



The 2016 Perseids

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The Perseid meteor shower is a prolific annual shower, known to outburst.

At least 2 spacecraft have suffered anomalies potentially caused by meteoroid impacts during Perseid outbursts.

The Perseids may outburst again in 2016. Observing geometry favors Russia/Europe and North America.

Goal: Describe preliminary predictions, encourage discussion and observation planning.



Perseid background info



Parent comet: 109P/Swift-Tuttle

- Peak: Max. around Aug 11-13
- Activity range: Jul 17 Aug 24

Speed: 59 km/s

Radiant: $\alpha = 48^{\circ}$, $\delta = +58^{\circ}$ at peak

Typical ZHR: 100/hr

Recent major displays: 1991-1995, 2004, 2009

Features: Not known to storm, but can produce enhanced activity (100s meteors/hr)

Prediction history: Forecasts less accurate than those for Leonids



Perseid fireball recorded Aug 12, 2012





Spacecraft affected by Perseids





Olympus ESA communication satellite

Struck by a Perseid near the time of the shower peak in August 1993

Sent tumbling, fuel exhausted, end of mission ^{Caswell et al. (1995)}



Landsat-5 NASA/USGS imaging satellite

Struck by a Perseid near the time of the shower peak in August 2009

Sent tumbling, stabilized, returned to normal operations



MSFC Meteoroid Stream Model



What

Model of particle ejection and subsequent meteoroid stream evolution from comets.

Why

To provide accurate meteor shower forecasts to spacecraft operators for hazard mitigation and mission planning purposes.



Meteoroid stream ejected from parent comet

Who

International Space Station and science spacecraft.



2016 Perseid model results: MSFC preliminary







2016 Perseid model results: MSFC preliminary







2016 Perseid model results: MSFC preliminary



Predicted ZHR





2016 Perseid model results - Summary -



Modeler	Rev	Date	Time (UT)	λ _s (°)	ZHR	r _d -r _E (AU)
Maslov (web, undated)	1862	Aug 11	22:34	139.436	?	-0.00134
Vaubaillon (Jenniskens, 2006)	1862	Aug 11	22:36	139.438	1	-0.00327
MSFC single rev (June 2015)	1862	Aug 11	22:47	139.445	-	-0.00170
Maslov (Rao, 2012)	-	Aug 11	23:23	-	160-180	-
Maslov (web, undated)	1479	Aug 11	23:23	139.468	?	0.00008
Vaubaillon (Rao, 2012)	-	Aug 12	~00:00	-	"Unusually high activity"	-
Main MSFC (June 2015)	Combined 15 revs	Aug 12	00:32	139.515	210 ± 50	-
MSFC single rev (June 2015)	1079	Aug 12	04:36	139.678	-	0.00194
Vaubaillon (Jenniskens, 2006)	1079	Aug 12	04:43	139.683	580	0.00023
MSFC single rev (June 2015)	441	Aug 12	13:03	140.016	Comprises secondary peak?	-0.00046

Increased activity lasts about half a day, from late-Aug 11 to mid-Aug 12.



















Jacobs, ESSSA Group/MEO/D.E. Moser





































12 Aug 2016 10:30:00.000









Lunar observing geometry



Perseids Aug 12 at 00:00 UT



LunarScan output (Gural 2007)

- Phase not good (62%) for lunar impact observing during the peak. (First Quarter on Aug 10.)
- Moonset around 12-1 am local time.



General camera deployment considerations



- Predicted peak observable
 - Night time for optical cameras
- Radiant high in the sky
 - Higher radiant = better rates
 - Keep radiant alt. >15° for the max. amount of time
- Good weather
- Minimal light pollution
- Mobility
 - Don't deploy cameras to islands, valleys, etc.
 - Choose area with wellconnected road systems
- Choose camera pointing directions to max. collecting area





- (a) Total night sky brightness acct. for alt., at zenith
- (b) Naked eye star visibility (V mag)



Spacecraft risk







Summary



- The Perseids may outburst in 2016.
- Increased activity predicted late Aug 11 Aug 12, lasting ~half a day.
 - Rates predicted between 160 580/hr.
 - Observing best from Russia & Europe, then North America.
- The outburst may represent a time of increased risk to spacecraft.





Backup Slides



2016 Perseid model results: Vaubaillon





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http://www.imcce.fr/langues/en/ephemerides/phenomenes/meteor/DATABASE/Perseids/BIN-tout/Noeuds-Earth2016.jpg



Other weather data: Night only



Completely Clear Sky

Frequency of Occurrence (%)

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Past NASA deployment 2014 May Camelopardalids





WEST SYSTEM



Past NASA deployment 2014 May Camelopardalids





Orion capture device



Analog to SDI converter



Ronin video display



Future outbursts



- 2020 Ursids
- 2022 τ-Herculids
- 2027 Perseids
- 2028 Perseids
- 2034 Leonids



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http://www.imcce.fr/langues/en/ephemerides/phenomenes/meteor/DATABASE/Perseids/BIN-tout/Noeuds-Earth2016.jpg