A Consideration that the Fireballs Associated with the Perseids Meteor Shower are an Indication of a Previous Low Angle Skip Impact by Comet 109P/Swift–Tuttle.

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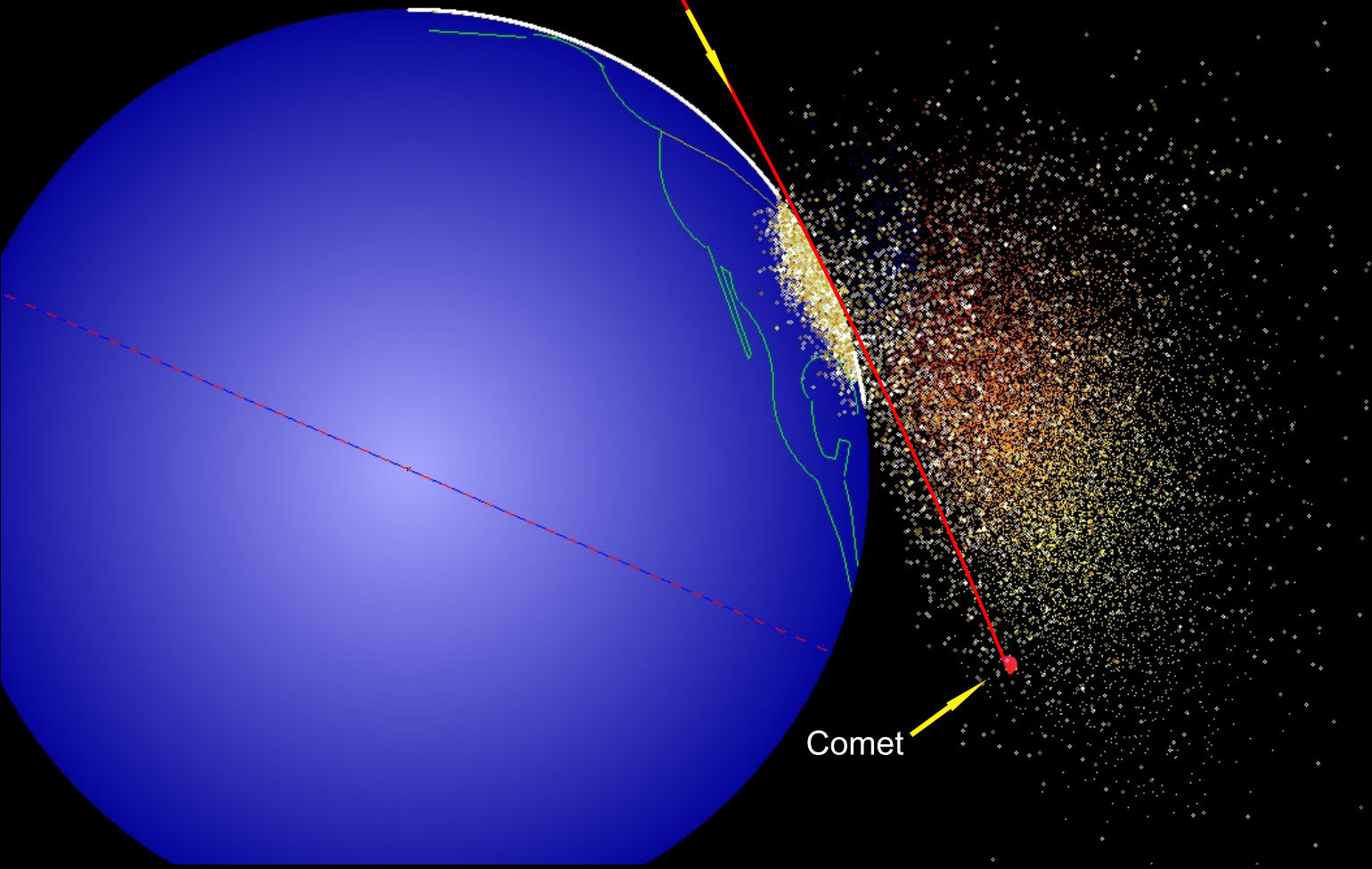
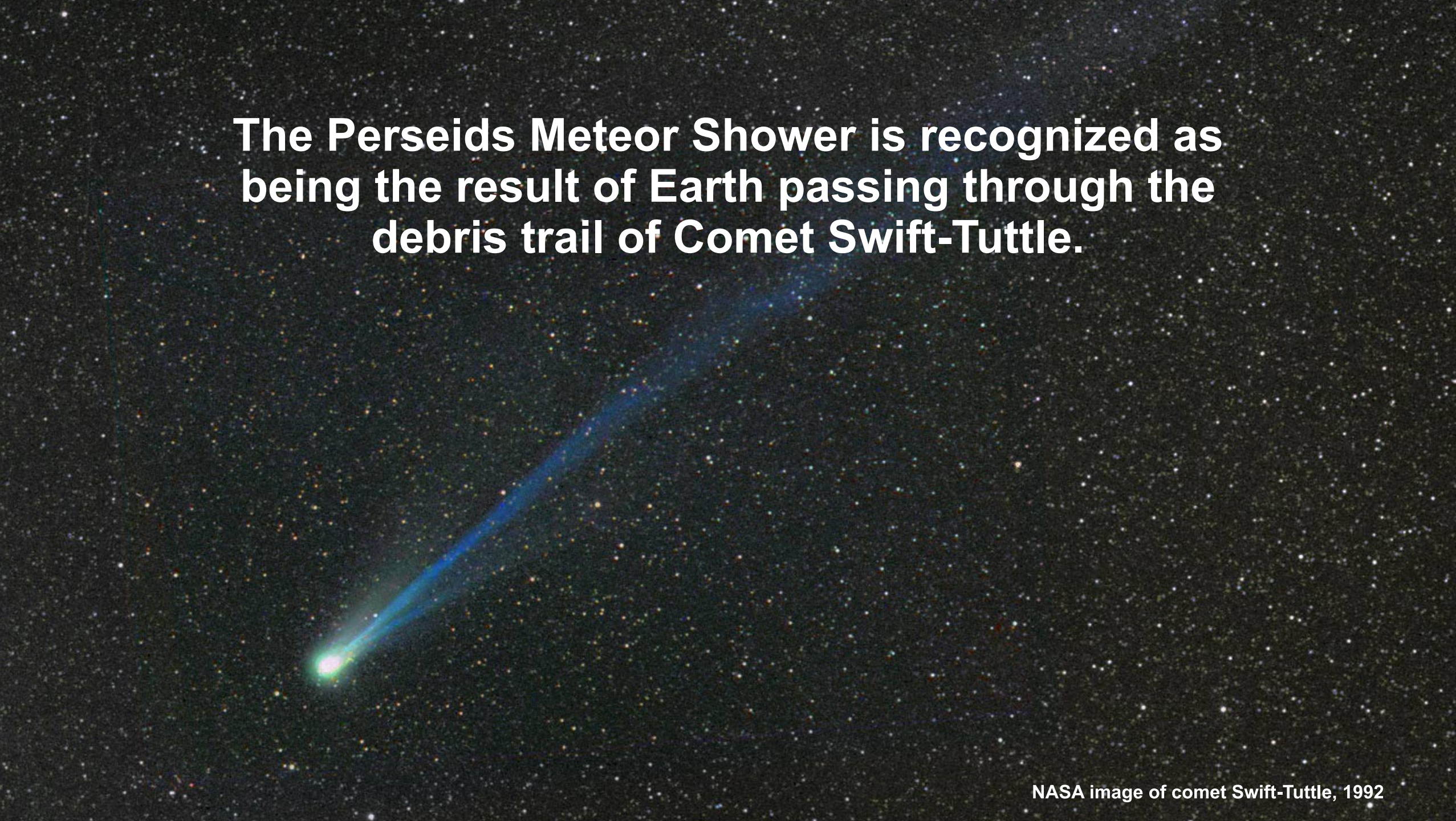


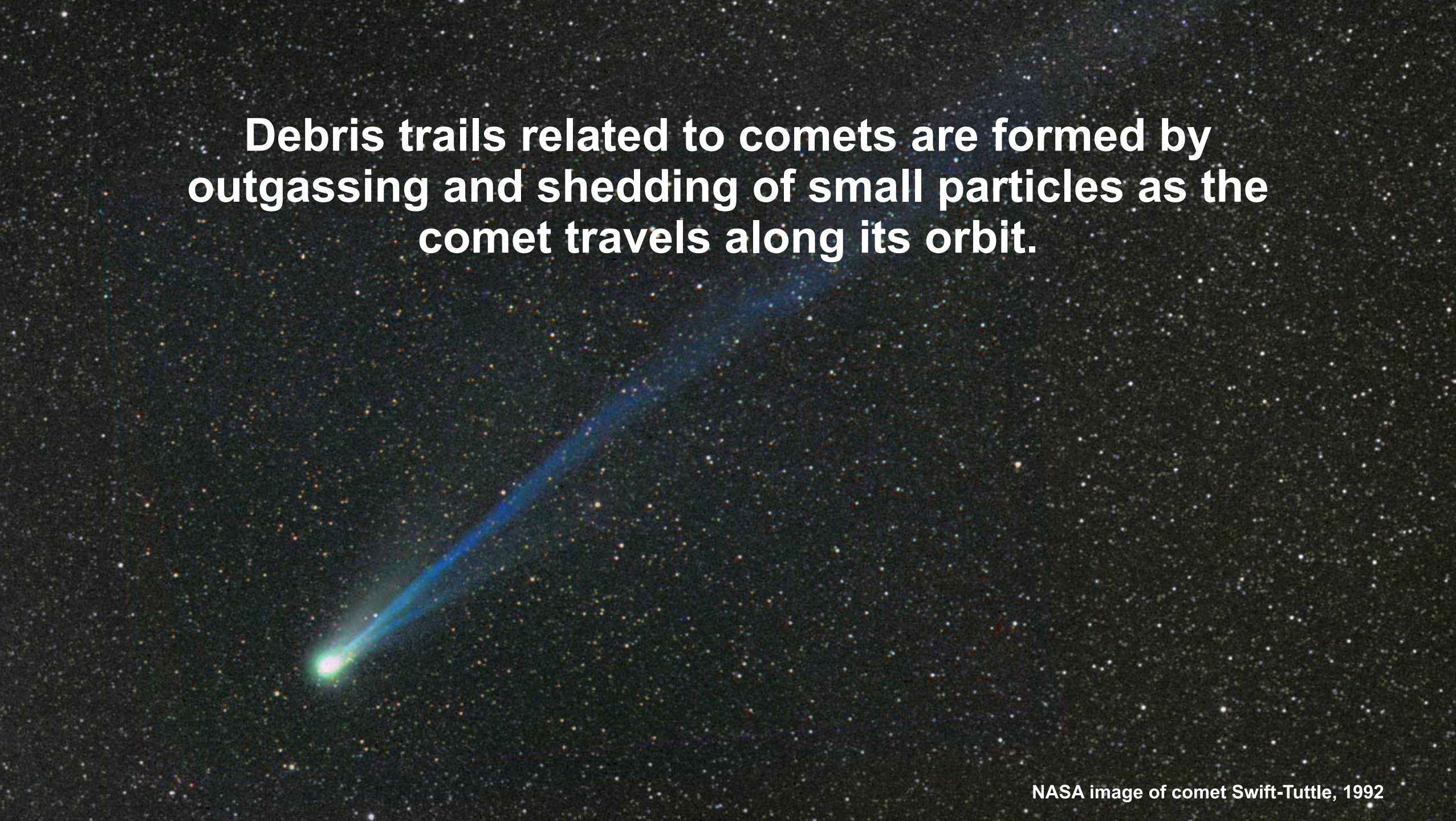

The Perseids Meteor Shower occurs each August,
with the predicted peak on August 12 in 2021.

The Perseids Meteor Shower is recognized as being the result of Earth passing through the debris trail of Comet Swift-Tuttle.

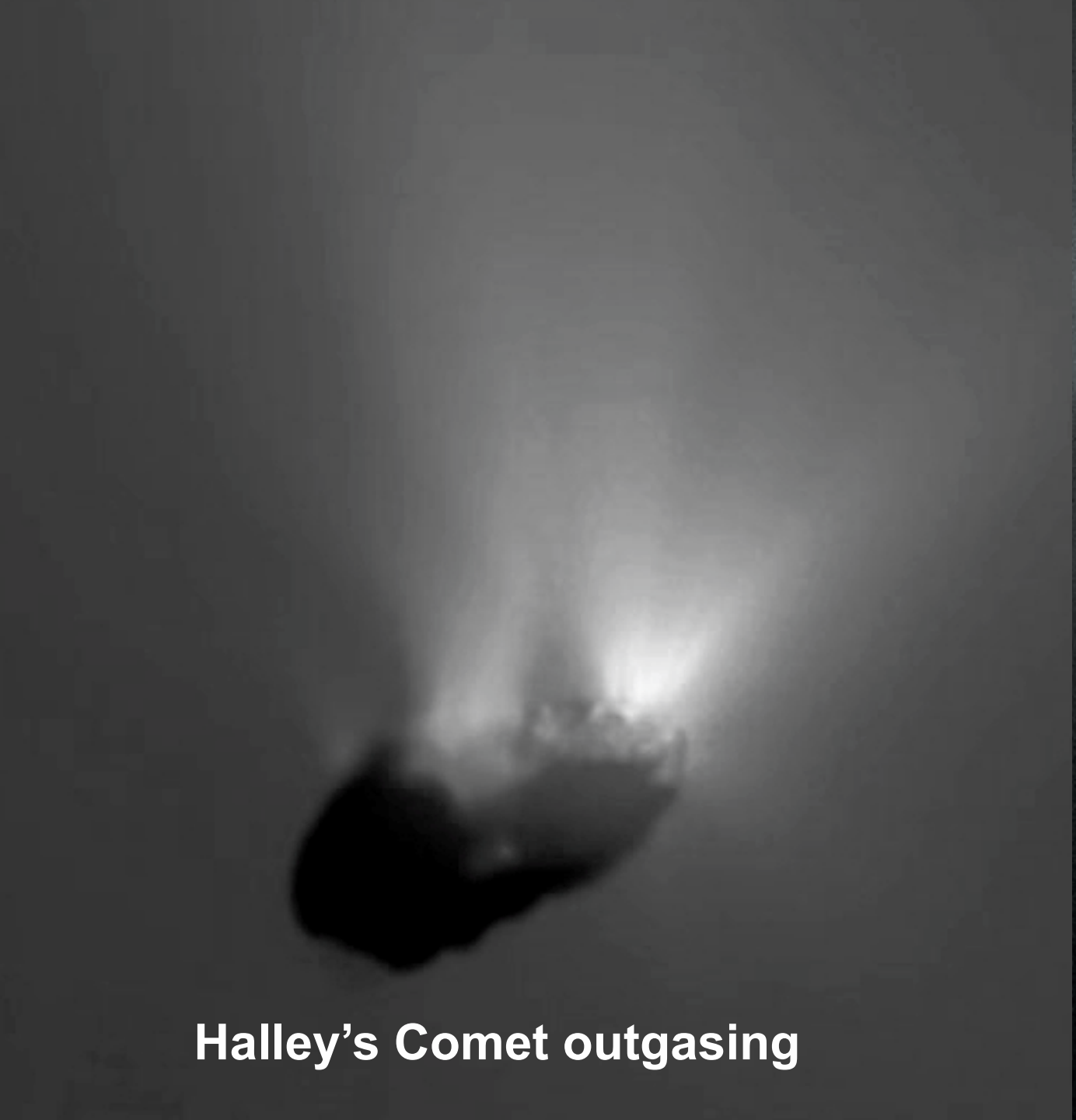


NASA image of comet Swift-Tuttle, 1992

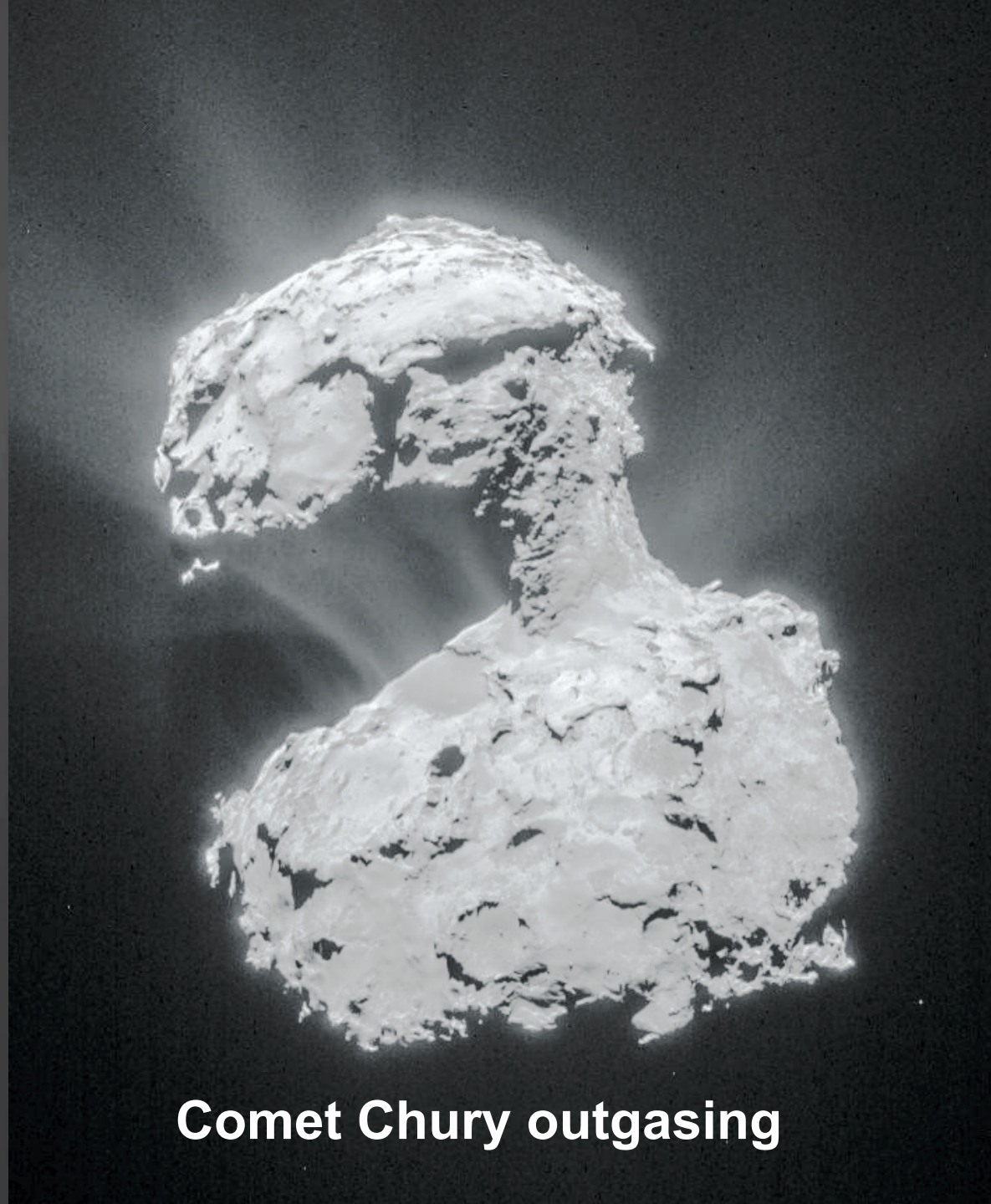
Debris trails related to comets are formed by outgassing and shedding of small particles as the comet travels along its orbit.



