How good is the IMO Working List of Meteor Showers? - A Complete Analysis of the IMO Video Meteor Database

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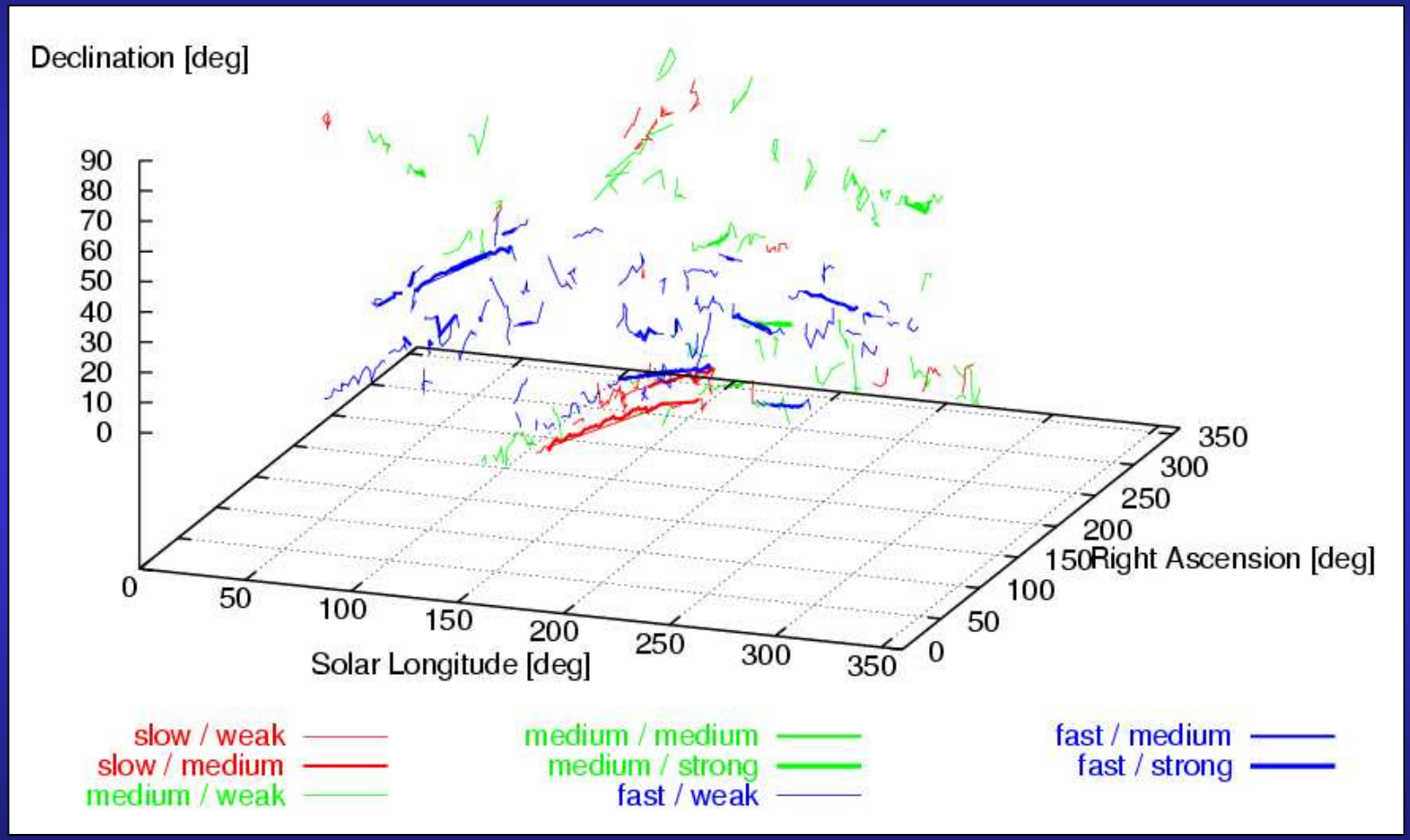
Result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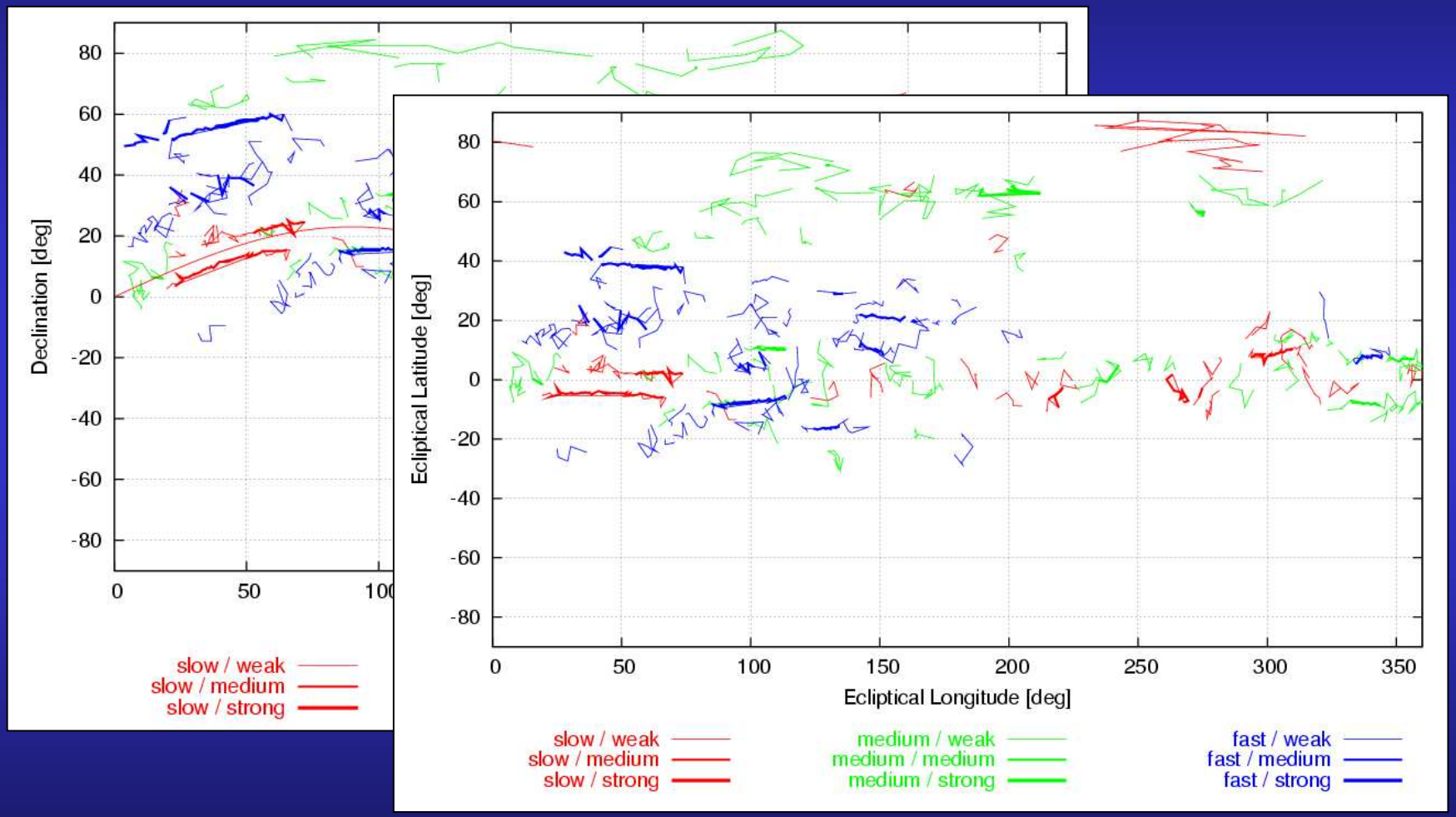
70
60
50
40
30
20
10
0
0
50
100
150
200
250
300
350
Solar Longitude [deg]
0
50
100
150
200
250
300
350
Right Ascension [deg]
slow / weak
slow / medium
medium / weak
medium / medium
medium / strong
fast / weak
fast / medium
fast / strong

Result


Declination [deg]
80
60
40
20
0
-20
-40
-60
-80
0
50
slow / weak
slow / medium
slow / strong
Ecliptical Latitude [deg]
80
60
40
20
0
-20
-40
-60
-80
0
50
100
150
200
250
300
350
Ecliptical Longitude [deg]
slow / weak
slow / medium
slow / strong
medium / weak
medium / medium
medium / strong
fast / weak
fast / medium
fast / strong

Overview

Part 1:

- Introduction
- Basics
- Implemenation

Part 2:

- Results

Introduction

Motivation

- Plenty of video data are collected, but meteor shower analyses were carried out for a few selected showers only (e.g. the Taurid analysis by Triglav / Arlt)
- Short-term outbursts are recorded by the camera network but only noticed, if an observers gets aware of it by chance (c.f. the Carmelopardalid outburst of October 5, 2005)
- When the video network was started, the aim was to cover the annual meteor shower activity completely within 3..5 years, and then to analyse the data → that was in 1999

Introduction

How the analysis started ...

- RadFind – a tool for the automated radiant search based on MetRec logfiles
- Enhancement: Read more than one input file
- Enhancement: Read PosDat files alternatively to MetRec logfiles

» Can also be used for visual observations!

- Enhancement: Solar longitude as selection criterion

» Can be used to analyse the full video meteor database!

- Completed by StrmFind to search for meteor showers

Basics

A little bit of theory ...

- *Bayes' Decision Rule* is the basis of all statistical pattern recognition systems; using Bayes' rule guarantees optimal classification results.

$$R = \underset{R'}{\operatorname{argmax}}\ P(R' \mid M)$$

with: *R ... set of radiants*

M ... set of meteors

P (R | M) ... a-posteriori (=posterior) probability distribution

- The a-posteriori probability distribution P (R | M) is unknown, which is why it is usually transformed with *Bayes' Identity*:

$$P(R \mid M) = \frac{P(R) * P(M \mid R)}{P(M)}$$

with: P (M | R) ... class-conditional probability distribution

P (R), P(M) ... a-priori (= prior) probability distribution

Basics

- Therefore: $$R = \underset{R'}{\operatorname{argmax}} \frac{P(R') * P(M \mid R')}{P(M)}$$
- Conditional probability distribution P (M | R) can be modeled easily
» Standard criterion for the meteor shower assignment, based on the radiant altitude, distance from the radiant, velocity, …
» Analytical derivation of the maximum is impossible, therefore full search over all possible radiants
- A-priori distribution of radiants P (R) can be modeled as well:

  e.g. radiants near the ecliptic plane are more probable then others
» In the most simple case, P (R) is assumed to be equally distributed and becomes a constant factor that can be neglected
- Probability of the observation P (M) is a constant factor as well

Basics

Algorithm (Theory)

- Four-dimensional coordinate system (right ascension, declination, velocity, solar longitude)
- Accumulation of the probabilities P (M | R) over all meteors and all radiants with high resolution along all four axes
- Search for elongated maxima along the solar longitude axis

» Difficult to implement (4-D Hough transform?, tremendous memory requirements, complex search algorithm)

Basics

Algorithm (Practice)

1.) Separated accumulation of probabilities P (M | R) for each solar longitude interval in a three-dimensional coordinate system (right ascension, declination, velocity)

» like an automatic run of the Radiant software for all possible velocities

2.) Determination of local maxima (radiants) at each solar longitude interval (program RadFind)

3.) Conneting radiants in consecutive solar longitude intervals to derive possible meteor showers (program StrmFind)

4.) optional: Re-calculation of radiant positions with the average velocity determined for each shower (program RadFind)

5.) Identification of meteor showers based on IMO‘s Working List and known sporadic sources

Implementation

RadFind

- Accumulation of radiant probabilities for all meteors in a given solar longitude interval
- Solar longitude: 360 intervals (2° step size, 1° shift)
- Right ascension / declination: ½° step size
- Velocity: 1 km/s stepp size

» 2 x 2.5 Million radiant probabilities per meteor!

- About 1 month of computation time on two four-CPU servers

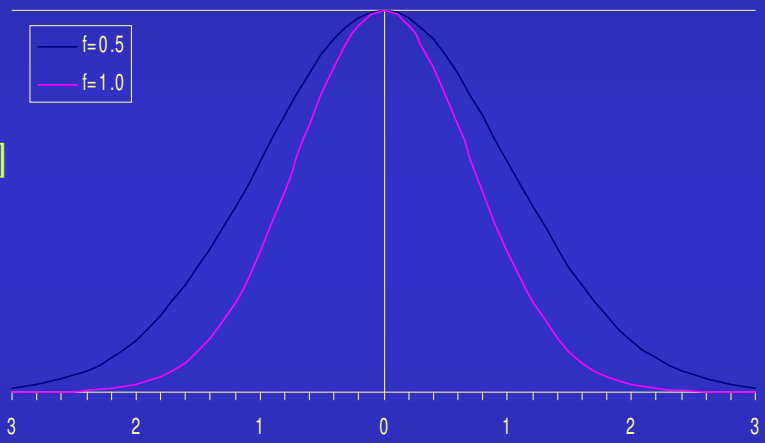
» Intensive use of the BMW hardware test lab :-)

Implementation

Practical Aspects RadFind

- Probability distribution: $P(M \mid R) = [\exp(-0.5\ D^2) * \exp(-1.5\ V^2)] / N$

with: D ... Miss distance between backward prolongated meteor and radiant [°]
V ... Difference between expected and observed angular meteor velocity [°/s]
N ... Norm factor
for all suitable radiants R (above the horizon, suitable position relative to the meteor)



» Empirical scaling factors (0.5/1.5)

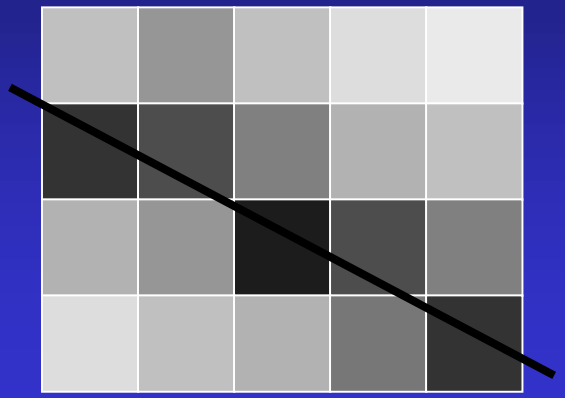
- Normalized vs. unnormalized distribution:

» Normalized distribution is conform to probability theory, but gives short meteors too much weight (known behaviour from Radiant)

» Unnormed distribution (N=1) gives long meteors more weight

- Here: unnormed distribution, equaly distributed P (R) (empirical)

Implementation



- Imperfect meteor distribution and discrete sampling of radiant positions may result in more than one local probability maximum
- Strong showers may hide weak showers completely

» Iterative algorithm (useful feature for Radiant?):

→Compute probability distribution over all meteors

→ Loop:

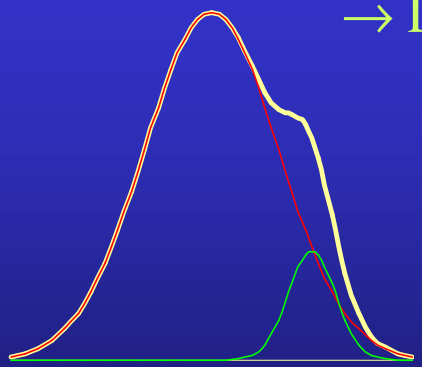
→ Determine the global maximum

→ Determine all meteors belonging to this maximum

→ Compute the partial probability distribution for these meteors

→ Determine meteor shower parameters from partial distribution

→ Subtract partial from overall probability distribution



Implementation

- The meteor number alone is a poor estimate for meteor shower activity, since the effective observing time varies between different solar longitude intervals
- The meteor number relative the overall number of meteors per solar longitude interval is better, but affected by other meteor showers (e.g. number of Taurids during the Leonids)

» Determine all meteor showers active at a given solar longitude interval; subtract these from the overall meteor count → remaining meteors are the „sporadic background“

» Meteor shower activity = ratio between shower meteor count and „sporadic background“

Implementation

StrmFind

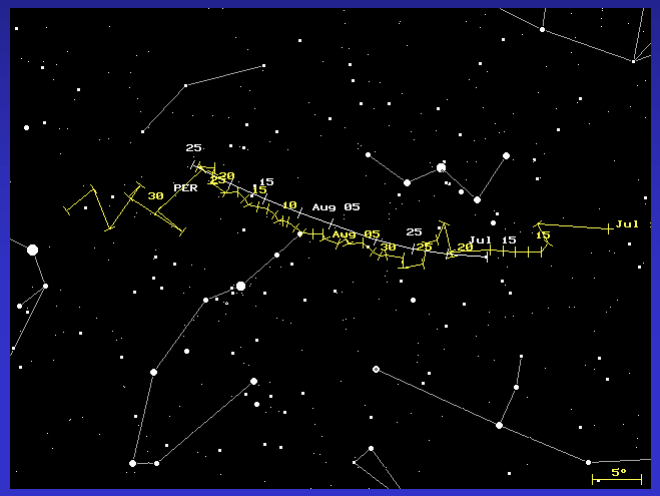
- Search for radiants with similar position / velocity (at most 7° / 7 km/s difference, empirical) in subsequent solar longitude intervals
- » Each shower needs to be detected in at least 4 subsequent solar longitude intervals (empirical)
- Identification of showers from the IMO Working List and six known sporadic sources (N/S Apex, N/S Toroidal, Helion, Anthelion) with at most 15° /15 km/s maximum deviation based on the mean meteor shower parameters
- Problem: Result depends strongly on the choosen parameter set
- » Plenty of meteor showers can be „generated“
- » Tighter criteria for unknown showers

Implementation

Re-calculation of Radiant Positions

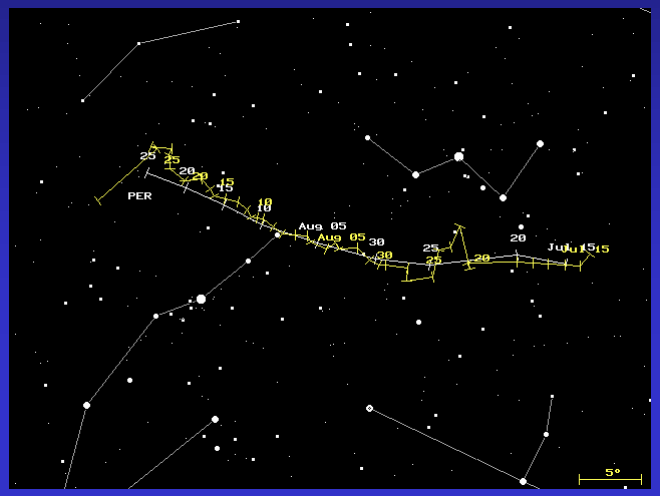
- Meteor showers have a fixed velocity, but RadFind computed the optimum position and velocity for each solar longitude interval
- Re-calculation of individual radiant positions with fixed velocity (= average velocity) seems useful
- » The iterative procedure relies on the fact that the contributions of other showers are removed sucessively. With a fixed velocity, many showers are not detected anymore and the shower activity cannot be computed reliably anymore
- » Radiant positions were not re-calculated for this analysis

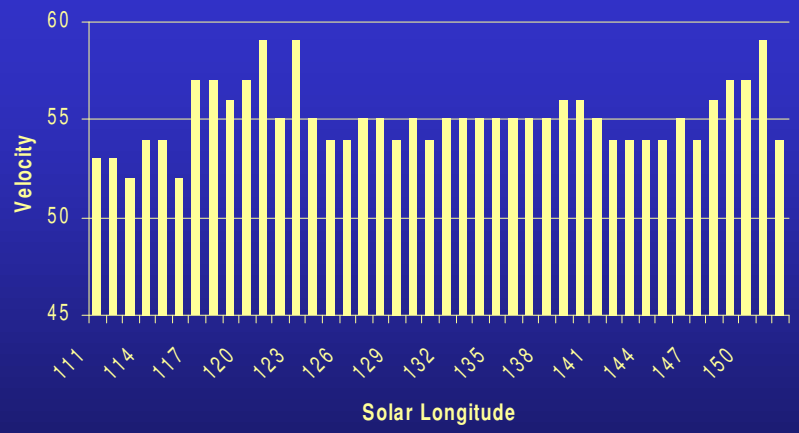
Implementation

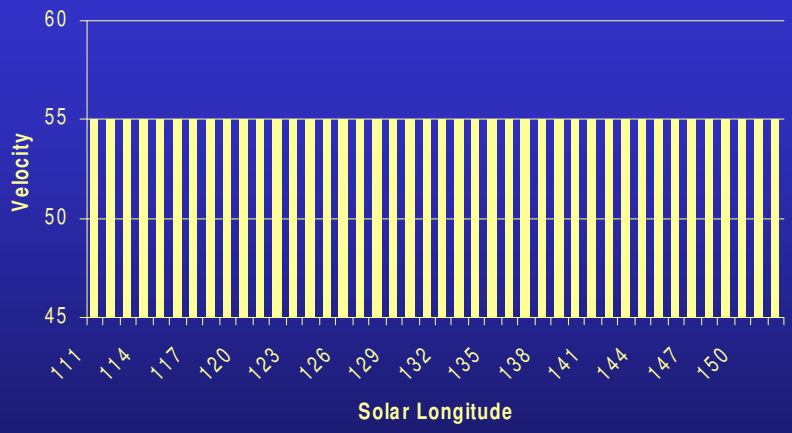


Example

Perseids



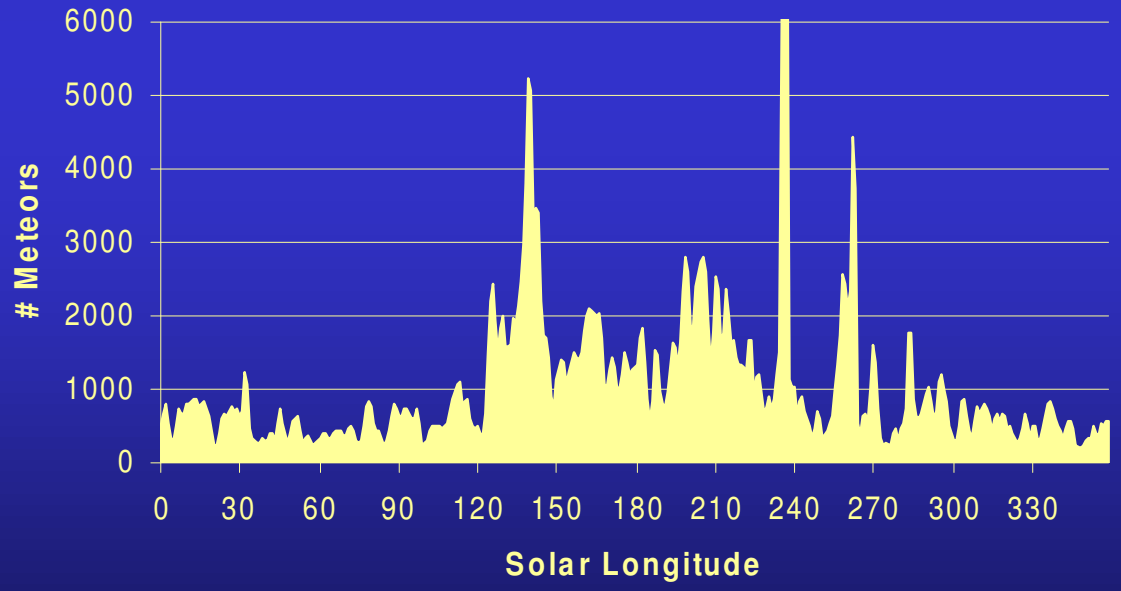




Results

Statistics

- 188.068 meteors overall, recorded between 1993 and 2006
- between 200 (March 7 / solar longitude 348°) and 13.021 meteors (November 19 / solar longitude 236°) per interval



Results

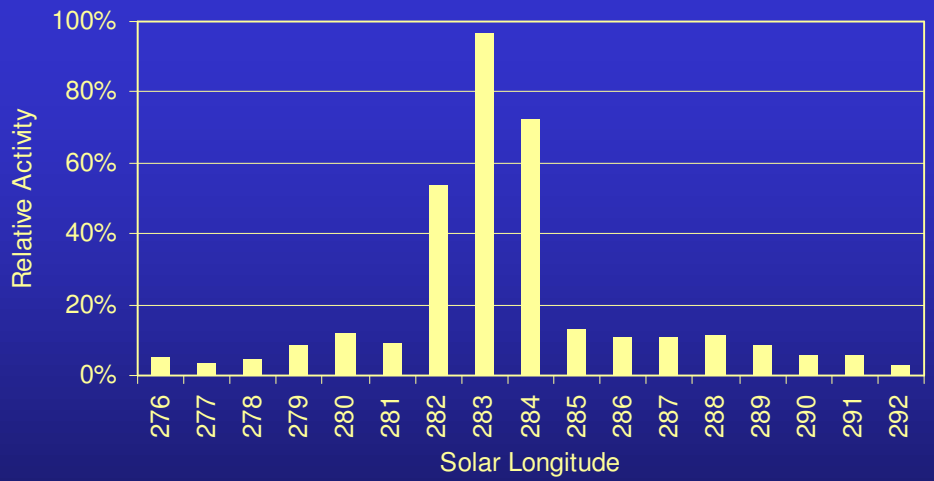
Statistics

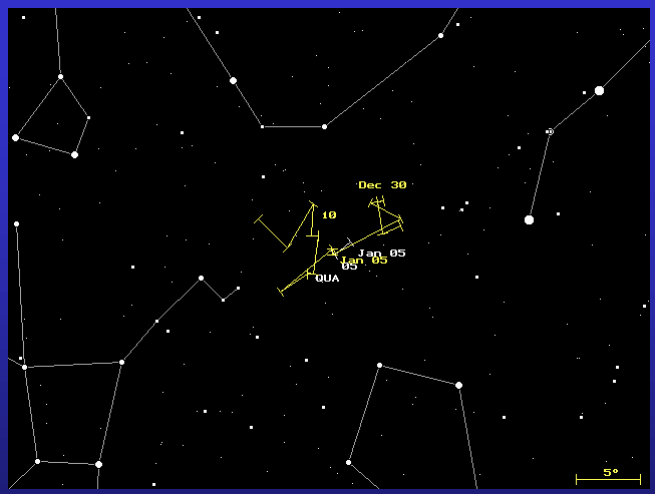
- With the given settings:
» 54 meteor shower candidates, including
» 24 meteor showers from the IMO Working List
» 4 sporadic sources
» 26 meteor showers, that neither belong to the IMO working list nor fit to a known sporadic source
» 3 meteor showers from the IMO Working List > -20° declination were not found

Results

	Period of Activity			Maximum		
	Solar Longitude	Date	Meteors	Solar Longitude	Date	Activity
Shower 83	276-292	Dec 28-Jan 12	2177	283	Jan 04	96.4%
QUA	280-284	Jan 01-Jan 05	-	282	Jan 03	-

Mean Parameters	Solar Longitude	Date	Right Ascension	Declination	Drift	Velocity
Shower 83	283	Jan 04	230.2	49.5	1.0 / -0.1	41 km/s
QUA			230	49	0.8 / -0.2	41 km/s

