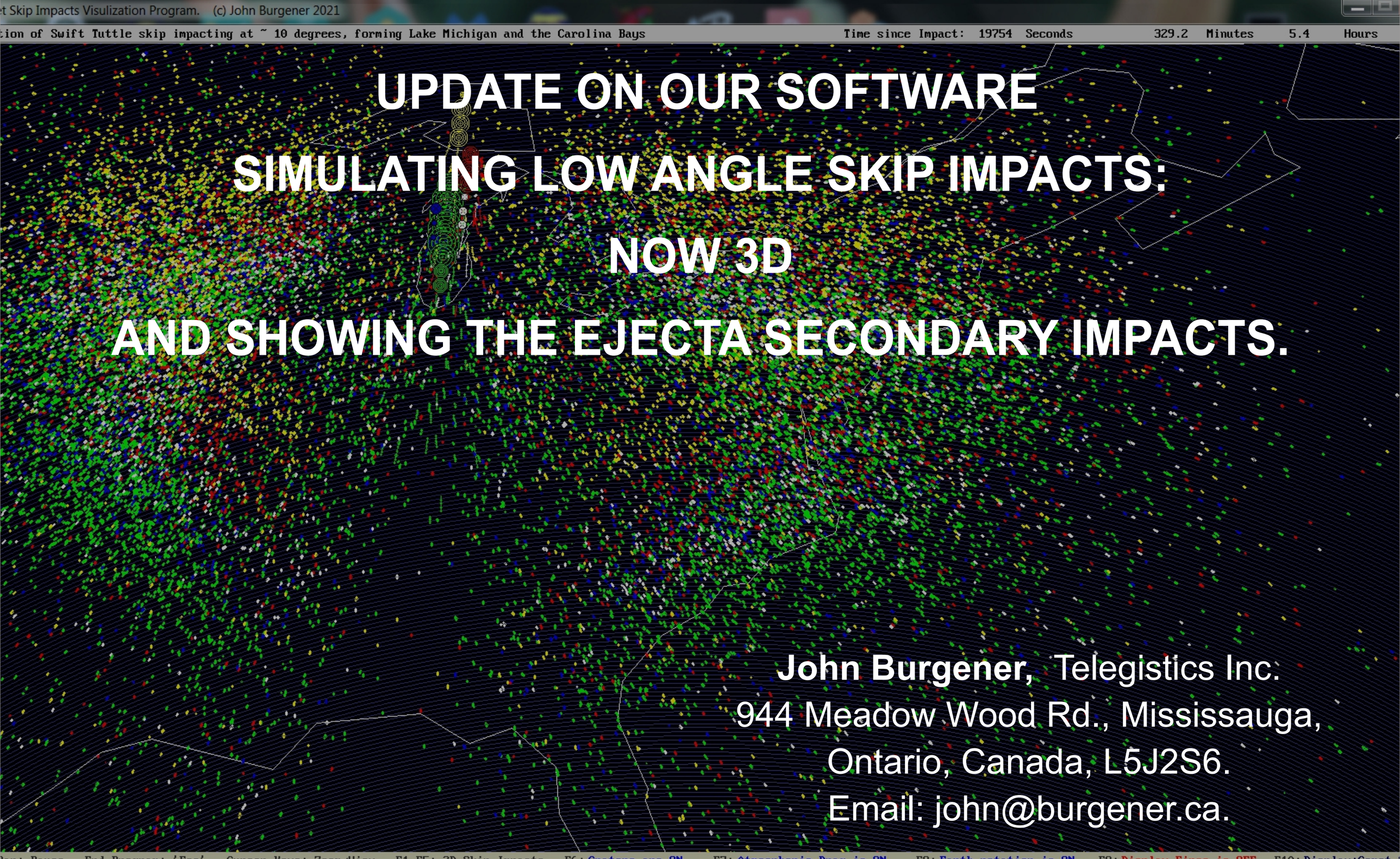
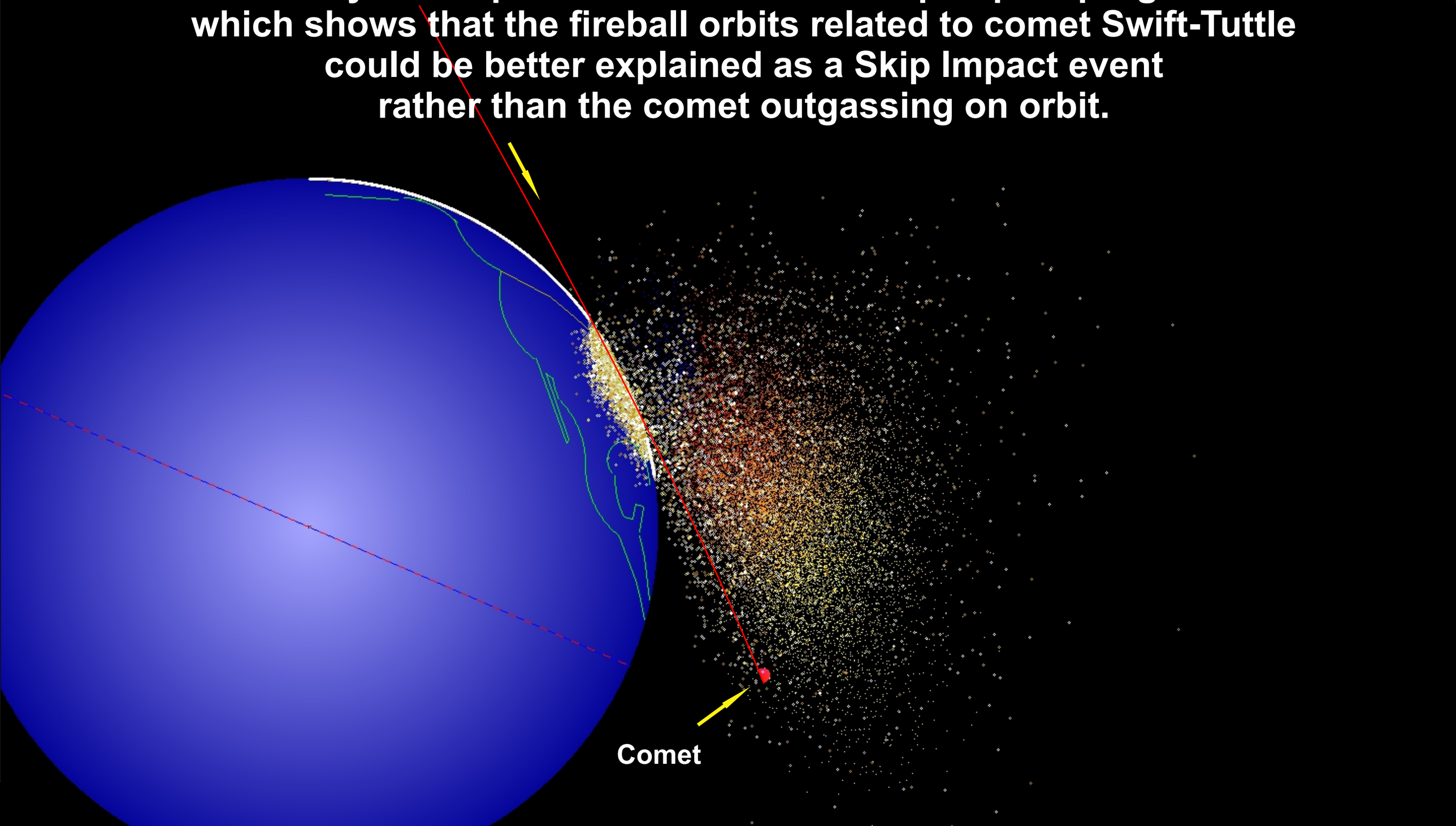


John Burgener, Telegistics Inc.
944 Meadow Wood Rd., Mississauga,
Ontario, Canada, L5J2S6.
Email: john@burgener.ca.

Last year we presented the Comet Skip Impact program which shows that the fireball orbits related to comet Swift-Tuttle could be better explained as a Skip Impact event rather than the comet outgassing on orbit.



Comet Skip Impact Visulization Program. (c) John Burgener 2020

A Ski Impact will produce
a wide range of orbits
for the debris.

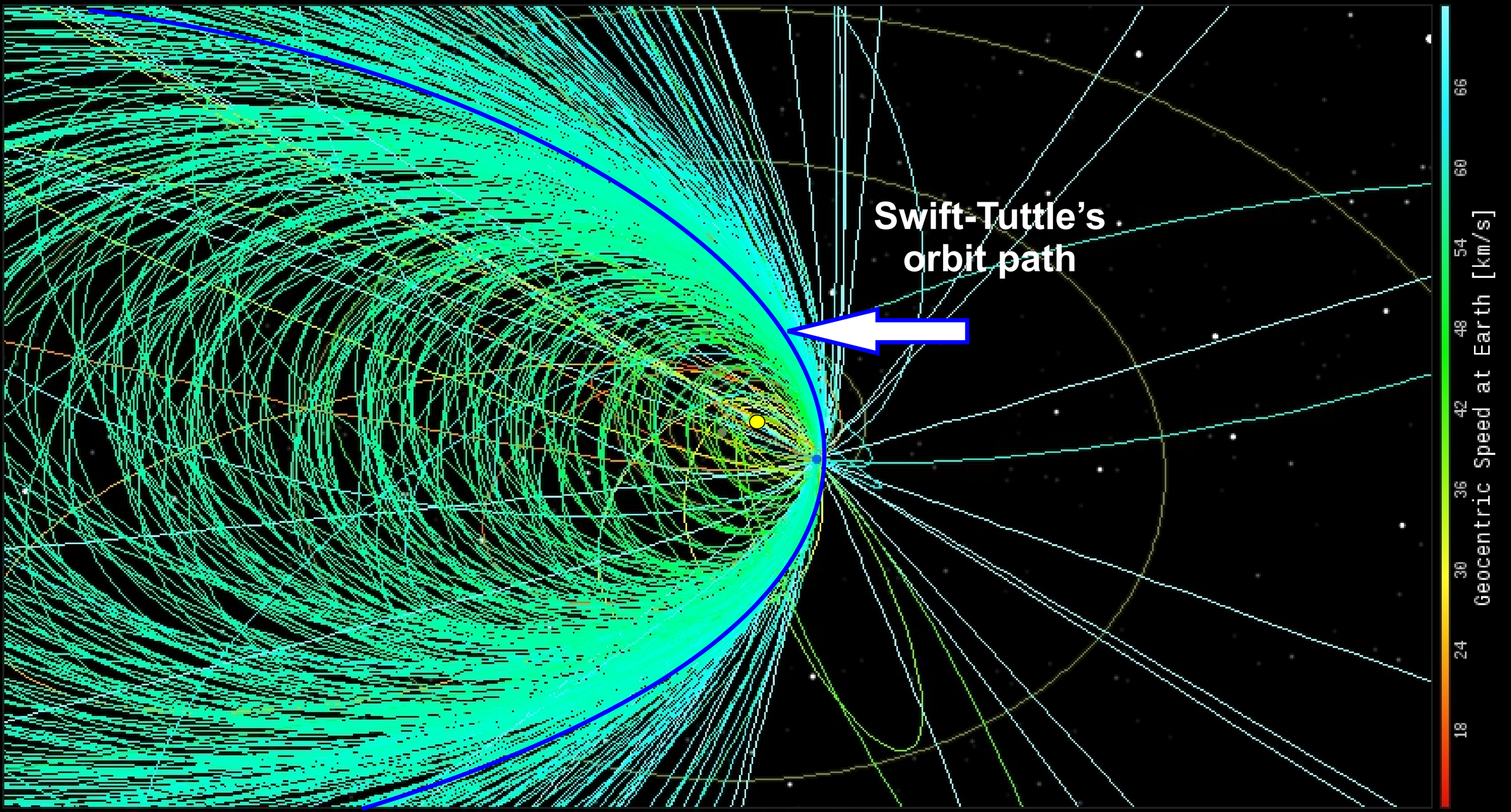
Swift-Tuttle's
orbit path

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 empty area is where lower speed particles fall into the sun or are pulled back to Earth.