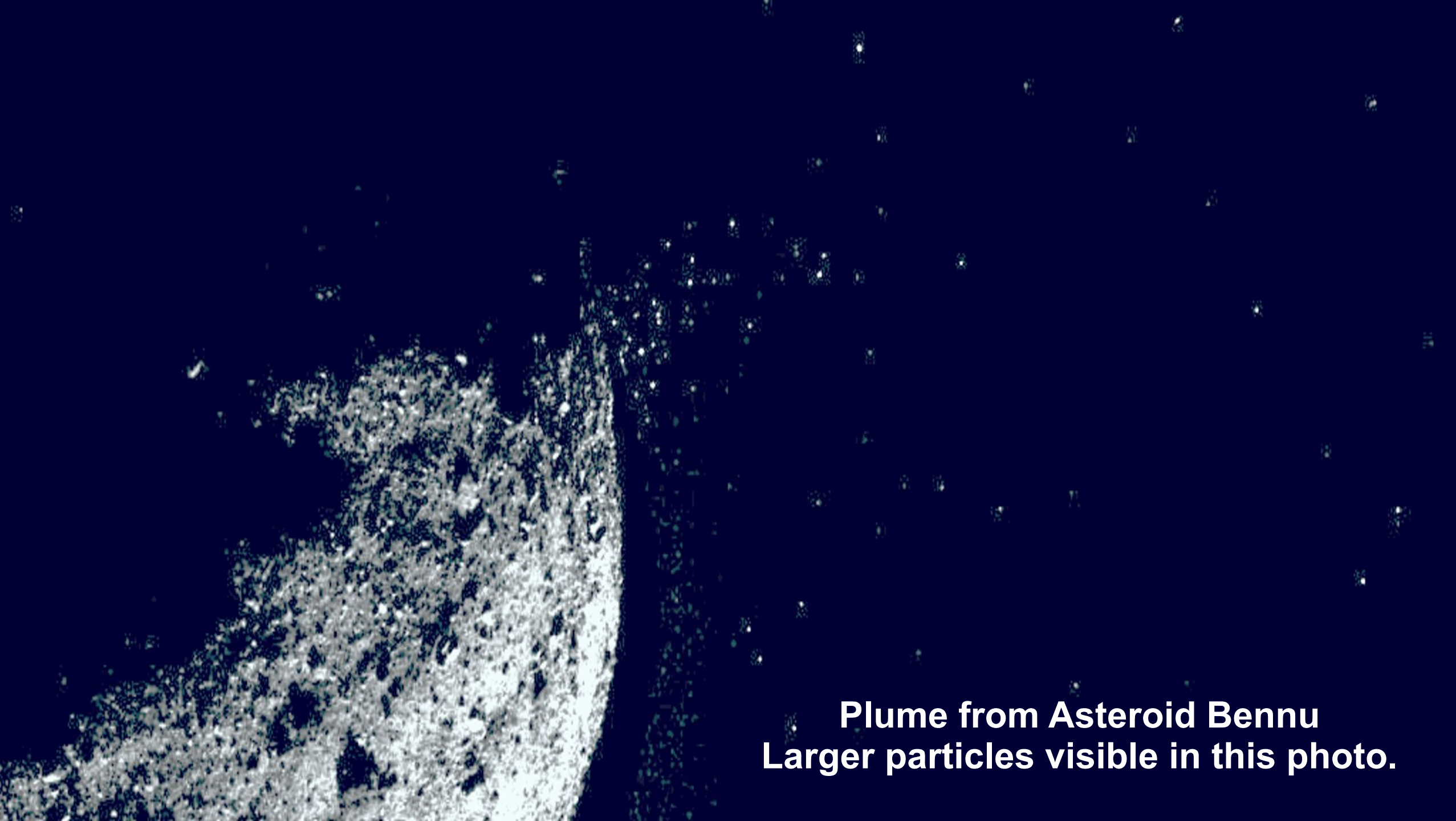
NASA image of comet Swift-Tuttle, 1992



Halley’s Comet outgasing



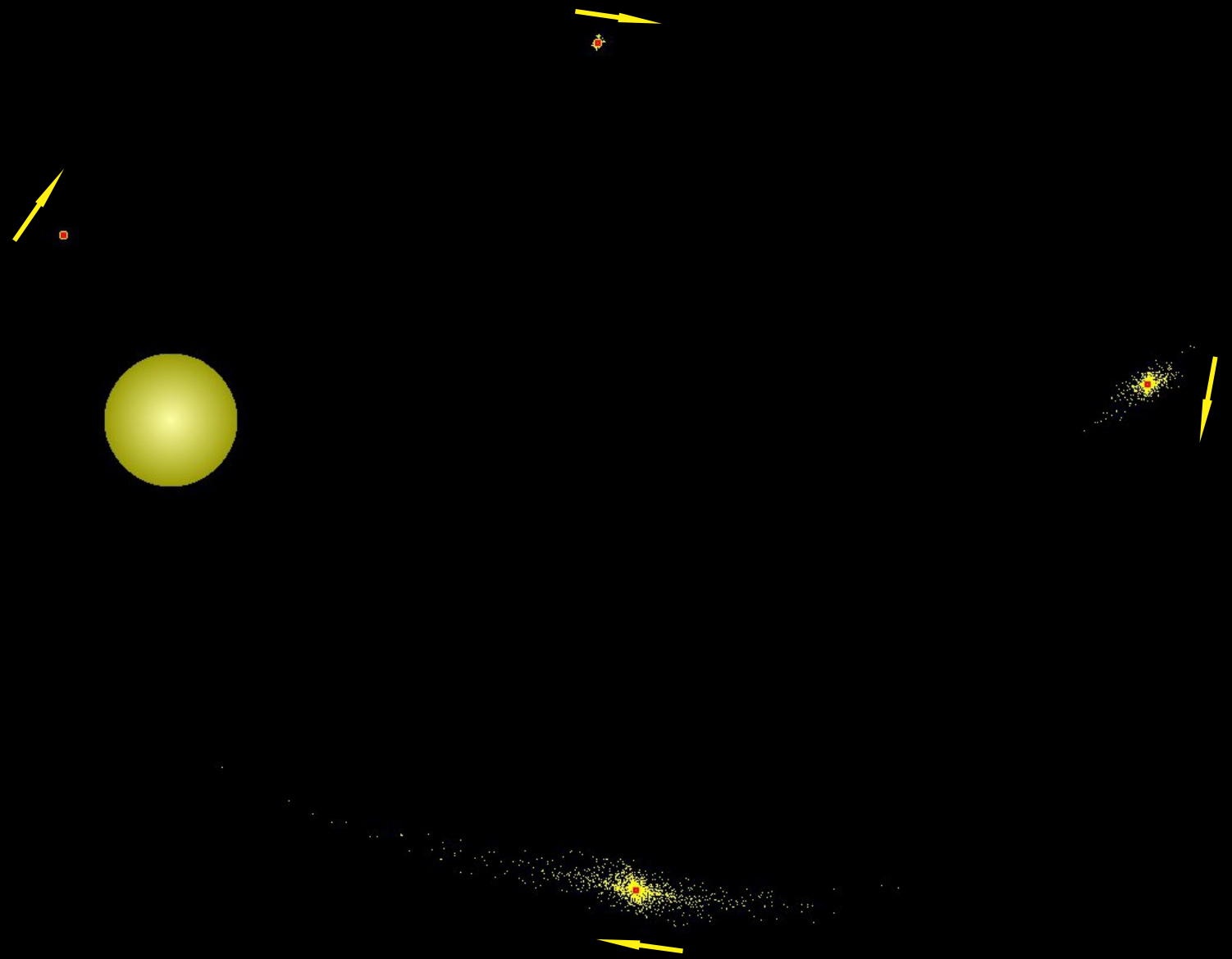
Comet Chury outgasing


Plume from Asteroid Bennu
Larger particles visible in this photo.

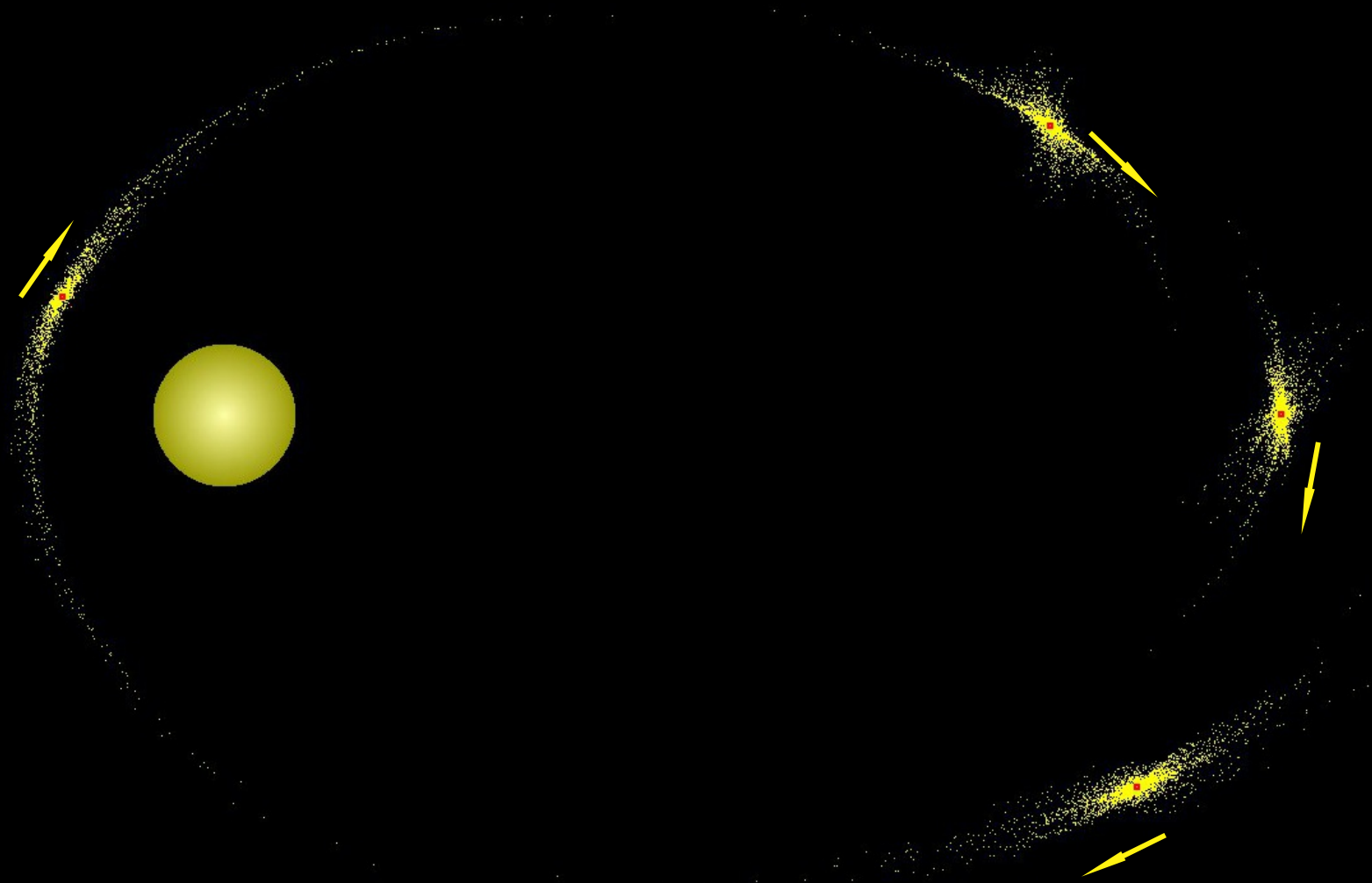
How does a comet form a debris trail along its entire orbit?

As a comet orbits the sun, the particles outgased will be at a different distance from the Sun, causing the Sun's gravity to pull each particle at slightly different speeds. These minor speed differences spread the particles out over time and cause the particles to move ahead or behind at sufficient differences that over hundreds of orbits, a debris trail forms.

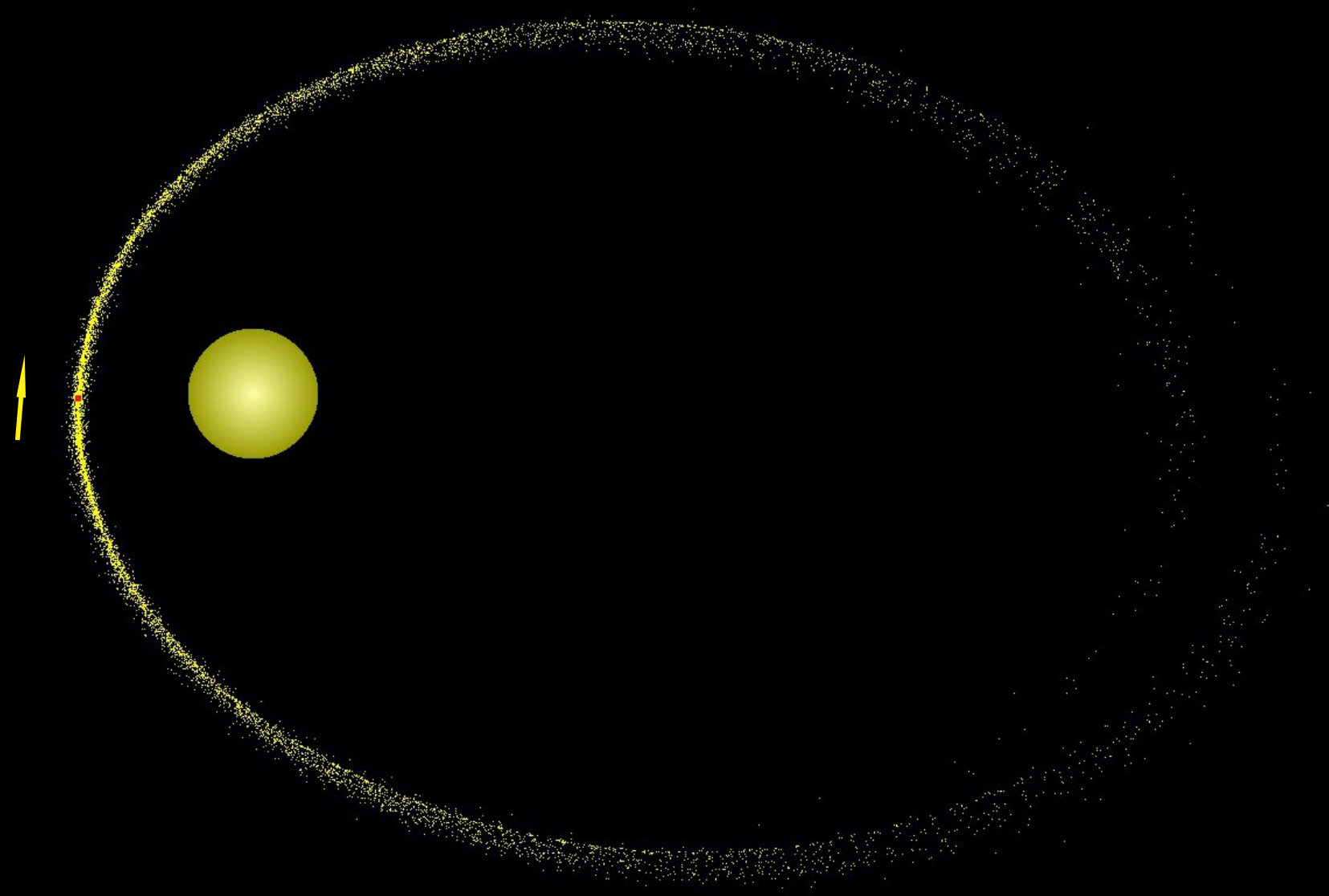
Comet orbiting the Sun, 1st orbit, beginning to outgas:



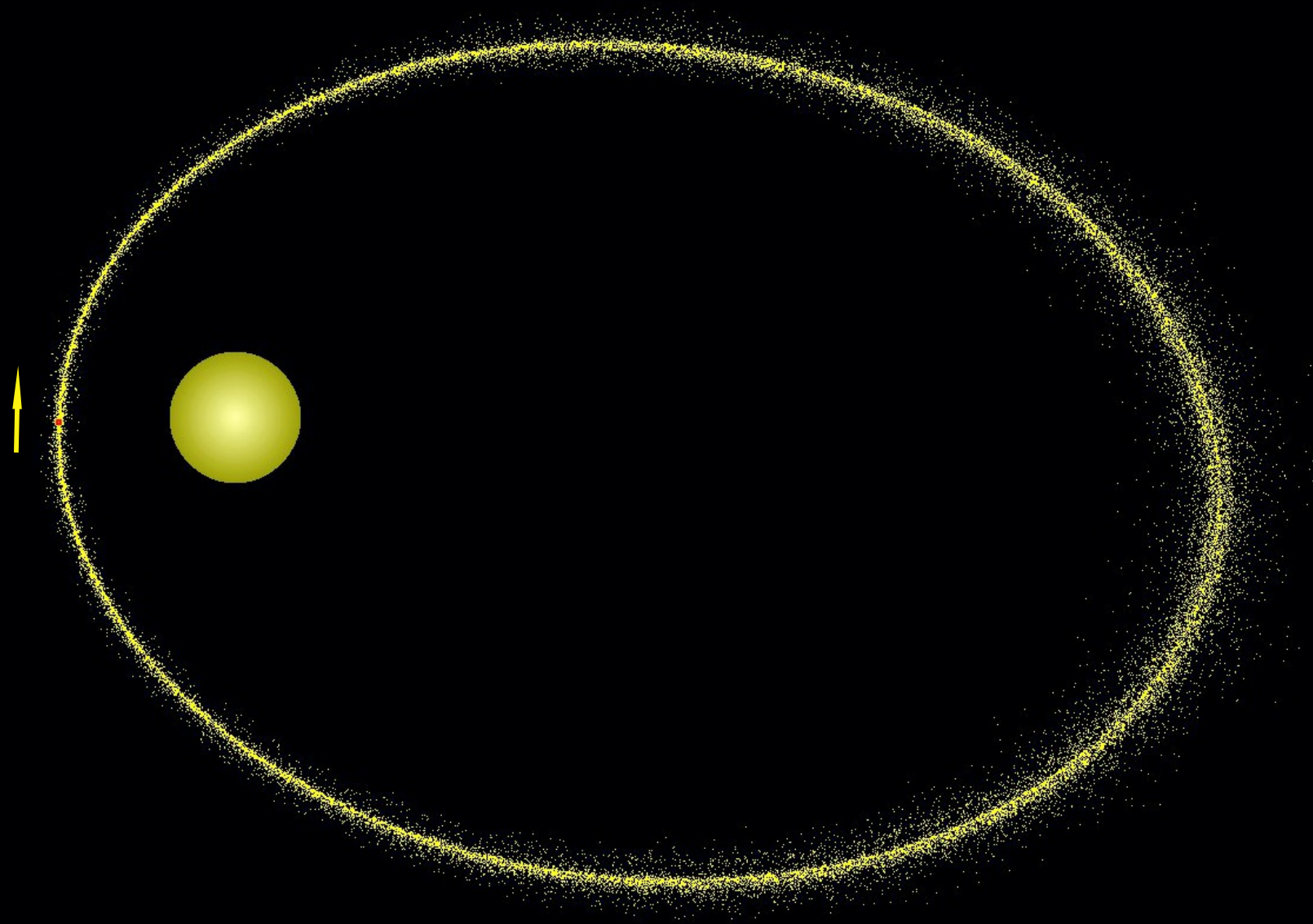
Comet orbiting the Sun, 2nd orbit, continuing to outgas:



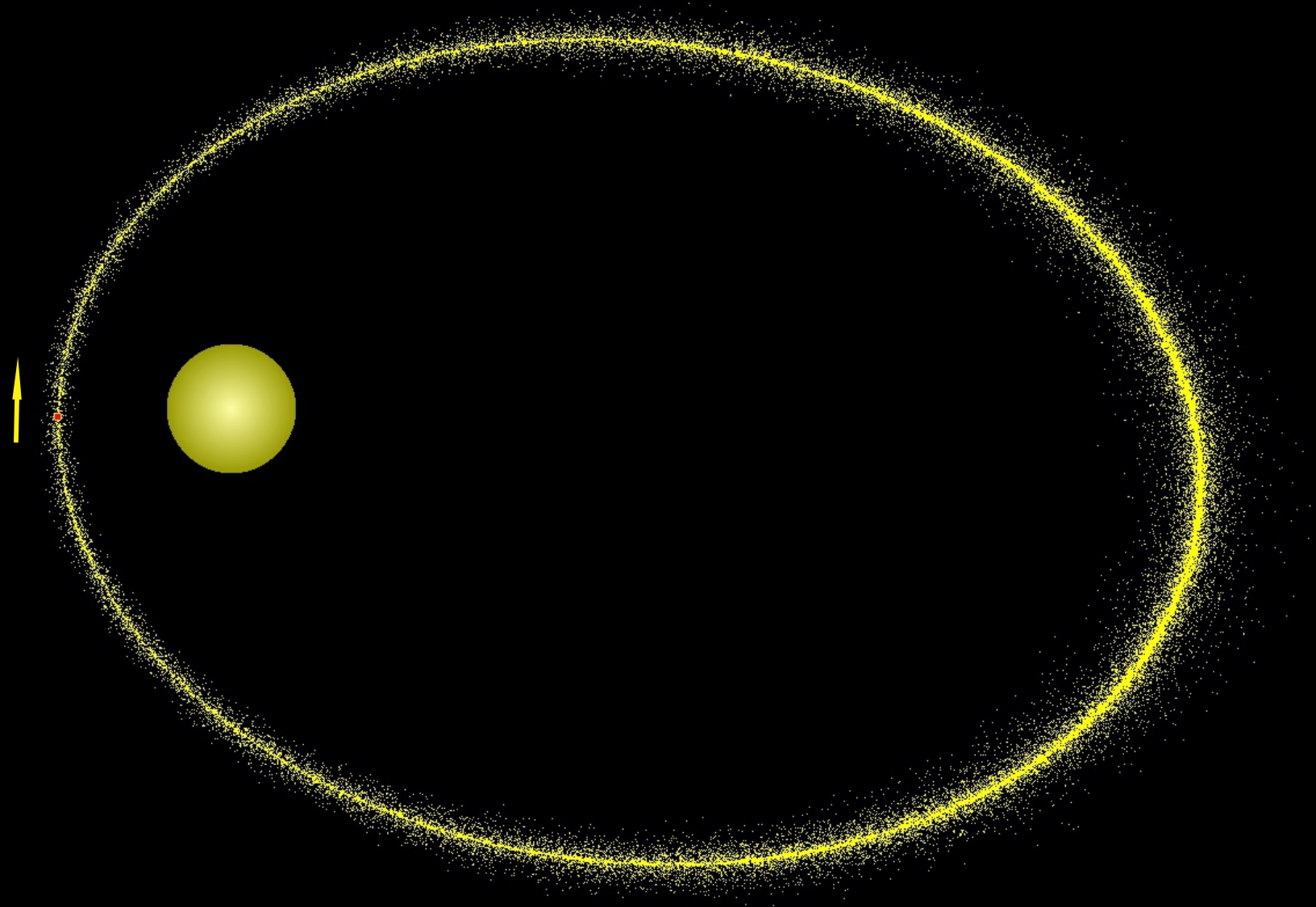
Comet orbiting the Sun, after 10 orbits:



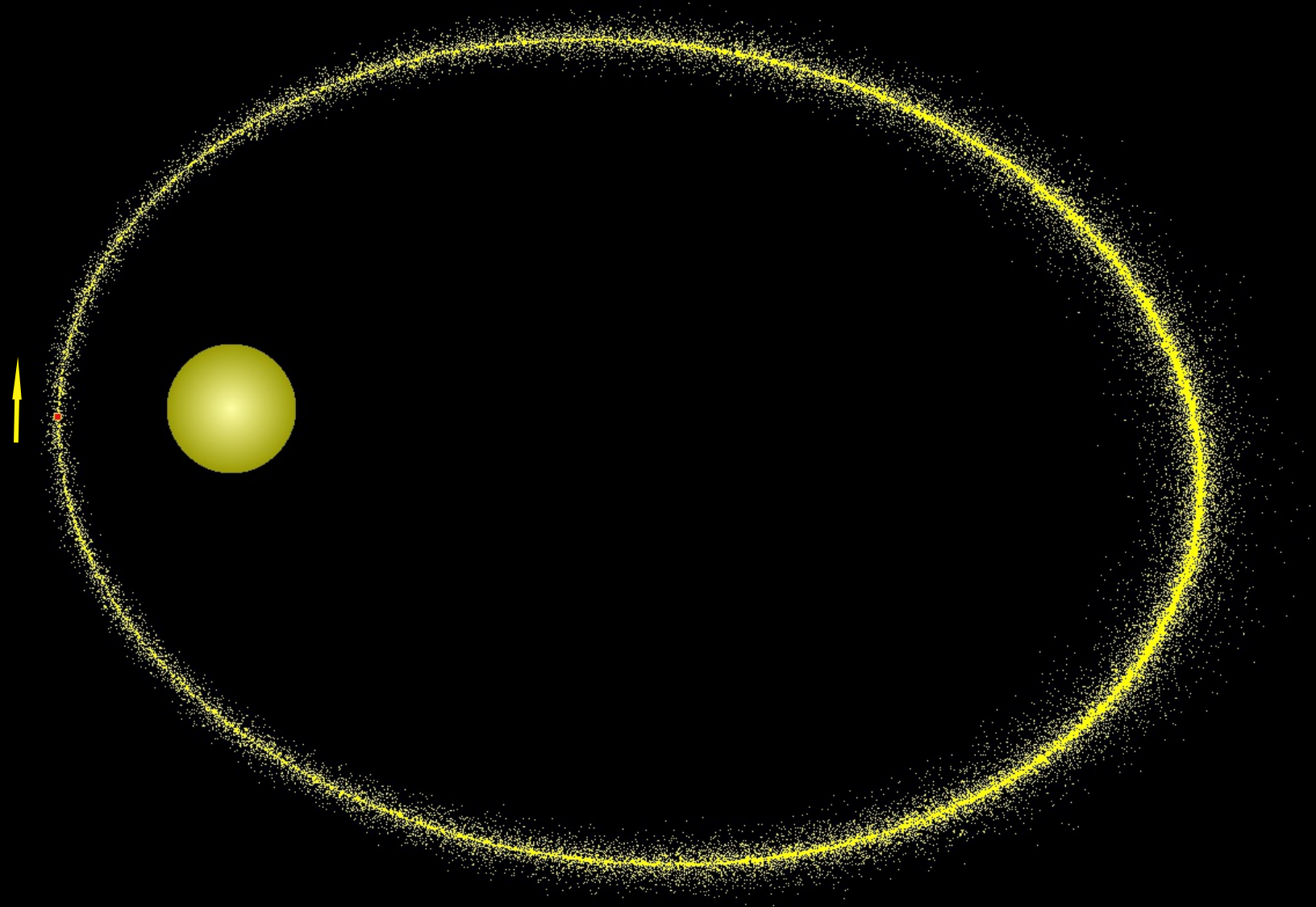
Comet orbiting the Sun, about 50 orbits later, with well developed debris trail:



Comet orbiting the Sun, about 200 orbits later, with fully developed debris trail:
(For Swift-Tuttle, 200 orbits = 26,000 years)



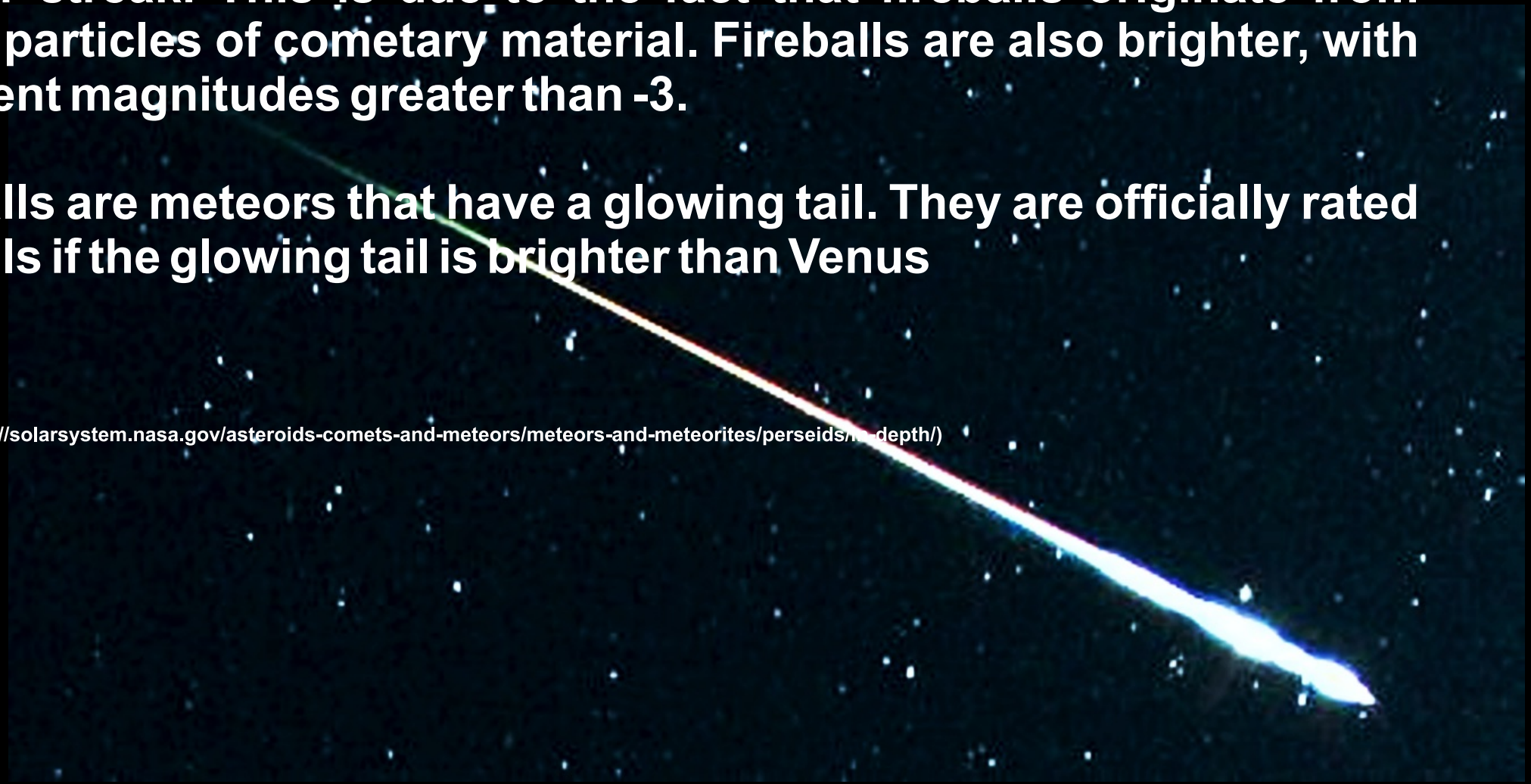
Note that the debris trail remains close to the orbital path of the comet.
Which is why a meteor shower is typically of very short duration.



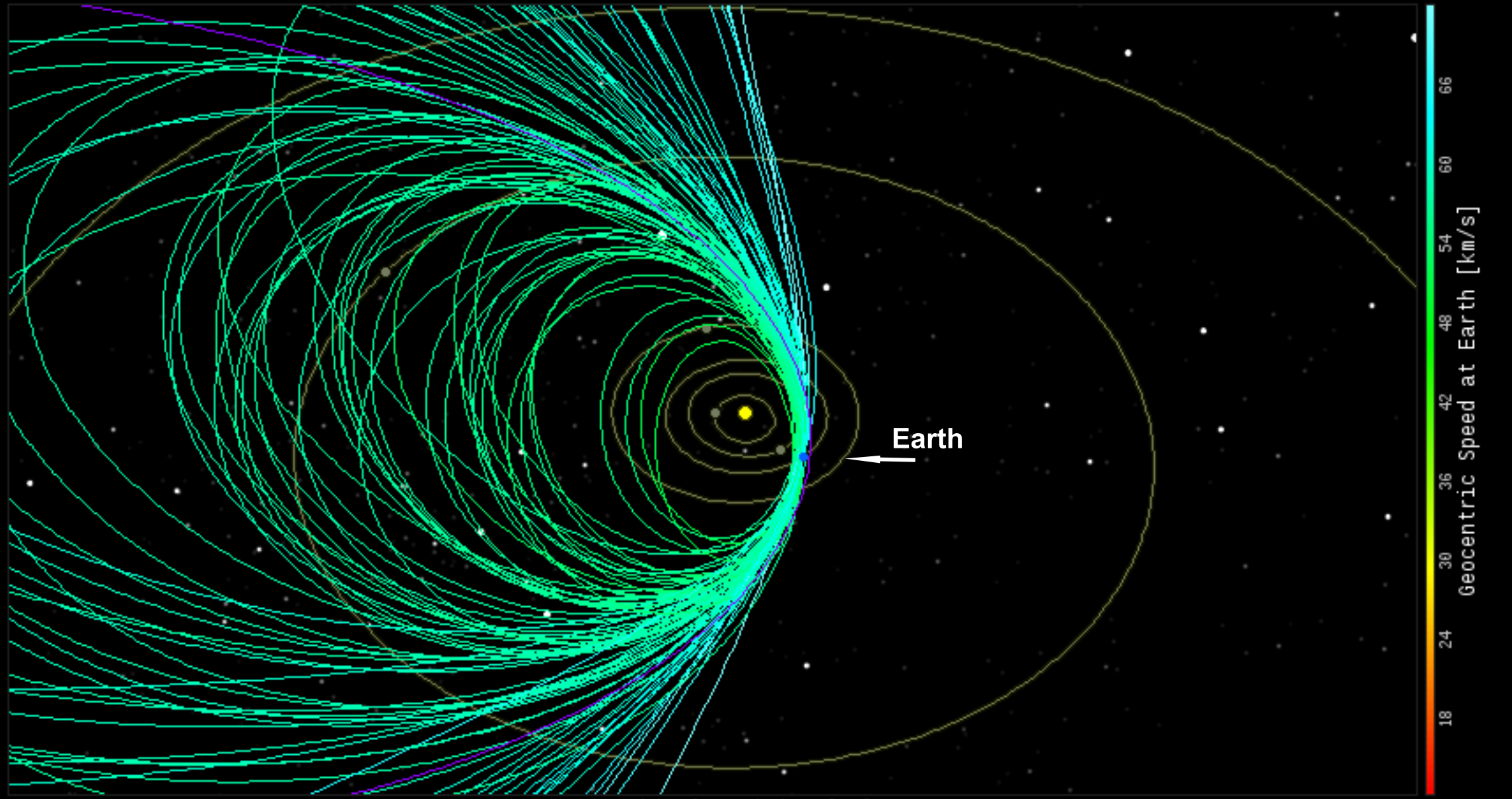
The Perseids are also known for their fireballs. Fireballs are larger explosions of light and color that can persist longer than an average meteor streak. This is due to the fact that fireballs originate from larger particles of cometary material. Fireballs are also brighter, with apparent magnitudes greater than -3.

Fireballs are meteors that have a glowing tail. They are officially rated fireballs if the glowing tail is brighter than Venus

(Source: https://solarsystem.nasa.gov/asteroids-comets-and-meteors/meteors-and-meteorites/perseids/in-depth/)

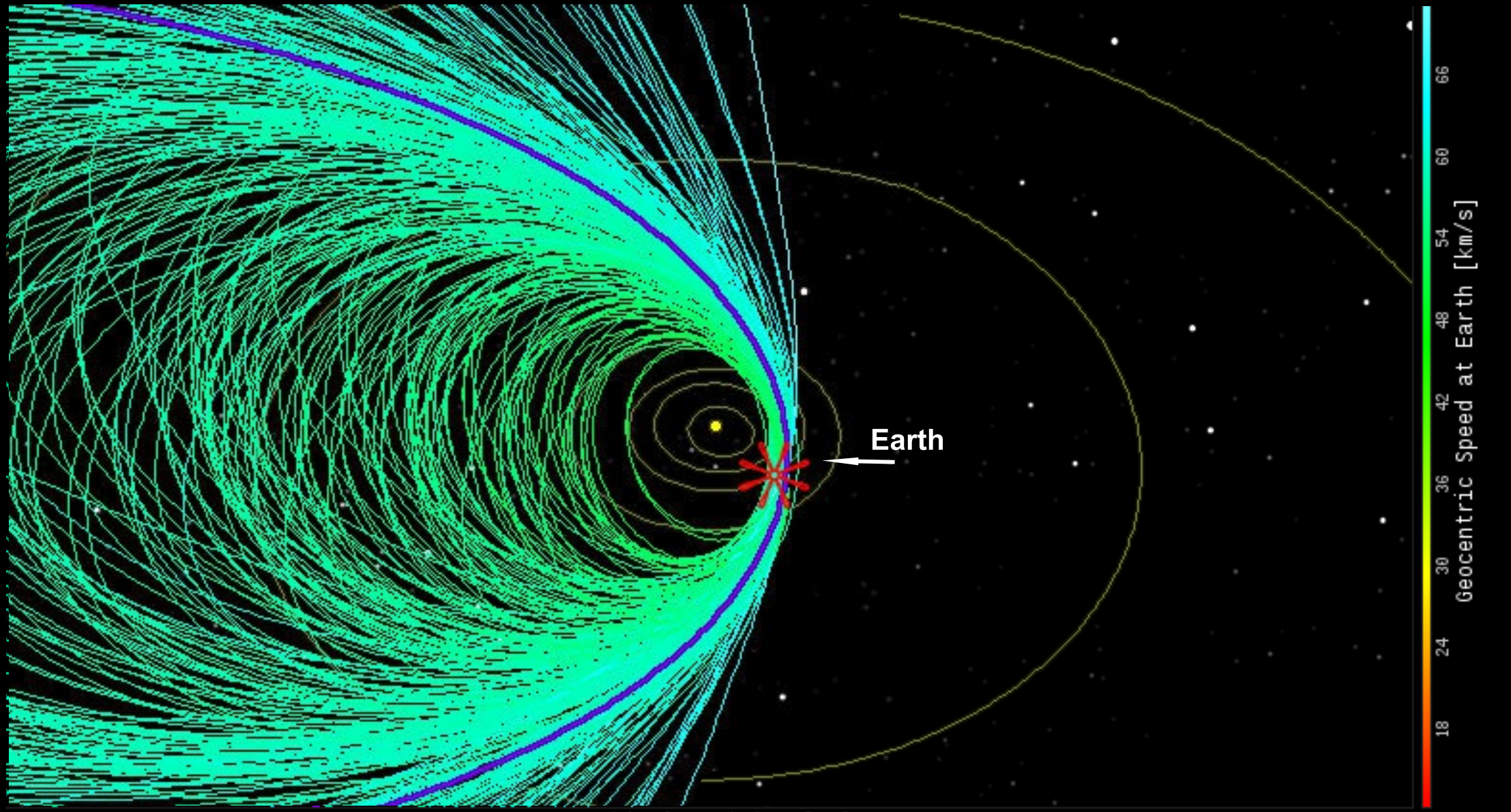


In 2012, William Cooke, NASA Meteoroid Environment Office, presented orbit charts of the first 78 fireballs associated with comet Swift-Tuttle by Aug 7:



Orbits of 78 Fireballs associated with the Perseids, Aug 7, 2012

And a chart of 300 orbits of fireballs associated with comet Swift-Tuttle by Aug 12:

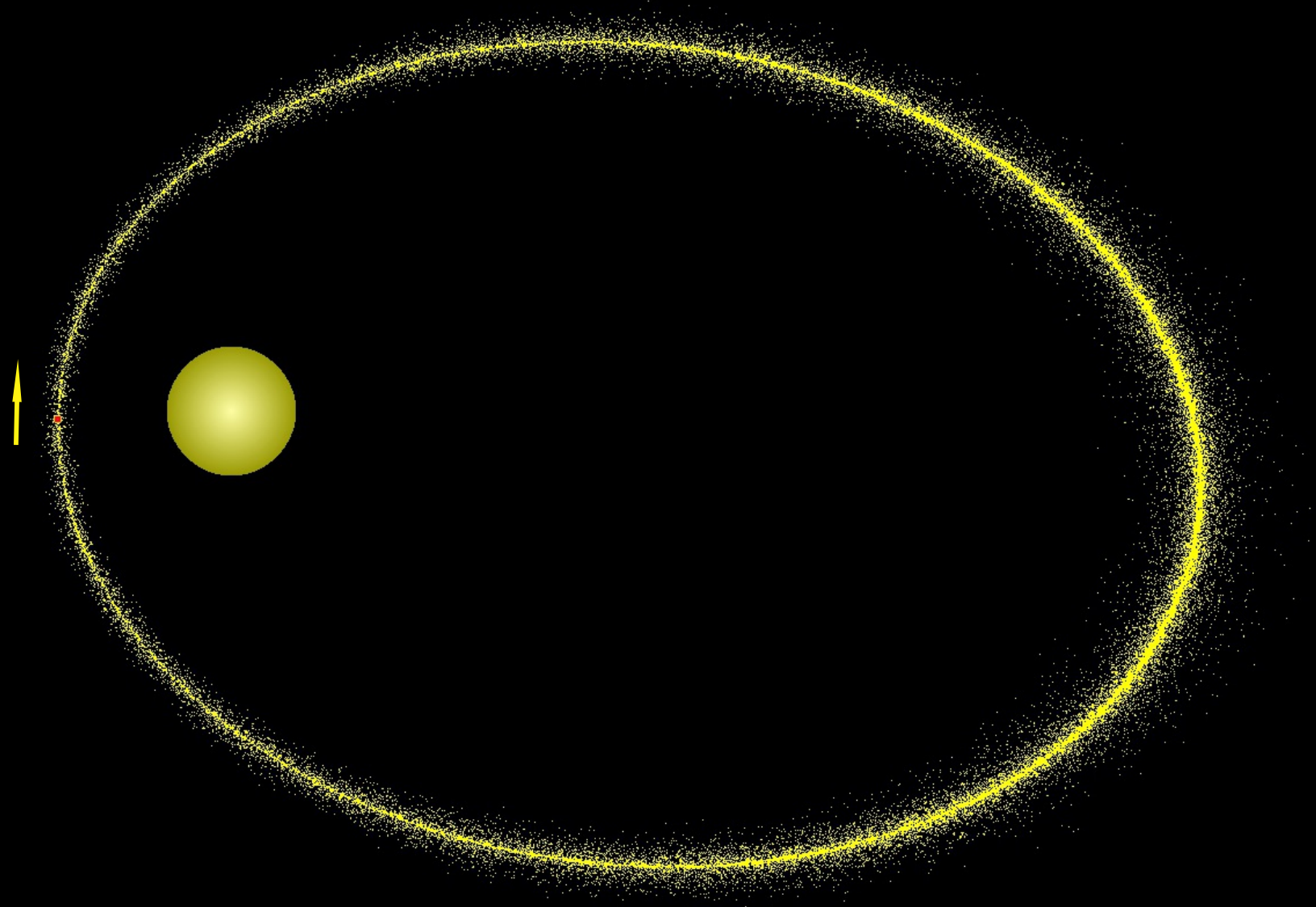


Orbits of 300 Fireballs associated with the Perseids, Aug 12, 2012

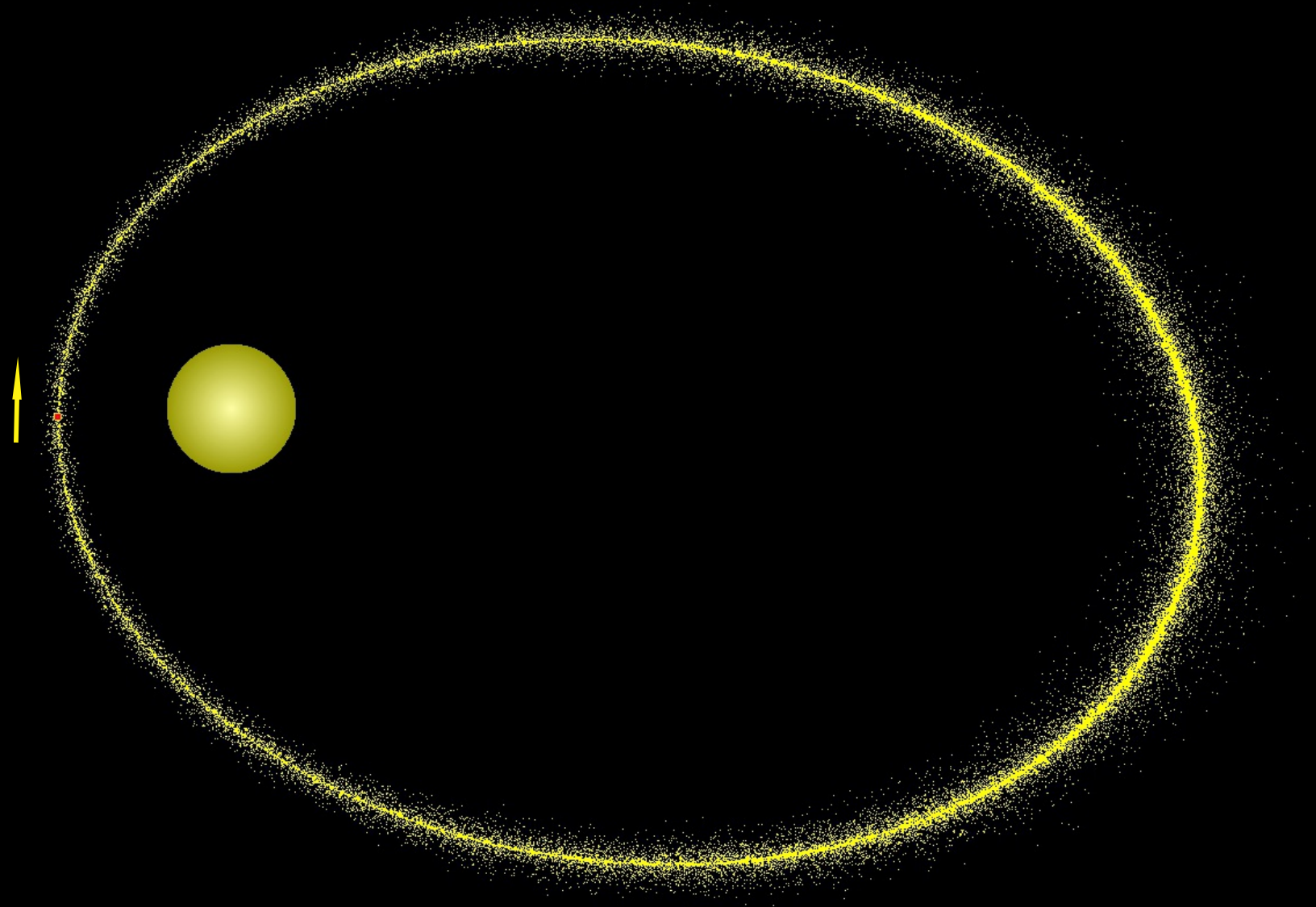
The Perseids’ fireball orbits do not follow the Comet’s orbit. Instead many orbits are shown, of various duration, with only one thing in common: They all intersect Earth's orbit at one point.

The obvious rational explanation is that they all ORIGINATED from Earth, starting at the same time.

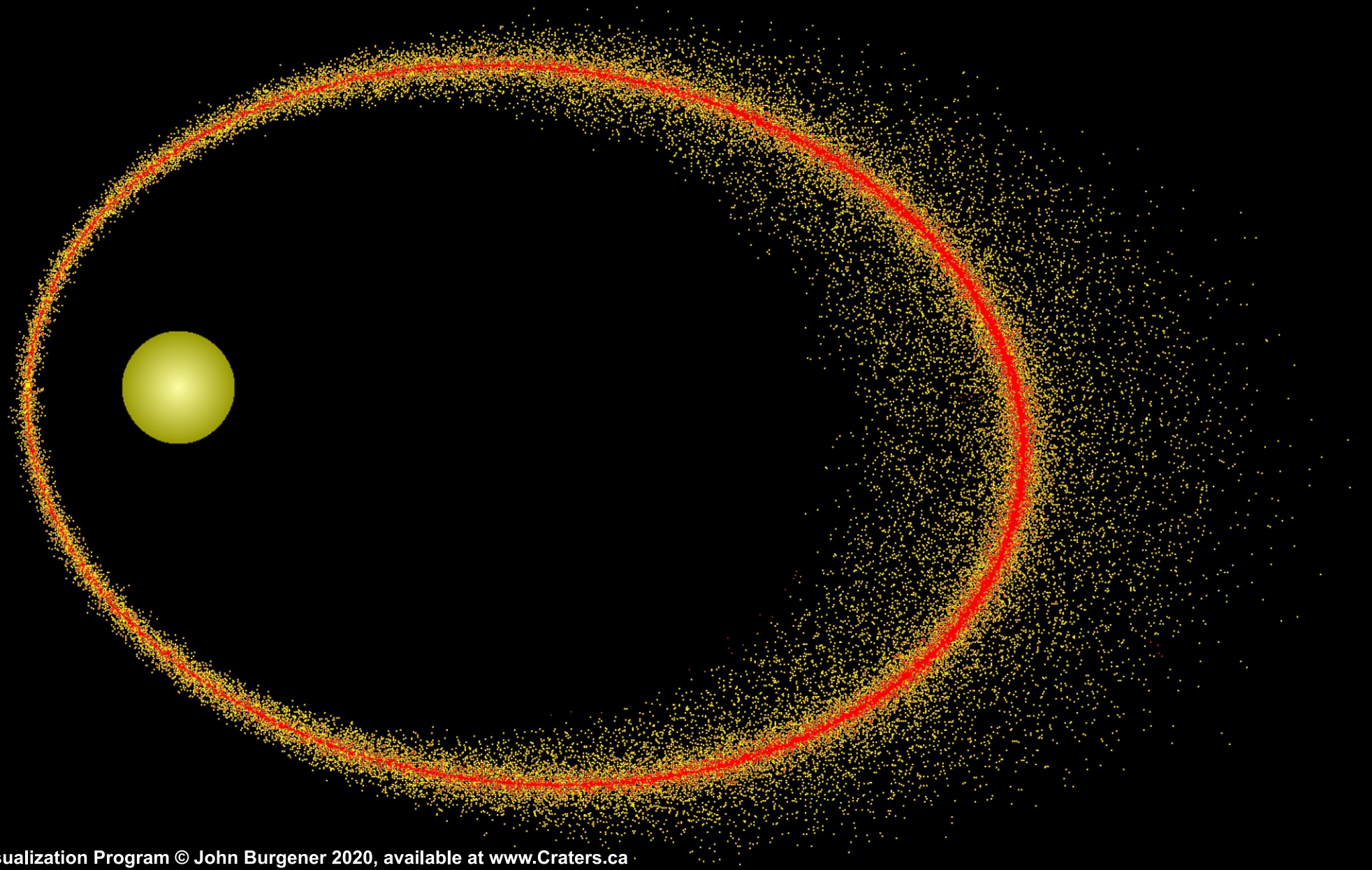
The debris trail shown previously is what happens if the comet outgases along the orbit.