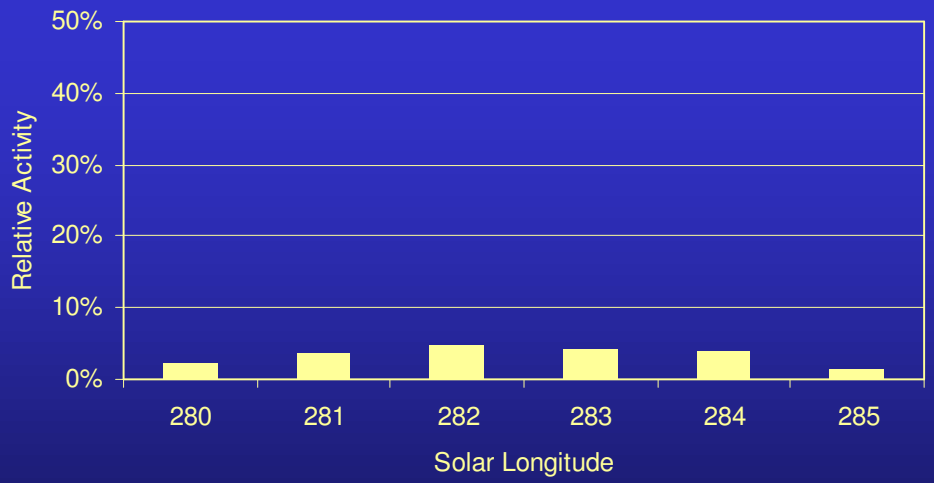


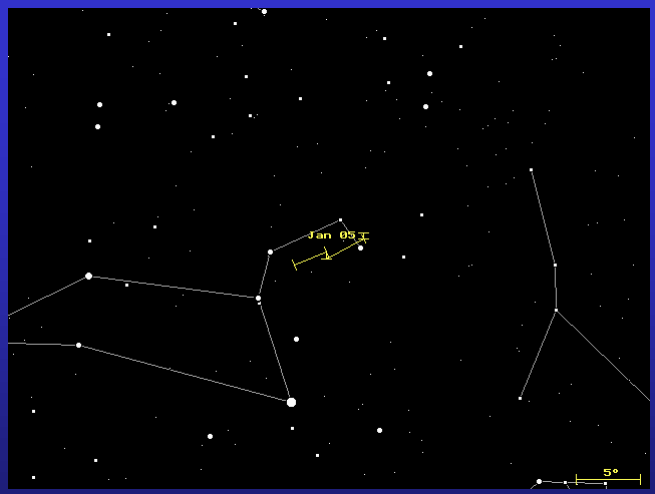


Results

	Period of Activity			Maximum		
	Solar Longitude	Date	Meteors	Solar Longitude	Date	Activity
Shower 86	280-285	Jan 01-Jan 06	118	282	Jan 03	4.7%
-	-	-	-	-		

Mean Parameters	Solar Longitude	Date	Right Ascension	Declination	Drift	Velocity
Shower 86	282	Jan 03	146.2	24.5	1.2 / -0.5	55 km/s
-			-	-	-	-

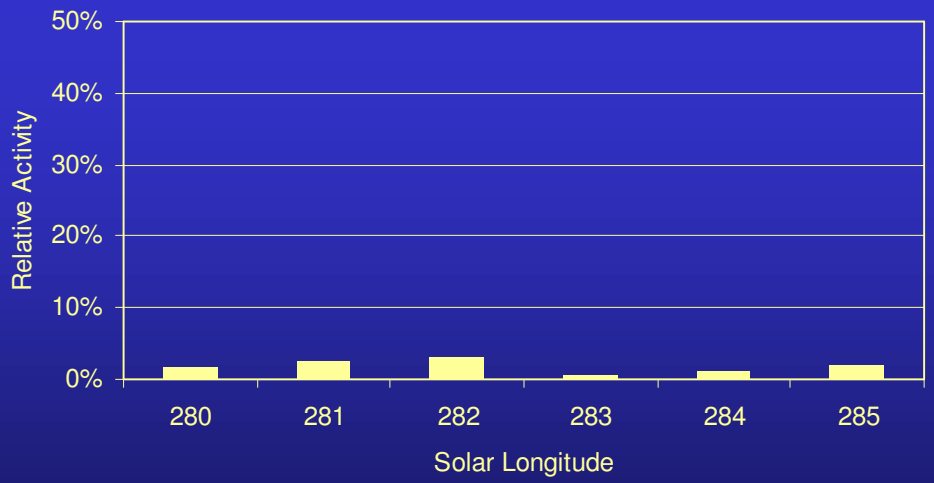


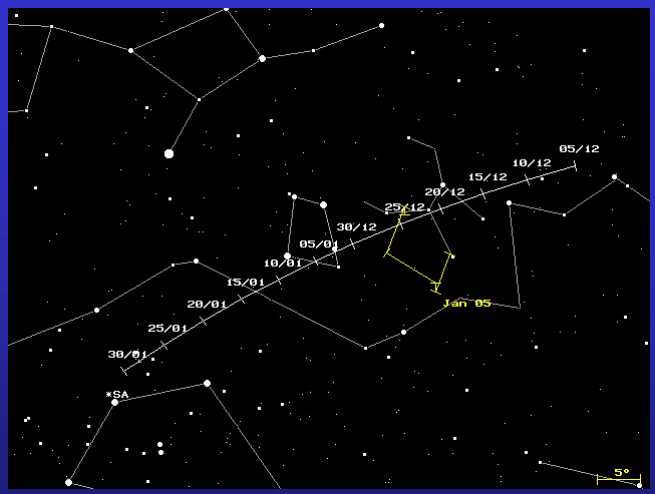


Results

	Period of Activity			Maximum		
	Solar Longitude	Date	Meteors	Solar Longitude	Date	Activity
Shower 87	280-285	Jan 01-Jan 06	56	282	Jan 03	3.2%
S Apex	-	-	-	-		

Mean Parameters	Solar Longitude	Date	Right Ascension	Declination	Drift	Velocity
Shower 87	282	Jan 03	176.0	-23.0	-1.4 / -1.5	62 km/s
S Apex	-	-	-	-	0.9 / -0.4	60 km/s

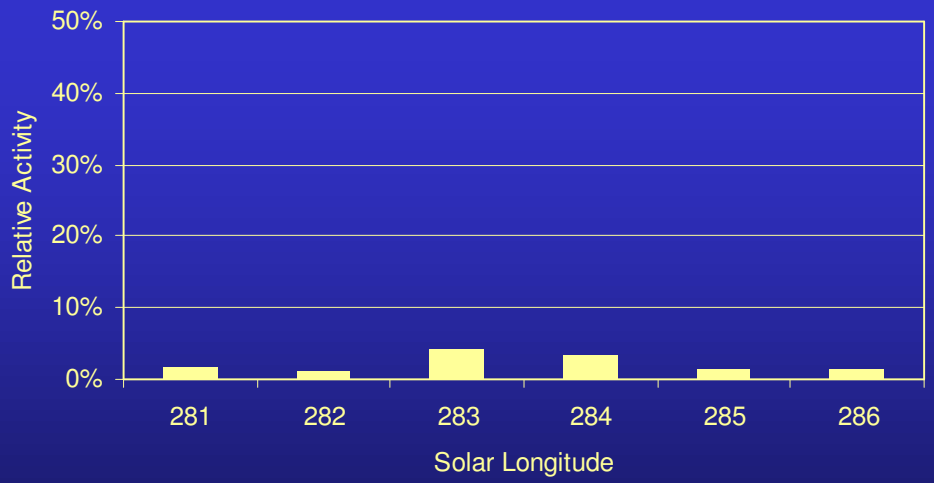


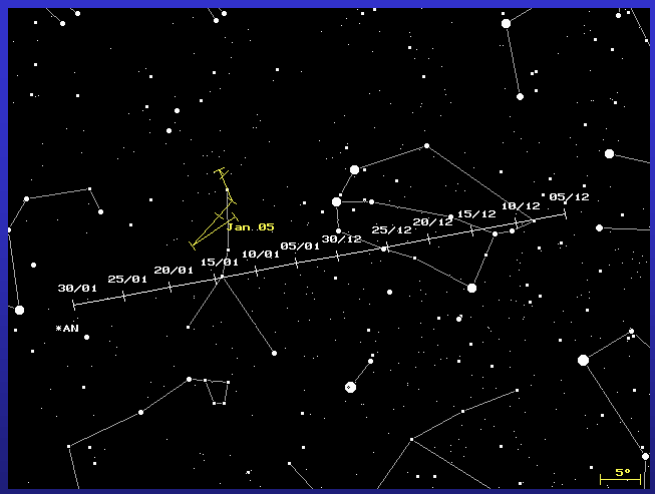


Results

	Period of Activity			Maximum		
	Solar Longitude	Date	Meteors	Solar Longitude	Date	Activity
Shower 88	281-286	Jan 02-Jan 07	90	283	Jan 04	4.2%
Anthelion	-	-	-	-	-	

Mean Parameters	Solar Longitude	Date	Right Ascension	Declination	Drift	Velocity
Shower 88	283	Jan 04	130.8	27.5	0.0 / -1.6	39 km/s
Anthelion	-	-	-	-	1.0 / -0.2	30 km/s

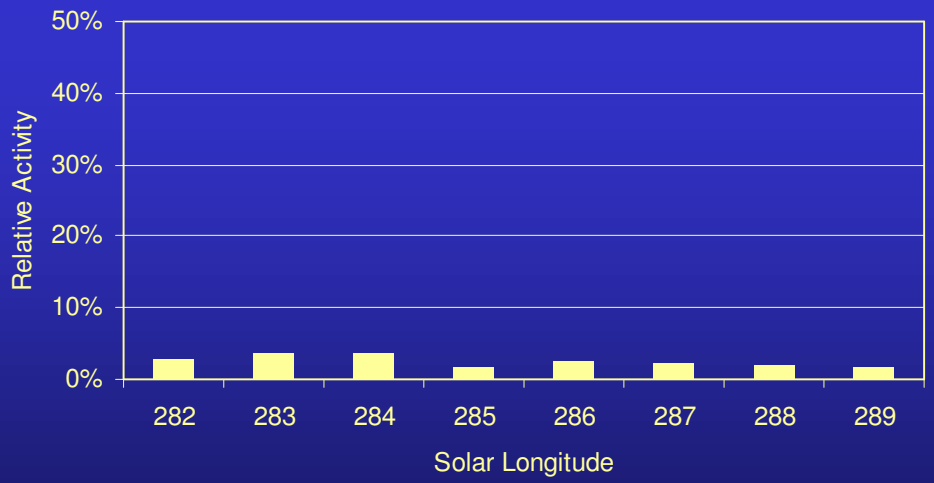


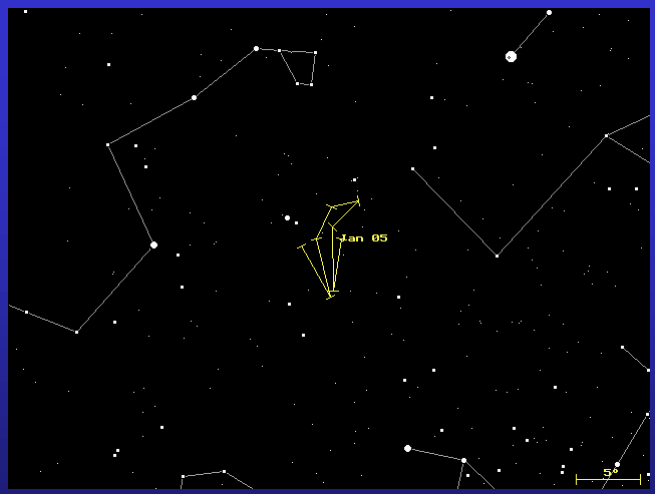


Results

	Period of Activity			Maximum		
	Solar Longitude	Date	Meteors	Solar Longitude	Date	Activity
Shower 89	282-289	Jan 03-Jan 09	128	283	Jan 4	3.7%
-	-	-	-	-		

Mean Parameters	Solar Longitude	Date	Right Ascension	Declination	Drift	Velocity
Shower 89	283	Jan 04	128.0	-12.5	0.4 / -0.1	39 km/s
-			-	-	-	-

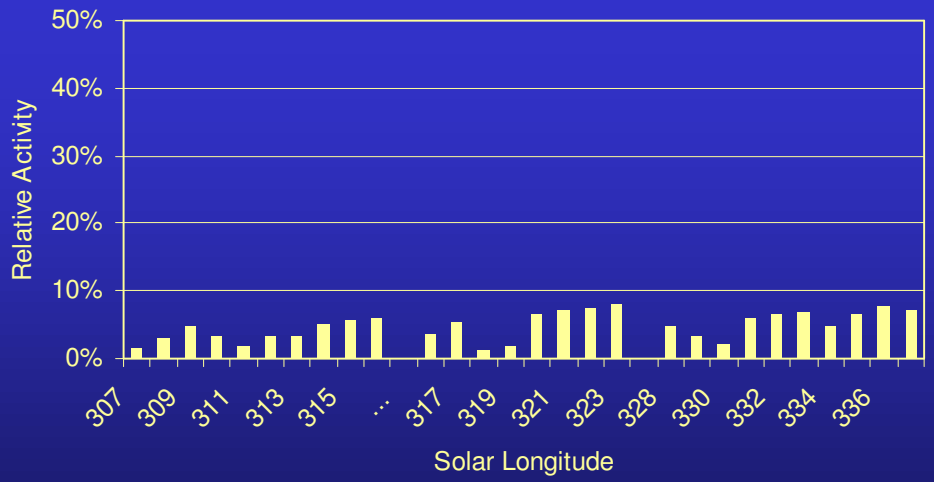


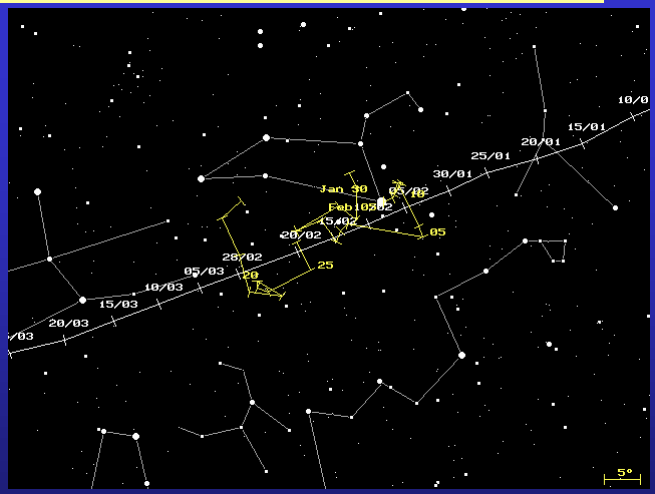


Results

	Period of Activity			Maximum		
	Solar Longitude	Date	Meteors	Solar Longitude	Date	Activity
Shower 92	307-316	Jan 27-Feb 05	213	316	Feb 05	5.9%
Shower 94	316-323	Feb 05-Feb 12	204	323	Feb 12	8.1%
Shower 95	328-337	Feb 17-Feb 26	282	336	Feb 25	7.8%
ANT	-	-	-	-	-	-

Mean Parameters	Solar Longitude	Date	Right Ascension	Declination	Drift	Velocity
Shower 92	316	Feb 05	156.9	9.0	0.3 / -0.8	36 km/s
Shower 94	323	Feb 12	151.8	12.0	0.6 / 0.6	30 km/s
Shower 95	336	Feb 25	162.2	2.5	-1.1 / -0.7	27 km/s
ANT	-	-	-	-	1.0 / 0.0	30 km/s

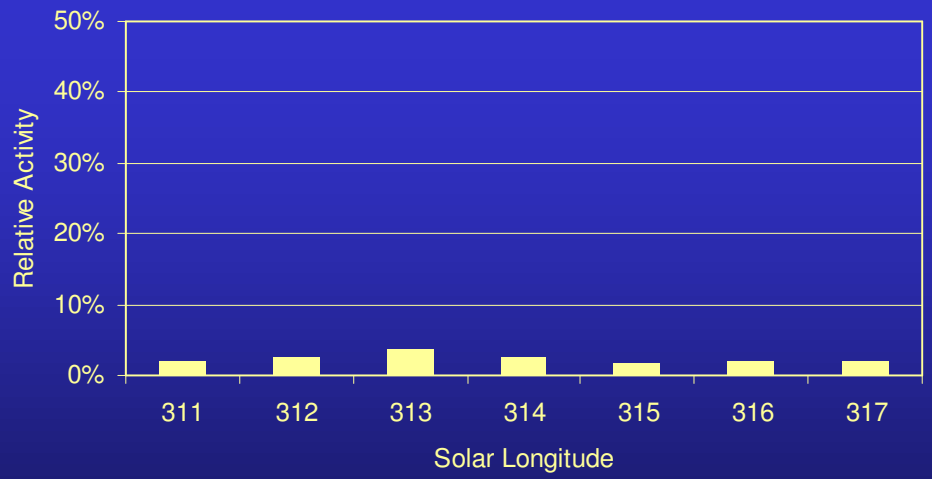


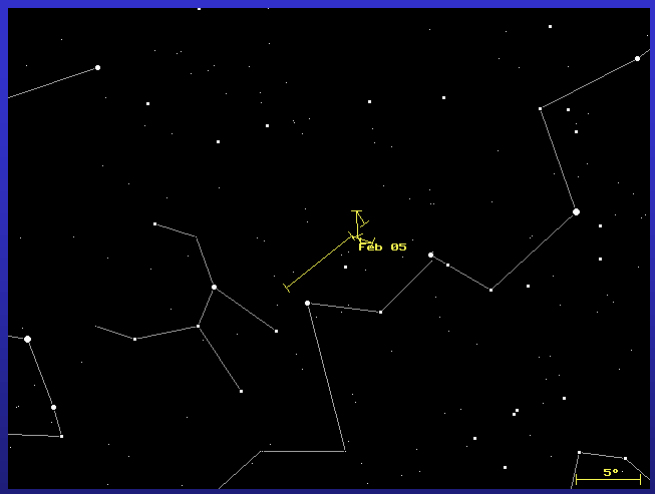


Results

	Period of Activity			Maximum		
	Solar Longitude	Date	Meteors	Solar Longitude	Date	Activity
Shower 93	311-317	Jan 31-Feb 06	101	313	Feb 02	3.7%
-	-	-	-	-		

Mean Parameters	Solar Longitude	Date	Right Ascension	Declination	Drift	Velocity
Shower 93	313	Feb 02	158.4	-11.0	0.7 / -0.7	42 km/s
-			-	-	-	-

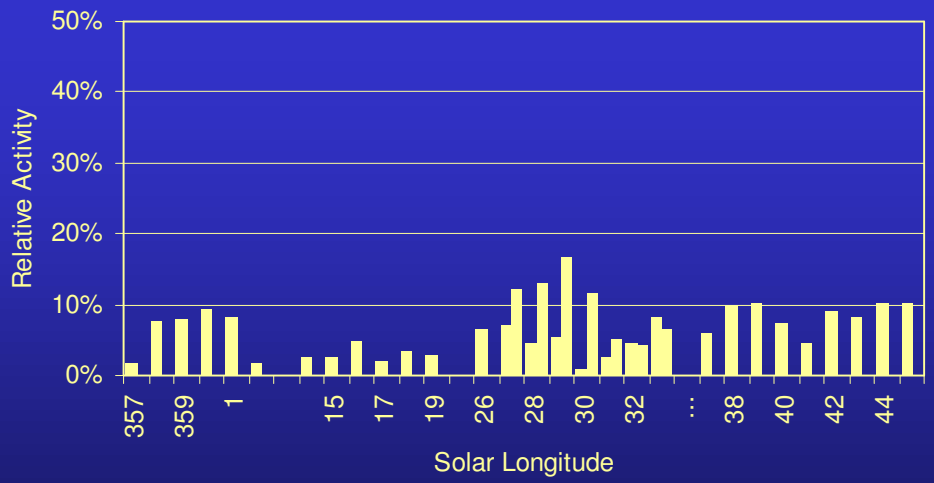


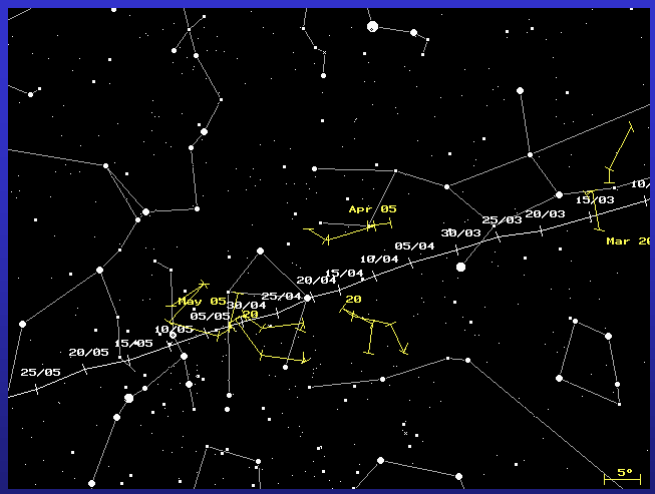


Results

	Period of Activity			Maximum		
	olar Longitud	Date	Meteors	olar Longitud	Date	Activity
Shower 1	357-2	Mar 18-Mar 2	197	1	Mar 22	8.2%
Shower 4	14-19	Apr 04-Apr 0	118	18	Apr 08	3.4%
Shower 5	26-33	Apr 16-Apr 2	241	33	Apr 23	8.2%
Shower 6	27-33	Apr 17-Apr 2	406	29	Apr 19	16.8%
Shower 8	37-45	Apr 27-May 0	246	44	May 05	10.3%
ANT	-	-	-	-	-	-

Mean Parameters	olar Longitud	Date	Right Ascension	Declination	Drift	Velocity
Shower 1	1	Mar 22	185.6	1.5	-0.6 / 1.4	30 km/s
Shower 4	18	Apr 08	220.1	-8.0	2.3 / -0.4	37 km/s
Shower 5	33	Apr 23	223.3	-24.0	0.0 / -0.7	29 km/s
Shower 6	29	Apr 19	217.6	-17.5	-1.1 / -0.2	29 km/s
Shower 8	44	May 05	241.4	-16.0	1.1 / 0.4	30 km/s
ANT	-	-	-	-	1.0 / -0.4	30 km/s

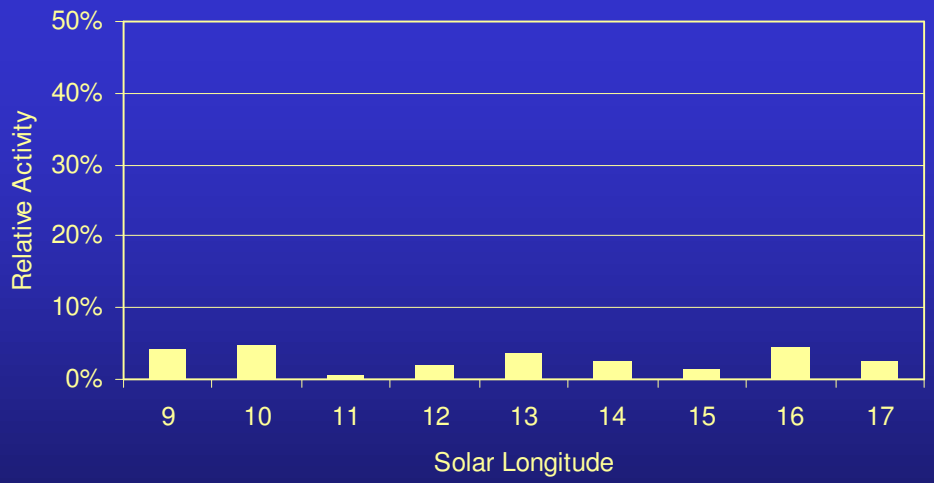


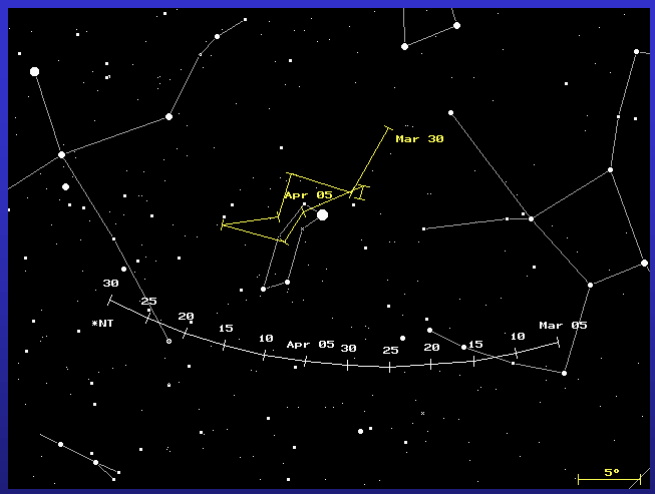


Results

	Period of Activity			Maximum		
	Solar Longitude	Date	Meteors	Solar Longitude	Date	Activity
Shower 2	9-17	Mar 30-Apr 07	190	10	Mar 31	4.7%
N Toroidal	-	-	-	-	-	

Mean Parameters	Solar Longitude	Date	Right Ascension	Declination	Drift	Velocity
Shower 2	10	Mar 31	276.2	40.5	0.1 / -0.5	41 km/s
N Toroidal	-	-	-	-	0.7 / 0.1	35 km/s

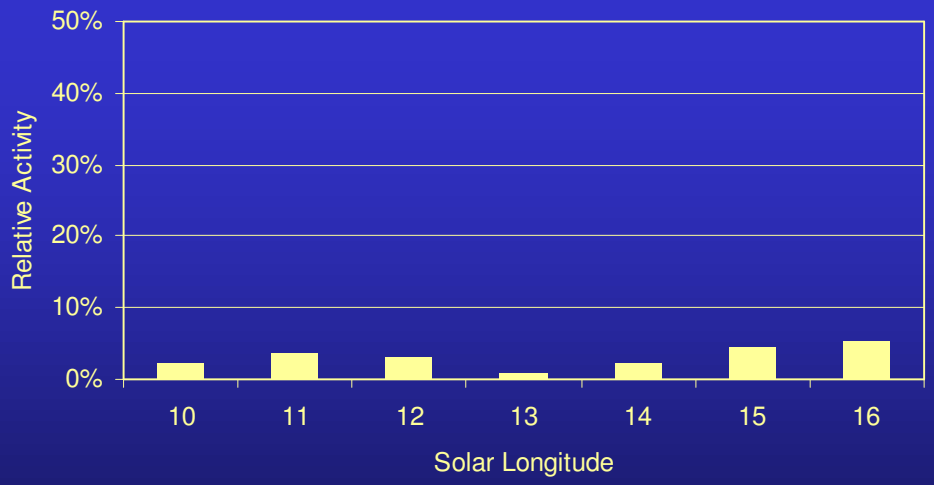


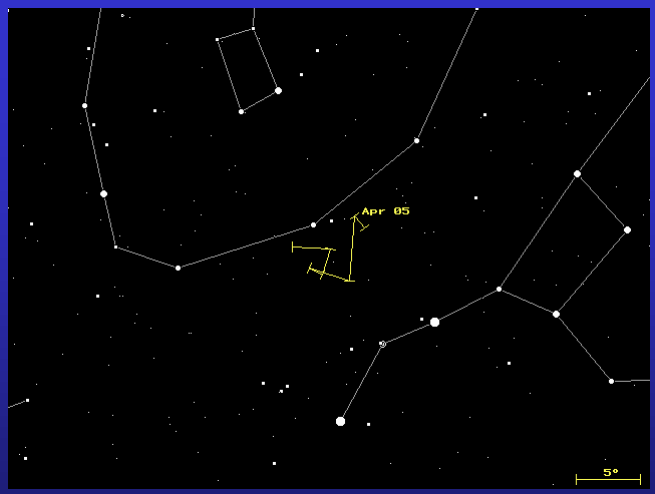


Results

	Period of Activity			Maximum		
	Solar Longitude	Date	Meteors	Solar Longitude	Date	Activity
Shower 3	10-16	Mar 31-Apr 06	163	16	Apr 06	5.2%
-	-	-	-	-		

