

# How good is the IMO Working List of Meteor Showers?

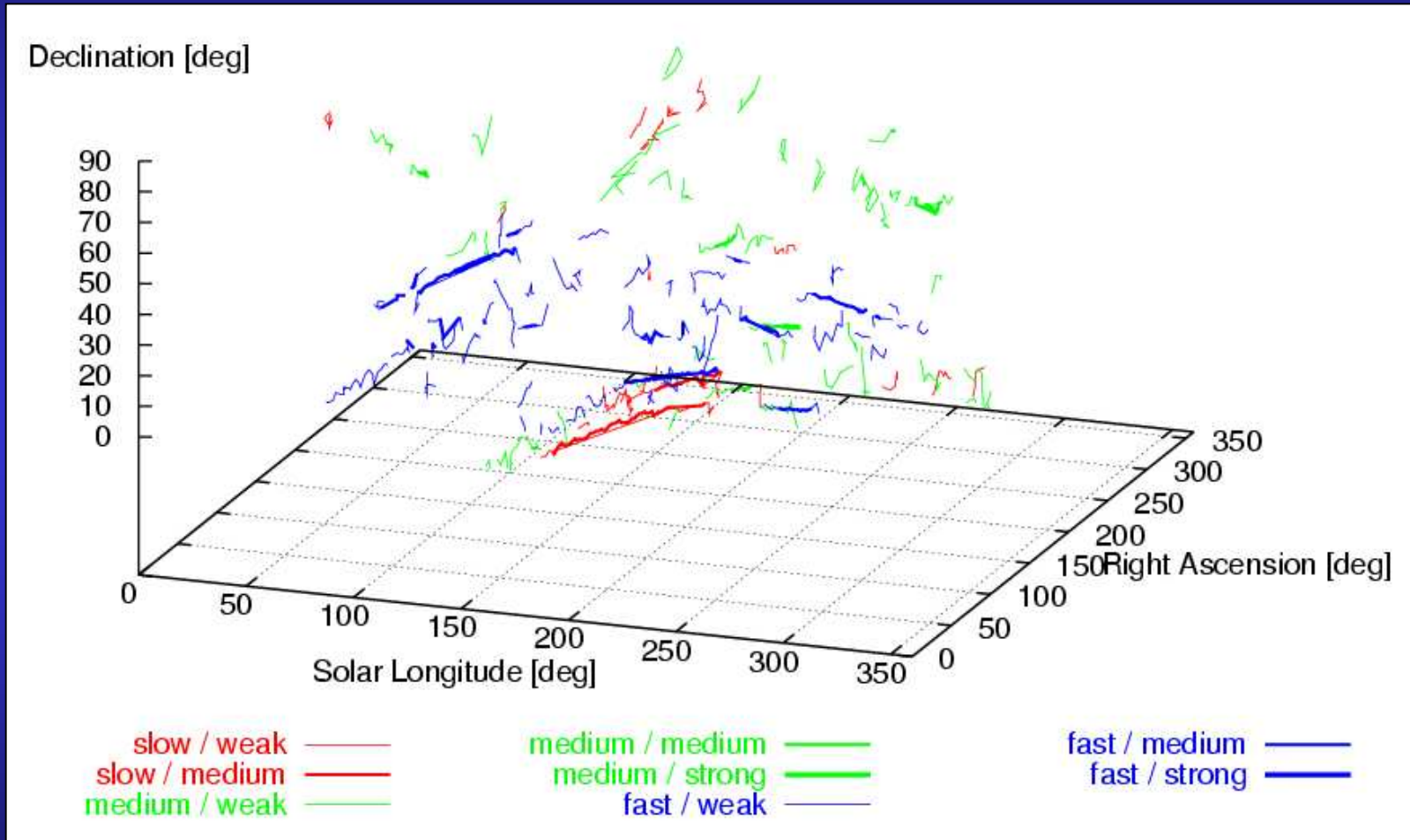
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## A Complete Analysis of the IMO Video Meteor Database

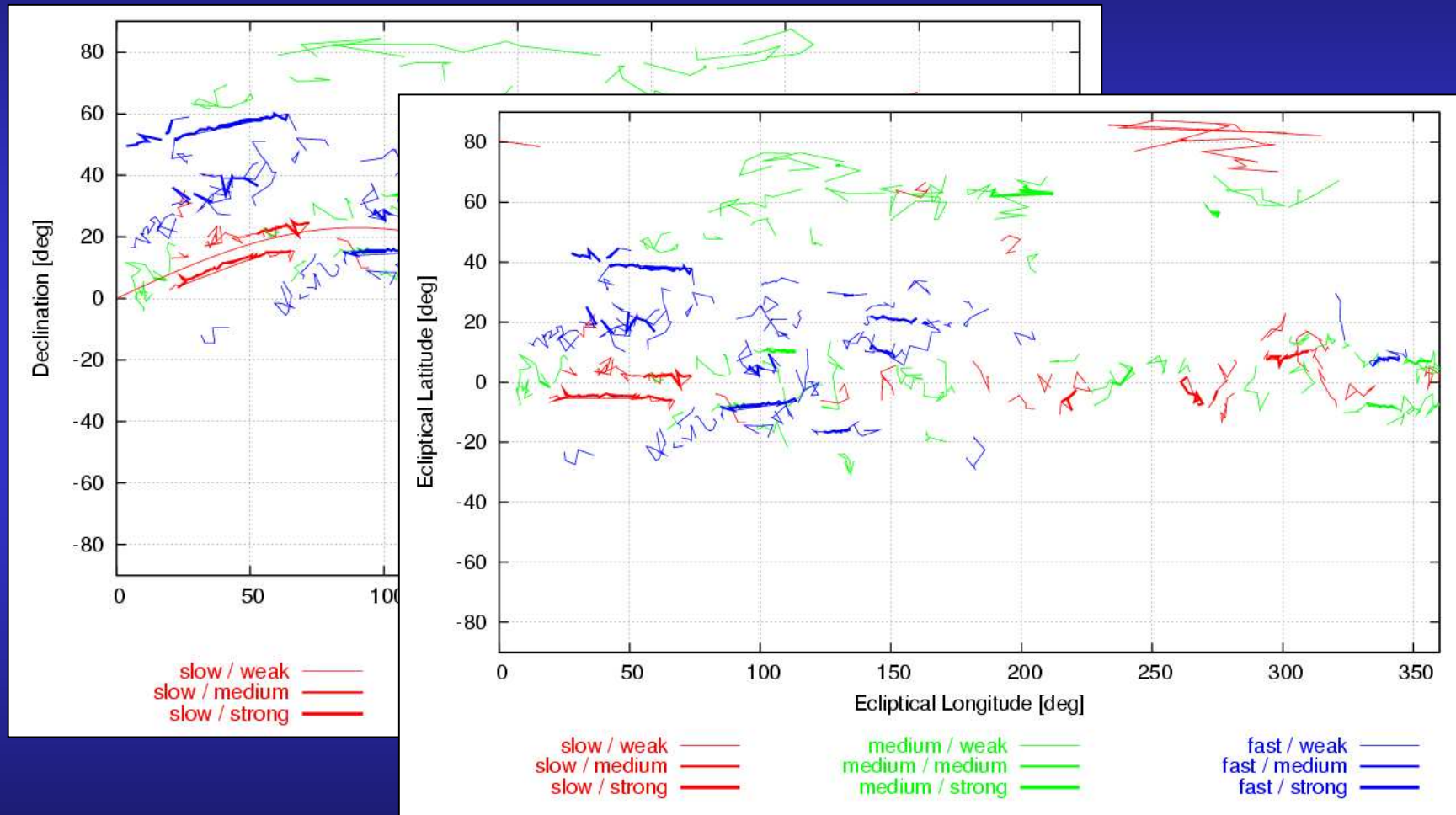
*Sirko Molau*

*Arbeitskreis Meteore e.V. (AKM), Germany*

# Result



# Result



# Overview

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## Part 1:

- Introduction
- Basics
- Implementation

## Part 2:

- Results

# Introduction

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## 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

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## 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

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## A little bit of theory ...

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

$$R = \operatorname{argmax}_{R'} P(R' | M)$$

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*:

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

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

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

# Basics

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- Therefore: 
$$R = \operatorname{argmax}_{R'} \frac{P(R') * P(M | R')}{P(M)}$$
- 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 than 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

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## 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

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## 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.) Connecting 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

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## RadFind

- Accumulation of radiant probabilities for all meteors in a given solar longitude interval
- Solar longitude: 360 intervals ( $2^\circ$  step size,  $1^\circ$  shift)
- Right ascension / declination:  $\frac{1}{2}^\circ$  step size
- Velocity: 1 km/s step 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:  $P(M | R) = [\exp(-0.5 D^2) * \exp(-1.5 V^2)] / N$

with: D ... Miss distance between backward prolonged 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)

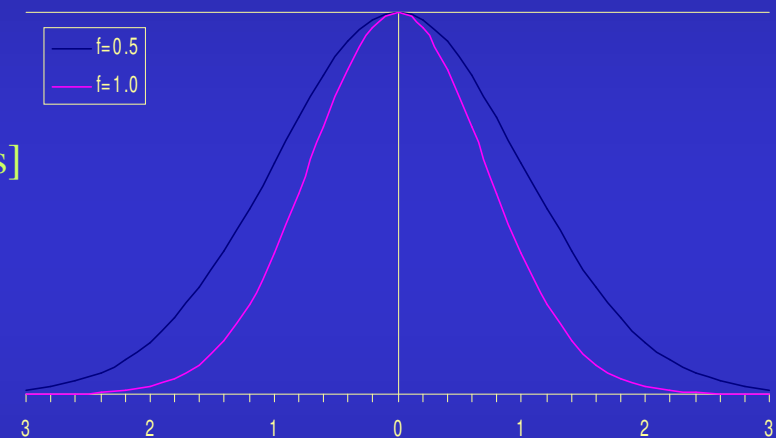
» Empirical scaling factors (0.5/1.5)

- Normalized vs. unnormalized distribution:

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

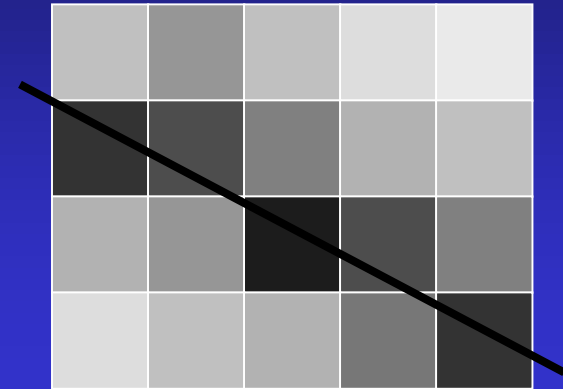
» Unnormed distribution (N=1) gives long meteors more weight

- Here: unnormed distribution, equally 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:

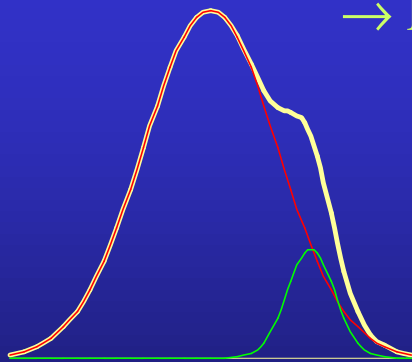
→ Determine the global maximum

→ 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

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- 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

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## StrmFind

- Search for radiants with similar position / velocity (at most  $7^\circ$  / 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  $15^\circ$  / 15 km/s maximum deviation based on the mean meteor shower parameters
- Problem: Result depends strongly on the chosen parameter set
  - » Plenty of meteor showers can be „generated“
  - » Tighter criteria for unknown showers

# Implementation

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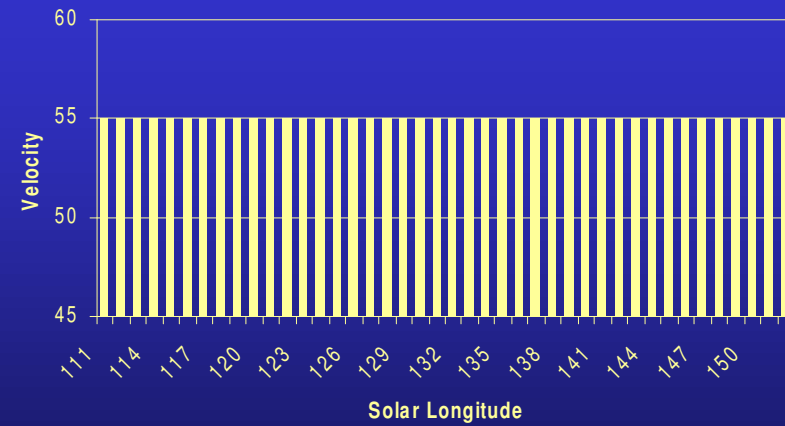
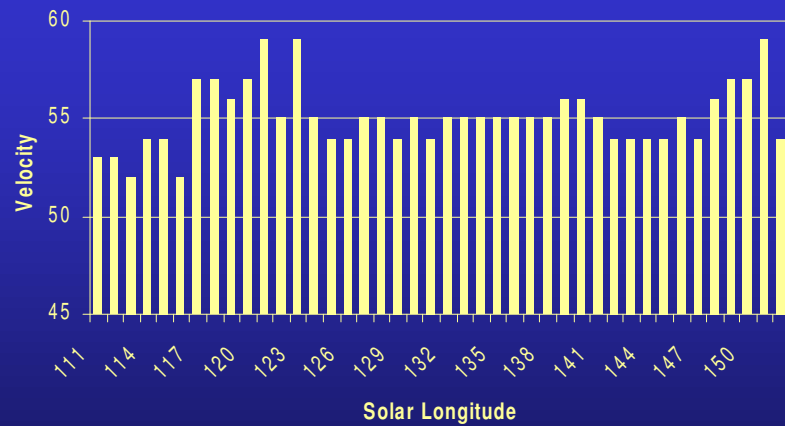
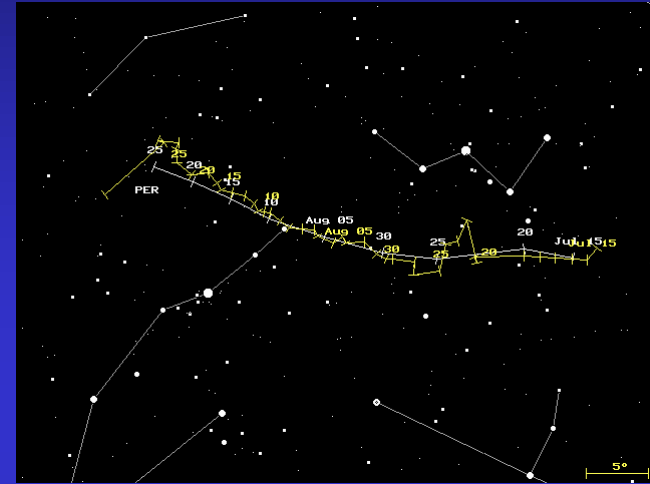
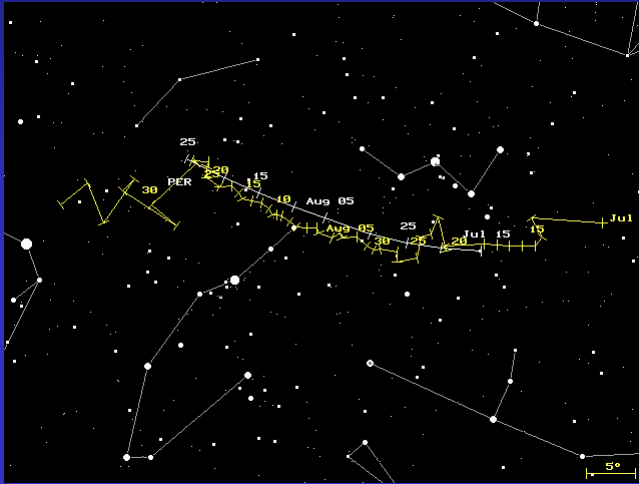
## Re-calculation of Radiant Positions

- 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 successively. 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

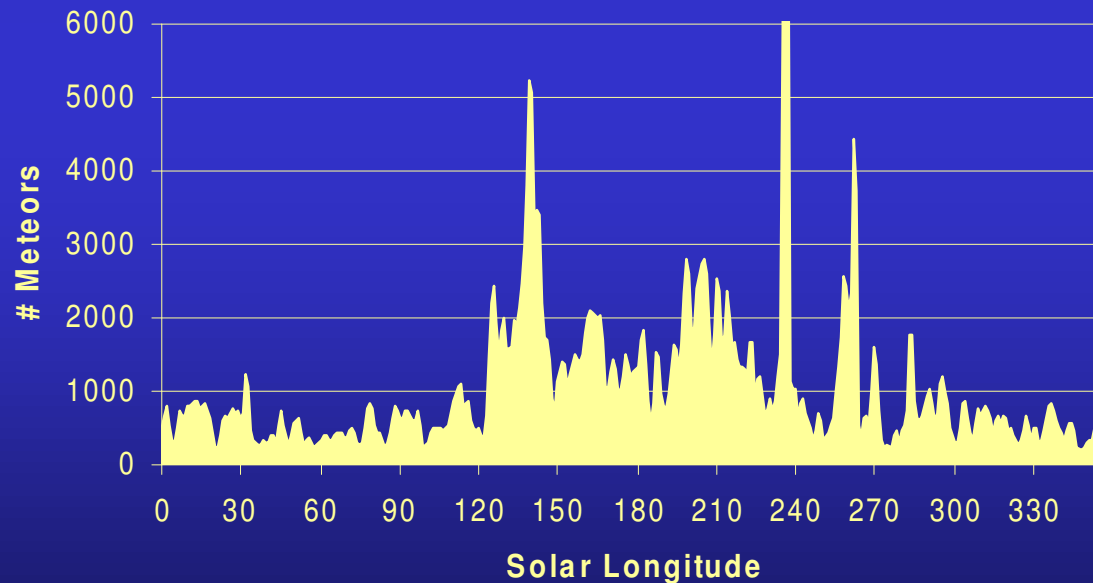


# Results

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## Statistics

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



# Results

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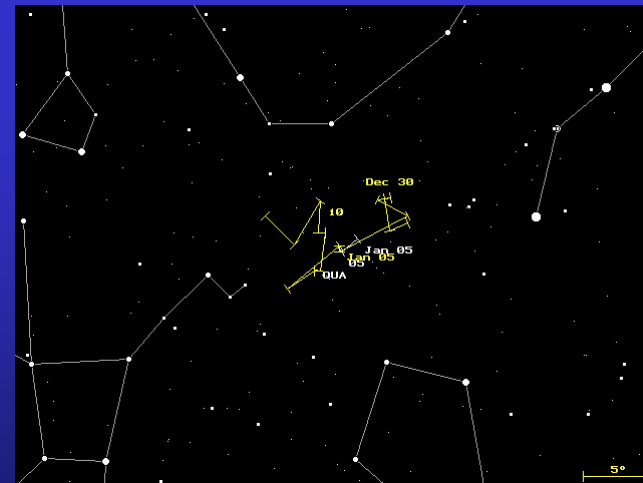
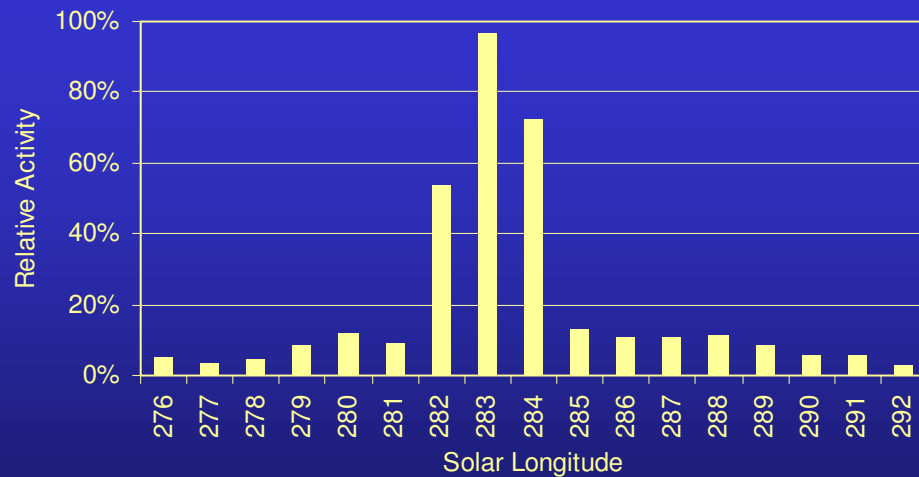
## Statistics

- 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  $> -20^\circ$  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	-

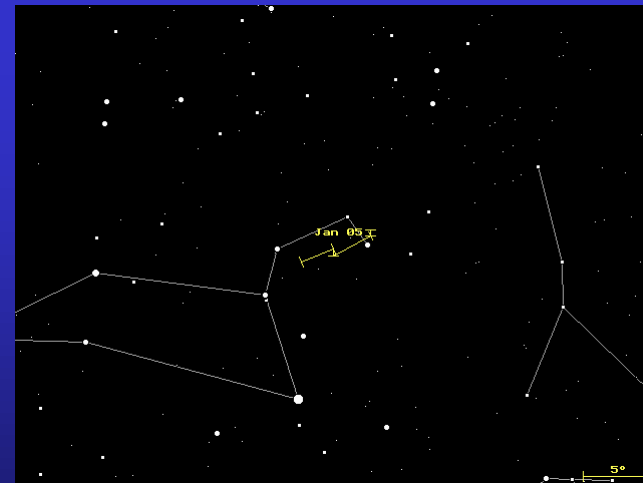
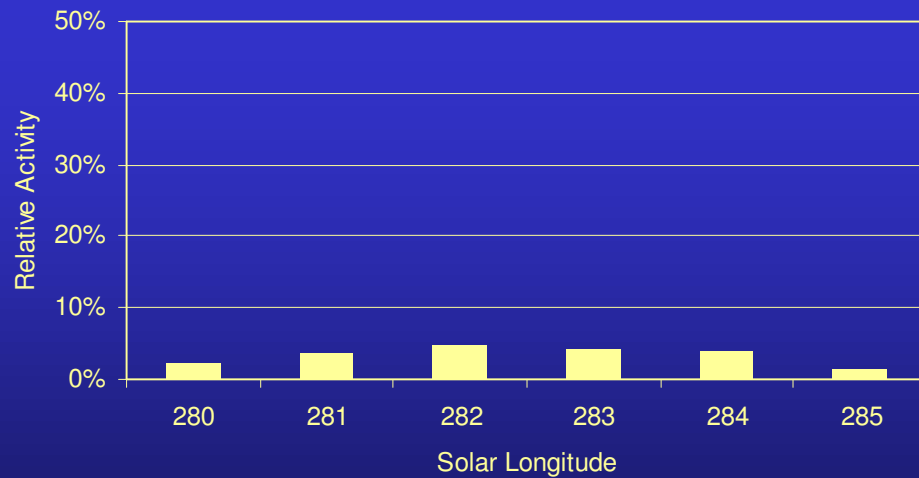
Mean Parameters	Solar Longitude	Date	Right Ascension	Declination	Drift	Velocity
Shower 83	283	Jan 04	230.2	49.5	1.0 / -0.1	41 km/s
QUA			230	49	0.8 / -0.2	41 km/s



