJA	7.0	7.1	7.2	7.2	7.2	-	-	-	-	-	7.3	7.9	-	-	8.0
	-	7.3	7.2	-	7.4	7.4	7.4	-	-	7.2	7.3	7.9	-	-	8.2
	1.9	2.4	2.7	2.4	-	7.5	3.4	3.9	0.3	7.7	-	8.0	-	-	7.9
	1.7	7.6	7.5	7.1	7.7	-	-	-	-	-	7.4	7.8	-	-	8.2
	7.2	7.3	7.4	6.5	6.7	-	-	-	-	-	7.5	7.9	-	-	8.3
KOSDE	-	6.8	8.6	-	8.2	8.9	8.8	9.0	9.0	-	-	-	9.1	9.1	9.2
	7.8	8.1	8.3	-	6.3	8.3	7.9	7.8	8.8	8.5	9.1	-	6.6	7.6	8.9
	5.5	3.6	5.7	-	3.0	5.3	-	-	-	-	4.7	2.5	-	6.4	6.4
MACMA	4.1	6.3	7.0	4.6	7.0	7.1	7.3	7.4	6.3	-	7.0	2.5	6.3	7.5	7.7
	4.5	6.1	6.8	4.6	6.7	6.8	7.0	7.0	7.2	-	6.9	3.0	6.8	7.4	7.3
	3.5	5.7	6.5	3.4	6.0	5.6	6.3	6.1	5.4	-	6.2	2.6	6.2	7.3	5.9
MARGR	-	-	-	-	-	1.4	2.9	8.6	1.5	6.5	7.9	8.8	6.4	8.7	7.7
MASMI	-	4.1	1.0	4.1	-	-	-	-	-	4.2	-	-	-	-	-
MOLSI	6.1	6.2	1.7	6.3	3.2	-	-	-	-	4.7	2.0	3.4	3.1	-	-
	6.9	7.0	1.7	7.1	3.8	3.5	2.8	1.6	4.0	4.8	0.9	4.3	4.6	4.1	7.8
	6.1	6.1	3.5	6.0	6.0	1.9	1.6	1.0	6.6	4.1	6.0	2.5	7.1	7.1	0.4
	6.2	6.2	3.1	6.3	6.4	2.4	1.8	1.6	6.6	3.9	6.2	2.6	7.1	7.0	0.8
	6.2	6.3	2.0	6.3	6.4	1.8	0.8	0.9	6.6	3.5	5.7	2.4	7.1	6.7	0.4
MORJO	7.3	7.2	7.4	7.1	6.0	7.4	7.5	7.5	3.2	4.3	7.6	7.7	2.0	1.6	7.5
OTTMI	3.9	2.8	4.2	1.1	2.2	6.4	4.2	4.2	4.3	-	-	7.1	6.0	1.4	2.8
PERZS	-	7.3	7.4	7.3	-	7.5	7.6	7.6	-	-	-	7.9	-	1.3	8.1
PUCRC	7.3	7.2	-	2.5	-	6.8	7.6	4.6	-	-	7.0	8.2	-	-	-
ROTEC	-	6.0	3.3	1.6	6.1	-	-	1.7	6.1	1.5	5.0	1.1	6.6	7.0	-
SARAN	6.2	8.3	7.8	6.8	3.2	5.8	5.9	8.5	4.3	8.4	8.7	6.3	8.7	7.6	8.7
	6.0	7.8	8.2	7.6	3.5	8.3	6.1	7.7	7.5	8.3	8.4	6.5	8.5	8.5	8.6
	5.8	8.0	8.1	6.9	2.8	8.1	6.2	8.3	-	8.4	8.4	4.9	8.5	8.4	8.6
SCALE	7.2	6.2	6.6	7.4	6.8	7.2	3.7	2.4	-	7.1	6.7	7.5	3.0	2.8	7.5
SCHHA	5.9	2.8	4.5	3.7	5.5	6.5	-	5.4	4.3	1.5	7.3	2.4	5.2	2.1	7.2
SLAST	6.5	6.4	6.9	6.2	7.2	7.2	7.2	5.1	4.0	4.1	5.5	7.0	-	4.5	5.8
STOEN	7.6	7.6	7.4	7.7	7.7	7.8	6.9	2.6	0.4	8.0	8.2	8.1	6.1	7.8	8.3
	7.7	7.6	7.5	7.7	7.7	7.8	7.4	2.8	-	8.1	8.2	8.2	6.6	6.2	8.0
	7.7	7.3	7.5	7.2	7.3	7.9	5.8	2.5	0.5	8.1	8.2	8.2	6.1	6.9	8.3
STORO	-	-	-	-	6.5	-	-	-	-	7.2	7.2	2.4	-	-	-
	-	-	-	-	6.2	-	-	-	-	6.2	6.6	5.5	-	7.2	-
STRJO	5.6	5.7	5.3	5.9	1.9	5.5	-	5.2	2.8	3.0	2.7	4.1	6.4	6.7	2.2
	5.6	5.7	4.8	5.9	2.2	5.2	0.2	4.9	2.7	2.8	2.5	4.4	5.8	6.7	2.2
	3.5	2.1	1.9	3.0	1.1	2.8	-	3.4	1.8	0.9	1.8	3.5	1.9	4.2	0.6
	5.6	5.5	4.8	5.9	2.2	5.9	-	5.4	2.9	3.0	2.6	4.4	5.8	6.7	2.2
