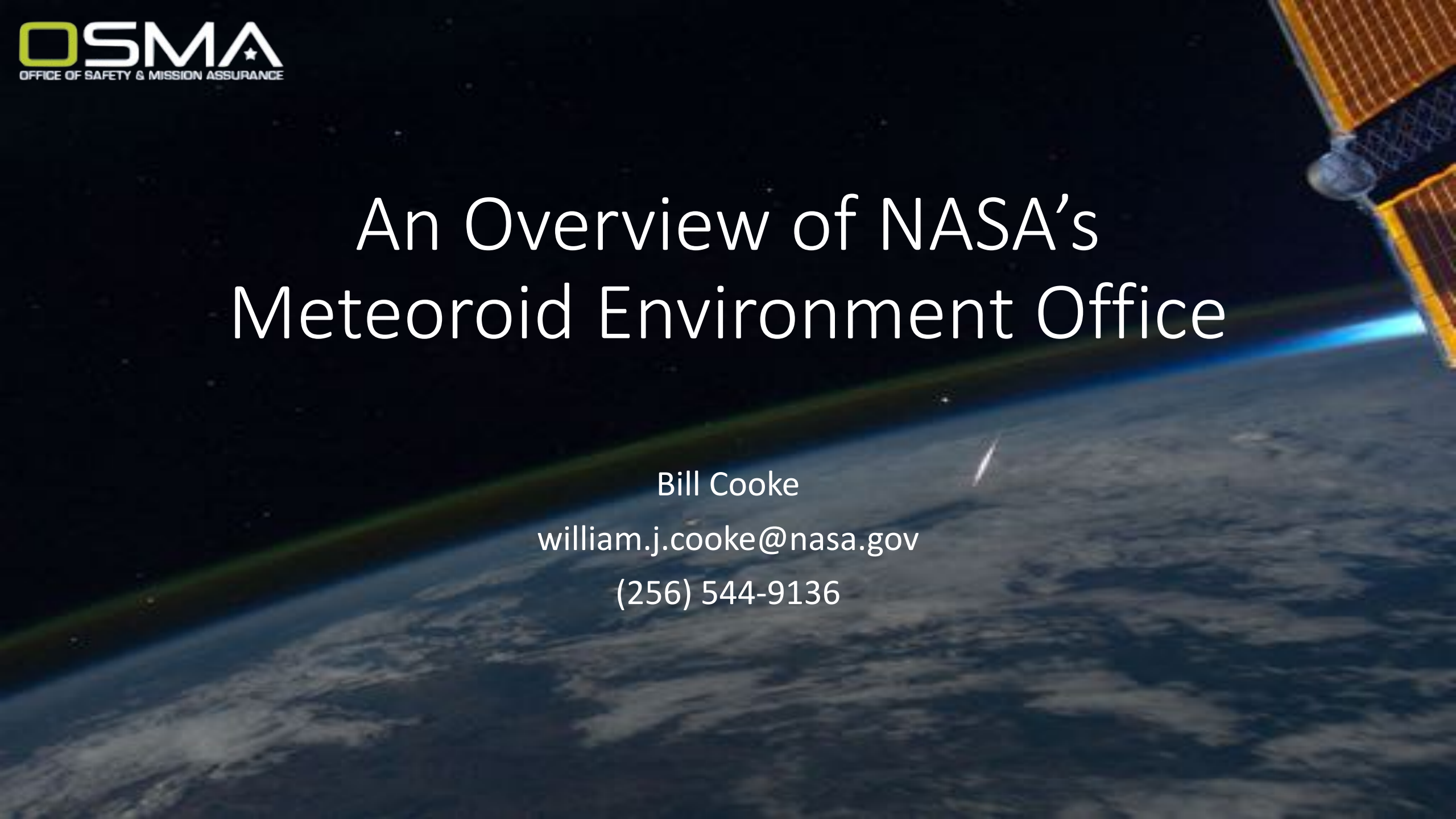

An Overview of NASA's Meteoroid Environment Office

Bill Cooke

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Who we are

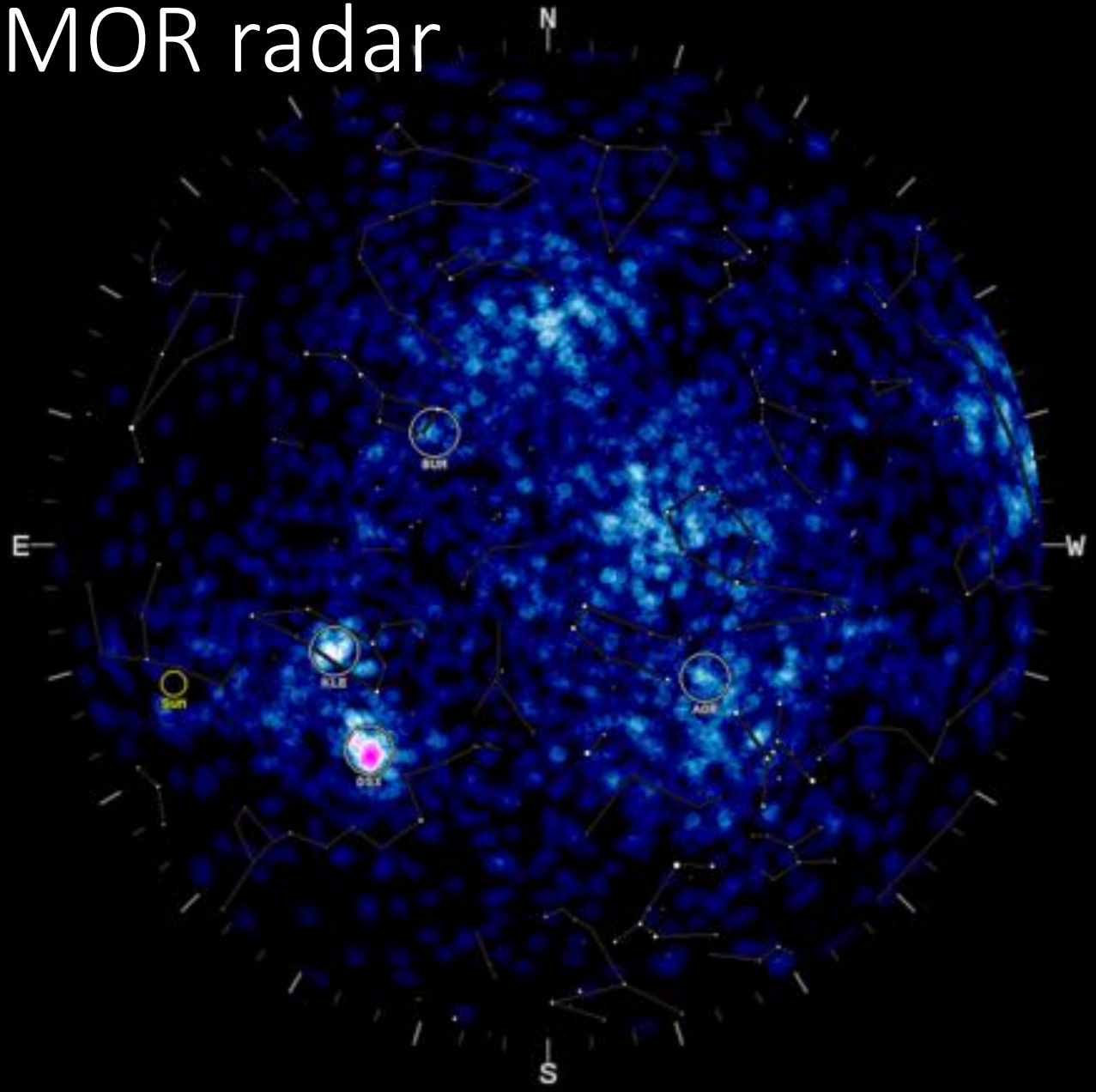
- Established in FY05 in response to NASA findings that agency meteoroid expertise had been lost since shutdown of meteor programs in the mid-1970's.
- Reside in the Natural Environments Branch (EV44) at the Marshall Space Flight Center.
- Office consists of 2.5 civil servants and 5 support contractors.
- Roles and responsibilities defined in NASA NPR 8715.6B, section 2.1.4.

