Meteor Properties and Examples

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Meteor Session

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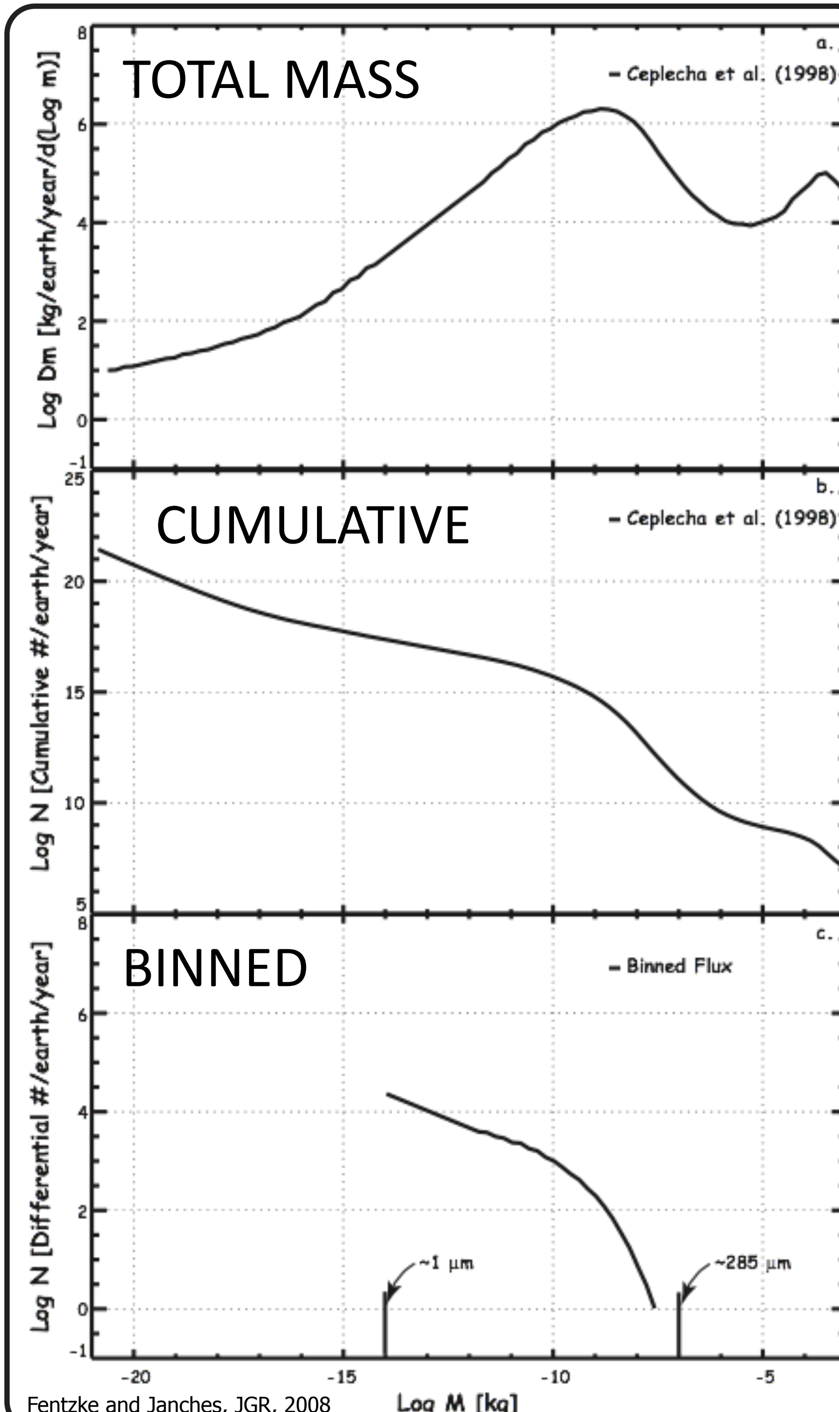
Mass Input

Table 1: Past Estimates of Global Mass Influx

Mean Mass Flux (Metric Ton/day)	Reference
7	[Mathews et a1., 2001]
42	[Ceplecha et al., 1998]
44	[Hughes, 1978]
54	[Grün et al., 1985]
120	[Love and Brownlee, 1993]
210	[Wasson and Kyte, 1987]

Characteristic Dimensions of Meteoroids [Bronshten, 1983]