TEPIS	6.6	-	7.0	2.5	7.0	7.1	7.2	7.3	0.4	4.1	7.1	5.8	-	6.9	4.5
YRJIL	-	1.7	2.9	3.0	2.9	3.4	-	0.6	-	1.7	1.9	4.2	-	-	-
Sum	316.4	357.3	356.3	317.3	360.7	371.0	284.9	289.1	215.0	294.1	375.3	357.9	247.2	328.4	374.1

August	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
BANPE	7.3	6.5	6.8	1.1	-	0.6	2.2	-	-	-	-	-	-	6.7	6.7	4.7
BERER	7.9	7.9	7.9	5.4	1.6	-	7.7	5.3	-	-	-	7.3	-	-	7.8	-
	7.9	7.3	7.9	6.6	-	-	6.7	5.8	-	-	-	6.9	-	-	7.6	-
	7.9	7.9	7.9	5.0	1.8	-	6.0	4.3	-	-	-	6.9	-	-	7.8	-
BIRSZ	7.7	7.8	7.9	1.1	-	8.0	8.0	2.4	-	-	5.8	2.9	1.4	5.9	8.6	3.6
BOMMA	8.2	8.3	8.4	-	3.2	7.6	8.5	2.3	1.4	3.9	3.1	5.1	5.2	5.9	5.3	6.7
BREMA	-	-	2.4	-	-	-	-	-	-	-	-	-	-	-	-	-
	-	-	2.1	3.6	6.1	7.7	-	3.5	-	7.6	6.1	2.3	8.1	8.1	5.6	6.9
BRIBE	3.1	-	-	5.8	7.6	7.8	-	7.6	0.3	6.8	1.6	2.8	8.3	8.2	4.8	5.5
	3.9	1.5	-	7.4	7.4	7.6	1.5	7.8	1.4	2.3	3.2	3.6	8.1	-	5.1	7.2
CRIST	8.1	8.2	8.2	2.8	8.3	8.4	7.4	3.8	1.8	2.1	2.5	4.5	8.5	8.7	8.7	8.9
	8.1	8.2	8.2	3.9	8.3	8.4	8.5	4.0	3.1	2.8	1.3	5.1	8.6	8.8	8.9	8.9
	8.1	8.2	8.2	4.7	8.3	8.4	8.4	4.7	1.4	1.6	1.1	6.7	8.1	8.4	8.7	8.9
DINJE	5.9	6.6	6.5	-	1.8	5.0	5.2	3.5	2.7	5.2	5.6	7.8	9.0	9.3	8.9	-
ELTMA	8.4	8.5	6.8	-	3.1	6.3	6.1	1.8	-	-	4.8	2.6	3.3	5.0	6.4	8.7
GONRU	7.6	3.0	8.8	8.9	8.5	3.1	7.4	2.7	8.8	8.7	9.1	9.2	8.8	9.1	9.3	9.4
	7.8	6.6	8.9	8.9	8.9	4.7	6.1	-	8.8	8.8	9.2	9.3	9.2	9.2	9.4	9.3
	6.4	5.7	8.9	8.8	8.7	3.9	7.6	1.5	8.8	8.8	8.9	7.9	7.7	9.0	9.0	9.0
	7.8	6.1	8.9	8.9	8.9	3.9	6.7	-	8.9	8.9	9.2	9.3	7.9	9.1	9.4	9.5
GOVMI	8.0	8.0	8.1	2.4	0.5	0.2	4.1	2.2	5.1	-	0.9	-	1.5	8.8	8.8	8.8
	8.1	8.2	7.7	2.2	0.2	-	3.5	-	3.6	-	1.1	-	2.1	8.9	8.9	-
	8.0	8.1	8.0	1.8	0.2	0.6	4.2	-	1.3	-	0.5	-	1.3	8.8	8.8	8.7
HINWO	5.9	3.2	-	-	0.2	2.2	4.5	3.2	3.9	-	2.3	-	6.1	7.1	3.7	-
IGAAN	7.9	6.2	8.1	2.9	-	3.2	4.1	0.3	2.1	1.2	3.2	0.8	0.4	4.4	8.2	8.8
	7.9	7.9	7.9	8.0	7.1	2.0	7.7	6.5	3.9	-	-	-	-	3.1	6.0	6.7
	5.6	3.5	6.0	5.0	-	1.1	2.9	0.7	0.5	0.6	0.6	2.4	-	2.7	7.9	7.6
	7.7	7.7	7.8	2.6	-	4.9	7.6	0.6	-	-	0.4	0.8	-	-	2.3	2.8
KACJA	8.0	8.1	8.0	-	-	-	-	-	-	-	-	-	2.7	8.6	8.0	7.5
	8.2	7.2	8.4	-	-	-	-	-	-	-	-	-	-	-	-	-
	2.9	8.2	4.8	-	-	-	1.4	-	-	-	-	1.4	1.5	4.4	5.7	3.8
	8.1	8.2	8.1	-	-	-	-	-	-	-	-	0.8	3.1	8.7	8.3	7.7
