

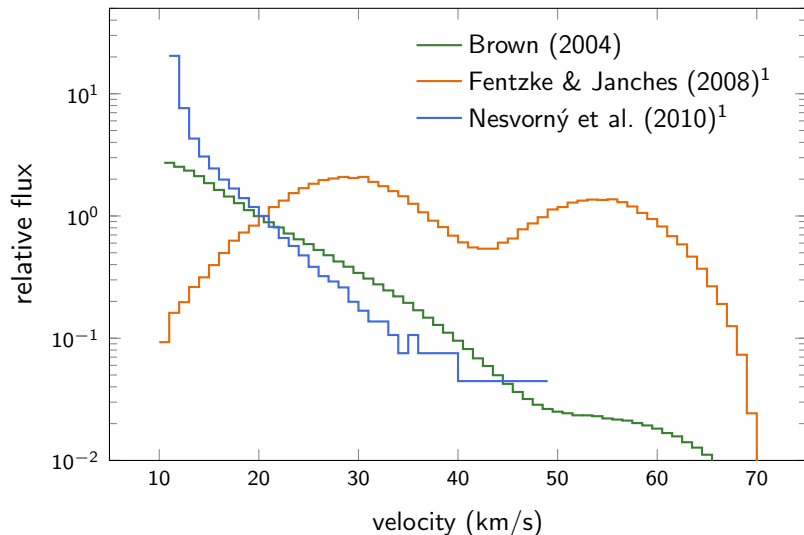
Optical and radar measurements of the meteor speed distribution

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Meteoroid speed distribution(s)



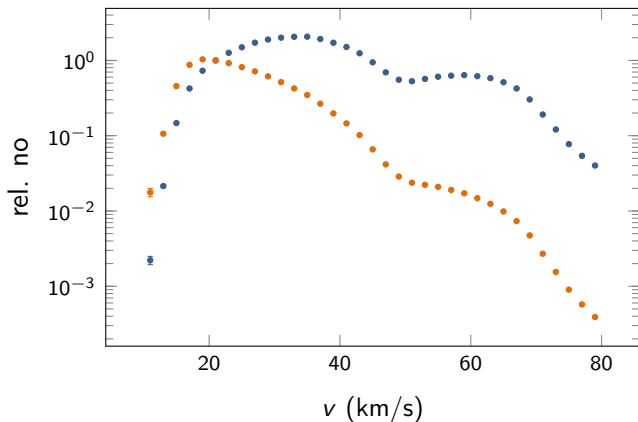
¹ As represented in Janches et al. (2014)

Goals

- Have: Start with the meteor speed distribution to constant limiting radar amplitude
- Improve: Re-weight the radar speed distribution to constant limiting KE
 - ▶ Use improved bias estimations
 - ▶ Use modern forms of β
- New: Characterize associated uncertainties
- New: Re-weight the radar speed distribution to constant limiting magnitudes and compare with optical measurements

Correcting to a limiting mass

$$q \propto m^a v^b, \text{ flux} \propto m^{-\alpha} \rightarrow N_{>m_{ref}} = N v^{-b\alpha/a} \text{ (Taylor, 1995)}$$

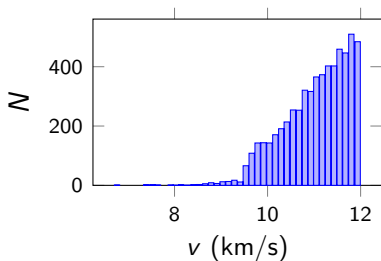
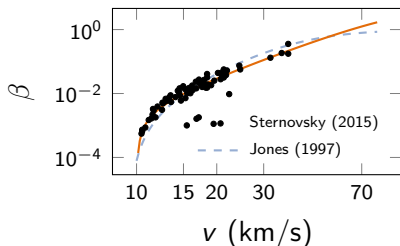


Ionization efficiency

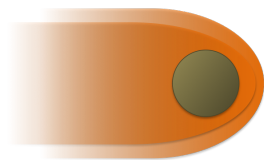
- ▶ Jones (1997) predicts $q \propto v^b$
- ▶ Experiments confirm this for iron (Sternovsky, 2015)
- ▶ Radar detections show a “cliff” near 9.5 km/s

~~$$q \propto m^a v^b$$~~

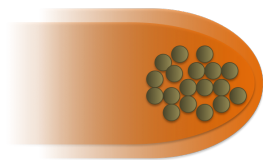
$$q = -\frac{\beta(v)}{\mu v} \frac{dm}{dt}$$



Mass ablation rate



$$\frac{dm}{dt} \propto m^{2/3}$$



$$\frac{dm}{dt} \propto m$$

$$\frac{dm}{dt} = -\frac{\Lambda A}{2\xi} \left(\frac{m}{m_{frag}}\right)^x \left(\frac{m}{\rho_m}\right)^{2/3} \rho_a v_m^3$$

