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

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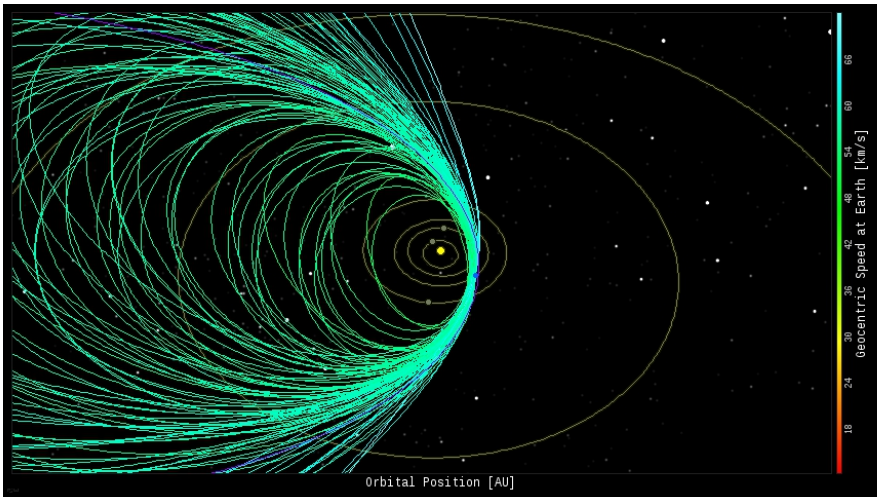
November 24, 2022

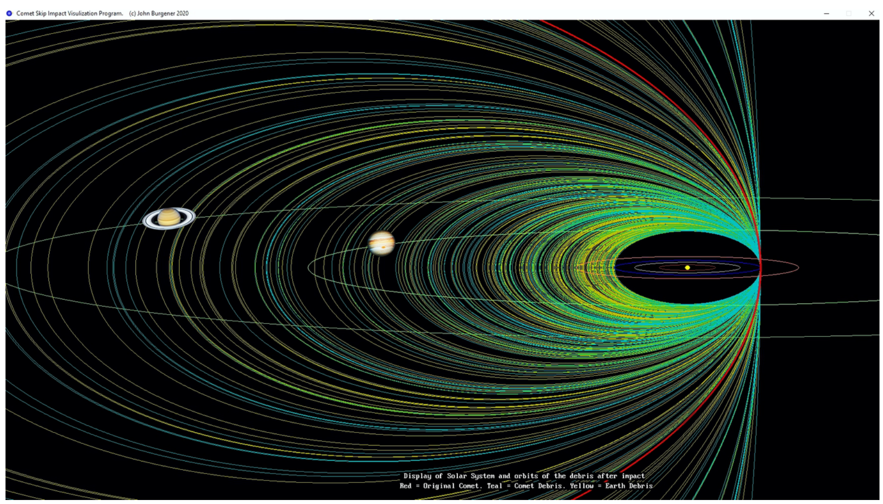
Abstract

It is accepted that the Perseids Meteor Shower each August is related to the comet Swift Tuttle. It is apparent that the outgassing as the comet travels spreads a cloud of dust along its 133 year long orbital path, and that as the Earth passes through the dust each year, the larger particles burn in the atmosphere creating the meteor shower. Fireballs are also common at the same time, associated with Comet Swift Tuttle. Fireballs are much larger objects than expected from comets outgassing, but the timing and association with the Perseids and Comet Swift Tuttle is significant enough to comfortably assign a large number of mid August fireballs to a relationship with Swift Tuttle. William Cooke of NASA's Meteoroid Environment Office has plotted the orbits of the fireballs associated with Swift Tuttle as shown in the attached image. They show a large range of orbits, with only one common factor: They all intersect Earth's orbit in mid-August. Some have very short periods and others long periods. The image shown in this abstract is a diagram of the orbital paths of the fireballs presented by NASA. Studies with iSALE impact hydrocode show that comets hitting Earth at low angles such as 5 degrees or less can skip and continue on a new path at similar speeds to the original orbital speeds. Such a skip will cause part of the comet to drag across the surface of Earth, and both portions of the comet and portions of the Earth's surface will be carried into space at above Earth escape velocities. Such an occurrence would send some fragments at high speeds similar to or higher than the speed of the comet, and other fragments would be tossed at slower speeds, all depending on the location of the fragments during the impact event. It would be expected that such fragments would travel away from Earth on a wide range of orbits, with the common feature of all of the orbits being the initiation point of the event: the skip impact of Swift Tuttle with Earth. It is proposed that Comet Swift Tuttle has previously impacted Earth at a low angle, causing a skip event which sent fragments of the comet and of the Earth into the wide range of orbits seen in the fireball orbits associated with the Perseids Meteor Showers. The .gif image shows a graphic rendition of such a skip impact. The third image shows the calculated orbits of the resultant debris. The debris from a skip impact produces the same range of orbits as determined by NASA.

Hosted file

`swifttuttleskipimpact.gif` available at https://authorea.com/users/551172/articles/604262-a-consideration-that-the-fireballs-associated-with-the-perseids-meteor-shower-are-an-indication-of-a-previous-low-angle-impact-skip-by-comet-109p-swift-tuttle


Orbital Position [AU]
Geocentric Speed at Earth [km/s]
18
24
30
36
42
48
54
60
66


Comet Skip Impact Visulization Program. (c) John Burgener 2020
Display of Solar System and orbits of the debris after impact
Red = Original Comet. Teal = Comet Debris. Yellow = Earth Debris