# 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%
-	-	-	-	-	-	-

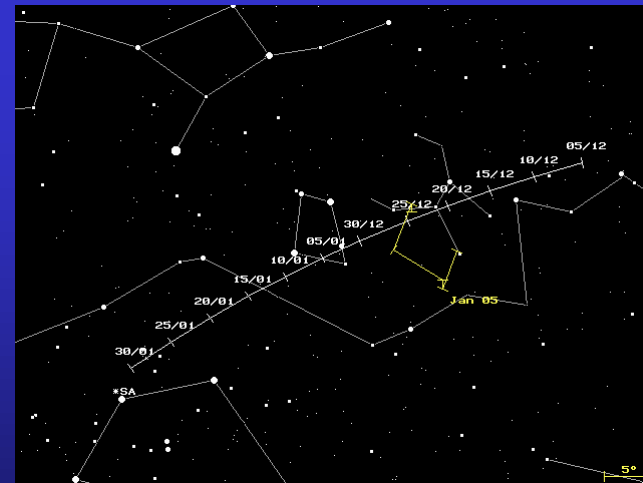
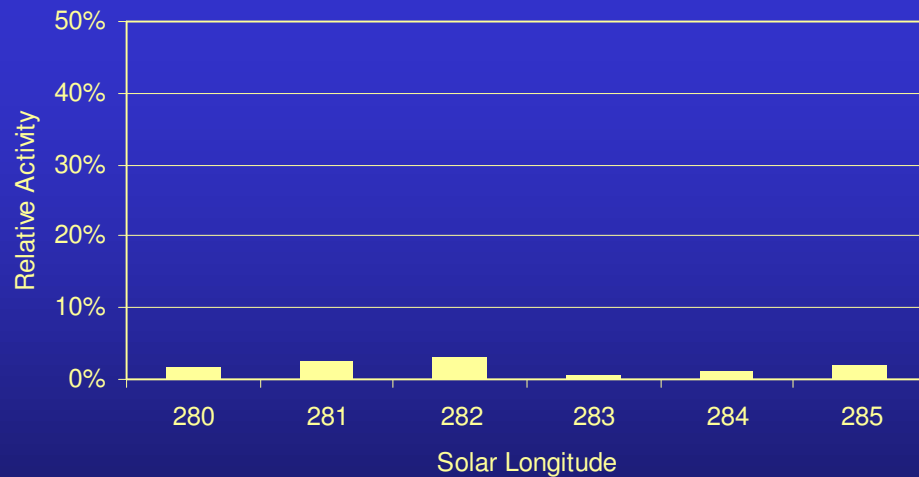
Mean Parameters	Solar Longitude	Date	Right Ascension	Declination	Drift	Velocity
Shower 86	282	Jan 03	146.2	24.5	1.2 / -0.5	55 km/s
-	-	-	-	-	-	-



# 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	-	-	-	-	-	-

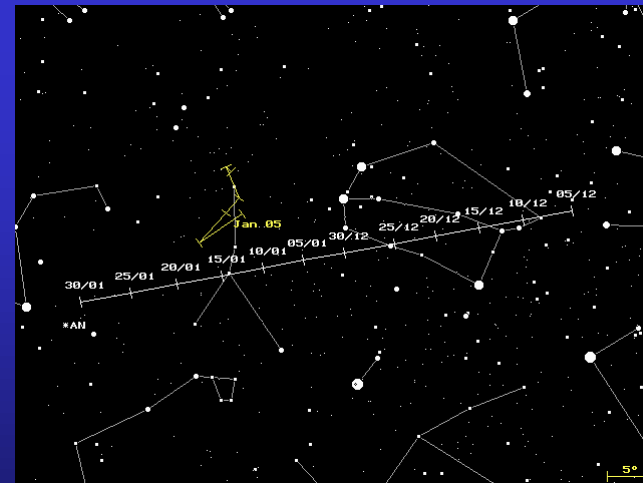
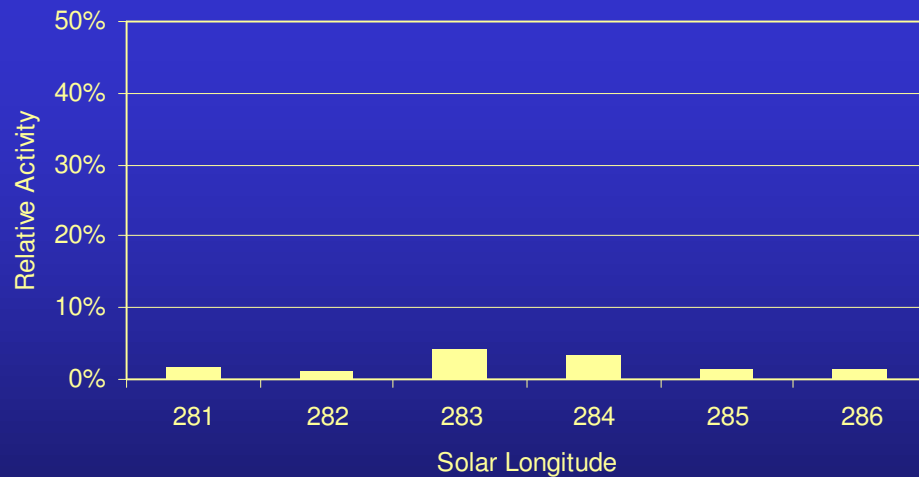
Mean Parameters	Solar Longitude	Date	Right Ascension	Declination	Drift	Velocity
Shower 87	282	Jan 03	176.0	-23.0	-1.4 / -1.5	62 km/s
S Apex	-	-	-	-	0.9 / -0.4	60 km/s



# 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	-	-	-	-	-	-

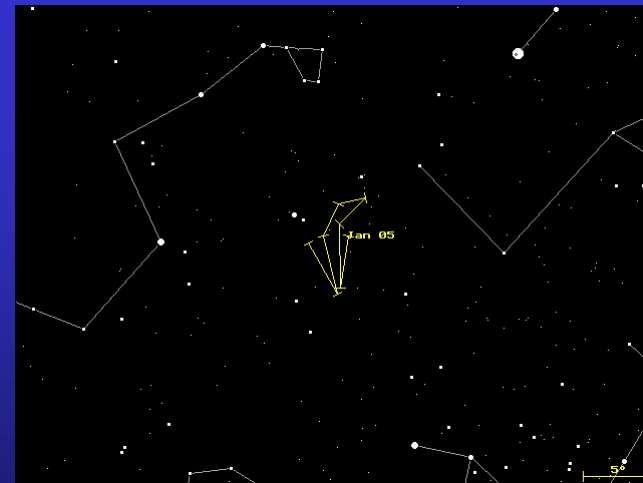
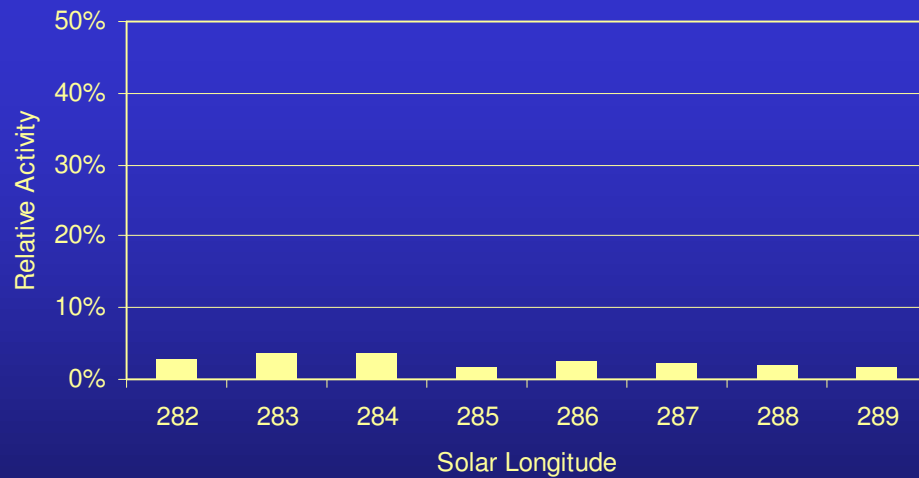
Mean Parameters	Solar Longitude	Date	Right Ascension	Declination	Drift	Velocity
Shower 88	283	Jan 04	130.8	27.5	0.0 / -1.6	39 km/s
Anthelion	-	-	-	-	1.0 / -0.2	30 km/s



# 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
-	-	-	-	-	-	-

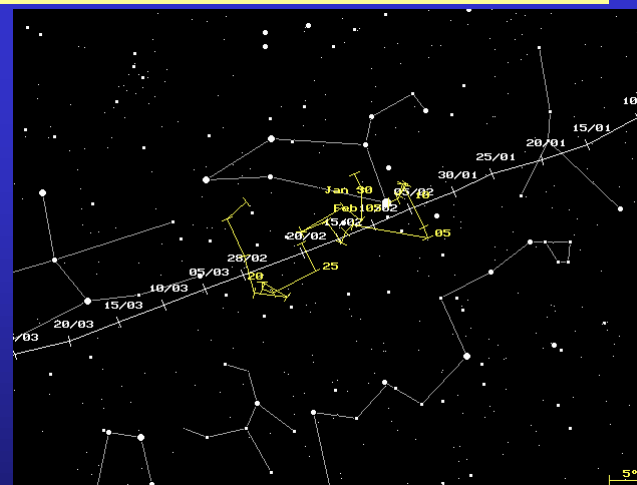
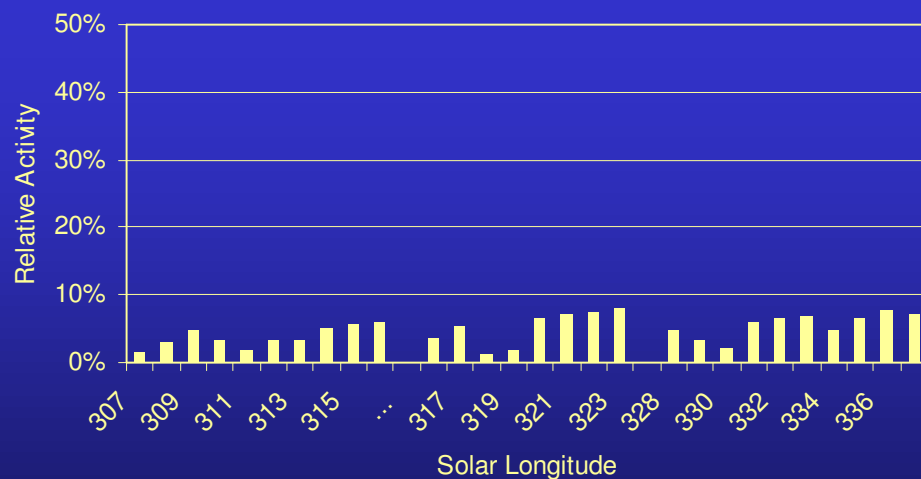




# Results

	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	-	-	-	-	-	-

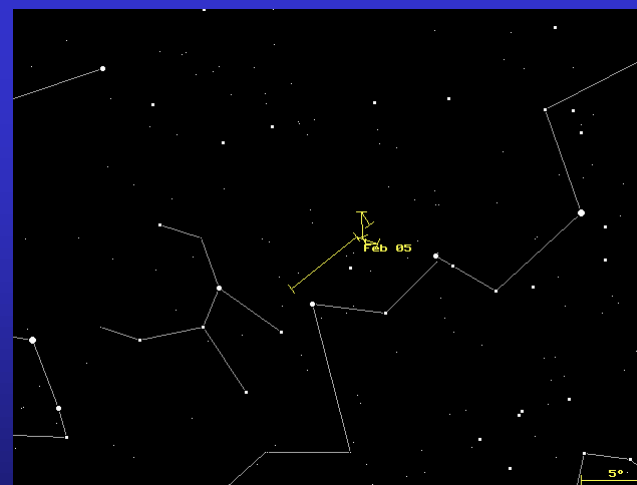
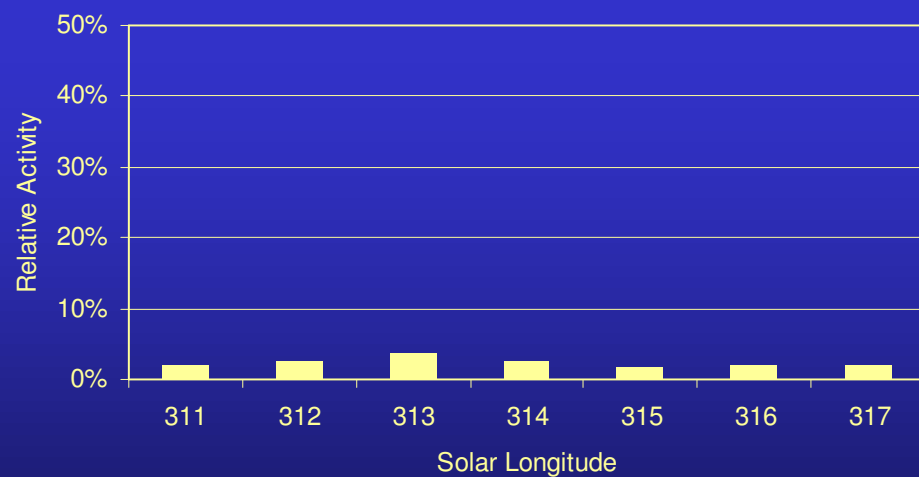
Mean Parameters	Solar Longitude	Date	Right Ascension	Declination	Drift	Velocity
Shower 92	316	Feb 05	156.9	9.0	0.3 / -0.8	36 km/s
Shower 94	323	Feb 12	151.8	12.0	0.6 / 0.6	30 km/s
Shower 95	336	Feb 25	162.2	2.5	-1.1 / -0.7	27 km/s
ANT	-	-	-	-	1.0 / 0.0	30 km/s



# 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%
-	-	-	-	-	-	-

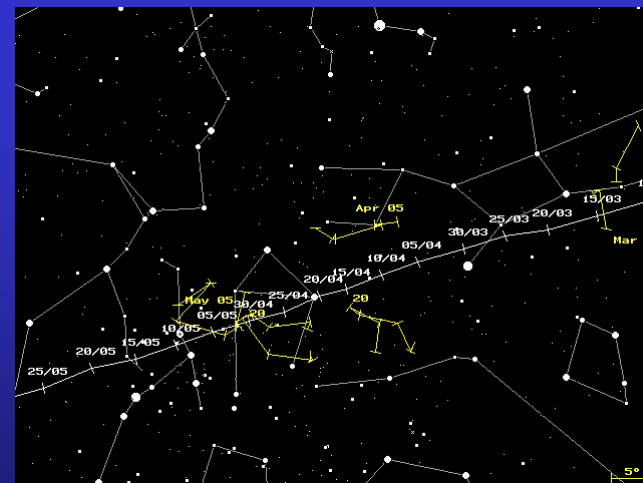
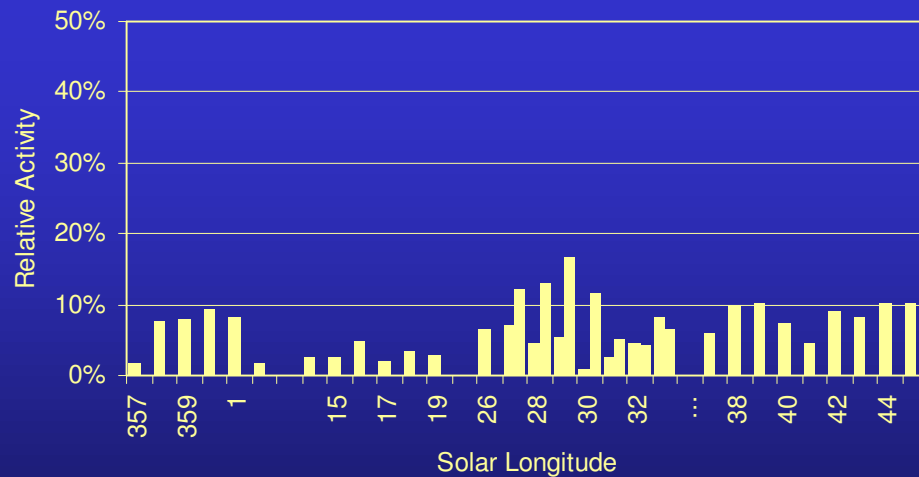
Mean Parameters	Solar Longitude	Date	Right Ascension	Declination	Drift	Velocity
Shower 93	313	Feb 02	158.4	-11.0	0.7 / -0.7	42 km/s
-	-	-	-	-	-	-



# Results

	Period of Activity			Maximum		
	Solar Longitud	Date	Meteors	Solar Longitud	Date	Activity
Showers 1	357-2	Mar 18-Mar 23	197	1	Mar 22	8.2%
Showers 4	14-19	Apr 04-Apr 09	118	18	Apr 08	5.4%
Showers 5	26-33	Apr 16-Apr 23	241	33	Apr 23	8.2%
Showers 6	27-33	Apr 17-Apr 23	406	29	Apr 19	16.8%
Showers 8	37-45	Apr 27-May 06	246	44	May 05	10.3%
ANT	-	-	-	-	-	-

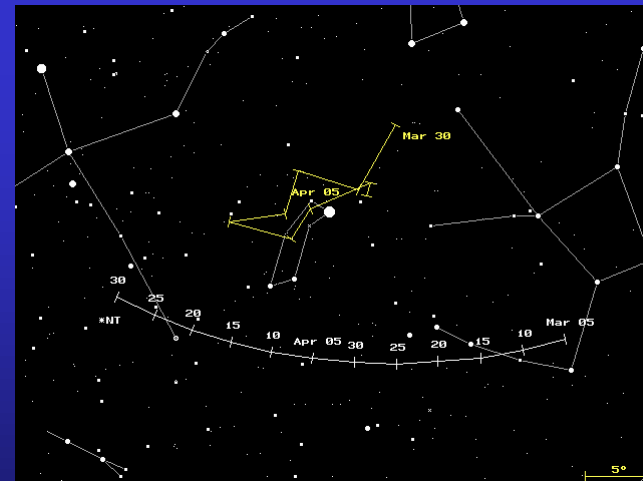
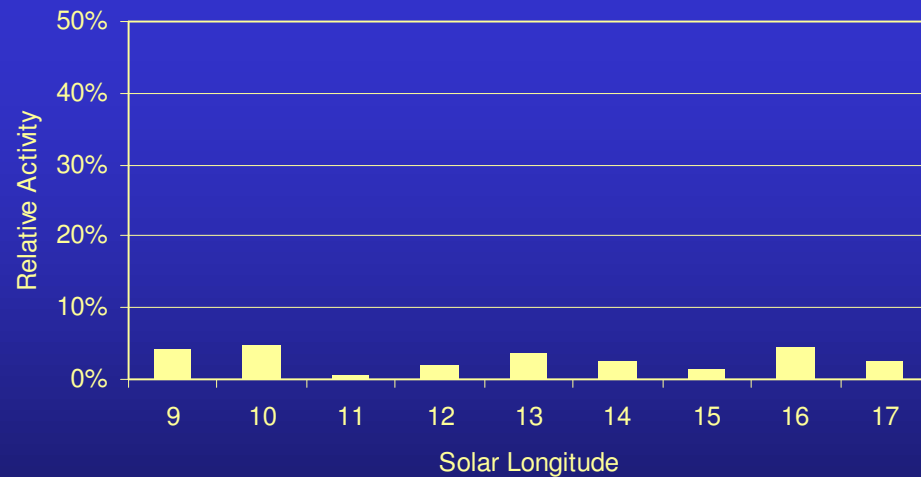
Mean Parameters	Solar Longitud	Date	Right Ascension	Declination	Drift	Velocity
Showers 1	1	Mar 22	185.6	1.5	-0.6 / 1.4	30 km/s
Showers 4	18	Apr 08	220.1	-8.0	2.3 / -0.4	37 km/s
Showers 5	33	Apr 23	223.3	-24.0	0.0 / -0.7	29 km/s
Showers 6	29	Apr 19	217.6	-17.5	-1.1 / -0.2	29 km/s
Showers 8	44	May 05	241.4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

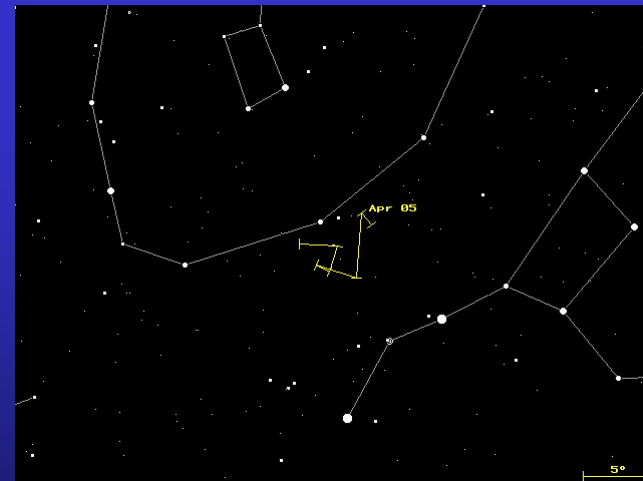
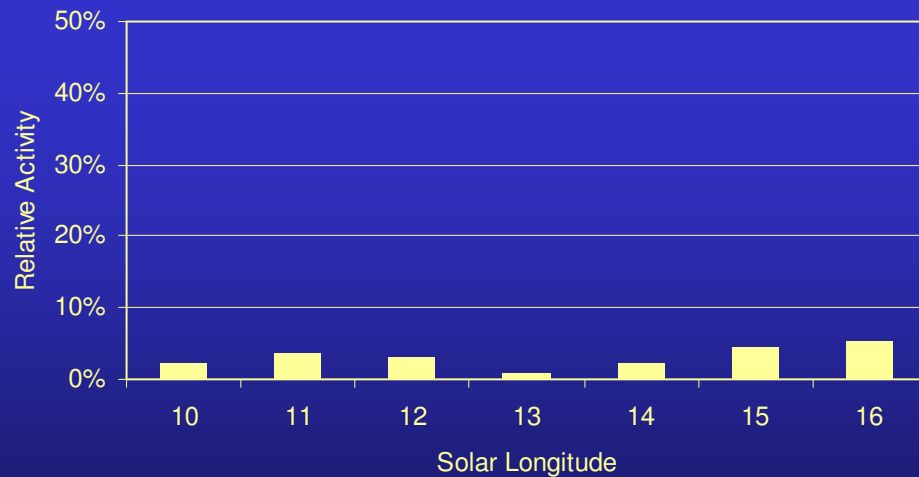
Mean Parameters	Solar Longitude	Date	Right Ascension	Declination	Drift	Velocity
Shower 2	10	Mar 31	276.2	40.5	0.1 / -0.5	41 km/s
N Toroidal	-	-	-	-	0.7 / 0.1	35 km/s



