The Perseid meteor shower has been observed for millennia and is known for its visually spectacular meteors and occasional outbursts. Normal activity displays Zenithal Hourly Rates (ZHRs) of ~100. The Perseids were expected to outburst in 2016, primarily due to particles released during the 1862 and 1479 revolutions of comet Swift-Tuttle. NASA’s Meteor Environment Office predicted the timing, strength and duration of the outburst for spacecraft risk using the M3C Meteoroid Stream Model. (1) A double peak was predicted, with an outburst displaying a ZHR of 210 ± 50 at 00:30 UTC Aug 12 (10:30 Solar Longitude), and a traditional peak ~12 hours later with rates still heightened from the outburst. (2) Video, visual, and radar observations taken worldwide by various entities were used to characterize the shower and compare to predictions.

Introduction & Predictions

Past Notable Perseid Outbursts:
• 1993: ZHR ~300 (delayed STS-51 Launch).
• 1997: ZHR of 2300.
• 2004: ZHR of 187.
• 2009: Triple outburst of ZHR ~180–220 prior, during, and after traditional peak. See predictions and results below in Figure 3.

Why does this happen?
• Jupiter perturbs the orbit of debris left by Comet Tempel 1/2-Tuttle.

All Sky Camera Network Results

• NASA’s All Sky Fireball Network consists of 15 cameras, placed in 4 groups around continental USA to detect meteors brighter than the planet Venus (V ~4 magnitude).
• Observers of this brightness correspond to cm-sized meteors, weighing ~1 gram.
• During 2016, clouds were over most of the networks approaching the peak of the Perseids, but cleared off soon after dark on the peak night.
• Being in North America and constrained by daylight, these cameras missed the outburst event, resulting in the lowest counts (Figure 4).
• Rates were heightened in 2016 over 2015.

MAARSY Results

• Middle Atmosphere Alomar Radar System (MAARSY) is an HPLA radar employing an active phased array antenna suitable to monitor the Perseid radiant (6,7).
• It was modified to conduct continuous meter observations and meter shower studies in 2016 for the Perseid outburst.
• System has a limiting mass of 10^8–10^9 grams.
• During 2015 and 2016, MAARSY detected enough Perseid meteors to produce an activity curve with 3 hour bins.
• Activity is comparable from 2015 to 2016, but notable outburst in this small size range.
• The population index is low – ~1.8 during the outburst indicating the outburst may have been rich in bright particles, not the lower mass particles that MAARSY detects (Figure 11). Additionally, Figure 4 indicates that the most significant new component of particles for the 2016 outburst is in a more massive range.

Conclusions

• NASA’s Meteor Environment Office predicted a Perseid Outburst in 2016 with a peak ZHR of 210, 12 hours prior to the traditional peak, and a traditional peak still slightly heightened.
• The outburst was clearly seen in IMO Video & Visual Results, as well as NASA All Sky Fireball Network data. The peak of the outburst was seen to have a ZHR of ~280 according to IMO video observations, and 205 as seen in visual observations.
• The outburst was not seen in MAARSY, which has a limiting mass of 10^8–10^9 grams. This indicates the outburst was detected primarily in larger particles over smaller particles.
• NASA’s IMO correctly predicted the timing and approximate strength.
• The forecast over-estimates the flux from Perseids approaching and leaving the peak, particularly in large sizes as seen in Figures 6 and 7.

References

Characterizing the 2016 Perseid Meteor Shower Outburst

R.C. Blaauw1, D.E. Moser2, S. Molau3, C. Schult4, G. Stober4
1All Points Logistics/Avanti ESSSA Group/NASA Meteor Environment Office (IMO), Huntsville, AL. 25812, USA, rchrist.mola@nasa.gov
2Avanti ESSSA Group/NASA M4, Huntsville, AL. 35812, USA. 3International Meteor Organization, Almenrath: 13B, D-54072 Siegburg, Germany. 4Leibniz Institute of Atmospheric Physics, Rothenburg, Germany.