Display of Solar System and orbits of the debris after impact
Red = Original Comet. Teal = Comet Debris. Yellow = Earth Debris

Which matches the observed fireball orbits better than the present theories.

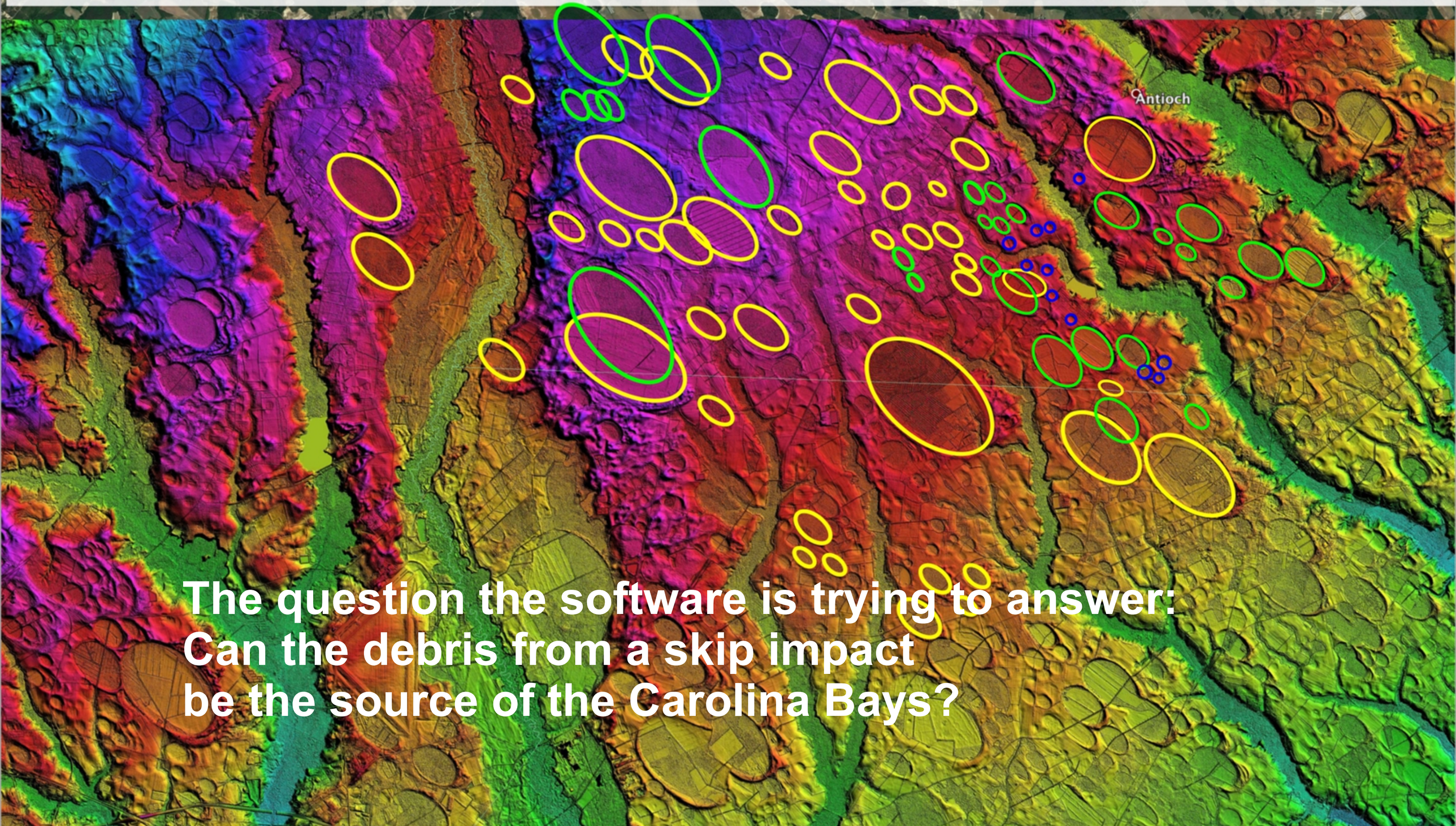


Last year’s program was 2 dimensional
and focused on the debris sent into orbit.

The program handles vast numbers of particles
and their gravitational effects,
perhaps adding a 3rd dimension would be possible?

This image was generated with 1.5 m resolution LiDAR elevation data. False color shader is HSV (hue-saturation-value), driven by elevation values which are exaggerated by 20x to punch up the relief. The field of view is 35 km e-w and 17 km n-s, and encompasses ~600 square km. Imagery generated within Global Mapper GIS, exported as kml-jpeg, and visualized in the Google Earth virtual globe using the network linked file at http://cintos.org/AGU_2017_LiDAR
Elevation values extend from 46 masl in lower right to 90 masl in upper left, for a total relief of 44m over the diagonal distance of 38km. This land is FLAT!

The large triangular area in the lower left represents the three ~2km long runways of the Laurinburg-Maxton Airport. Note that the airport has expanded over a Carolina bay, yet the bay's planform continues to be apparent in the topography.



3D presentation of a skip impact

n and the Carolina Bays Time since Impact: 251 Seconds 4.1

Side View

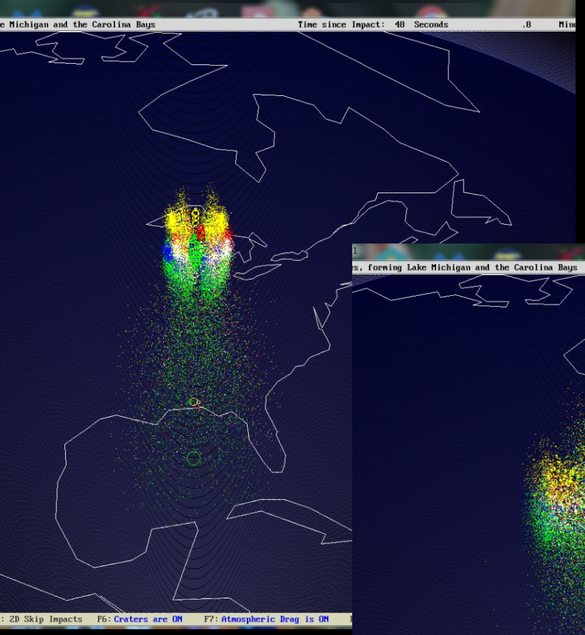
Impacts F6: Craters are ON F7: Atmospheric Drag is ON F8: Earth rotation is ON F9: Display Fir

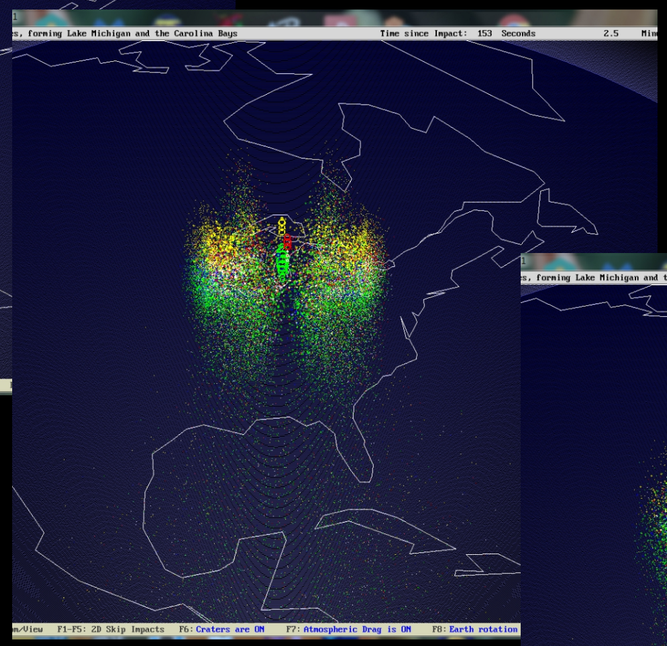
s, forming Lake Michigan and the Carolina Bays Time since Impact: 250 Seconds

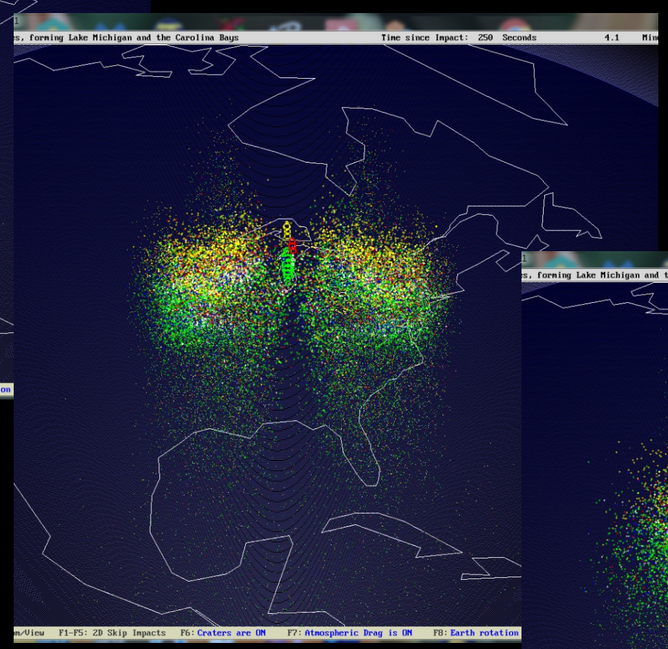
Front View

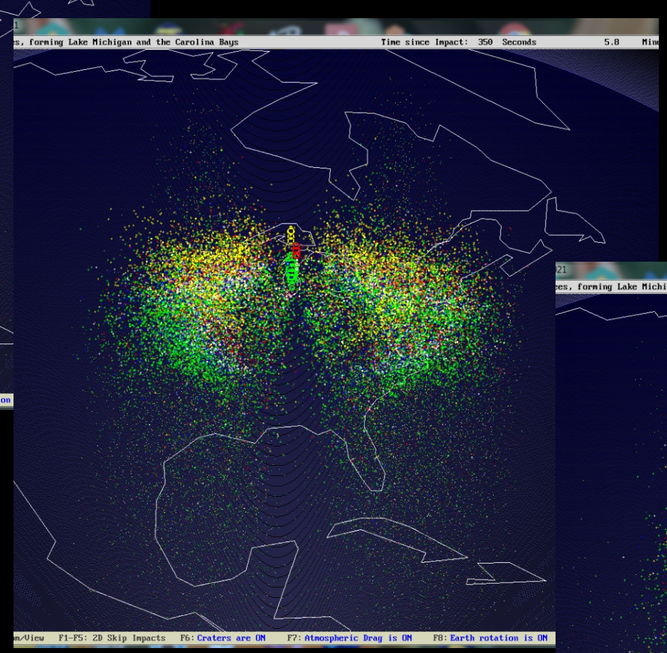
m/View F1-F5: 2D Skip Impacts F6: Craters are ON F7: Atmospheric Drag is ON F8: Earth rotation is ON F9: Di