# 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%
-	-	-	-	-	-	-

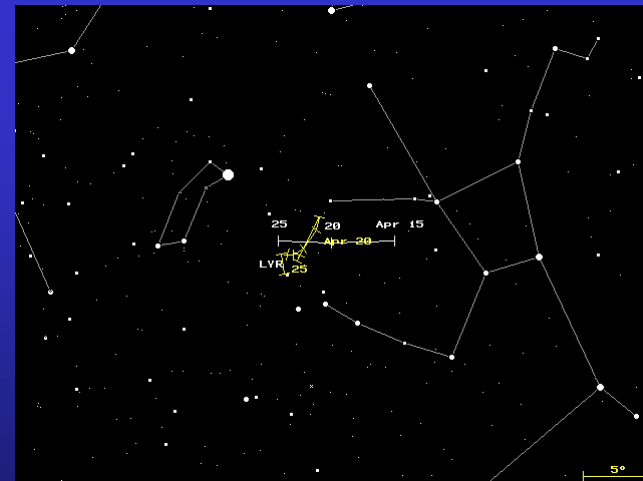
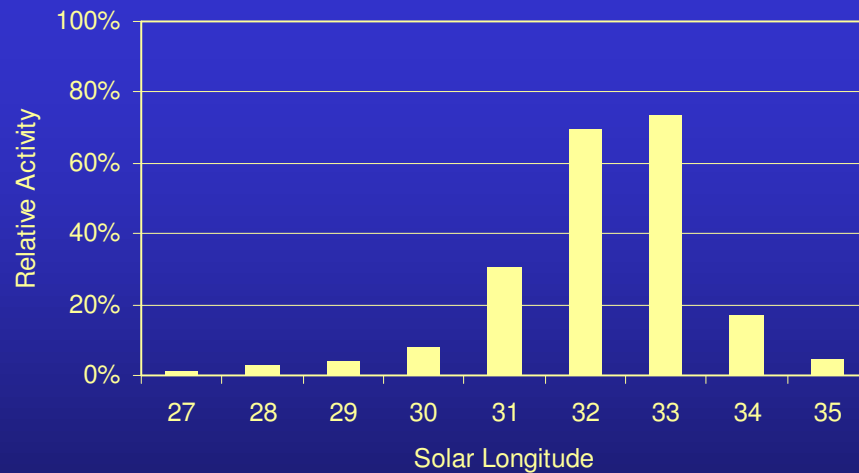
Mean Parameters	Solar Longitude	Date	Right Ascension	Declination	Drift	Velocity
Shower 3	16	Apr 06	201.9	64.0	-1.8 / 0.3	18 km/s
-	-	-	-	-	-	-



# 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	-

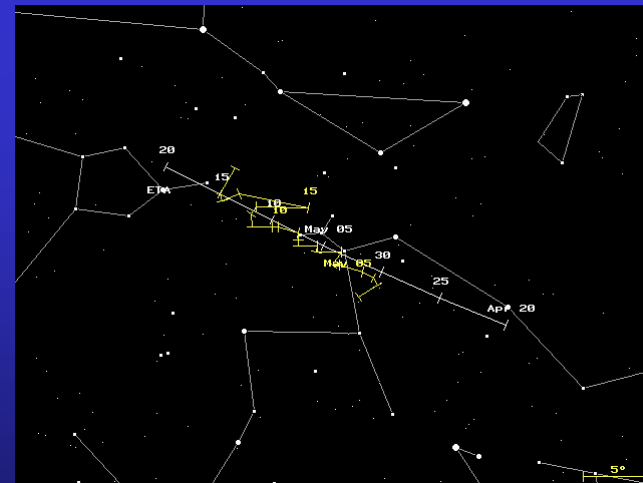
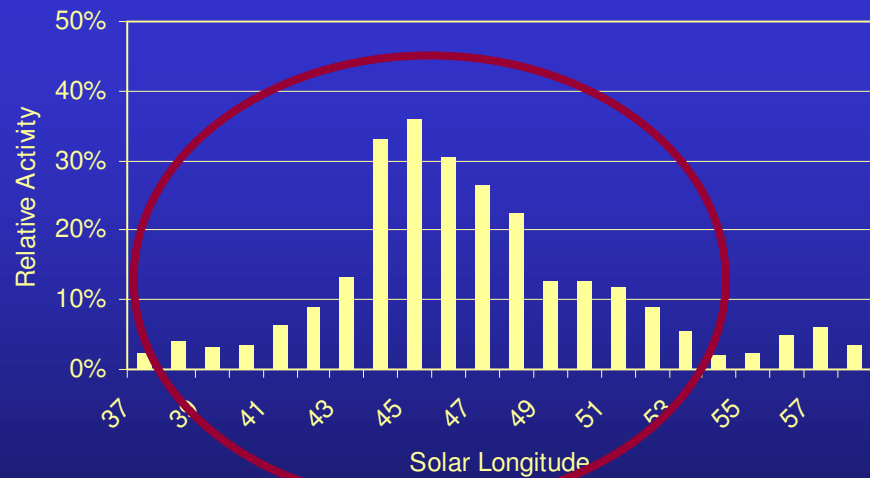
Mean Parameters	Solar Longitude	Date	Right Ascension	Declination	Drift	Velocity
Shower 7	33	Apr 23	273.1	33.0	0.3 / -0.2	45 km/s
LYR			271	34	1.1 / 0.0	49 km/s



# 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	-

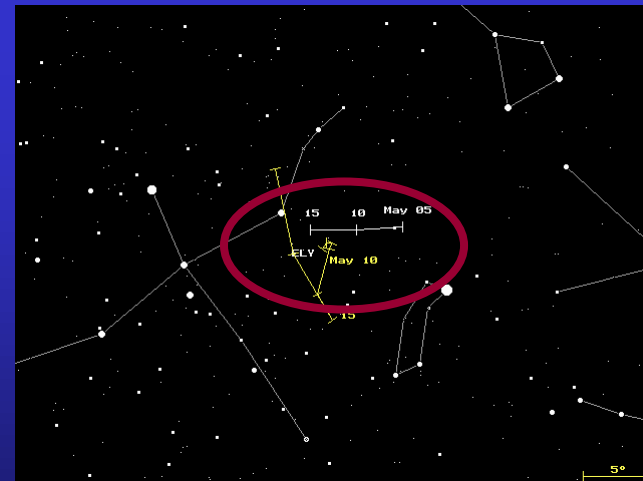
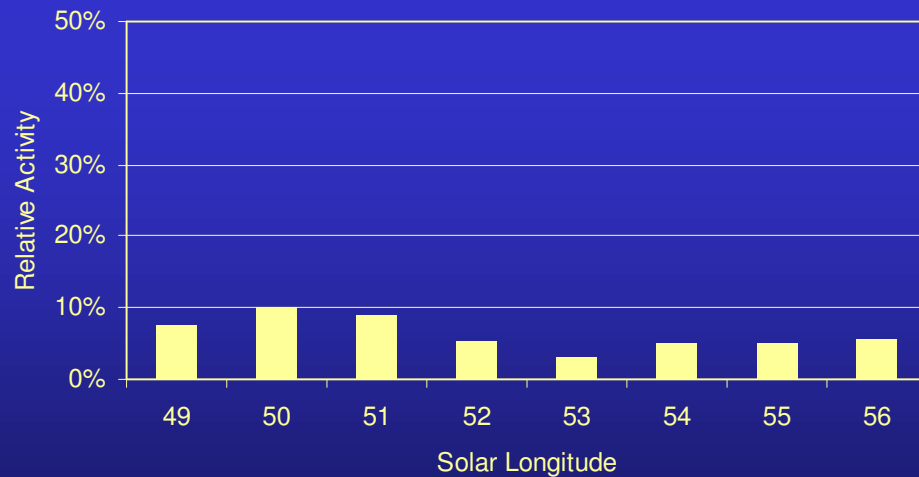
Mean Parameters	Solar Longitude	Date	Right Ascension	Declination	Drift	Velocity
Shower 9	45	May 06	337.5	-1.0	0.6 / 0.4	59 km/s
ETA			338	-1	0.9 / 0.4	66 km/s



# 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

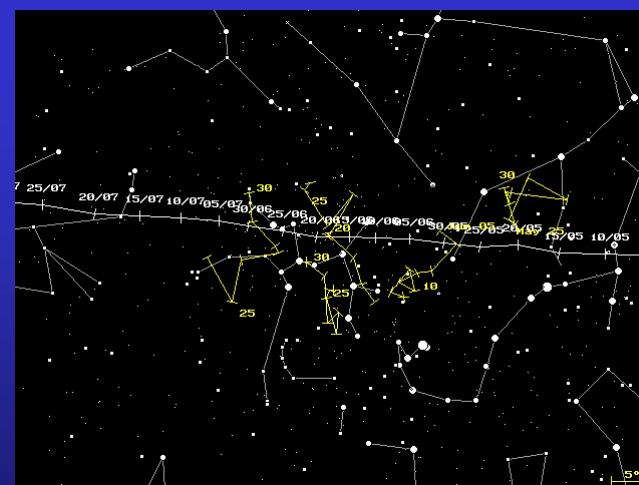
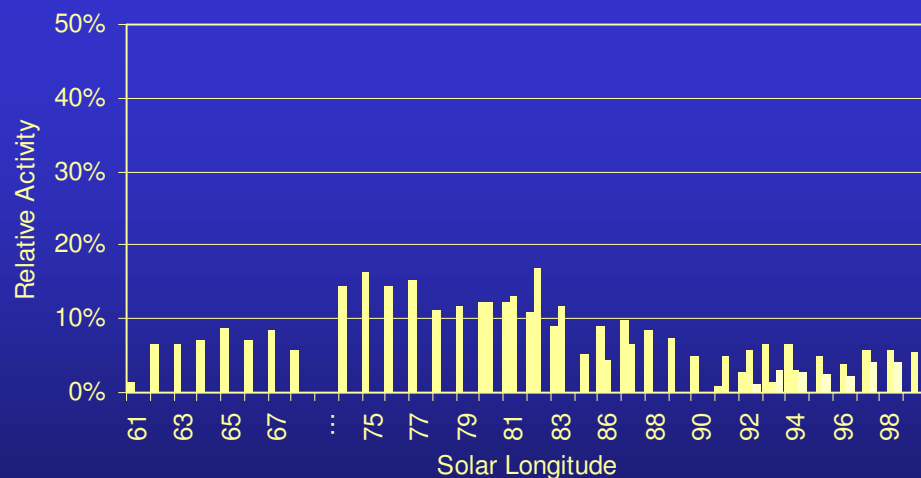




# Results

	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	-	-	-	-	-	-

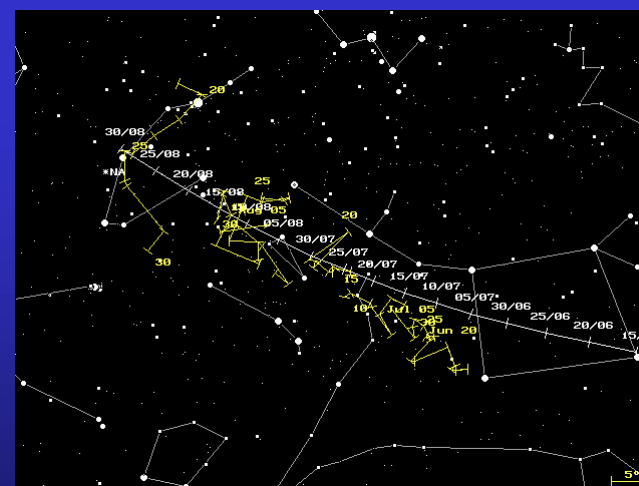
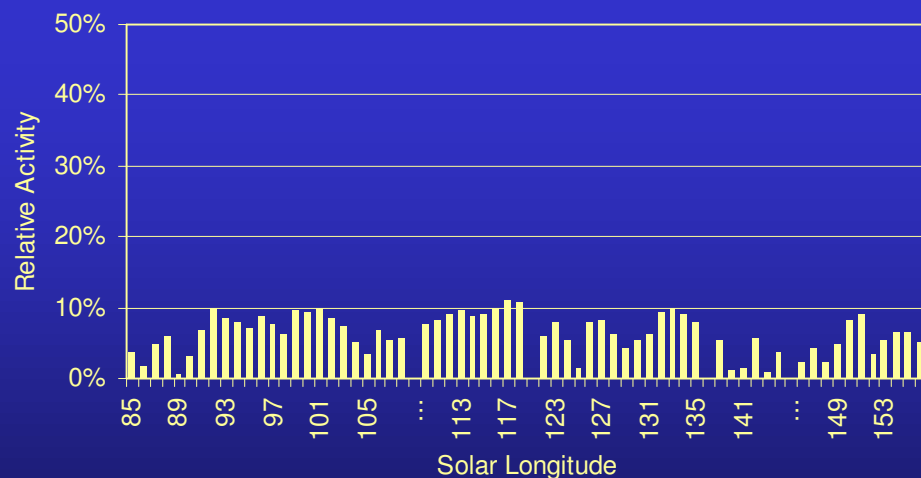
Mean Parameters	Solar Longitude	Date	Right Ascension	Declination	Drift	Velocity
Shower 11	67	May 29	254.2	-15.5	-0.2 / 0.3	30 km/s
Shower 12	75	Jun 06	260.2	-23.0	0.7 / -1.0	27 km/s
Shower 14	87	Jun 18	274.0	-29.5	1.2 / 2.0	26 km/s
Shower 15	99	Jul 01	282.7	-26.5	0.5 / 0.6	24 km/s
Shower 17	97	Jun 29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

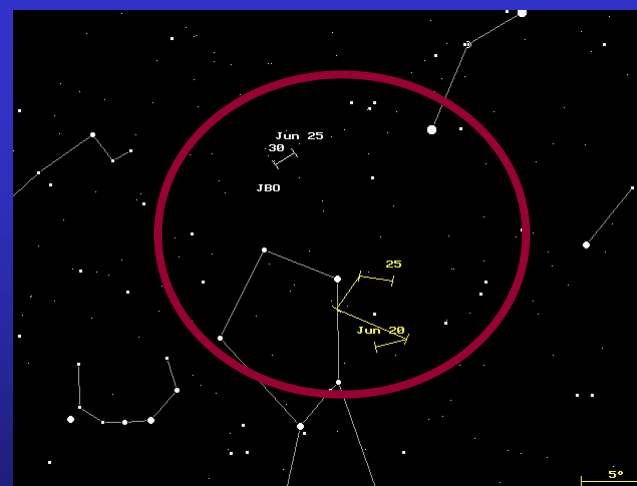
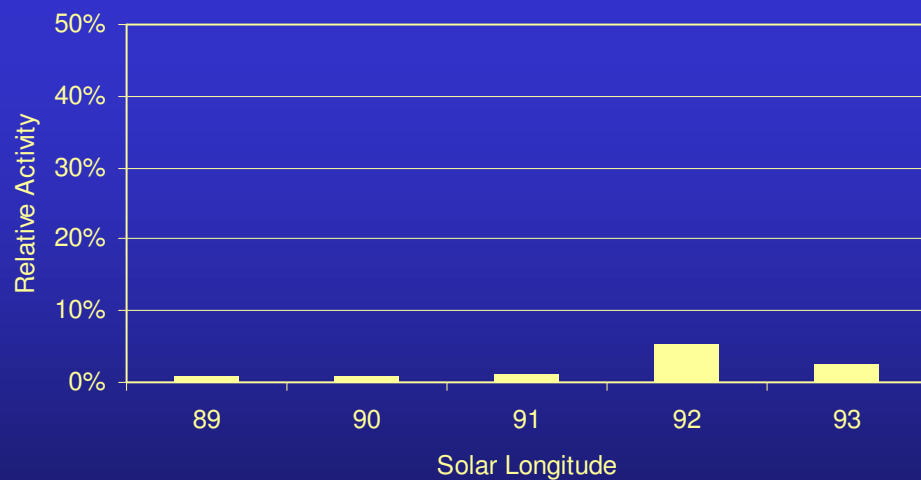
Mean Parameters	Solar Longitude	Date	Right Ascension	Declination	Drift	Velocity
Shower 13	101	Jul 03	12.7	25.5	0.6 / 0.5	65 km/s
Shower 21	117	Jul 20	21.0	36.0	0.6 / 0.4	62 km/s
Shower 27	133	Aug 06	43.4	39.5	0.8 / -0.3	60 km/s
Shower 35	142	Aug 15	40.2	36.0	1.4 / 1.5	54 km/s
Shower 38	151	Aug 24	58.3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

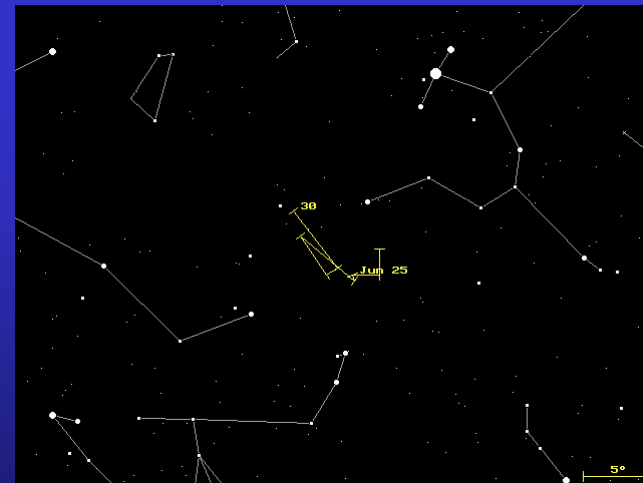
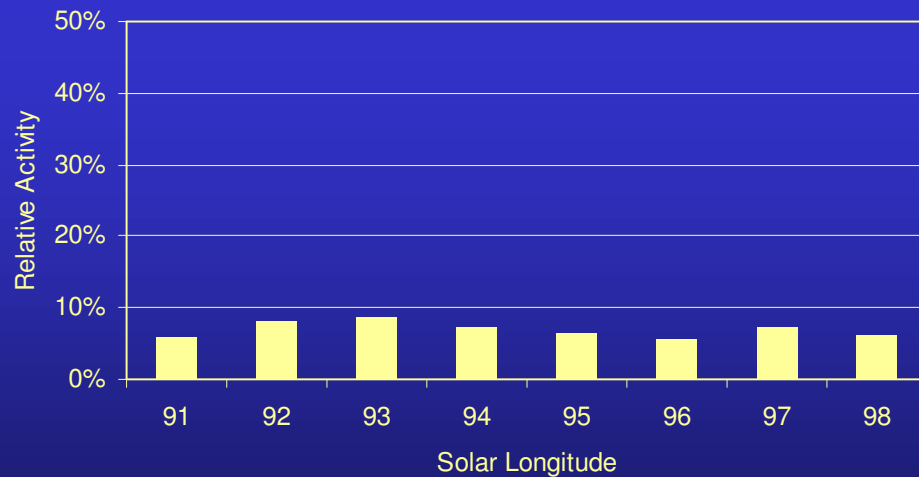
Mean Parameters	Solar Longitude	Date	Right Ascension	Declination	Drift	Velocity
Shower 14a	92	Jun 24	215.9	38.5	0.0 / 1.5	15 km/s
JBO			224	48	0.4 / -0.2	18 km/s



# 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%
-	-	-	-	-	-	-

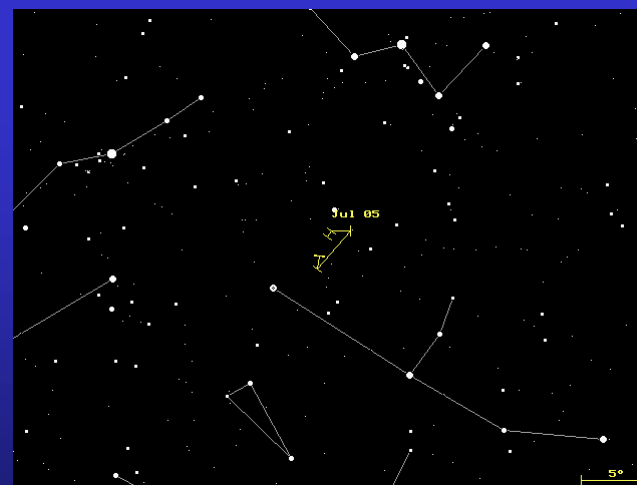
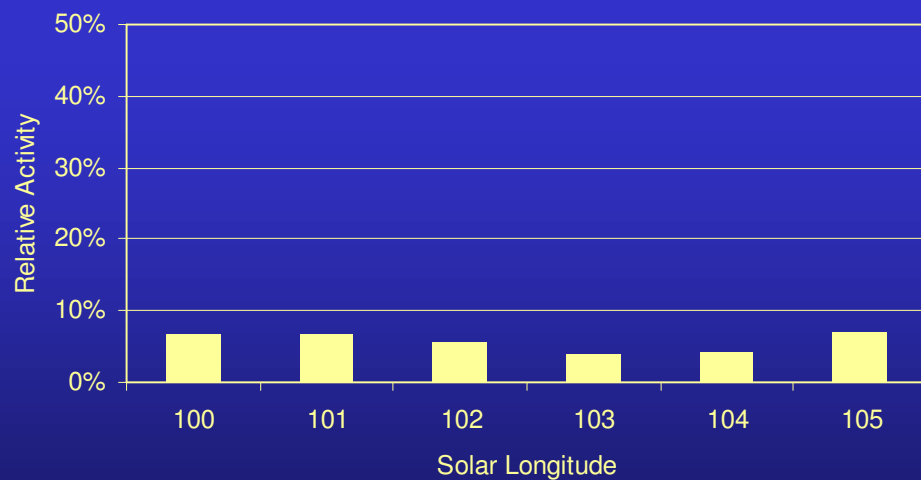
Mean Parameters	Solar Longitude	Date	Right Ascension	Declination	Drift	Velocity
Shower 16	93	Jun 25	304.0	-6.5	0.9 / 0.3	40 km/s
-	-	-	-	-	-	-



# 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%
-	-	-	-	-	-	-

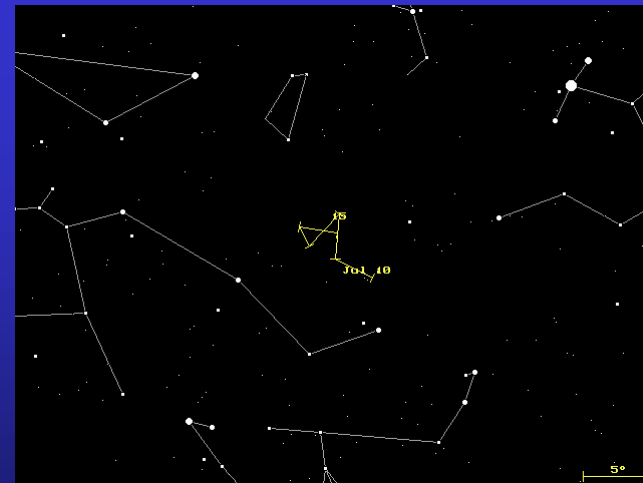
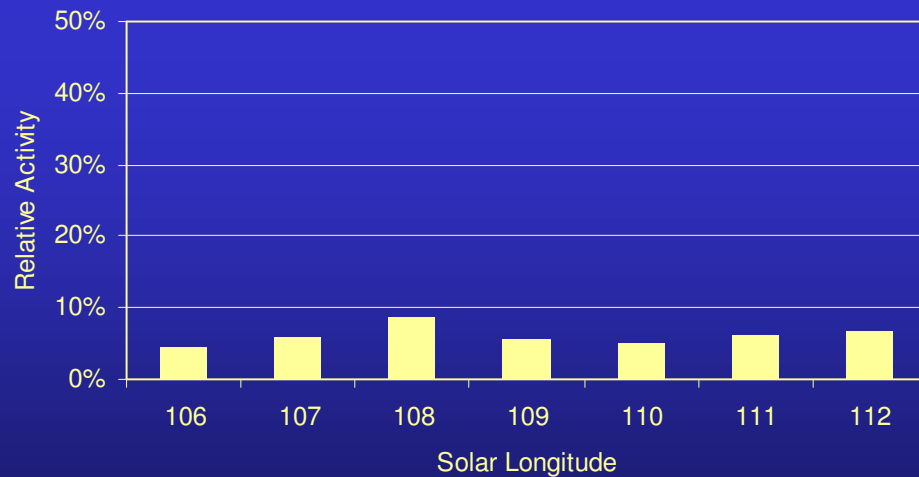
Mean Parameters	Solar Longitude	Date	Right Ascension	Declination	Drift	Velocity
Shower 18	105	Jul 07	25.4	46.5	-0.3 / 0.5	56 km/s
-	-	-	-	-	-	-



