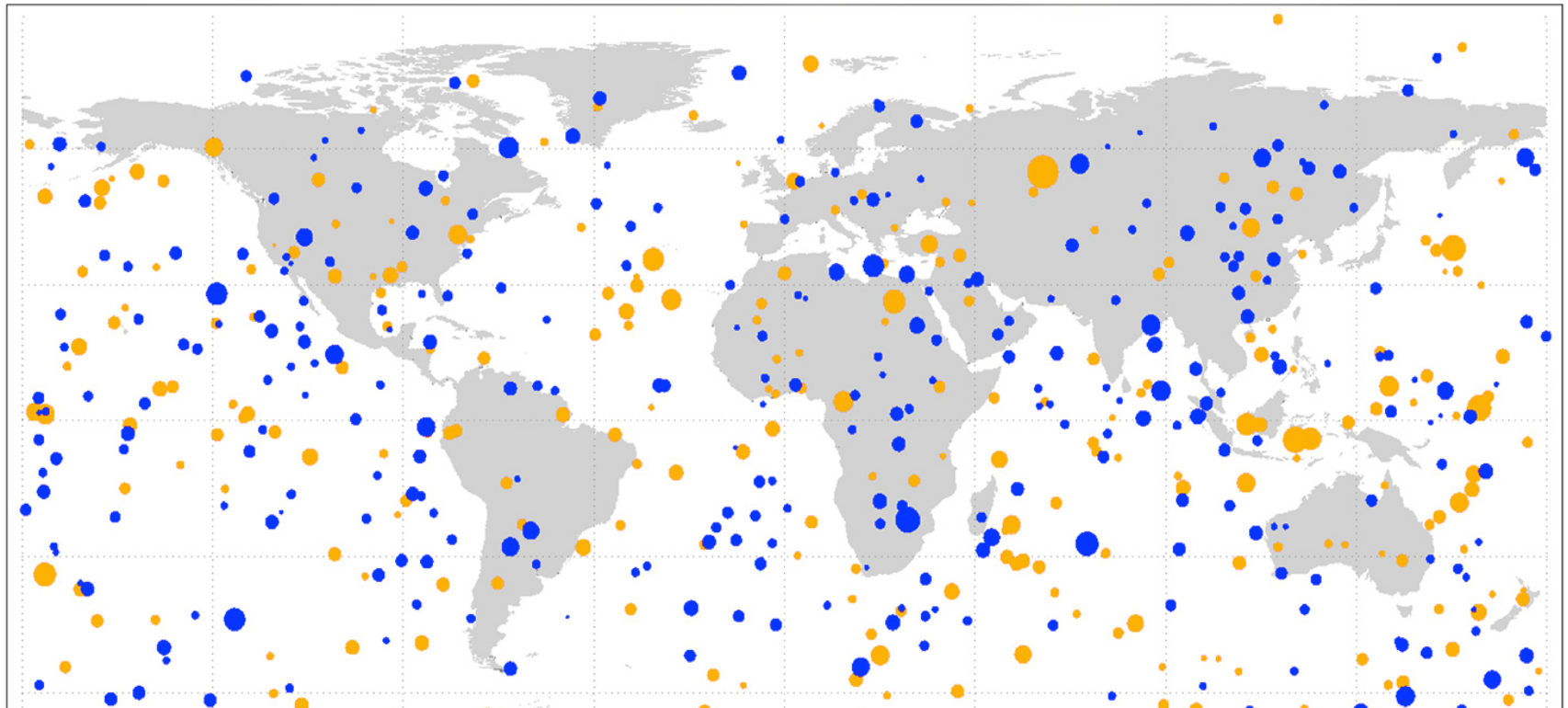


What are the Odds?

Bolide events 1994-2013

(Small asteroids that disintegrated in the Earth's atmosphere)



Frequency of **bolides**, small asteroids roughly 1 to 20 meters in diameter impacting Earth's atmosphere.