Mean Parameters	Solar Longitude	Date	Right Ascension	Declination	Drift	Velocity
Shower 3	16	Apr 06	201.9	64.0	-1.8 / 0.3	18 km/s
-			-	-	-	-

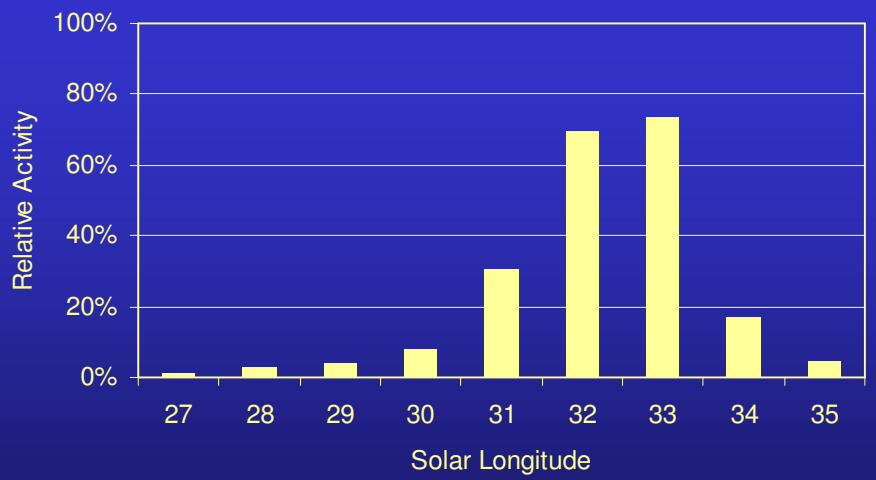


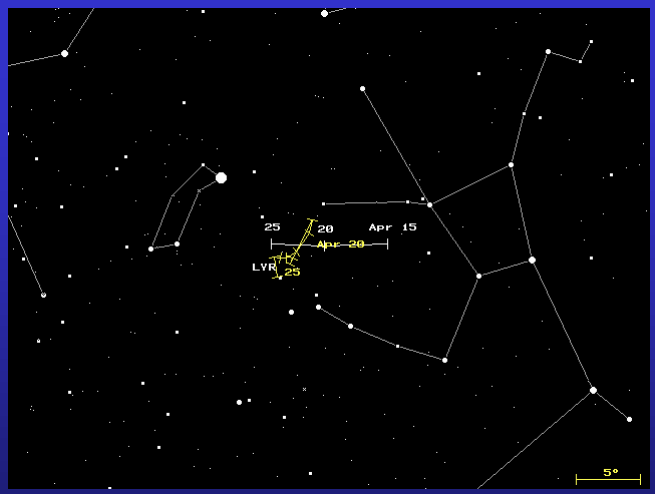


Results

	Period of Activity			Maximum		
	Solar Longitude	Date	Meteors	Solar Longitude	Date	Activity
Shower 7	27-35	Apr 17-Apr 25	1216	33	Apr 23	73.5%
LYR	26-35	Apr 16-Apr 25	-	32	Apr 22	-

Mean Parameters	Solar Longitude	Date	Right Ascension	Declination	Drift	Velocity
Shower 7	33	Apr 23	273.1	33.0	0.3 / -0.2	45 km/s
LYR			271	34	1.1 / 0.0	49 km/s

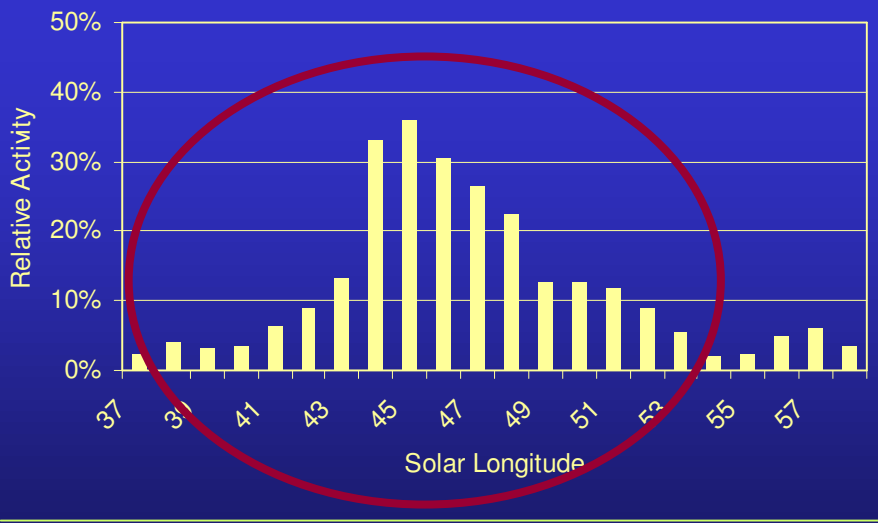


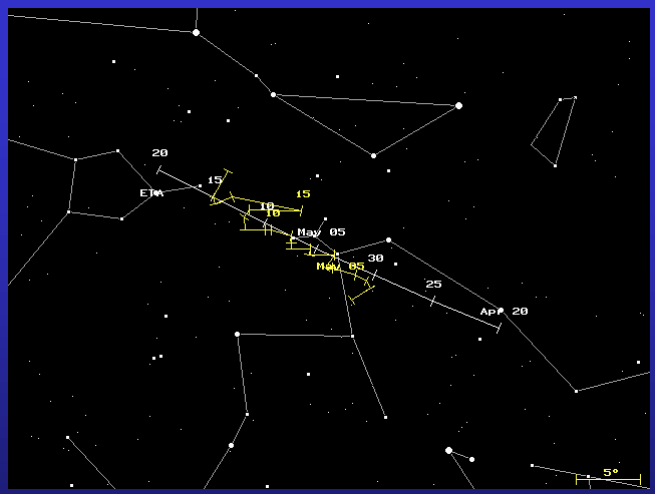


Results

	Period of Activity			Maximum		
	Solar Longitude	Date	Meteors	Solar Longitude	Date	Activity
Shower 9	37-58	Apr 27-May 19	959	45	May 06	35.9%
ETA	29-67	Apr 19-May 29	-	44	May 05	-

Mean Parameters	Solar Longitude	Date	Right Ascension	Declination	Drift	Velocity
Shower 9	45	May 06	337.5	-1.0	0.6 / 0.4	59 km/s
ETA			338	-1	0.9 / 0.4	66 km/s

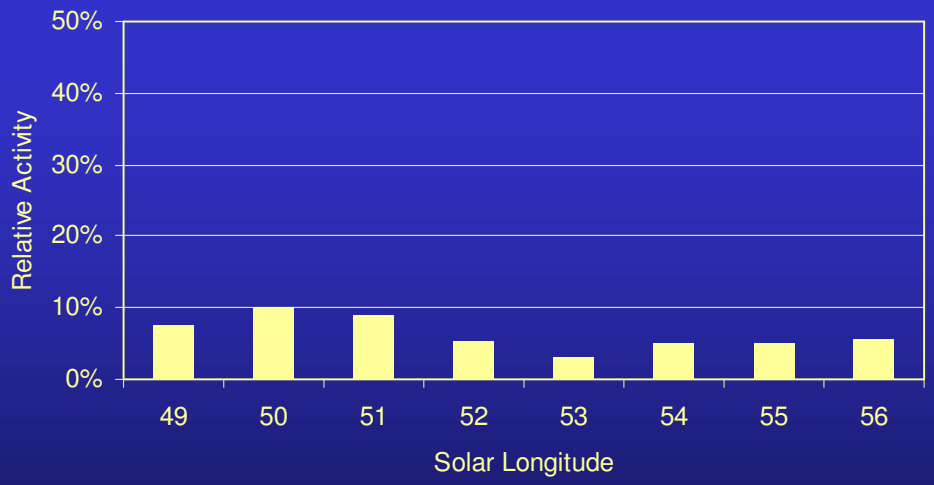


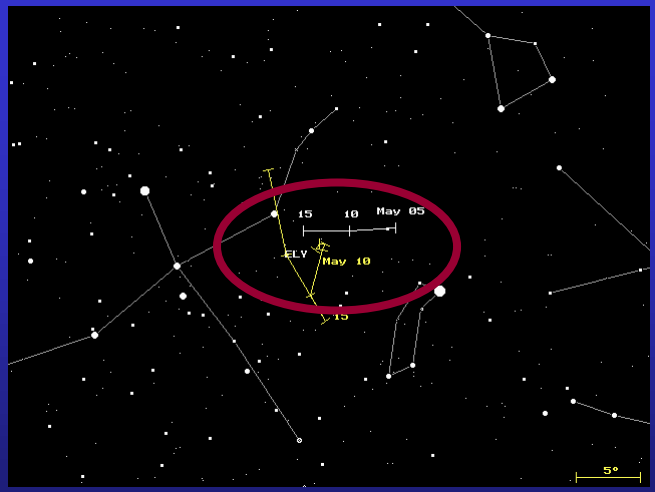


Results

	Period of Activity			Maximum		
	Solar Longitude	Date	Meteors	Solar Longitude	Date	Activity
Shower 10	49-56	May 10-May 17	203	50	May 11	10.0%
ELY	42-51	May 03-May 12	-	48	May 09	-

Mean Parameters	Solar Longitude	Date	Right Ascension	Declination	Drift	Velocity
Shower 10	50	May 11	291.2	43.0	0.7 / 0.2	43 km/s
ELY			287	44	1.0 / 0.0	44 km/s

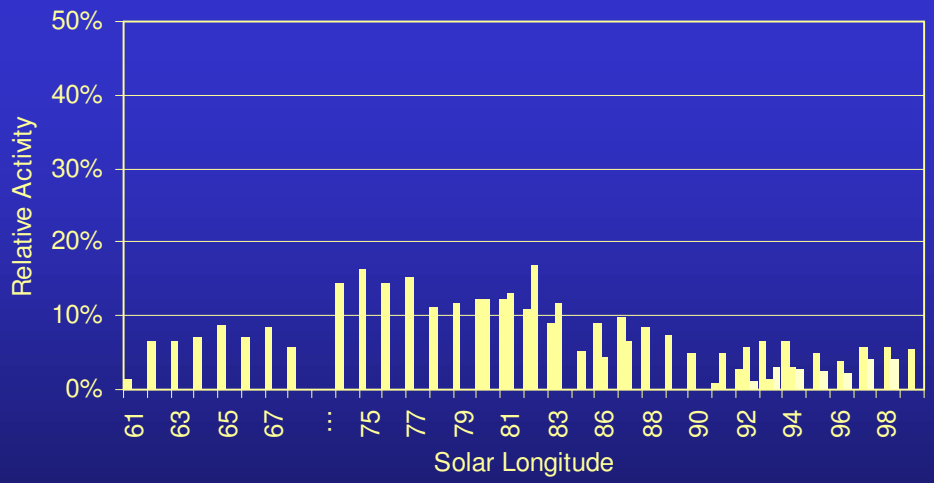


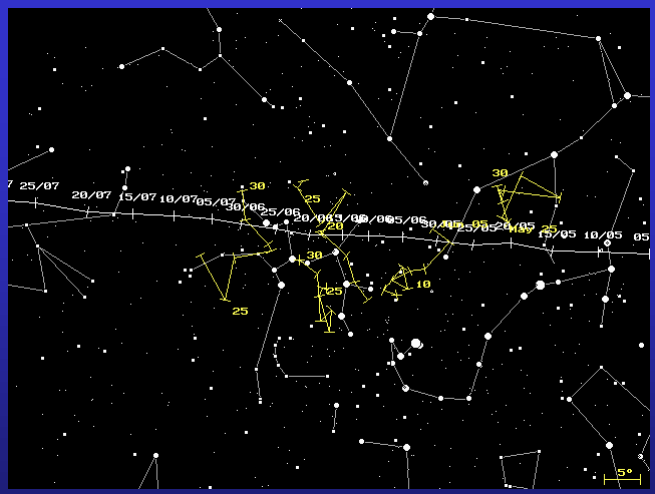


Results

	Period of Activity			Maximum		
	Solar Longitude	Date	Meteors	Solar Longitude	Date	Activity
Shower 11	61-68	May 22-May 30	192	67	May 29	8.3%
Shower 12	74-83	Jun 05-Jun 14	566	75	Jun 06	16.4%
Shower 14	86-94	Jun 17-Jun 26	317	87	Jun 18	9.8%
Shower 15	91-99	Jun 23-Jul 01	189	99	Jul 01	5.5%
Shower 17	92-98	Jun 24-Jun 30	97	97	Jun 29	4.0%
ANT	-	-	-	-	-	-

Mean Parameters	Solar Longitude	Date	Right Ascension	Declination	Drift	Velocity
Shower 11	67	May 29	254.2	-15.5	-0.2 / 0.3	30 km/s
Shower 12	75	Jun 06	260.2	-23.0	0.7 / -1.0	27 km/s
Shower 14	87	Jun 18	274.0	-29.5	1.2 / 2.0	26 km/s
Shower 15	99	Jul 01	282.7	-26.5	0.5 / 0.6	24 km/s
Shower 17	97	Jun 29	290.4	-20.5	-1.2 / 1.7	32 km/s
ANT	-	-	-	-	1.0 / -0.1	30 km/s

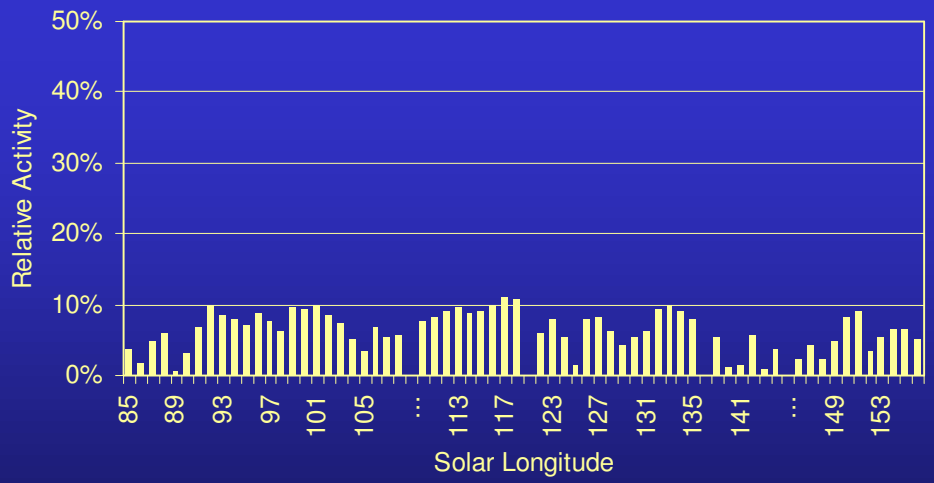


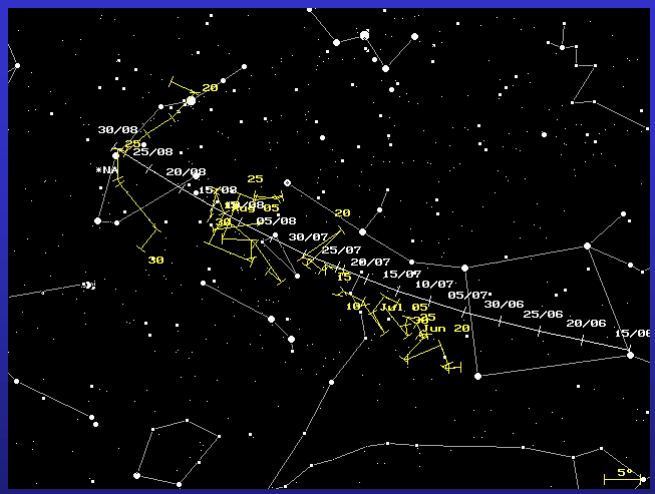


Results

	Period of Activity			Maximum		
	Solar Longitude	Date	Meteors	Solar Longitude	Date	Activity
Shower 13	85-108	Jun 16-Jul 10	683	101	Jul 03	9.8%
Shower 21	110-118	Jul 13-Jul 21	498	117	Jul 20	10.9%
Shower 27	122-135	Jul 25-Aug 08	853	133	Aug 06	10.0%
Shower 35	139-144	Aug 12-Aug 17	254	142	Aug 15	5.7%
Shower 38	146-156	Aug 19-Aug 30	529	151	Aug 24	8.9%
N Apex	-	-	-	-	-	

Mean Parameters	Solar Longitude	Date	Right Ascension	Declination	Drift	Velocity
Shower 13	101	Jul 03	12.7	25.5	0.6 / 0.5	65 km/s
Shower 21	117	Jul 20	21.0	36.0	0.6 / 0.4	62 km/s
Shower 27	133	Aug 06	43.4	39.5	0.8 / -0.3	60 km/s
Shower 35	142	Aug 15	40.2	36.0	1.4 / 1.5	54 km/s
Shower 38	151	Aug 24	58.3	41.0	0.1 / -2.2	57 km/s
N Apex	-	-	-	-	0.9 / 0.4	60 km/s

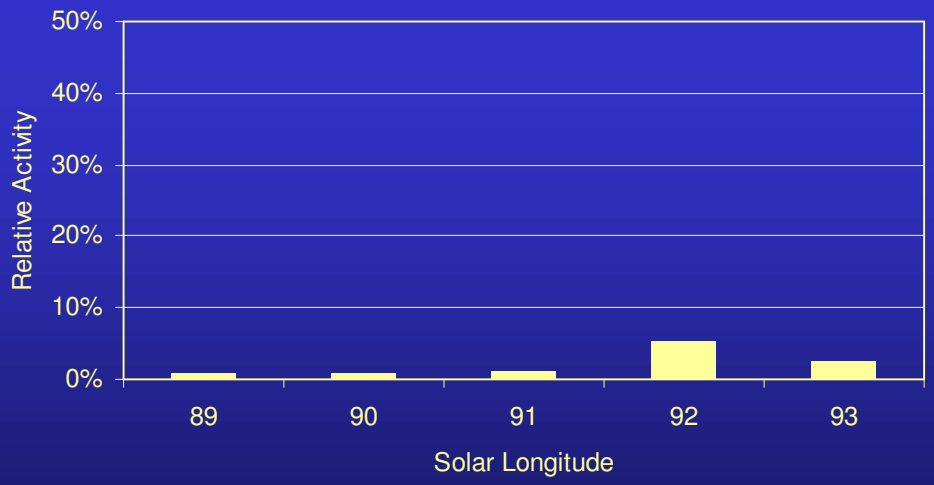


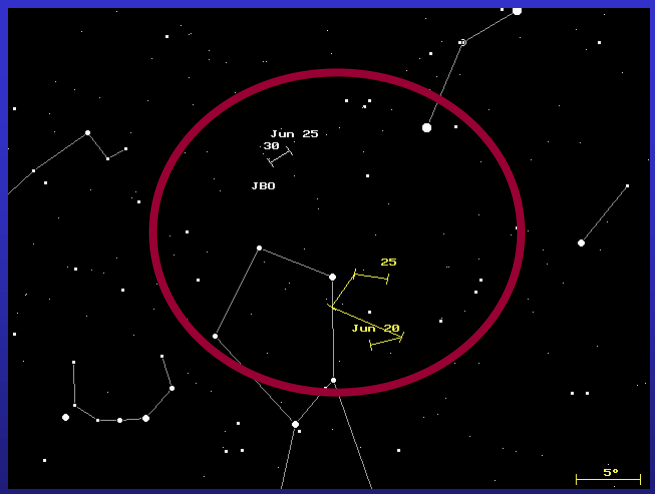


Results

	Period of Activity			Maximum		
	Solar Longitude	Date	Meteors	Solar Longitude	Date	Activity
Shower 14a	89-93	Jun 20-Jun 25	58	92	Jun 24	5.4%
JBO	90-100	Jun 22-Jul 02	-	95	Jun 27	-

Mean Parameters	Solar Longitude	Date	Right Ascension	Declination	Drift	Velocity
Shower 14a	92	Jun 24	215.9	38.5	0.0 / 1.5	15 km/s
JBO			224	48	0.4 / -0.2	18 km/s

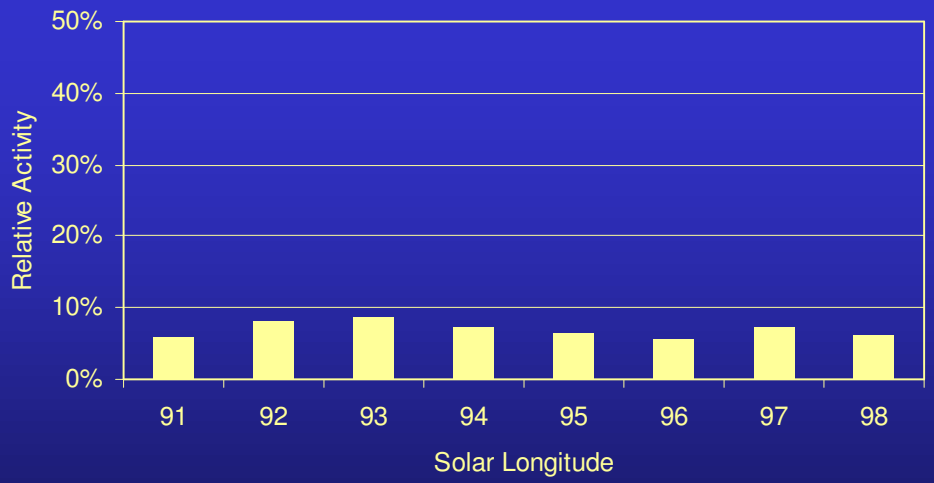


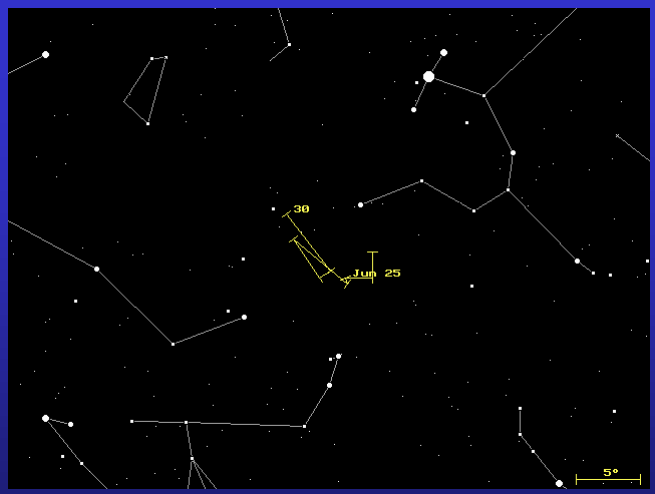


Results

	Period of Activity			Maximum		
	Solar Longitude	Date	Meteors	Solar Longitude	Date	Activity
Shower 16	91-98	Jun 23-Jun 30	288	93	Jun 25	8.7%
-	-	-	-	-		

Mean Parameters	Solar Longitude	Date	Right Ascension	Declination	Drift	Velocity
Shower 16	93	Jun 25	304.0	-6.5	0.9 / 0.3	40 km/s
-			-	-	-	-

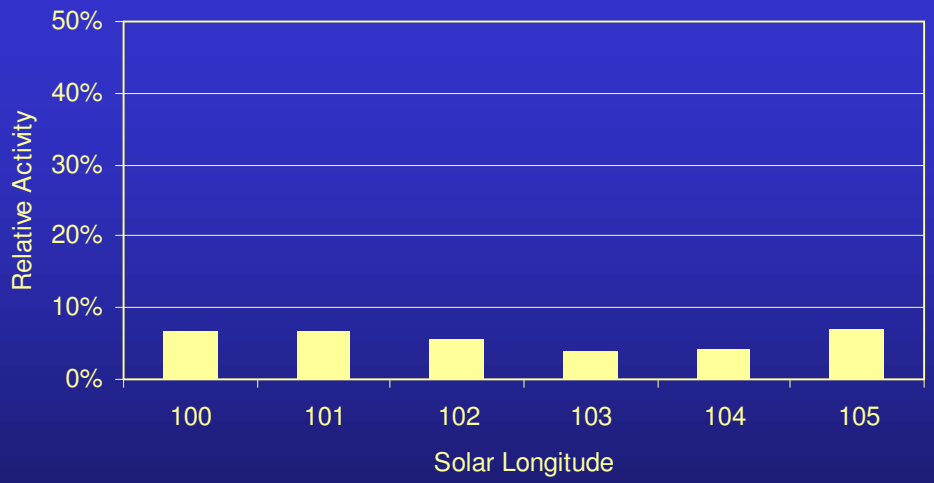


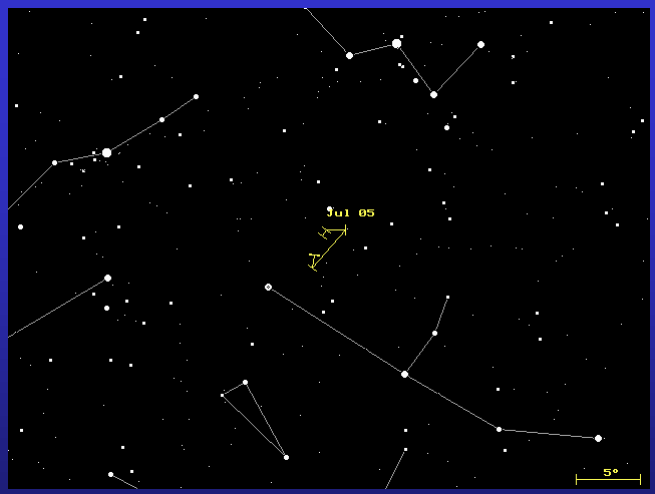


Results

	Period of Activity			Maximum		
	Solar Longitude	Date	Meteors	Solar Longitude	Date	Activity
Shower 18	100-105	Jul 02-Jul 07	123	105	Jul 07	6.9%
-	-	-	-	-		

Mean Parameters	Solar Longitude	Date	Right Ascension	Declination	Drift	Velocity
Shower 18	105	Jul 07	25.4	46.5	-0.3 / 0.5	56 km/s
-			-	-	-	-