	8.4	8.4	8.5	-	-	-	-	-	-	-	-	0.8	1.3	8.2	5.9	2.7
KOSDE	9.2	5.4	9.3	-	-	-	-	-	-	8.7	9.4	9.5	9.6	9.6	9.6	9.7
	9.1	8.3	7.1	0.5	-	-	-	2.2	2.4	4.5	4.1	5.7	6.3	7.4	7.8	8.3
	-	-	2.2	2.8	6.2	6.4	-	-	2.9	6.8	6.8	5.2	6.9	6.9	-	5.5
MACMA	7.4	7.1	6.5	3.5	3.0	-	4.0	1.4	7.8	8.3	3.8	7.0	1.0	1.6	8.3	6.4
	7.5	7.7	7.6	6.3	6.7	-	5.9	3.4	7.6	7.1	4.0	7.4	2.1	-	8.2	7.6
	7.3	6.9	-	5.1	6.9	-	5.5	3.3	8.1	7.2	3.7	7.2	1.7	-	8.5	7.4
MARGR	6.8	5.0	4.8	-	-	5.8	7.2	-	-	-	9.5	9.5	9.5	9.6	9.6	9.6
MASMI	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MOLSI	-	-	-	-	-	-	-	-	-	-	-	-	-	7.9	6.6	-
	7.8	7.9	-	3.2	5.9	8.2	6.6	6.4	-	3.7	-	-	3.9	8.6	7.0	-
	7.1	4.1	4.8	0.4	1.8	7.4	6.4	7.6	7.3	7.7	6.9	4.5	7.3	7.6	4.3	7.3
	7.0	3.8	4.5	-	1.3	5.9	4.8	7.7	7.5	7.6	7.2	5.7	7.7	8.1	3.6	7.4
	6.9	3.6	3.8	0.3	1.6	7.0	6.7	7.8	7.7	8.0	7.1	4.2	7.0	7.8	1.9	4.5
MORJO	7.7	7.8	7.8	3.2	-	7.5	5.6	1.0	1.9	1.1	2.8	3.7	3.6	4.8	8.8	8.7
OTTMI	3.9	3.4	3.6	2.7	-	-	-	6.8	7.2	5.0	2.6	-	3.2	-	-	-
PERZS	-	-	8.1	0.9	-	-	-	-	8.2	-	1.2	-	-	-	-	8.0
PUCRC	-	-	5.4	-	4.2	8.1	3.1	-	-	-	-	3.2	5.7	8.6	8.6	8.6
ROTEC	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SARAN	8.6	8.9	8.9	6.0	3.1	-	-	-	5.4	-	7.2	7.3	-	5.1	8.4	8.3
	8.5	8.6	8.8	-	8.1	-	8.9	-	8.6	8.4	8.2	8.8	9.0	8.9	8.9	9.1
	7.9	7.4	7.5	-	-	-	-	-	8.6	8.7	8.2	9.1	9.2	9.2	8.6	9.1
SCALE	8.0	8.1	7.2	-	3.5	5.4	6.9	2.1	-	-	3.4	0.9	0.6	3.1	5.0	7.3
SCHHA	-	0.6	0.7	6.4	6.5	7.7	2.3	2.4	0.5	5.7	-	6.7	7.2	7.7	6.3	6.8
SLAST	7.9	7.8	7.8	-	-	-	5.8	-	-	-	-	-	1.9	6.3	3.8	5.8
STOEN	8.3	8.4	7.5	0.2	2.7	8.6	8.0	2.3	-	0.2	4.3	1.6	2.2	2.5	4.3	8.7
	8.4	8.5	8.2	0.3	2.5	8.5	8.0	3.7	-	0.4	4.2	1.6	2.1	1.5	4.2	8.9
	8.4	8.4	8.3	0.2	3.6	8.5	8.3	3.8	-	-	4.2	1.3	1.2	1.3	4.6	8.8
STORO	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
STRJO	3.8	-	-	0.2	7.0	5.3	-	7.3	0.3	7.0	7.6	2.5	-	-	2.2	4.3
	3.8	0.2	1.2	0.3	6.5	4.5	-	4.8	-	7.3	7.6	1.8	4.9	1.2	1.2	4.2
	0.8	-	-	0.2	1.5	1.3	-	7.2	-	6.2	7.6	-	-	-	-	-
	3.7	0.4	-	-	7.0	4.3	-	7.4	-	6.2	7.6	2.8	7.8	7.7	4.0	7.8
TEPIS	7.7	7.8	7.7	0.7	-	5.7	7.9	3.1	-	-	5.6	2.5	2.0	7.6	8.6	5.6
YRJIL	3.7	-	3.0	4.5	2.2	2.7	4.3	5.9	6.0	5.9	5.4	5.8	6.0	5.5	6.0	5.3
Sum	394.0	347.3	368.4	155.7	192.5	224.4	260.2	172.1	165.8	201.0	230.7	232.7	251.8	341.2	389.4	371.3