Kinetic energy distribution

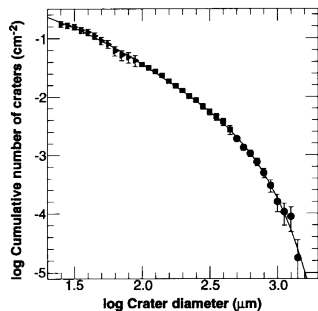
- ▶ Impact experiments are KE-limited

$$\begin{aligned} p &= 5.24 \times d^{19/18} \text{BH}^{-1/4} \left(\frac{\rho_p}{\rho_t} \right)^{1/2} \left(\frac{v_p \cos \beta}{c_s} \right)^{2/3} \\ &= 0.739 \times \text{KE}^{19/54} \text{BH}^{-1/4} \frac{\rho_p^{4/27}}{\rho_t^{1/2}} v_p^{-1/27} \left(\frac{\cos \beta}{c_s} \right)^{-2/3} \end{aligned}$$

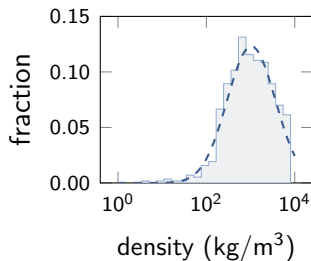
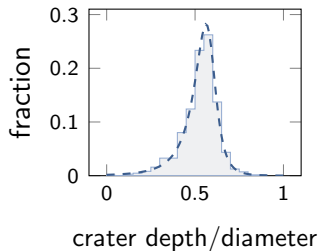
- ▶ Meteor observations are *closer* to being KE-limited than mass-limited

$$\begin{aligned} q &\sim m v^{3.5} \\ &\sim \text{KE} v^{1.5} \end{aligned}$$

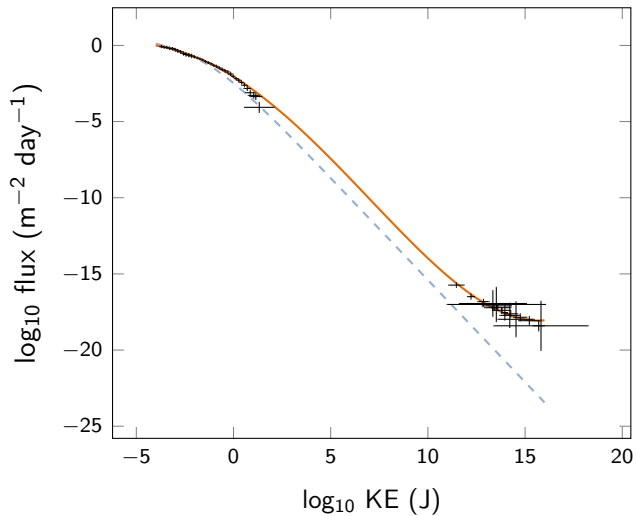
Kinetic energy distribution



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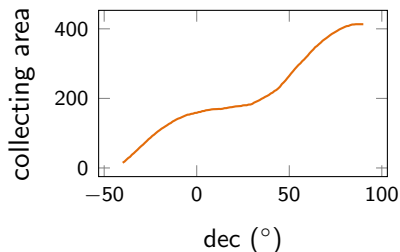
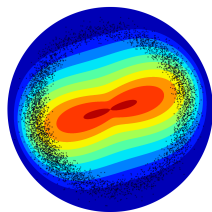