Meteoroid Type	Velocity (km/sec)	R_{melt} (cm)	$M_{critical}$ (kg)
Stony	15	3.3×10^{-3}	4.5×10^{-10}
	30	4.6×10^{-4}	1.2×10^{-12}
	60	5.8×10^{-5}	2.5×10^{-15}
Iron	15	1.2×10^{-3}	2.2×10^{-11}
	30	7.0×10^{-4}	4.3×10^{-12}
	60	2.2×10^{-5}	1.3×10^{-16}



Fentzke and Janches, JGR, 2008

Velocity

- 6 Radiant Sources & Vel. Distributions
- 11-72 km/sec
- Weighted average by source % and characteristic velocity [assuming vertical entry] = ~35 km/sec

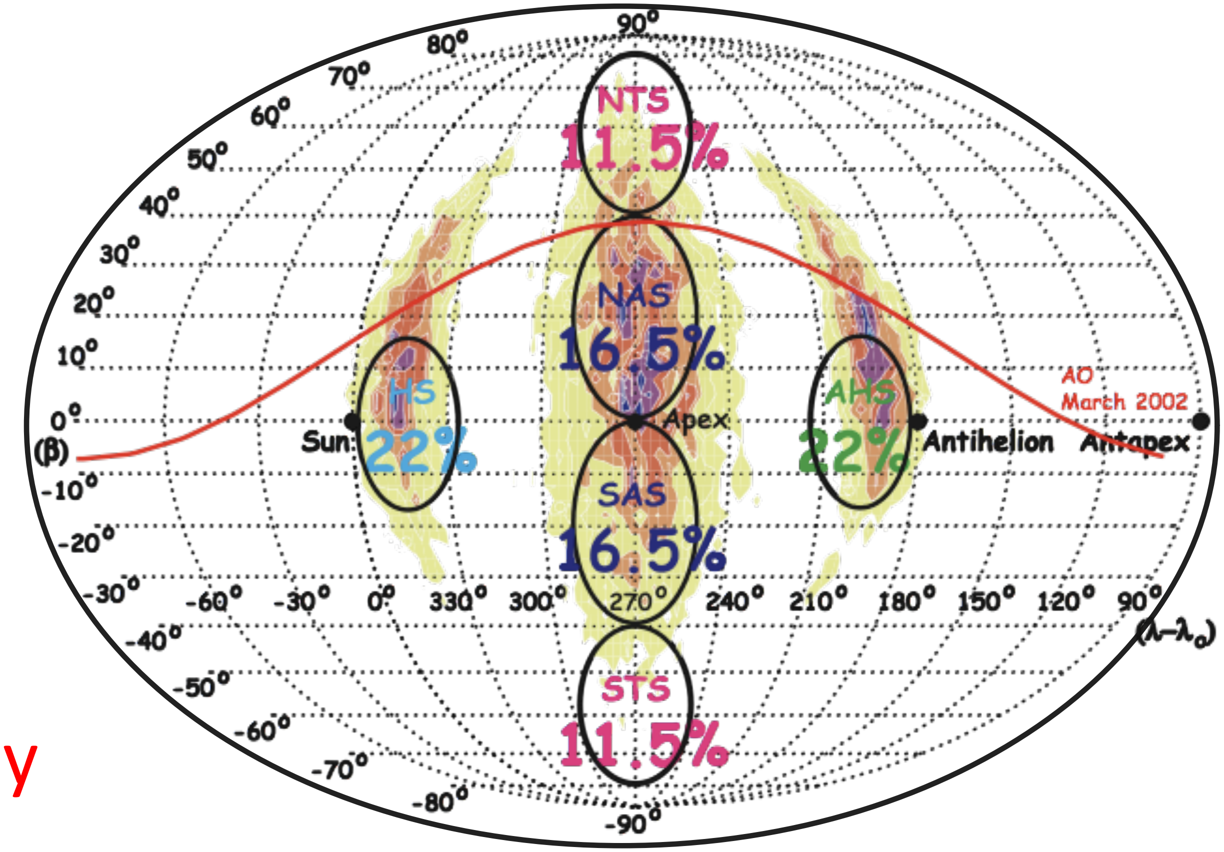


Table 1: Average Annual Modeled Source Contributions above Arecibo

Source Name	Input (%) (1 AU)	Model Avg. (%) (MLT)	Yearly Min (%) (MLT)	Yearly Max (%) (MLT)
Apex	33.0	56.17	49.93	58.85
Helion	22.0	19.26	15.15	23.43
Anti-Helion	22.0	19.44	15.13	23.43
North Toroidal	11.5	4.32	3.65	4.98
South Toroidal	11.5	1.16	0.25	2.05