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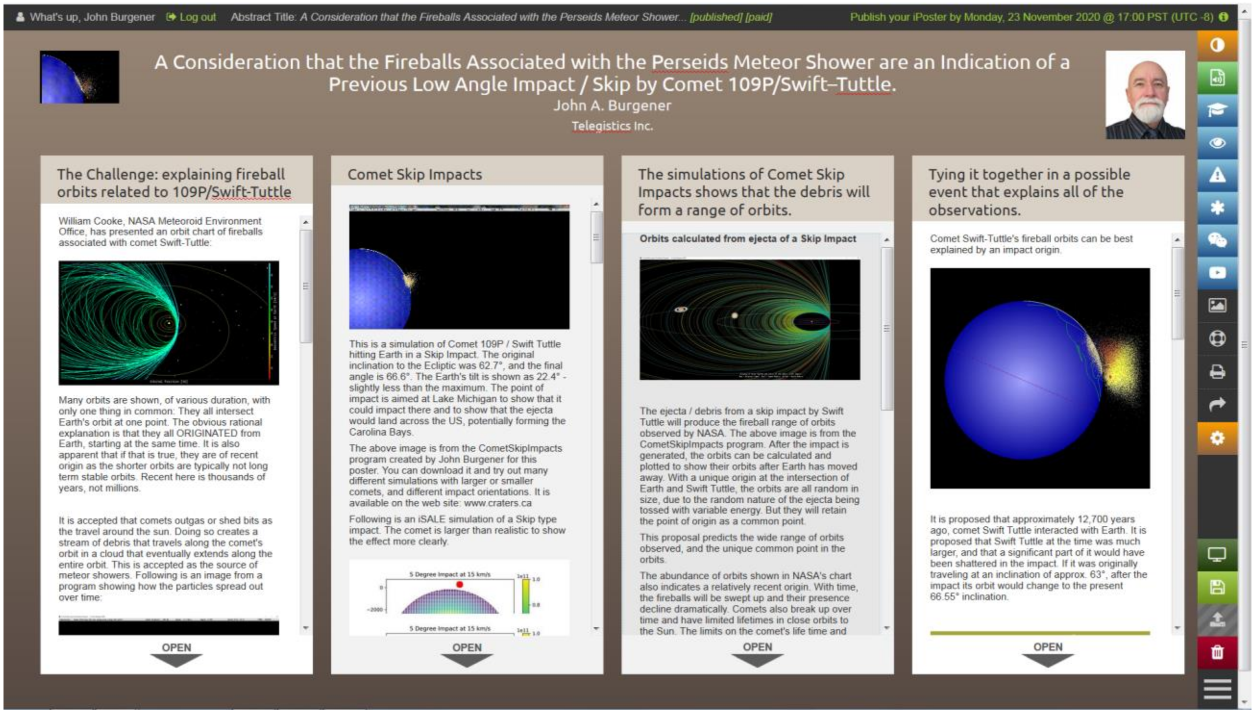

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Telegistics Inc.

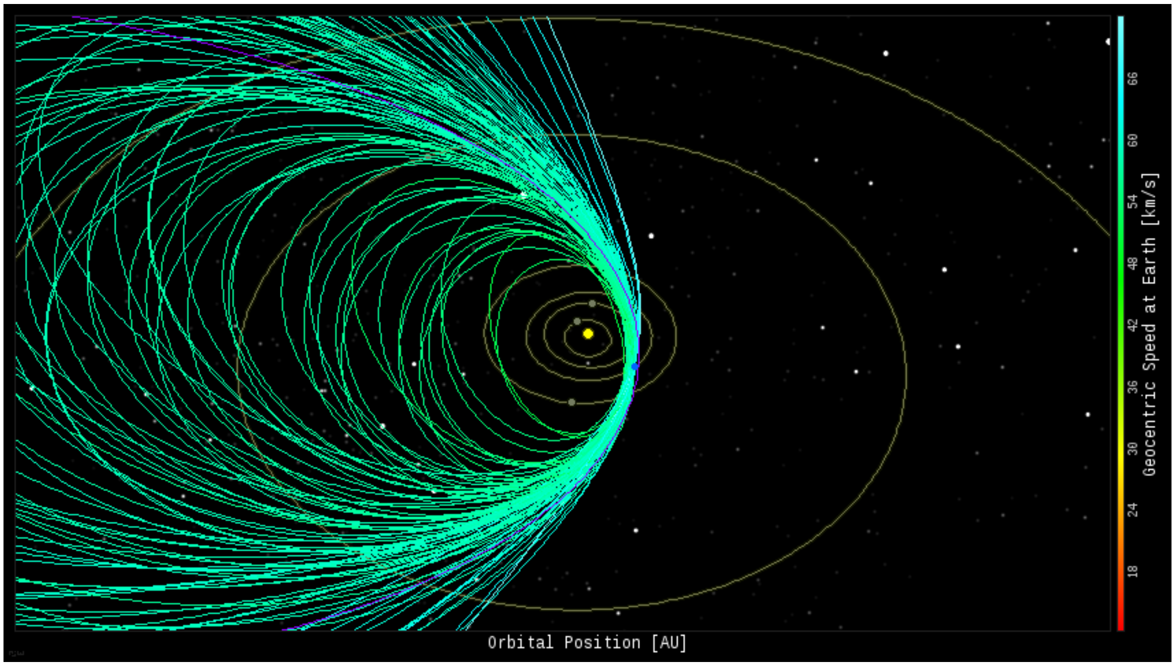
Presented at:

This presentation was originally presented at the AGU 2020 online conference. Many of the images are moving .gif format and show short movies of comets impacting Earth and comets moving in space around the Sun. To see the poster on line with the moving .gif active, try the link:

https://agu2020fallmeeting-agu.ipostersessions.com/default.aspx?s=D8-B6-18-14-CF-D3-6D-C0-06-50-85-39-2D-5D-C6-0A&guestview=true

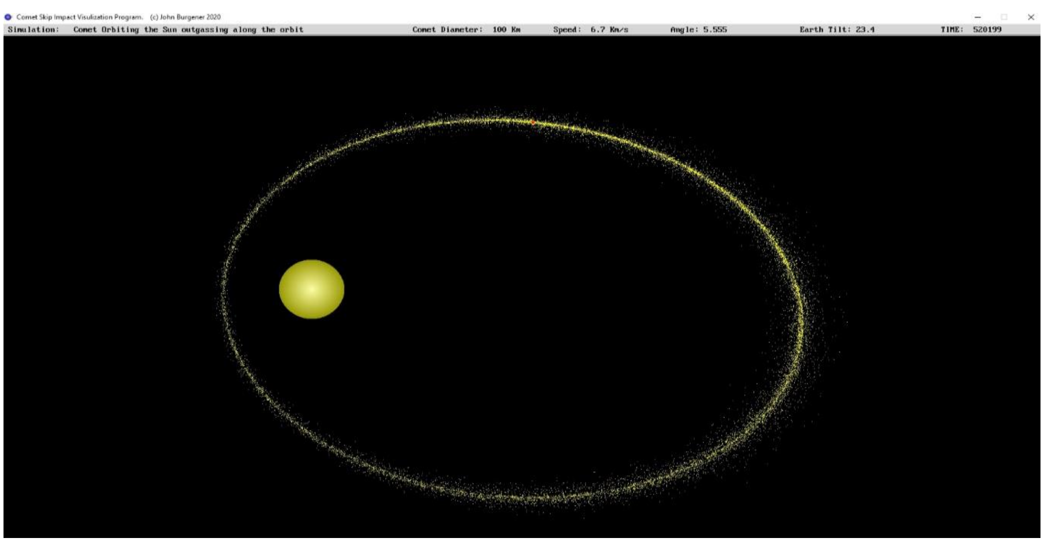
The Challenge: explaining fireball orbits related to 109P/Swift-Tuttle