Kinetic energy distribution

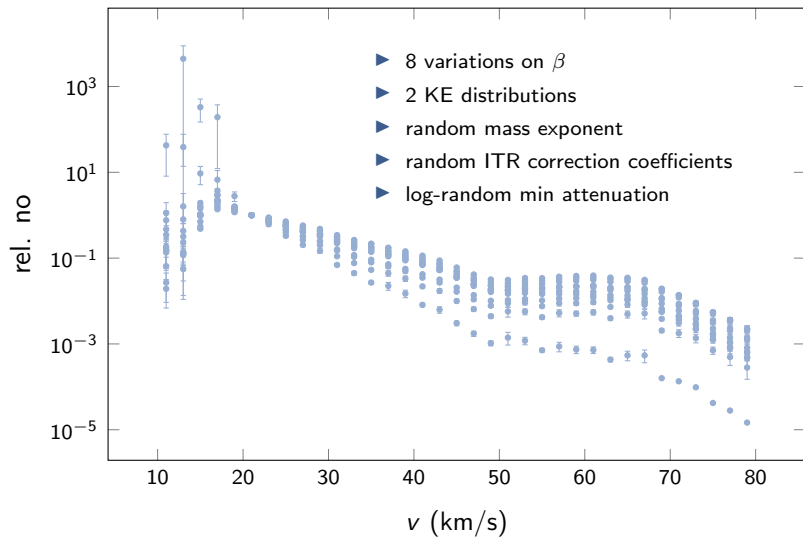


Radar bias corrections

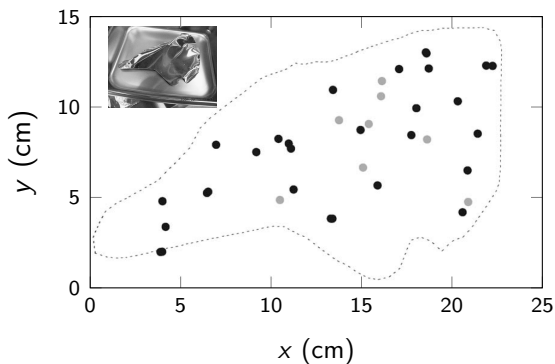
- ▶ Pulse repetition effect
- ▶ Finite velocity effect
- ▶ Initial trail radius effect
 - ▶ Empirical relation (with uncertainties!) from Jones & Campbell-Brown (2005)
- ▶ Beam pattern/radiant visibility



Corrected speed distribution

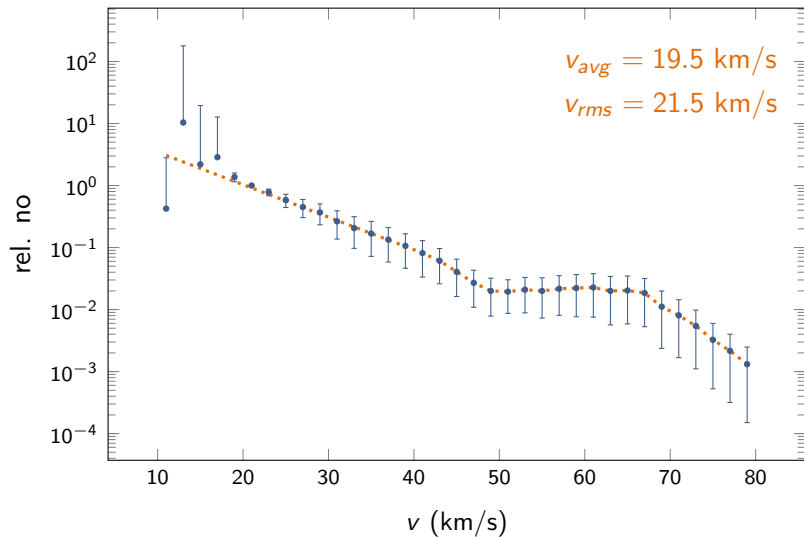


Gravitational focusing constraints

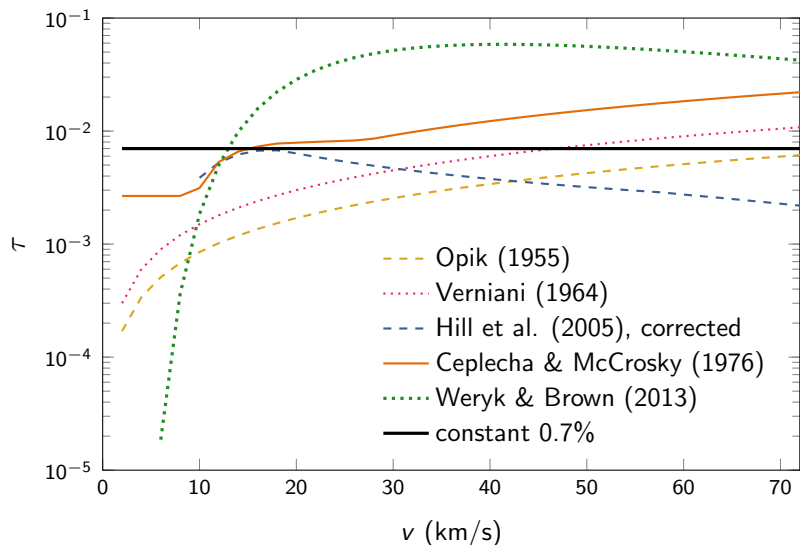


- ▶ Cratering rate on Genesis near L1 was within 40% of near-Earth rate (Love & Allton, 2006)