3. Results (Meteors)

August	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15
BANPE	-	-	18	10	28	22	29	8	-	63	38	145	-	-	36
BERER	108	139	123	12	168	122	143	64	8	4	391	327	1	147	153
	32	39	42	7	43	41	40	30	7	2	133	116	-	50	51
	26	23	20	6	29	23	31	11	7	3	92	86	2	31	25
BIRSZ	39	46	44	10	49	52	43	53	2	60	6	108	-	54	46
BOMMA	9	65	45	48	72	79	28	35	21	149	253	321	171	114	96
BREMA	47	37	42	42	42	50	-	37	26	16	48	36	-	47	29
	47	21	41	23	23	41	-	42	15	4	36	33	-	31	42
BRIBE	48	16	25	31	25	42	-	44	22	72	33	20	83	43	31
	47	9	29	61	15	51	-	31	17	21	88	17	101	55	20
CRIST	70	73	51	70	75	66	61	10	110	156	221	304	22	94	92
	-	54	26	32	56	60	34	10	91	95	184	238	3	93	63
	90	87	54	92	92	83	71	10	111	139	215	318	22	89	90
DONJE	-	-	-	-	-	75	39	28	14	166	248	323	165	103	102
ELTMA	53	65	53	69	51	51	30	27	-	127	232	257	81	99	74
GONRU	22	56	46	44	43	62	61	66	74	56	57	37	94	60	10
	33	69	65	54	63	53	61	72	65	95	52	48	101	57	14
	34	47	50	50	53	39	57	47	47	50	23	15	64	58	4
	-	-	73	77	75	75	74	79	104	112	83	60	136	65	6
GOVMI	61	43	56	44	56	63	65	38	3	61	148	208	-	33	65
	33	13	12	21	30	39	42	17	6	50	101	147	-	-	-
	34	22	25	28	39	42	40	15	6	50	120	191	-	20	41
HINWO	49	56	13	13	57	-	-	-	-	8	-	-	-	69	52
IGAAN	3	5	1	2	5	9	5	-	11	-	-	-	8	1	51
	22	39	41	54	57	70	56	39	46	37	180	217	72	1	54
	39	26	21	35	33	41	30	36	10	17	96	179	23	9	42
	15	18	18	1	25	20	22	18	2	20	52	73	-	19	12
KACJA	103	120	85	64	78	-	-	-	-	-	243	376	-	-	116
	-	65	38	-	47	49	45	-	-	70	71	135	-	-	45
	8	4	5	5	-	28	8	5	2	71	-	189	-	-	41
	39	135	94	84	103	-	-	-	-	-	235	352	-	-	122
	80	88	64	64	66	-	-	-	-	-	225	342	-	-	95
KOSDE	-	39	61	-	71	73	69	82	77	-	-	-	103	87	76
	72	91	108	-	100	118	120	88	118	130	168	-	117	135	118
	76	26	104	-	29	63	-	-	-	-	73	25	-	96	80
MACMA	12	37	42	17	36	42	40	35	34	-	60	21	64	68	36
	28	54	56	23	60	49	52	46	40	-	104	36	89	91	55
	17	23	31	12	23	20	25	20	23	-	50	15	43	43	36
MARGR	-	-	-	-	-	9	29	66	18	58	92	160	90	58	38
MASMI	-	35	10	25	-	-	-	-	-	41	-	-	-	-	-
MOLSI	162	143	27	140	60	-	-	-	-	59	31	87	94	-	-
	69	40	10	41	25	26	6	3	12	24	1	45	28	46	46
	106	93	24	72	80	13	3	4	119	37	143	59	192	117	2
	67	63	11	57	51	7	4	12	73	22	85	37	139	79	2