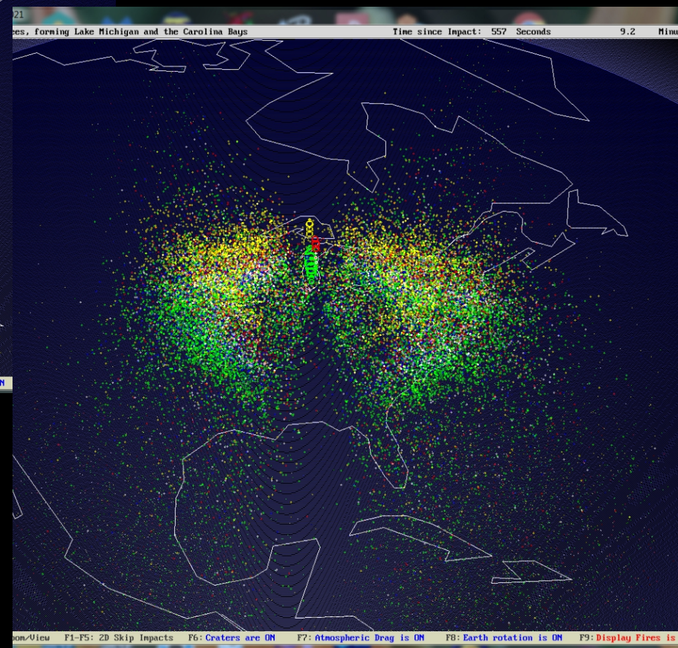
3D presentation of a skip impact







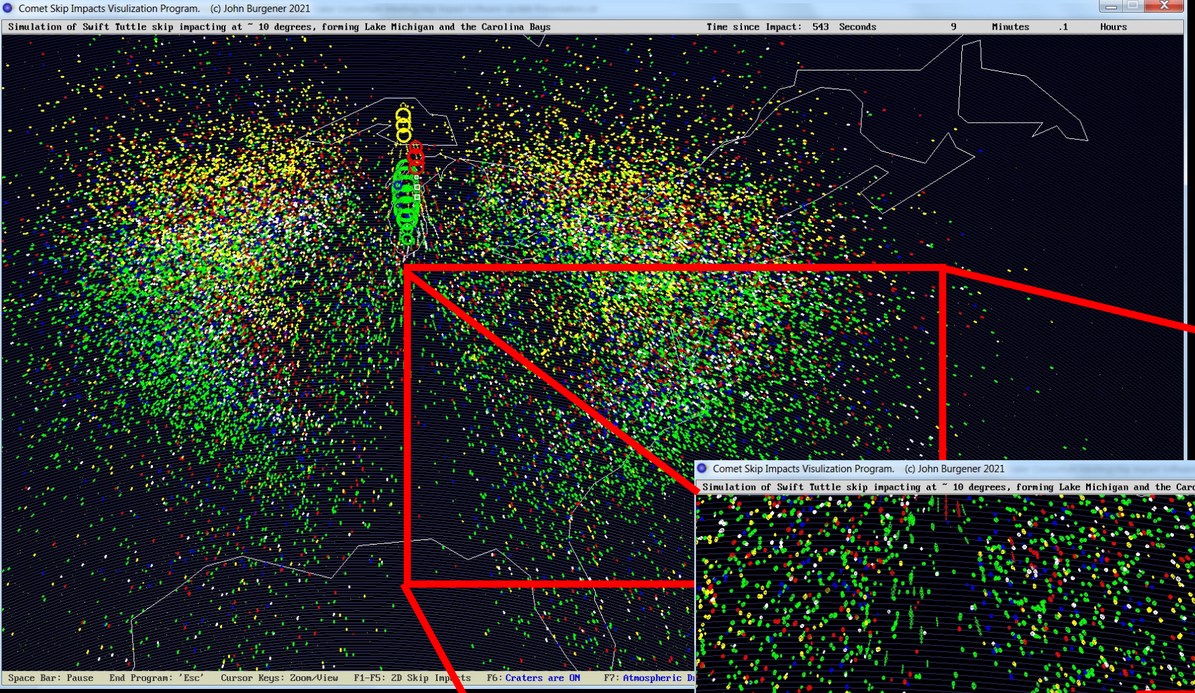


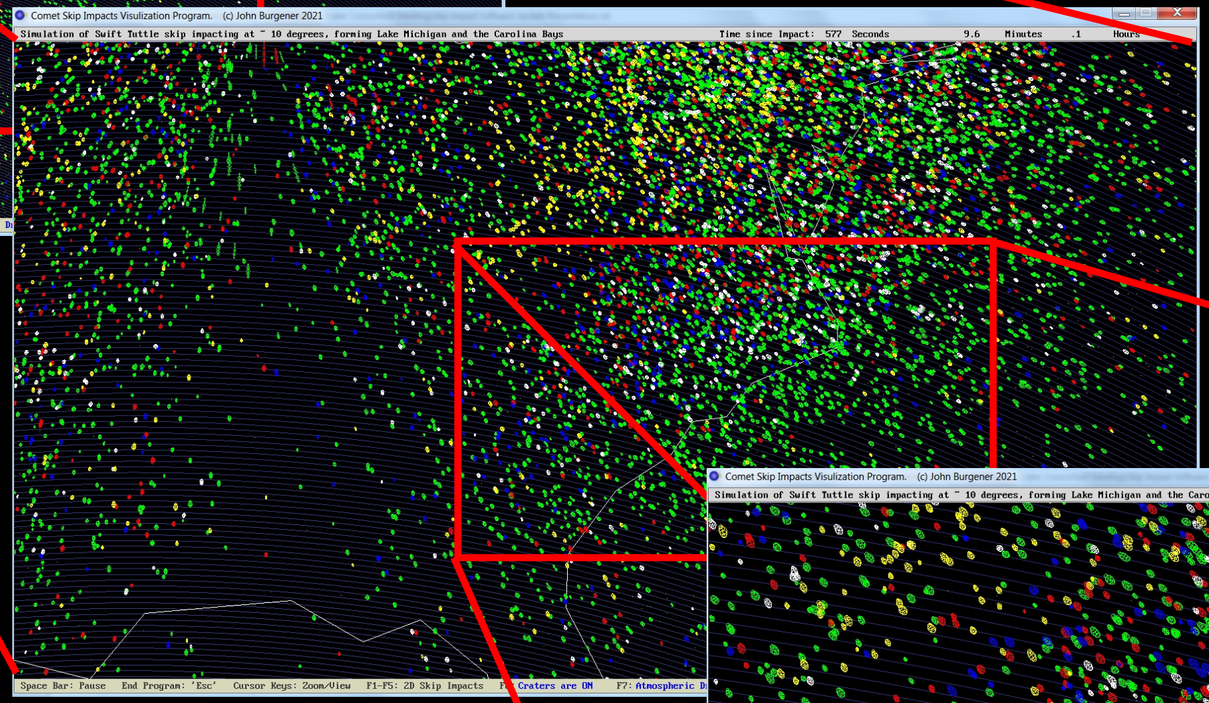


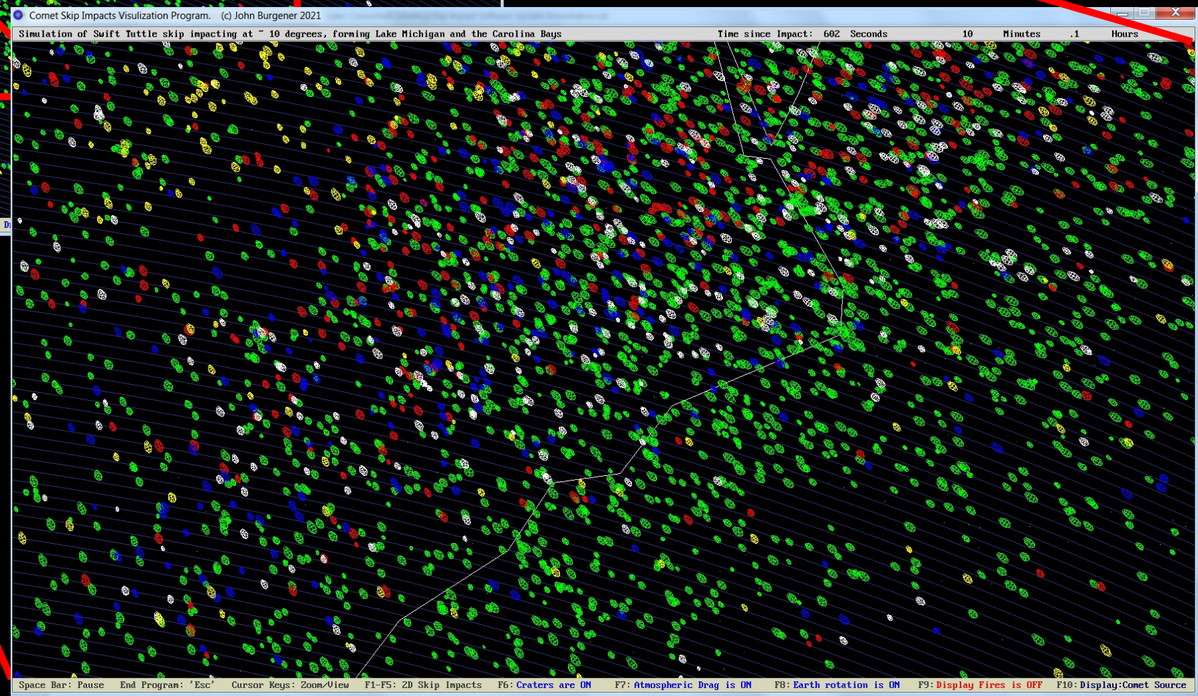
Comet Skip Impacts Visulization Program. (c) John Burgener 2021

Simulation of Swift Tuttle skip impacting at ~ 10 degrees, forming Lake Michigan and the Carolina Bays Time since Impact: 614 Seconds 10.2 Minutes .1 Hours

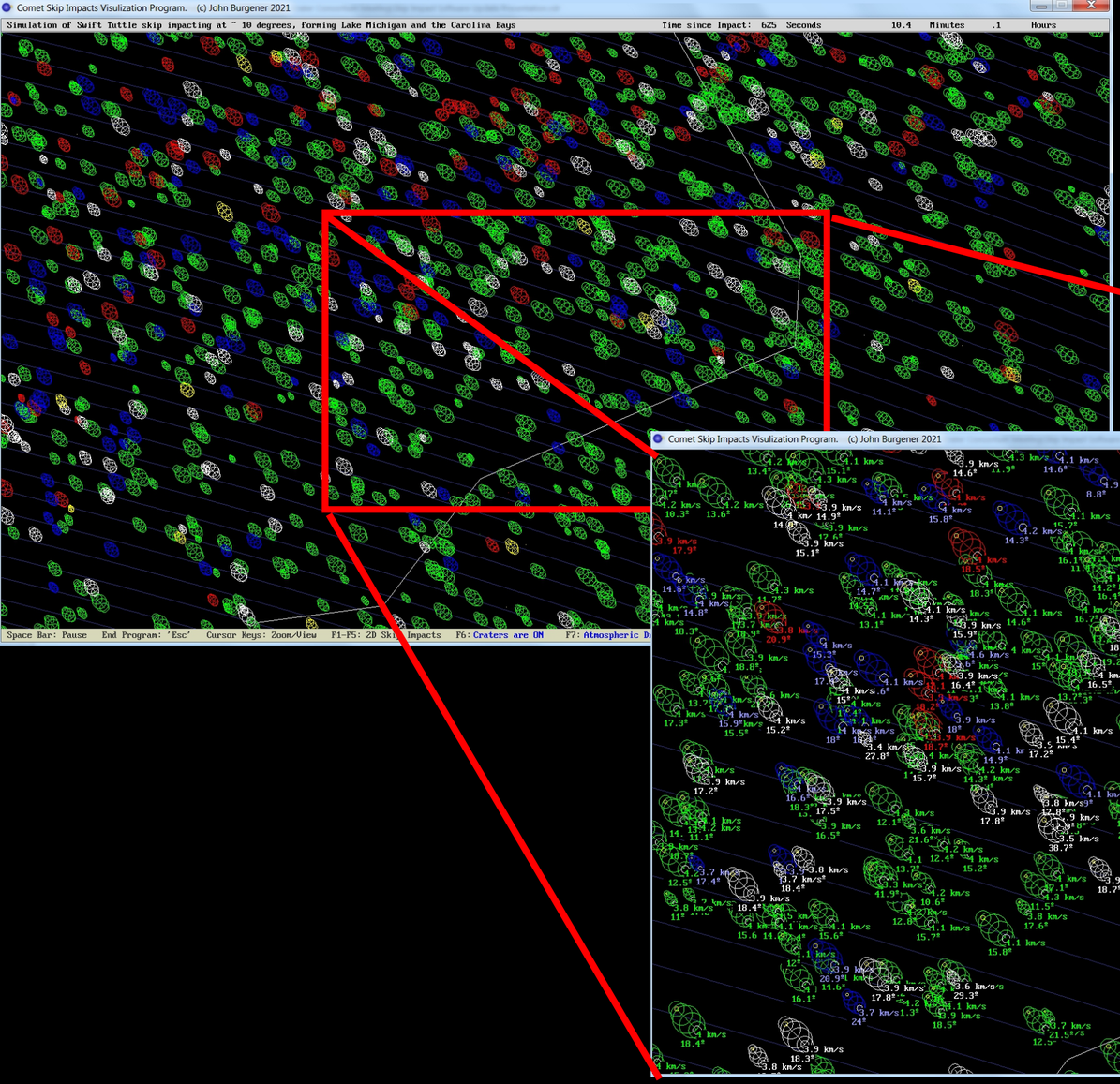
The 3D program shows the debris impacting the planet