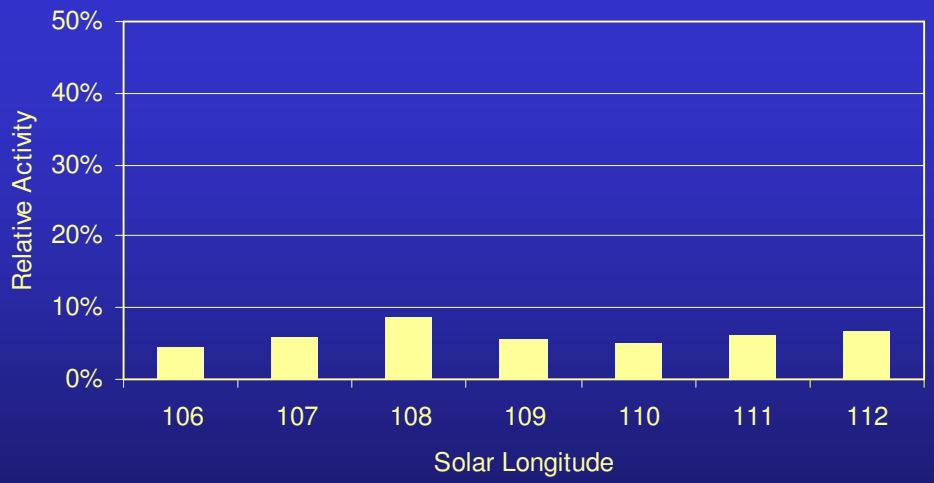


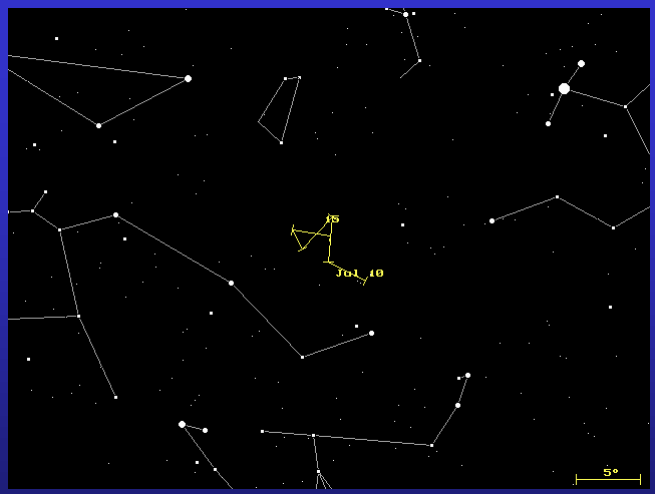


Results

	Period of Activity			Maximum		
	Solar Longitude	Date	Meteors	Solar Longitude	Date	Activity
Shower 19	106-112	Jul 08-Jul 15	251	108	Jul 10	8.7%
-	-	-	-	-		

Mean Parameters	Solar Longitude	Date	Right Ascension	Declination	Drift	Velocity
Shower 19	108	Jul 10	315.3	-4.0	0.6 / 0.6	40 km/s
-			-	-	-	-

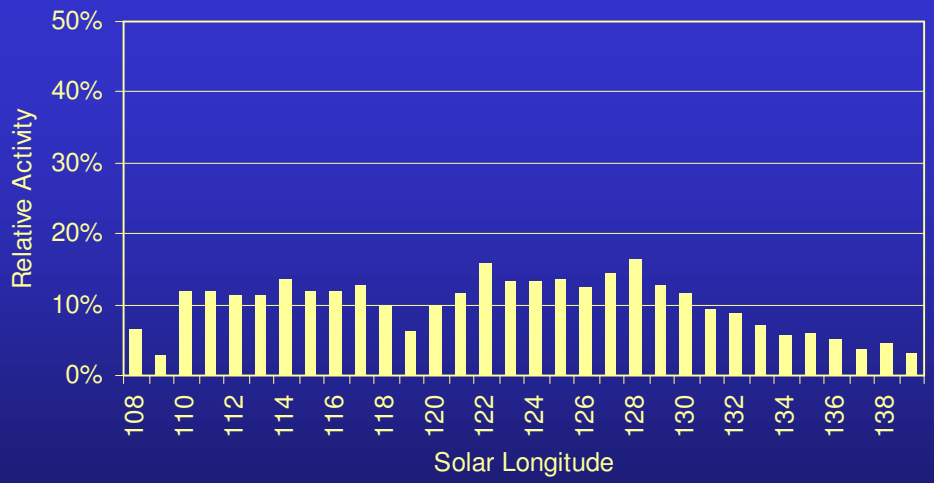


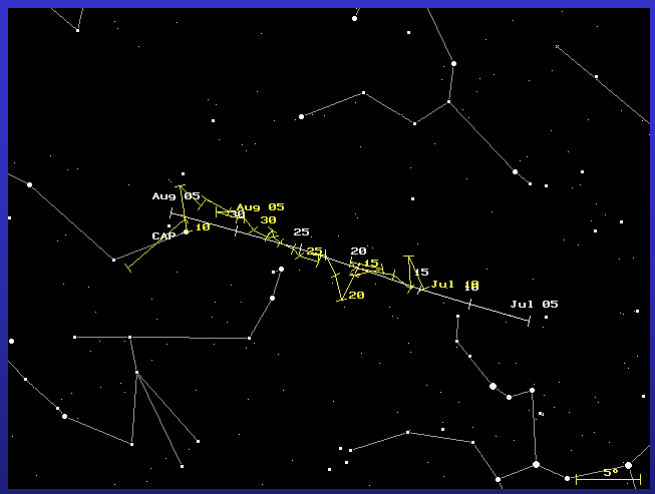


Results

	Period of Activity			Maximum		
	Solar Longitude	Date	Meteors	Solar Longitude	Date	Activity
Shower 20	108-139	Jul 10-Aug 12	2440	128	Jul 31	16.4%
CAP	101-142	Jul 03-Aug 15	-	127	Jul 30	-

Mean Parameters	Solar Longitude	Date	Right Ascension	Declination	Drift	Velocity
Shower 20	128	Jul 31	306.7	-9.5	0.6 / 0.2	24 km/s
CAP			308	-10	1.0 / 0.3	23 km/s

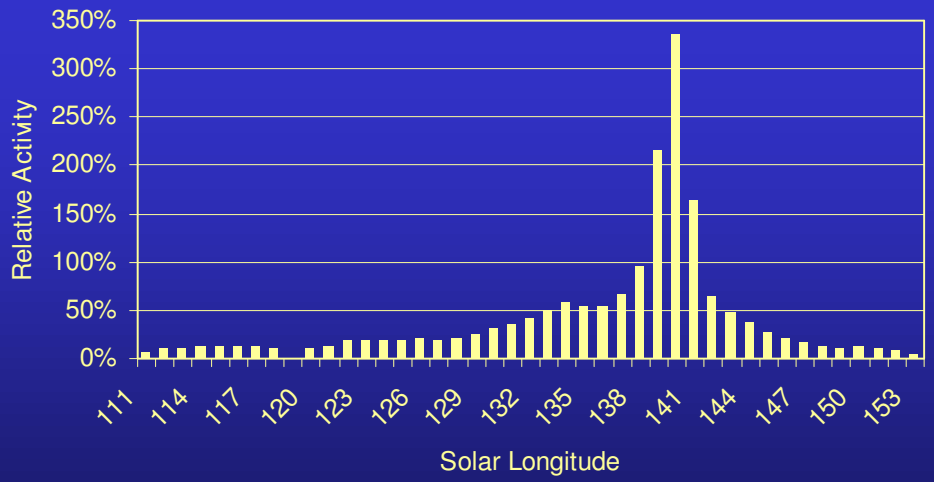


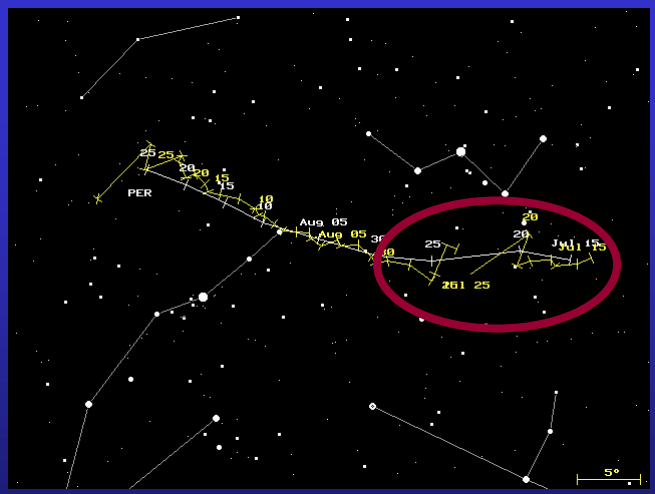


Results

	Period of Activity			Maximum		
	Solar Longitude	Date	Meteors	Solar Longitude	Date	Activity
Shower 22	111-118	Jul 14-Jul 21	523	116	Jul 19	12.5%
Shower 26	120-153	Jul 23-Aug 26	21176	140	Aug 13	335.1%
PER	114-151	Jul 17-Aug 24	-	139	Aug 12	-

Mean Parameters	Solar Longitude	Date	Right Ascension	Declination	Drift	Velocity
Shower 22	116	Jul 19	11.9	51.0	1.5 / 0.4	52 km/s
Shower 26	140	Aug 13	46.5	57.5	1.4 / 0.2	56 km/s
PER	139	Aug 12	46	58	1.3 / 0.2	59 km/s

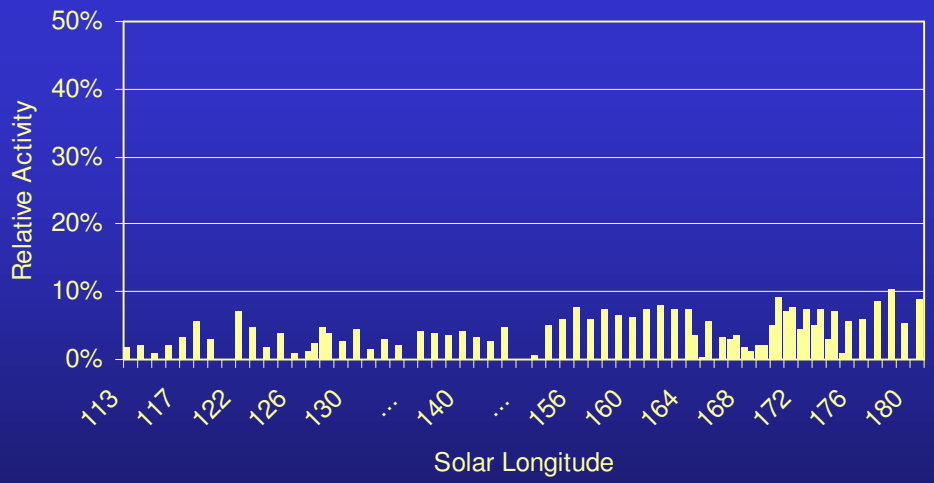


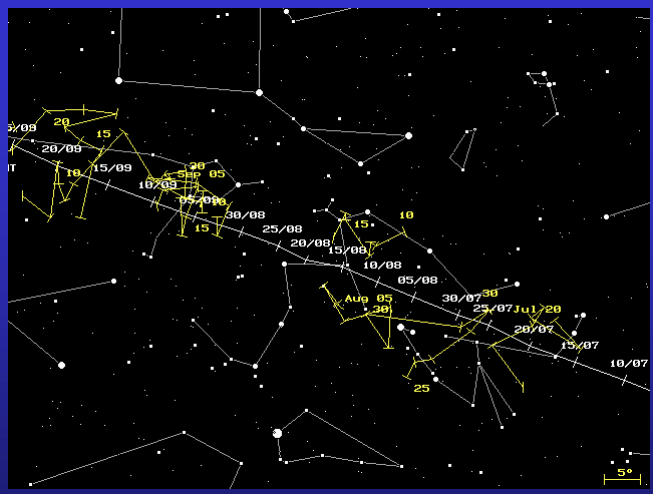


Results

	Period of Activity			Maximum		
	Solar Longitude	Date	Meteors	Solar Longitude	Date	Activity
Shower 23	113-119	Jul 16-Jul 22	88	118	Jul 21	5.6%
Shower 28	122-128	Jul 25-Jul 31	155	122	Jul 25	7.2%
Shower 30	127-133	Jul 30-Aug 06	185	130	Aug 02	4.3%
Shower 34	137-143	Aug 10-Aug 16	387	143	Aug 16	4.8%
Shower 42	153-165	Aug 26-Sep 08	1015	162	Sep 05	8.0%
Shower 48	164-169	Sep 07-Sep 12	272	165	Sep 08	5.6%
Shower 50	167-175	Sep 10-Sep 18	337	171	Sep 14	7.0%
Shower 51	170-180	Sep 13-Sep 23	865	178	Sep 21	10.3%
ANT	-	-	-	-	-	-

Mean Parameters	Solar Longitude	Date	Right Ascension	Declination	Drift	Velocity
Shower 23	118	Jul 21	314.6	-17.5	1.0 / -1.0	31 km/s
Shower 28	122	Jul 25	325.8	-22.5	-1.7 / 1.5	28 km/s
Shower 30	130	Aug 02	334.7	-15.5	1.3 / 0.6	28 km/s
Shower 34	143	Aug 16	336.3	-4.0	1.5 / 0.3	35 km/s
Shower 42	162	Sep 05	357.9	4.0	0.8 / 0.6	31 km/s
Shower 48	165	Sep 08	9.5	1.0	0.8 / -0.3	35 km/s
Shower 50	171	Sep 14	356.7	-3.5	0.6 / 0.0	25 km/s
Shower 51	175	Sep 18	9.5	7.7	1.0 / 0.5	32 km/s
ANT			305	-18	0.9 / 0.2	30 km/s

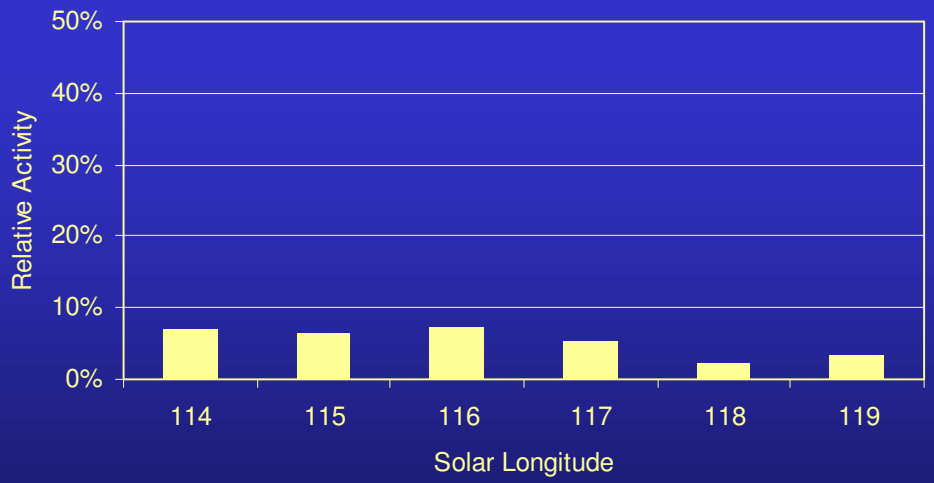


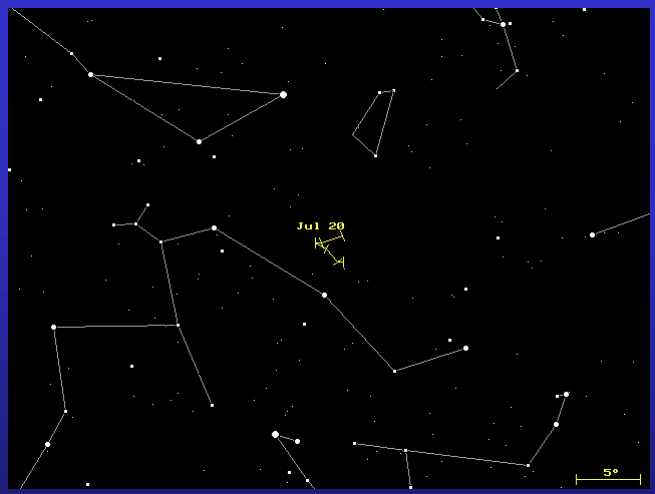


Results

	Period of Activity			Maximum		
	Solar Longitude	Date	Meteors	Solar Longitude	Date	Activity
Shower 24	114-119	Jul 17-Jul 22	159	116	Jul 19	7.2%
-	-	-	-	-		

Mean Parameters	Solar Longitude	Date	Right Ascension	Declination	Drift	Velocity
Shower 24	116	Jul 19	322.7	-2.0	0.1 / 0.4	39 km/s
-			-	-	-	-

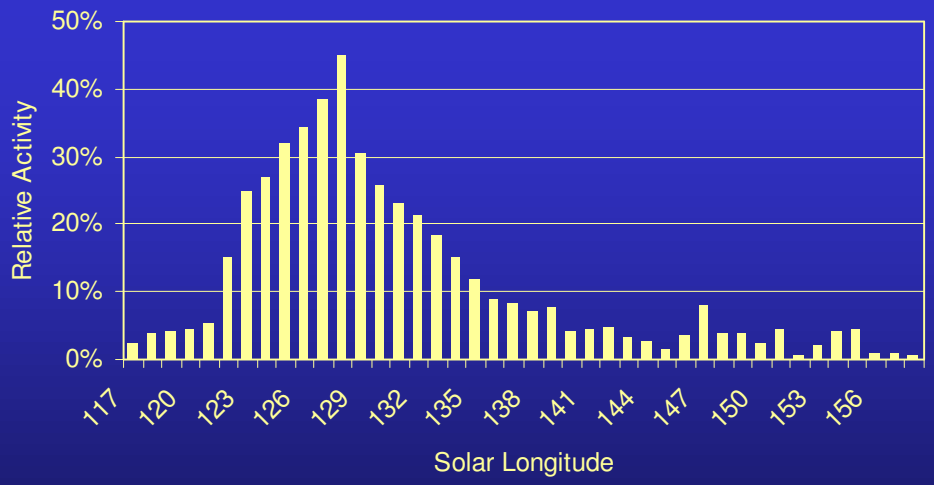


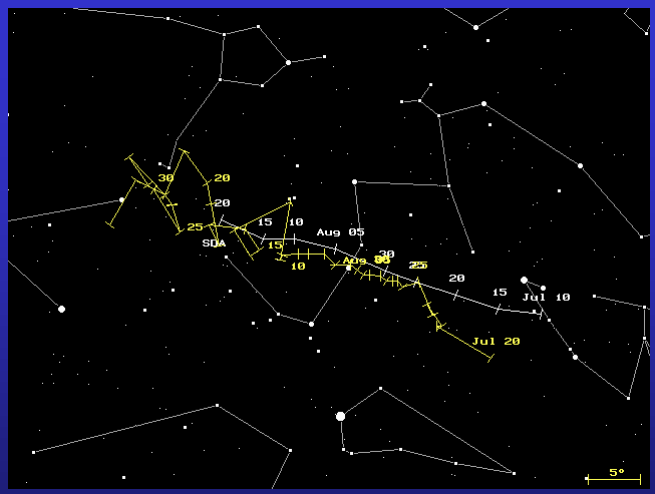


Results

	Period of Activity			Maximum		
	Solar Longitude	Date	Meteors	Solar Longitude	Date	Activity
Shower 25	117-158	Jul 20-Sep 01	4577	128	Jul 31	45.0%
SDA	110-146	Jul 13-Aug 19	-	125	Jul 28	-

Mean Parameters	Solar Longitude	Date	Right Ascension	Declination	Drift	Velocity
Shower 25	128	Jul 31	341.6	-16.5	0.8 / 0.3	41 km/s
SDA			339	-16	1.0 / 0.3	41 km/s

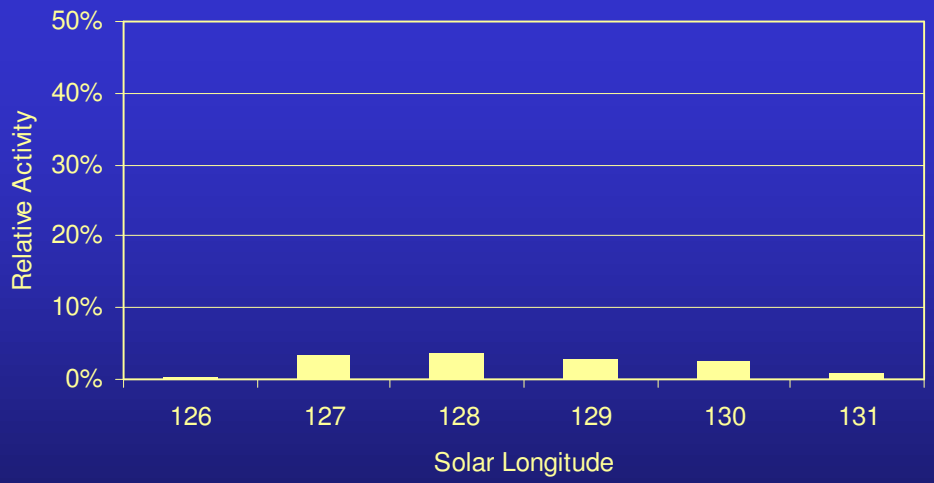


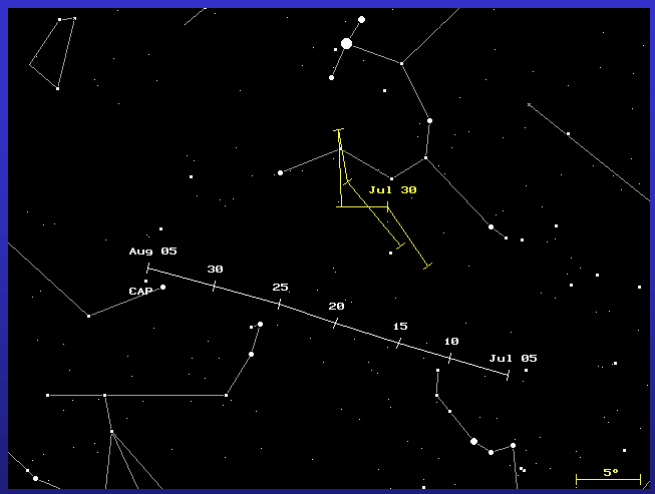


Results

	Period of Activity			Maximum		
	Solar Longitude	Date	Meteors	Solar Longitude	Date	Activity
Shower 29	126-131	Jul 29-Aug 04	133	128	Jul 31	3.6%
(CAP)	101-142	Jul 03-Aug 15	-	127	Jul 30	-

Mean Parameters	Solar Longitude	Date	Right Ascension	Declination	Drift	Velocity
Shower 29	128	Jul 31	298.1	-3.5	0.6 / 0.6	22 km/s
(CAP)			308	-10	1.0 / 0.3	23 km/s

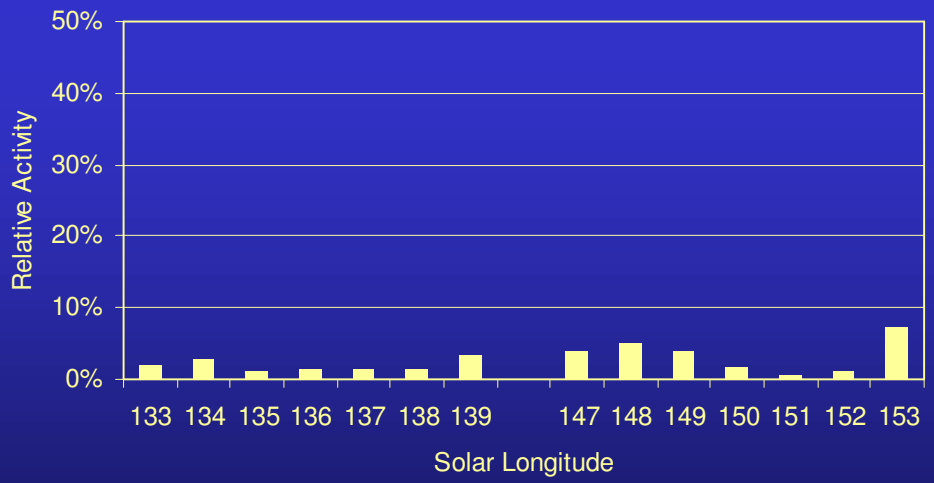


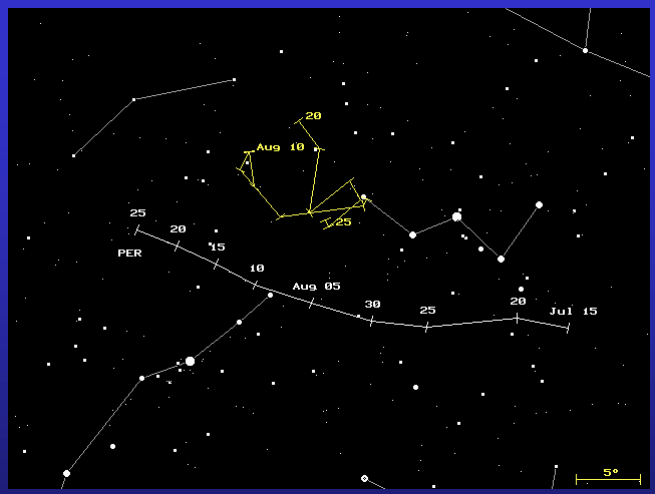


Results

	Period of Activity			Maximum		
	Solar Longitude	Date	Meteors	Solar Longitude	Date	Activity
Shower 31	133-139	Aug 06-Aug 12	164	139	Aug 12	3.4%
Shower 39	147-153	Aug 20-Aug 26	196	153	Aug 26	7.3%
(PER)	114-151	Jul 17-Aug 24	-	139	Aug 12	-

Mean Parameters	Solar Longitude	Date	Right Ascension	Declination	Drift	Velocity
Shower 31	139	Aug 12	47.9	64.0	3.9 / 0.5	50 km/s
Shower 39	153	Aug 26	35.1	62.0	-1.1 / -1.2	50 km/s
(PER)	139	Aug 12	46	58	1.3 / 0.2	59 km/s

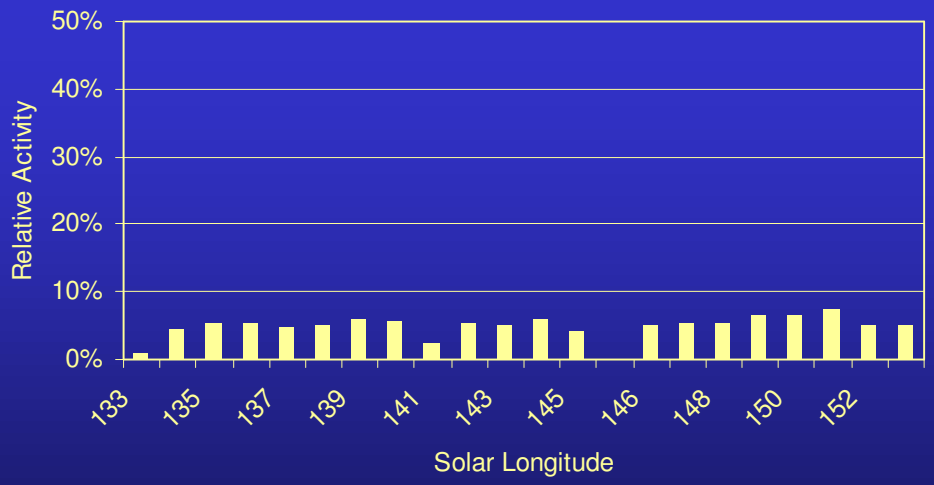


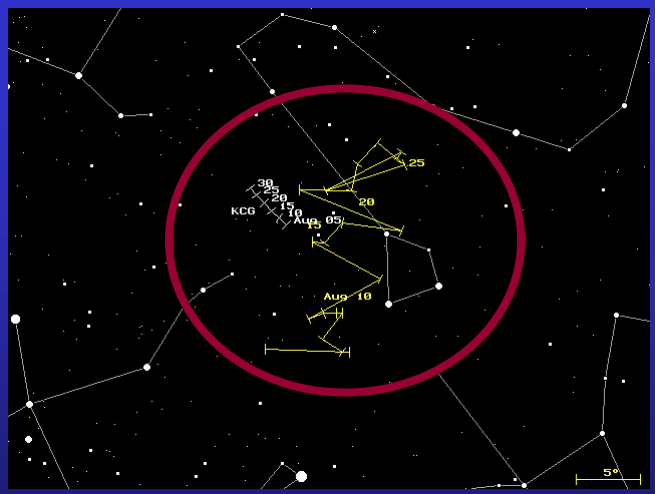


Results

	Period of Activity			Maximum		
	Solar Longitude	Date	Meteors	Solar Longitude	Date	Activity
Shower 32	133-145	Aug 06-Aug 18	802	144	Aug 17	5.8%
Shower 37	146-153	Aug 19-Aug 26	405	151	Aug 24	7.3%
KCG	131-152	Aug 04-Aug 25	-	144	Aug 17	-