William Cooke, NASA Meteoroid Environment Office, has presented an orbit chart of fireballs associated with comet Swift-Tuttle:



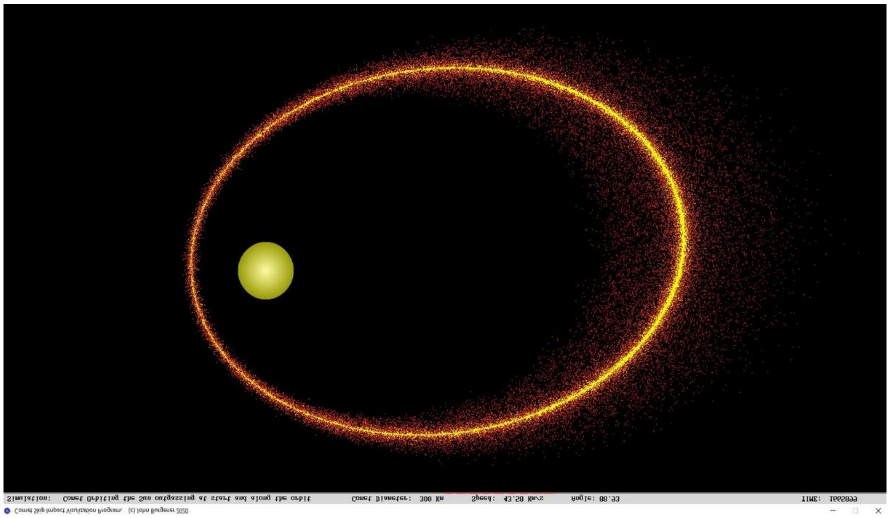
Many orbits are shown, of various duration, with only one thing in common: They all intersect Earth's orbit at one point. The obvious rational explanation is that they all ORIGINATED from Earth, starting at the same time. It is also apparent that if that is true, they are of recent origin as the shorter orbits are typically not long term stable orbits. Recent here is thousands of years, not millions.

It is accepted that comets outgas or shed bits as the travel around the sun. Doing so creates a stream of debris that travels along the comet's orbit in a cloud that eventually extends along the entire orbit. This is accepted as the source of meteor showers. Following is an image from a program showing how the particles spread out over time:



For a comet with a 100 year+ orbit, this takes thousands of years to occur - about 50 or more orbits to spread out debris along the entire orbit.

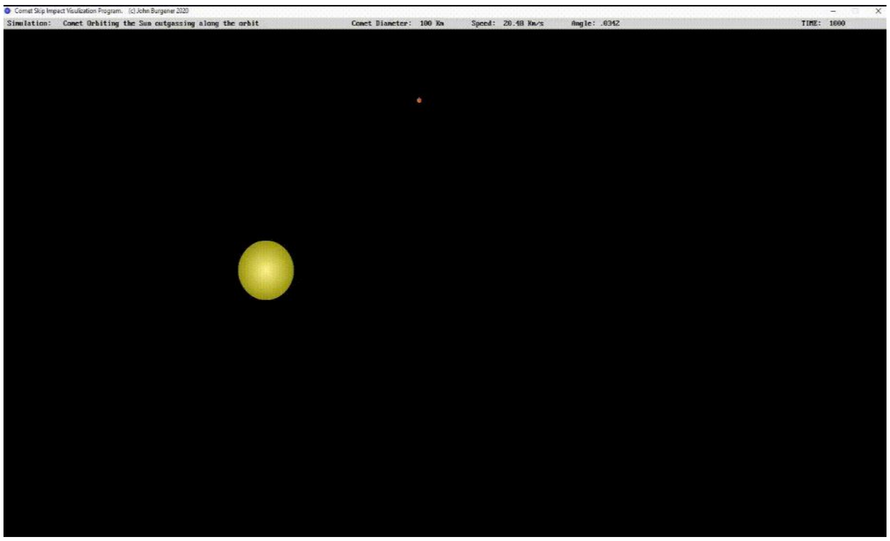
The comet debris shown above is what occurs if the debris is emitted from the comet as it travels around the sun. If the debris is emitted at one point, the trail looks different with a narrow band at the point of emission and a much wider band far out in orbit:



Debris distribution after a single point event near the sun.

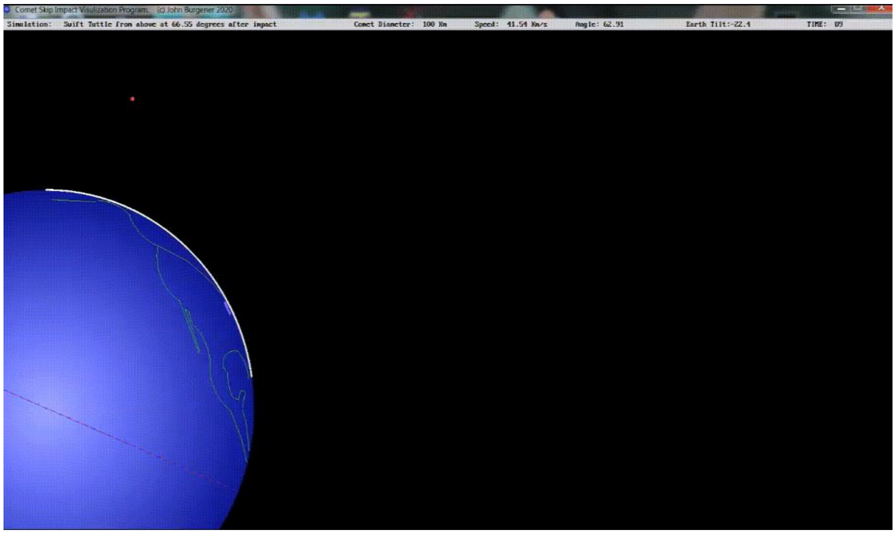
In the image, the yellow points are particles tossed off the comet as it travels around the sun, the same as in the previous image. To produce the red point distribution, a cloud of 300 km diameter was created while the comet was closest to the sun. The cloud has spread out due to the significant gravitational 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 the above pattern.