	29	26	4	22	21	4	3	3	31	13	34	19	51	25	2
MORJO	38	38	34	27	30	49	40	57	10	33	119	168	10	13	46
OTTMI	15	29	43	10	6	16	34	45	42	-	-	103	73	9	21
PERZS	-	107	86	78	-	102	104	124	-	-	-	448	-	12	136
PUCRC	88	69	-	25	-	132	109	29	-	-	192	304	-	-	-
ROTEC	-	34	5	11	23	-	-	8	28	3	50	12	65	59	-
SARAN	24	43	49	30	9	23	36	49	20	51	77	54	55	35	46
	33	53	60	36	11	62	40	48	60	62	102	95	63	26	49
	20	28	47	22	6	31	32	44	-	58	82	31	49	37	43
SCALE	53	53	36	35	41	51	20	10	-	100	175	229	27	14	48
SCHHA	61	14	37	36	40	37	-	25	29	7	168	40	75	7	60
SLAST	27	17	15	18	18	23	23	12	5	18	17	59	-	10	39
STOEN	109	124	74	102	90	78	74	13	5	198	259	319	90	131	108
	81	114	56	75	69	86	49	17	-	171	296	326	85	129	100
	120	121	76	81	73	91	64	11	9	177	306	337	88	139	128
STORO	-	-	-	-	208	-	-	-	-	213	337	63	-	-	-
	-	-	-	-	248	-	-	-	-	294	401	296	-	114	-
STRJO	27	20	19	29	6	17	-	37	9	16	16	63	54	27	8
	75	37	28	48	7	32	1	42	17	24	24	117	88	47	13
	34	15	14	26	9	21	-	31	18	7	18	45	12	34	4
	57	27	21	55	11	32	-	48	20	33	27	109	78	49	15
TEPIS	68	-	64	17	70	65	63	54	1	66	171	131	-	68	33
YRJIL	-	15	18	15	18	34	-	3	-	6	36	103	-	-	-
Sum	2759	3108	2590	2338	3147	2854	2155	1938	1645	3695	7618	9174	3071	3247	3108

August	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
BANPE	40	31	17	5	-	2	10	-	-	-	-	-	-	20	22	13
BERER	114	98	75	26	3	-	48	25	-	-	-	41	-	-	73	-
	52	30	43	11	-	-	11	7	-	-	-	14	-	-	28	-
	26	25	18	5	1	-	8	7	-	-	-	3	-	-	10	-
BIRSZ	39	35	33	1	-	14	28	4	-	-	16	8	7	18	23	10
BOMMA	86	69	58	-	20	39	34	15	5	21	20	45	49	62	54	72
BREMA	-	-	5	-	-	-	-	-	-	-	-	-	-	-	-	-
	-	-	2	17	9	9	-	9	-	27	22	9	11	14	16	22
BRIBE	5	-	-	24	28	23	-	20	2	23	10	5	28	7	9	25
	13	2	-	36	33	30	3	31	5	13	10	16	41	-	13	28
CRIST	66	81	40	17	24	18	17	12	12	11	9	28	46	54	42	36
	51	42	34	22	38	32	30	11	14	16	6	34	26	33	36	35
	87	74	74	28	48	39	39	21	4	13	4	29	60	54	49	55
DONJE	76	63	62	-	16	44	58	20	4	23	20	50	61	80	69	-
ELTMA	59	58	42	-	20	21	12	5	-	-	18	14	11	22	25	35
GONRU	21	6	46	35	24	3	24	4	28	16	35	24	40	49	5	17
	33	20	34	42	34	7	9	-	30	15	28	24	35	40	34	40
	28	23	37	25	31	8	14	1	20	13	22	19	22	23	21	22
	37	18	56	49	18	5	8	-	18	27	36	18	31	34	32	31
GOVMI	62	47	23	7	5	1	18	1	13	-	3	-	2	49	47	51