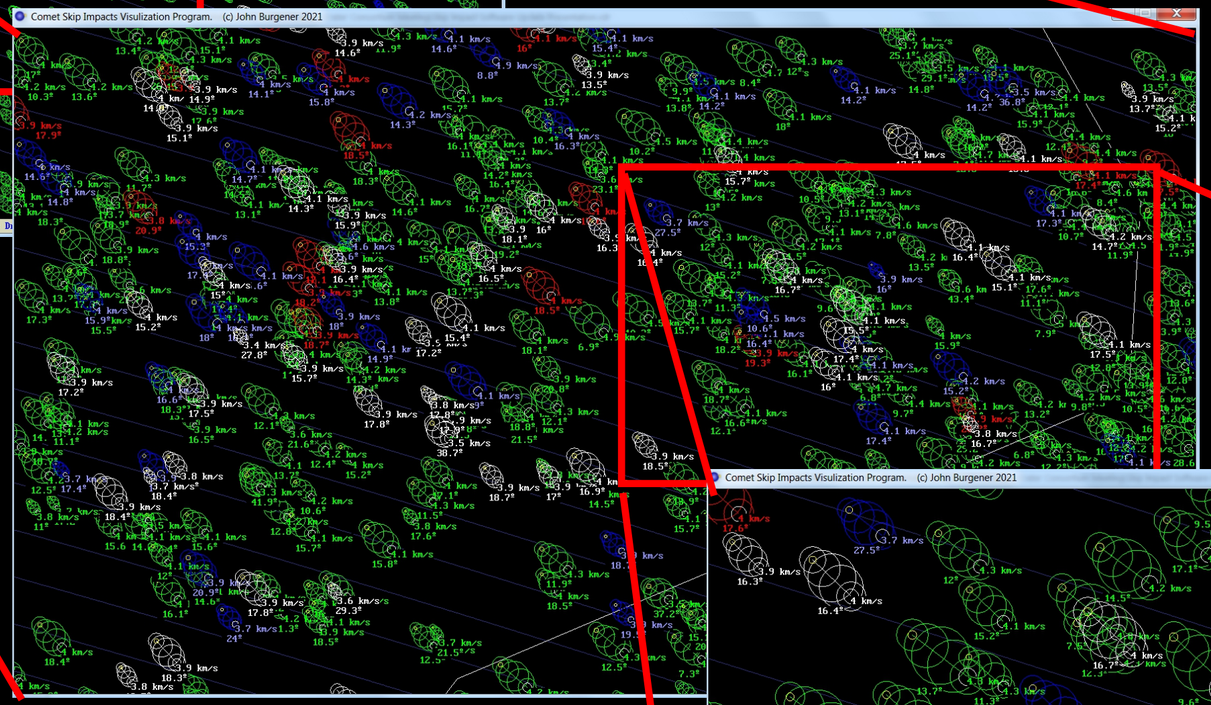


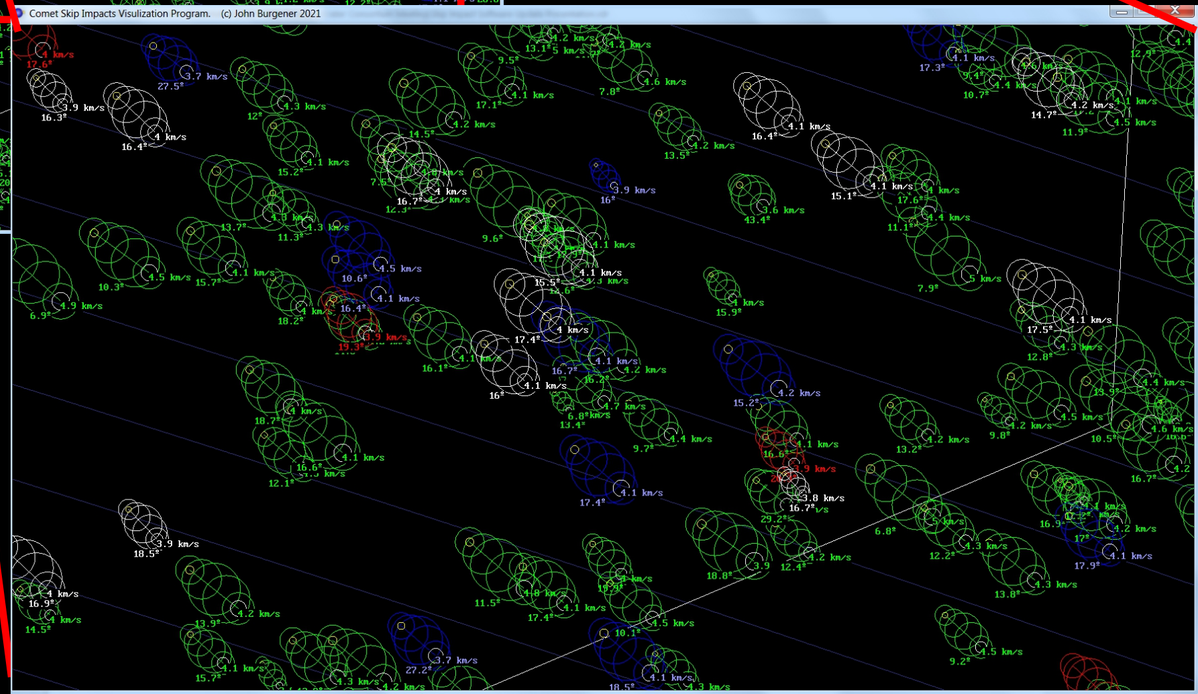




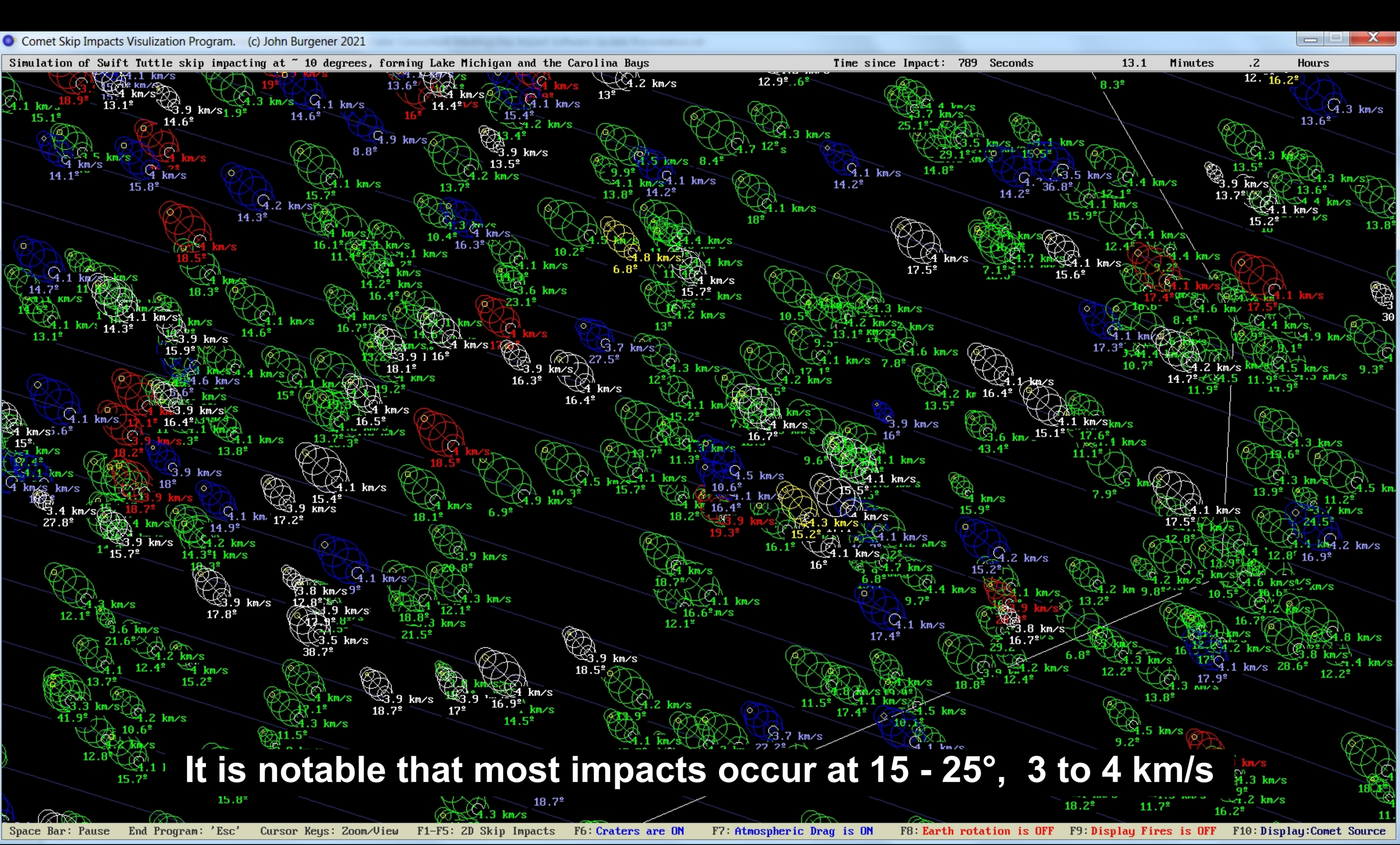
With Zooming,
one can see the details
of the secondary impacts