While the comet particles 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, which is a good description of a skip impact.

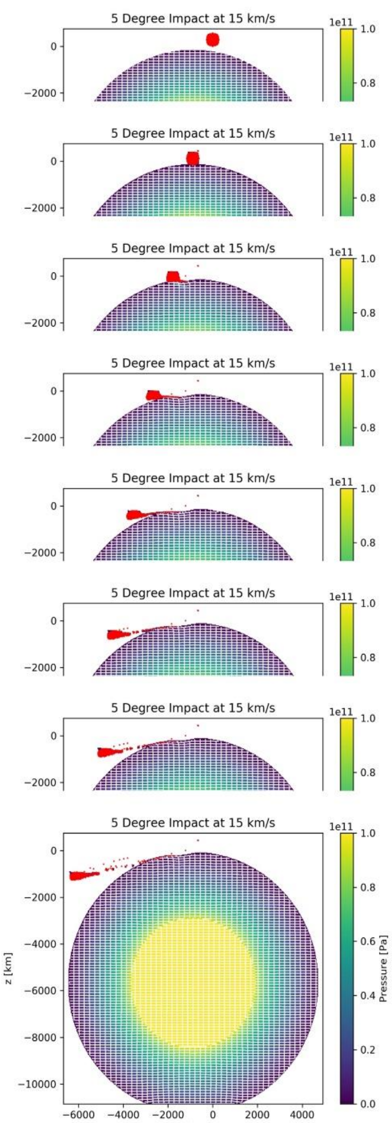


Here is a video, run at high speed showing how a comet out-gassing along its orbit eventually reaches a steady state with a cloud of debris along the entire orbit. Time is sped up to about 250 years per second, assuming a 150 year orbit.

Comet Skip Impacts



This is a simulation of Comet 109P / Swift Tuttle hitting Earth in a Skip Impact. The original inclination to the Ecliptic was 62.7°, and the final angle is 66.6°. The Earth's tilt is shown as 22.4° - slightly less than the maximum. The point of impact is aimed at Lake Michigan to show that it could impact there and to show that the ejecta would land across the US, potentially forming the Carolina Bays.



The above image is from the CometSkipImpacts program created by John Burgener for this poster. You can download it and try out many different simulations with larger or smaller comets, and different impact orientations. It is available on the web site: www.craters.ca

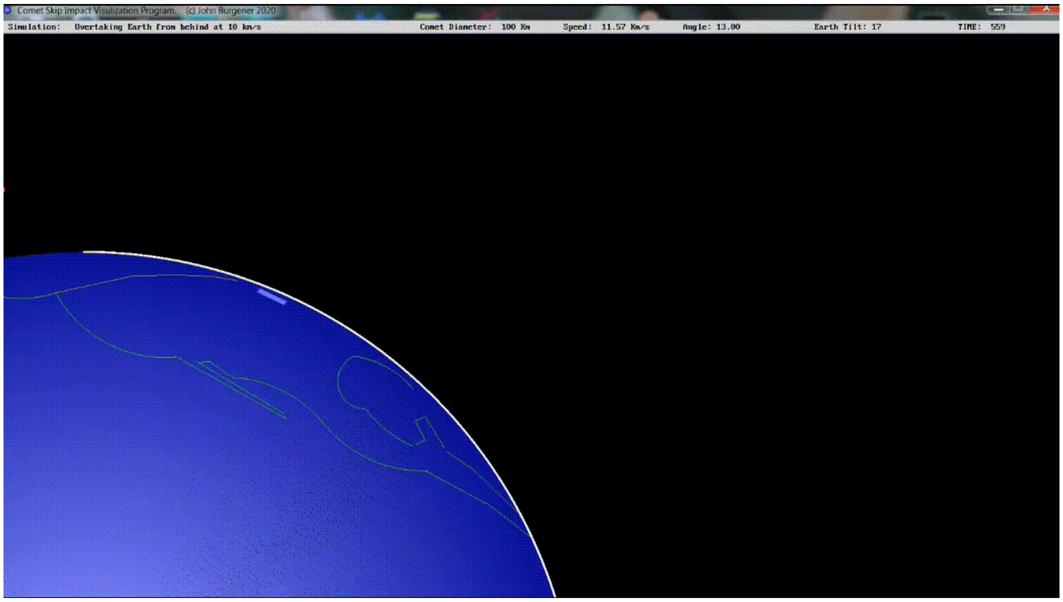
Here is an iSALE simulation of a Skip type impact. The comet is larger than realistic to show the effect more clearly.

iSALE shows that comets can do low angle skip type impacts and produce effects such as shown above. However, iSALE simulations are less detailed due to limitations of the size of blocks being considered, and due to time. An iSALE run takes weeks. The CometSkipImacts program runs a simulation in minutes.