Table 1: Gaussian Fitting Parameterization of Radiant Source Distribution

Source Name	Geocentric Velocity Distribution						Sun Centered Location		Sun Centered Width	
	$A_\circ$		$\bar{V}$ (km/sec)		σ (km/sec)					
	Fast Part	Slow Part	Fast Part	Slow Part	Fast Part	Slow Part	λ (deg)	$\bar{\sigma}$ (deg)	σ_λ (deg)	σ_β (deg)
Apex	0.8	0.2	55	17.3	2.5	2.60	270	0	19	32
Helion		1.0		30.0		2.57	350	0	8	20
Anti-Hel.		1.0		30.0		2.57	190	0	8	20
N. Tor.		1.0		30.0		2.57	270	60	17	17
S. Tor.		1.0		30.0		2.57	270	-60	17	17

Energy Budget

- Assume Mechanical Dissipation (Heat Flux) is equivalent to avg. KE
- take global daily mass flux of Ceplecha as ‘average’ condition = 42 metric ton/day or 4.2e4 kg / 86400 sec over earth ‘surface’ area [4*pi*Re^2=~5.11e14 m^2]
- Assume average entry Velocity = ~35 km/sec

KE=0.5*m_avg*v_avg^2

=0.5*4.2e4 (kg) * [35e3 (m/s)]^2

=2.57e13 Joules

Assuming 1 Day (86400 sec) ->

~300 MW globally or ->

5.8e-7 W/m^2

Where Does the Atmosphere Get Its Energy?

Heat Source	Heat Flux* [W/m^2]	Relative Input
Solar Irradiance	340.20	1.000
Heat Flux from Earth's Interior	0.0612	1.8E-04
Radioactive Decay	0.0480	1.4E-04
Geothermal	0.0132	3.9E-05
Infrared Radiation from the Full Moon	0.0102	3.0E-05
Sun's Radiation Reflected from Moon	0.0034	1.0E-05
Energy Generated by Solar Tidal Forces in the Atmosphere	0.0034	1.0E-05
Combustion of Coal, Oil, and Gas in US (1965)	0.0024	7.0E-06
Energy Dissipated in Lightning Discharges	0.0002	6.0E-07
Dissipation of Magnetic Storm Energy	6.8E-05	2.0E-07
Radiation from Bright Aurora	4.8E-05	1.4E-07
Energy of Cosmic Radiation	3.1E-05	9.0E-08
Dissipation of Mechanical Energy of Micrometeorites	2.0E-05	6.0E-08
Total Radiation from Stars	1.4E-05	4.0E-08
Energy Generated by Lunar Tidal Forces in the Atmosphere	1.0E-05	3.0E-08
Radiation from Zodiacal Light	3.4E-06	1.0E-08
Total of All Non-Solar Energy Sources	*0.0810*	*2.4E-04*

* global average

$T \approx 30$ K without Sun

Physical Climatology, W.D. Sellers, Univ. of Chicago Press, 1965
Table 2 on p. 12 is from unpublished notes from
H.H. Lettau, Dept. of Meteorology, Univ. of Wisconsin.

Reverse Energy Budget

-Assume Seller Chart/Latteu calculation to be correct,

-what's the mass/velocity/KE?

2e-5 W/m^2 -> ~1e10 W or ~10 GW globally

[notice the nice round numbers from the 60's]

This implies 8.8e14 J as opposed to 2.57e13 from before.

This implies a lot more mass AND higher velocity.

OR

This implies a LOT MORE mass at the avg. velocity from before.

Meteor Energy Equivalent

-1 gram TNT has 1000 calories or 1 Calorie

-1 gram TNT = 4.184×10^3 J = 1 Calorie

KE=0.5*m_avg*v_avg^2 [assume 55 km/sec]

4.184×10^3 J =0.5* X* [55e3 (m/s)]^2

X=2.77e-6 kg or ~3 microgram

THEREFORE: 3 microgram@55 km/sec = 1 g of TNT

[Happens: ~ 1 second globally]

[assume 1 gram meteor @ ~30 km/sec]

KE=0.5*.001 (kg)* [30e3 (m/s)]^2 = ~100 Calories

THEREFORE: 1 g meteor@30 km/sec = 100x energy of 1 g of TNT