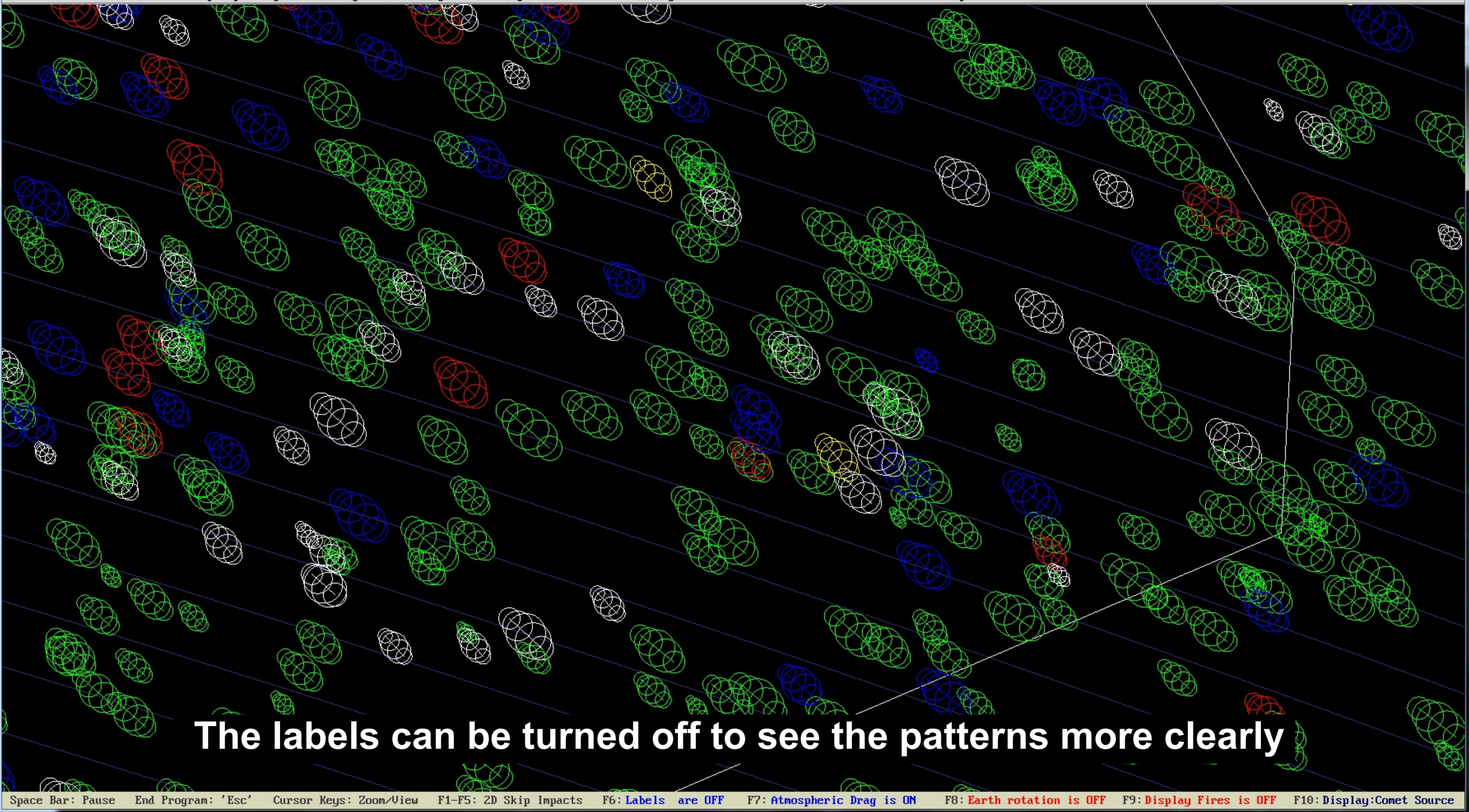


The program calculates the impact angle and speed, and the shapes of the secondary impacts


Comet Skip Impacts Visulization Program. (c) John Burgener 2021
Simulation of Swift Tuttle skip impacting at ~ 10 degrees, forming Lake Michigan and the Carolina Bays
Time since Impact: 789 Seconds 13.1 Minutes .2 Hours
It is notable that most impacts occur at 15 - 25°, 3 to 4 km/s
Space Bar: Pause End Program: 'Esc' Cursor Keys: Zoom/View F1-F5: 2D Skip Impacts F6: Craters are ON F7: Atmospheric Drag is ON F8: Earth rotation is OFF F9: Display Fires is OFF F10: Display:Comet Source

Comet Skip Impacts Visulization Program. (c) John Burgener 2021

Simulation of Swift Tuttle skip impacting at ~ 10 degrees, forming Lake Michigan and the Carolina Bays Time since Impact: 885 Seconds 14.7 Minutes .2 Hours

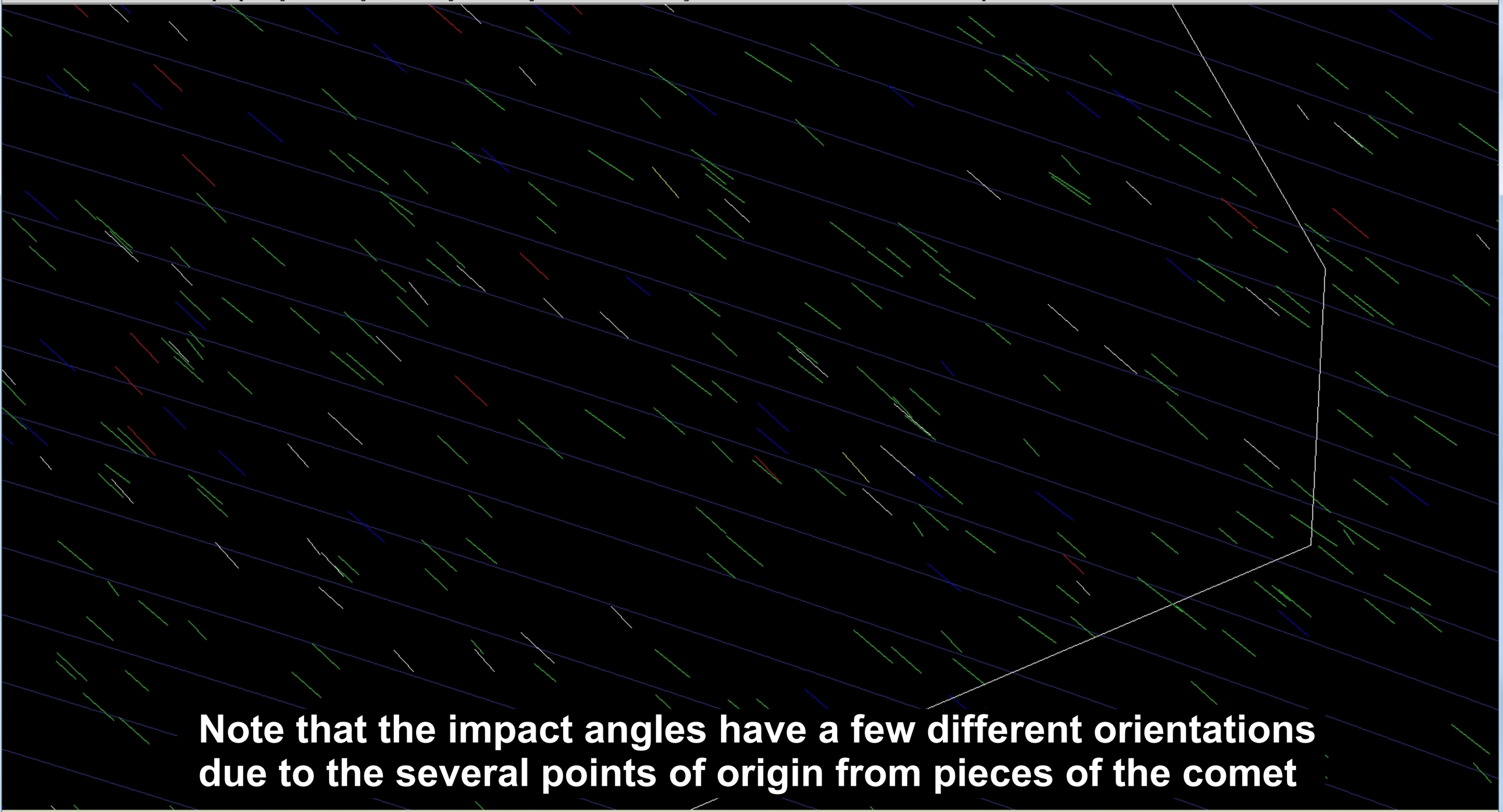


The labels can be turned off to see the patterns more clearly

Space Bar: Pause End Program: 'Esc' Cursor Keys: Zoom/View F1-F5: 2D Skip Impacts F6: Labels are OFF F7: Atmospheric Drag is ON F8: Earth rotation is OFF F9: Display Fires is OFF F10: Display:Comet Source

Comet Skip Impacts Visulization Program. (c) John Burgener 2021

Simulation of Swift Tuttle skip impacting at ~ 10 degrees, forming Lake Michigan and the Carolina Bays Time since Impact: 802 Seconds 13.3 Minutes .2 Hours



Note that the impact angles have a few different orientations due to the several points of origin from pieces of the comet

Space Bar: Pause End Program: 'Esc' Cursor Keys: Zoom/View F1-F5: 2D Skip Impacts F6: Craters are OFF F7: Atmospheric Drag is ON F8: Earth rotation is OFF F9: Display Fires is OFF F10: Display:Comet Source

https://isale-code.github.io

Search

iSALE

Menu

PLANETARY COLLISIONS IN THE EARLY SOLAR SYSTEM

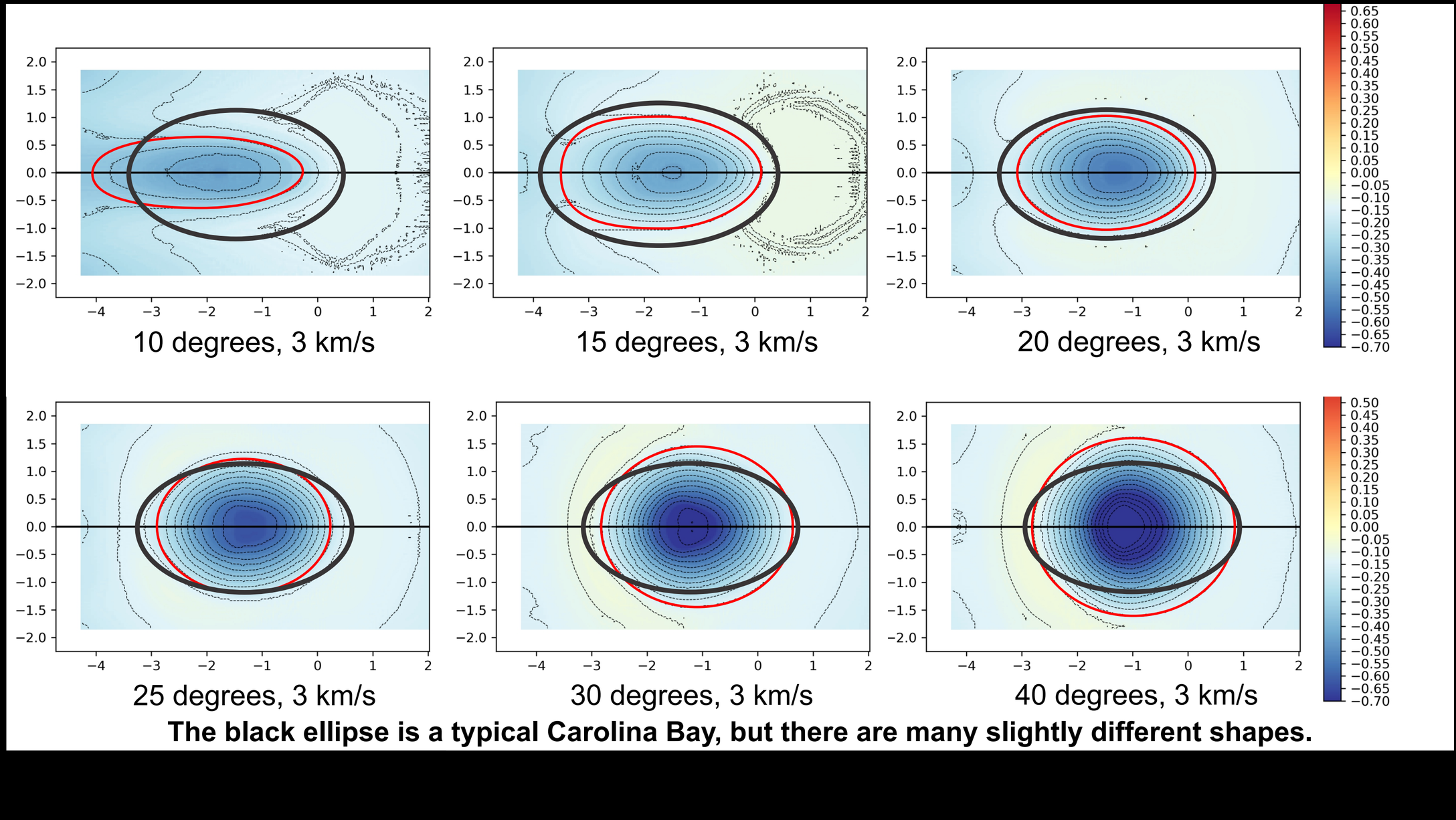
iSALE

APPLY

iSALE software is used by universities to simulate impacts on planets.