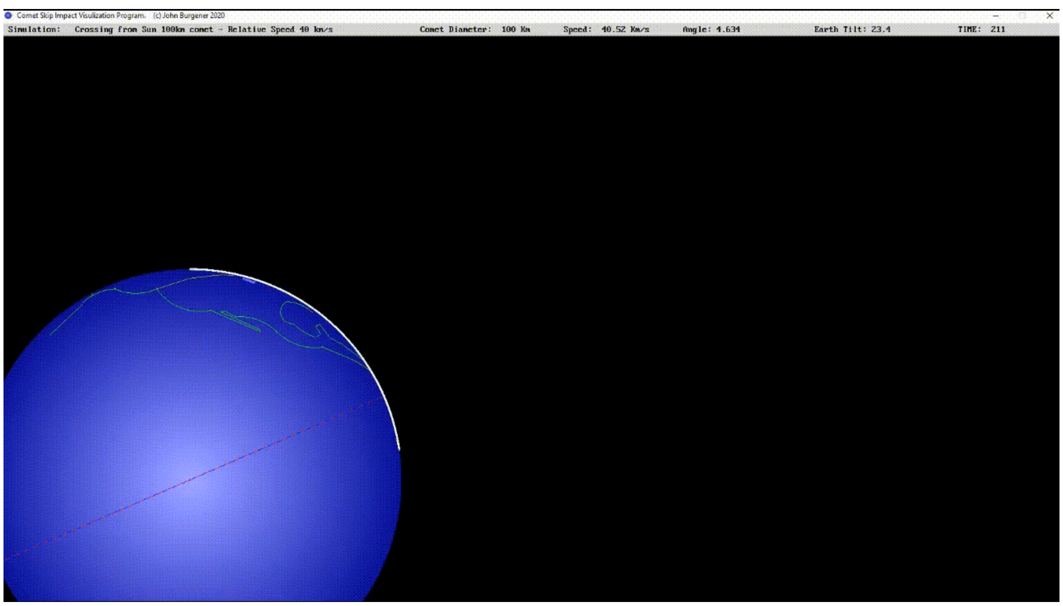
There are many alternative Skip Impacts that can happen. Following are some more examples. These and many other configurations are possible. Direct impacts are also possible. The intent of this poster is not to show all possibilities, but the one that best fits the explanation for the present fireball orbit distribution. Many possibilities exist, but only ONE actually happened. And only two cases can provide a 66.55° final orbital inclination after the impact: The Swift Tuttle Impact and the comet overtaking Earth. Both also are able to hit Earth at the location of Lake Michigan. It is worth noting that a impact by a comet traveling from the sun or head on will not be able to produce a Lake Michigan location of a skip impact.

Sample Skip Impacts

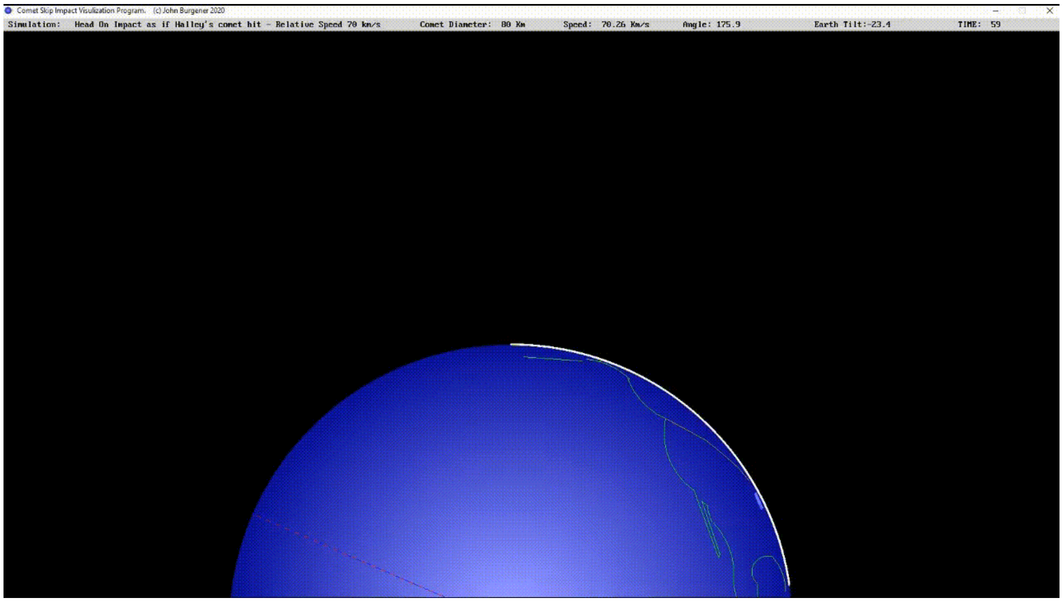
Skip Impact by comet overtaking Earth. Relative speed of 10 to 11 km/s:



Skip Impact by comet traveling from closer approach to sun and crossing Earth's orbit at approx. 90°. Relative speed of such an impact is approximately 41 km/s.



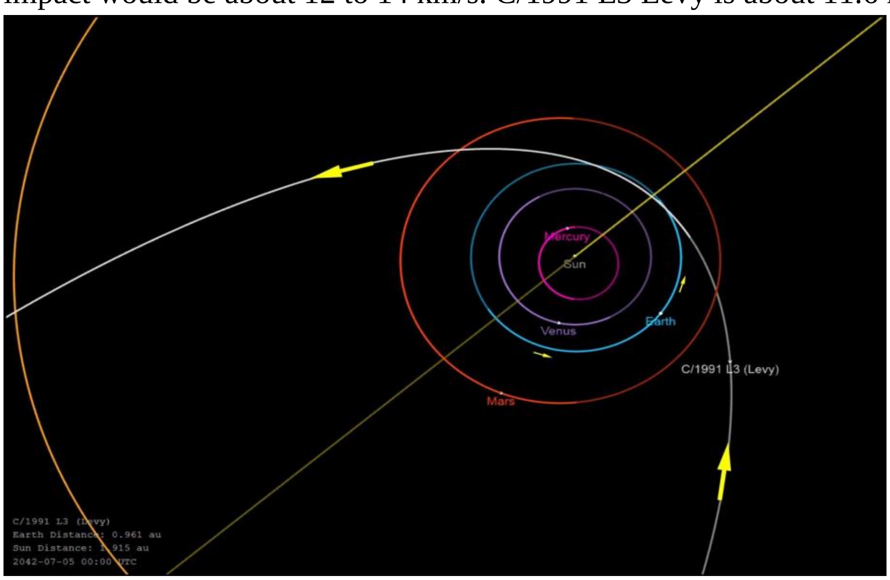
Skip Impact by comet traveling in retrograde orbit, hitting head-on, with a relative speed of 70 km/s:



Real Comets with similar orientations as above examples:

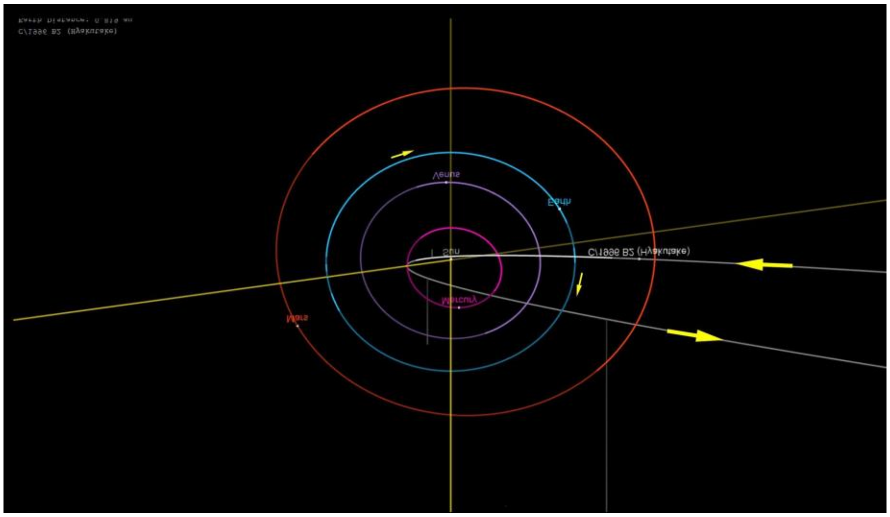
Comets typically travel in the Ecliptic Plane, and typically in the same direction as Earth and the planets circle around the Sun. With most comets originating from the Kuiper Belt, this is expected and accepted as the main group of comets. However, as comets interact with the planets, their orbits often get changed and any imaginable orientation is possible. So there are 4 main categories of comet orbits that intersect Earth's orbit:

1. Approaching Earth in a similar plane and direction to Earth's Orbit. The example below is the orbit of C/1991 L3 Levy. Levy's orbit merges with Earth's Orbit on the Ecliptic, with both traveling in the same direction as they pass. Levy moves faster than Earth, so an impact would require Levy to approach from behind Earth, and catch up. The original speeds are 41 and 30 km/s, the difference about 11 km/s, but gravity would add to the difference as they approach, so such an impact would be about 12 to 14 km/s. C/1991 L3 Levy is about 11.6 km in diameter.



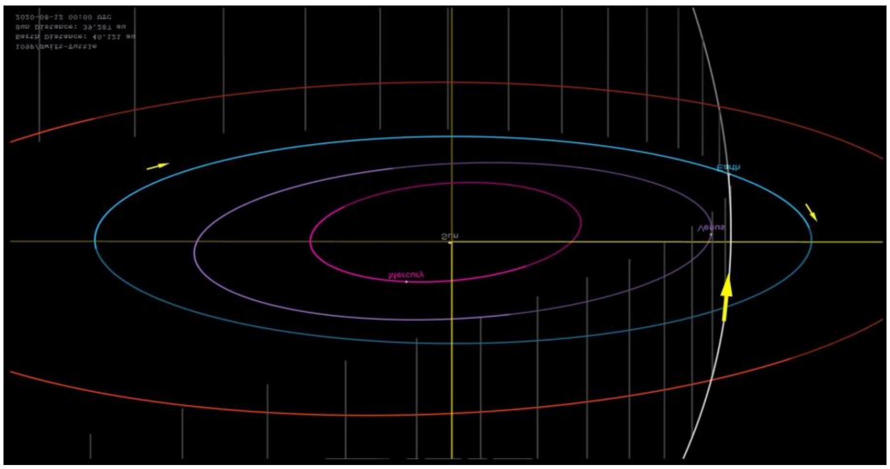
Comet C/1991 L3 Levy approaching Earth in similar plane and direction to Earth's Orbit - Image from JPL Small-Body Database Browser

2. Crossing Earth's orbit on a closer approach to the Sun. For example, C/1996 B2 (Hyakutake): which crosses Earth’s Orbit on the Ecliptic, but still at right angles to Earth's orbit. Impacts would be at ~ 41 - 43 km/s.



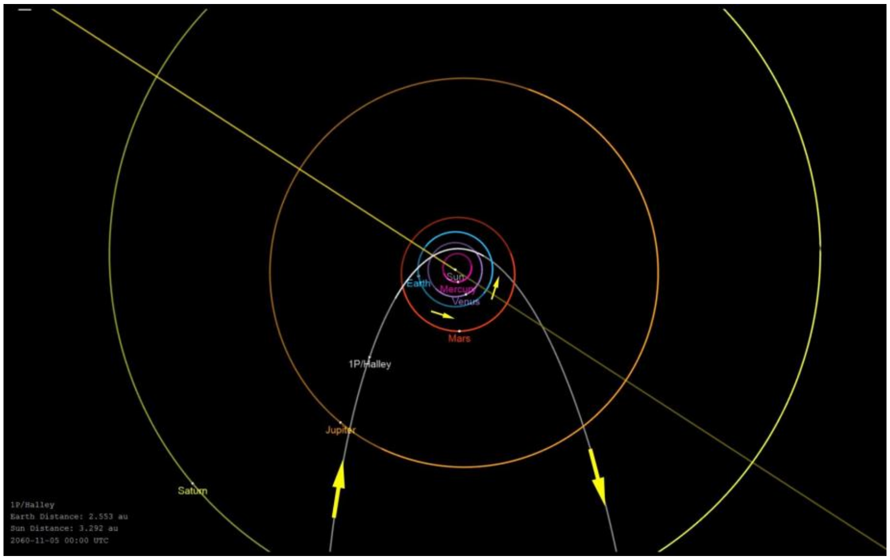
C/1996 B2 (Hyakutake): Crossing Earth’s Orbit on the Ecliptic

3. Crossing Earth's Orbit from above/below the Ecliptic plane. For example, comet 109P Swift-Tuttle. It is presently inclined at 66.55°. Crossing Earth’s orbit from above the Ecliptic, adding its vector speed to Earths at nearly a right angle, so the impact speeds would be ~ 41 to 43 km/s.