	36	29	18	2	1	-	7	-	5	-	1	-	3	19	17	-
	43	24	25	1	2	3	16	-	2	-	1	-	2	23	20	17
HINWO	64	32	-	-	1	10	12	18	17	-	16	-	37	32	15	-
IGAAN	44	36	38	1	-	7	13	2	7	8	3	2	3	10	15	31
	39	41	34	21	16	3	18	23	11	-	-	-	-	17	27	16
	37	25	25	17	-	4	9	4	3	2	1	7	-	8	14	35
	19	12	6	3	-	6	4	2	-	-	3	3	-	-	4	1
KACJA	111	81	52	-	-	-	-	-	-	-	-	-	3	57	31	24
	48	21	16	-	-	-	-	-	-	-	-	-	-	-	-	-
	9	24	13	-	-	-	1	-	-	-	-	3	1	6	10	4
	116	95	79	-	-	-	-	-	-	-	-	2	18	75	46	59
	78	55	55	-	-	-	-	-	-	-	-	1	5	34	22	14
KOSDE	65	41	76	-	-	-	-	-	-	78	78	83	85	83	77	80
	109	122	117	14	-	-	-	15	26	36	44	61	87	123	113	144
	-	-	6	8	23	22	-	-	6	28	47	26	26	23	-	23
MACMA	30	25	21	7	8	-	5	7	19	20	6	18	2	2	13	2
	47	39	23	14	11	-	14	11	38	40	19	22	6	-	26	14
	27	18	-	10	5	-	7	4	15	22	10	9	4	-	8	8
MARGR	29	14	28	-	-	5	18	-	-	-	28	21	31	30	24	25
MASMI	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MOLSI	-	-	-	-	-	-	-	-	-	-	-	-	-	160	96	-
	46	44	-	17	23	27	7	19	-	10	-	-	3	31	22	-
	96	25	41	2	11	33	23	67	52	72	67	18	61	40	9	80
	62	13	21	-	3	9	16	42	22	31	70	21	47	39	7	59
	20	4	13	1	4	2	3	20	11	21	17	4	15	15	1	4
MORJO	43	33	27	5	-	12	11	1	9	2	1	4	3	14	14	25
OTTMI	30	27	22	21	-	-	-	18	11	33	18	-	19	-	-	-
PERZS	-	-	42	5	-	-	-	-	27	-	6	-	-	-	-	59
PUCRC	-	-	51	-	19	25	13	-	-	-	-	17	23	40	40	37
ROTEC	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SARAN	22	33	20	17	6	-	-	-	12	-	10	8	-	6	14	13
	26	36	39	-	12	-	24	-	12	20	16	13	20	10	17	14
	19	22	18	-	-	-	-	-	16	9	6	13	11	7	9	12
SCALE	47	54	33	-	16	11	24	17	-	-	18	7	3	17	21	25
SCHHA	-	2	1	20	20	26	11	8	2	19	-	24	26	23	24	18
SLAST	26	12	9	-	-	-	3	-	-	-	-	-	6	32	8	16
STOEN	120	96	66	1	24	52	36	14	-	1	22	16	11	16	19	69
	99	98	53	2	18	35	29	22	-	2	19	11	10	12	13	58
	129	102	76	1	33	52	46	29	-	-	20	10	8	9	27	62
STORO	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
STRJO	9	-	-	1	17	5	-	15	2	13	15	3	-	-	15	32
	21	1	2	2	26	19	-	18	-	45	37	13	45	8	8	34
	5	-	-	1	10	9	-	13	-	13	13	-	-	-	-	-
	14	2	-	-	25	8	-	21	-	14	31	15	37	15	9	25
TEPIS	70	60	50	4	-	29	37	19	-	-	23	5	15	24	55	22
YRJIL	32	-	9	16	6	13	25	37	35	23	42	30	25	9	20	19
Sum	2782	2120	1924	564	692	722	803	659	515	780	967	871	1171	1628	1538	1672