# 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%
-	-	-	-	-	-	-

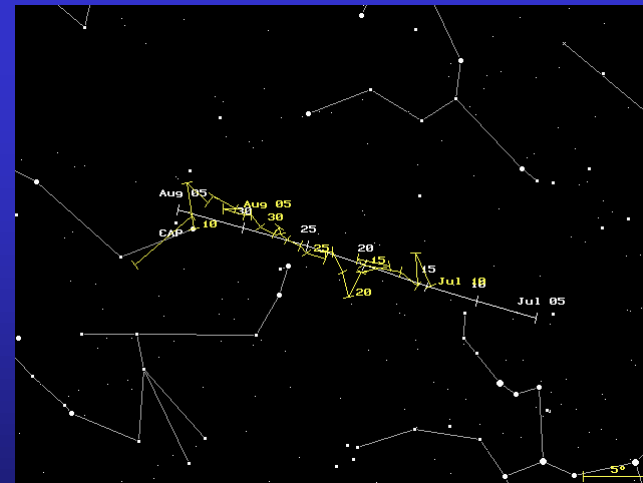
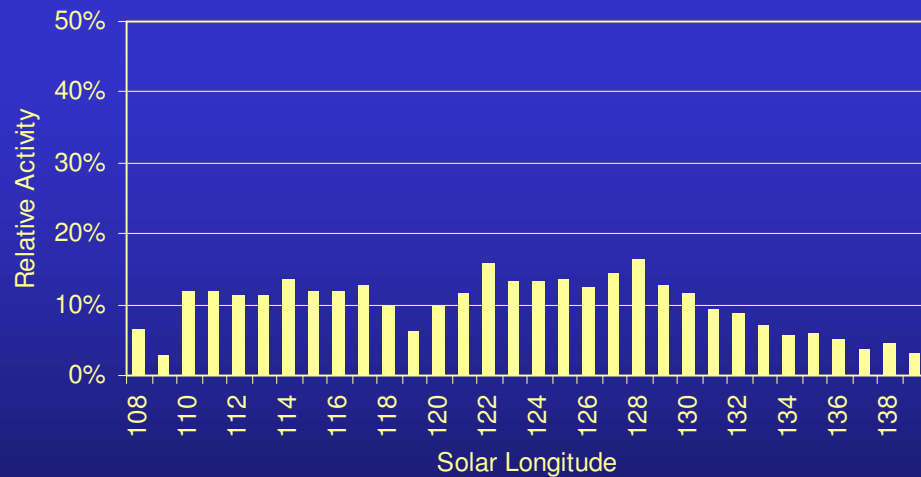
Mean Parameters	Solar Longitude	Date	Right Ascension	Declination	Drift	Velocity
Shower 19	108	Jul 10	315.3	-4.0	0.6 / 0.6	40 km/s
-	-	-	-	-	-	-



# 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	-

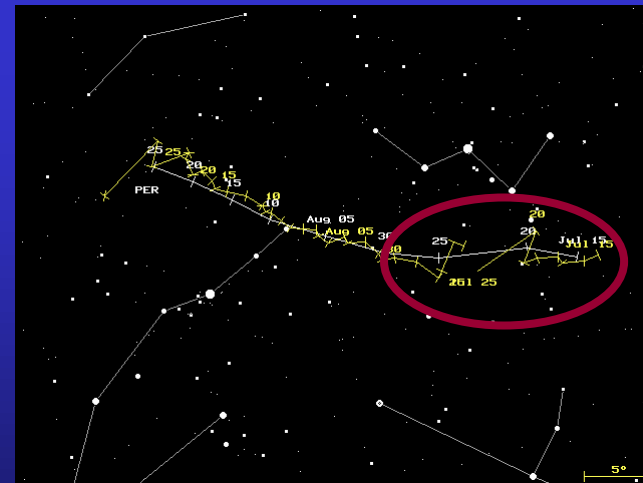
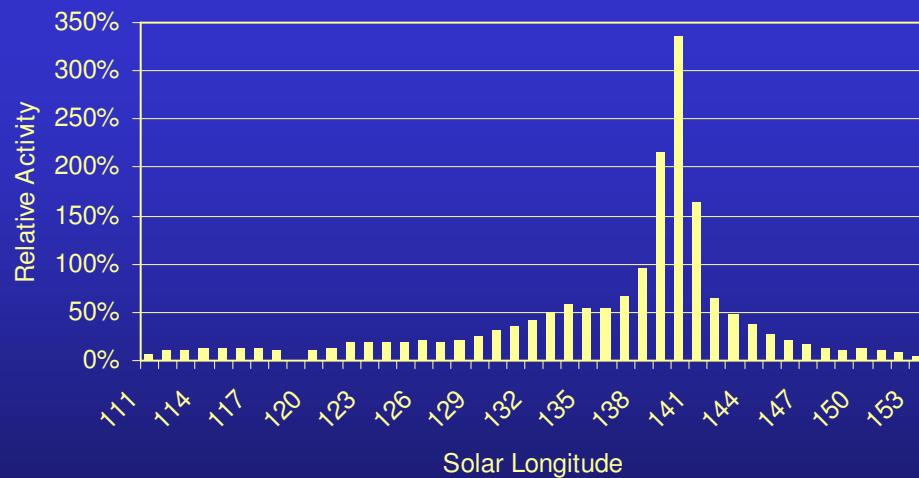
Mean Parameters	Solar Longitude	Date	Right Ascension	Declination	Drift	Velocity
Shower 20	128	Jul 31	306.7	-9.5	0.6 / 0.2	24 km/s
CAP			308	-10	1.0 / 0.3	23 km/s



# 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

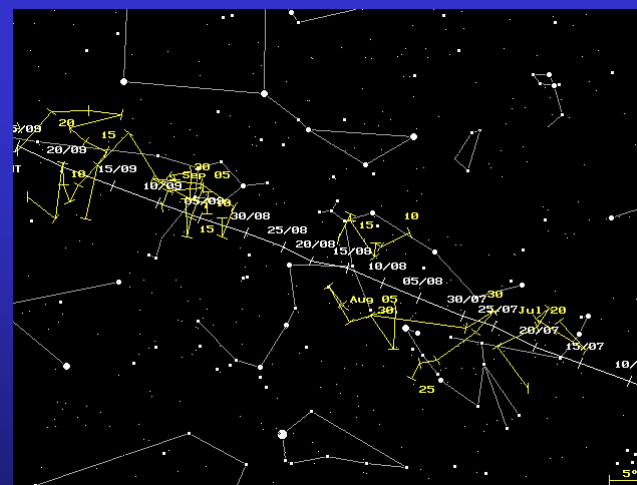
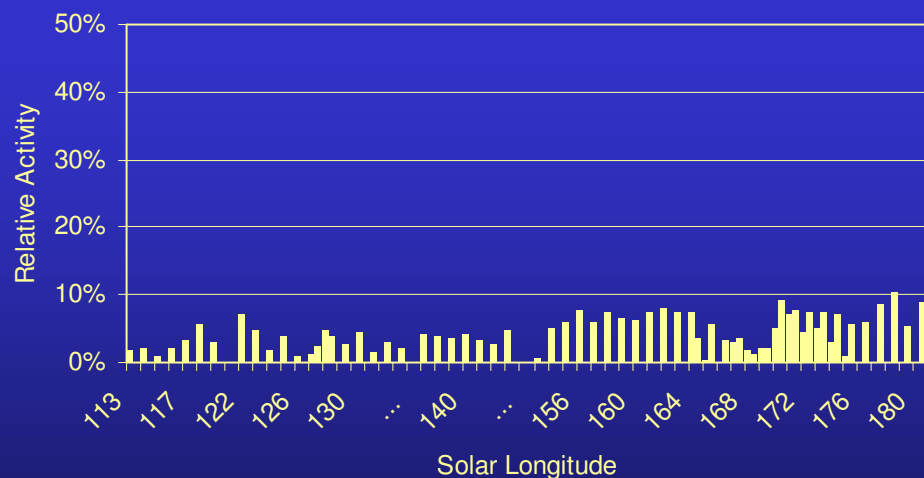




# Results

	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	-	-	-	-	-	-

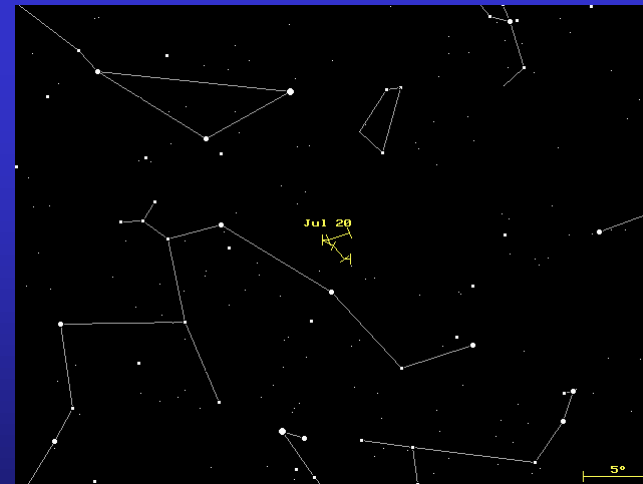
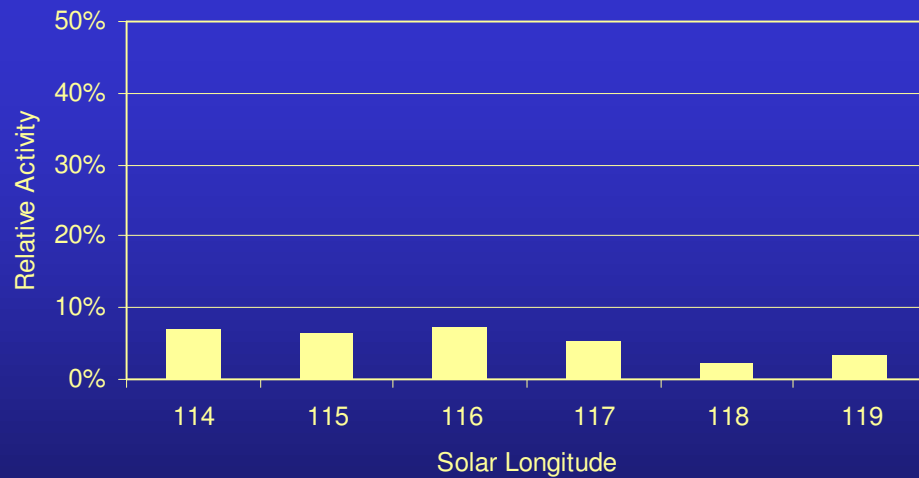
Mean Parameters	Solar Longitude	Date	Right Ascension	Declination	Drift	Velocity
Shower 23	118	Jul 21	314.6	-17.5	1.0 / -1.0	31 km/s
Shower 28	122	Jul 25	325.8	-22.5	-1.7 / 1.5	28 km/s
Shower 30	130	Aug 02	334.7	-15.5	1.3 / 0.6	28 km/s
Shower 34	143	Aug 16	336.3	-4.0	1.5 / 0.3	35 km/s
Shower 42	162	Sep 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%
-	-	-	-	-	-	-

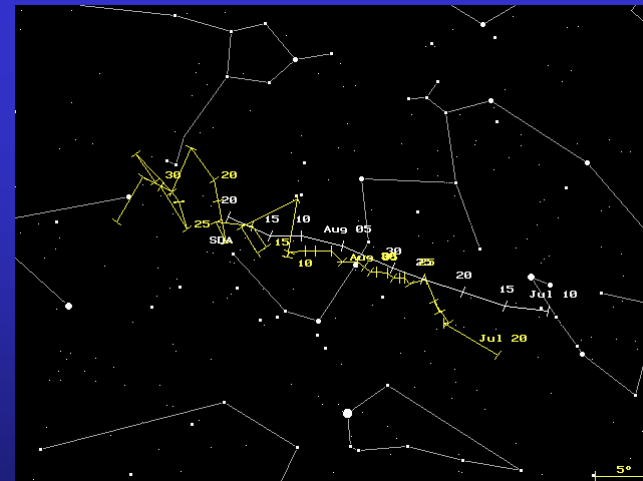
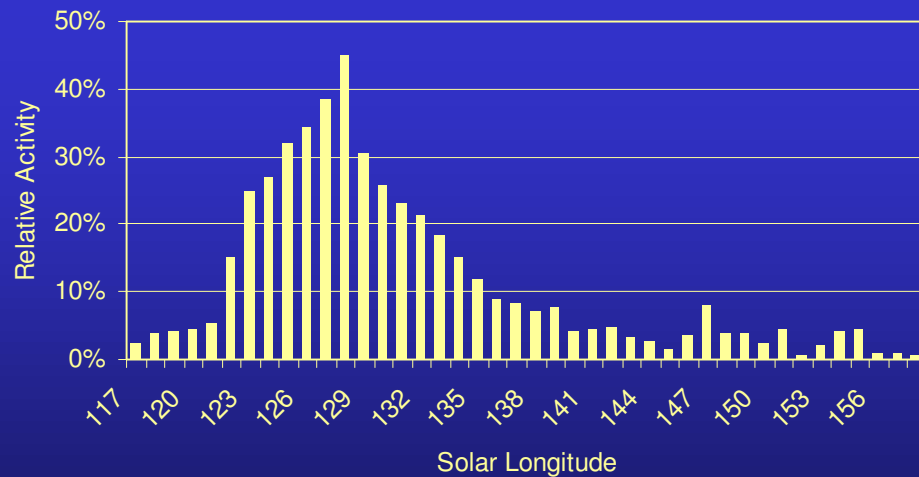
Mean Parameters	Solar Longitude	Date	Right Ascension	Declination	Drift	Velocity
Shower 24	116	Jul 19	322.7	-2.0	0.1 / 0.4	39 km/s
-	-	-	-	-	-	-



# 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	-

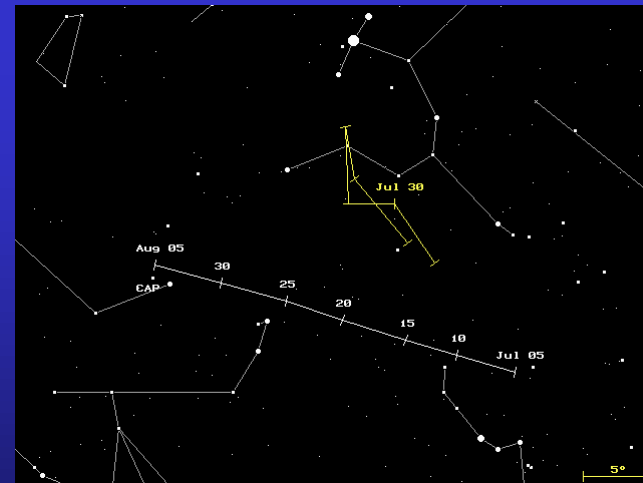
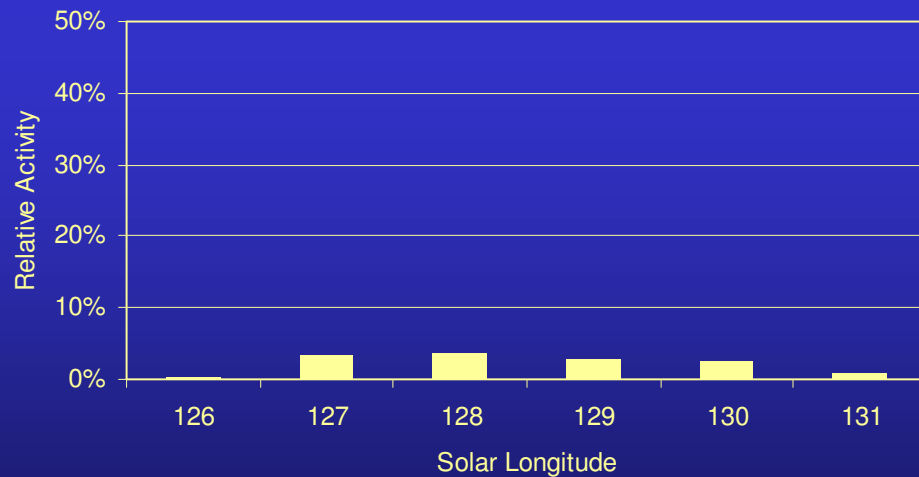
Mean Parameters	Solar Longitude	Date	Right Ascension	Declination	Drift	Velocity
Shower 25	128	Jul 31	341.6	-16.5	0.8 / 0.3	41 km/s
SDA			339	-16	1.0 / 0.3	41 km/s



# 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	-

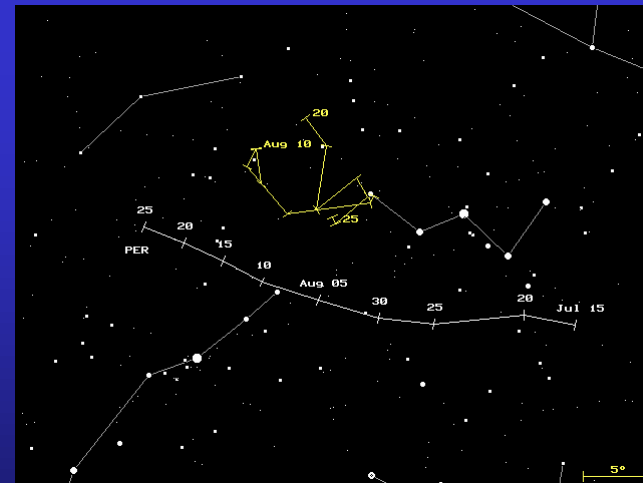
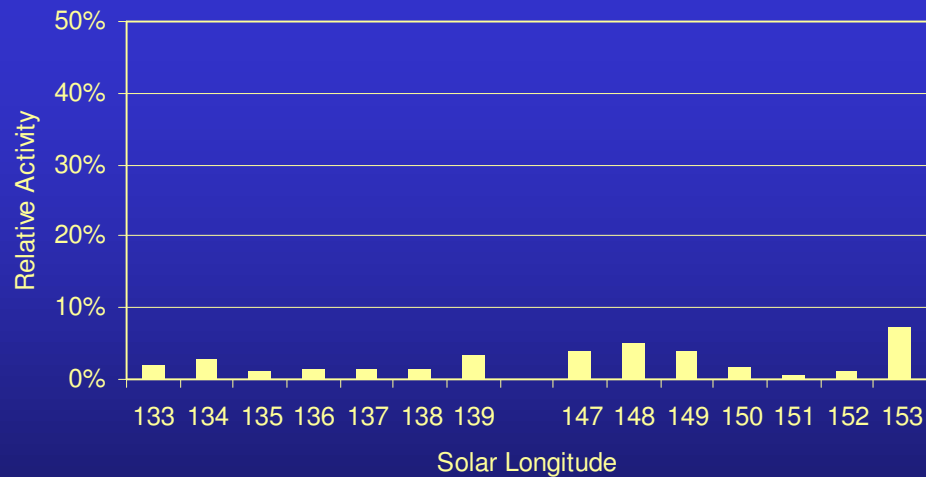
Mean Parameters	Solar Longitude	Date	Right Ascension	Declination	Drift	Velocity
Shower 29	128	Jul 31	298.1	-3.5	0.6 / 0.6	22 km/s
(CAP)			308	-10	1.0 / 0.3	23 km/s



# 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	-

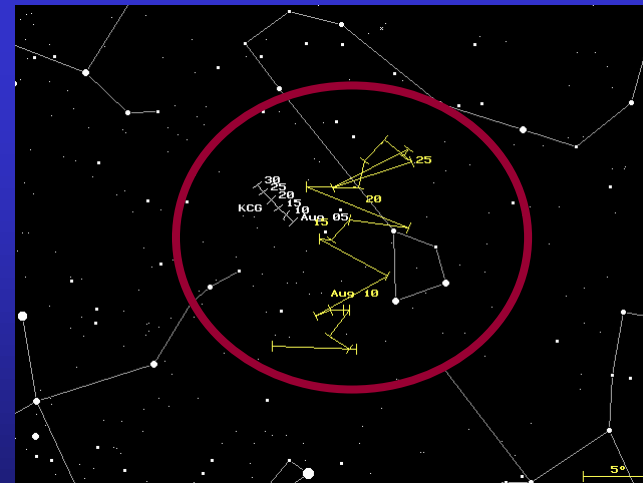
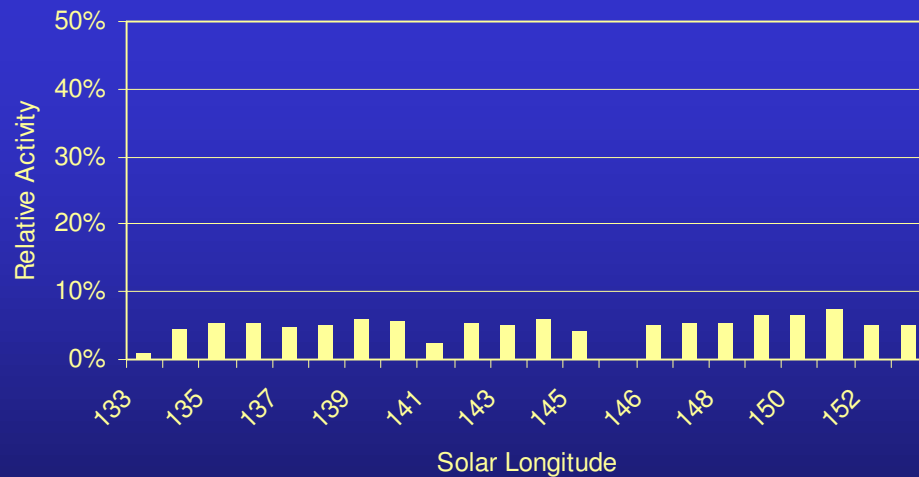
Mean Parameters	Solar Longitude	Date	Right Ascension	Declination	Drift	Velocity
Shower 31	139	Aug 12	47.9	64.0	3.9 / 0.5	50 km/s
Shower 39	153	Aug 26	35.1	62.0	-1.1 / -1.2	50 km/s
(PER)	139	Aug 12	46	58	1.3 / 0.2	59 km/s