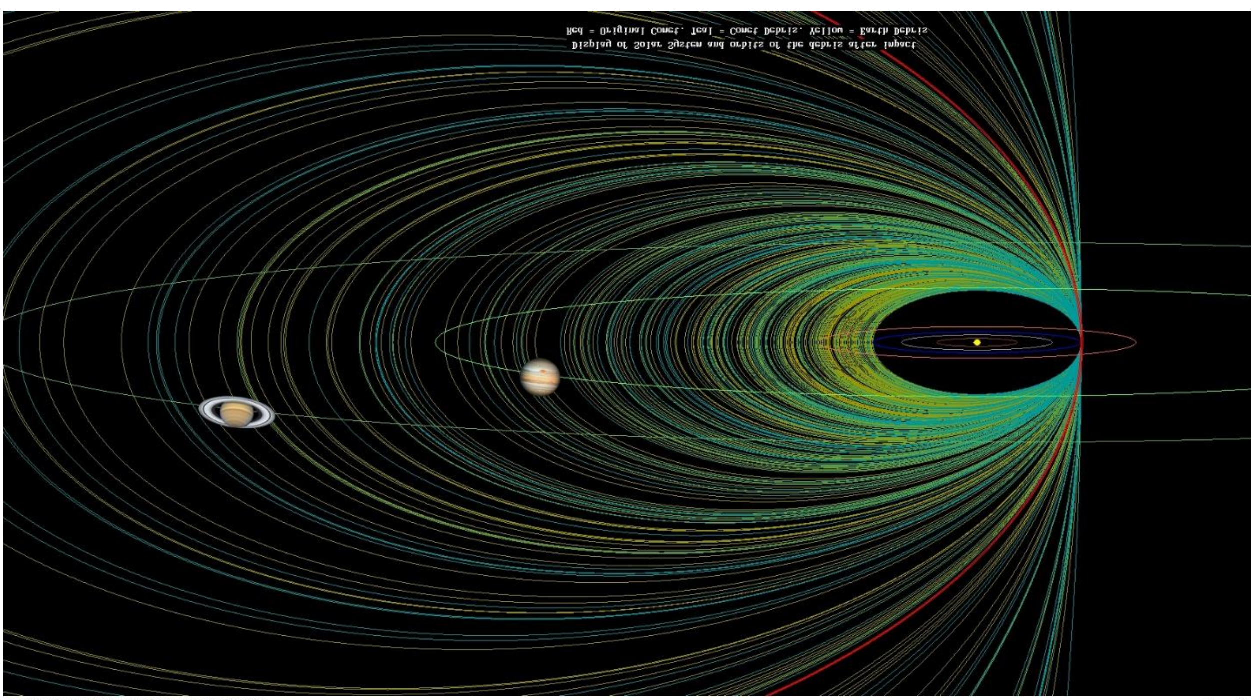
109P Swift-Tuttle: Crossing Earth’s orbit from above the Ecliptic, present inclination of 66.55°.

4. Approaching Earth in a similar plane but opposite direction to Earth's Orbit. The example below is 1P Halley's Comet. It is in a retrograde orbit, passing Earth at ~ 41 km/s, in the opposite direction to Earth's orbit, so impacts would be in the order of 70 km/s.



1P Halley's Comet: Retrograde orbit.

The simulations of Comet Skip Impacts shows that the debris will form a range of orbits.



Orbits calculated from ejecta of a Skip Impact

The ejecta / debris from a skip impact by Swift Tuttle will produce the fireball range of orbits observed by NASA. The above image is from the CometSkipImpacts program. After the impact is generated, the orbits can be calculated and plotted to show their orbits after Earth has moved away. With a unique origin at the intersection of Earth and Swift Tuttle, the orbits are all random in size, due to the random nature of the ejecta being tossed with variable energy. But they will retain the point of origin as a common point.

This proposal predicts the wide range of orbits observed, and the unique common point in the orbits.

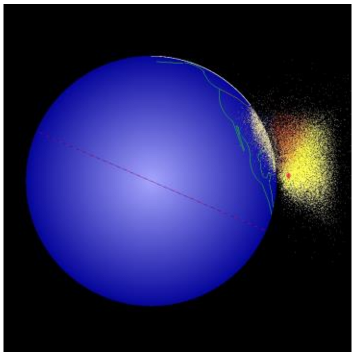
The abundance of orbits shown in NASA's chart also indicates a relatively recent origin. With time, the fireballs will be swept up and their presence decline dramatically. Comets also break up over time and have limited lifetimes in close orbits to the Sun. The limits on the comet's life time and the debris' lifetimes indicates that the skip impact must have been in the past several thousand years, not millions of years ago.

Ice Falls:

Assuming that Swift Tuttle hit Earth at the end of the ice age, causing the Carolina Bays and the Younger Dryas event, then one should expect that a lot of blocks of ice were tossed into space. Not surprisingly, there are many recorded reports of large ice blocks falling out of the sky. John Saul reports a long list of ice falls in the Meteorite - Quarterly Magazine, 2006. One item in particular is the June 26, 1985, fall of a 1500 pound slab of ice, Hartford, Connecticut. It is expected if there is a lot of ice debris in space, but not possible as an atmospheric phenomena. For more information on ice falls, there are several web sites on the topic at present such as: tierra.rediris.es/megacryometeors/

A possible objection would be that if the comet did impact Earth as proposed, then there must be many very large pieces of debris. The fireballs are small relative to the amount of debris that would be tossed into space. However, it is apparent that larger pieces would have lower velocity - less velocity for a given amount of energy transfer. As such, most of the larger pieces fell back to Earth. Some in-between sizes would have been sent out to space, but still would have lower velocities than the smaller pieces, so their orbits would send them much closer to the sun, dramatically shortening their life expectancy.

Tying it together in a possible event that explains all of the observations.