Mean Parameters	Solar Longitude	Date	Right Ascension	Declination	Drift	Velocity
Shower 32	144	Aug 17	274.6	58.0	-0.5 / 0.9	24 km/s
Shower 37	151	Aug 24	277.2	60.5	-1.7 / 0.2	26 km/s
KCG	144	Aug 17	286	59	0.0 / 0.0	25 km/s

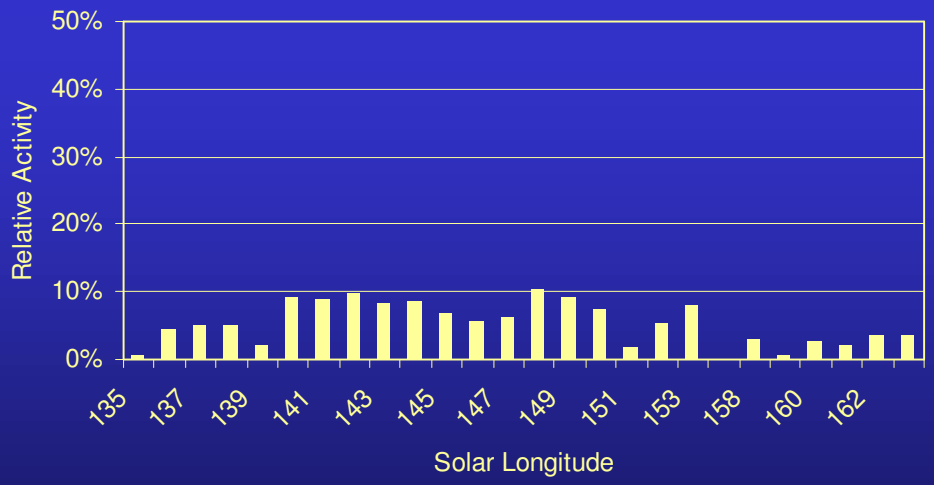


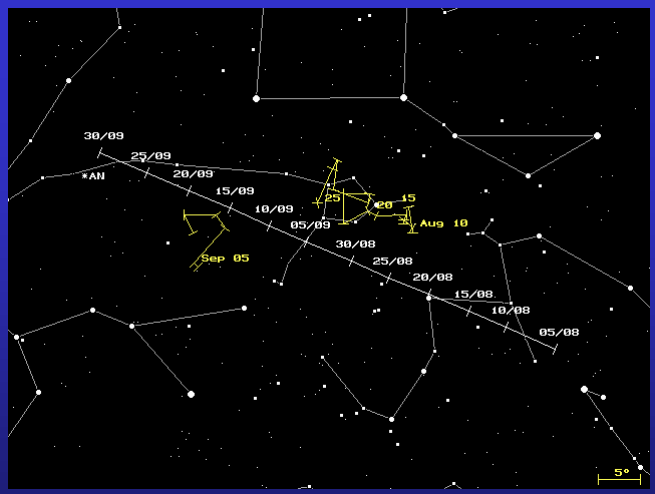


Results

	Period of Activity			Maximum		
	Solar Longitude	Date	Meteors	Solar Longitude	Date	Activity
Shower 33	135-153	Aug 08-Aug 26	1403	149	Aug 22	9.1%
Shower 46	158-163	Sep 01-Sep 06	227	162	Sep 05	3.5%
Anthelion	-	-	-	-	-	

Mean Parameters	Solar Longitude	Date	Right Ascension	Declination	Drift	Velocity
Shower 33	149	Aug 22	354.3	5.0	0.7 / 0.3	39 km/s
Shower 46	162	Sep 05	10.5	-3.5	-0.2 / -1.1	39 km/s
Anthelion	-	-	-	-	0.9 / 0.4	30 km/s

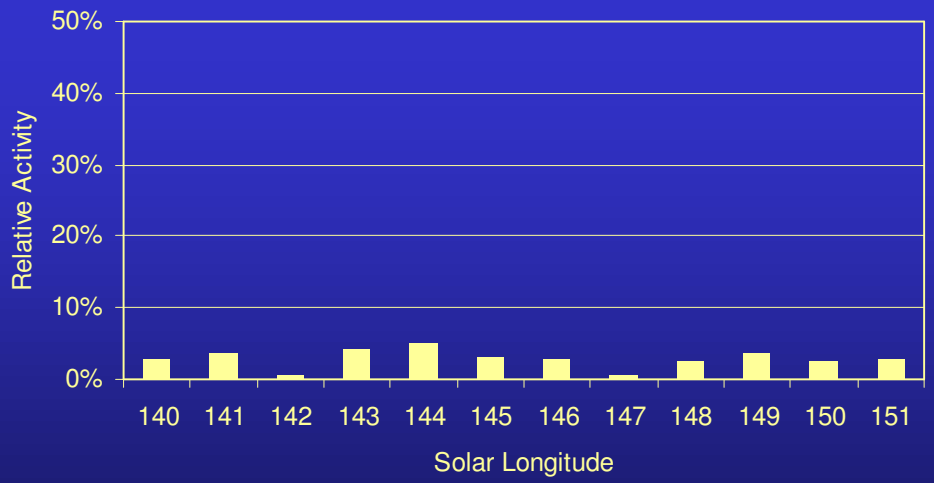


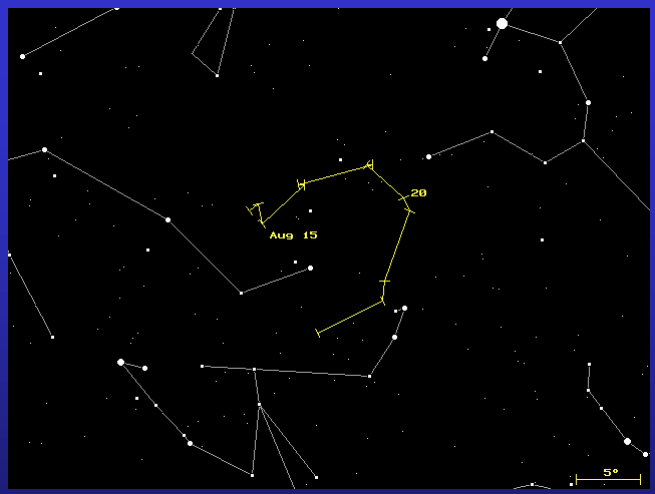


Results

	Period of Activity			Maximum		
	Solar Longitude	Date	Meteors	Solar Longitude	Date	Activity
Shower 36	140-151	Aug 13-Aug 24	376	149	Aug 22	3.5%
-	-	-	-	-		

Mean Parameters	Solar Longitude	Date	Right Ascension	Declination	Drift	Velocity
Shower 36	149	Aug 22	306.1	-10.5	-1.0 / -0.8	19 km/s
-			-	-	-	-

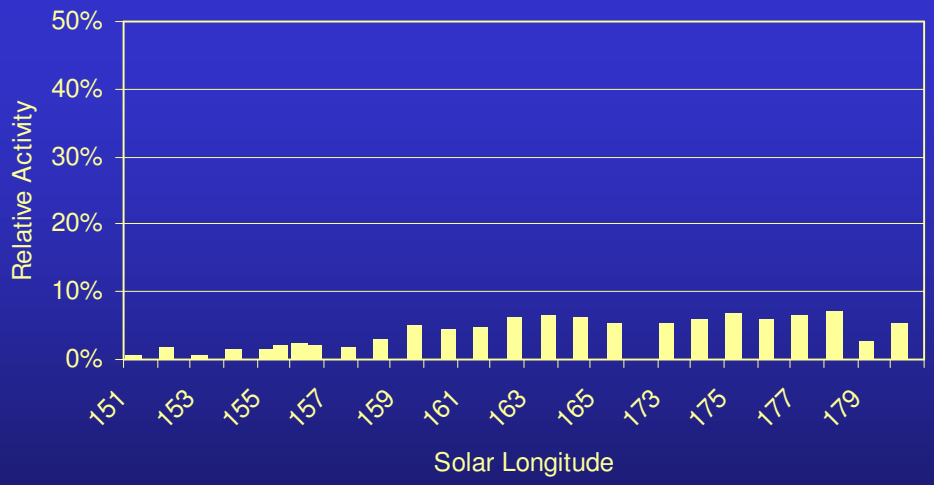


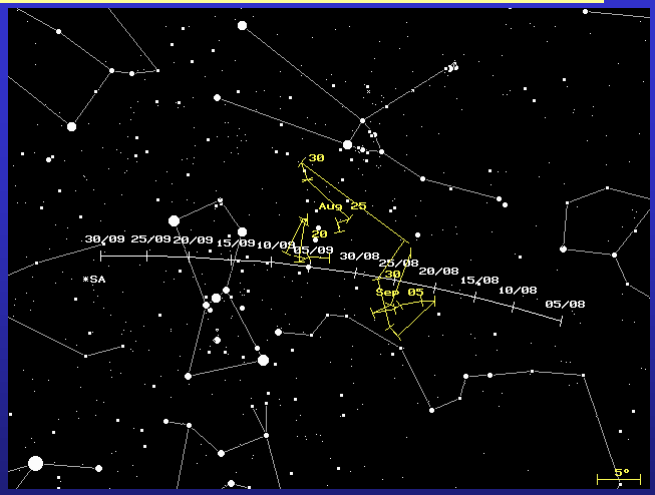


Results

	Period of Activity			Maximum		
	Solar Longitude	Date	Meteors	Solar Longitude	Date	Activity
Shower 40	151-156	Aug 24-Aug 30	88	156	Aug 30	2.4%
Shower 43	155-165	Aug 28-Sep 08	680	163	Sep 06	6.4%
Shower 52	173-180	Sep 16-Sep 23	465	178	Sep 21	7.1%
S Apex	-	-	-	-	-	

Mean Parameters	Solar Longitude	Date	Right Ascension	Declination	Drift	Velocity
Shower 40	156	Aug 30	74.4	14.5	1.1 / 1.7	65 km/s
Shower 43	163	Sep 06	66.1	-3.0	0.0 / -0.1	58 km/s
Shower 52	178	Sep 21	73.7	8.0	0.4 / 0.5	60 km/s
S Apex	-	-	-	-	0.9 / 0.2	60 km/s

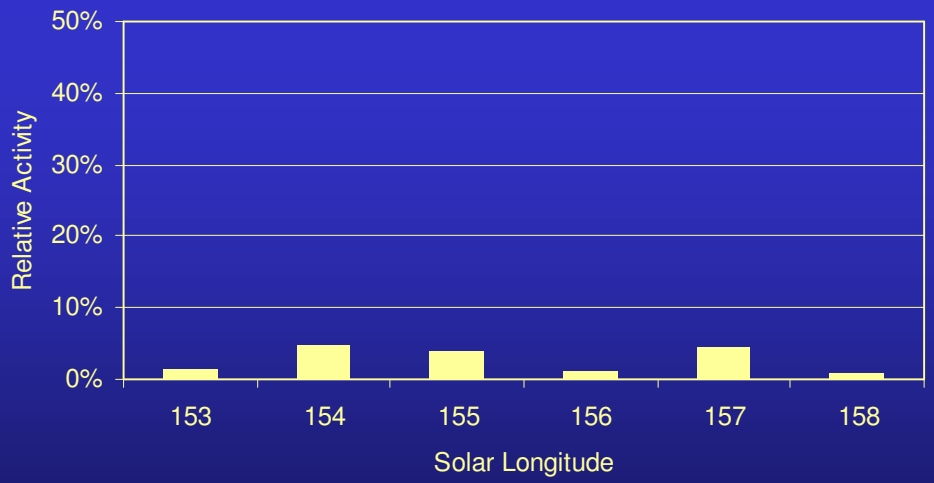


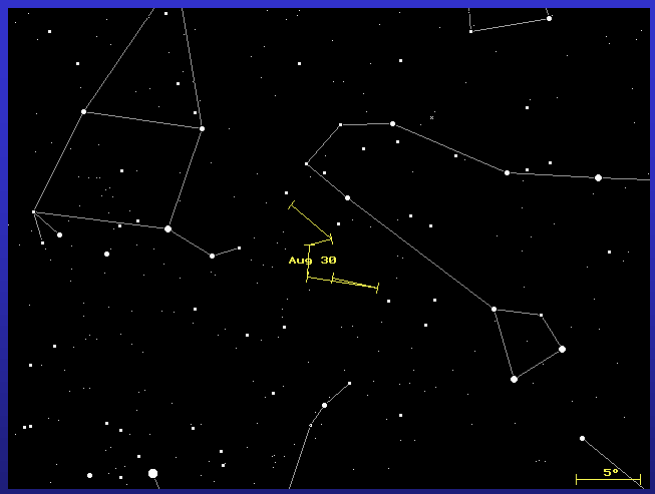


Results

	Period of Activity			Maximum		
	Solar Longitude	Date	Meteors	Solar Longitude	Date	Activity
Shower 41	153-158	Aug 26-Sep 01	172	154	Aug 27	4.7%
-	-	-	-	-		

Mean Parameters	Solar Longitude	Date	Right Ascension	Declination	Drift	Velocity
Shower 41	154	Aug 27	291.5	64.5	-1.8 / -1.2	30 km/s
-			-	-	-	-

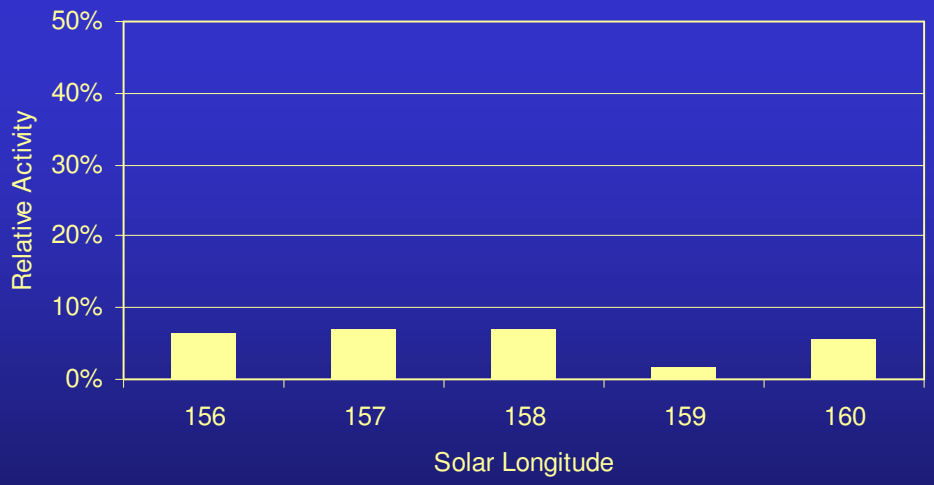


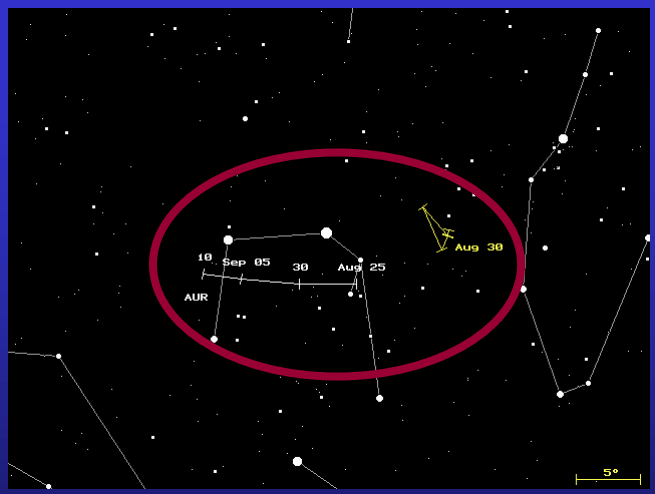


Results

	Period of Activity			Maximum		
	Solar Longitude	Date	Meteors	Solar Longitude	Date	Activity
Shower 41a	156-160	Aug 30-Sep 03	323	158	Sep 01	6.9%
AUR	152-165	Aug 25-Sep 08	-	158	Sep 01	-

Mean Parameters	Solar Longitude	Date	Right Ascension	Declination	Drift	Velocity
Shower 41a	158	Sep 01	68.1	47.5	-0.1 / 0.2	69 km/s
AUR			84	42	1.1 / 0.0	66 km/s

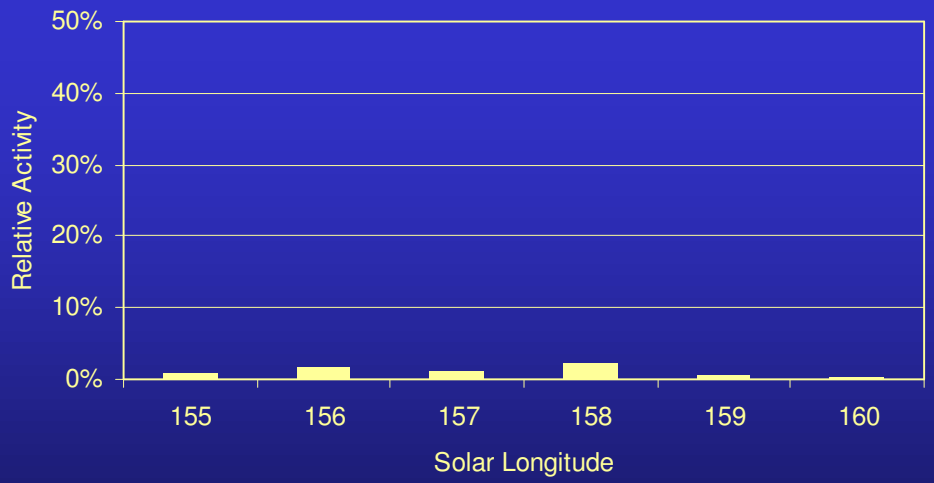


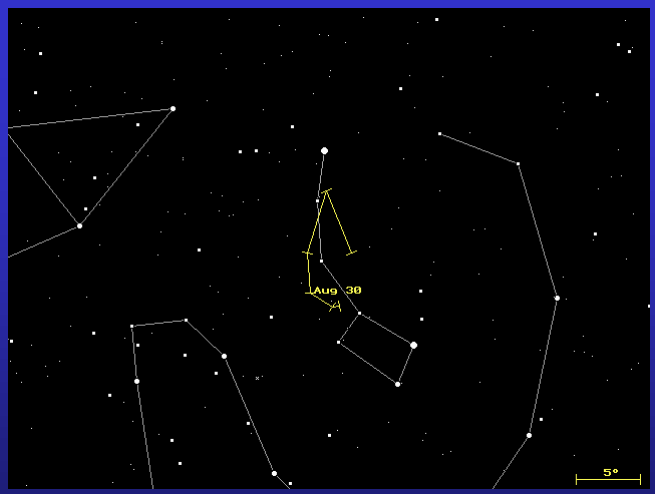


Results

	Period of Activity			Maximum		
	Solar Longitude	Date	Meteors	Solar Longitude	Date	Activity
Shower 44	155-160	Aug 28-Sep 03	80	158	Sep 01	2.3%
-	-	-	-	-		

Mean Parameters	Solar Longitude	Date	Right Ascension	Declination	Drift	Velocity
Shower 44	158	Sep 01	260.5	82.5	-0.7 / 1.4	38 km/s
-			-	-	-	-

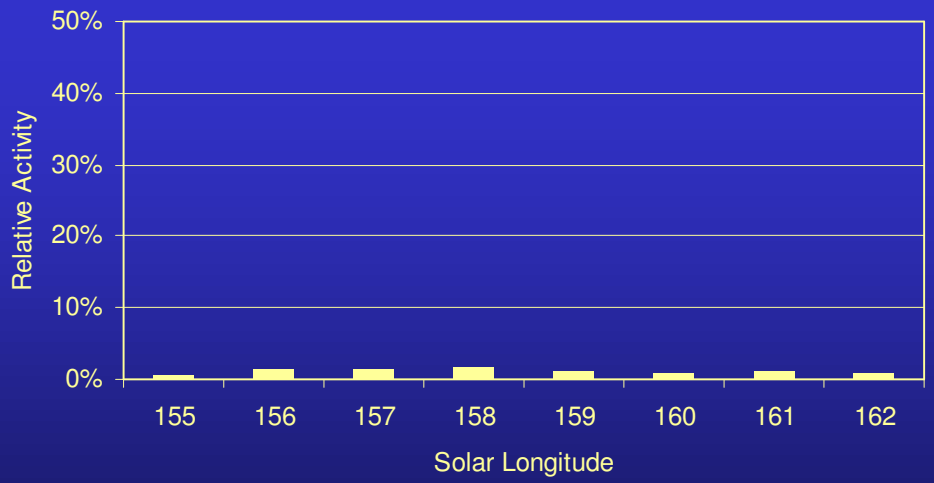


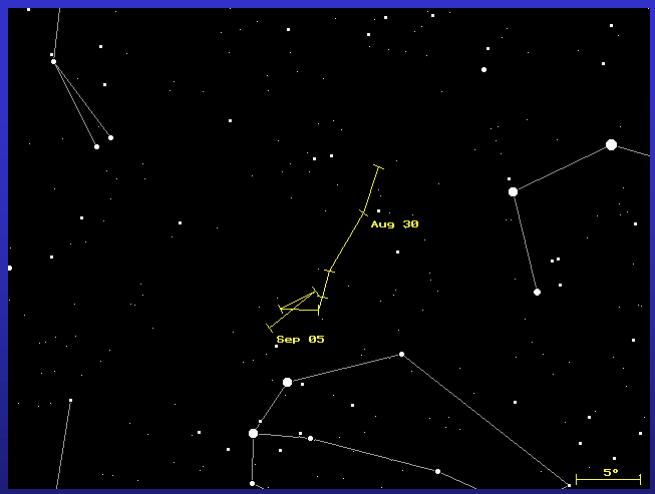


Results

	Period of Activity			Maximum		
	Solar Longitude	Date	Meteors	Solar Longitude	Date	Activity
Shower 45	155-162	Aug 28-Sep 05	113	158	Sep 01	1.6%
-	-	-	-	-		

Mean Parameters	Solar Longitude	Date	Right Ascension	Declination	Drift	Velocity
Shower 45	158	Sep 01	110.5	38.5	1.4 / -1.5	52 km/s
-			-	-	-	-

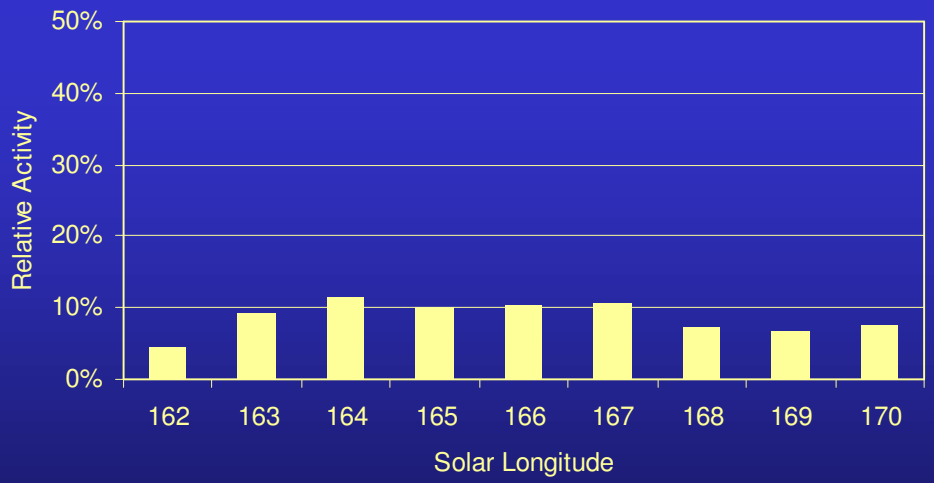


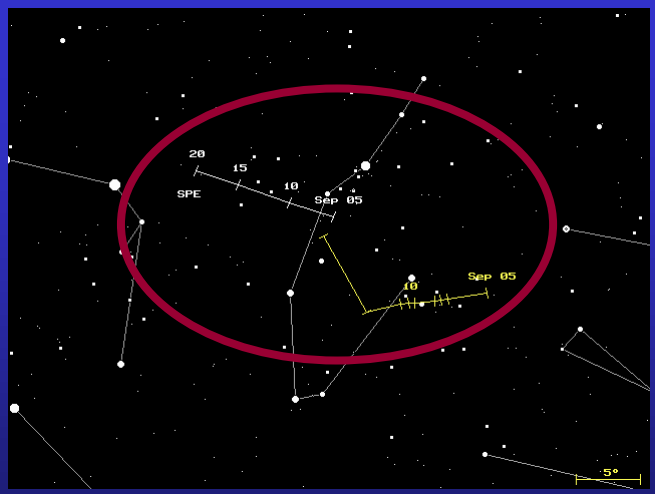


Results

	Period of Activity			Maximum		
	Solar Longitude	Date	Meteors	Solar Longitude	Date	Activity
Shower 47	162-170	Sep 05-Sep 13	1067	164	Sep 07	11.4%
SPE	162-174	Sep 05-Sep 17	-	166	Sep 09	-

Mean Parameters	Solar Longitude	Date	Right Ascension	Declination	Drift	Velocity
Shower 47	164	Sep 07	44.4	39.0	1.7 / 0.3	60 km/s
SPE			59	47	1.1 / 0.1	64 km/s

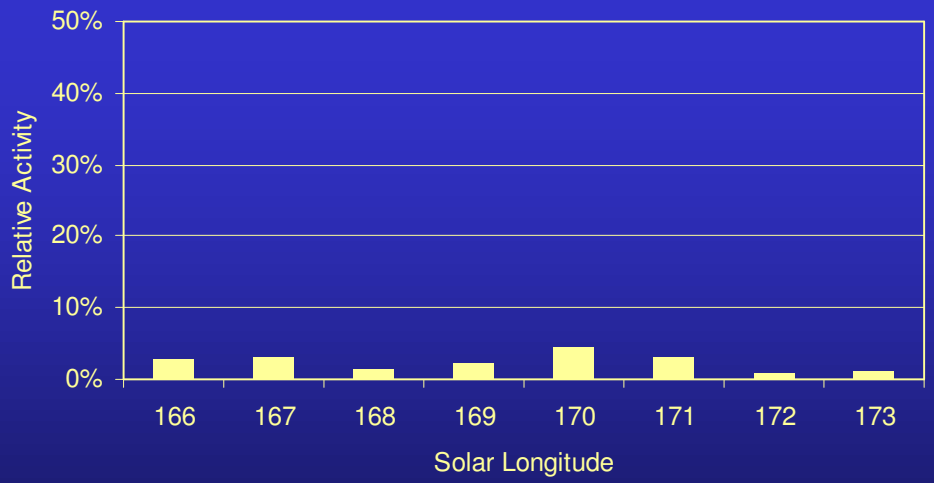


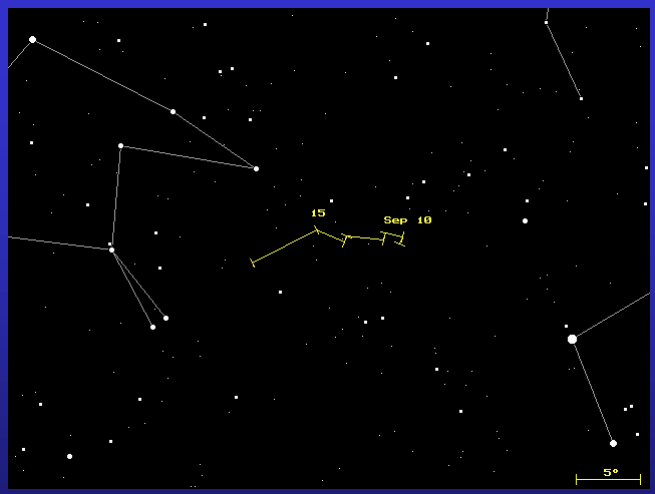


Results

	Period of Activity			Maximum		
	Solar Longitude	Date	Meteors	Solar Longitude	Date	Activity
Shower 49	166-173	Sep 09-Sep 16	220	170	Sep 13	4.5%
-	-	-	-	-		