# 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	-

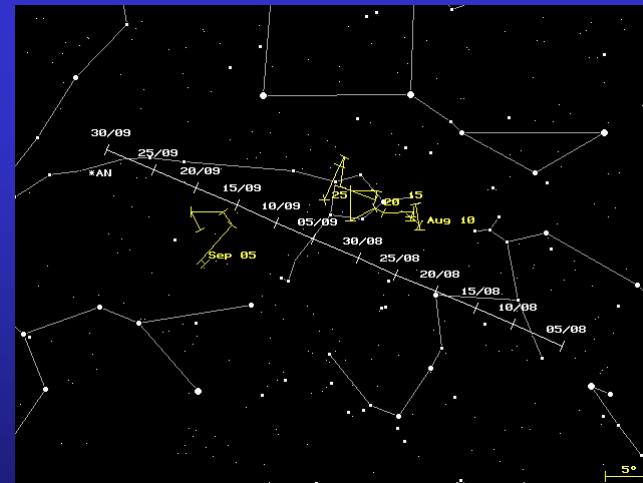
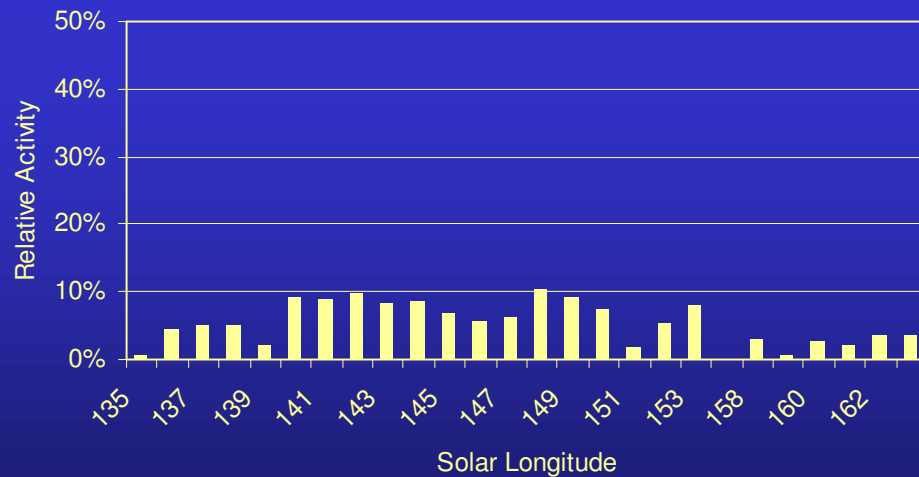
Mean Parameters	Solar Longitude	Date	Right Ascension	Declination	Drift	Velocity
Shower 32	144	Aug 17	274.6	58.0	-0.5 / 0.9	24 km/s
Shower 37	151	Aug 24	277.2	60.5	-1.7 / 0.2	26 km/s
KCG	144	Aug 17	286	59	0.0 / 0.0	25 km/s



# 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	-	-	-	-	-	-

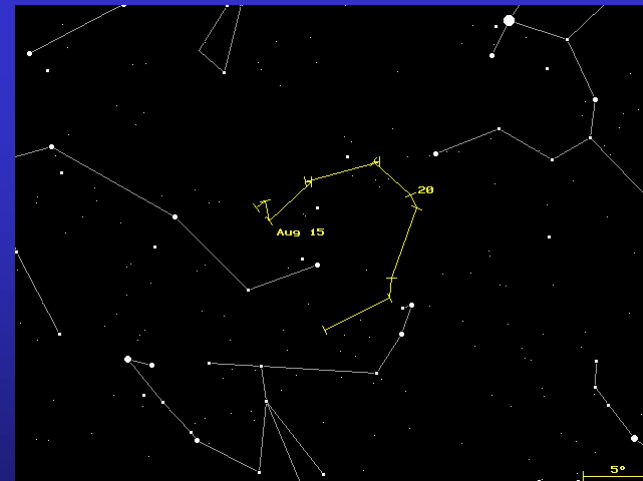
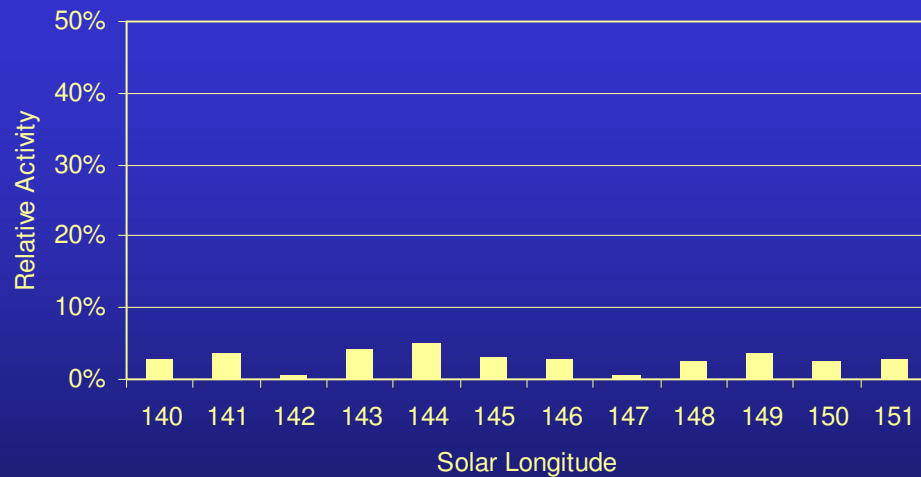
Mean Parameters	Solar Longitude	Date	Right Ascension	Declination	Drift	Velocity
Shower 33	149	Aug 22	354.3	5.0	0.7 / 0.3	39 km/s
Shower 46	162	Sep 05	10.5	-3.5	-0.2 / -1.1	39 km/s
Anthelion	-	-	-	-	0.9 / 0.4	30 km/s



# 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
-	-	-	-	-	-	-

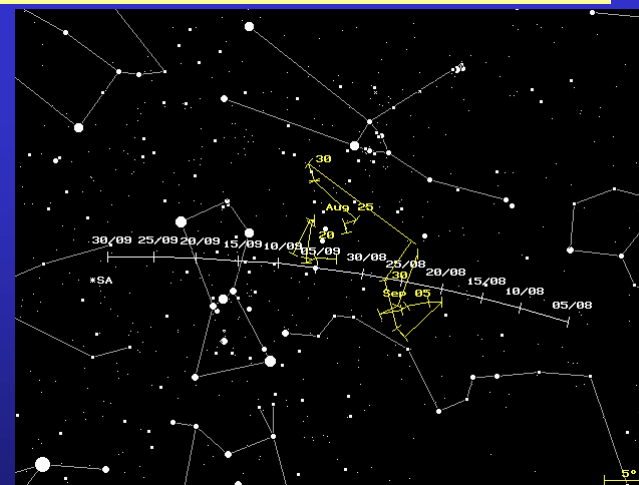
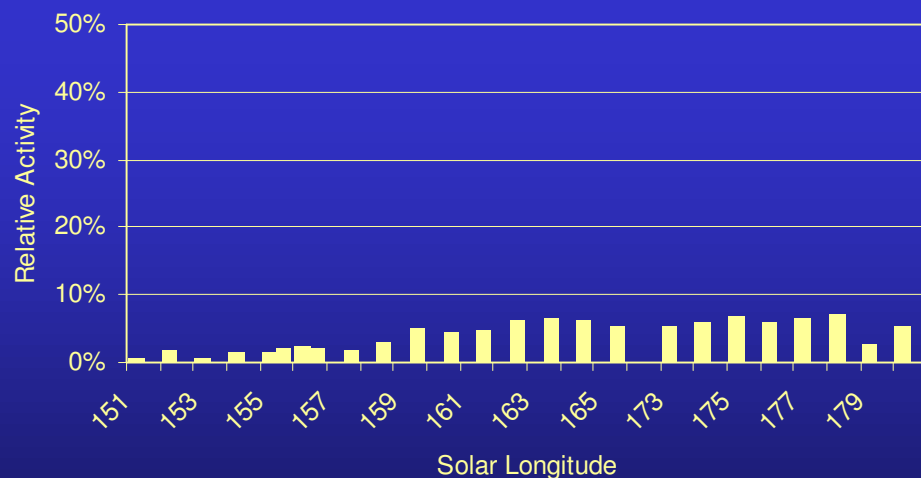




# Results

	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	-	-	-	-	-	-

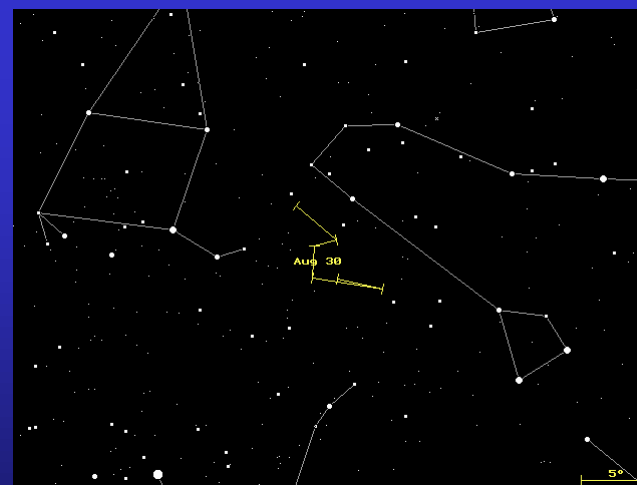
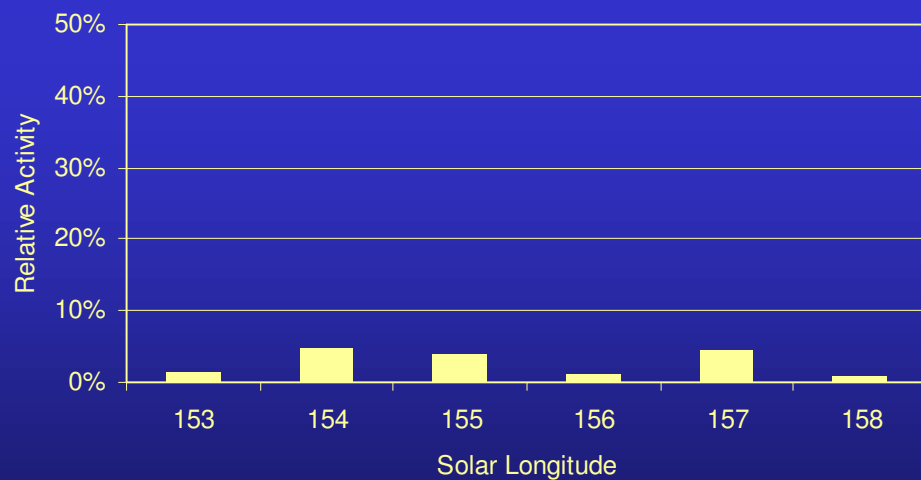
Mean Parameters	Solar Longitude	Date	Right Ascension	Declination	Drift	Velocity
Shower 40	156	Aug 30	74.4	14.5	1.1 / 1.7	65 km/s
Shower 43	163	Sep 06	66.1	-3.0	0.0 / -0.1	58 km/s
Shower 52	178	Sep 21	73.7	8.0	0.4 / 0.5	60 km/s
S Apex	-	-	-	-	0.9 / 0.2	60 km/s



# 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%
-	-	-	-	-	-	-

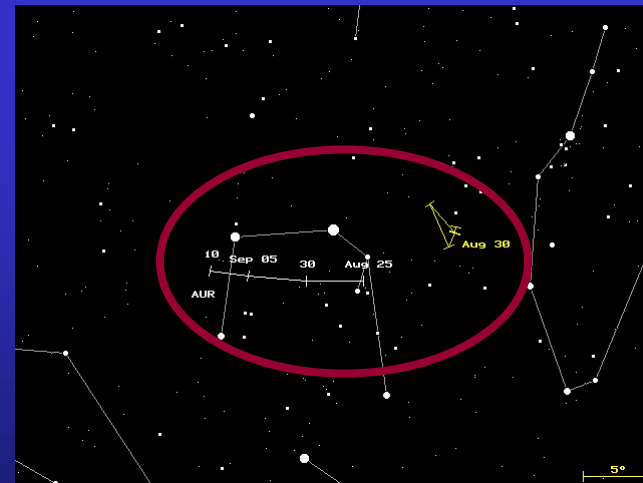
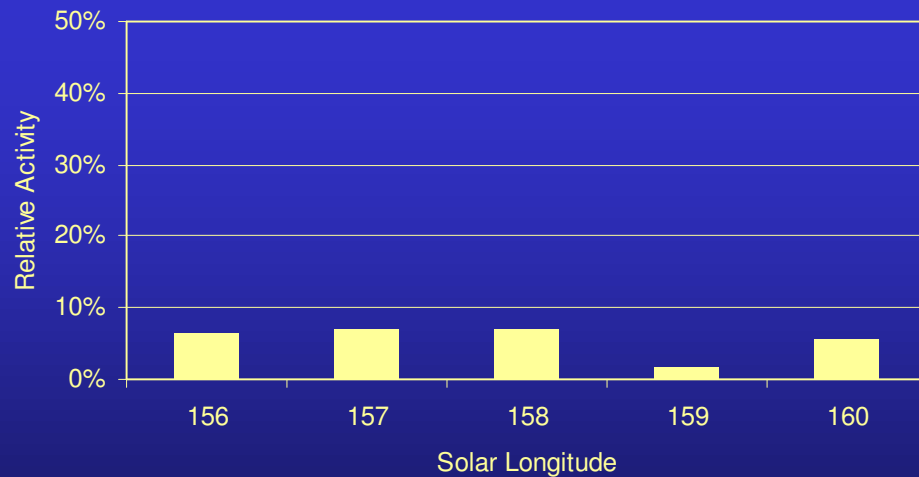
Mean Parameters	Solar Longitude	Date	Right Ascension	Declination	Drift	Velocity
Shower 41	154	Aug 27	291.5	64.5	-1.8 / -1.2	30 km/s
-			-	-	-	-



# 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	-

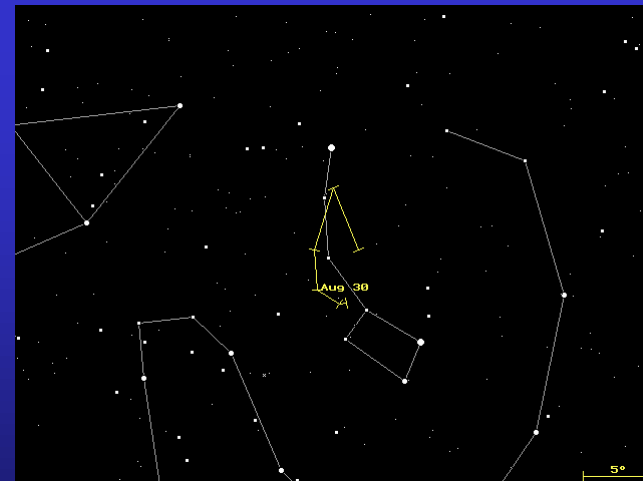
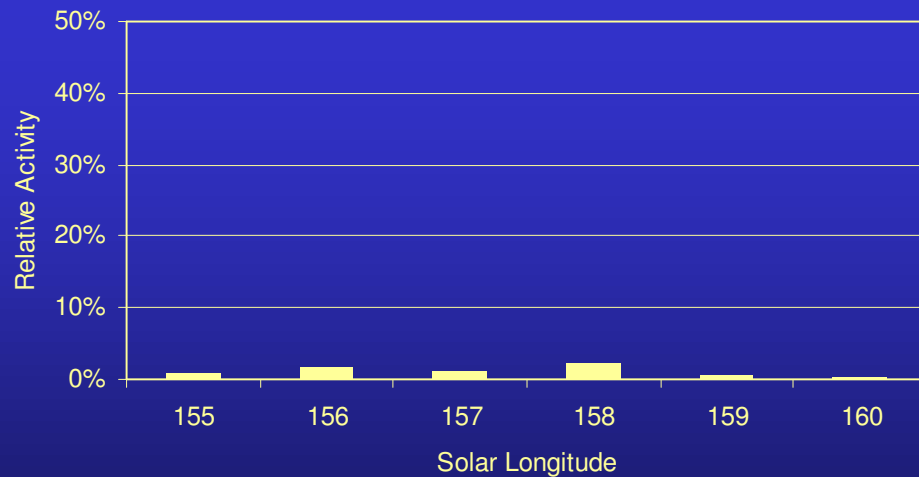
Mean Parameters	Solar Longitude	Date	Right Ascension	Declination	Drift	Velocity
Shower 41a	158	Sep 01	68.1	47.5	-0.1 / 0.2	69 km/s
AUR			84	42	1.1 / 0.0	66 km/s



# 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%
-	-	-	-	-	-	-

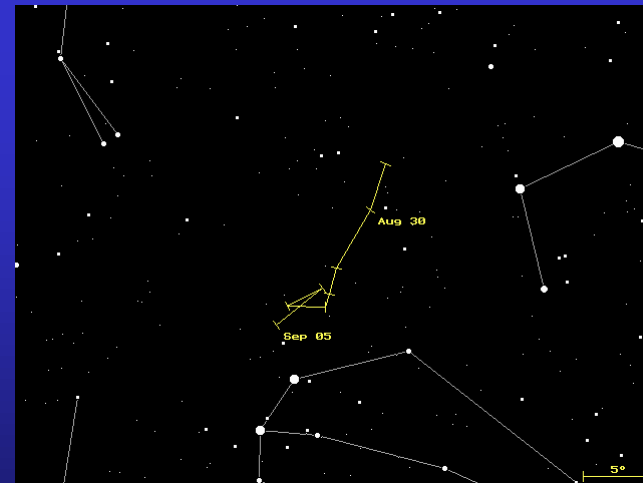
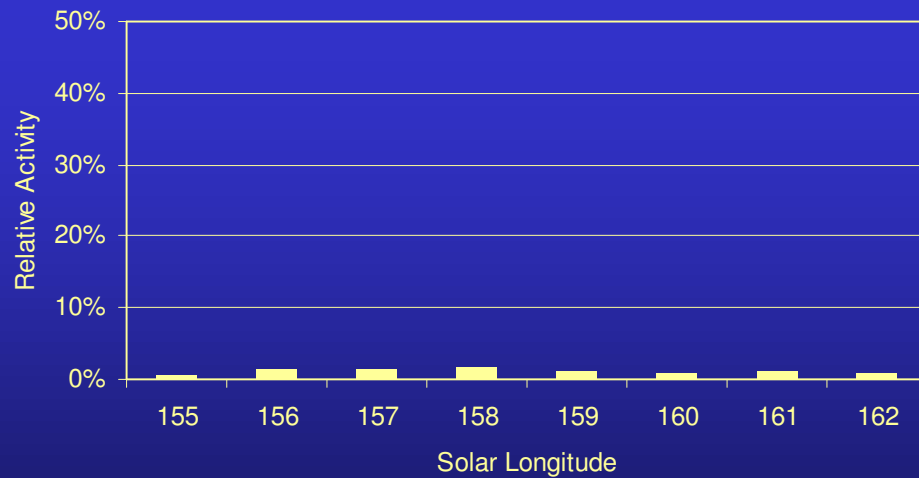
Mean Parameters	Solar Longitude	Date	Right Ascension	Declination	Drift	Velocity
Shower 44	158	Sep 01	260.5	82.5	-0.7 / 1.4	38 km/s
-	-	-	-	-	-	-



# 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%
-	-	-	-	-	-	-

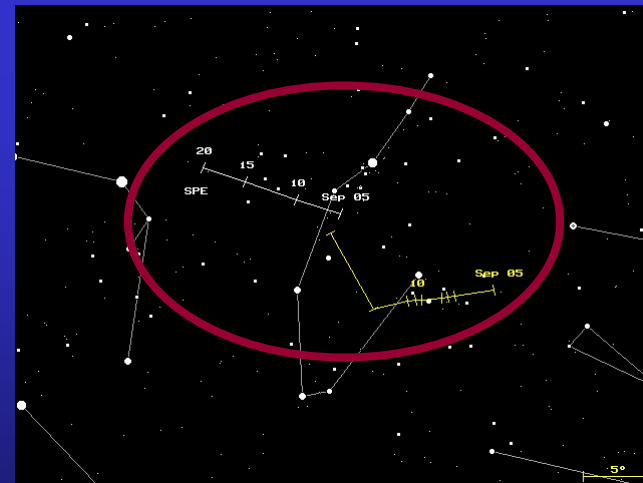
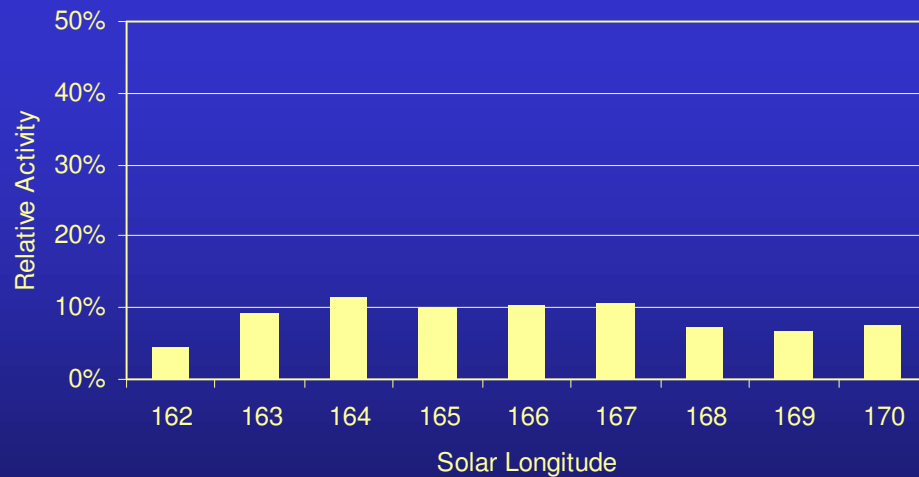
Mean Parameters	Solar Longitude	Date	Right Ascension	Declination	Drift	Velocity
Shower 45	158	Sep 01	110.5	38.5	1.4 / -1.5	52 km/s
-	-	-	-	-	-	-



# 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	-

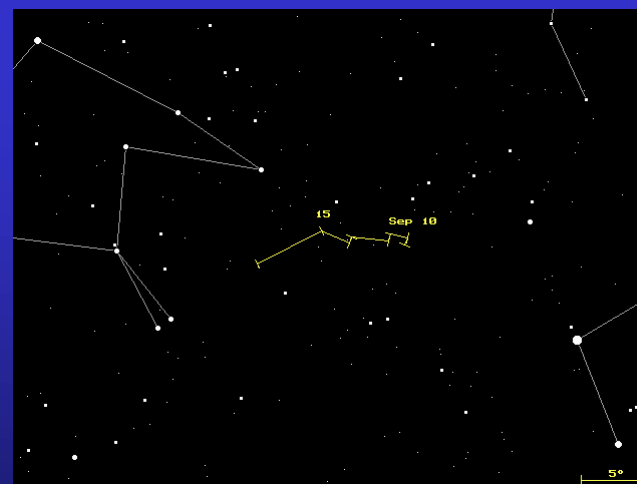
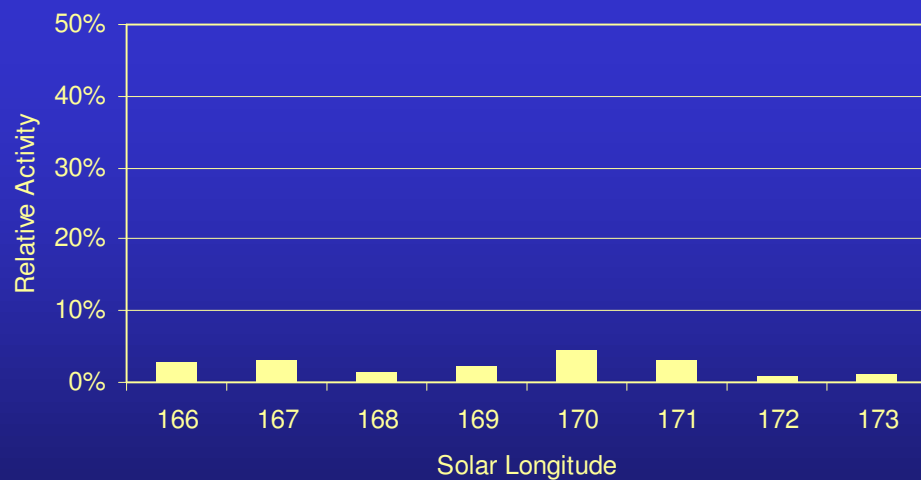
Mean Parameters	Solar Longitude	Date	Right Ascension	Declination	Drift	Velocity
Shower 47	164	Sep 07	44.4	39.0	1.7 / 0.3	60 km/s
SPE			59	47	1.1 / 0.1	64 km/s