Personnel

- Dr. Bill Cooke, office lead - bureaucrat and wise meteor guru of group
- Dr. Althea Moorhead, modeler - sporadic and shower environments
- Dr. Rob Suggs, program interface - optical systems, lunar impact monitoring

- Dr. Steve Ehlert - meteor analysis and spacecraft effects
- Aaron Kingery - meteor analysis and optical systems
- Danielle Moser - meteor analysis, all sky camera network, and meteor shower forecasting
- Derek Peloquin - IT
- <open slot> - meteor analysis and environment modelling

CMOR radar



- 3 frequency, 24/7 meteor radar.
- Only full time meteor radar operating in the northern hemisphere.
- Only patrol radar currently equipped with automated optical stations.
- Operated through cooperative agreement with the University of Western Ontario.
- Observes thousands of meteors caused by mm-size meteoroids per day.

Frequencies ……17.45, 29.85 & 38.15 MHz
Peak power ……. 6kW
P.R.F. ……... 532pps
Sampling rate ……..... 50ksps
Range increment ……3kms
Bandwidth …….. 28kHz
Pulse length …… 75μs
Remote link Freq……450 MHz

Magnitude limit ……+8
Minimal Detectable Mass….10^{-5} g
(velocity dependent)
Minimal Detectable
Meteoroid Size……..0.1 mm
Height range ……. 80-120 km
Range interval……..70-250 km
Effective Atmospheric
Collecting Area……..~100 - 300 km^2

All Sky Camera Network

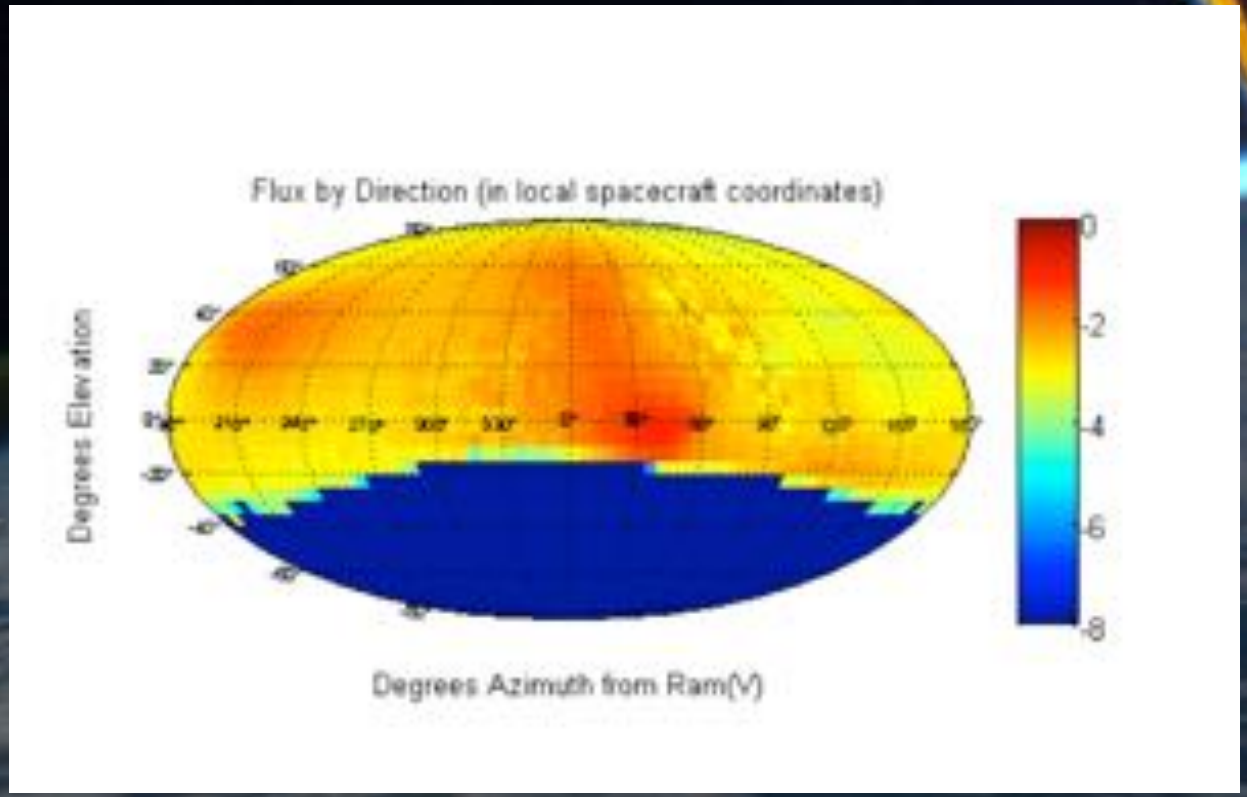
- Network of 15 all sky cameras designed to observe bright meteors/fireballs.
- Fully automated – data is uploaded throughout evening to server, where it is analysed.
- Used to characterize the 1 cm population and individual fireball events.
- Results posted on web site (fireballs.ndc.nasa.gov) each morning at 10 AM Central.