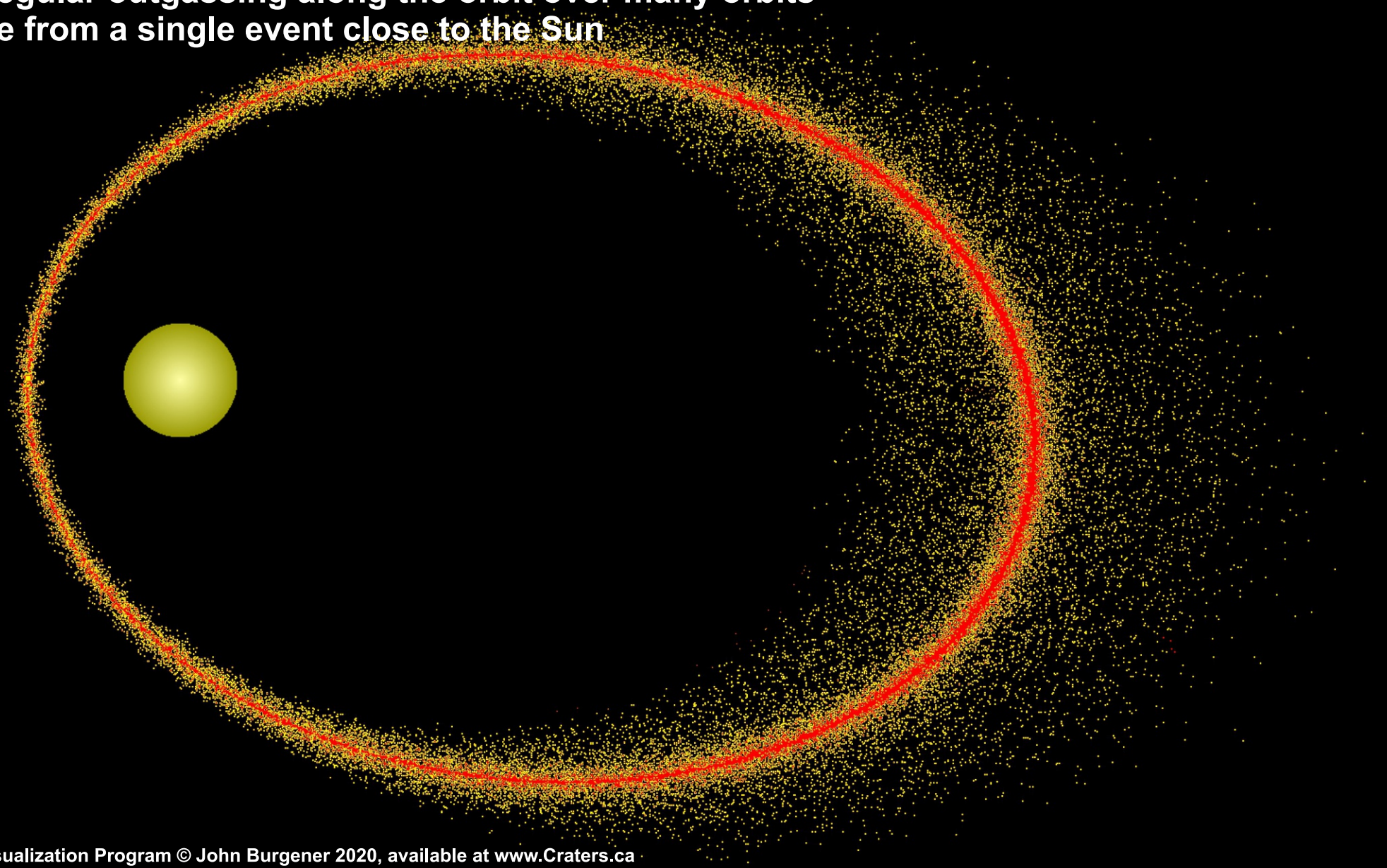
How will the debris trail look if a major outgassing event occurs while it is near the Sun? For instance - what if an asteroid hits the comet?



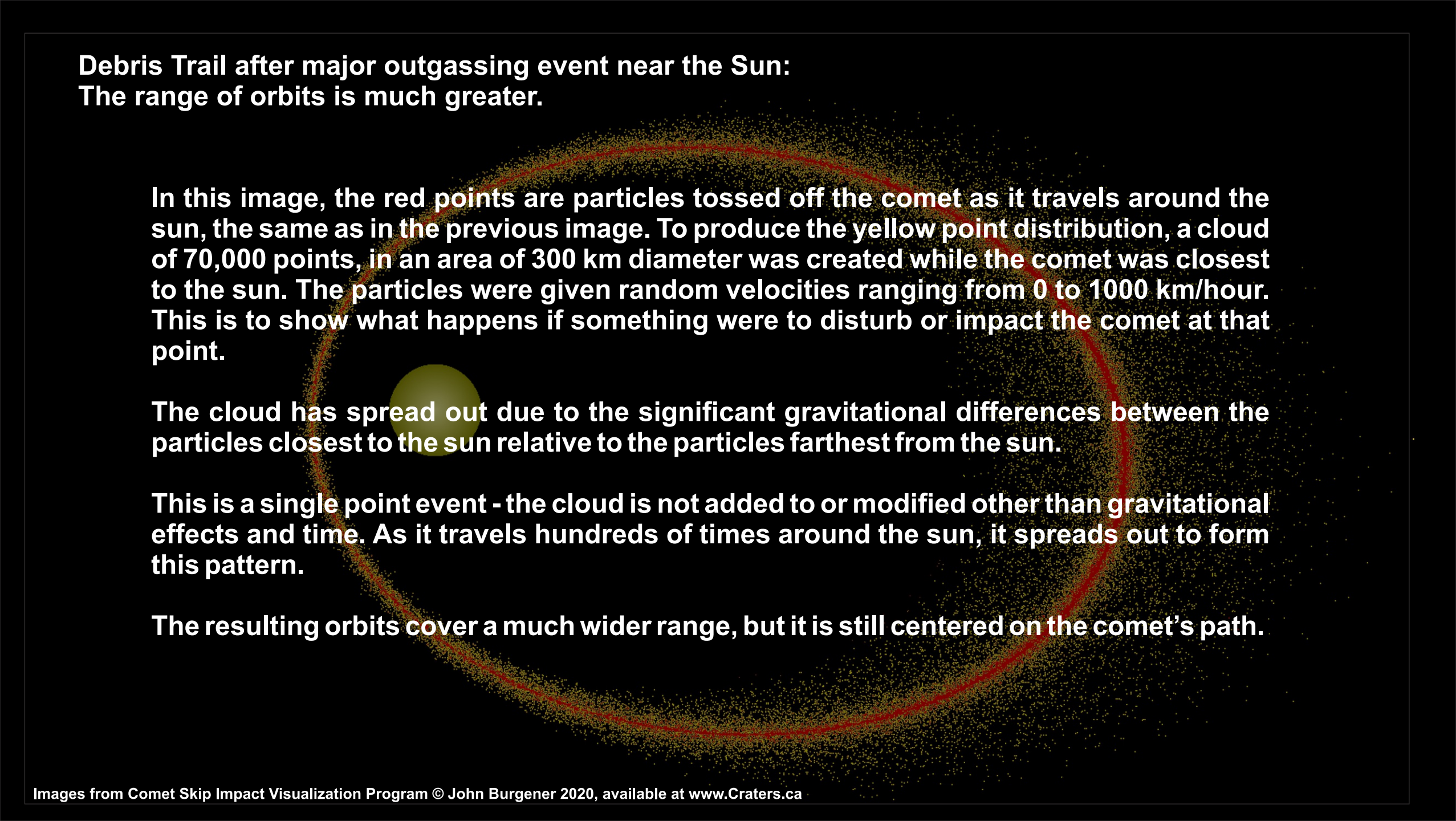
Debris Trail after major outgassing event near the Sun:



Debris Trail after major outgassing event near the Sun:
Red points are regular outgassing along the orbit over many orbits
Yellow points are from a single event close to the Sun



Debris Trail after major outgassing event near the Sun:
The range of orbits is much greater.



In this image, the red points are particles tossed off the comet as it travels around the sun, the same as in the previous image. To produce the yellow point distribution, a cloud of 70,000 points, in an area of 300 km diameter was created while the comet was closest to the sun. The particles were given random velocities ranging from 0 to 1000 km/hour. This is to show what happens if something were to disturb or impact the comet at that point.

The cloud has spread out due to the significant gravitational differences between the particles closest to the sun relative to the particles farthest from the sun.

This is a single point event - the cloud is not added to or modified other than gravitational effects and time. As it travels hundreds of times around the sun, it spreads out to form this pattern.

The resulting orbits cover a much wider range, but it is still centered on the comet's path.

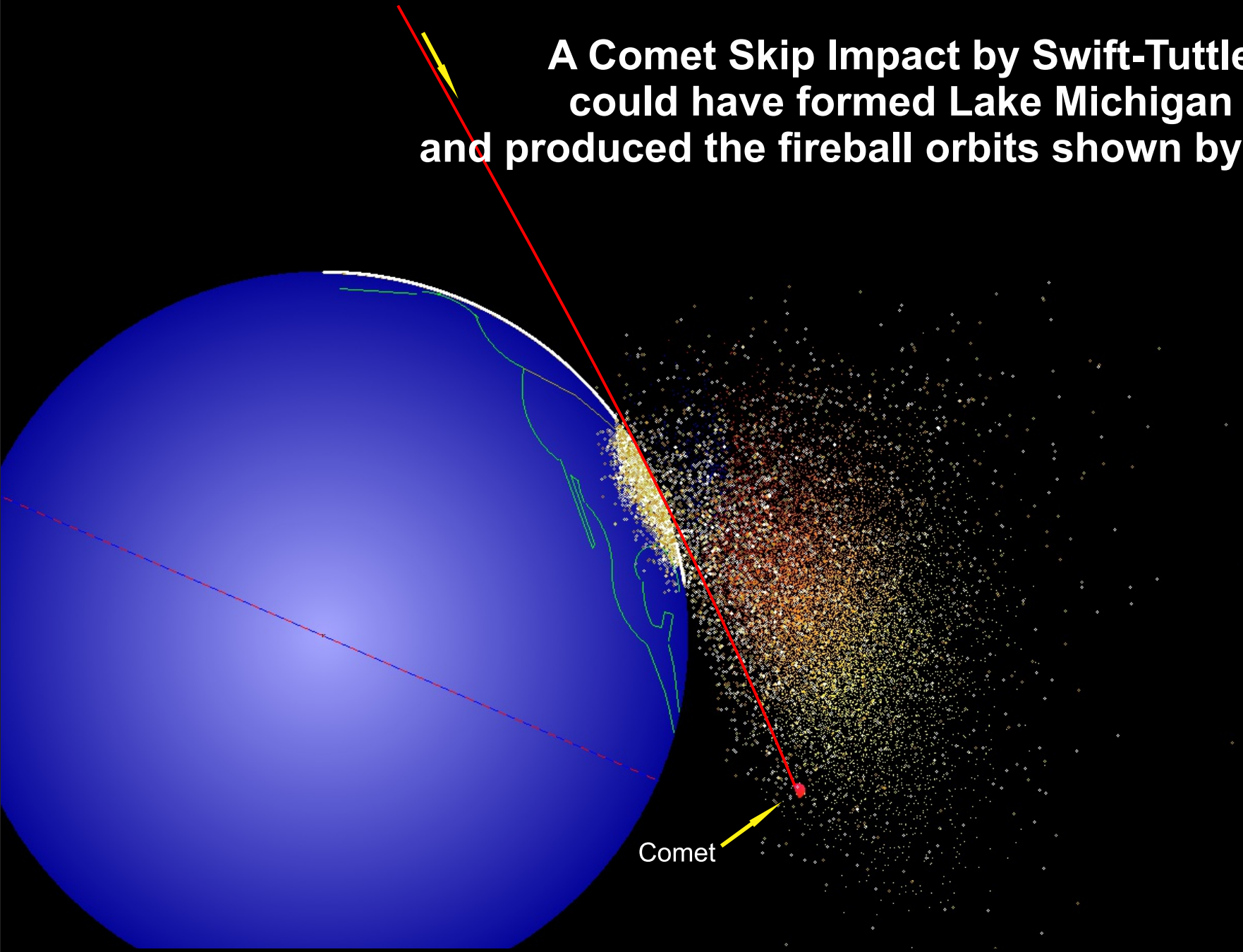
While the comet particle orbits are widely distributed, they are still limited in range compared to Cooke's image of fireball orbits.

And they required a single point event beside a large gravitational object to make the dispersion shown.

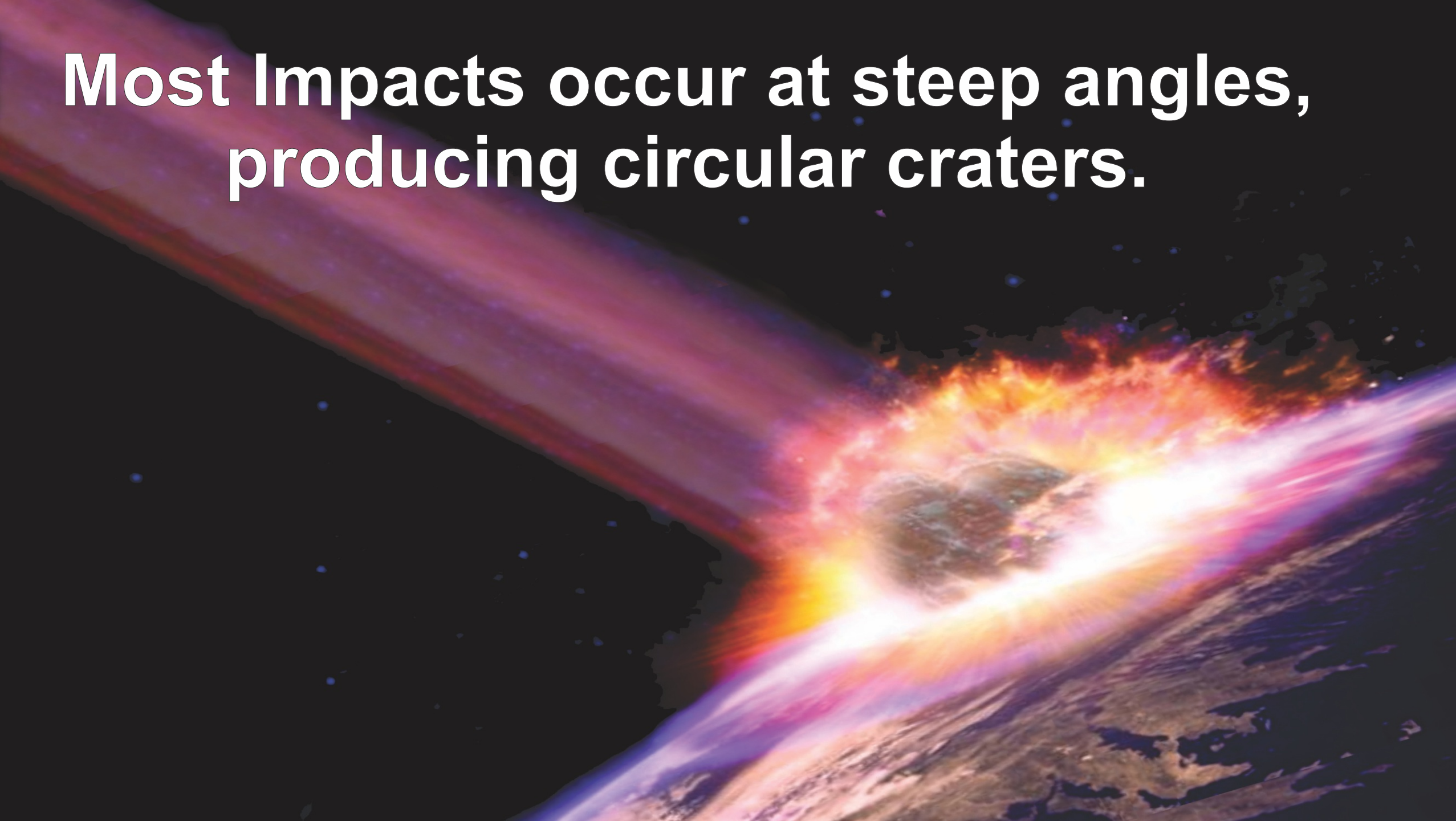
It would seem that wide distribution of orbits requires a unique single event near a large gravitational object. And apparently, a range of 0 - 1000 km/hour is NOT enough to produce the fireball orbit range plotted for the Swift-Tuttle fireballs.

A single event with a wide range of velocities resulting from it is a good description of a skip impact.

A Comet Skip Impact by Swift-Tuttle could have formed Lake Michigan and produced the fireball orbits shown by NASA.

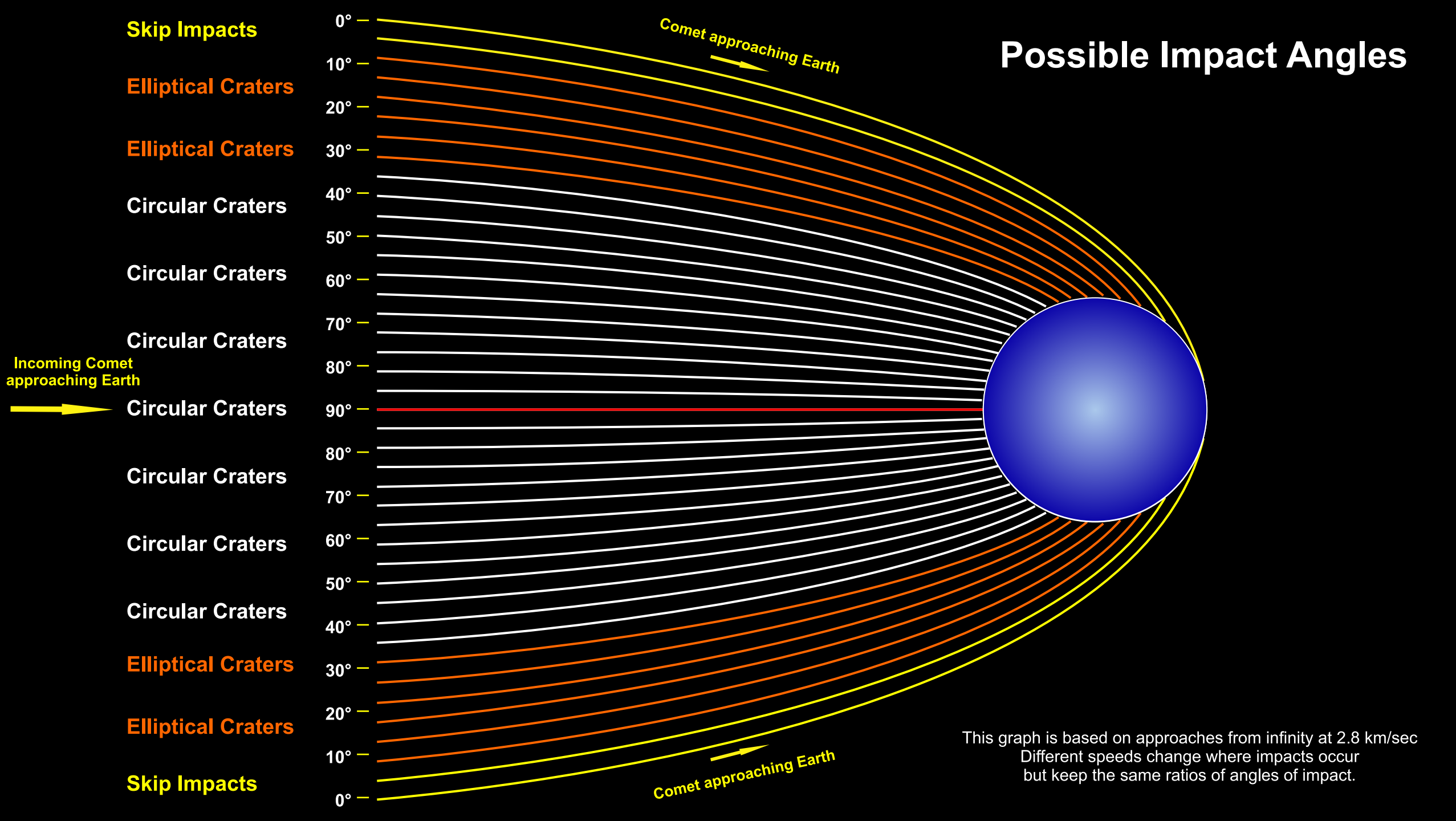


Most Impacts occur at steep angles, producing circular craters.