# 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%
-	-	-	-	-	-	-

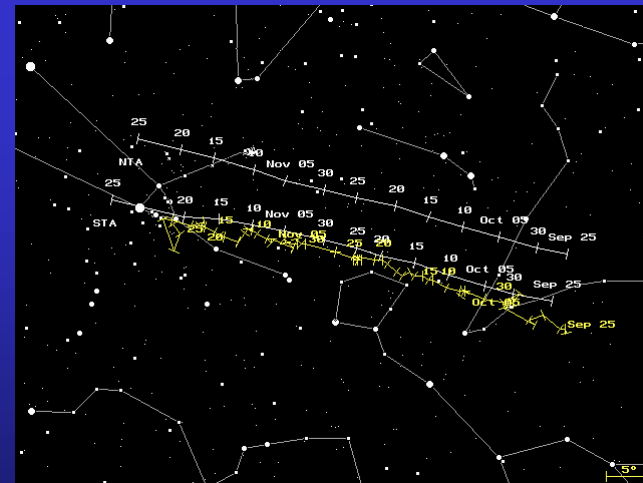
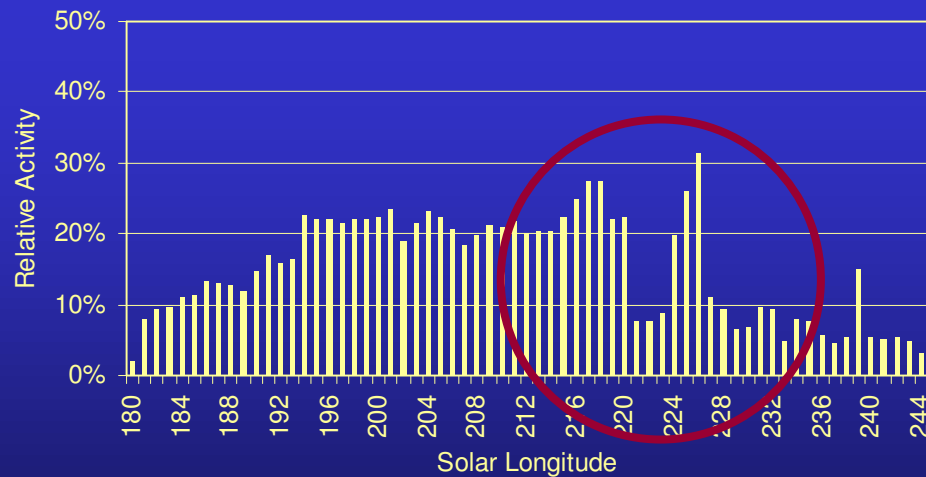
Mean Parameters	Solar Longitude	Date	Right Ascension	Declination	Drift	Velocity
Shower 49	170	Sep 13	113.6	56.0	2.6 / -0.1	53 km/s
-	-	-	-	-	-	-



# 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

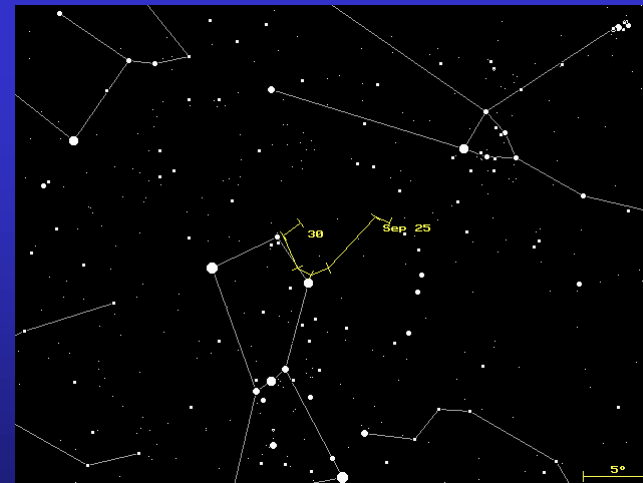
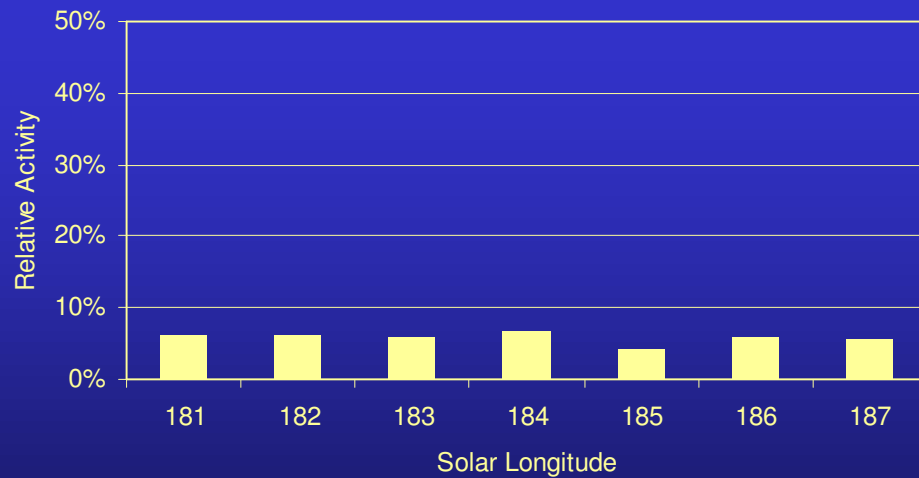




# Results

	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%
-	-	-	-	-	-	-

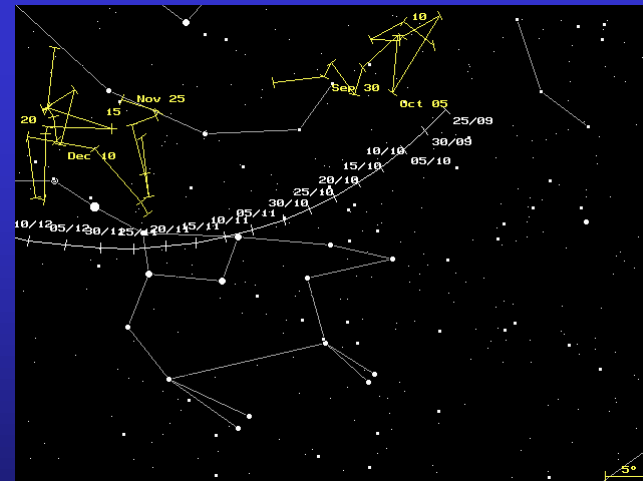
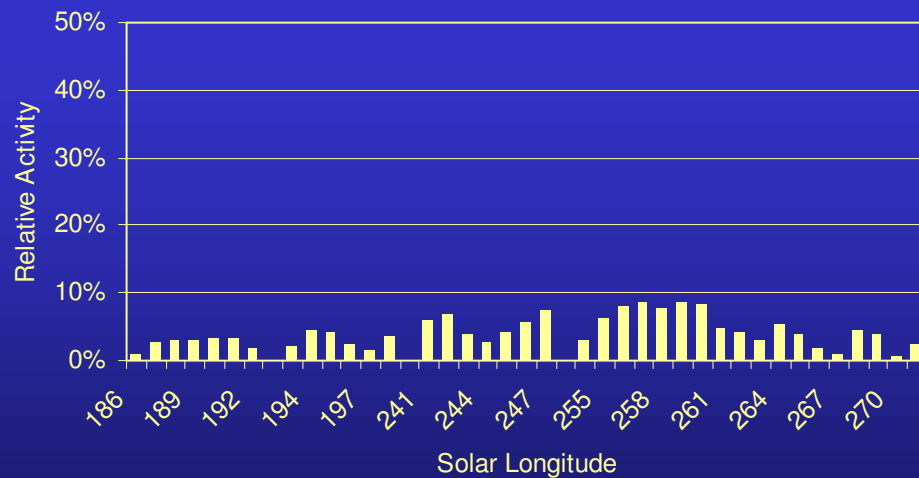
Mean Parameters	Solar Longitude	Date	Right Ascension	Declination	Drift	Velocity
Shower 54	184	Sep 27	81.1	7.0	1.4 / -0.1	59 km/s
-	-	-	-	-	-	-



# 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	-	-	-	-	-	

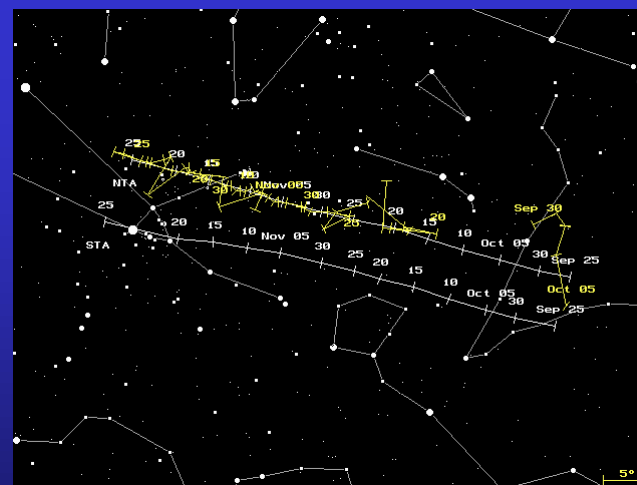
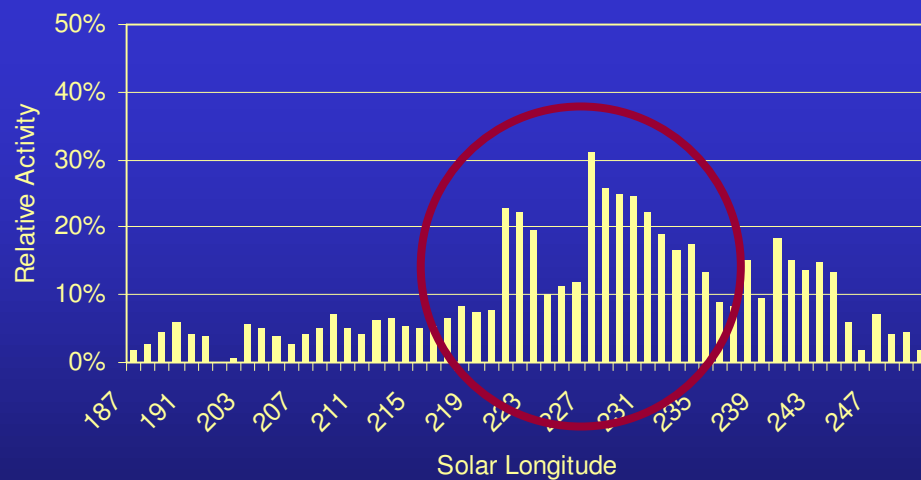
Mean Parameters	Solar Longitude	Date	Right Ascension	Declination	Drift	Velocity
Shower 55	191	Oct 04	80.4	82.5	-13.8 / -0.1	44 km/s
Shower 59	194	Oct 07	79.0	82.0	1.7 / 0.0	42 km/s
Shower 73	247	Nov 29	198.6	64.5	-2.3 / -0.7	43 km/s
Shower 78	259	Dec 11	213.8	61.5	-1.3 / -0.1	41 km/s
N Toroidal	-	-	-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

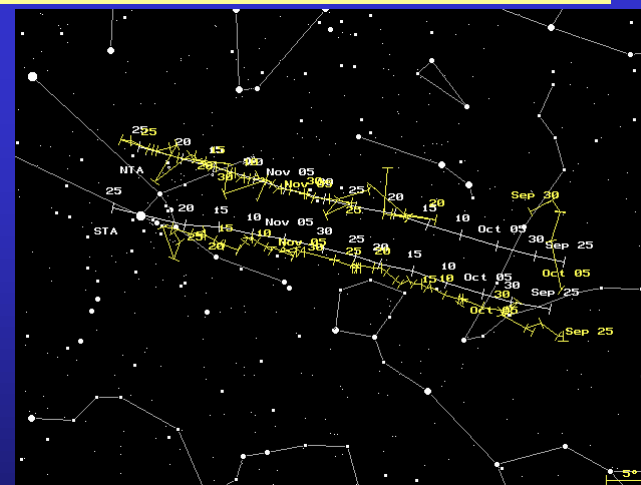
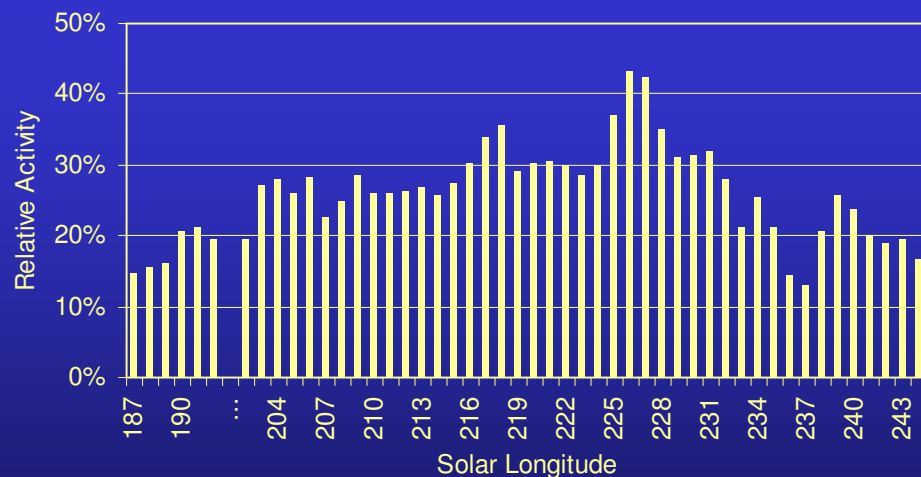
Mean Parameters	Solar Longitude	Date	Right Ascension	Declination	Drift	Velocity
Shower 56	190	Oct 03	18.8	16.5	-0.3 / -1.7	32 km/s
Shower 62	227	Nov 10	56.6	22.0	0.7 / 0.1	31 km/s
NTA	211	Oct 2	30	15	0.8 / 0.3	29 km/s



# 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	-

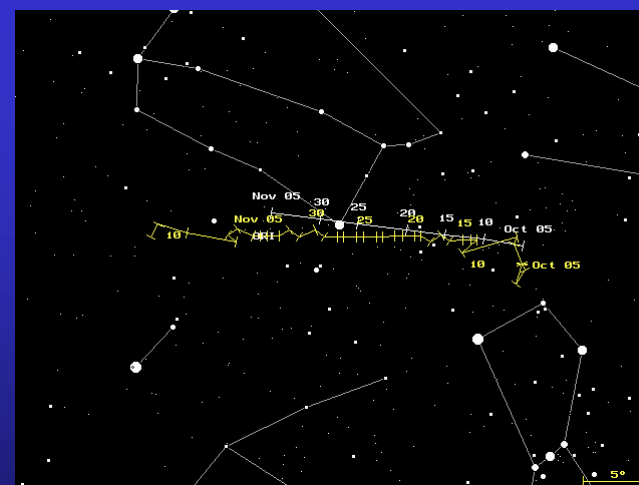
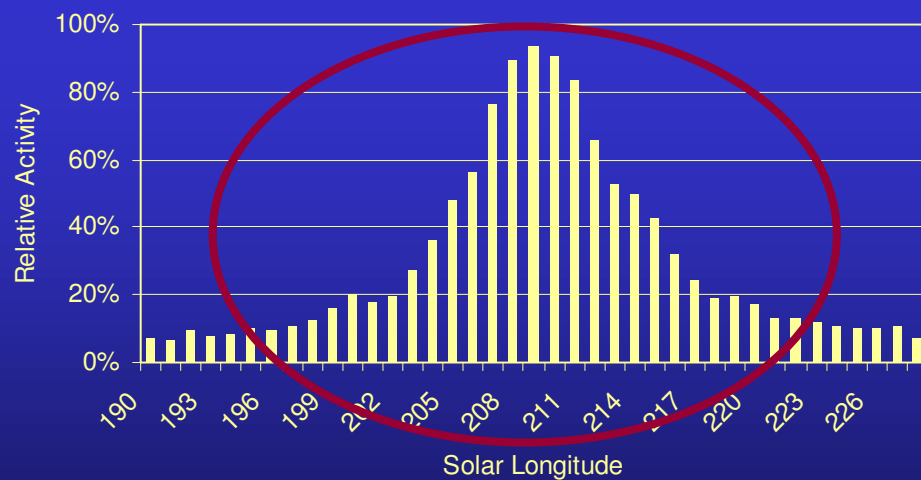
Mean Parameters	Solar Longitude	Date	Right Ascension	Declination	Drift	Velocity
Shower 53	226	Nov 09	55.9	15.0	0.7 / 0.2	30 km/s
Shower 56	190	Oct 03	18.8	16.5	-0.3 / -1.7	32 km/s
Shower 62	227	Nov 10	56.6	22.0	0.7 / 0.1	31 km/s
TAU	211	Oct 2	43	15	0.8 / 0.2	28 km/s



# 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	-

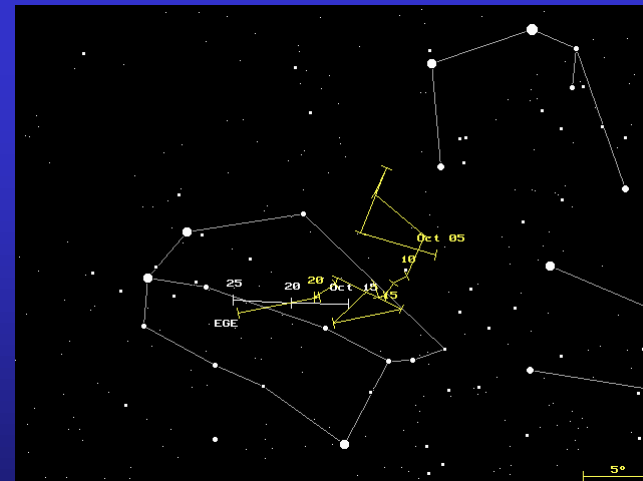
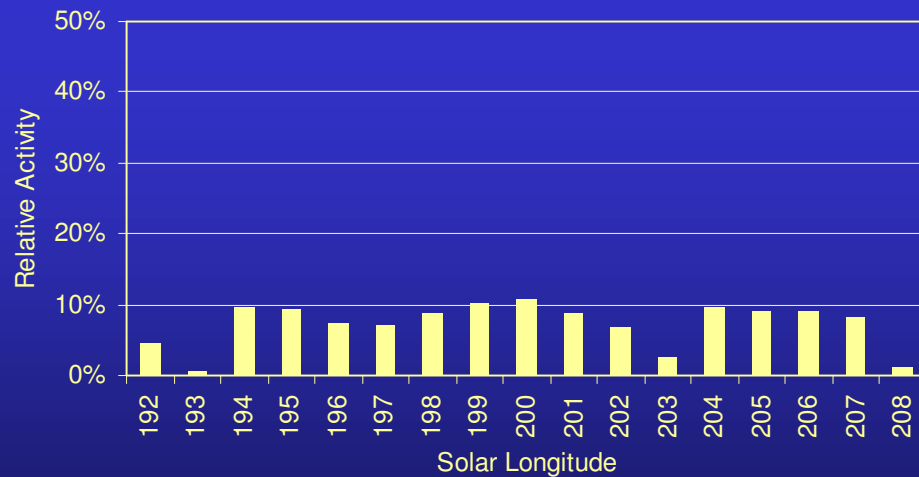
Mean Parameters	Solar Longitude	Date	Right Ascension	Declination	Drift	Velocity
Shower 57	209	Oct 23	96.0	16.0	0.8 / 0.1	61 km/s
ORI			95	16	0.7 / 0.1	66 km/s



# 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	-

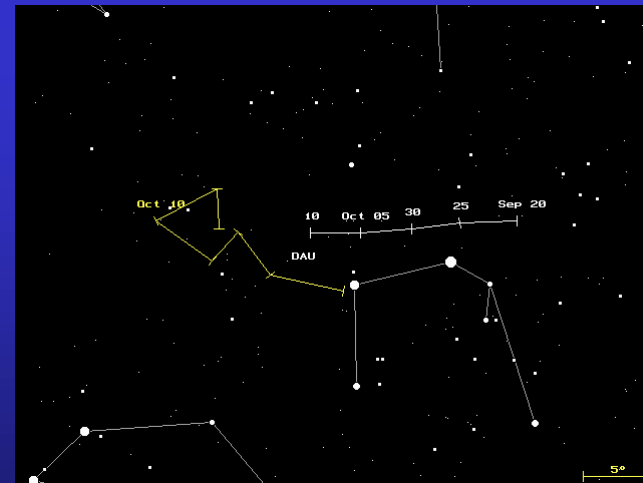
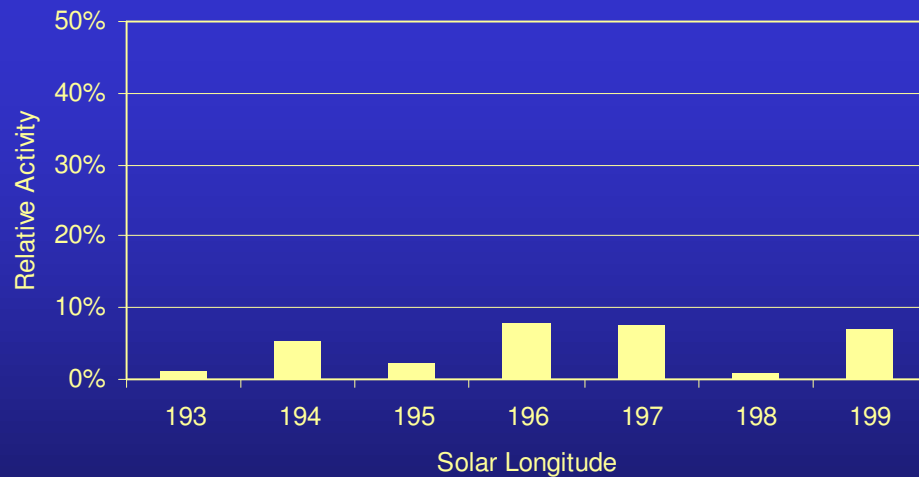
Mean Parameters	Solar Longitude	Date	Right Ascension	Declination	Drift	Velocity
Shower 58	200	Oct 14	96.4	27.5	0.7 / -0.5	64 km/s
EGE			102	27	1.0 / 0.0	70 km/s



# 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	-

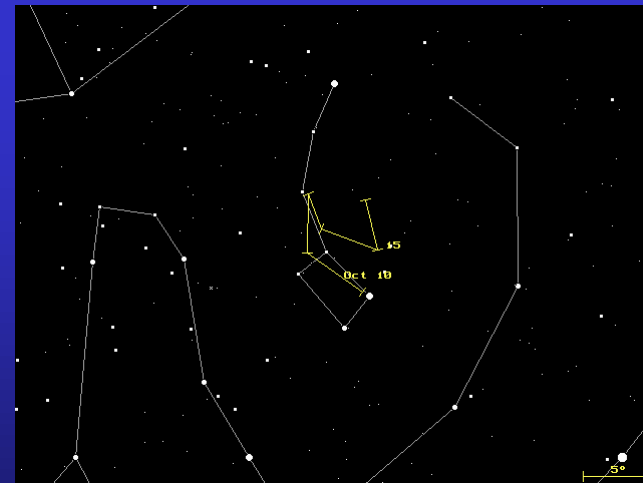
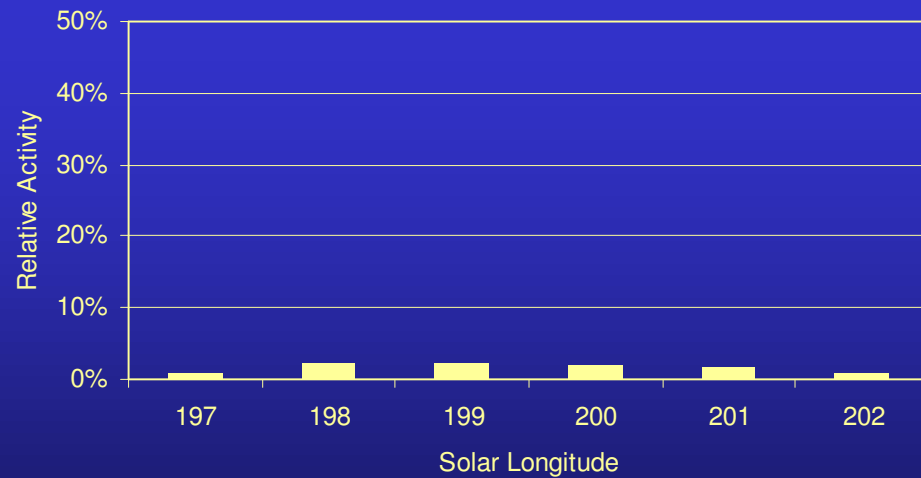
Mean Parameters	Solar Longitude	Date	Right Ascension	Declination	Drift	Velocity
Shower 60	196	Oct 09	105.8	46.0	2.4 / 0.8	64 km/s
DAU			88	49	1.0 / 0.0	64 km/s