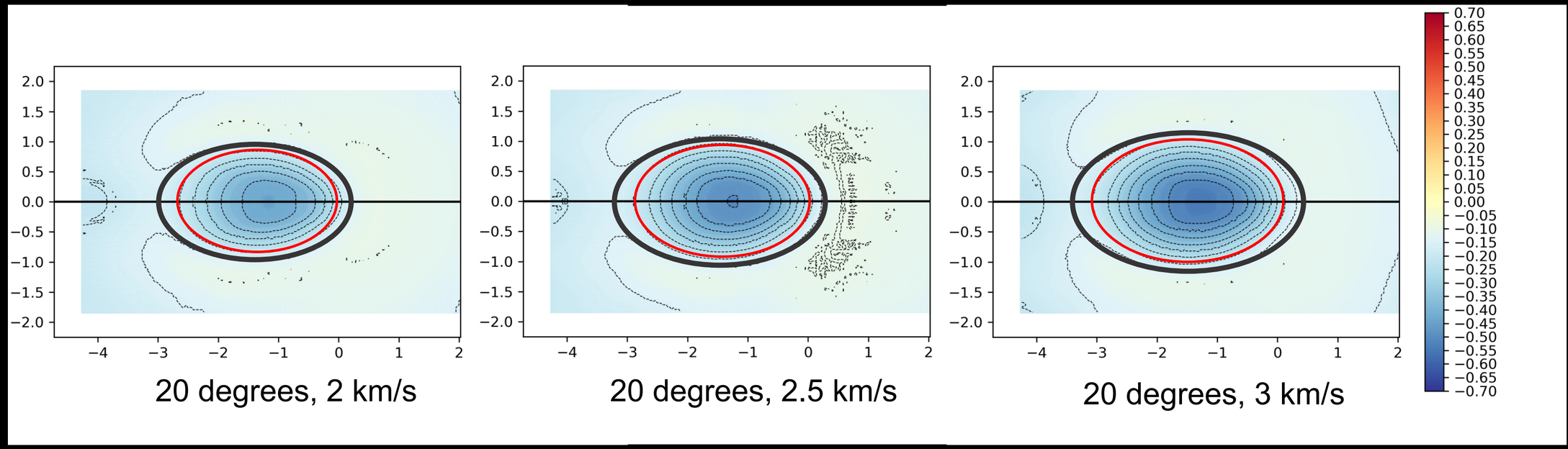
**It is recognized to produce excellent results,
matching well with observations of real craters.**

iSALE calculates a range of craters from low speed, low angle impacts:



The black ellipse is a typical Carolina Bay, but there are many slightly different shapes.

iSALE shows that minor velocity variations do not effect the crater shape as much as the impact angle:

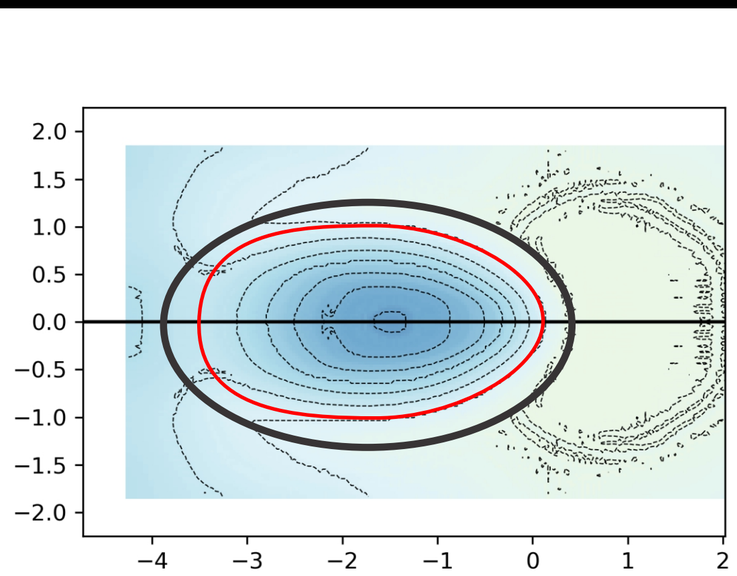


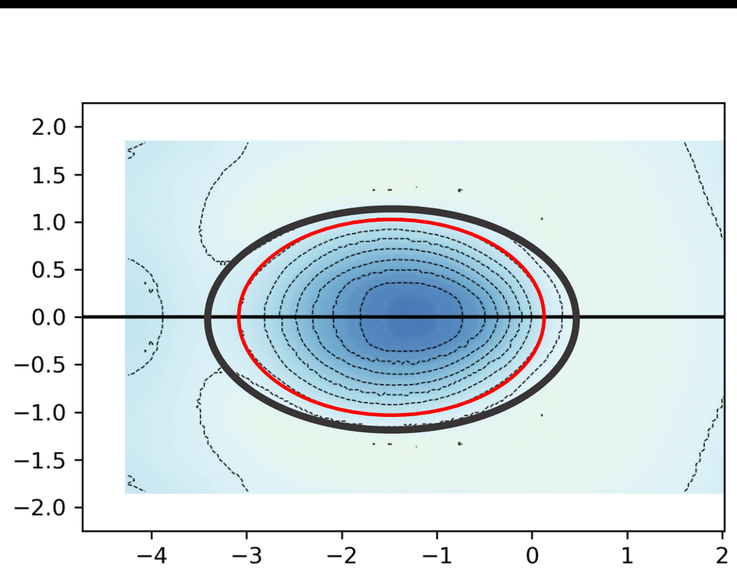
The black ellipse is a typical Carolina Bay, but many are slightly different shapes.

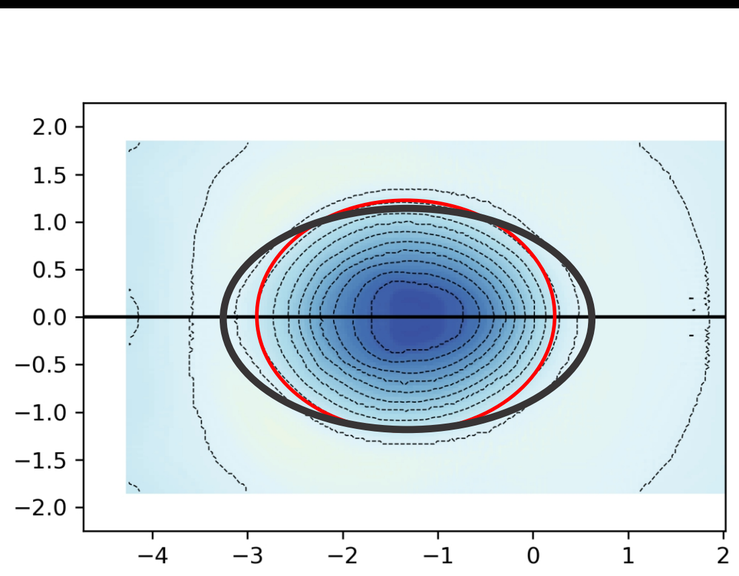
iSALE best fit craters for the Carolina Bays are:

15 - 25 degrees

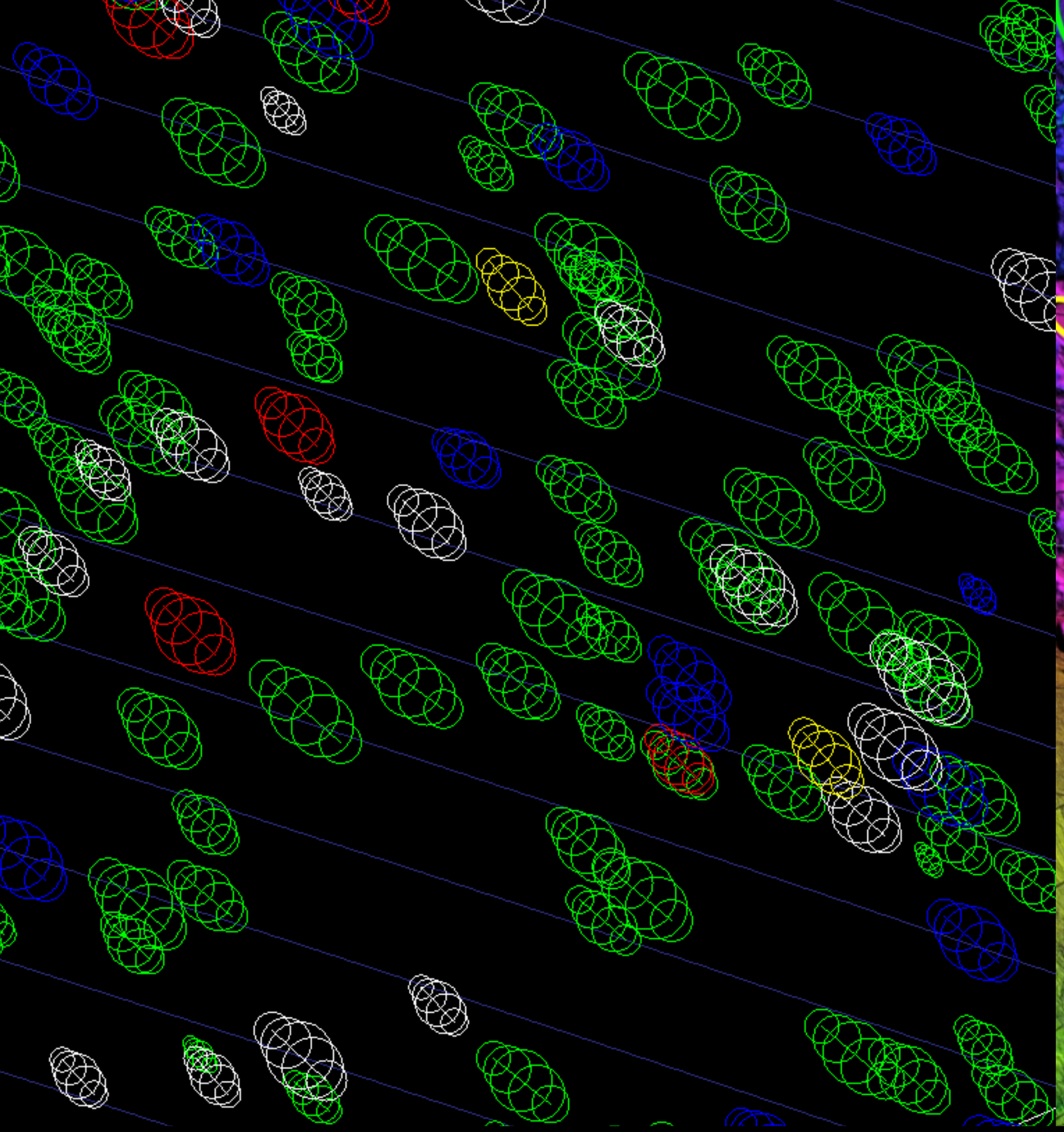
2 to 4 km/sec

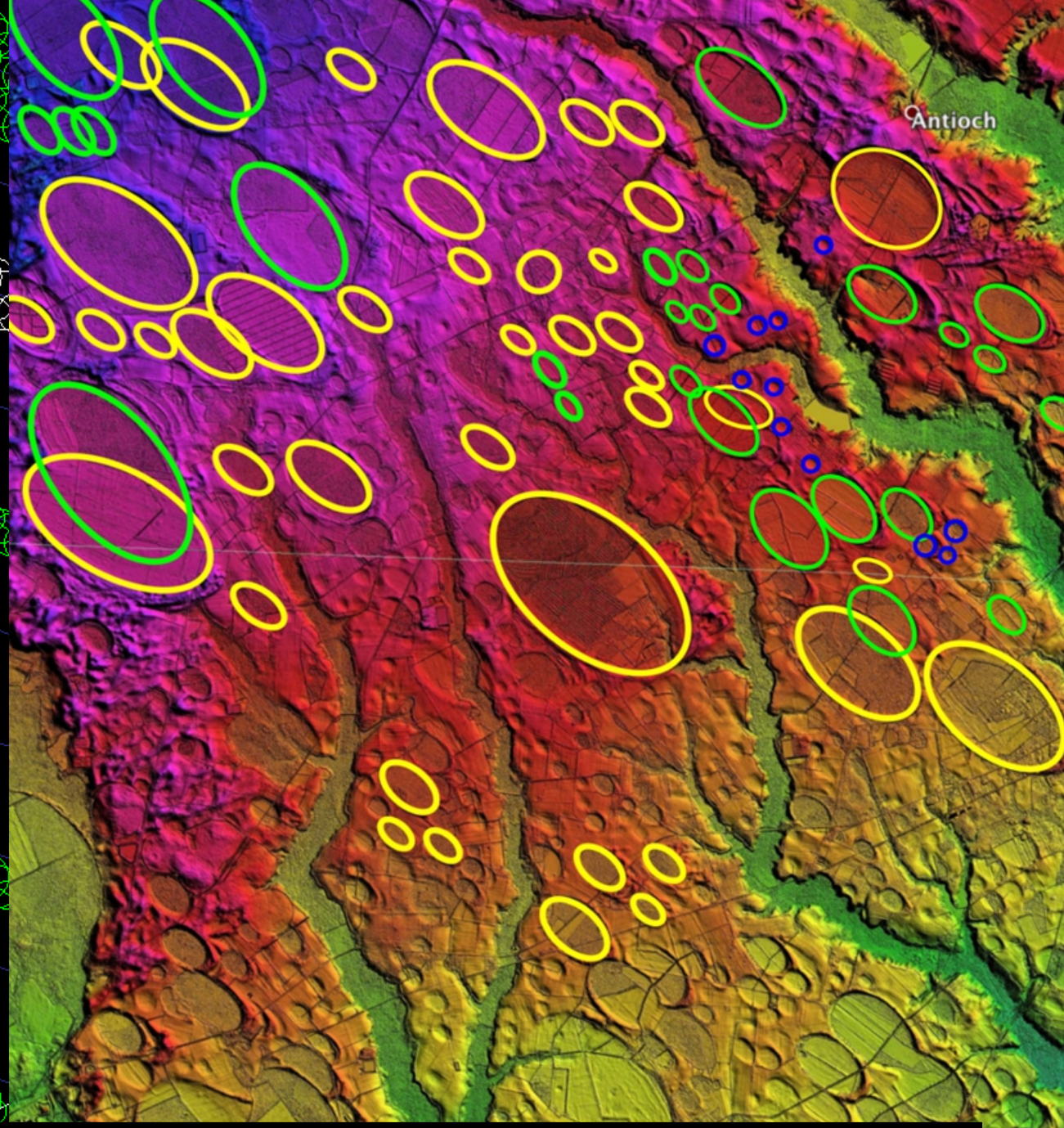






The black ellipse is a typical Carolina Bay, but many are slightly different shapes.

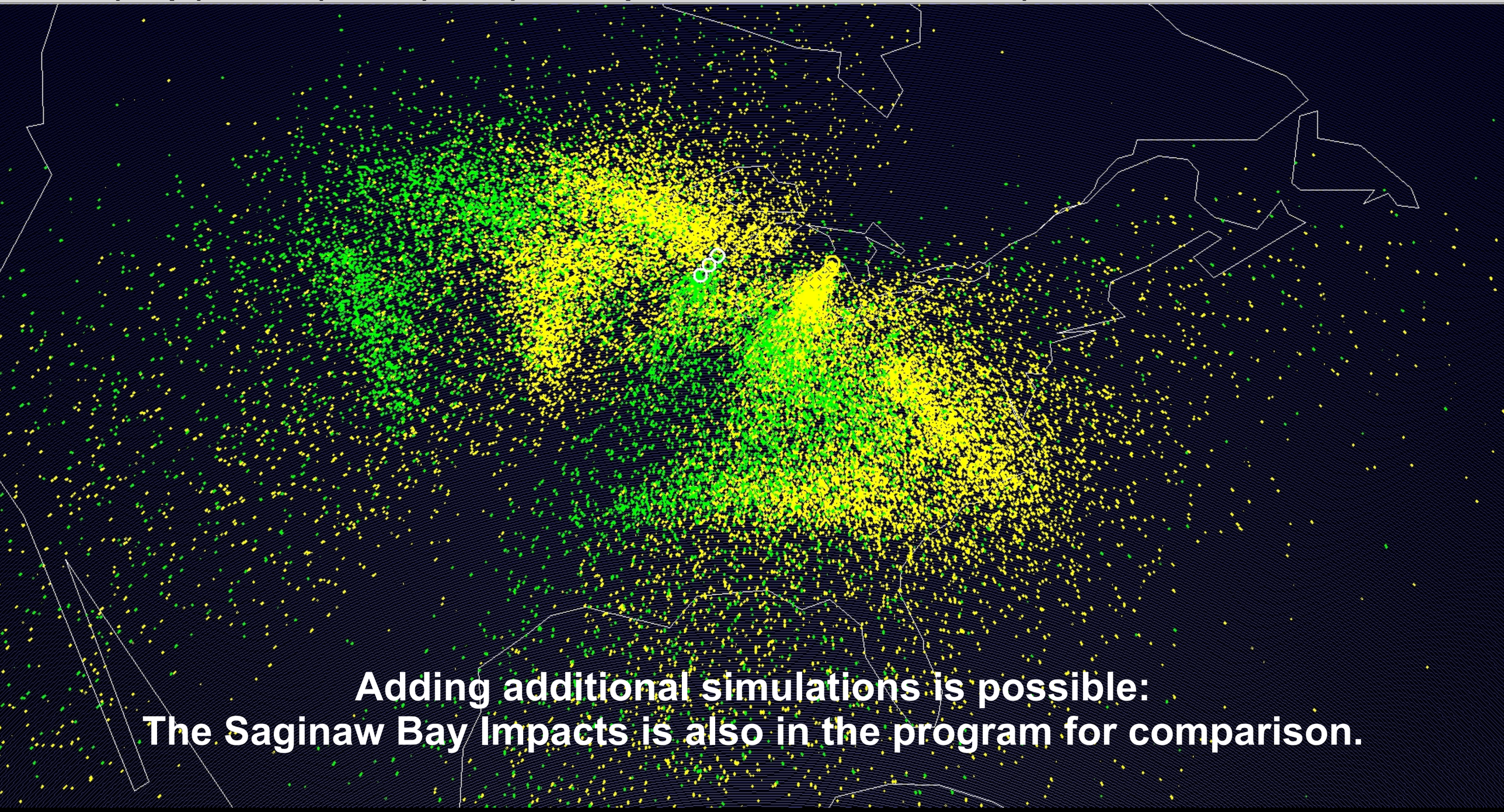




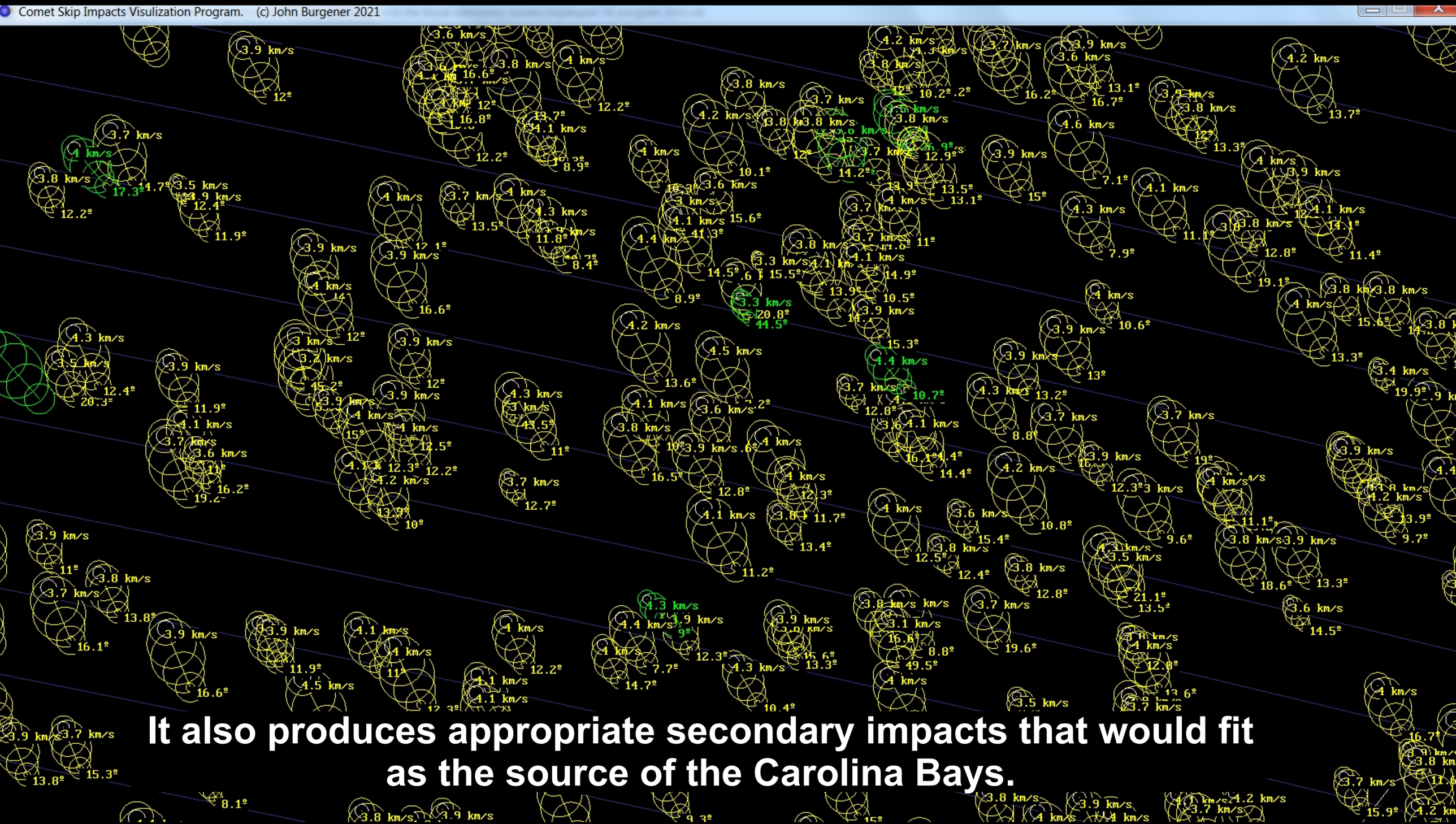
The secondary craters of the program closely match the Carolina Bays and fit the impact angles, shapes and speeds predicted by iSALE

Comet Skip Impacts Visulization Program. (c) John Burgener 2021

Simulation of Saginaw Bay Impact and second impact at ~ 20 degrees, forming the Carolina Bays Time since Impact: 1015 Seconds 16.9 Minutes .2 Hours



Adding additional simulations is possible:
The Saginaw Bay Impacts is also in the program for comparison.