Mean Parameters	Solar Longitude	Date	Right Ascension	Declination	Drift	Velocity
Shower 49	170	Sep 13	113.6	56.0	2.6 / -0.1	53 km/s
-			-	-	-	-

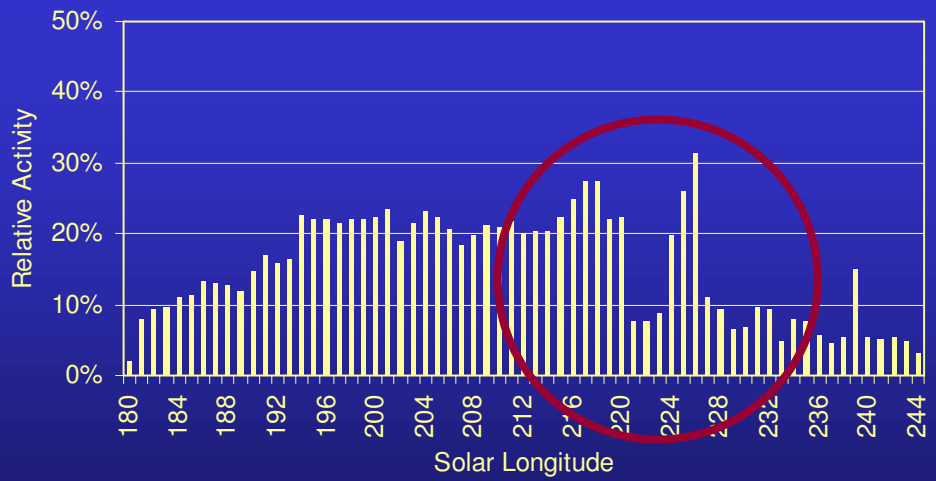


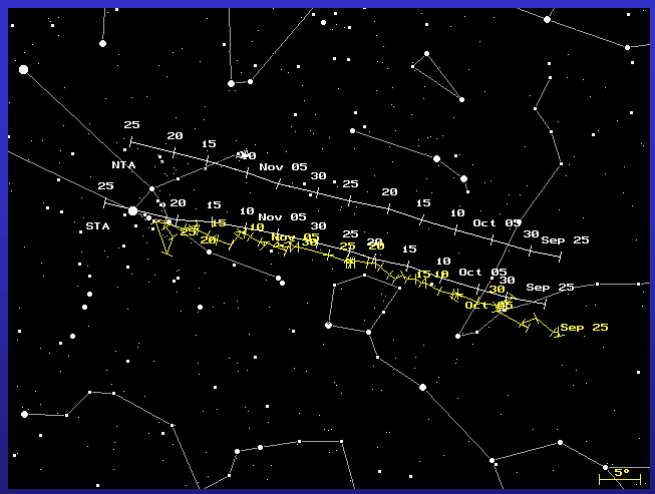


Results

	Period of Activity			Maximum		
	Solar Longitude	Date	Meteors	Solar Longitude	Date	Activity
Shower 53	180-244	Sep 23-Nov 26	10050	226	Nov 09	31.4%
STA	182-243	Sep 25-Nov 25	-	211	Oct 25	-

Mean Parameters	Solar Longitude	Date	Right Ascension	Declination	Drift	Velocity
Shower 53	226	Nov 09	55.9	15.0	0.7 / 0.2	30 km/s
STA			56	15	0.9 / 0.1	27 km/s

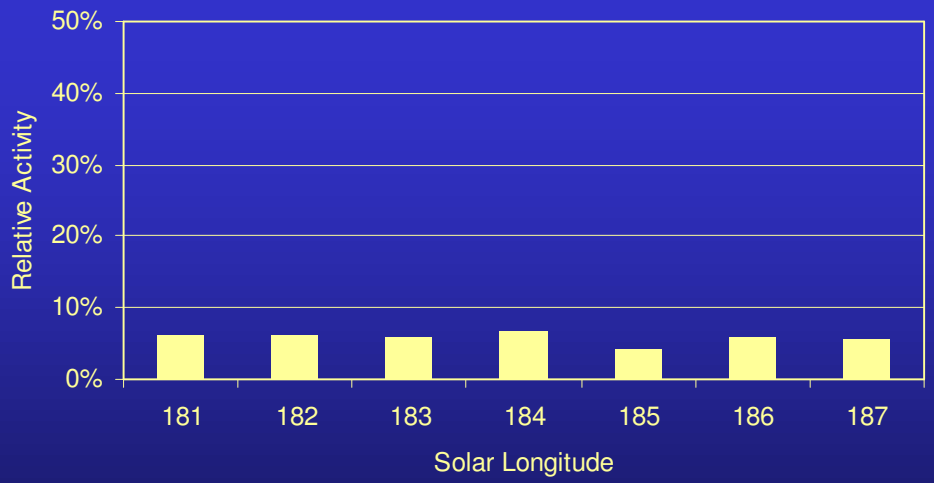


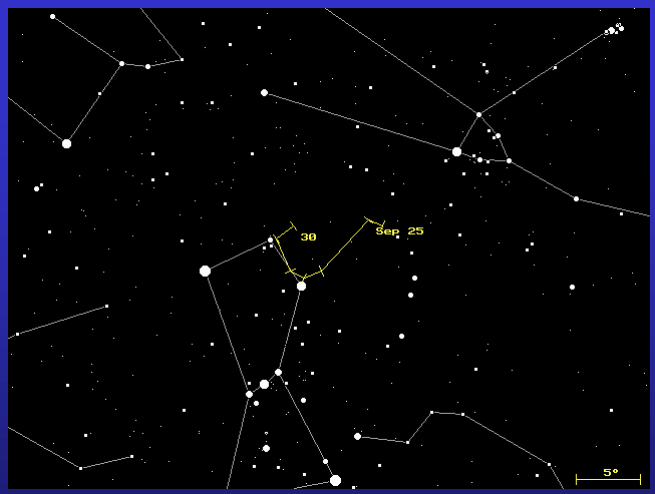


Results

	Period of Activity			Maximum		
	Solar Longitude	Date	Meteors	Solar Longitude	Date	Activity
Shower 54	181-187	Sep 24-Sep 30	432	184	Sep 27	6.6%
-	-	-	-	-		

Mean Parameters	Solar Longitude	Date	Right Ascension	Declination	Drift	Velocity
Shower 54	184	Sep 27	81.1	7.0	1.4 / -0.1	59 km/s
-			-	-	-	-

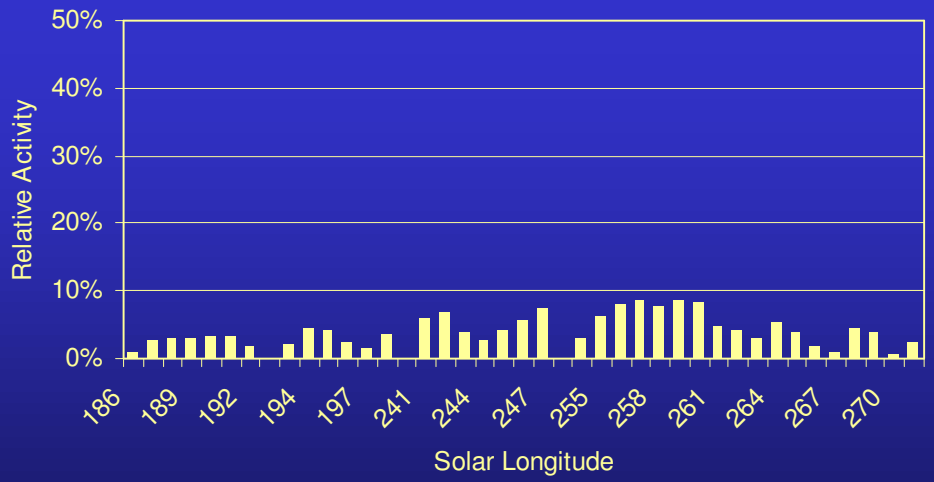


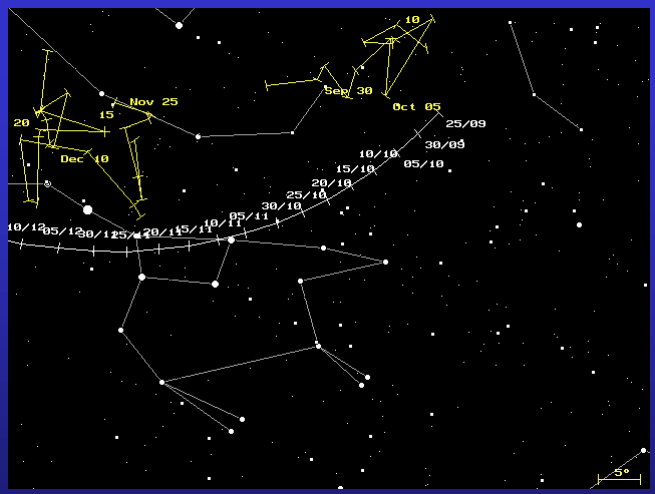


Results

	Period of Activity			Maximum		
	Solar Longitude	Date	Meteors	Solar Longitude	Date	Activity
Shower 55	186-192	Sep 29-Oct 05	156	191	Oct 04	3.4%
Shower 59	193-198	Oct 06-Oct 11	200	194	Oct 07	4.3%
Shower 73	241-247	Nov 23-Nov 29	167	247	Nov 29	7.4%
Shower 78	254-271	Dec 06-Dec 23	656	259	Dec 11	8.6%
N Toroidal	-	-	-	-	-	

Mean Parameters	Solar Longitude	Date	Right Ascension	Declination	Drift	Velocity
Shower 55	191	Oct 04	80.4	82.5	-13.8 / -0.1	44 km/s
Shower 59	194	Oct 07	79.0	82.0	1.7 / 0.0	42 km/s
Shower 73	247	Nov 29	198.6	64.5	-2.3 / -0.7	43 km/s
Shower 78	259	Dec 11	213.8	61.5	-1.3 / -0.1	41 km/s
N Toroidal	-	-	-	-	2.1 / -0.1	35 km/s

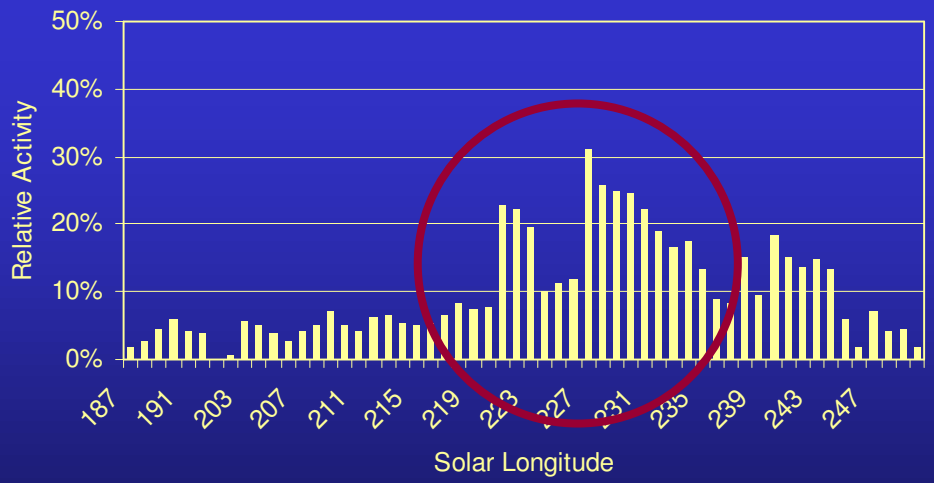


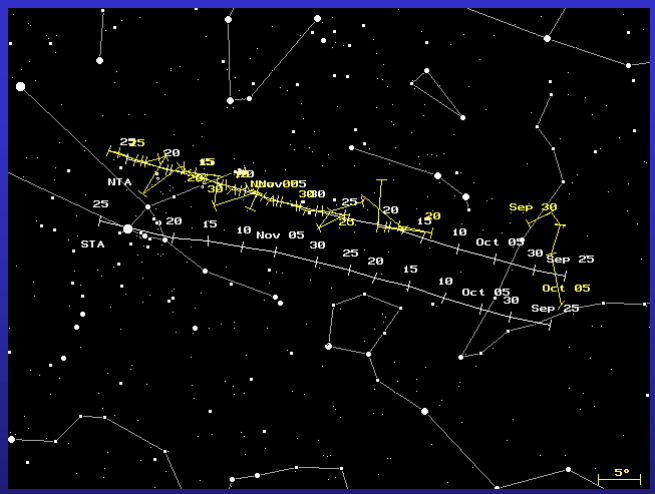


Results

	Period of Activity			Maximum		
	Solar Longitude	Date	Meteors	Solar Longitude	Date	Activity
Shower 56	187-192	Sep 30-Oct 05	179	190	Oct 03	6.0%
Shower 62	202-250	Oct 16-Dec 02	4532	227	Nov 10	31.2%
NTA	182-243	Sep 25-Nov 25	-	211	Oct 25	-

Mean Parameters	Solar Longitude	Date	Right Ascension	Declination	Drift	Velocity
Shower 56	190	Oct 03	18.8	16.5	-0.3 / -1.7	32 km/s
Shower 62	227	Nov 10	56.6	22.0	0.7 / 0.1	31 km/s
NTA	211	Oct 2	30	15	0.8 / 0.3	29 km/s

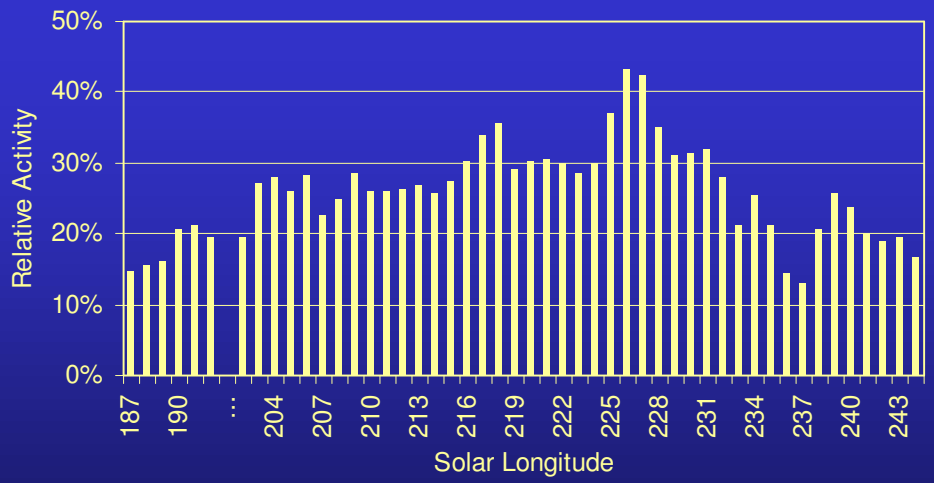


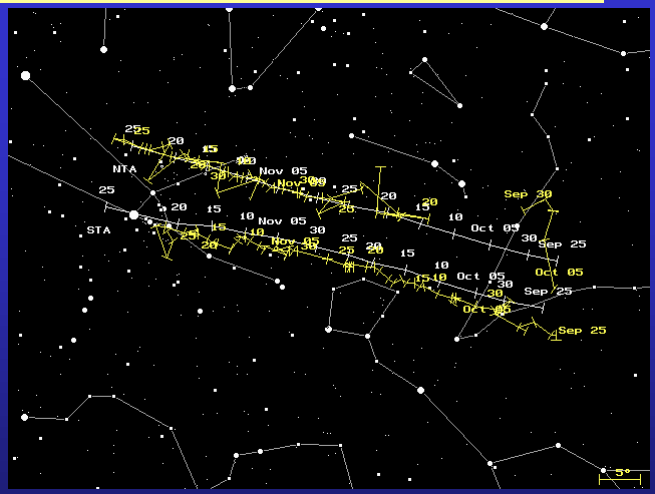


Results

	Period of Activity			Maximum		
	Solar Longitude	Date	Meteors	Solar Longitude	Date	Activity
Shower 53	180-244	Sep 23-Nov 26	10050	226	Nov 09	31.4%
Shower 56	187-192	Sep 30-Oct 05	179	190	Oct 03	6.0%
Shower 62	202-250	Oct 16-Dec 02	4532	227	Nov 10	31.2%
TAU	182-243	Sep 25-Nov 25	-	211	Oct 25	-

Mean Parameters	Solar Longitude	Date	Right Ascension	Declination	Drift	Velocity
Shower 53	226	Nov 09	55.9	15.0	0.7 / 0.2	30 km/s
Shower 56	190	Oct 03	18.8	16.5	-0.3 / -1.7	32 km/s
Shower 62	227	Nov 10	56.6	22.0	0.7 / 0.1	31 km/s
TAU	211	Oct 2	43	15	0.8 / 0.2	28 km/s

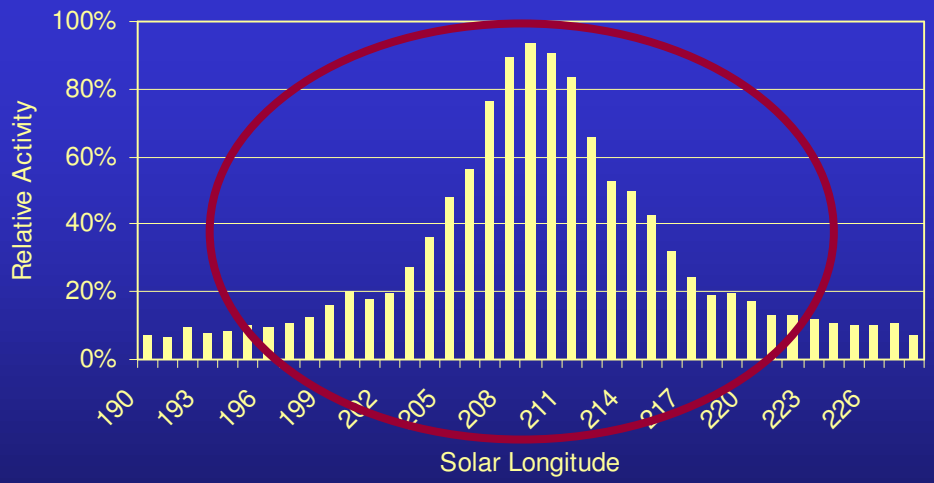


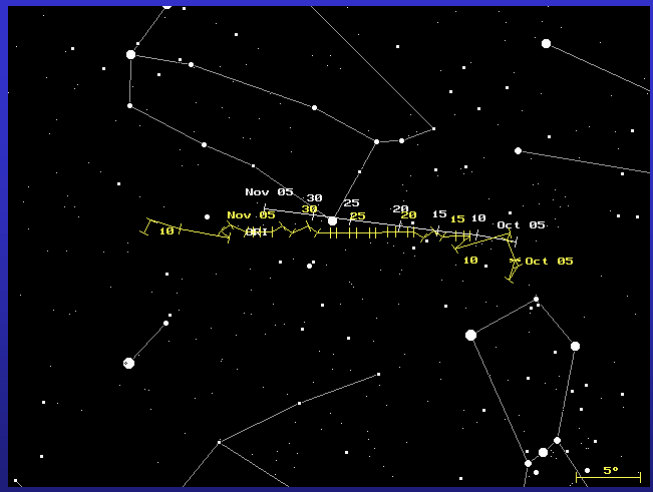


Results

	Period of Activity			Maximum		
	Solar Longitude	Date	Meteors	Solar Longitude	Date	Activity
Shower 57	190-228	Oct 03-Nov 11	11804	209	Oct 23	93.6%
ORI	189-224	Oct 02-Nov 07	-	207	Oct 21	-

Mean Parameters	Solar Longitude	Date	Right Ascension	Declination	Drift	Velocity
Shower 57	209	Oct 23	96.0	16.0	0.8 / 0.1	61 km/s
ORI			95	16	0.7 / 0.1	66 km/s

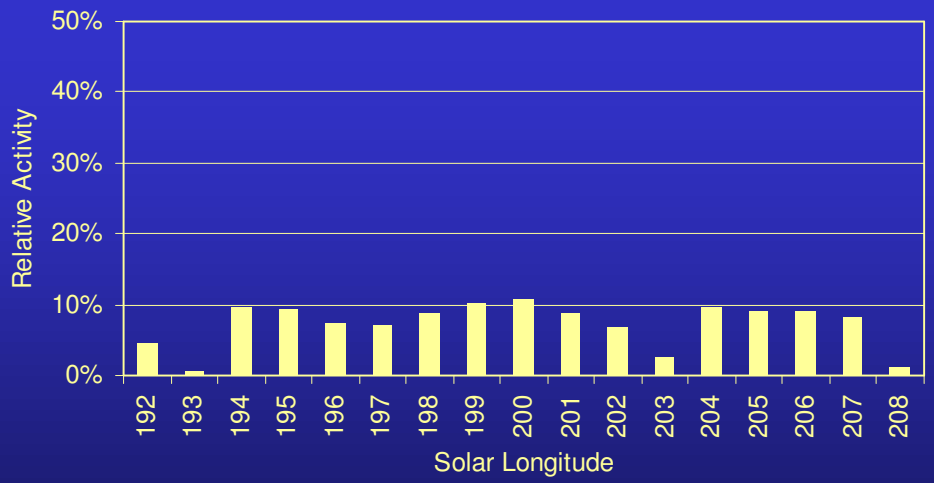


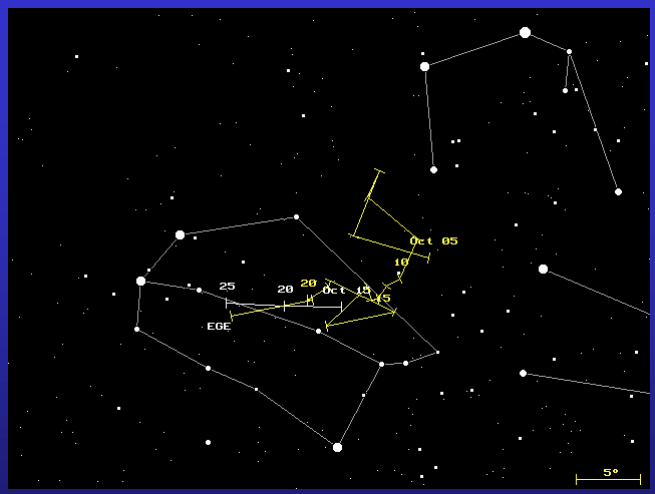


Results

	Period of Activity			Maximum		
	Solar Longitude	Date	Meteors	Solar Longitude	Date	Activity
Shower 58	192-208	Oct 05-Oct 22	1550	200	Oct 14	10.6%
EGE	200-213	Oct 14-Oct 27	-	204	Oct 18	-

Mean Parameters	Solar Longitude	Date	Right Ascension	Declination	Drift	Velocity
Shower 58	200	Oct 14	96.4	27.5	0.7 / -0.5	64 km/s
EGE			102	27	1.0 / 0.0	70 km/s

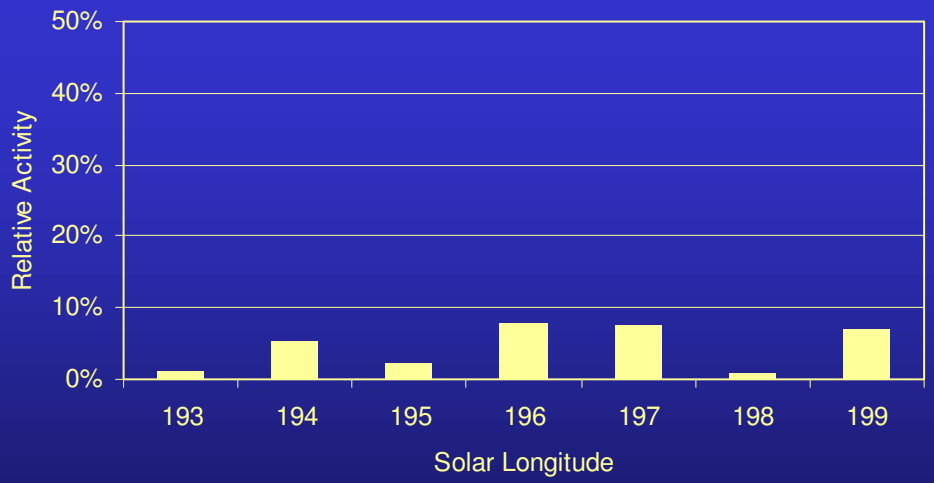


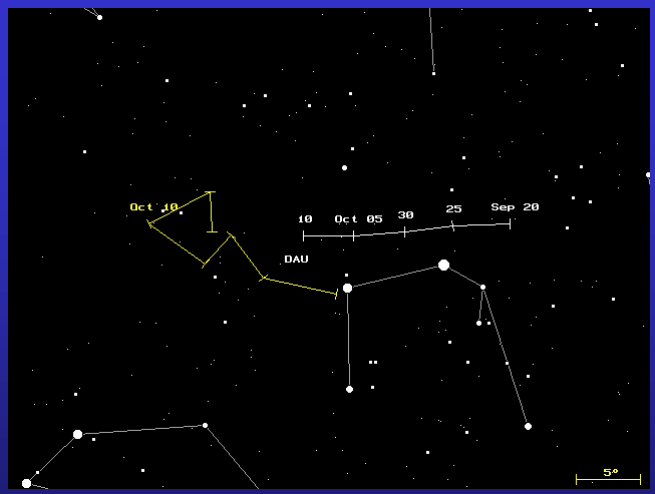


Results

	Period of Activity			Maximum		
	Solar Longitude	Date	Meteors	Solar Longitude	Date	Activity
Shower 60	193-199	Oct 06-Oct 12	374	196	Oct 09	7.9%
DAU	175-197	Sep 18-Oct 10	-	191	Oct 04	-

Mean Parameters	Solar Longitude	Date	Right Ascension	Declination	Drift	Velocity
Shower 60	196	Oct 09	105.8	46.0	2.4 / 0.8	64 km/s
DAU			88	49	1.0 / 0.0	64 km/s