# 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
-	-	-	-	-	-	-

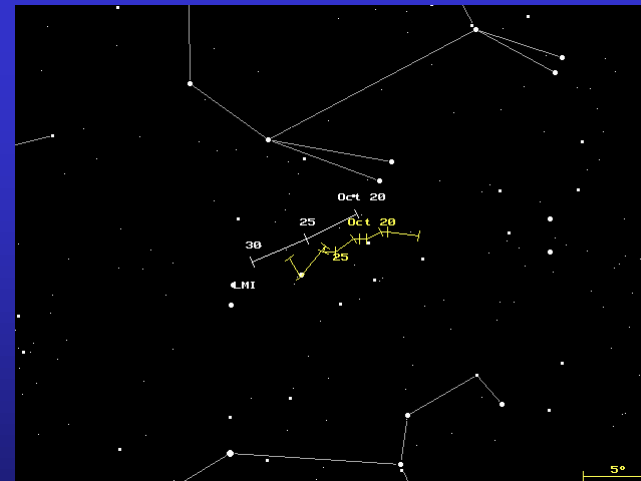
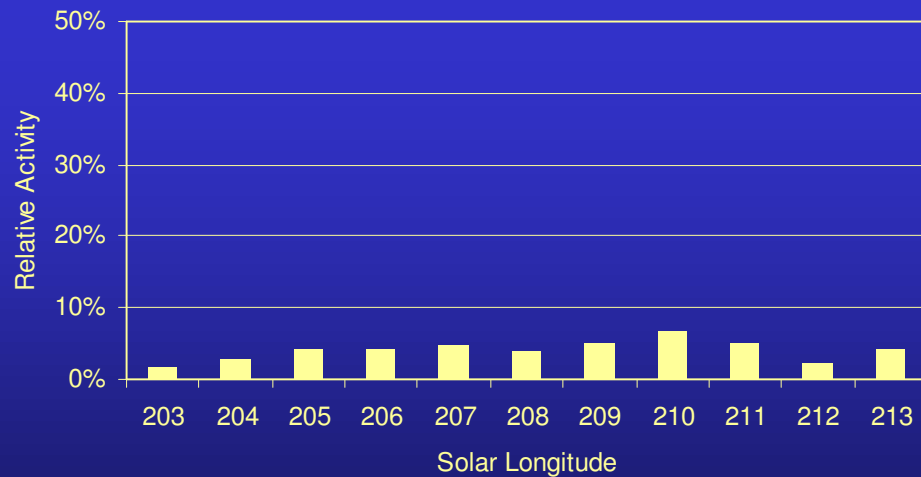




# Results

	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	-

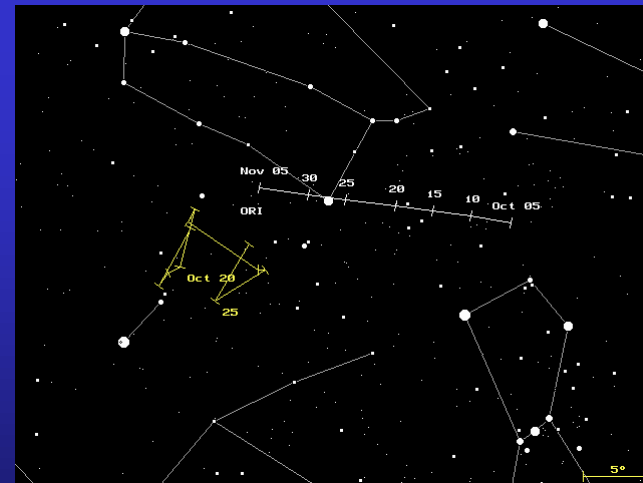
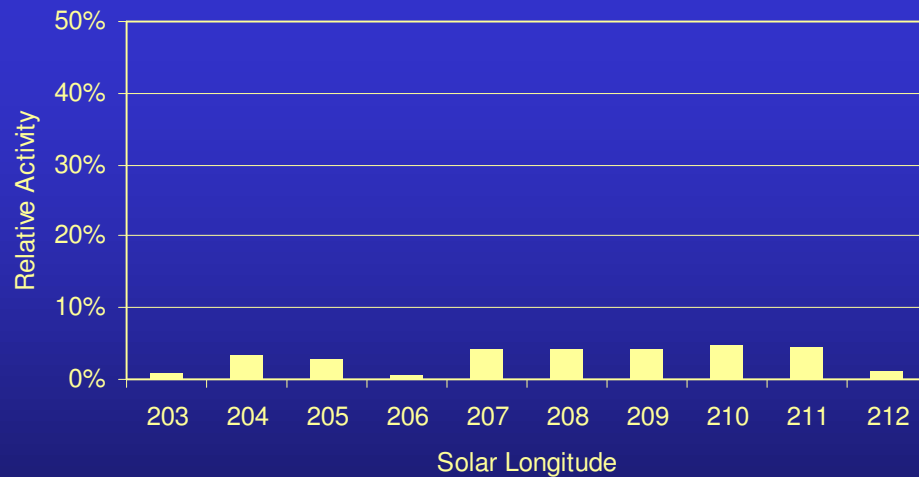
Mean Parameters	Solar Longitude	Date	Right Ascension	Declination	Drift	Velocity
Shower 63	210	Oct 24	161.3	36.0	1.1 / -0.3	56 km/s
LMI			162	37	1.0 / -0.4	62 km/s



# 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	-

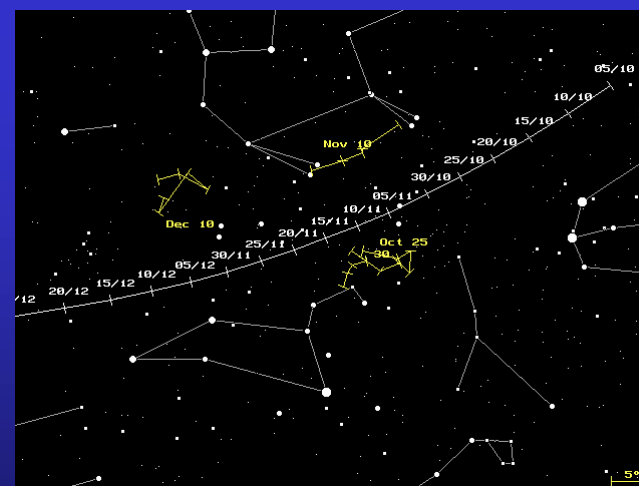
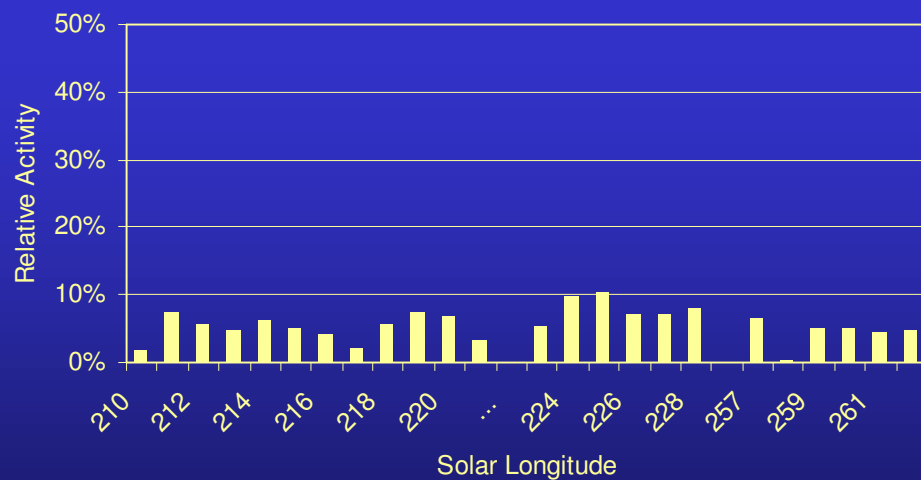
Mean Parameters	Solar Longitude	Date	Right Ascension	Declination	Drift	Velocity
Shower 64	210	Oct 24	104.4	11.0	-0.8 / -0.1	59 km/s
(ORI)			95	16	0.7 / 0.1	66 km/s



# 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	-	-	-	-	-	-

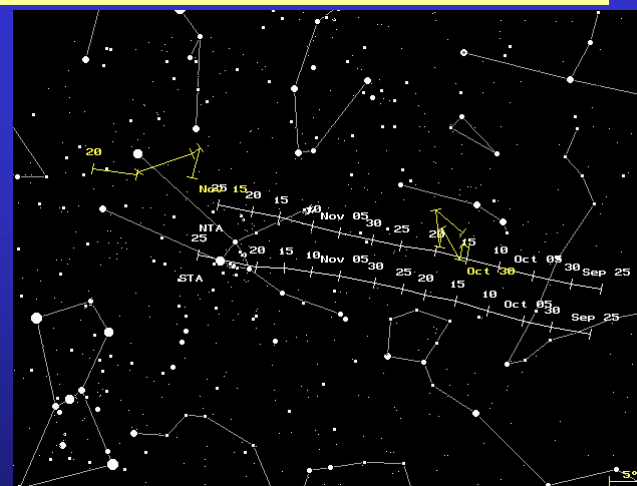
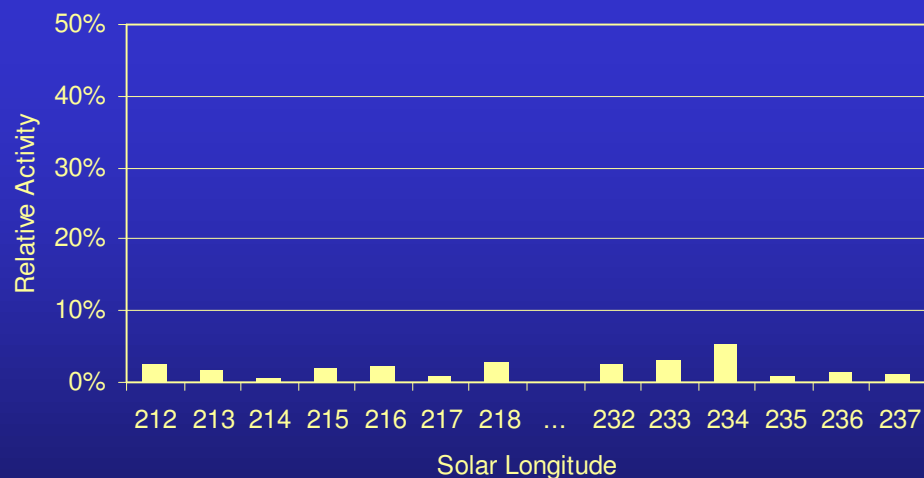
Mean Parameters	Solar Longitude	Date	Right Ascension	Declination	Drift	Velocity
Shower 65	220	Nov 03	148.9	28.0	0.8 / -0.2	63 km/s
Shower 68	225	Nov 08	145.8	44.5	2.9 / -0.9	58 km/s
Shower 80	257	Dec 09	178.8	35.0	0.0 / 0.7	53 km/s
N Apex			-	-	1.1 / -0.3	60 km/s



# 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	-

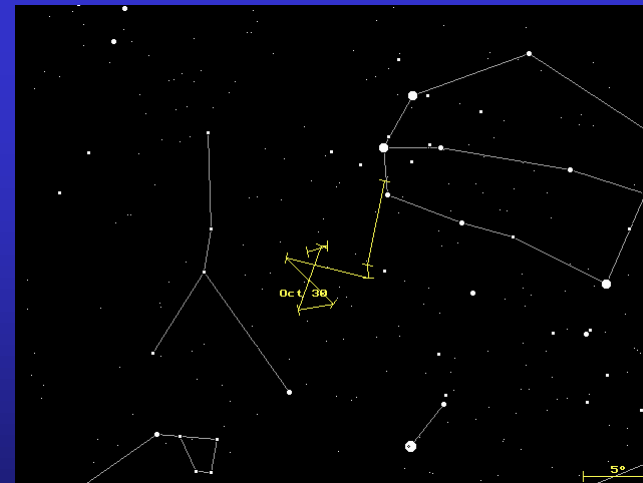
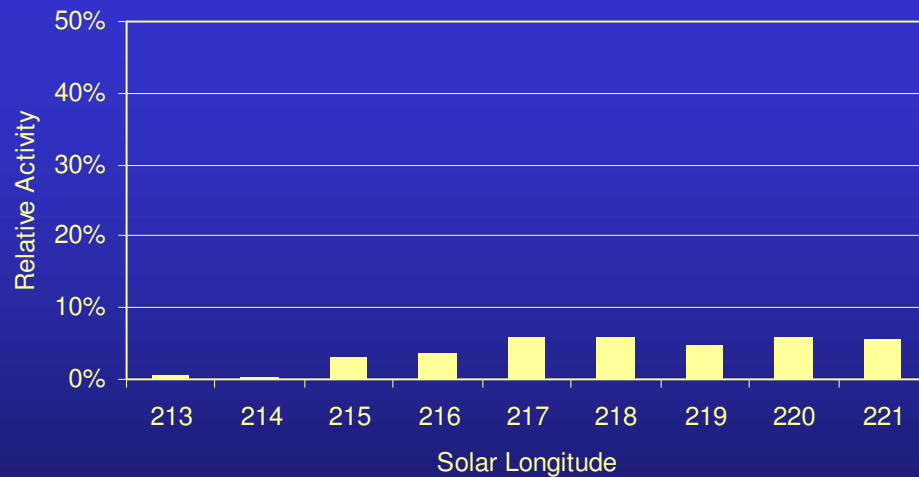
Mean Parameters	Solar Longitude	Date	Right Ascension	Declination	Drift	Velocity
Shower 66	218	Nov 01	33.6	18.0	-0.4 / -0.6	26 km/s
Shower 71	234	Nov 17	74.5	30.0	2.6 / -0.7	35 km/s
(STA)	211	Oct 25	56	15	0.9 / 0.1	27 km/s
(NTA)	211	Oct 25	56	22	0.9 / 0.2	29 km/s



# 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%
-	-	-	-	-	-	-

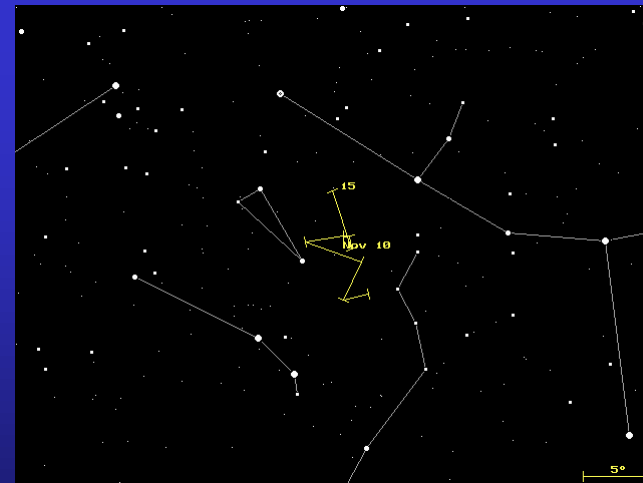
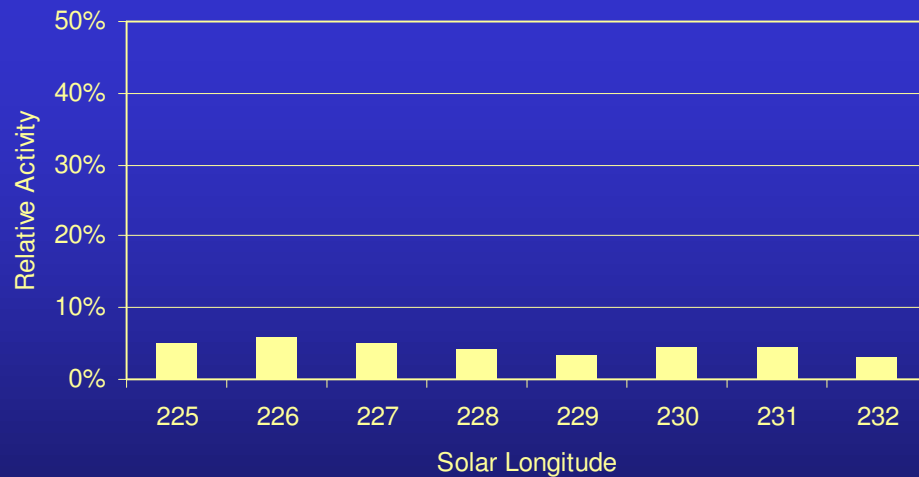
Mean Parameters	Solar Longitude	Date	Right Ascension	Declination	Drift	Velocity
Shower 67	217	Oct 31	120.7	16.0	-0.7 / 0.3	60 km/s
-	-	-	-	-	-	-



# 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%
-	-	-	-	-	-	-

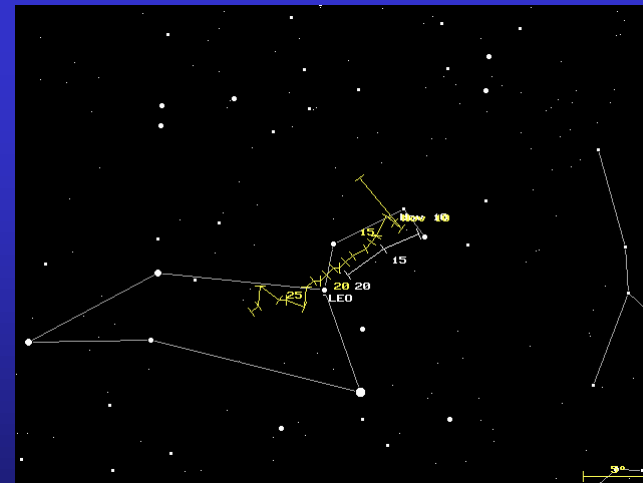
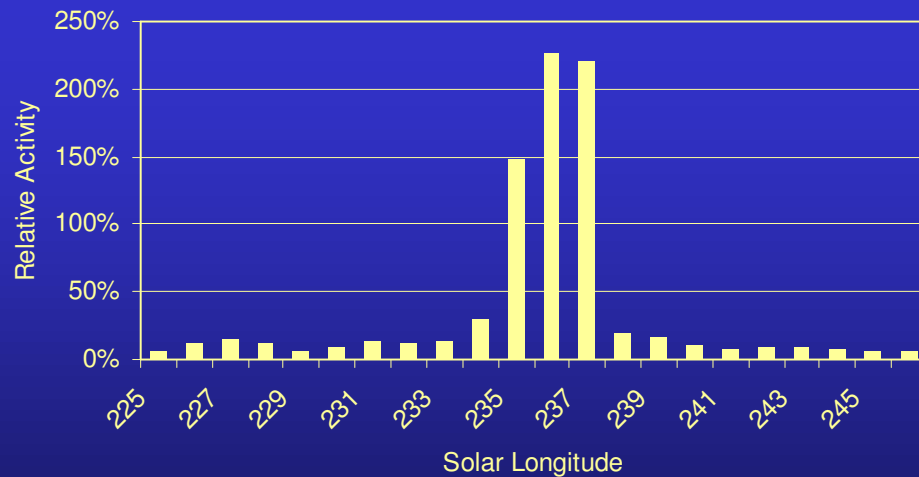
Mean Parameters	Solar Longitude	Date	Right Ascension	Declination	Drift	Velocity
Shower 69	226	Nov 09	24.6	26.5	0.2 / 1.0	20 km/s
-	-	-	-	-	-	-



# 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	-

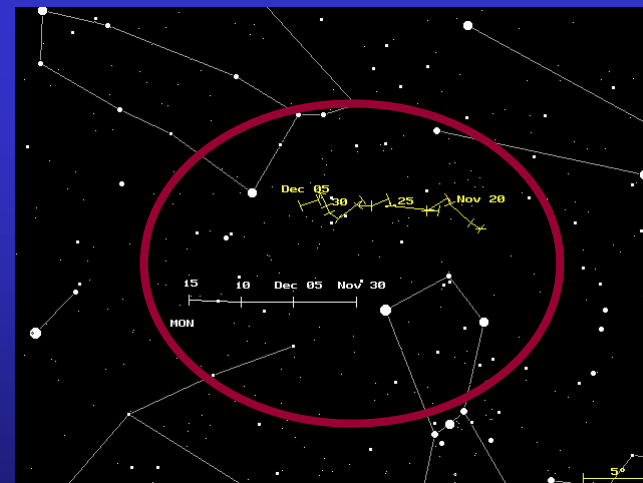
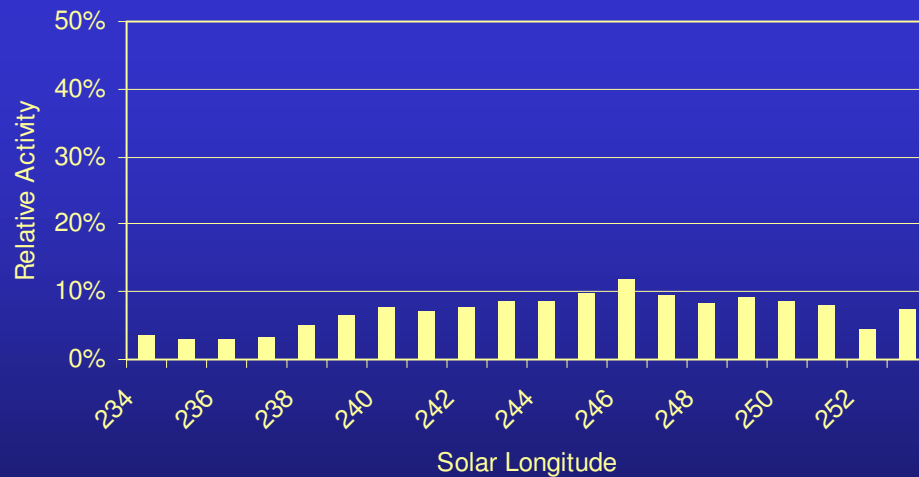
Mean Parameters	Solar Longitude	Date	Right Ascension	Declination	Drift	Velocity
Shower 70	236	Nov 19	154.2	21.5	0.6 / -0.4	64 km/s
LEO			151	22	0.7 / -0.4	71 km/s