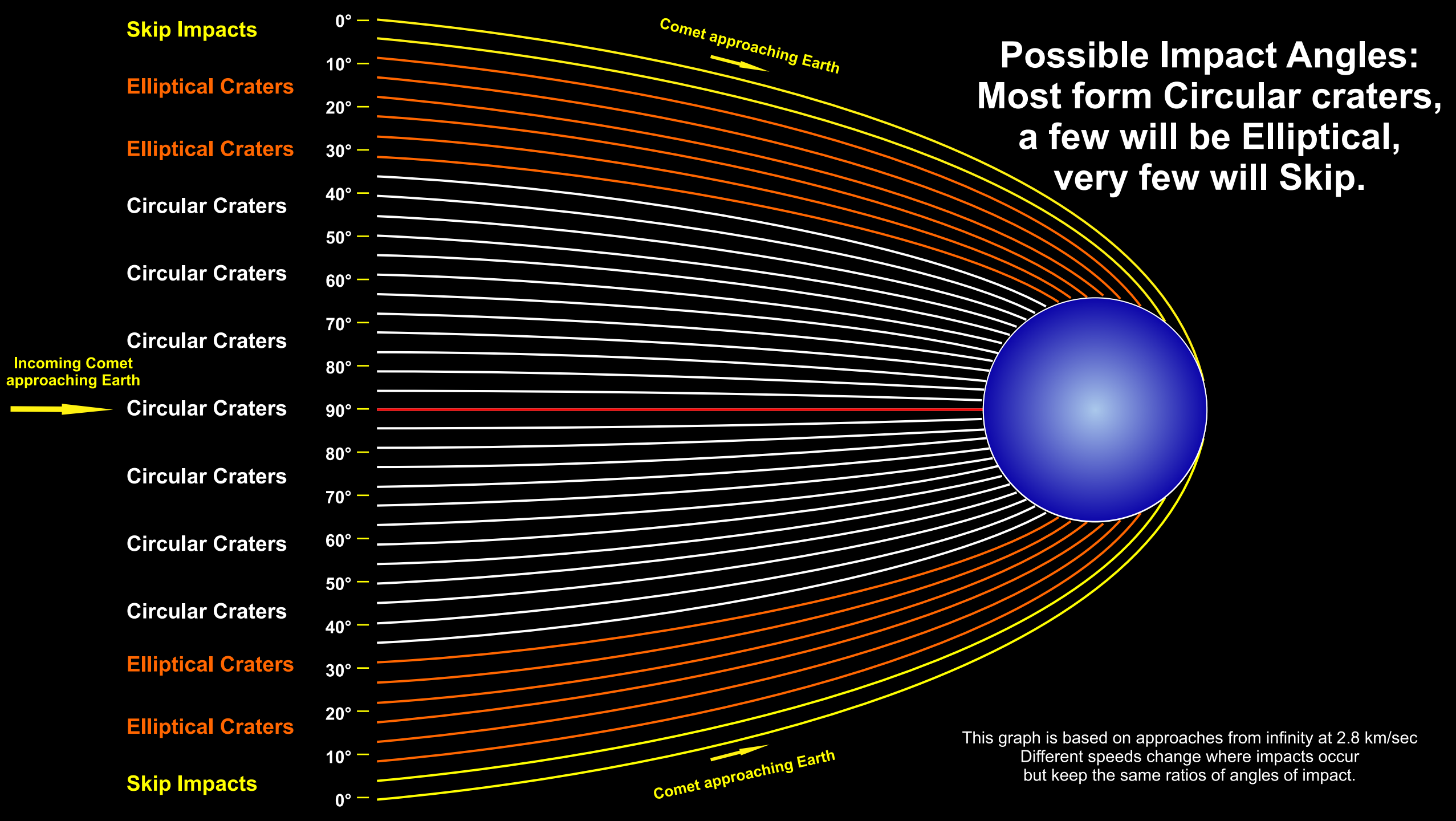



Such as Pingualuit Crater, Quebec

Possible Impact Angles



This graph is based on approaches from infinity at 2.8 km/sec
Different speeds change where impacts occur
but keep the same ratios of angles of impact.


Skip Impacts
Elliptical Craters
Elliptical Craters
Circular Craters
Circular Craters
Circular Craters
Incoming Comet approaching Earth
Circular Craters
Circular Craters
Circular Craters
Circular Craters
Elliptical Craters
Elliptical Craters
Skip Impacts
0°
10°
20°
30°
40°
50°
60°
70°
80°
90°
80°
70°
60°
50°
40°
30°
20°
10°
0°
Comet approaching Earth
Comet approaching Earth
Possible Impact Angles:
Most form Circular craters,
a few will be Elliptical,
very few will Skip.
This graph is based on approaches from infinity at 2.8 km/sec
Different speeds change where impacts occur
but keep the same ratios of angles of impact.

The chances of winning LotoMax is 1 in 33,294,800

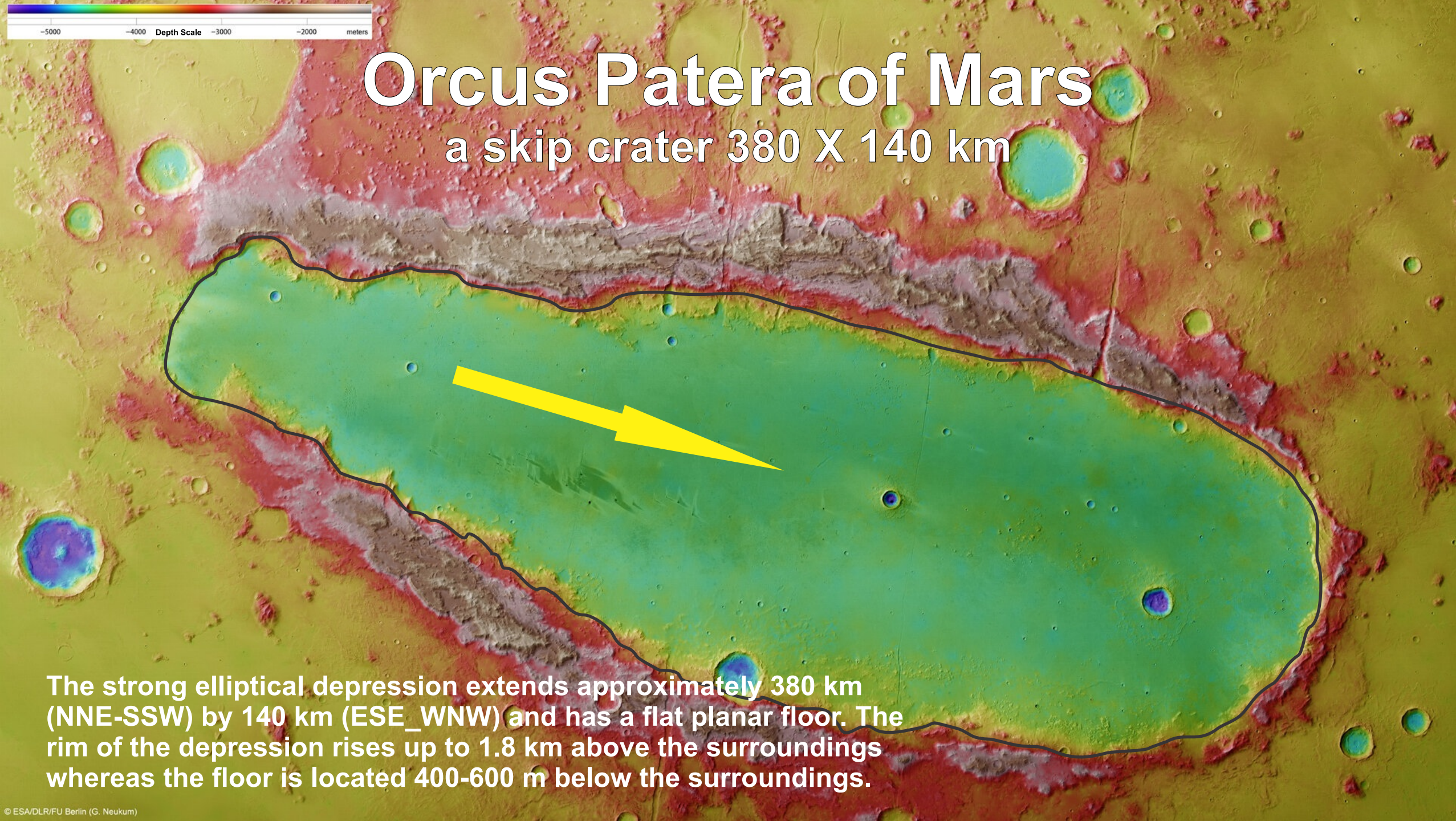
But it is won many times each year.

The chances of winning LotoMax is 1 in 33,294,800

But it is won many times each year.

The probability of a skip impact is ~ 2%
or 1 in 50

Earth should have some skip impact craters.

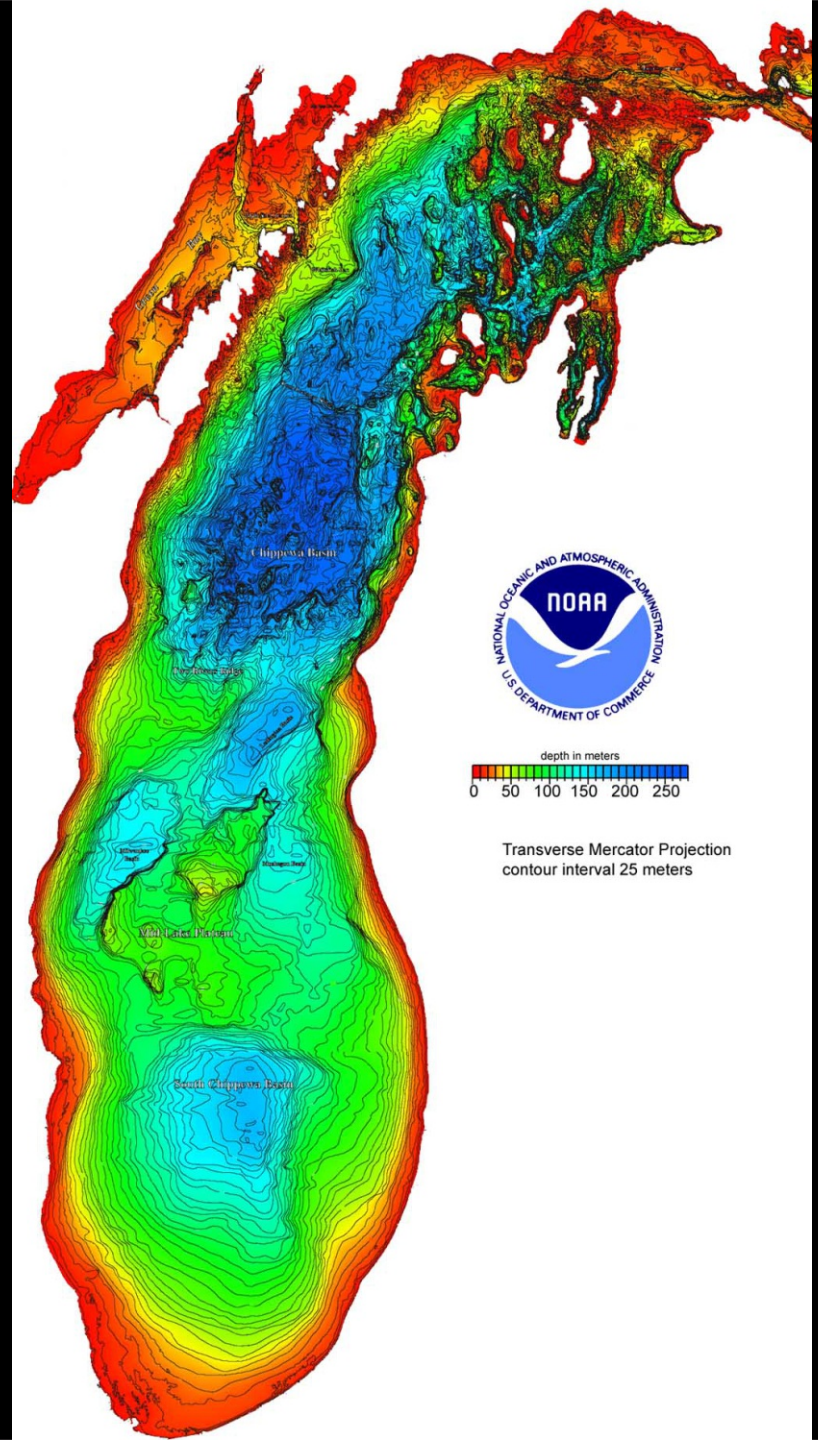


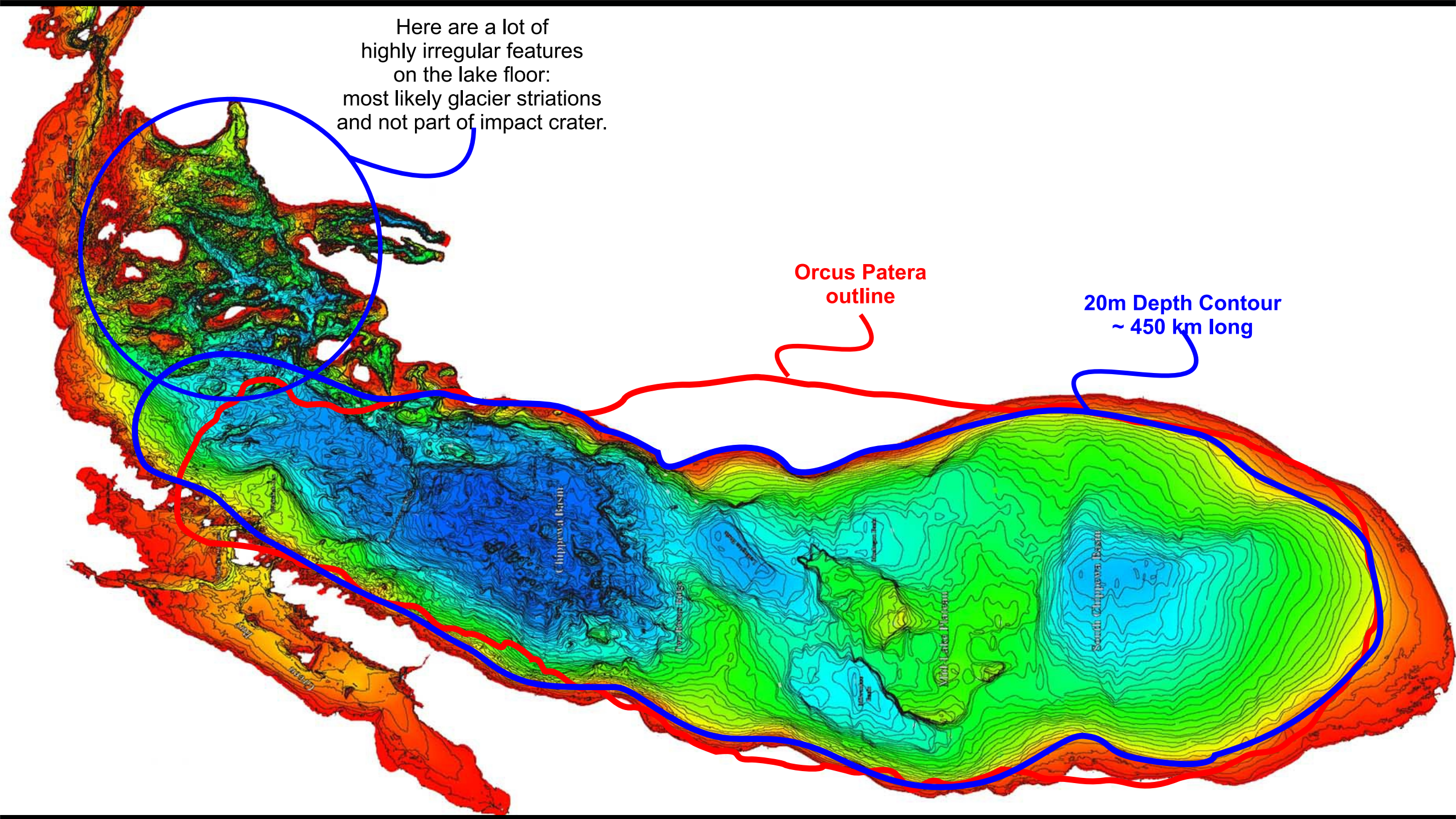
Orcus Patera of Mars

a skip crater 380 X 140 km

The strong elliptical depression extends approximately 380 km (NNE-SSW) by 140 km (ESE_WNW) and has a flat planar floor. The rim of the depression rises up to 1.8 km above the surroundings whereas the floor is located 400-600 m below the surroundings.

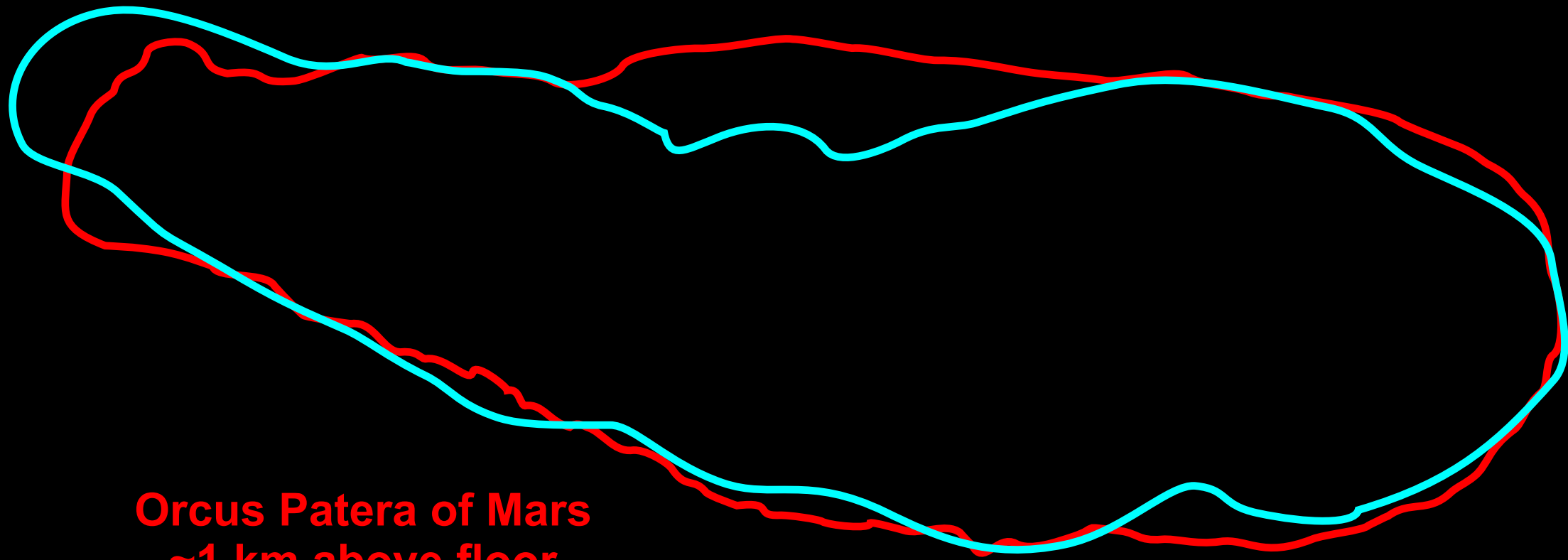
Lake Michigan
490 km long
150 km wide




Here are a lot of
highly irregular features
on the lake floor:
most likely glacier striations
and not part of impact crater.
Orcus Patera
outline
20m Depth Contour
~ 450 km long
Chippewa Basin
Two Rivers Ridge
Mid-Lake Plateau
South Chippewa Basin

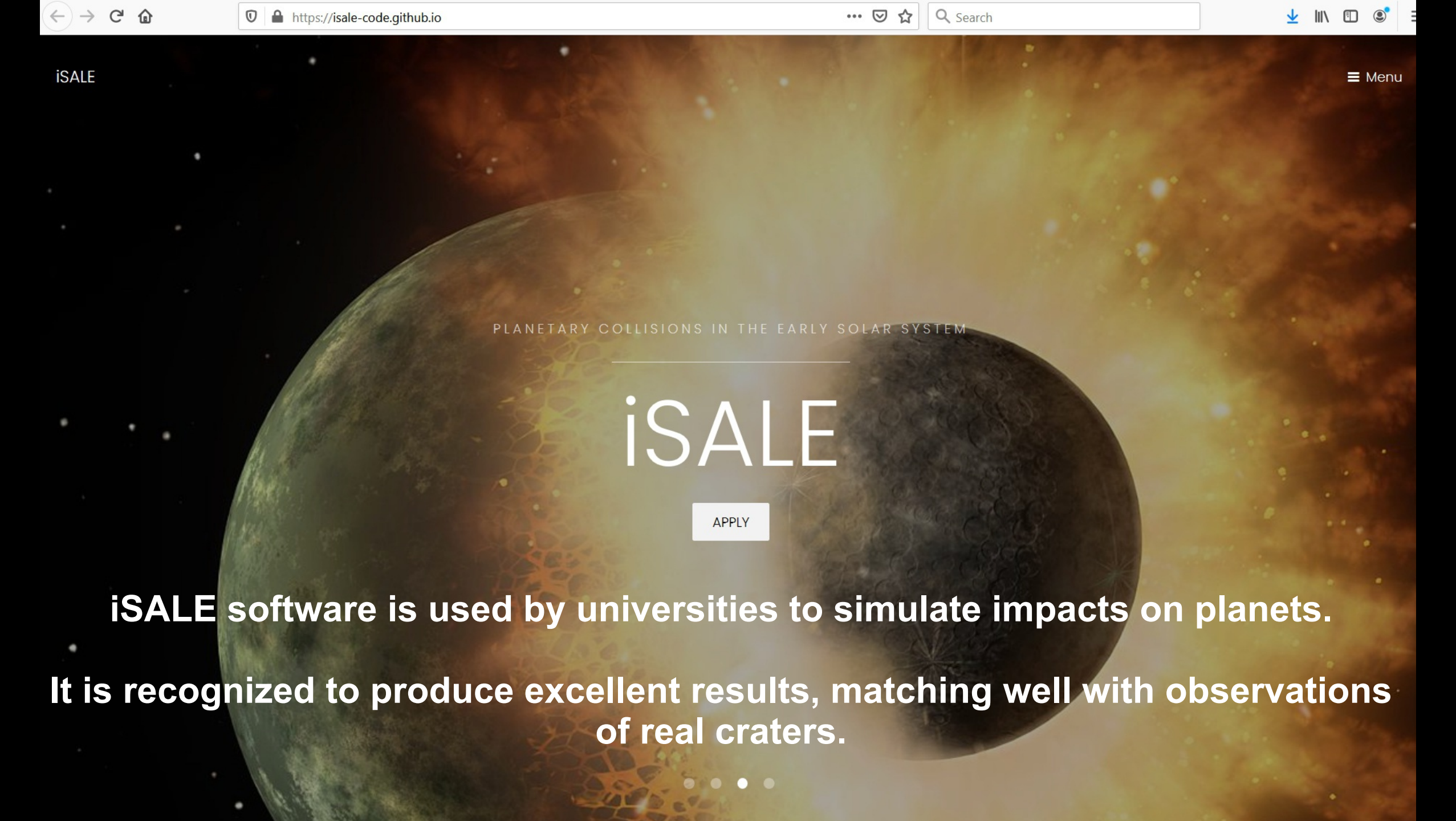
Lake Michigan and Orcus Patera match very well
It is proposed that Lake Michigan is a skip impact crater