Day (255)

Night (301)

1

10

100

1000

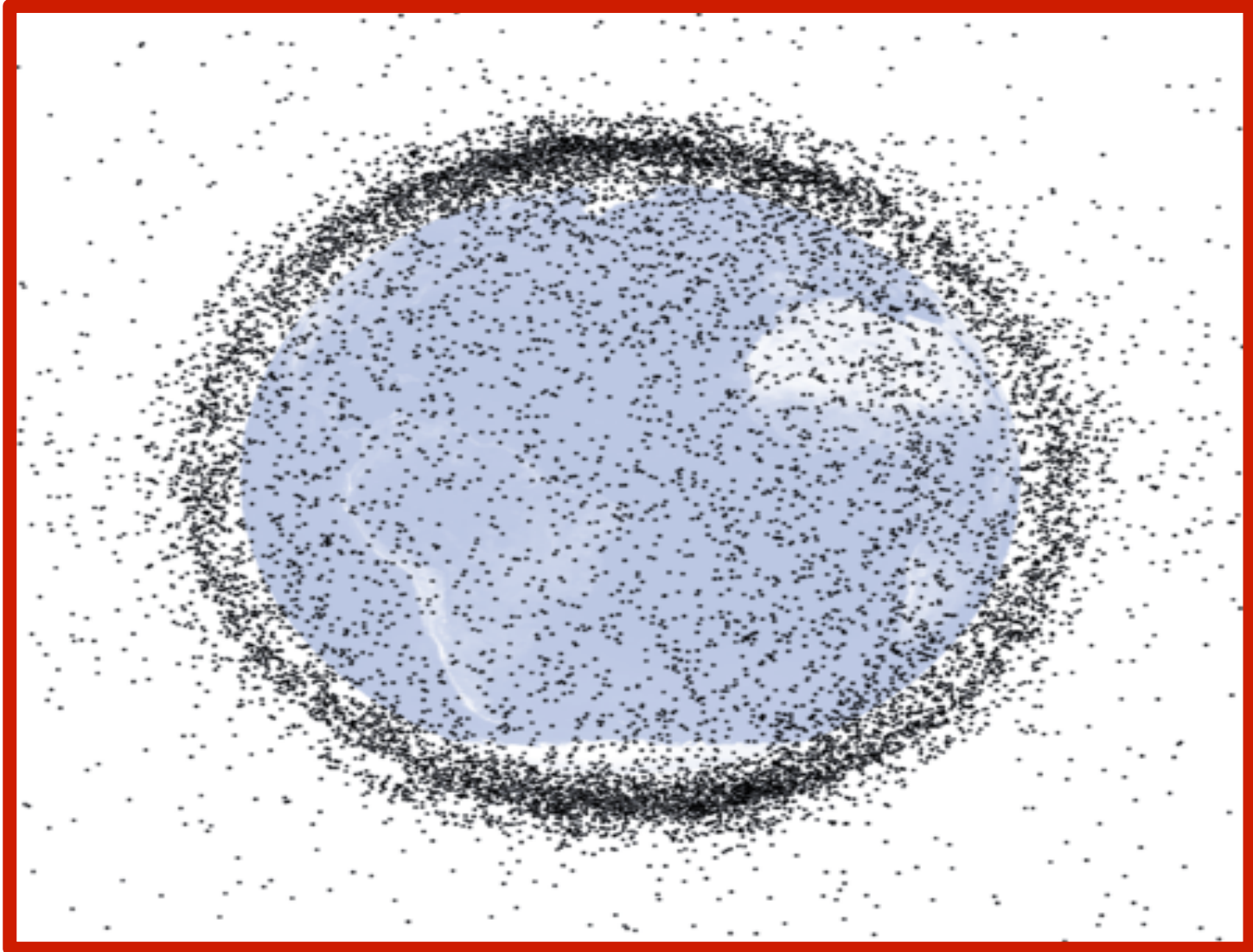
10000

100000

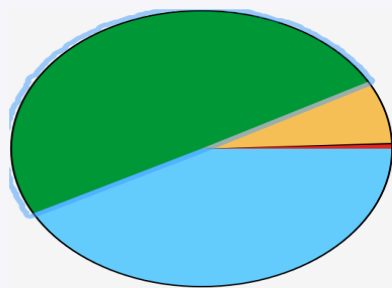
1000000

Energy (GJ)

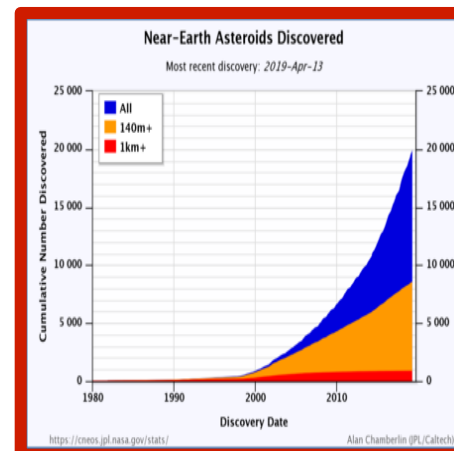
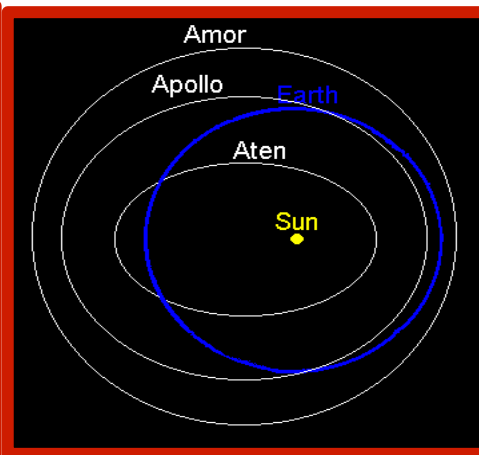
Image made from models used to track debris in earth orbit