Products

	Meteoroid Engineering Model (MEM)	shower forecasts	"sky falls"
what does it model?	sporadic complex	meteor showers	individual bright events
how important is it to spacecraft?	95-99% of risk	1-5% of risk	$\sim$ 0% of risk
what form does it take?	software that users down-load and run	annual report and data files	individual emailed reports
what is it used for?	spacecraft design	operational mitigation	keeping the public informed

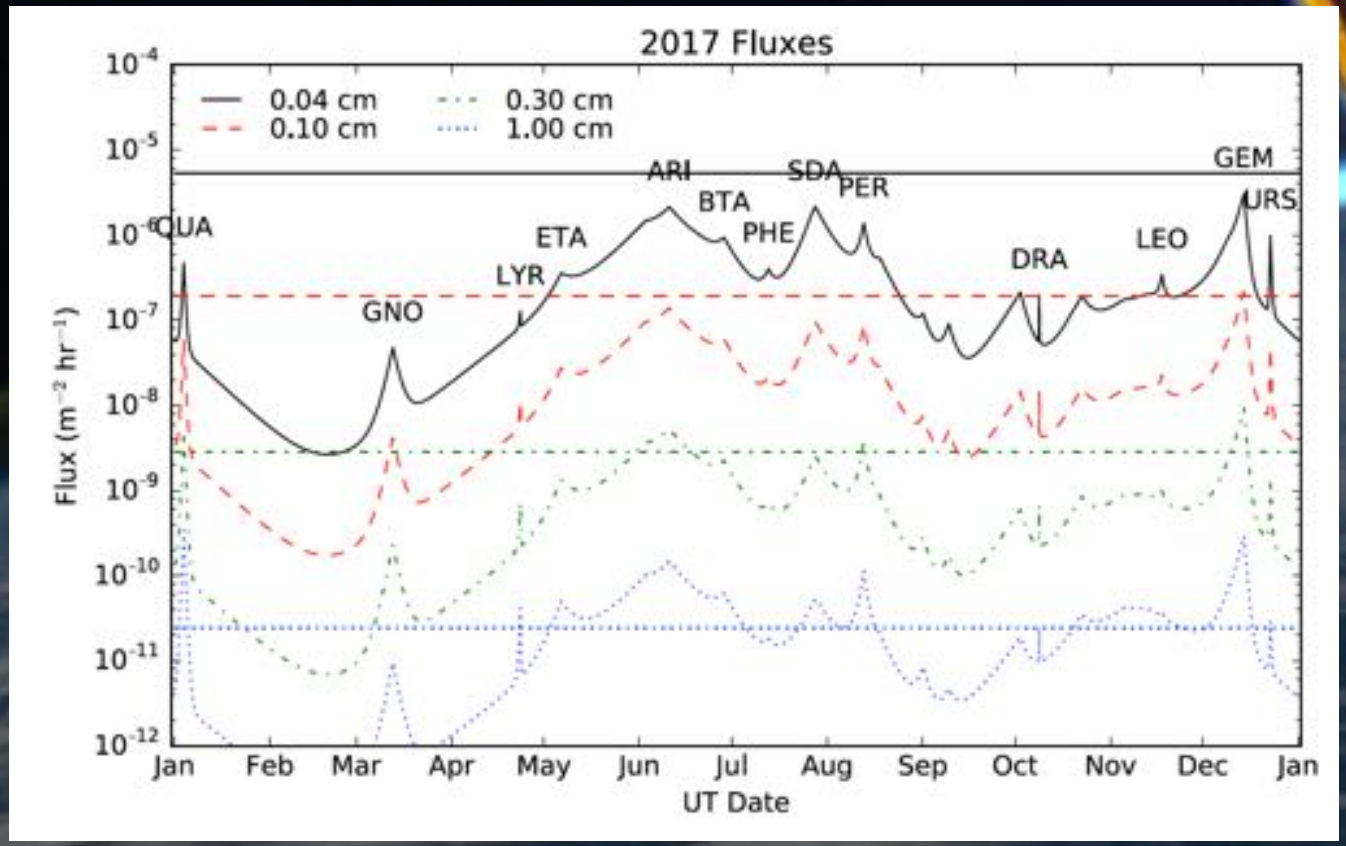
MEM – Meteoroid Engineering Model

- Describes the background or sporadic meteoroid environment.
- Does not include meteor showers.
- Only concerned with particle sizes damaging to spacecraft (0.1 mm to 1 cm).
- Valid from Mercury to the Asteroid Belt.
- Output compatible with BUMPER.
- Current version is MEM R2.



Annual Meteor Shower Forecast

- Generated for Earth orbit – other locations by request.
- Penetrating (kinetic energy weighted) fluxes are calculated at 1 hour intervals for entire year.
- Energies are chosen to correspond to suit penetration, composite tank/thermal shield damage, wall penetration, and catastrophic damage.
- All major showers and several minor showers – data is constantly acquired and reviewed to establish which showers are relevant to vehicle risk.



Sky falls

NASA Meteor Watch

Published by Hannah Olson [illegible] - 16 hrs -

Our all sky cameras at Kitt Peak National Observatory, Mount Lemmon Observatory, and the MMT Observatory captured footage of a brilliant fireball that occurred over southern Arizona at 8:32 PM Mountain Daylight Time on September 23rd (2017 September 24 03:27 UTC). The meteor originated 49 miles above the desert southwest of Tucson, Arizona. It travelled at about 29,300 miles per hour for 12 seconds, passing almost directly over the Tortolita suburb of Tucson, before disrupting 20 miles above the desert approximately 8 miles north of the town of Oracle, Arizona. The disruption produced a sonic boom that was picked up by a seismometer near Tucson. This indicates that the fireball may have produced meteorites that dropped somewhere over the desert. Analysis of our video data indicates that the object that produced the fireball was likely an asteroid fragment that weighed approximately 100 pounds and had a diameter of roughly 1 foot.