# 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

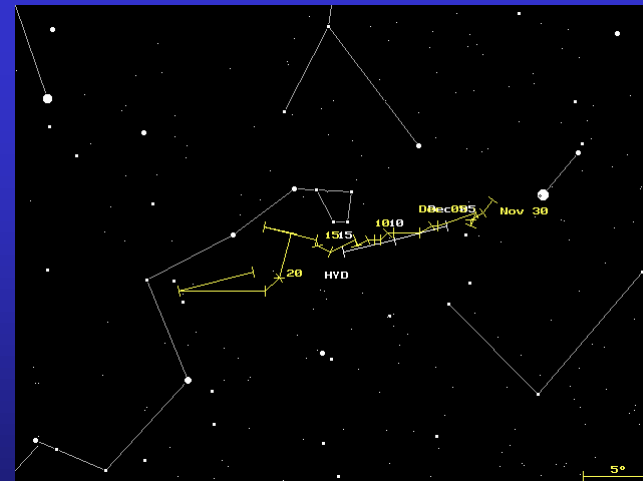
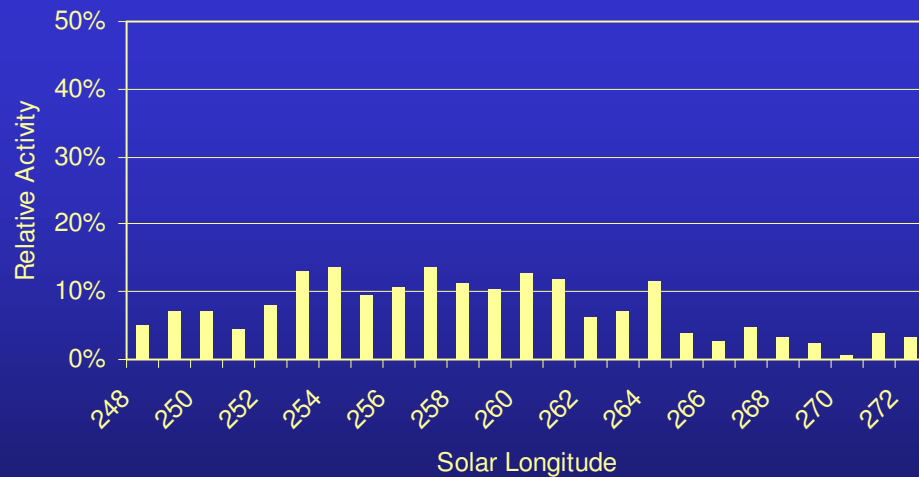




# Results

	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	-

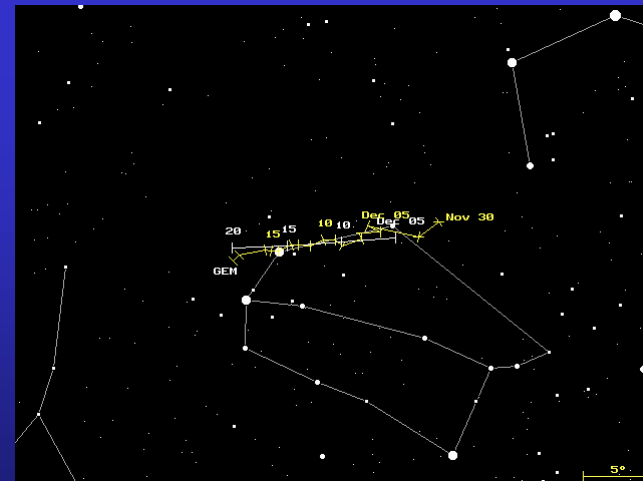
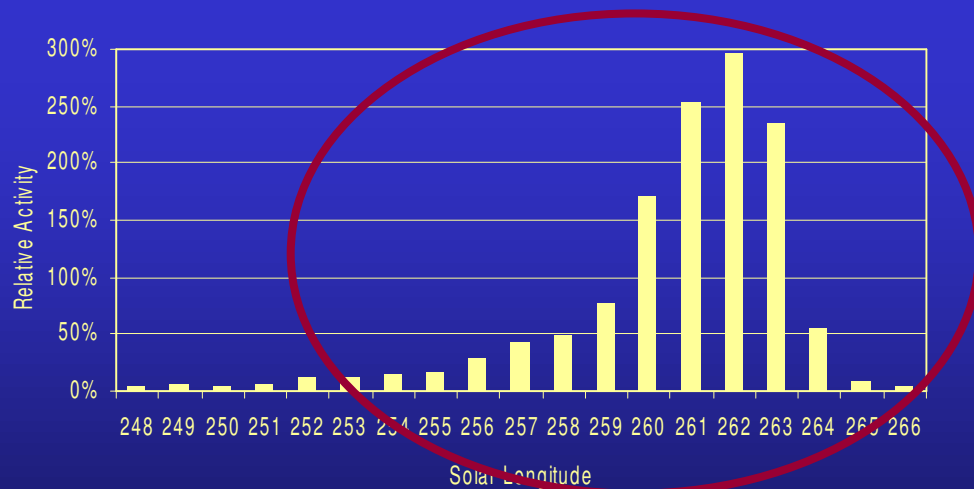
Mean Parameters	Solar Longitude	Date	Right Ascension	Declination	Drift	Velocity
Shower 74	257	Dec 09	126.6	2.5	0.9 / -0.2	56 km/s
HYD			128	2	0.8 / -0.2	58 km/s



# 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	-

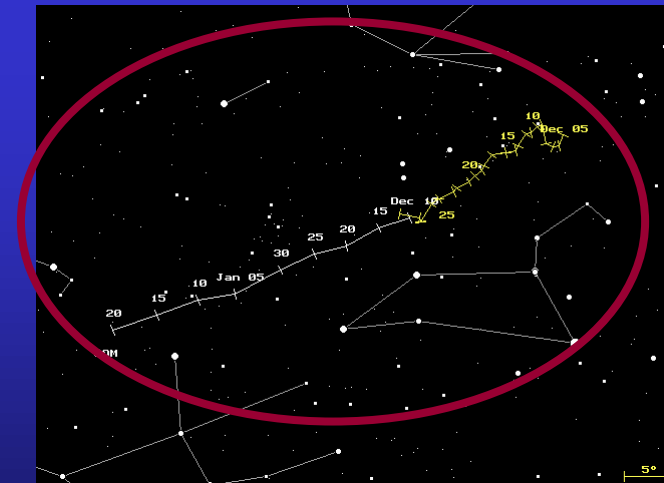
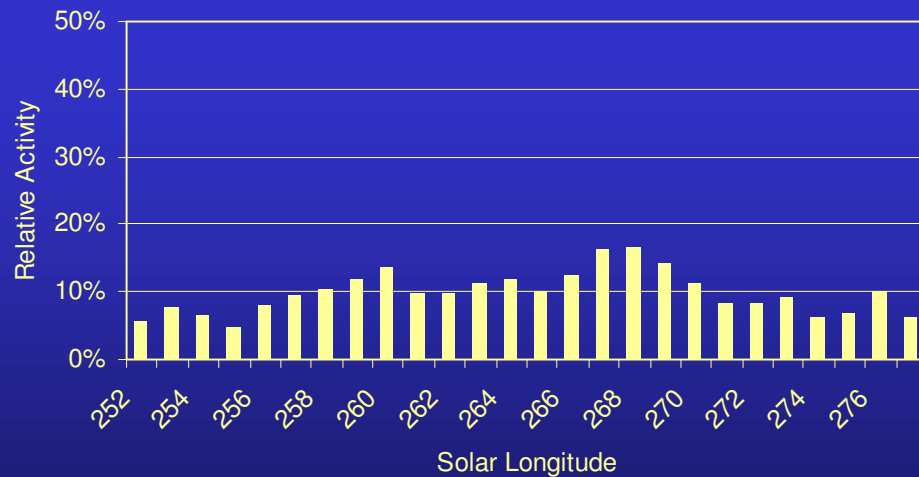
Mean Parameters	Solar Longitude	Date	Right Ascension	Declination	Drift	Velocity
Shower 75	262	Dec 14	113.8	32.0	1.1 / -0.1	36 km/s
GEM			112	33	1.0 / -0.1	35 km/s



# 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	-

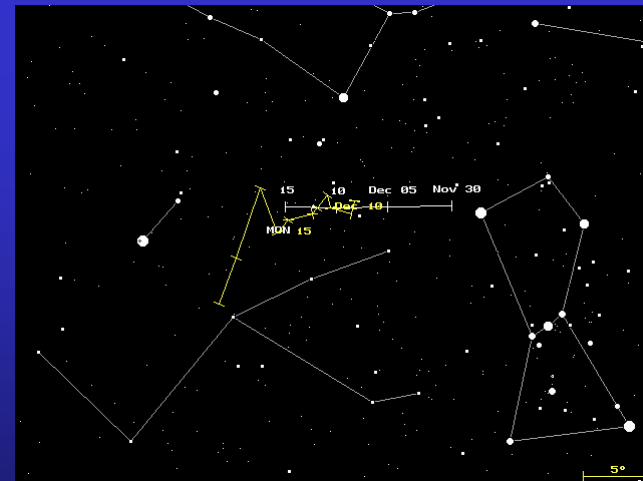
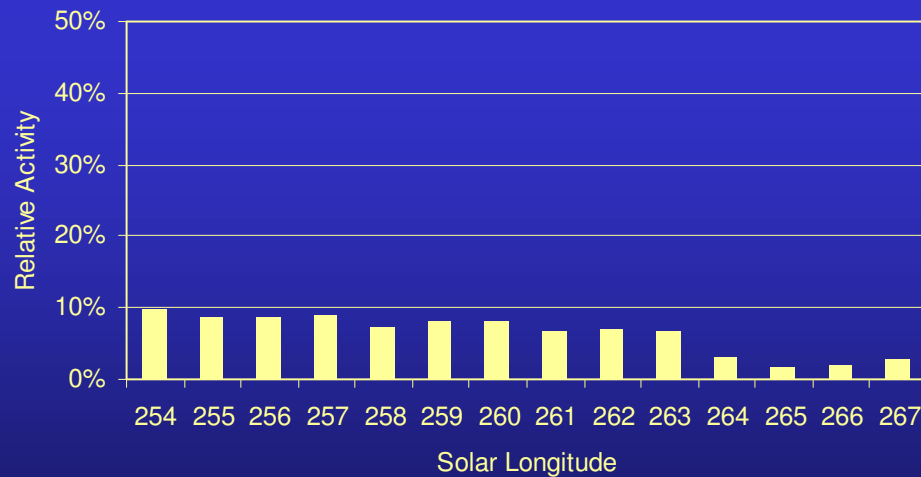
Mean Parameters	Solar Longitude	Date	Right Ascension	Declination	Drift	Velocity
Shower 76	268	Dec 20	161.3	30.5	0.8 / -0.3	59 km/s
COM			176	24	0.8 / -0.3	65 km/s



# 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	-

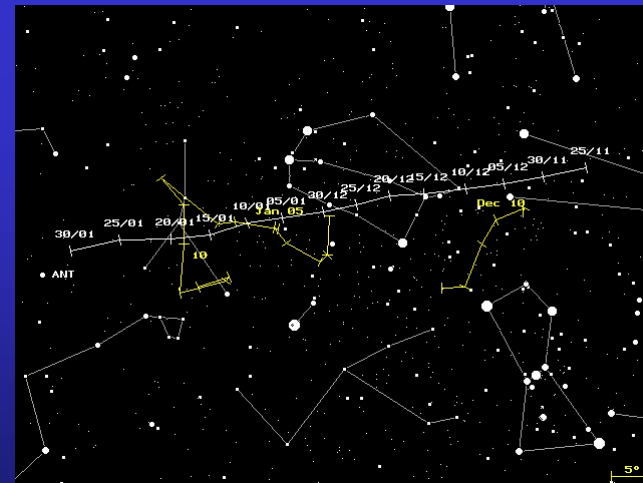
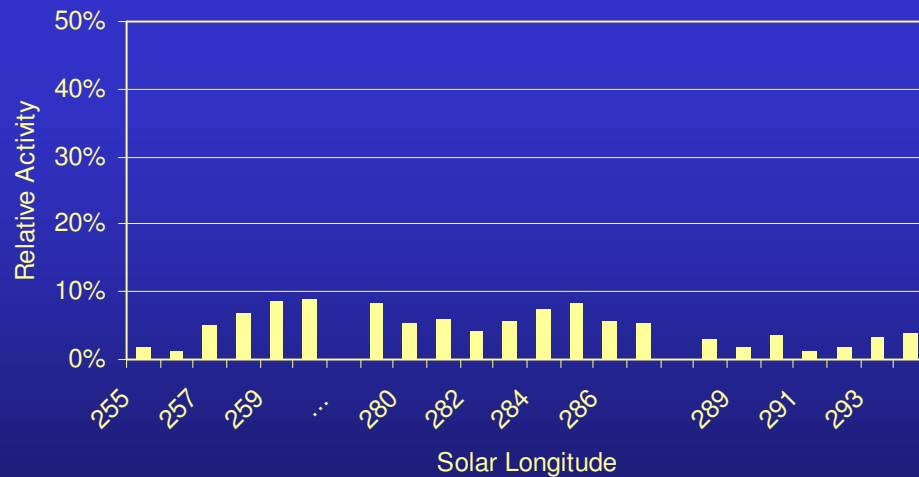
Mean Parameters	Solar Longitude	Date	Right Ascension	Declination	Drift	Velocity
Shower 77	254	Dec 06	98.6	8.5	0.8 / -0.4	41 km/s
MON			103	8	0.9 / 0.0	42 km/s



# 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	-	-	-	-	-	-

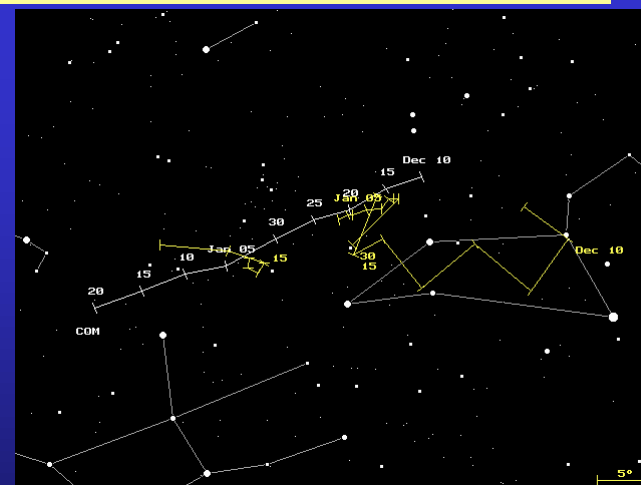
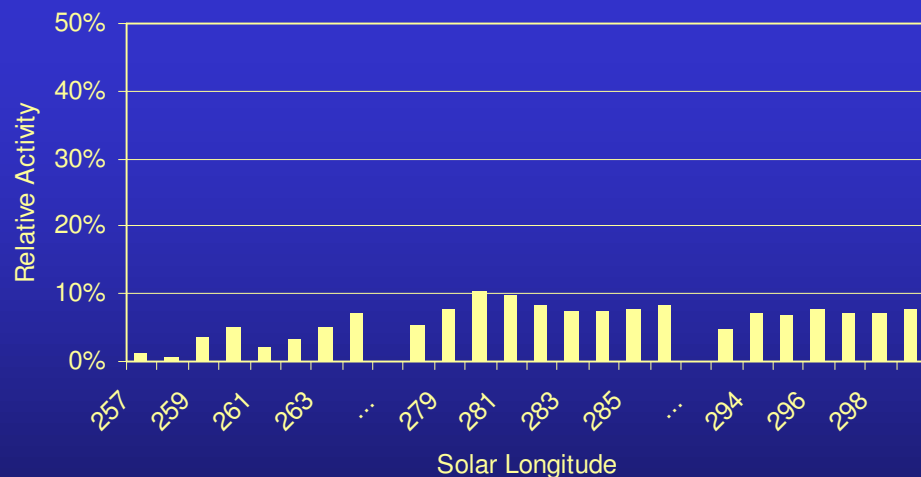
Mean Parameters	Solar Longitude	Date	Right Ascension	Declination	Drift	Velocity
Shower 79	260	Dec 12	83.0	19.0	-2.4 / 2.2	26 km/s
Shower 85	285	Jan 06	117.6	18.5	2.1 / 0.3	28 km/s
Shower 90	294	Jan 14	127.9	10.0	-1.4 / -2.3	28 km/s
ANT	-	-	-	-	1.0 / 0.0	30 km/s



# 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	-

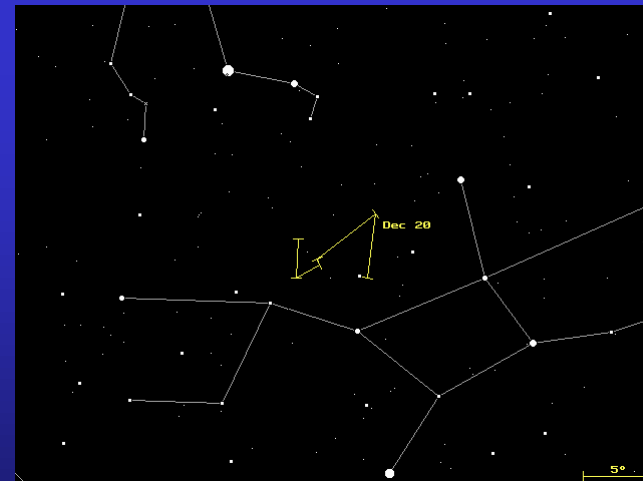
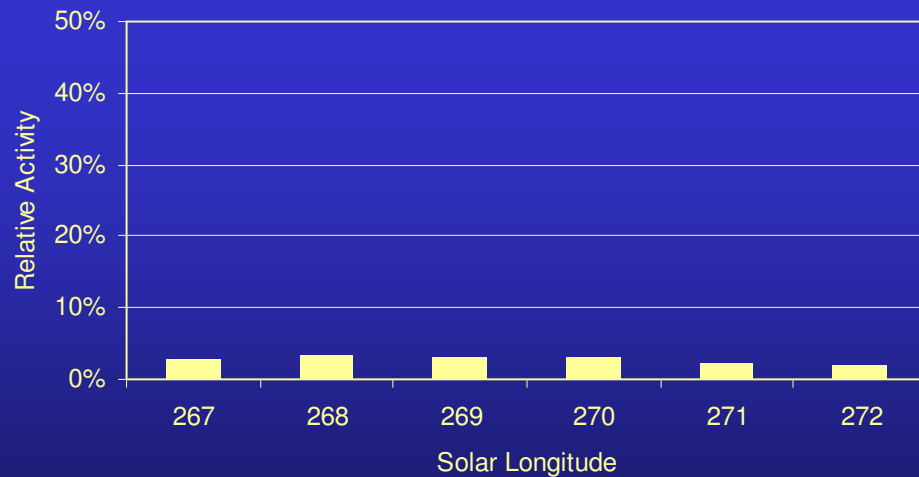
Mean Parameters	Solar Longitude	Date	Right Ascension	Declination	Drift	Velocity
Shower 81	264	Dec 16	173.9	25.5	3.2 / 0.4	64 km/s
Shower 84	280	Jan 01	172.1	25.0	0.6 / 0.0	58 km/s
Shower 91	296	Jan 16	186.1	18.5	-1.1 / -0.2	60 km/s
(COM)	267	Dec 19	176	24	0.8 / -0.3	65 km/s



# 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%
-	-	-	-	-	-	-

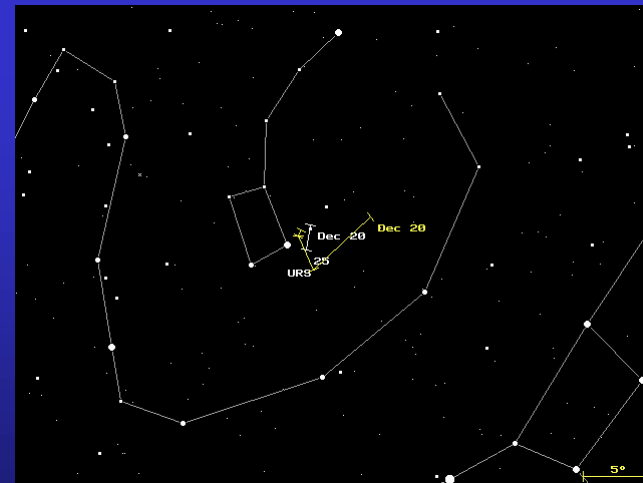
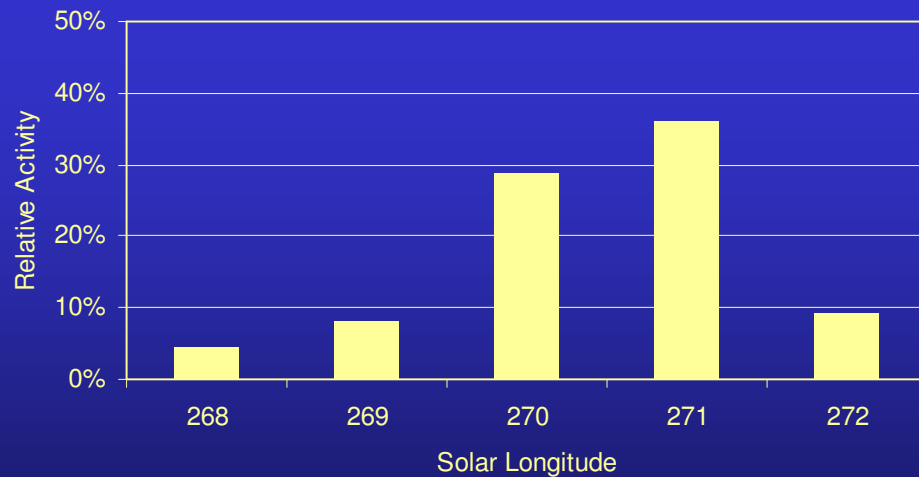
Mean Parameters	Solar Longitude	Date	Right Ascension	Declination	Drift	Velocity
Shower 82	268	Dec 20	202.2	8.5	1.3 / 0.0	62 km/s
-	-	-	-	-	-	-



# 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

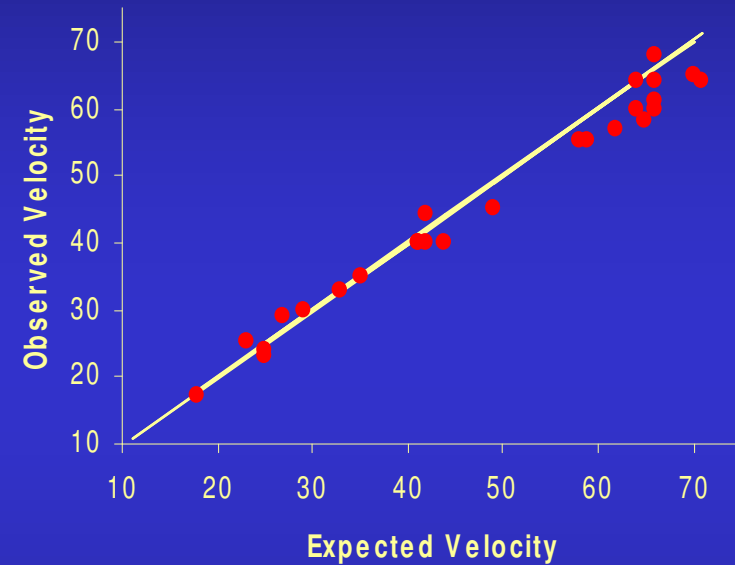




# Results

## Remarks

- The velocity of fast showers is systematically underestimated
  - » Just one shower >65 km/s
- 3 meteor showers north of  $\delta = -20^\circ$  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

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## 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!**