- ❑ A near-Earth object (**NEO**) is any **small Solar System body** whose orbit brings it to proximity with **Earth**.
- ❑ A Solar System body is an NEO if its closest approach to the Sun is less than 1.3 (**AU**).
- ❑ If an NEO's > 460 ft crosses the Earth's orbit it is considered a **potentially hazardous object (PHO)**.
- ❑ Most known PHOs and NEOs are **asteroids**, but a small fraction are **comets**.
- ❑ There are **19,229** known NEOs, divided into several orbital subgroups as of November 25, 2018.



Comets	107 (0.6%)
Atiras/Apohele	31 (0.2%)
Atens	1,411 (7.3%)
Apollos	9,559 (49.7%)
Amors	8,120 (42.2%)

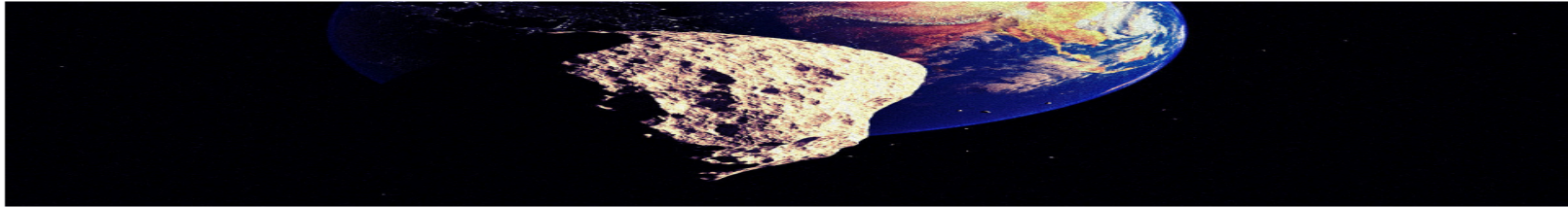


Cumulative discoveries of near-Earth asteroids known by size, 1980–2019

- ❑ Meteorites with a size > 2 or 3 cm do not vaporize on passage through the atmosphere, and thus strike the surface of the Earth.
- ❑ Sizes > 1 km produce effects that would be catastrophic, because such an impact would produce global effects.
- ❑ A 1 km sized object strikes the Earth about once every million years, and 10 km sized objects about once every 100 million years.

CLOSE CALL

“CITY KILLER” ASTEROID WHIZZES PAST EARTH ALMOST UNDETECTED



SHUTTERSTOCK/VICTOR TANGERMANN

- ❑ A space rock that could have leveled an entire city just hurtled right past Earth, coming within **six Earth diameters** of smashing into our home planet.
- ❑ Astronomers didn't spot the “city killer” asteroid, until days before it careened close to the Earth than the Moon.
- ❑ NASA data suggests the asteroid is about 100 meters wide.
- ❑ The massive meteor strike above Chelyabinsk in 2013 was only 20 meters across and yet exploded with more energy than a nuclear weapon.



This Asteroid **Had** 1-in-7,000
Chance of **Hitting** Earth This
Fall

- ❑ This fall, Earth had about a 1-in-7,000 chance of getting an uninvited extraterrestrial visitor: asteroid 2006 QV89.
- ❑ The space rock whizzed by our planet on Sept. 9, 2019 ??, according to the list of space objects that could collide with Earth.
- ❑ Out of 10 objects on the list, 2006 QV89 ranked fourth.
- ❑ Compared to the 6-mile-long asteroid that killed the nonavian dinosaurs 2006 QV89 is pretty dinky, measuring just 130 feet in diameter.

ABSOLUTE MUST SEE!!