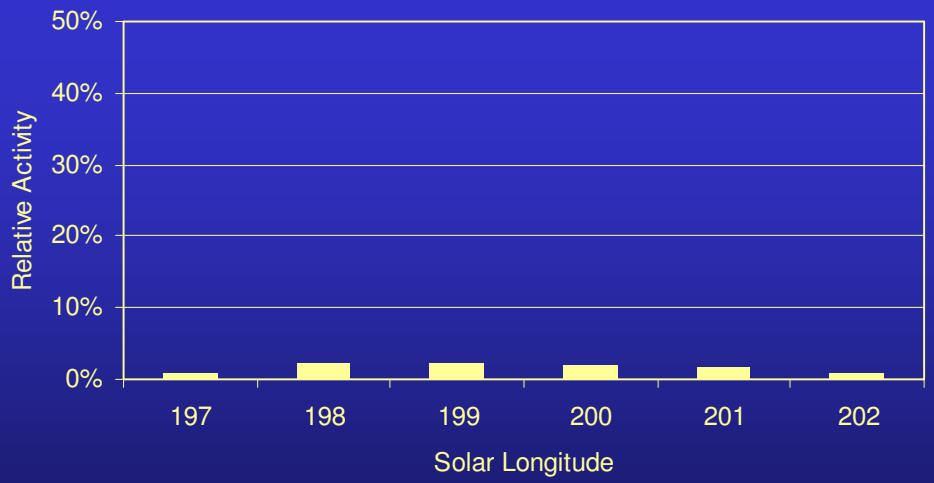


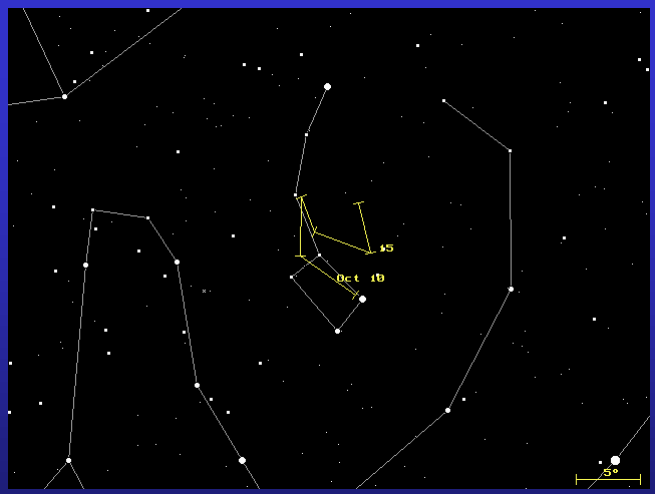


Results

	Period of Activity			Maximum		
	Solar Longitude	Date	Meteors	Solar Longitude	Date	Activity
Shower 61	197-202	Oct 10-Oct 16	141	199	Oct 12	2.1%
-	-	-	-	-		

Mean Parameters	Solar Longitude	Date	Right Ascension	Declination	Drift	Velocity
Shower 61	199	Oct 12	247.9	82.0	-3.6 / 0.9	35 km/s
-			-	-	-	-

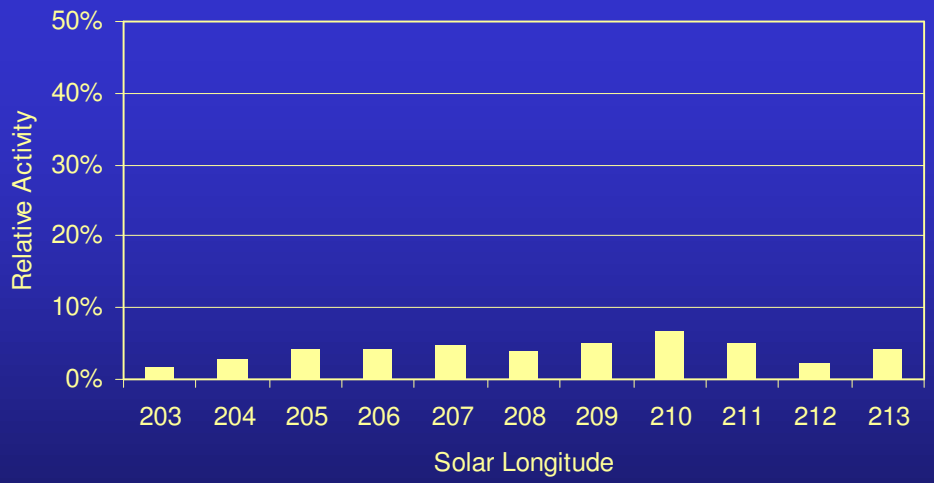


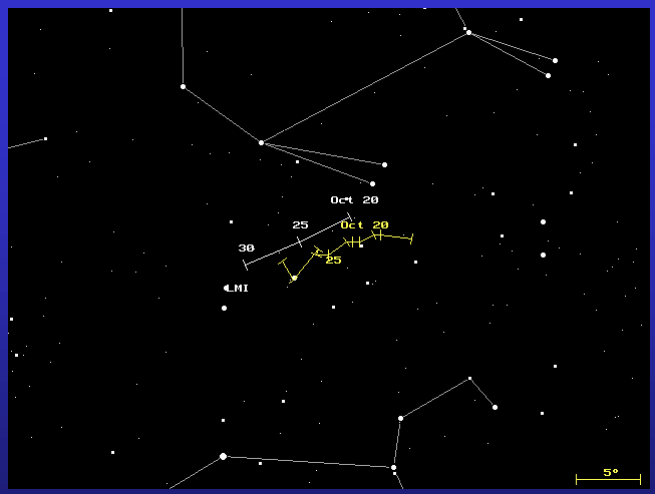


Results

	Period of Activity			Maximum		
	Solar Longitude	Date	Meteors	Solar Longitude	Date	Activity
Shower 63	203-213	Oct 17-Oct 27	469	210	Oct 24	6.8%
LMI	205-213	Oct 19-Oct 27	-	210	Oct 24	-

Mean Parameters	Solar Longitude	Date	Right Ascension	Declination	Drift	Velocity
Shower 63	210	Oct 24	161.3	36.0	1.1 / -0.3	56 km/s
LMI			162	37	1.0 / -0.4	62 km/s

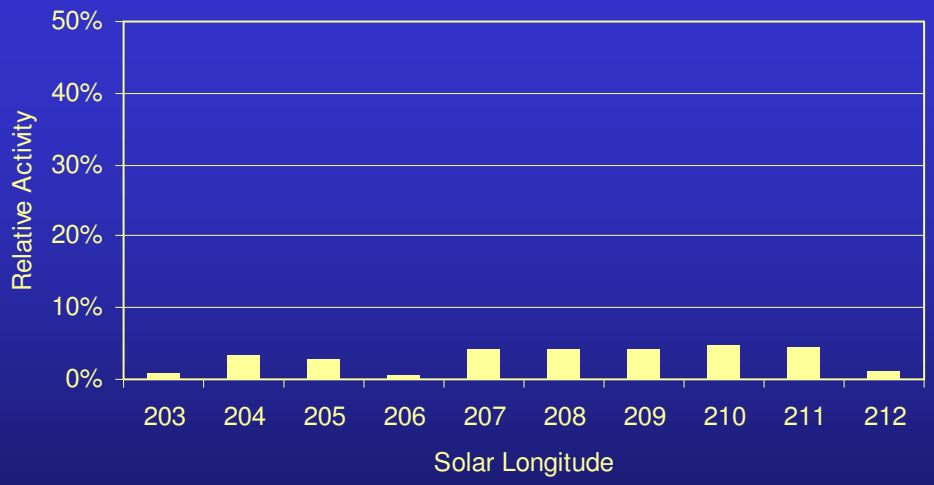


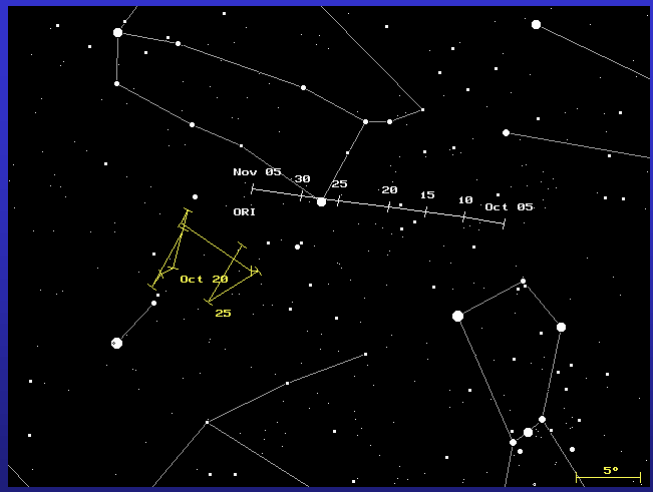


Results

	Period of Activity			Maximum		
	Solar Longitude	Date	Meteors	Solar Longitude	Date	Activity
Shower 64	203-212	Oct 17-Oct 26	309	210	Oct 24	4.7%
(ORI)	189-224	Oct 02-Nov 07	-	207	Oct 21	-

Mean Parameters	Solar Longitude	Date	Right Ascension	Declination	Drift	Velocity
Shower 64	210	Oct 24	104.4	11.0	-0.8 / -0.1	59 km/s
(ORI)			95	16	0.7 / 0.1	66 km/s

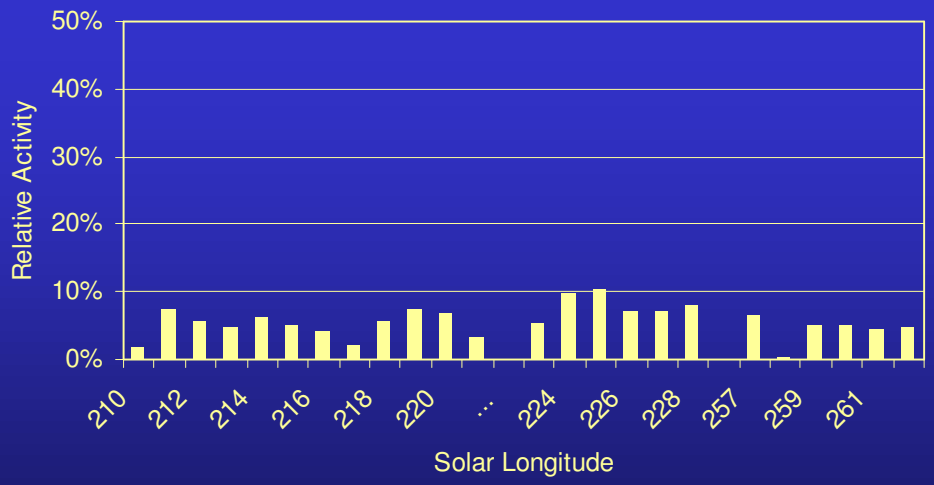


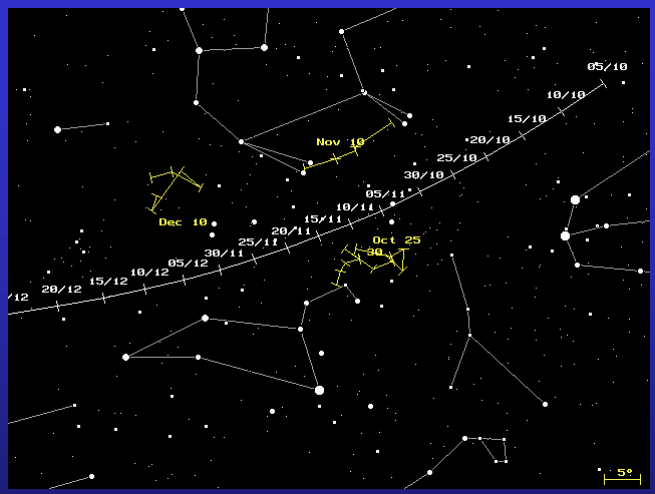


Results

	Period of Activity			Maximum		
	Solar Longitude	Date	Meteors	Solar Longitude	Date	Activity
Shower 65	210-221	Oct 24-Nov 04	569	220	Nov 03	6.9%
Shower 68	223-228	Nov 06-Nov 11	343	225	Nov 08	10.3%
Shower 80	257-262	Dec 09-Dec 14	220	257	Dec 09	6.5%
N Apex	-	-	-	-	-	

Mean Parameters	Solar Longitude	Date	Right Ascension	Declination	Drift	Velocity
Shower 65	220	Nov 03	148.9	28.0	0.8 / -0.2	63 km/s
Shower 68	225	Nov 08	145.8	44.5	2.9 / -0.9	58 km/s
Shower 80	257	Dec 09	178.8	35.0	0.0 / 0.7	53 km/s
N Apex			-	-	1.1 / -0.3	60 km/s

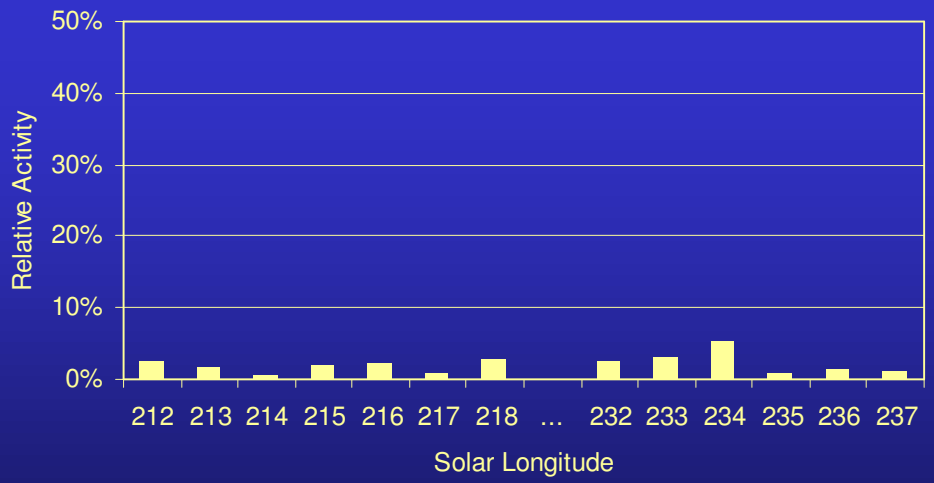


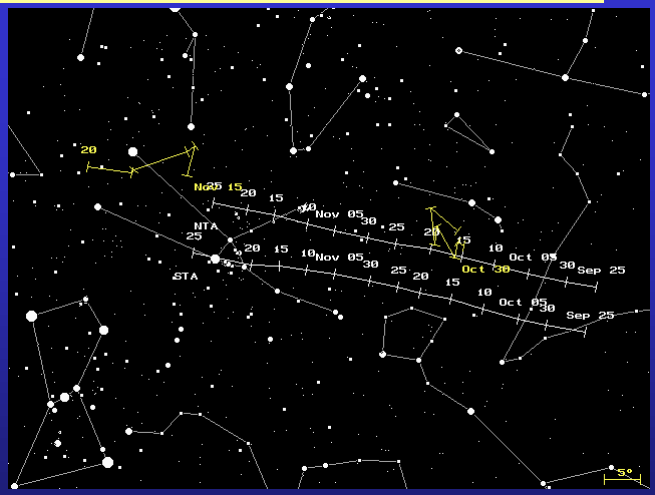


Results

	Period of Activity			Maximum		
	Solar Longitude	Date	Meteors	Solar Longitude	Date	Activity
Shower 66	212-218	Oct 26-Nov 01	115	218	Nov 01	2.7%
Shower 71	232-237	Nov 15-Nov 20	184	234	Nov 17	5.2%
(STA)	182-243	Sep 25-Nov 25	-	211	Oct 25	-
(NTA)	182-243	Sep 25-Nov 25	-	211	Oct 25	-

Mean Parameters	Solar Longitude	Date	Right Ascension	Declination	Drift	Velocity
Shower 66	218	Nov 01	33.6	18.0	-0.4 / -0.6	26 km/s
Shower 71	234	Nov 17	74.5	30.0	2.6 / -0.7	35 km/s
(STA)	211	Oct 25	56	15	0.9 / 0.1	27 km/s
(NTA)	211	Oct 25	56	22	0.9 / 0.2	29 km/s

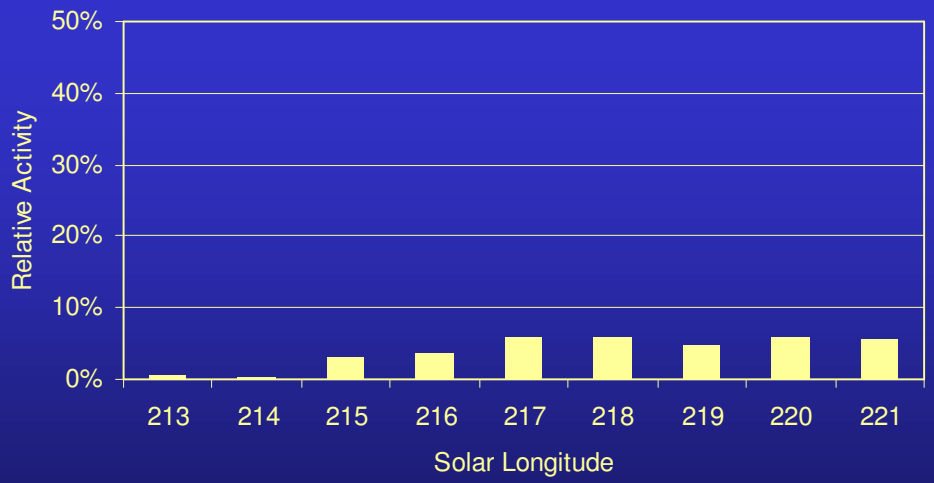


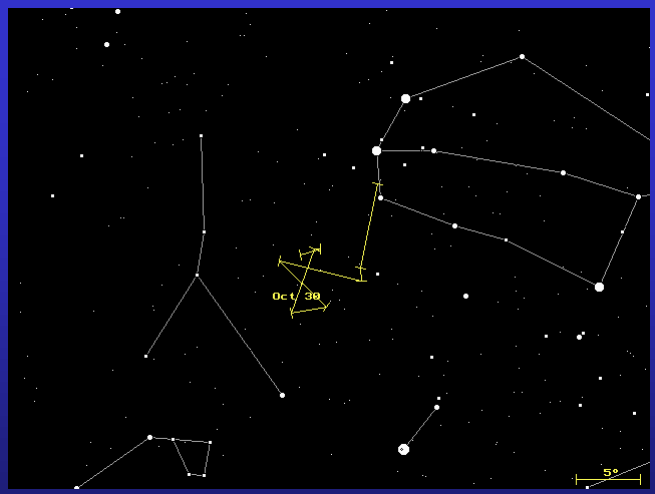


Results

	Period of Activity			Maximum		
	Solar Longitude	Date	Meteors	Solar Longitude	Date	Activity
Shower 67	213-221	Oct 27-Nov 04	324	217	Oct 31	6.0%
-	-	-	-	-		

Mean Parameters	Solar Longitude	Date	Right Ascension	Declination	Drift	Velocity
Shower 67	217	Oct 31	120.7	16.0	-0.7 / 0.3	60 km/s
-			-	-	-	-

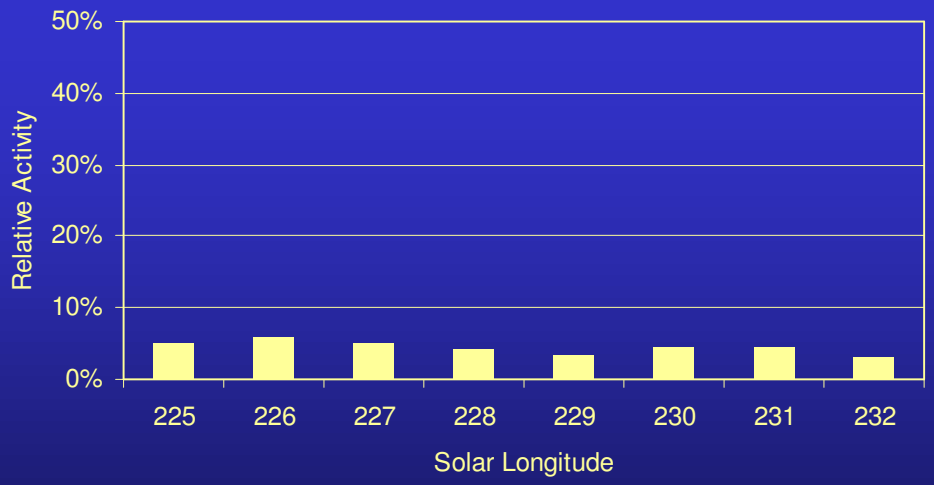


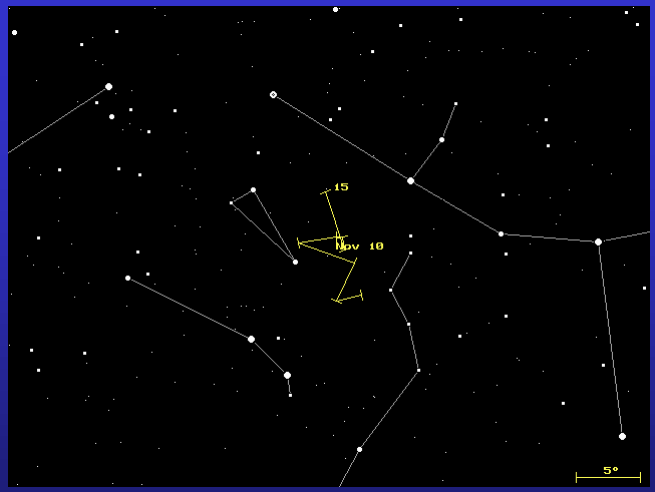


Results

	Period of Activity			Maximum		
	Solar Longitude	Date	Meteors	Solar Longitude	Date	Activity
Shower 69	225-232	Nov 08-Nov 15	204	226	Nov 09	5.9%
-	-	-	-	-		

Mean Parameters	Solar Longitude	Date	Right Ascension	Declination	Drift	Velocity
Shower 69	226	Nov 09	24.6	26.5	0.2 / 1.0	20 km/s
-			-	-	-	-

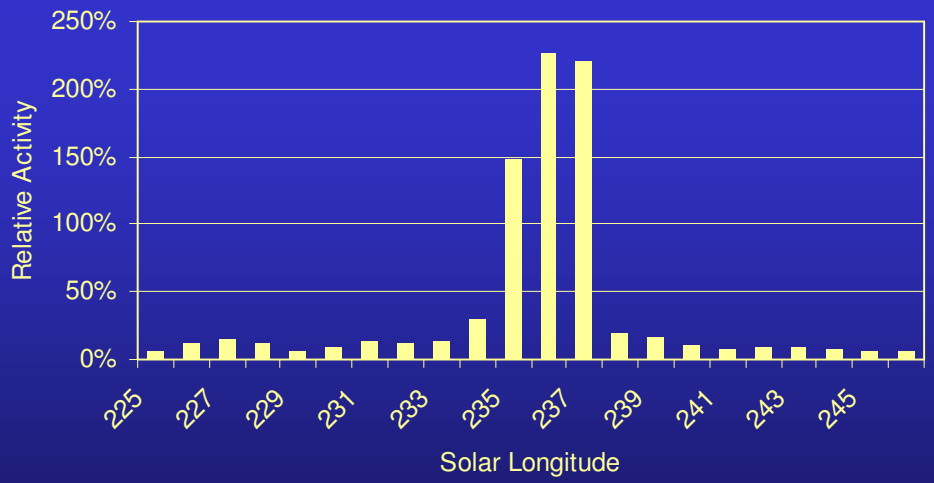


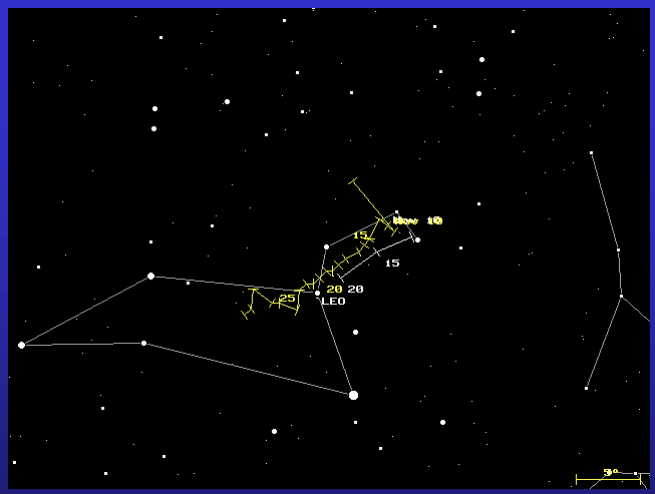


Results

	Period of Activity			Maximum		
	Solar Longitude	Date	Meteors	Solar Longitude	Date	Activity
Shower 70	225-246	Nov 08-Nov 28	18872	236	Nov 19	226.3%
LEO	227-241	Nov 10-Nov 23	-	234	Nov 17	-

Mean Parameters	Solar Longitude	Date	Right Ascension	Declination	Drift	Velocity
Shower 70	236	Nov 19	154.2	21.5	0.6 / -0.4	64 km/s
LEO			151	22	0.7 / -0.4	71 km/s

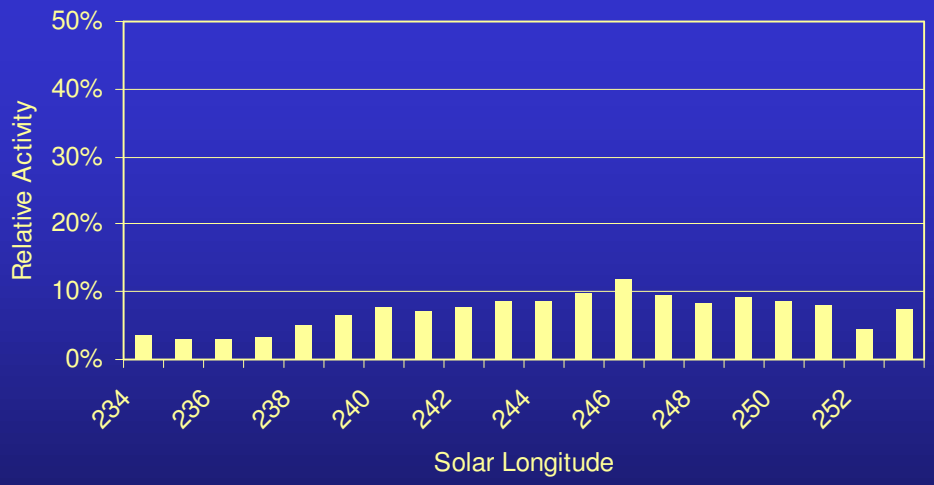


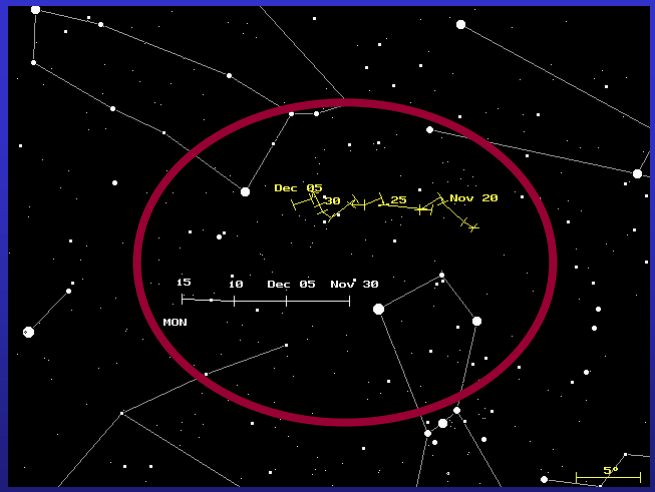


Results

	Period of Activity			Maximum		
	Solar Longitude	Date	Meteors	Solar Longitude	Date	Activity
Shower 72	234-253	Nov 17-Dec 05	915	246	Nov 28	11.8%
MON	245-265	Nov 27-Dec 17	-	257	Dec 09	-

Mean Parameters	Solar Longitude	Date	Right Ascension	Declination	Drift	Velocity
Shower 72	246	Nov 28	90.8	15.5	0.8 / 0.1	44 km/s
MON			103	8	0.9 / 0.0	42 km/s