Lake Michigan 20m depth contour
450:150km = 3:1 ratio of length to width

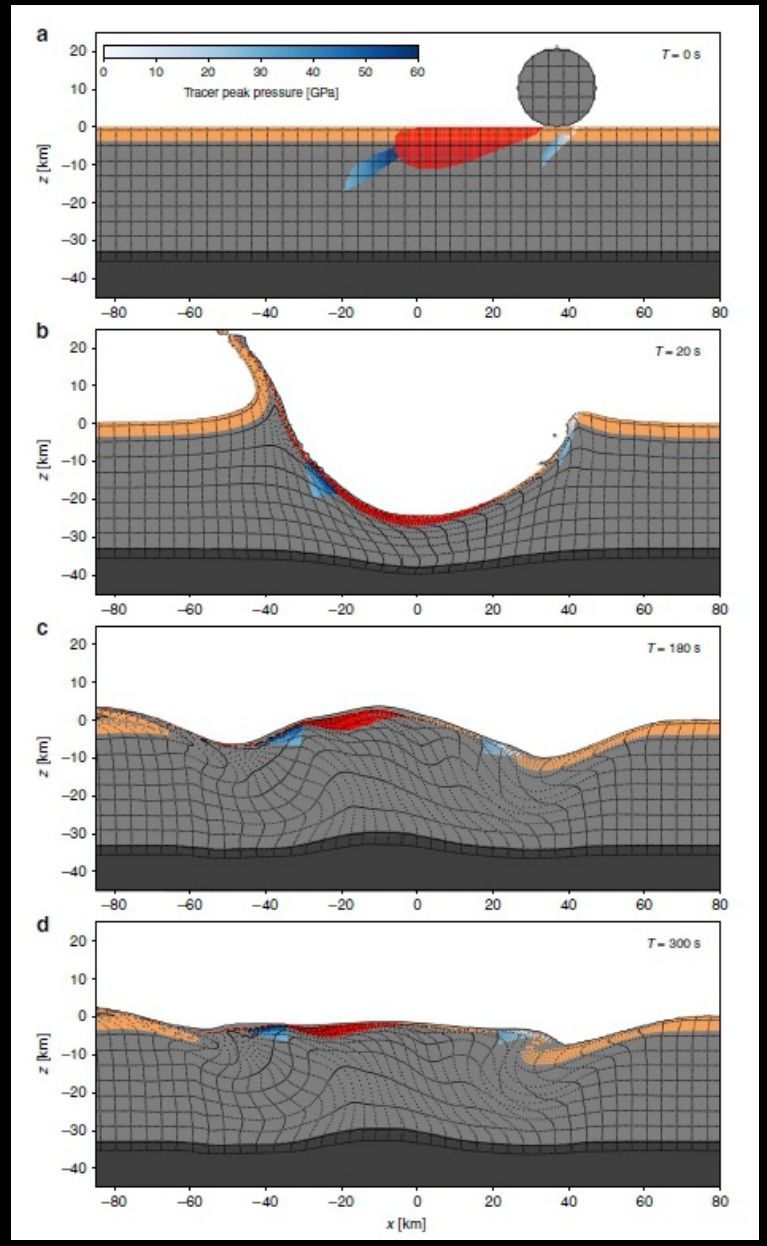


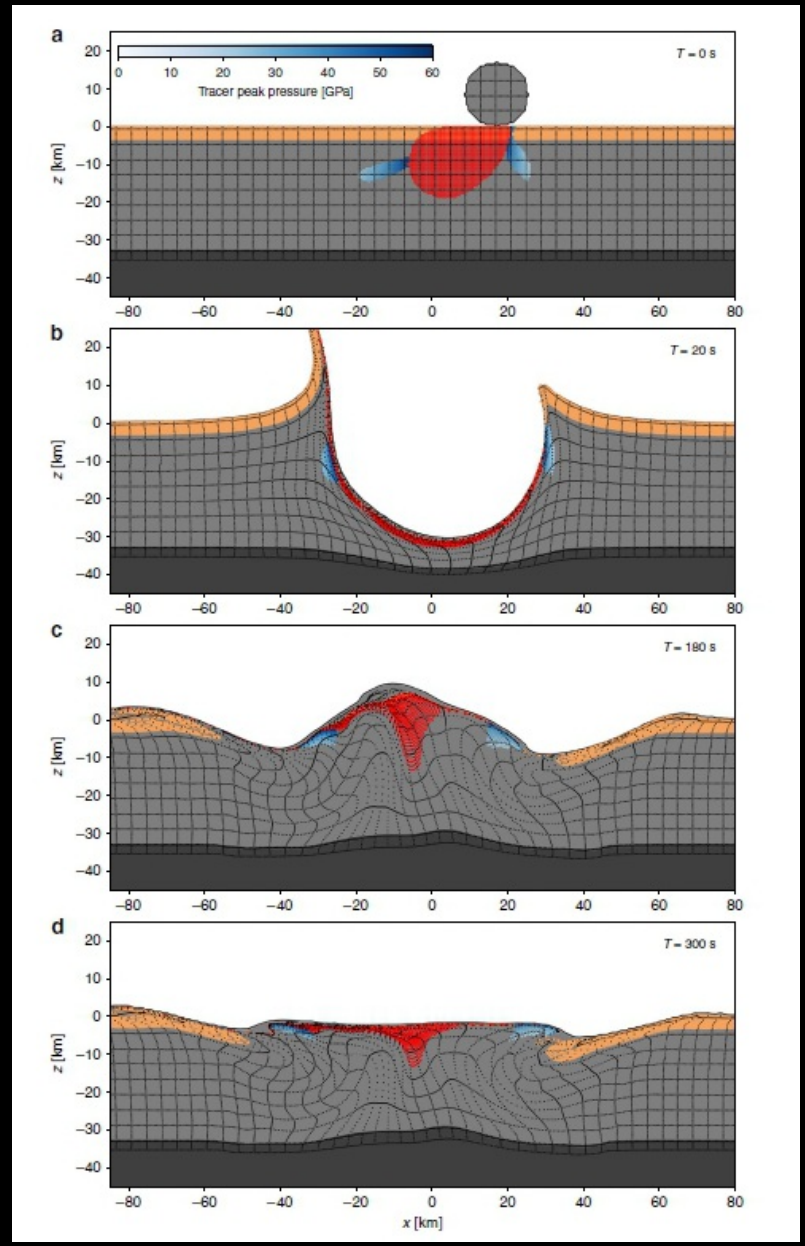
Orcus Patera of Mars
~1 km above floor
380:130km = 3:1 ratio of length to width

Are Skip type events possible?

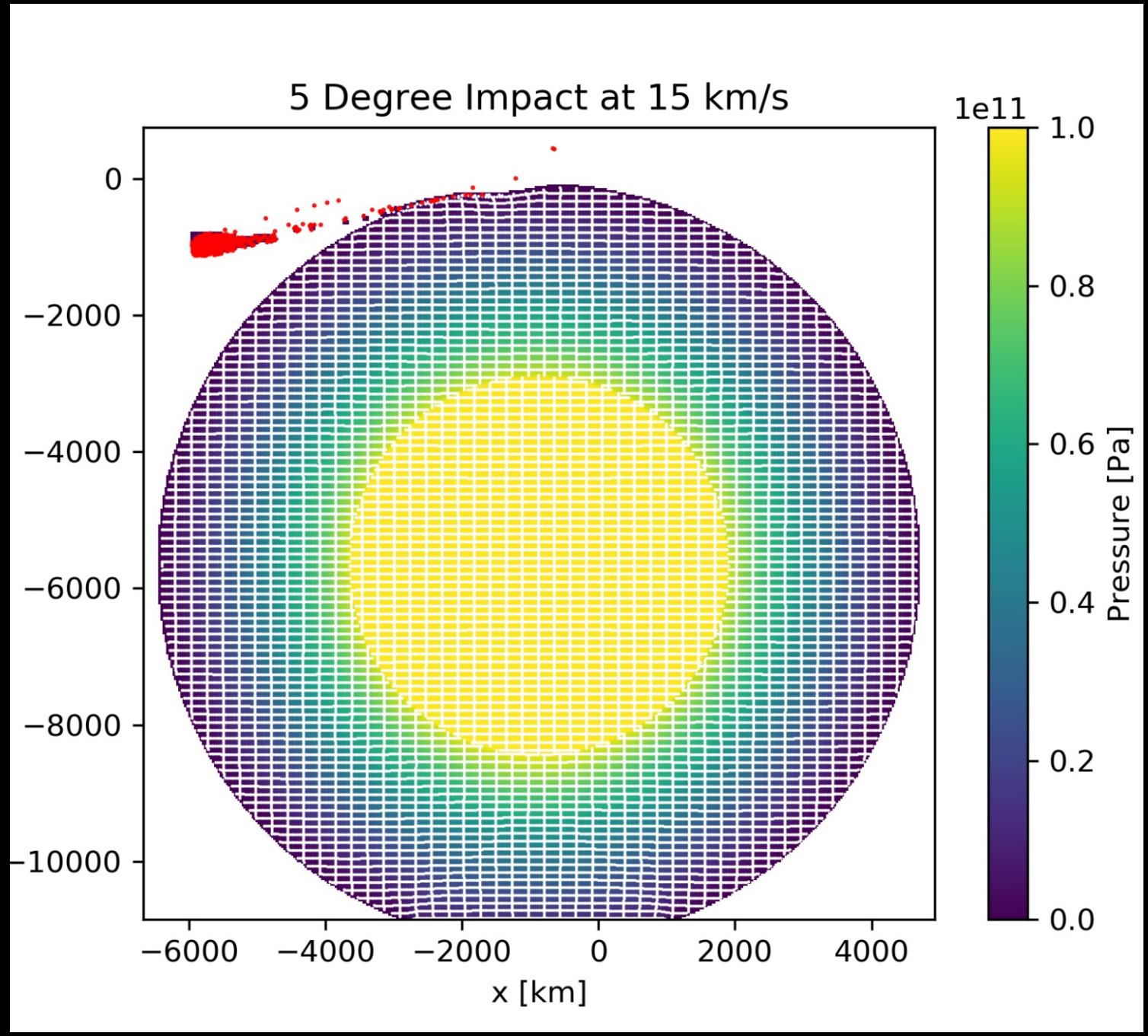

https://isale-code.github.io
Search
iSALE
Menu
PLANETARY COLLISIONS IN THE EARLY SOLAR SYSTEM
iSALE
APPLY
iSALE software is used by universities to simulate impacts on planets.
It is recognized to produce excellent results, matching well with observations of real craters.

Examples of iSALE simulations of the Chicxulub Impact: Development of the Chicxulub crater for 30 and 60 degree impacts.





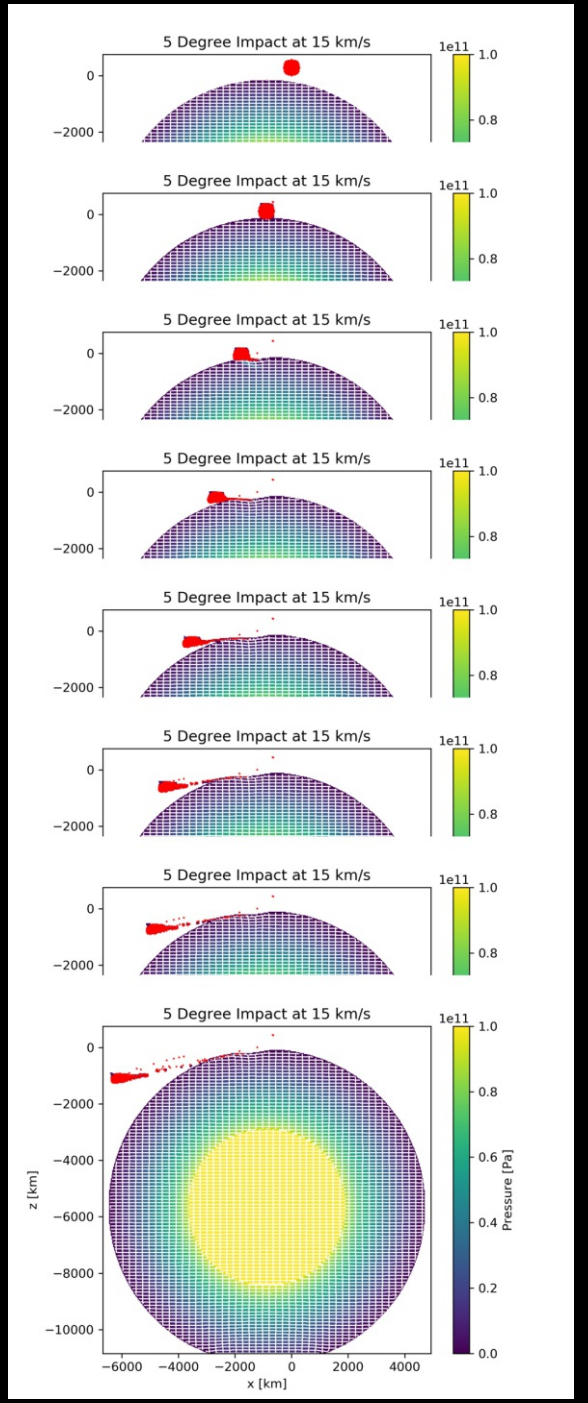
Here is an iSALE simulation of a skip impact on Earth.



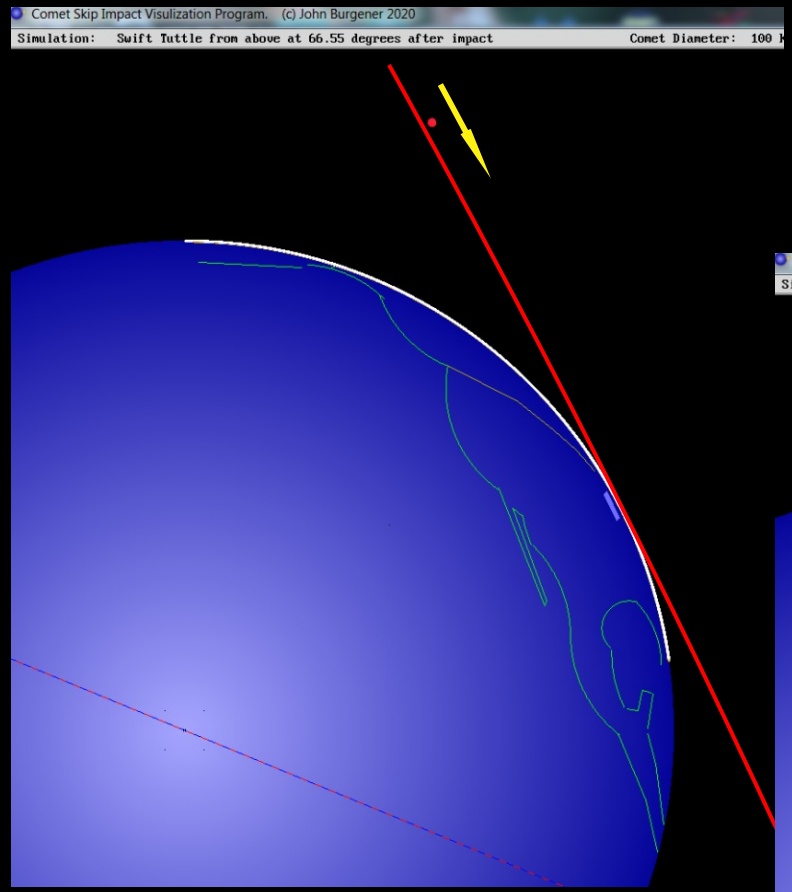
Here is an iSALE simulation
of a skip impact on Earth.

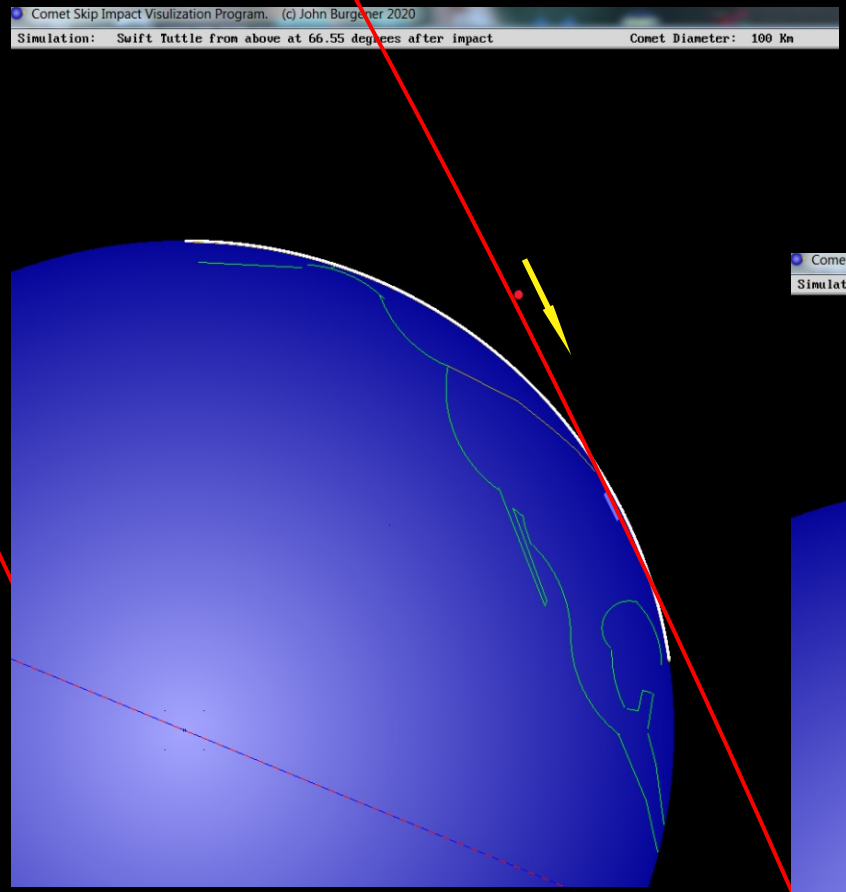
The iSALE simulation shows that a comet
CAN hit Earth and continue on its orbit.

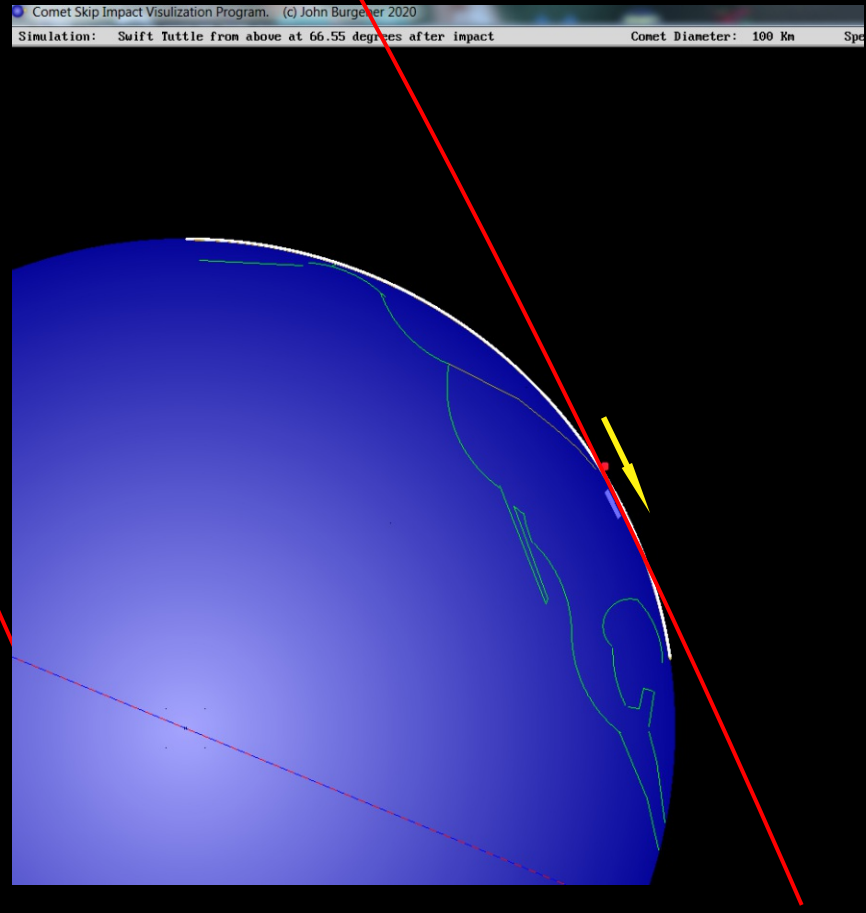
Part continues on orbit,
Part is shattered and tossed back into space as debris,
mixed with a lot of debris from Earth.



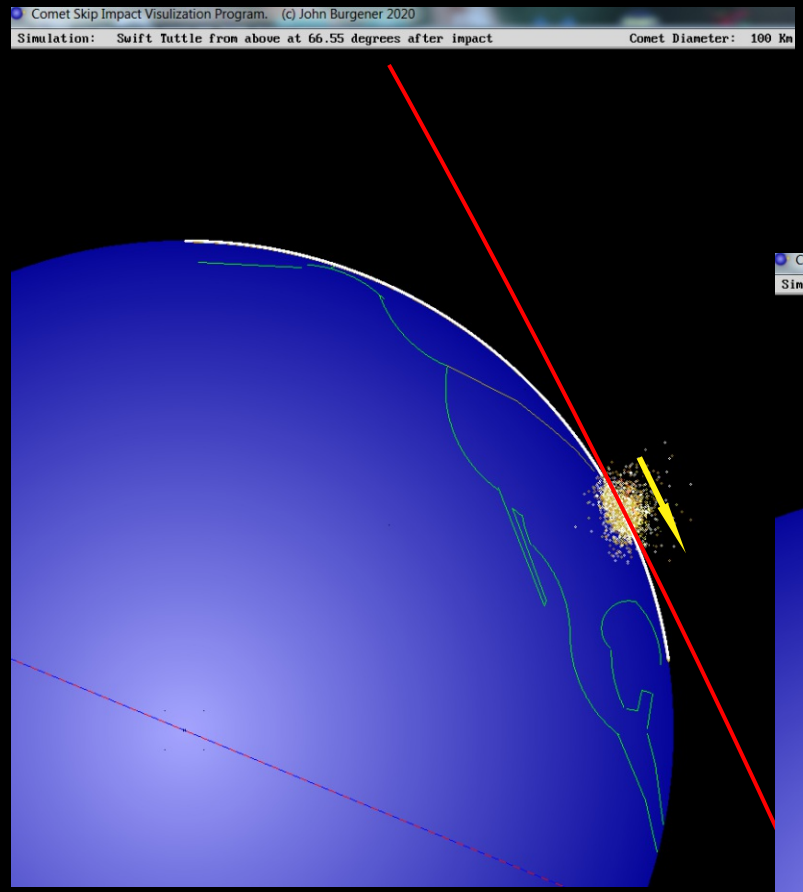
High resolution simulation of a comet skip impact