National Fossil Hall 'Deep Time' at the Smithsonian National Museum of Natural History





"In the nothing exists a

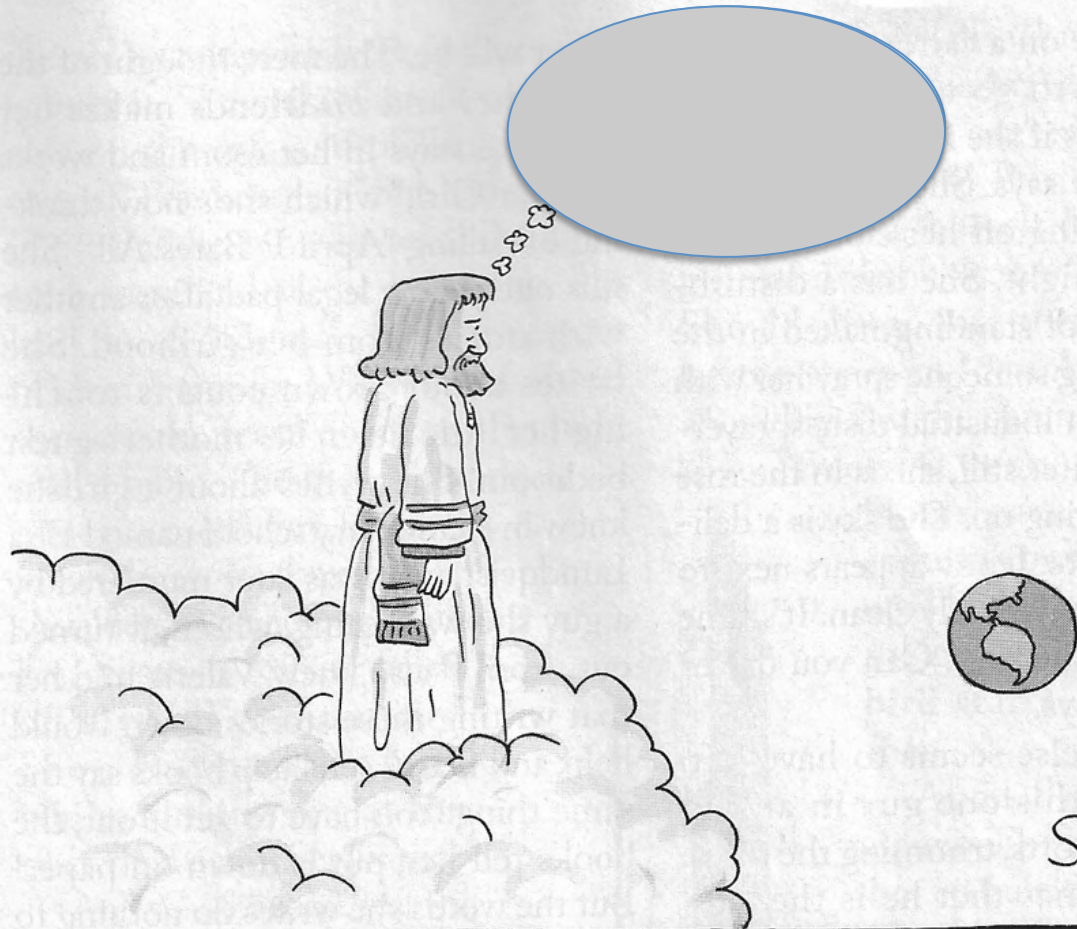
ICE-AGE PREDATORS

Mammoth Exhibition

ICE-AGE PREDATORS







Shanahar

CREATOR'S REMORSE

Tom Lehrer's "They're Rioting in Africa," written in 1958, seems eerily appropriate even today *(youtube.com)*



**They're rioting in Africa, they're starving in Spain.
There's hurricanes in Florida, and Texas needs rain.**

**The whole world is festering with unhappy souls.
The French hate the Germans, the Germans hate the Poles.**

**Italians hate Yugoslavs, South Africans hate the Dutch
And I don't like anybody very much!**

**But we can be tranquil, and thankful, and proud,
For man's been endowed with a mushroom-shaped cloud.**

**And we know for certain that some lovely day
Someone will set the spark off, and we will all be blown
away.**

They're rioting in Africa, there's strife in Iran

**What nature doesn't do to us,
will be done by our fellow man.**

What We Talked About

What Really Did Happen to Dinosaurs

Geology in the News

Geology 102

Stratigraphy

Index Fossils

Geologic Time (Periods, Eras,

Extinctions in Geologic History

K-T Extinction

Big Things From Space

What are the Odds?

ABSOLUTE MUST SEE!!



A DELICATE BALANCE: GLOBAL RESOURCES AND GLOBAL ENVIRONMENT

SPRING 2020