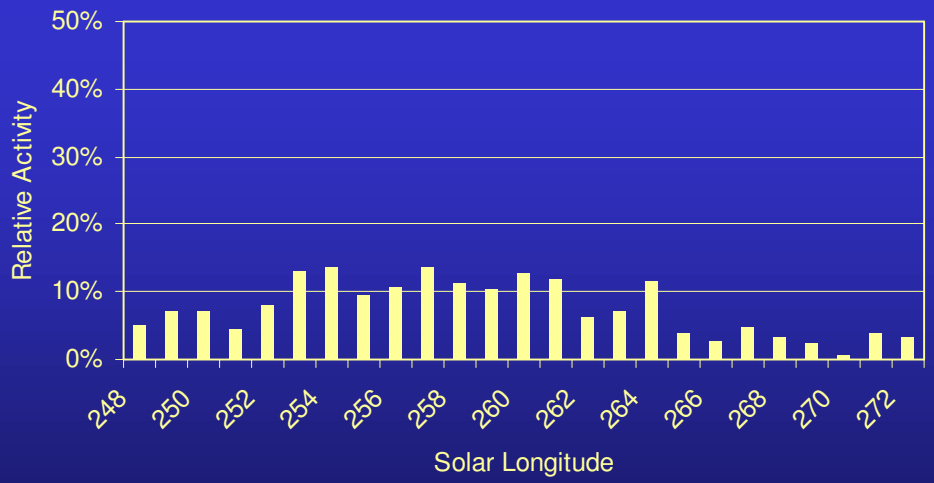


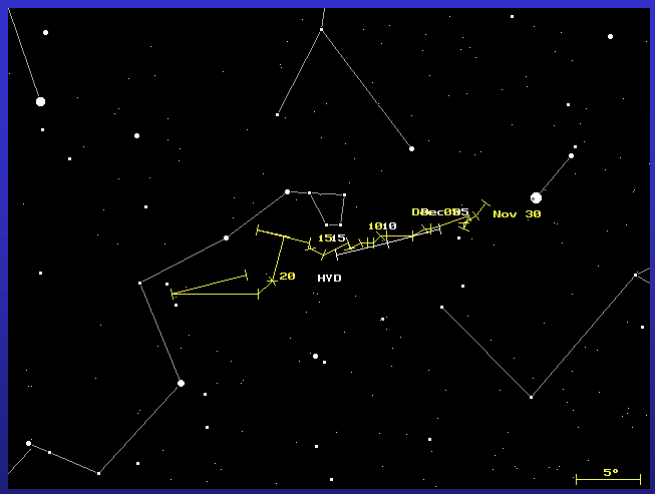


Results

	Period of Activity			Maximum		
	Solar Longitude	Date	Meteors	Solar Longitude	Date	Activity
Shower 74	248-272	Nov 30-Dec 24	1216	257	Dec 09	13.6%
HYD	251-263	Dec 03-Dec 15	-	260	Dec 1	-

Mean Parameters	Solar Longitude	Date	Right Ascension	Declination	Drift	Velocity
Shower 74	257	Dec 09	126.6	2.5	0.9 / -0.2	56 km/s
HYD			128	2	0.8 / -0.2	58 km/s

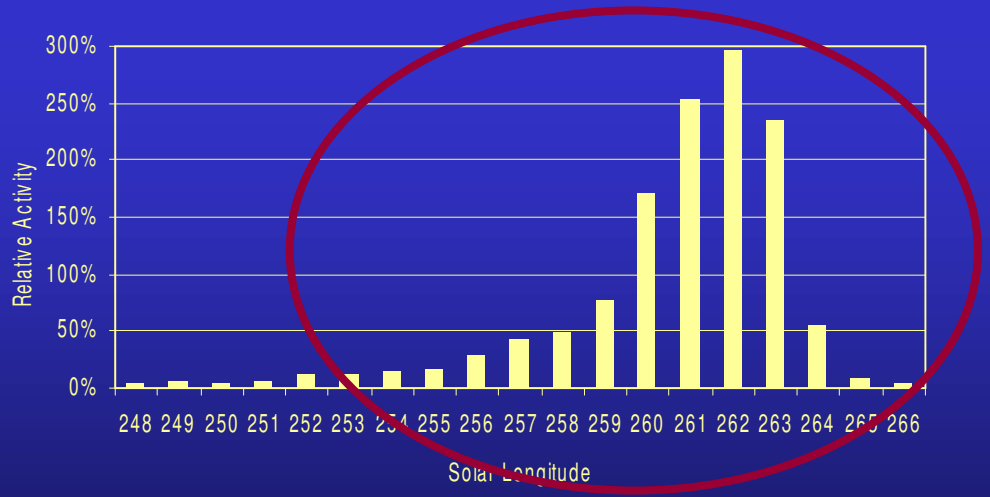


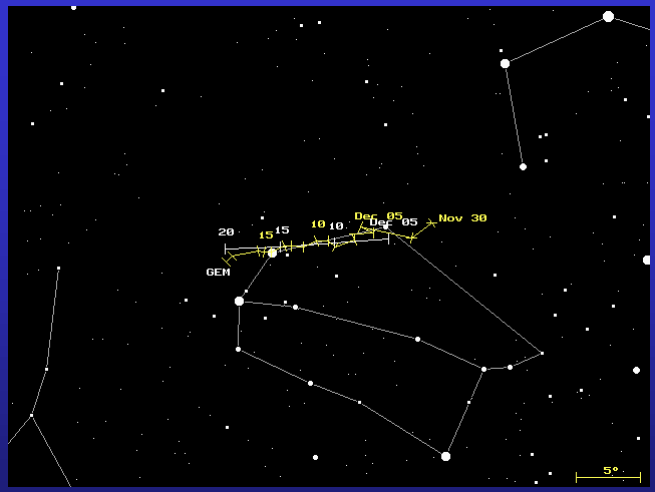


Results

	Period of Activity			Maximum		
	Solar Longitude	Date	Meteors	Solar Longitude	Date	Activity
Shower 75	248-266	Nov 30-Dec 18	10560	262	Dec 14	296.8%
GEM	255-265	Dec 07-Dec 17	-	262	Dec 14	-

Mean Parameters	Solar Longitude	Date	Right Ascension	Declination	Drift	Velocity
Shower 75	262	Dec 14	113.8	32.0	1.1 / -0.1	36 km/s
GEM			112	33	1.0 / -0.1	35 km/s

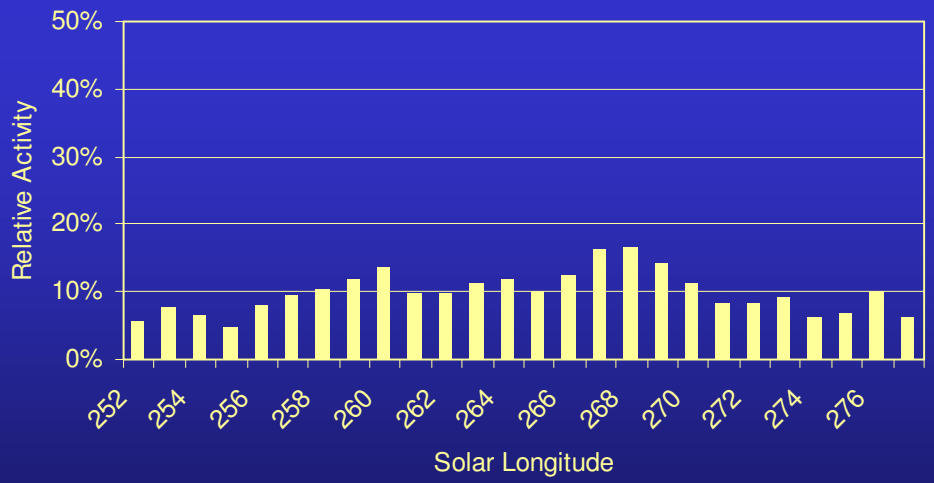


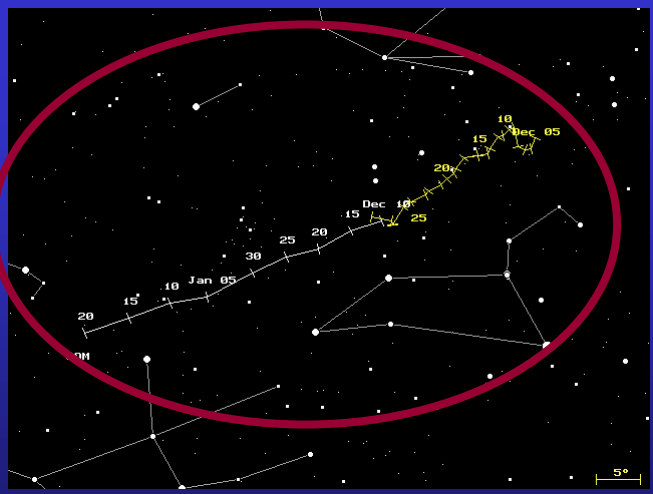


Results

	Period of Activity			Maximum		
	Solar Longitude	Date	Meteors	Solar Longitude	Date	Activity
Shower 76	252-277	Dec 04-Dec 29	1658	268	Dec 20	16.5%
COM	260-303	Dec 12-Jan 23	-	267	Dec 19	-

Mean Parameters	Solar Longitude	Date	Right Ascension	Declination	Drift	Velocity
Shower 76	268	Dec 20	161.3	30.5	0.8 / -0.3	59 km/s
COM			176	24	0.8 / -0.3	65 km/s

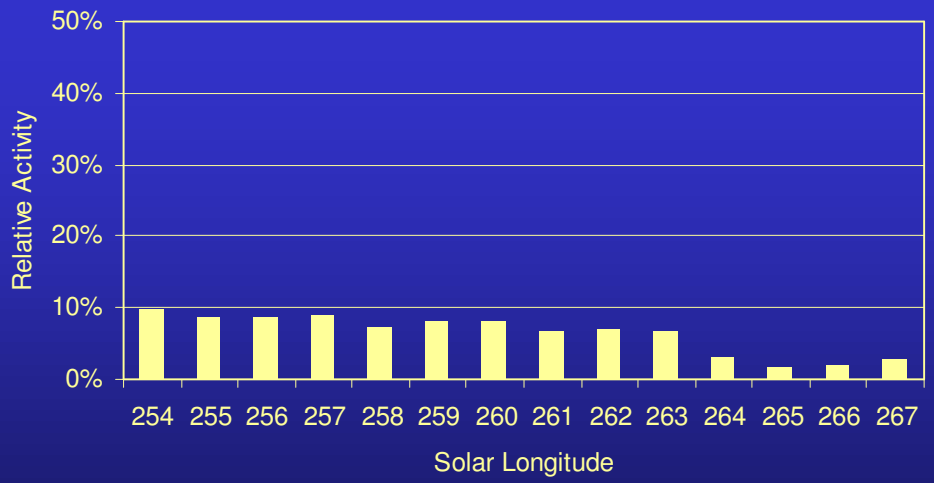


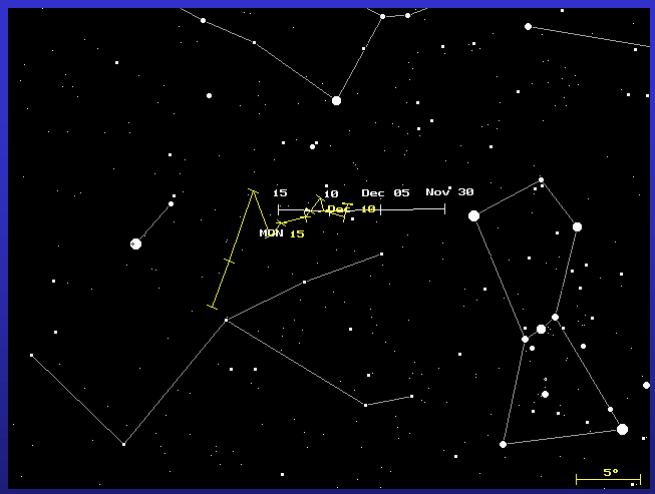


Results

	Period of Activity			Maximum		
	Solar Longitude	Date	Meteors	Solar Longitude	Date	Activity
Shower 77	254-267	Dec 06-Dec 19	692	254	Dec 06	9.8%
MON	245-265	Nov 27-Dec 17	-	257	Dec 09	-

Mean Parameters	Solar Longitude	Date	Right Ascension	Declination	Drift	Velocity
Shower 77	254	Dec 06	98.6	8.5	0.8 / -0.4	41 km/s
MON			103	8	0.9 / 0.0	42 km/s

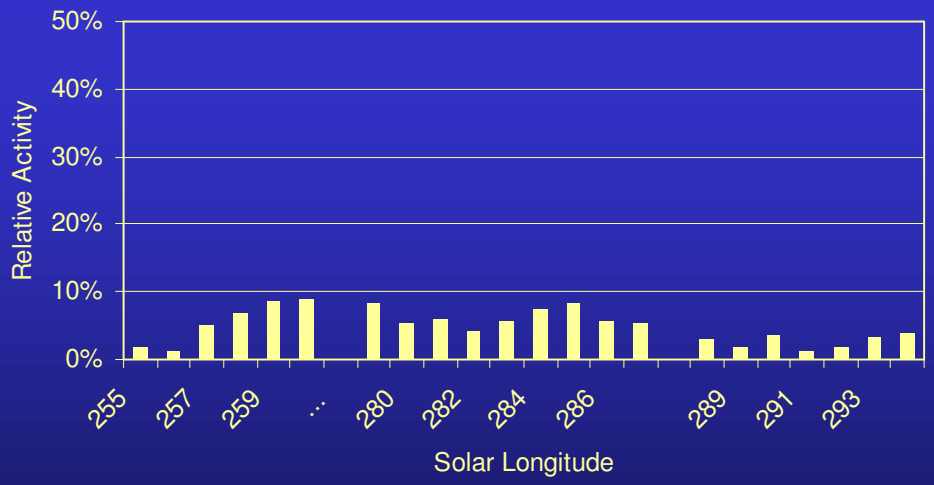


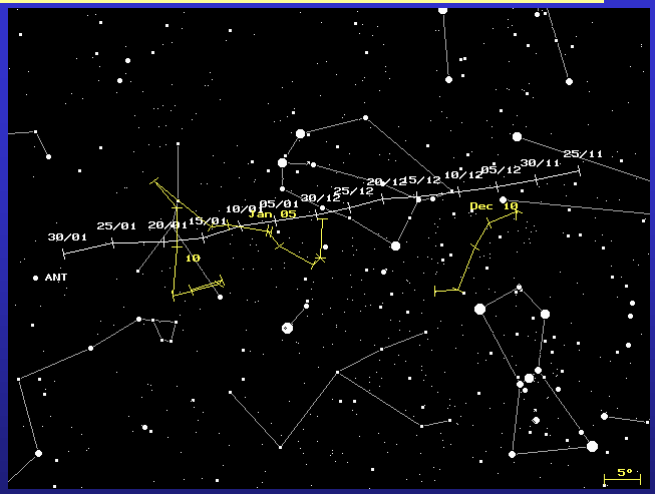


Results

	Period of Activity			Maximum		
	Solar Longitude	Date	Meteors	Solar Longitude	Date	Activity
Shower 79	255-260	Dec 07-Dec 12	304	260	Dec 12	9.0%
Shower 85	279-287	Dec 31-Jan 07	292	285	Jan 06	8.2%
Shower 90	288-294	Jan 08-Jan 14	127	294	Jan 14	3.8%
ANT	-	-	-	-	-	-

Mean Parameters	Solar Longitude	Date	Right Ascension	Declination	Drift	Velocity
Shower 79	260	Dec 12	83.0	19.0	-2.4 / 2.2	26 km/s
Shower 85	285	Jan 06	117.6	18.5	2.1 / 0.3	28 km/s
Shower 90	294	Jan 14	127.9	10.0	-1.4 / -2.3	28 km/s
ANT	-	-	-	-	1.0 / 0.0	30 km/s

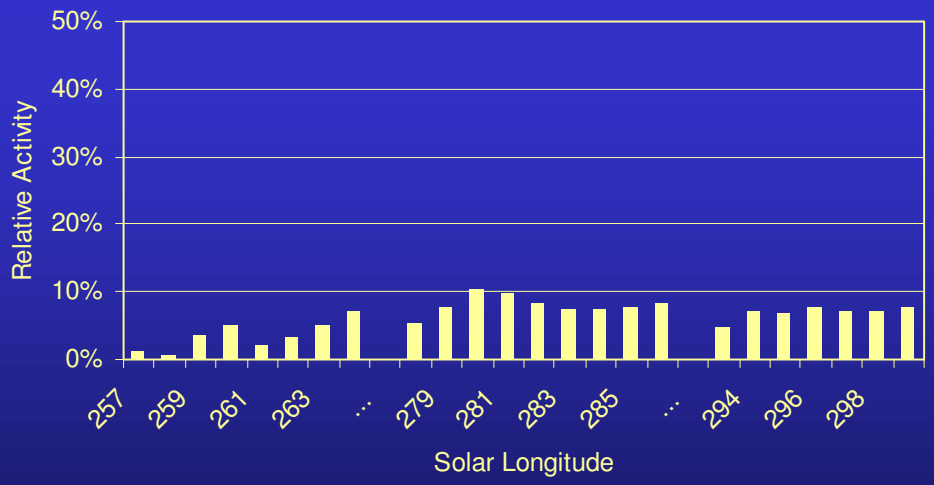


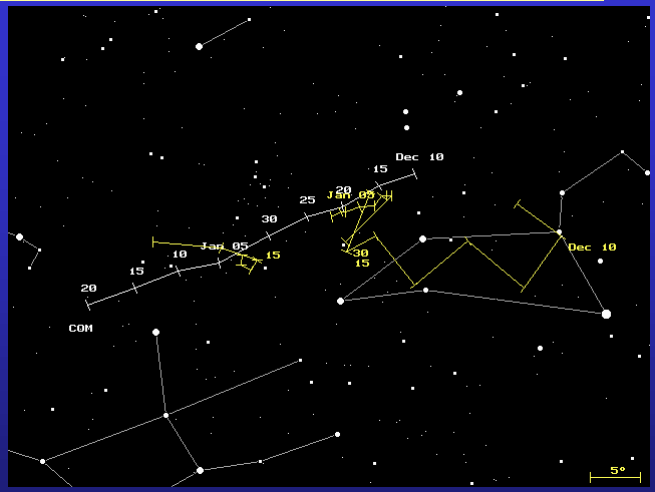


Results

	Period of Activity			Maximum		
	Solar Longitude	Date	Meteors	Solar Longitude	Date	Activity
Shower 81	257-264	Dec 09-Dec 16	201	264	Dec 16	7.1%
Shower 84	278-286	Dec 30-Jan 07	356	280	Jan 01	10.3%
Shower 91	293-299	Jan 13-Jan 19	373	296	Jan 16	7.7%
(COM)	260-303	Dec 12-Jan 23	-	267	Dec 19	-

Mean Parameters	Solar Longitude	Date	Right Ascension	Declination	Drift	Velocity
Shower 81	264	Dec 16	173.9	25.5	3.2 / 0.4	64 km/s
Shower 84	280	Jan 01	172.1	25.0	0.6 / 0.0	58 km/s
Shower 91	296	Jan 16	186.1	18.5	-1.1 / -0.2	60 km/s
(COM)	267	Dec 19	176	24	0.8 / -0.3	65 km/s

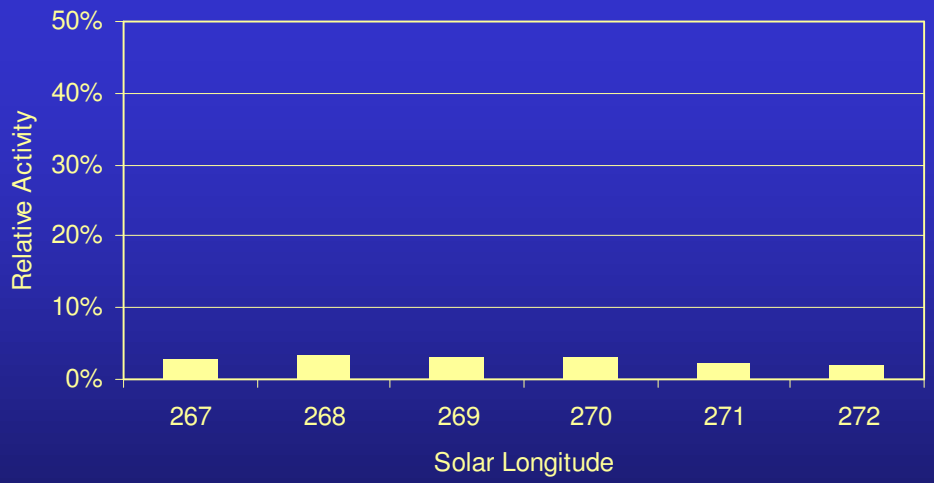


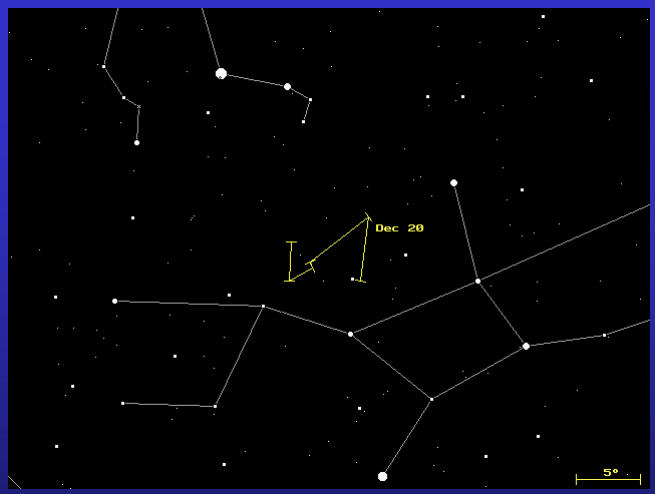


Results

	Period of Activity			Maximum		
	Solar Longitude	Date	Meteors	Solar Longitude	Date	Activity
Shower 82	267-272	Dec 19-Dec 24	131	268	Dec 20	3.4%
-	-	-	-	-		

Mean Parameters	Solar Longitude	Date	Right Ascension	Declination	Drift	Velocity
Shower 82	268	Dec 20	202.2	8.5	1.3 / 0.0	62 km/s
-			-	-	-	-

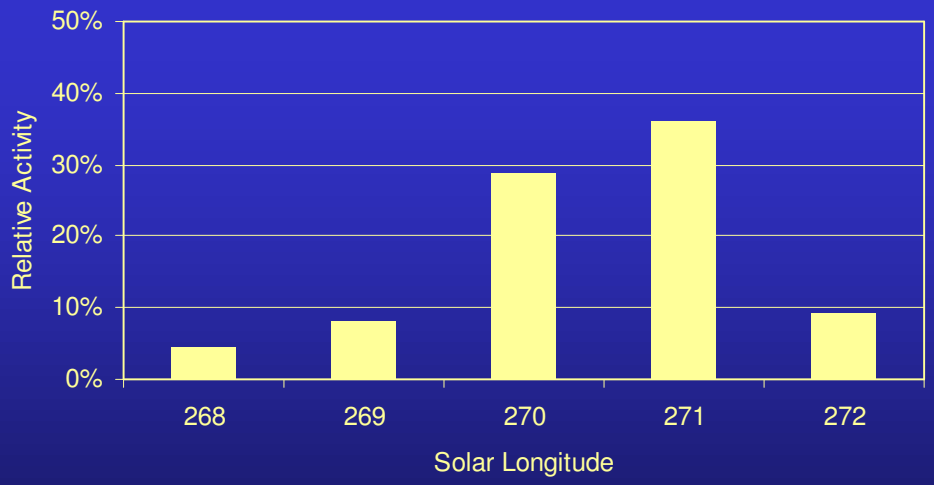


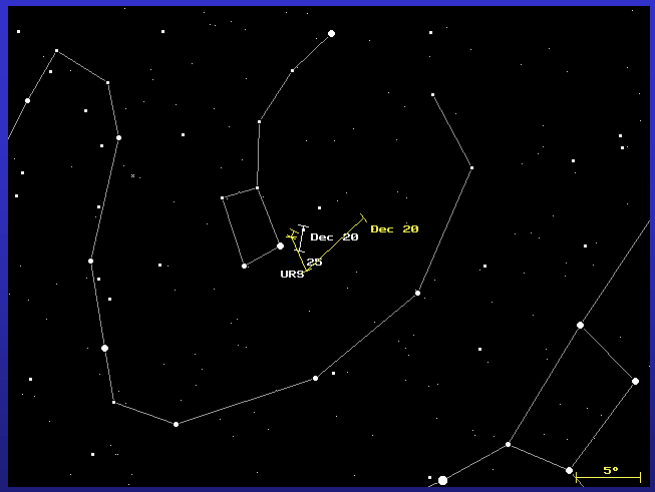


Results

	Period of Activity			Maximum		
	Solar Longitude	Date	Meteors	Solar Longitude	Date	Activity
Shower 82a	268-272	Dec 20-Dec 24	685	271	Dec 23	36.1%
URS	265-274	Dec 17-Dec 26	-	270	Dec 22	-

Mean Parameters	Solar Longitude	Date	Right Ascension	Declination	Drift	Velocity
Shower 82a	271	Dec 23	220.2	75.0	5.1 / 0.1	32 km/s
URS			217	75	0.0 / -0.4	33 km/s

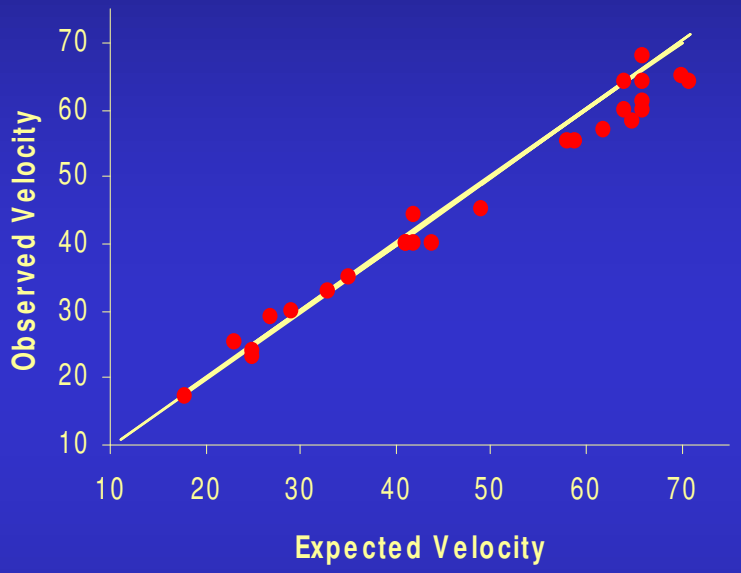




Results

Remarks

- The velocity of fast showers is systematically underestimated
  - » Just one shower >65 km/s
- 3 meteor showers north of $\delta = -20°$ N were not identified:
  - » DLE, GIA, AMO
- 2 sporadic sources were not identified:
  - » Helion, S Toroidal
- A few good candidates for further visual meteor showers



Results

Next Steps

- Further parameter and algorithm tuning (e.g. normalized distributions, fixed velocity)
- Verify meteor shower candidates by Radiant and other observations / shower catalogs

Conclusion

» New IMO Working List of Meteor Showers is largely confirmed

» A few discrepancies need to be sorted out and adaptations (especially with respect to the activity interval and radiant position of meteor showers) should take place

Thanks for your attention!