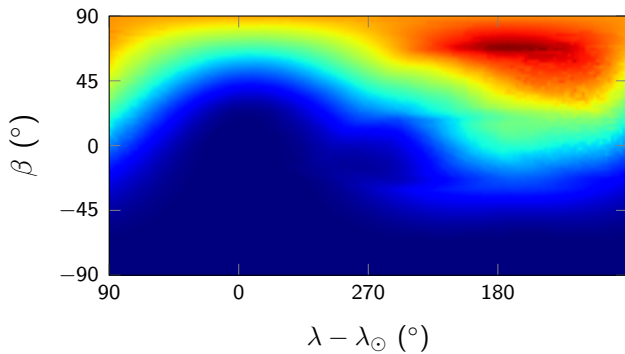
Weighted average speed distribution



Luminous efficiency

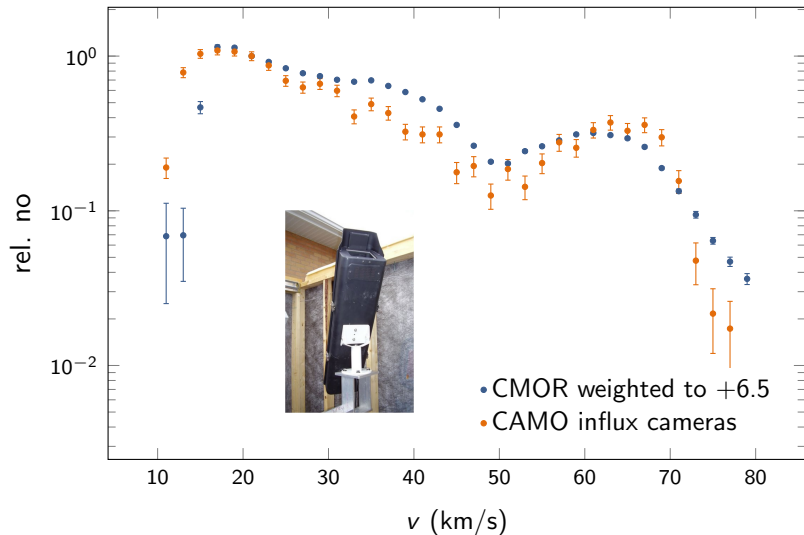


Radiant coverage



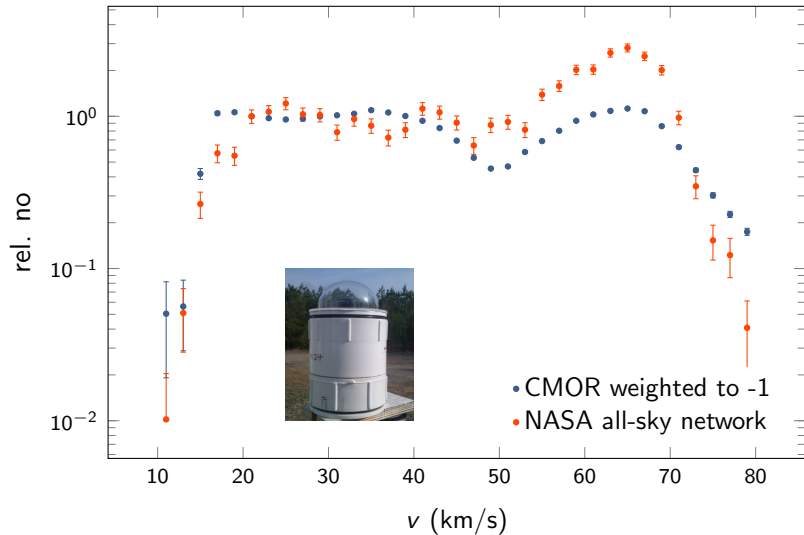
CAMO influx camera speed distribution

Limiting magnitude of +6.5

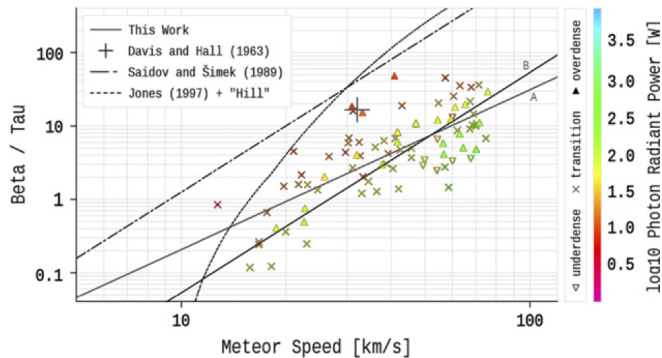


NASA all-sky network speed distribution

Limiting magnitude ~ -1



Luminous efficiency



$$\log_{10}(\beta/\tau) = c_v \log_{10} v - c_L \log_{10} L - c_c$$

Conclusions

Improved: Radar speed distribution to constant limiting KE

- ▶ Improved treatment of β yields more slow meteors

New: Characterized associated uncertainties

- ▶ Large uncertainty remains for slowest bins

New: Good agreement with video data for some β s

Future: Better characterization of τ , especially at low speed

Future: Refine speed distribution with additional in-situ constraints