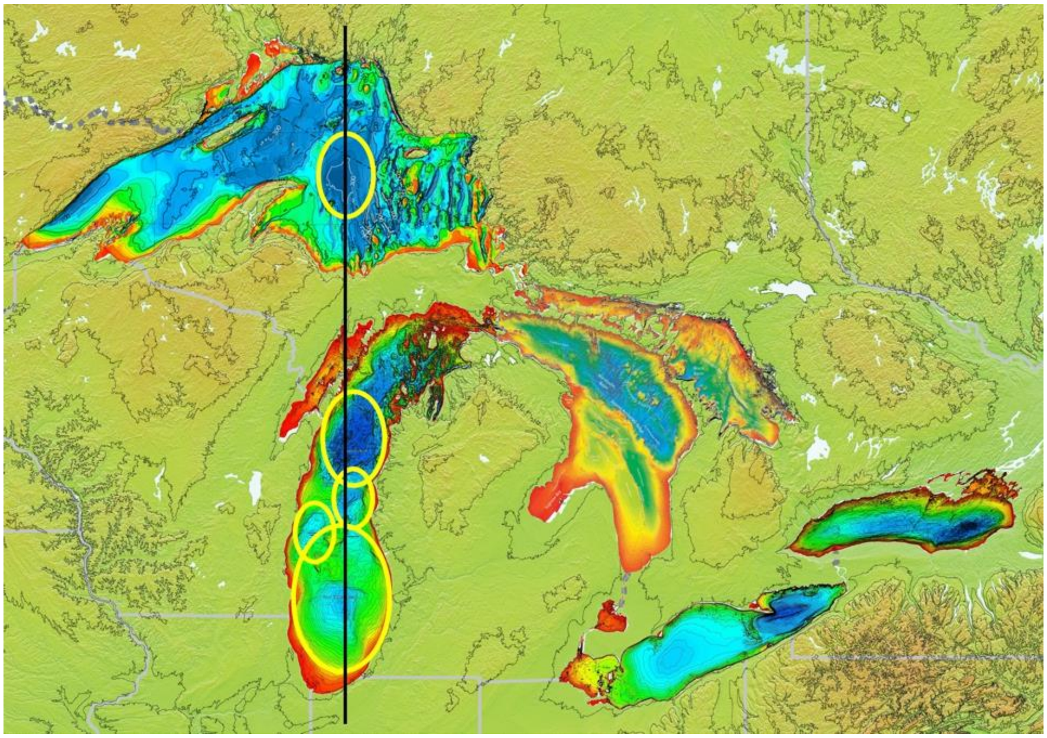
Comet Swift-Tuttle's fireball orbits can be best explained by an impact origin.

It is proposed that approximately 12,700 years ago, comet Swift Tuttle interacted with Earth. It is proposed that Swift Tuttle at the time was much larger, and that a significant part of it would have been shattered in the impact. If it was originally traveling at an inclination of approx. 63°, after the impact its orbit would change to the present 66.55° inclination.

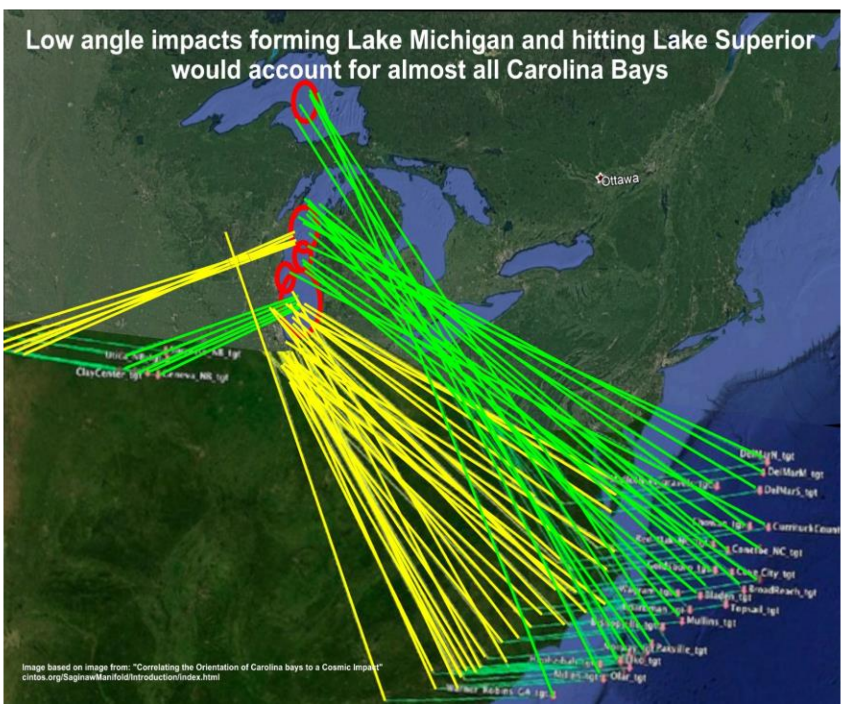
Orcus Patera on Mars
with overlay of Lake Michigan outline

It is proposed that it hit in the present location of Lake Michigan leaving a long, shallow, scar about 300 km long. The shape of Lake Michigan is close to the shape and size of Mar's Orcus Patera crater. Such craters are possible! Orcus Patera has raised sides from debris tossed sideways – effectively a crater rim. Lake Michigan would have had a 2 to 3 km thick layer of ice on the land at the time of the impact. The crater rim would have been mainly ice, and have melted away over time.

A comet in close approach to Earth is likely to break up due to gravitational stress. It would be expected that the impact would involve more than one piece. The Bathymetric maps of the great lakes shows 5 likely elliptical depressions that would fit as 5 spots of impact. Northern Lake Michigan is heavily scared from glaciation, as is most of Lake Superior. But the indicated elliptical areas are free of any glaciation scars, indicating that these areas were not formed by glaciers.



Bathymetric Map of the Great Lakes. Red = shallow. Dark Blue = very deep.



The Carolina Bays line up in a few limited orientations, all of which line up with the proposed impact locations in Lake Michigan and Lake Superior. An impact during the ice age would have 2 to 4 km of ice on the surface. A significant portion of the debris would be ice.

The debris that falls back to Earth from such an impact at the end of the ice age would also cause devastation across North America, and explain the extinction event that killed all of the large mammals in North America. Large ice blocks falling from the sky would kill animals as easily as rocks. The falling rocks would heat on return to the atmosphere, and set fires across North America.

At present, there is no recognized crater to account for a Younger Dryas impact. It is proposed that Lake Michigan is the impact crater related to the Younger Dryas event.

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web page: cintos.org/SaginawManifold/Introduction/index.html

iSALE-2D
We gratefully acknowledge the developers of iSALE-2D, including Gareth Collins, Kai Wünnemann, Dirk Elbeshausen, Tom Davison, Boris Ivanov and Jay Melosh.

iSALE-3D
We gratefully acknowledge the developers of iSALE-3D, including Dirk Elbeshausen, Kai Wünnemann, Gareth Collins and Tom Davison.

Saul, J. 2006. Ice meteorites: Is it prudent to ignore anecdotal reports. Meteorite Quarterly 12 (2), 20 – 21.