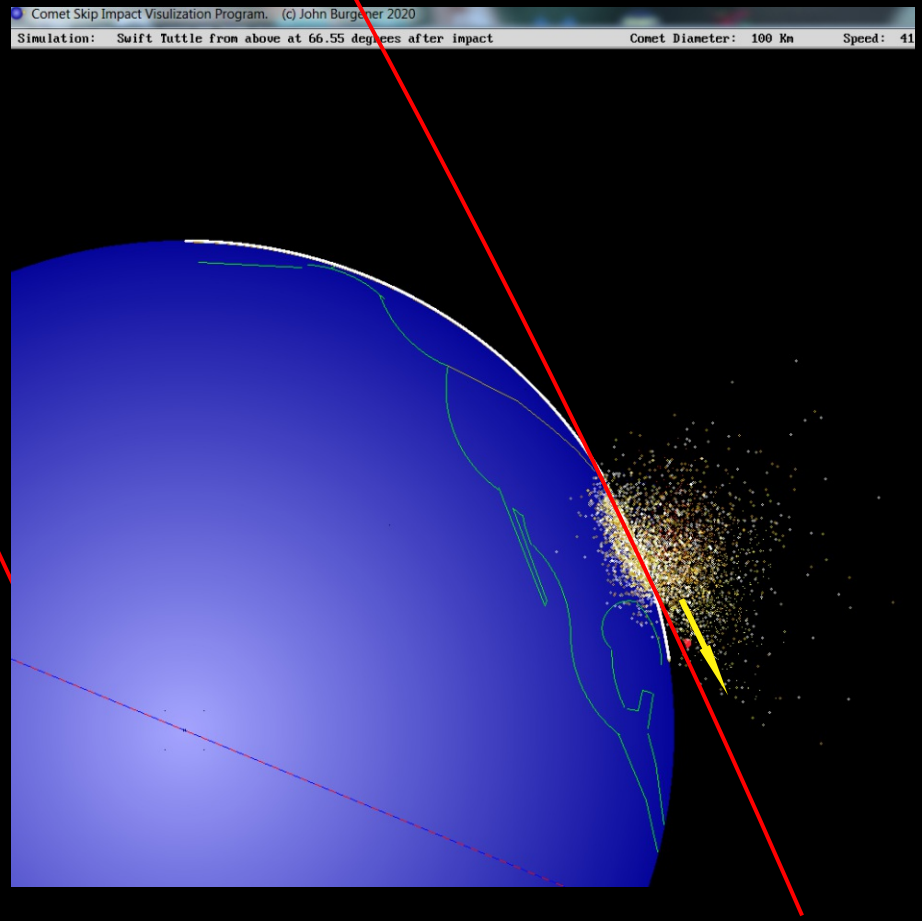


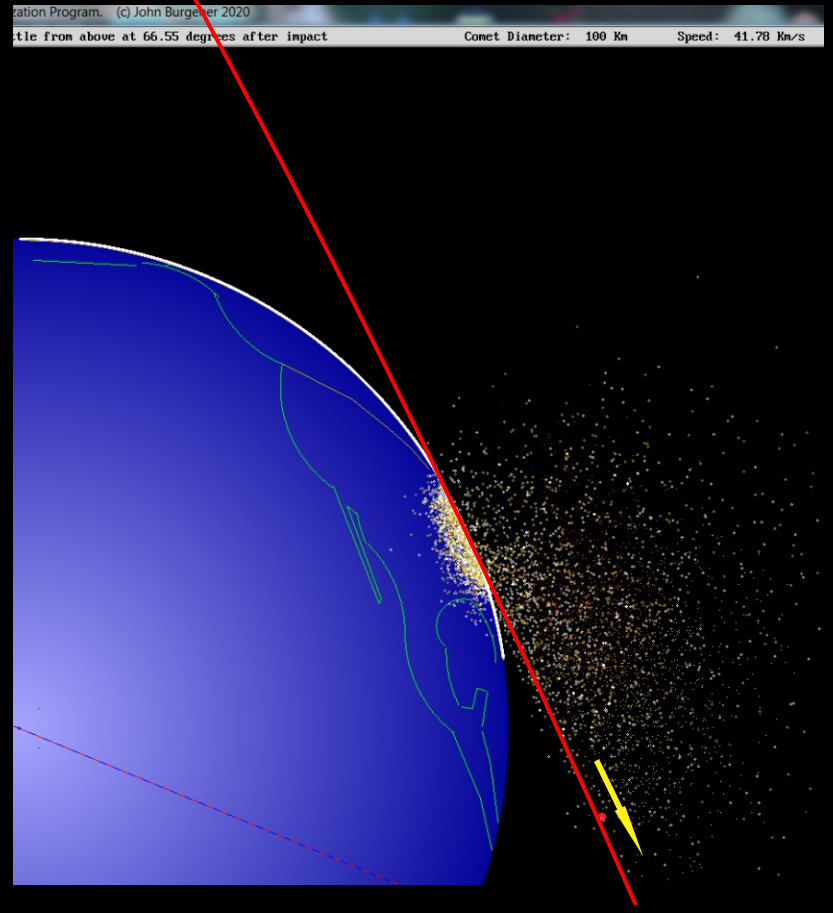




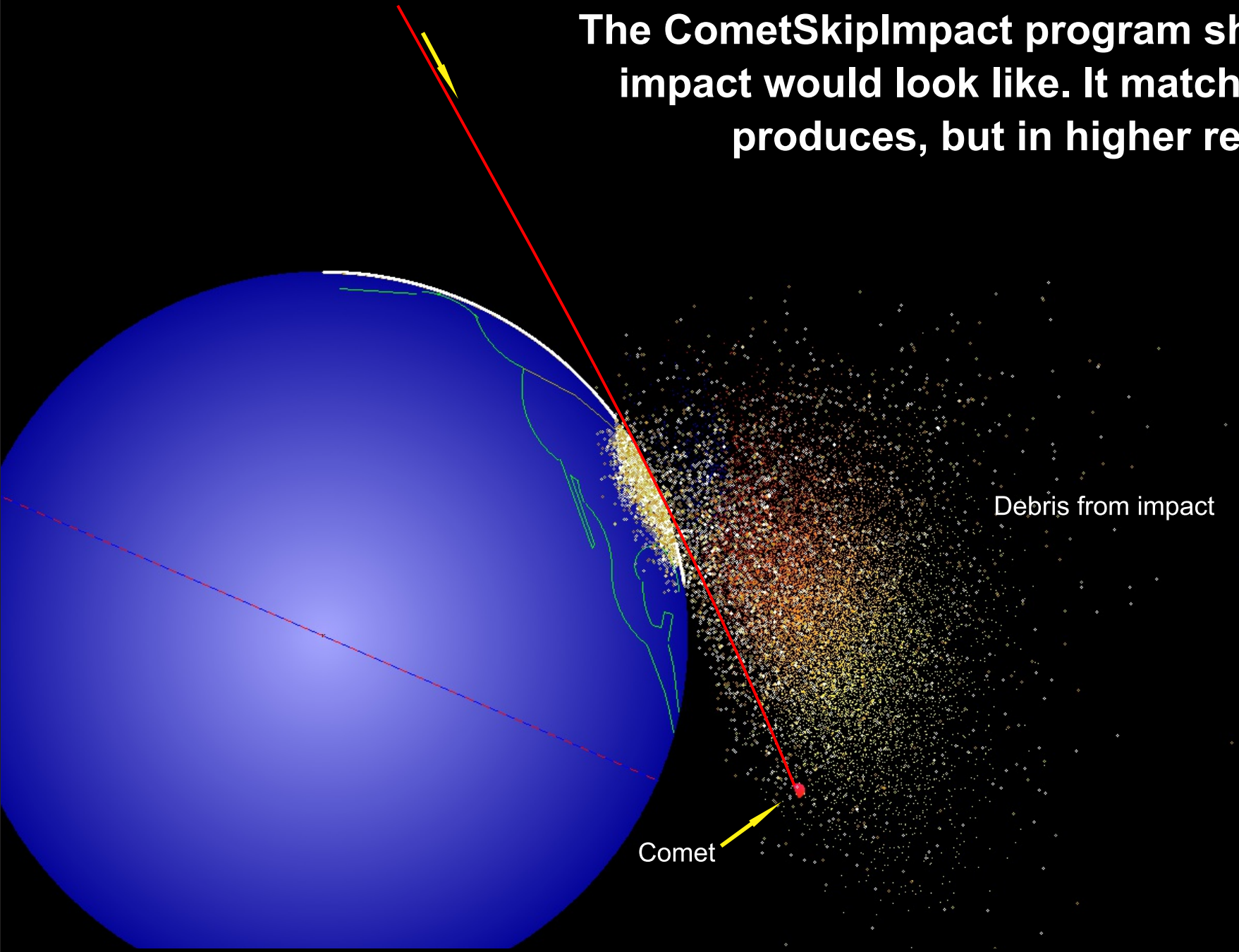
High resolution simulation of a comet skip impact



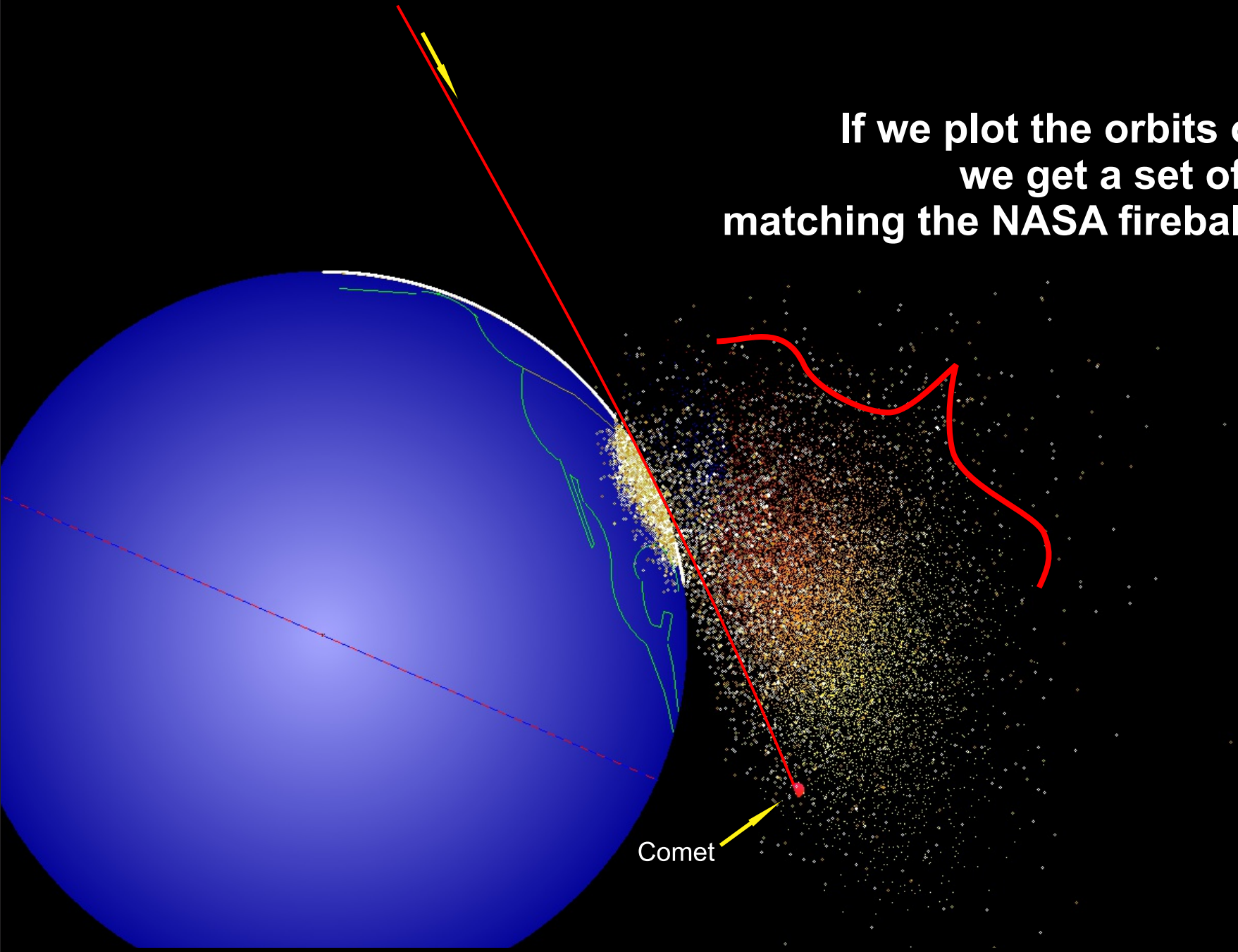




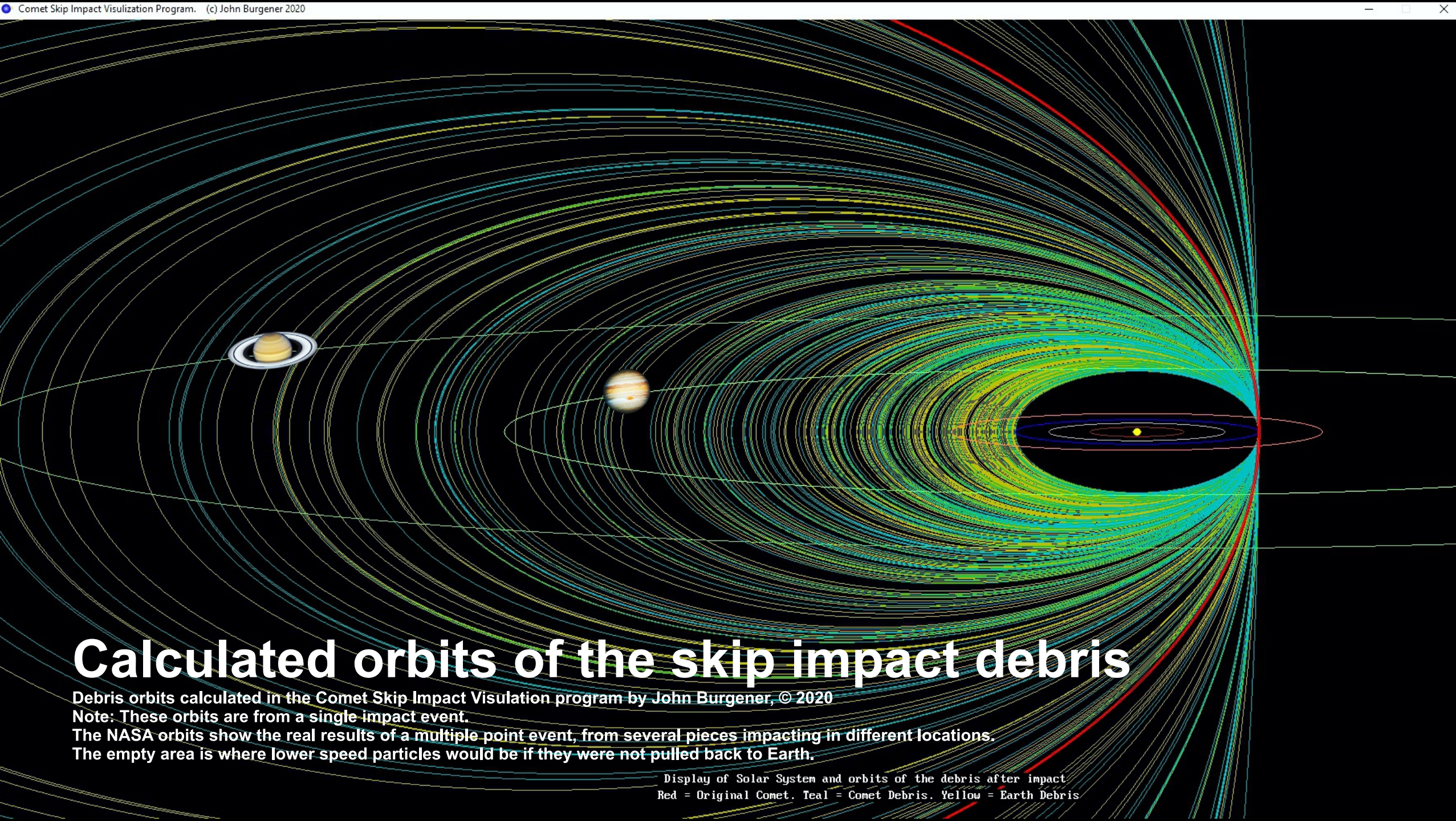
The CometSkipImpact program shows what a skip impact would look like. It matches what iSALE produces, but in higher resolution.



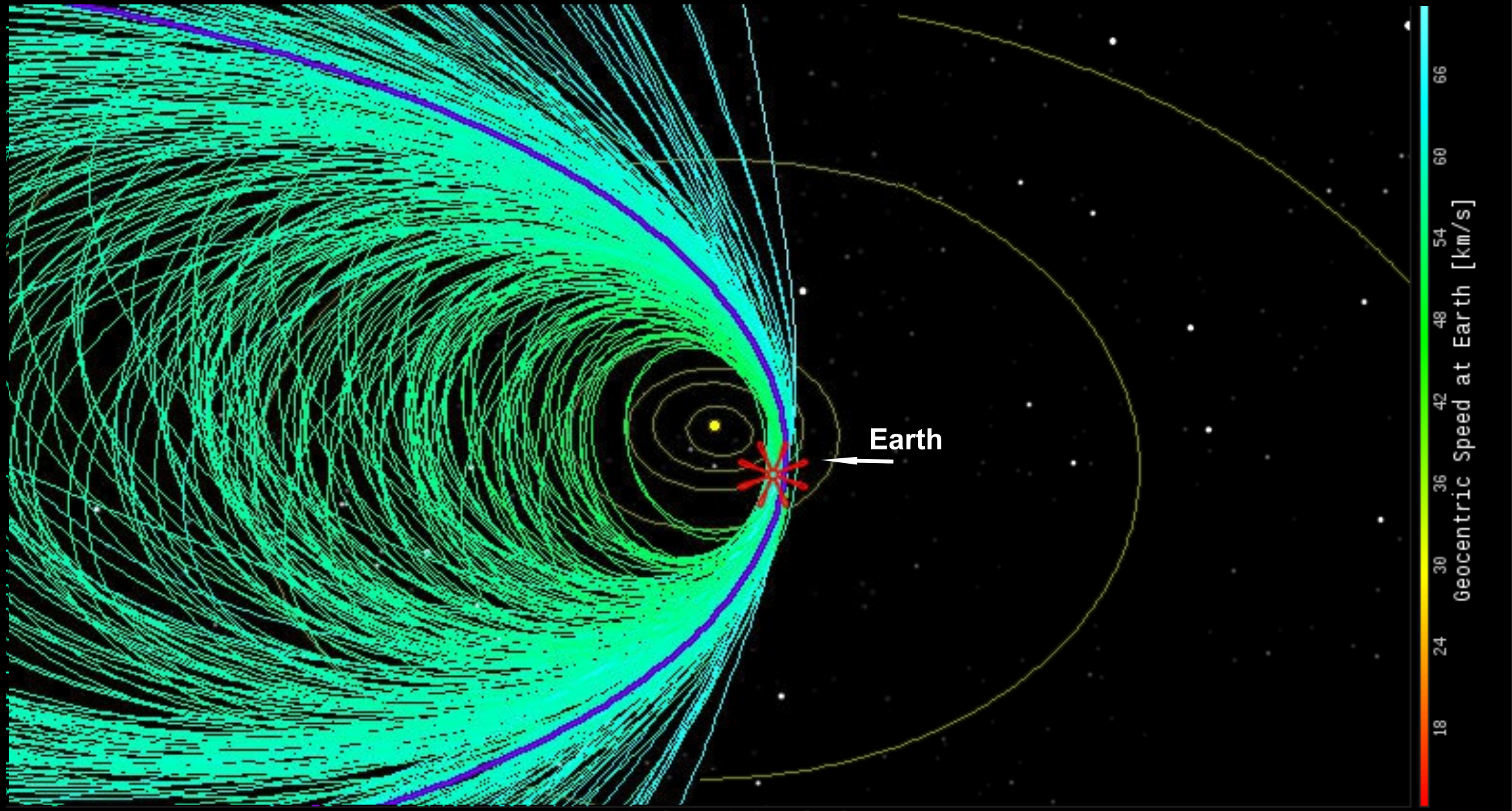
If we plot the orbits of the debris,
we get a set of orbits
matching the NASA fireball orbit distribution.



Debris colors:
Blue < Earth escape velocity
Red is above escape velocity
Yellow is way above escape velocity.


Comet Skip Impact Visulization Program. (c) John Burgener 2020
Calculated orbits of the skip impact debris
Debris orbits calculated in the Comet Skip Impact Visulation program by John Burgener, © 2020
Note: These orbits are from a single impact event.
The NASA orbits show the real results of a multiple point event, from several pieces impacting in different locations.
The empty area is where lower speed particles would be if they were not pulled back to Earth.
Display of Solar System and orbits of the debris after impact
Red = Original Comet. Teal = Comet Debris. Yellow = Earth Debris

It's the same pattern as the chart of 300 orbits of fireballs associated with comet Swift-Tuttle:

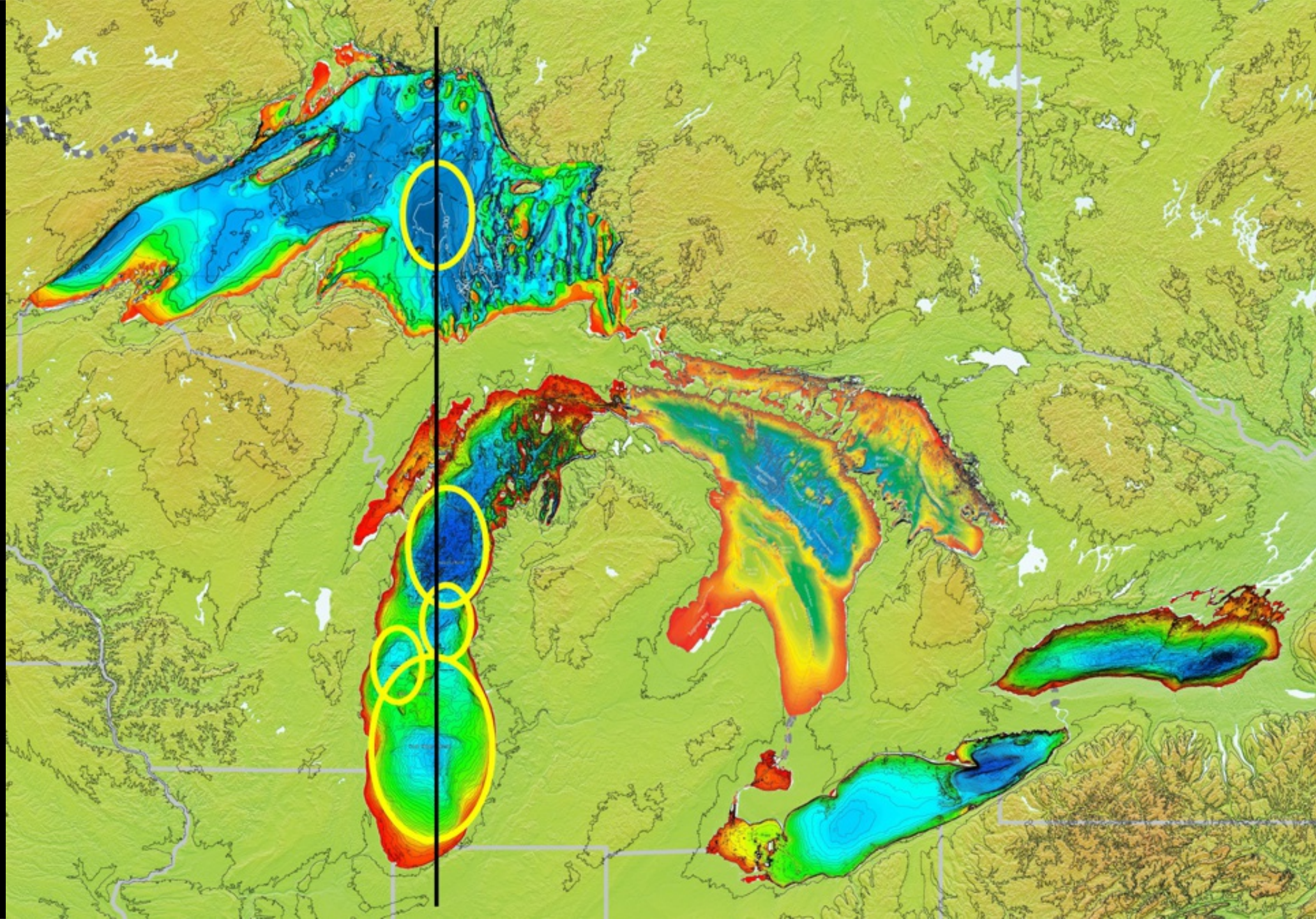


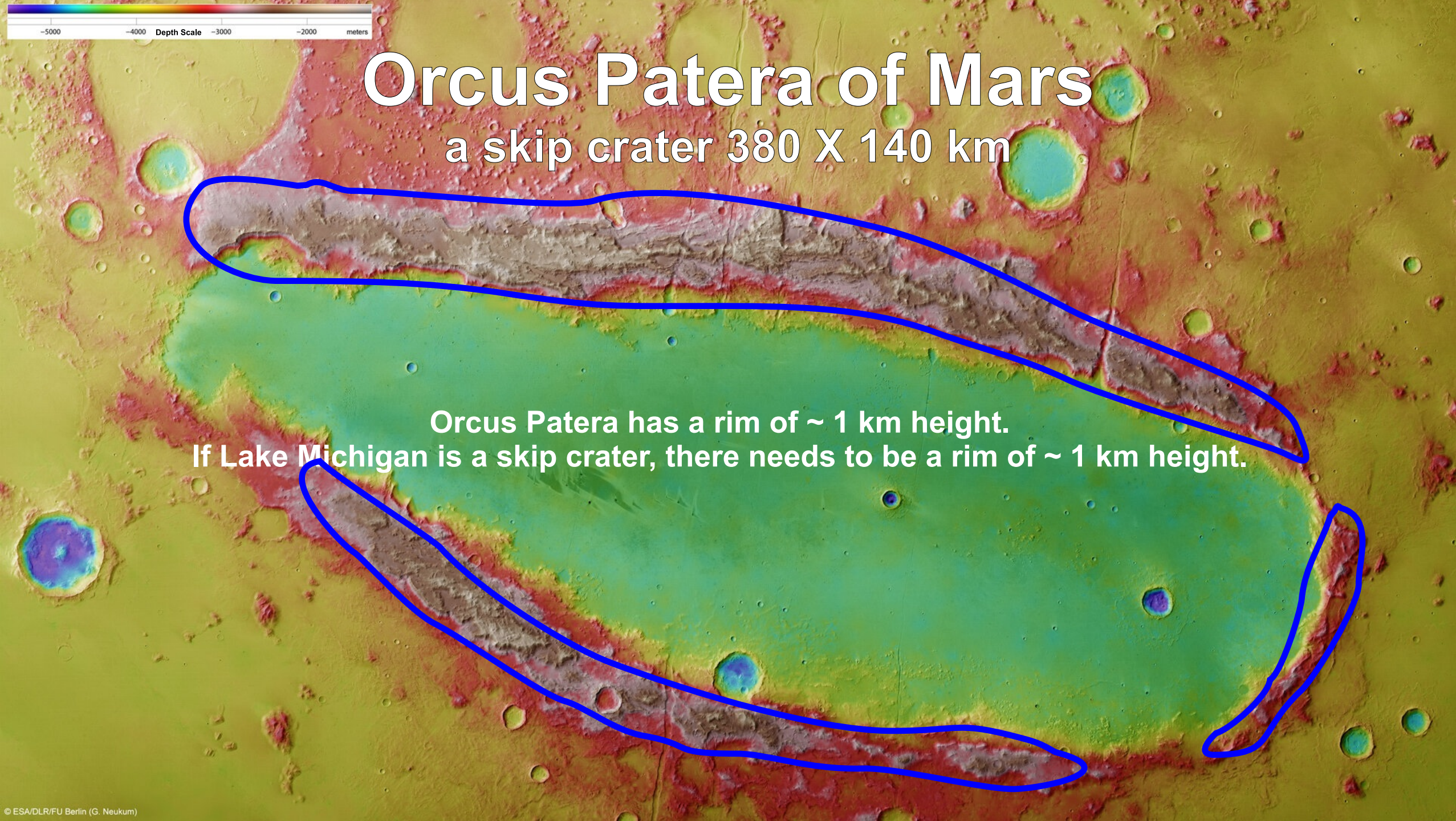
Orbits of 300 Fireballs associated with the Perseids, Aug 12, 2012

Does the proposed impact fit other evidence?
Does it explain anything presently in question?

A body approaching a planet will tend to break up into pieces. A skip impact would be expected to involve more than one piece.

Lake Michigan and a portion of Lake Superior have elliptical depressions that line up as would be expected from a object splitting apart as it approached the impact point.




−5000
−4000
Depth Scale
−3000
−2000
meters
Orcus Patera of Mars
a skip crater 380 X 140 km
Orcus Patera has a rim of ~ 1 km height.
If Lake Michigan is a skip crater, there needs to be a rim of ~ 1 km height.
© ESA/DLR/FU Berlin (G. Neukum)

It is proposed that the skip impact event occurred
at the end of the ice age, approximately 12,700 years ago.

The comet would have impacted onto a layer of 2 to 3 km of ice.
The crater “wall” would have mainly been ICE
and went away as the ice melted.

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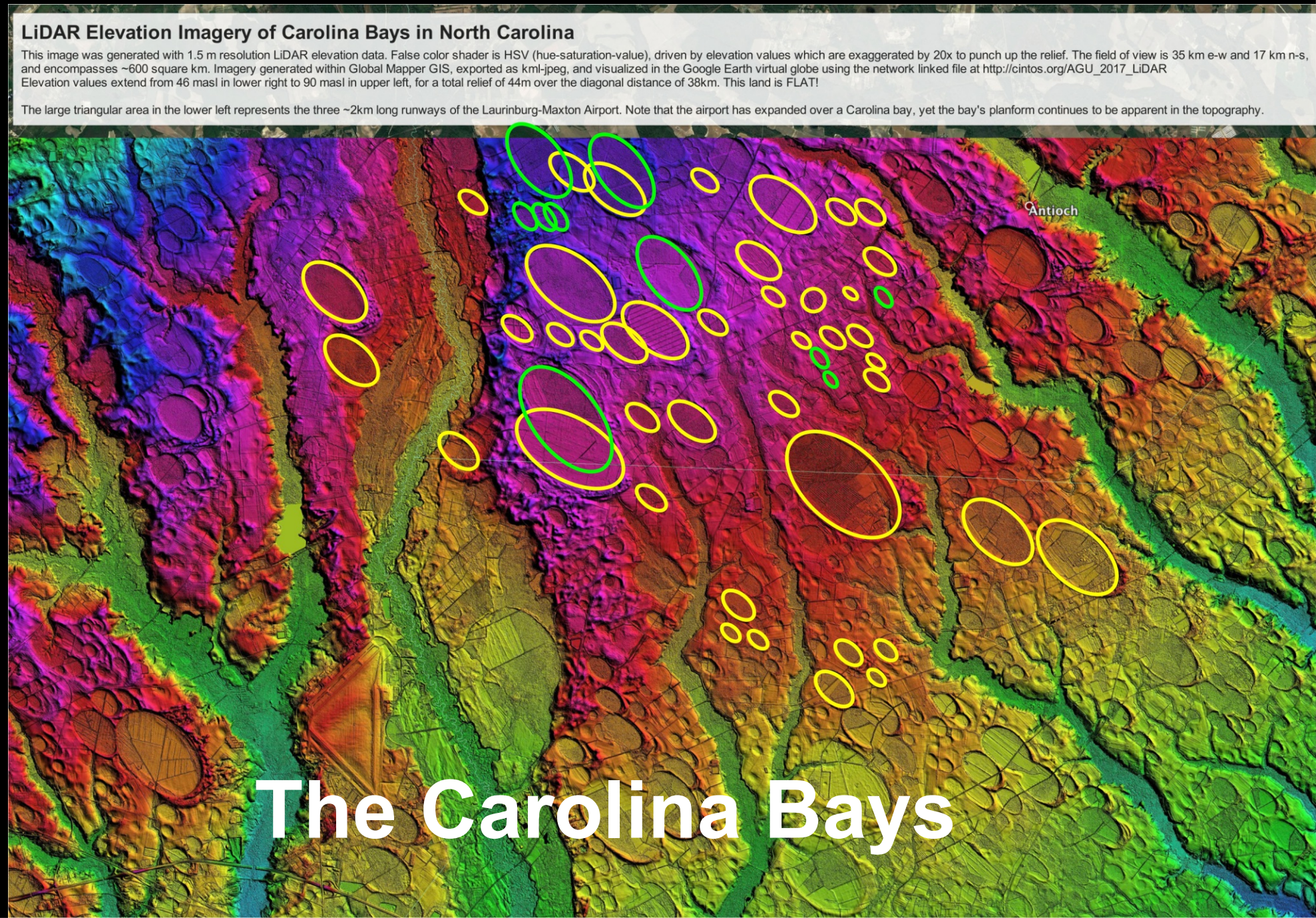
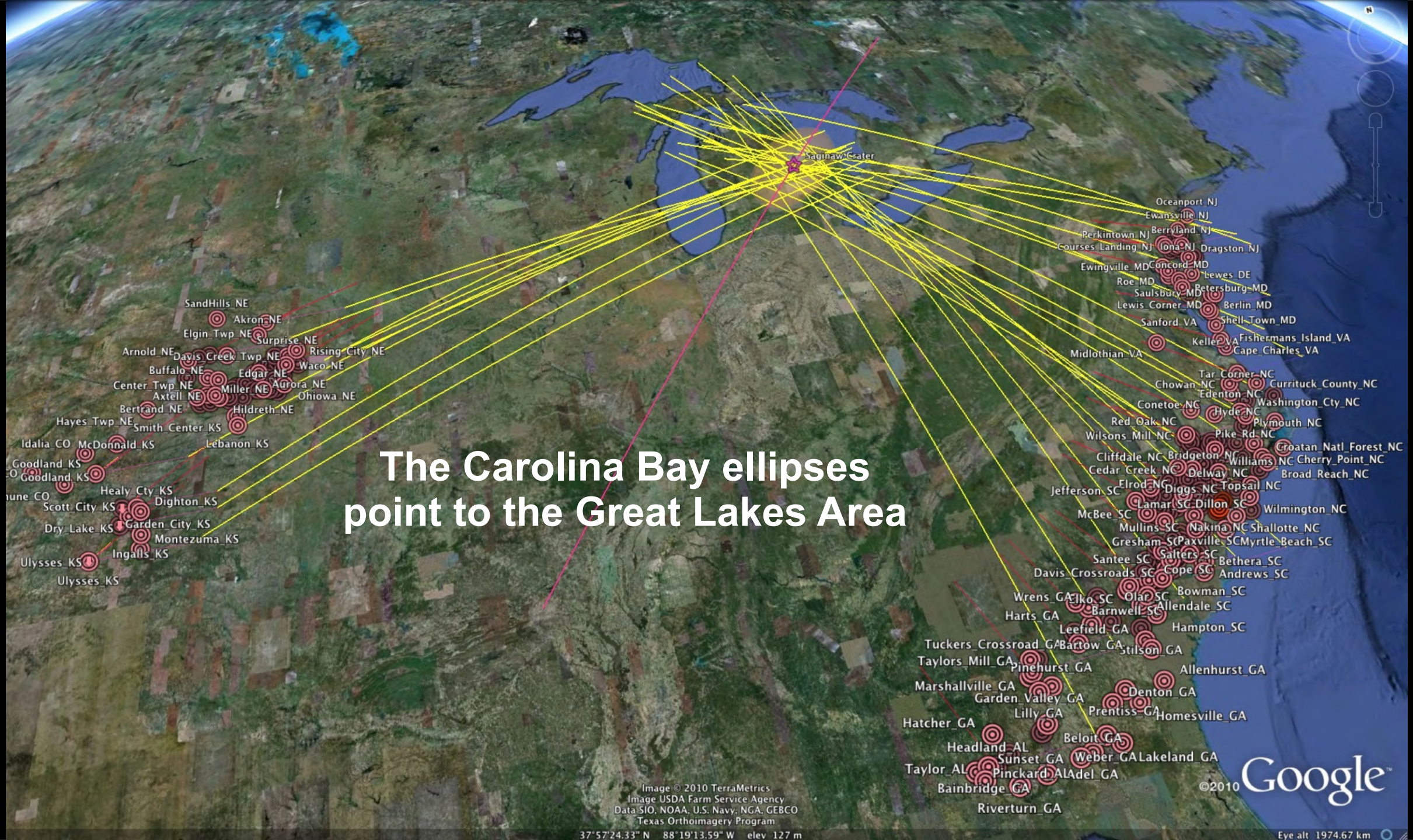
Is there any evidence of a lot of debris landing down range from Lake Michigan?

North America has hundreds of thousands of elliptical depressions along the East coast, and in the southwest. They are called Carolina Bays.

While there is some debate on the origins, most people favor the theory that they are impacts from low speed, small objects, all formed at the same time. Ice is generally considered the main likely impacting material since there is no remaining meteoritic material.




Saginaw Crater
The Carolina Bay ellipses
point to the Great Lakes Area
SandHills_NE
Akron_NE
Elgin Twp_NE
Surprise_NE
Arnold_NE
Davis Creek Twp_NE
Rising City_NE
Waco_NE
Buffalo_NE
Edgar_NE
Center Twp_NE
Miller_NE
Aurora_NE
Axtell_NE
Ohiowa_NE
Bertrand_NE
Hildreth_NE
Hayes Twp_NE
Smith Center_KS
Idalia_CO
McDonald_KS
Lebanon_KS
Goodland_KS
Goodland_KS
Healy Cty_KS
Dighton_KS
Scott City_KS
Garden City_KS
Dry Lake_KS
Montezuma_KS
Ingalls_KS
Ulysses_KS
Ulysses_KS
Oceanport_NJ
Ewansville_NJ
Berryland_NJ
Perkintown_NJ
Courses Landing_NJ
Iona_NJ
Dragston_NJ
Ewingville_MD
Concord_MD
Lewes_DE
Roe_MD
Petersburg_MD
Saulsbury_MD
Lewis Corner_MD
Berlin_MD
Sanford_VA
Shell Town_MD
Keller_VA
Fishermans Island_VA
Midlothian_VA
Cape Charles_VA
Tar Corner_NC
Chowan_NC
Currituck County_NC
Edenton_NC
Washington Cty_NC
Conetoe_NC
Hyde_NC
Red Oak_NC
Plymouth_NC
Wilsons Mill_NC
Pike Rd_NC
Croatan Natl Forest_NC
Cliffdale_NC
Bridgeton_NC
Williams_NC
Cherry Point_NC
Cedar Creek_NC
Delway_NC
Broad Reach_NC
Elrod_NC
Diggs_NC
Topsail_NC
Jefferson_SC
Lamar_SC
Dillon_SC
Wilmington_NC
McBee_SC
Mullins_SC
Nakina_NC
Shallotte_NC
Gresham_SC
Paxville_SC
Myrtle Beach_SC
Salters_SC
Santee_SC
Bethera_SC
Davis Crossroads_SC
Cope_SC
Andrews_SC
Wrens_GA
Elko_SC
Olar_SC
Bowman_SC
Barnwell_SC
Allendale_SC
Harts_GA
Leefield_GA
Hampton_SC
Tuckers Crossroad_GA
Bartow_GA
Stilson_GA
Taylors Mill_GA
Pinehurst_GA
Allenhurst_GA
Marshallville_GA
Garden Valley_GA
Denton_GA
Lilly_GA
Prentiss_GA
Homesville_GA
Hatcher_GA
Beloit_GA
Headland_AL
Sunset_GA
Weber_GA
Lakeland_GA
Taylor_AL
Pinckard_AL
Adel_GA
Bainbridge_GA
Riverturn_GA
Image © 2010 TerraMetrics
Image USDA Farm Service Agency
Data SIO, NOAA, U.S. Navy, NGA, GEBCO
Texas Orthoimagery Program
37°57'24.33" N 88°19'13.59" W elev 127 m
©2010 Google
Eye alt 1974.67 km

Low angle impacts forming Lake Michigan and hitting Lake Superior would account for almost all Carolina Bays

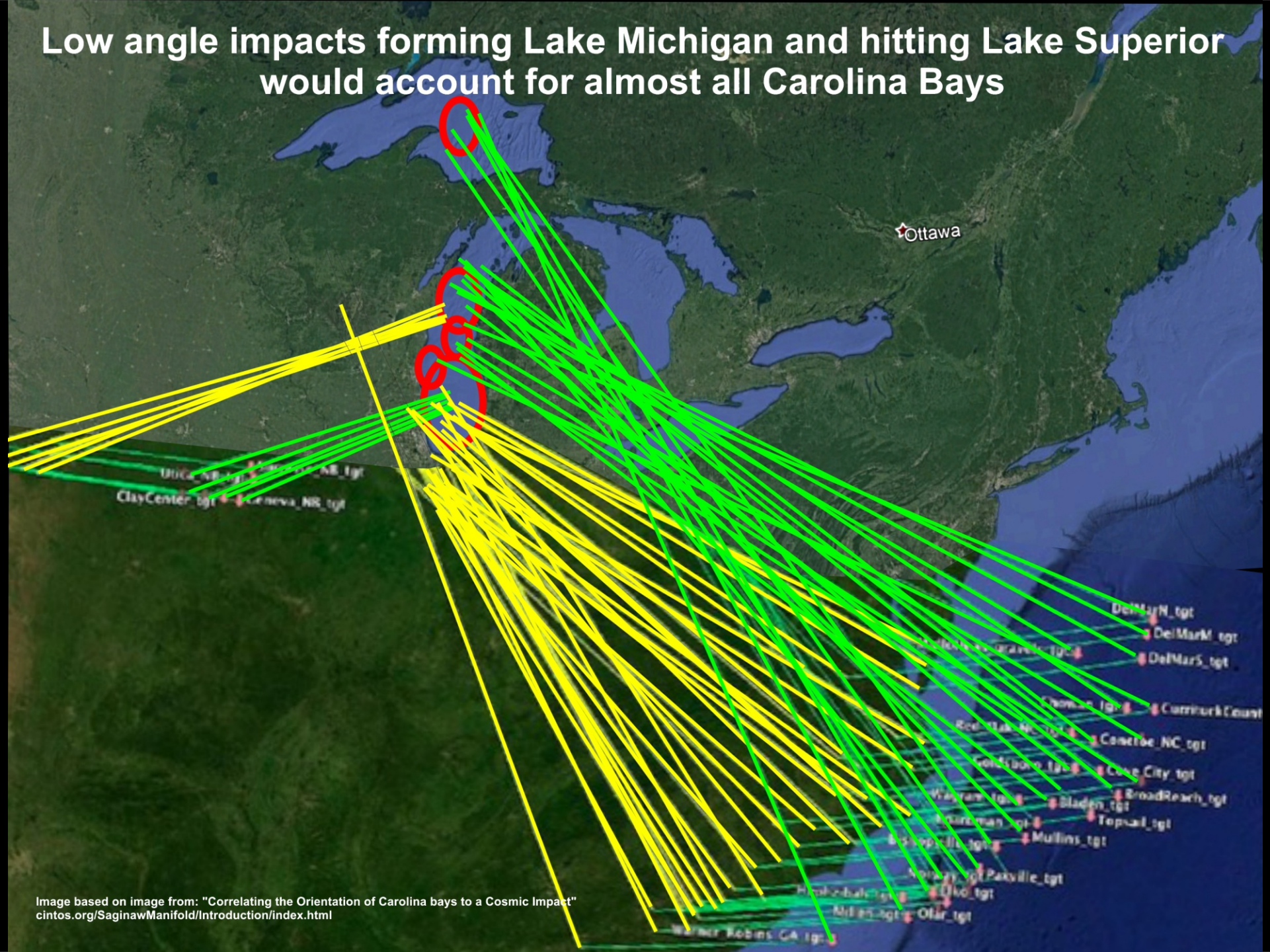


Image based on image from: "Correlating the Orientation of Carolina bays to a Cosmic Impact"
cintos.org/SaginawManifold/Introduction/index.html

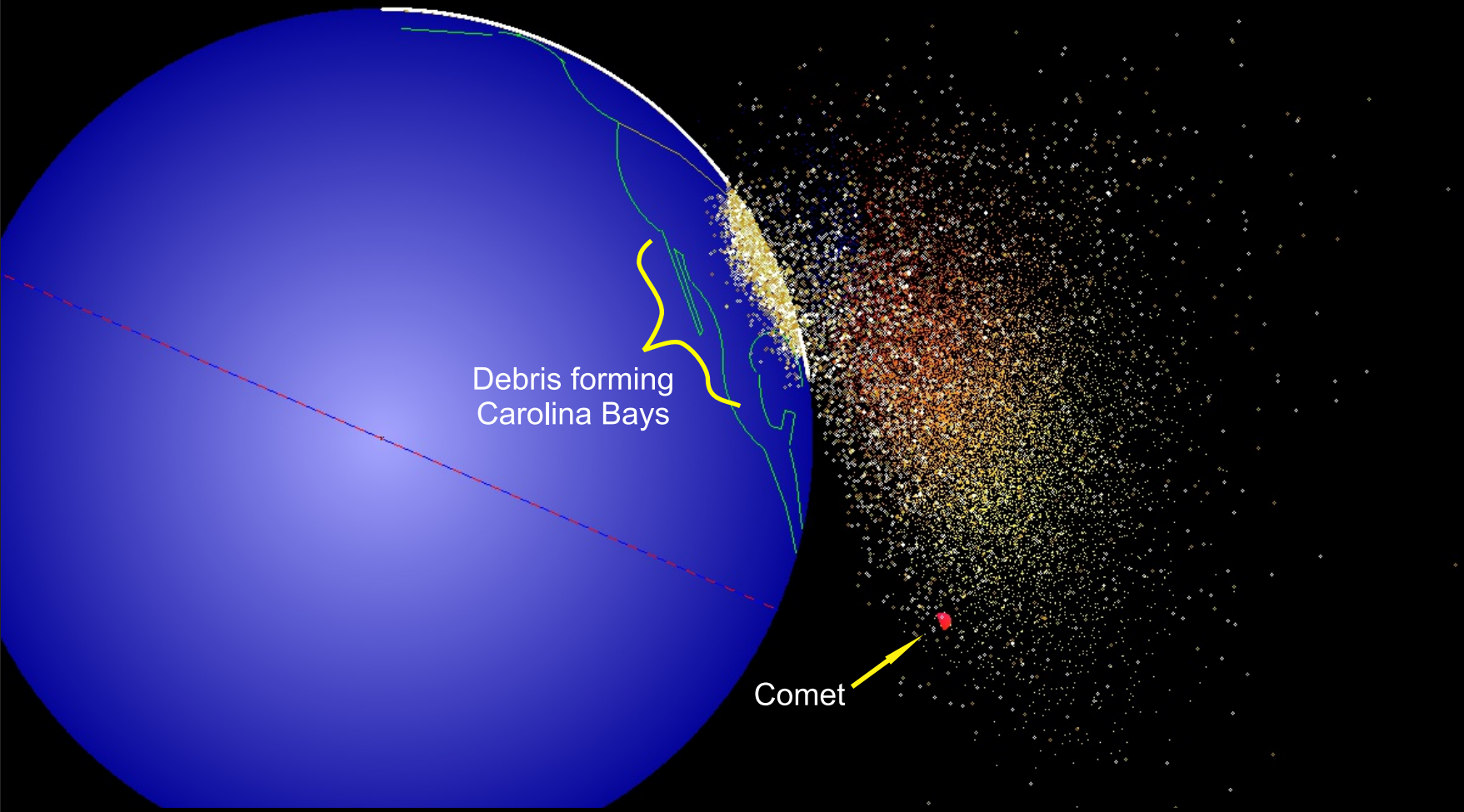
It is proposed that the skip impact event occurred
at the end of the ice age, approximately 12,700 years ago.

The evidence of an impact at the end of the ice age
shows in the Younger Dryas studies.

A skip impact forming Lake Michigan
would identify the crater responsible for the Younger Dryas event.

A skip impact forming Lake Michiagn explains:

1. **The range of orbits of the Fireballs related to the Perseids**
2. **The shape of Lake Michigan**
3. **The Carolina Bays**
4. **The Younger Dryas impact event**



The evidence's best fit is that Comet 109P/Swift–Tuttle impacted Earth in a low angle skip impact about 12,700 years ago.