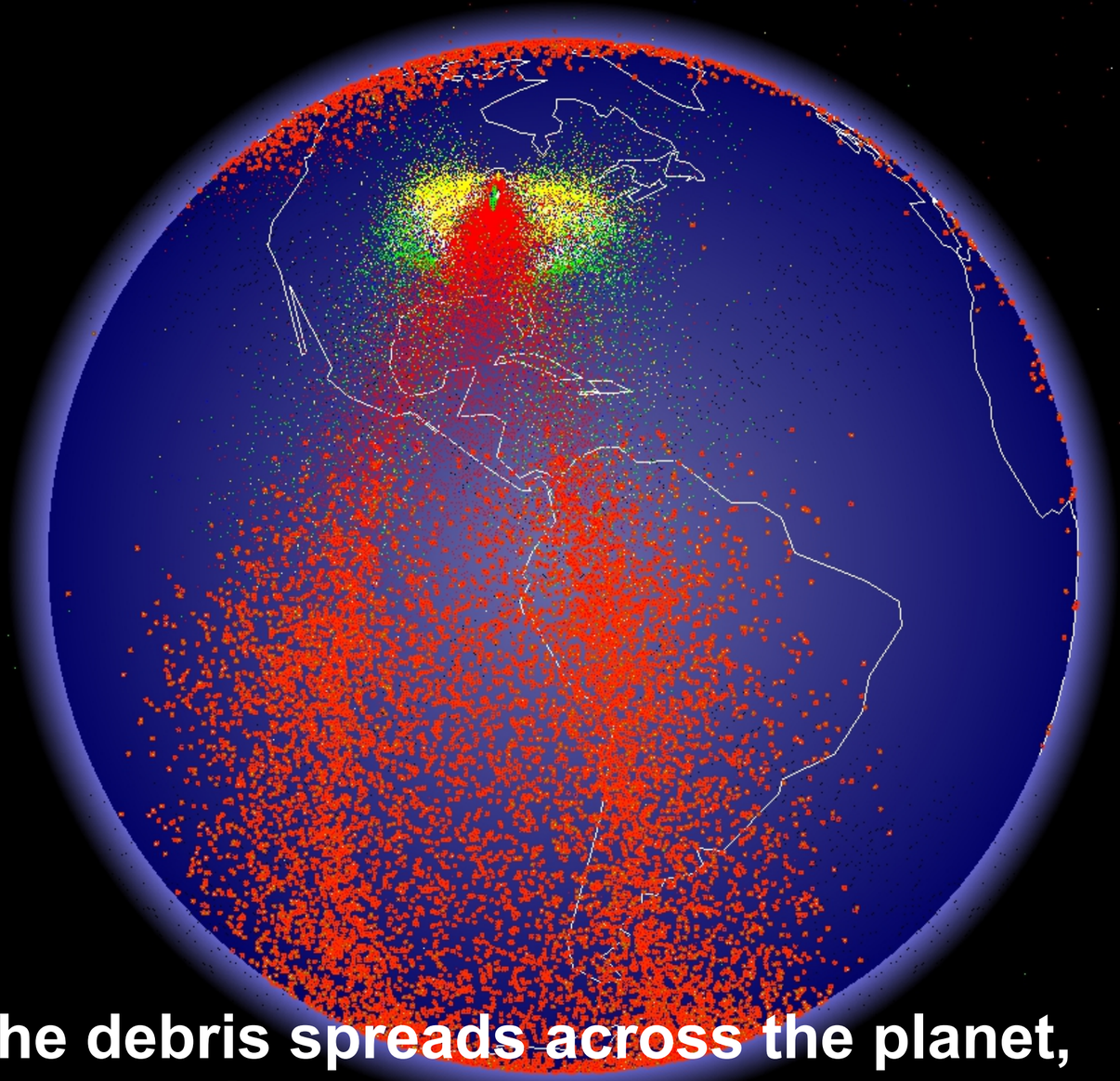
It also produces appropriate secondary impacts that would fit as the source of the Carolina Bays.

The program includes atmospheric drag, and can show which pieces land at higher speeds, burning in the atmosphere.

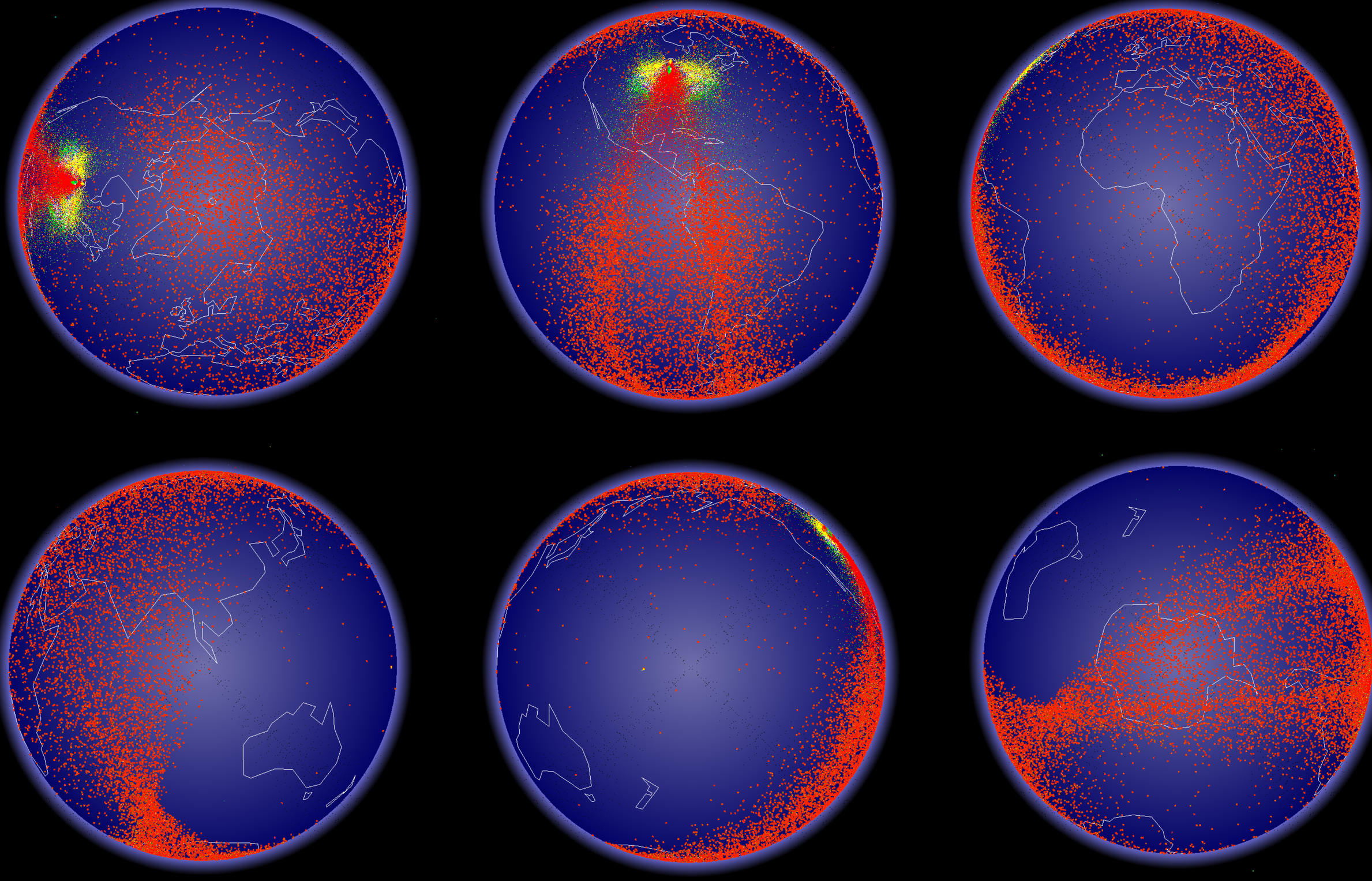
The atmospheric drag is based on US Standard Atmosphere, with a drag coefficient of 1.0, for objects of ice at a mass of 1.
(from US Standard Atmosphere charts of 1976 - us-standard-atmosphere_st76-1562_noaa.pdf)

Comet Skip Impacts Visulization Program. (c) John Burgener 2021

Simulation of Swift Tuttle skip impacting at ~ 10 degrees, forming Lake Michigan and the Carolina Bays Time since Impact: 19061 Seconds 317.6 Minutes 5.2 Hours 300

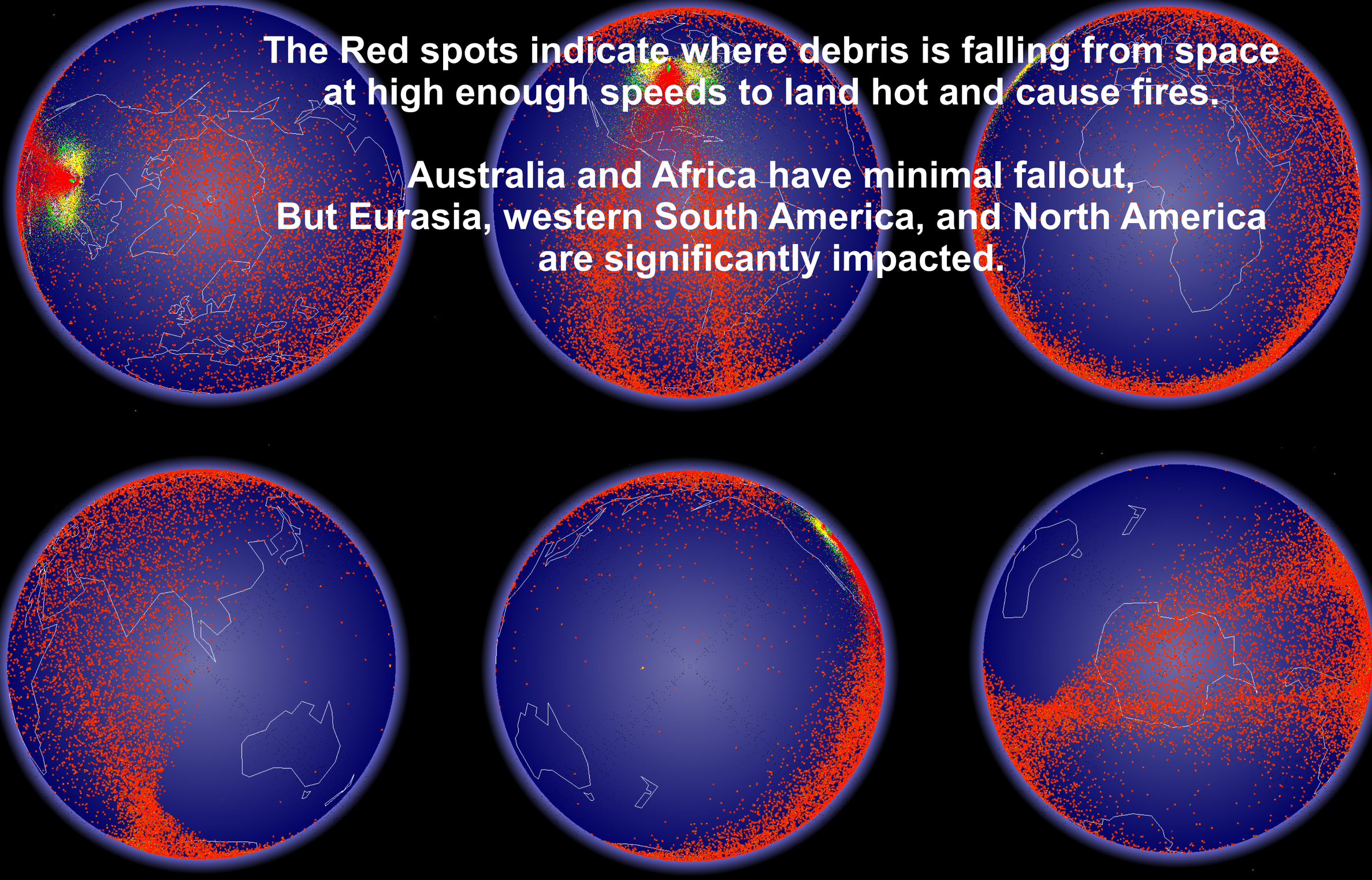


The debris spreads across the planet,
with the majority landing at high speeds, and very hot.



The Red spots indicate where debris is falling from space
at high enough speeds to land hot and cause fires.

Australia and Africa have minimal fallout,
But Eurasia, western South America, and North America
are significantly impacted.



A comment on the program's selection of waves for the comet splashes.

Some waves are highly focused in a small range of movement.

Some waves are less focused, but still are clearly defined.

Some waves are simply total chaos.

The 3D skip Impact program uses four styles of waves / tossed debris:

1. Shock wave with debris tossed in all directions.
   Typically shock waves will push out debris more horizontally than vertically, but the shock wave is spherical and can toss in any direction, including backwards.

2. Push ahead of the comet with debris mainly tossed forward, at close to comet speeds.

3. Bow Wave with debris tossed sideways in a typically focused wave

4. Bow Wave with debris tossed forwards and sideways, in a typically focused wave.

Shock waves will toss at speeds according to the speed of shock waves and speed of sound.
Push Ahead debris will be tossed at comet speeds +/- about half.
Bow waves will be tossed at speeds mixed with comet forward motion, shock wave speeds, and debris getting in the way of other debris, so typically much slower than the comet.

The program uses a mix of the above in its calculations.

With such variations happening, it is apparent that the program's debris waves will NOT be perfectly accurate.

However, the point of the program is to answer the question:

Can a skip impact produce secondary impacts from the debris?

The answer is definitely YES.

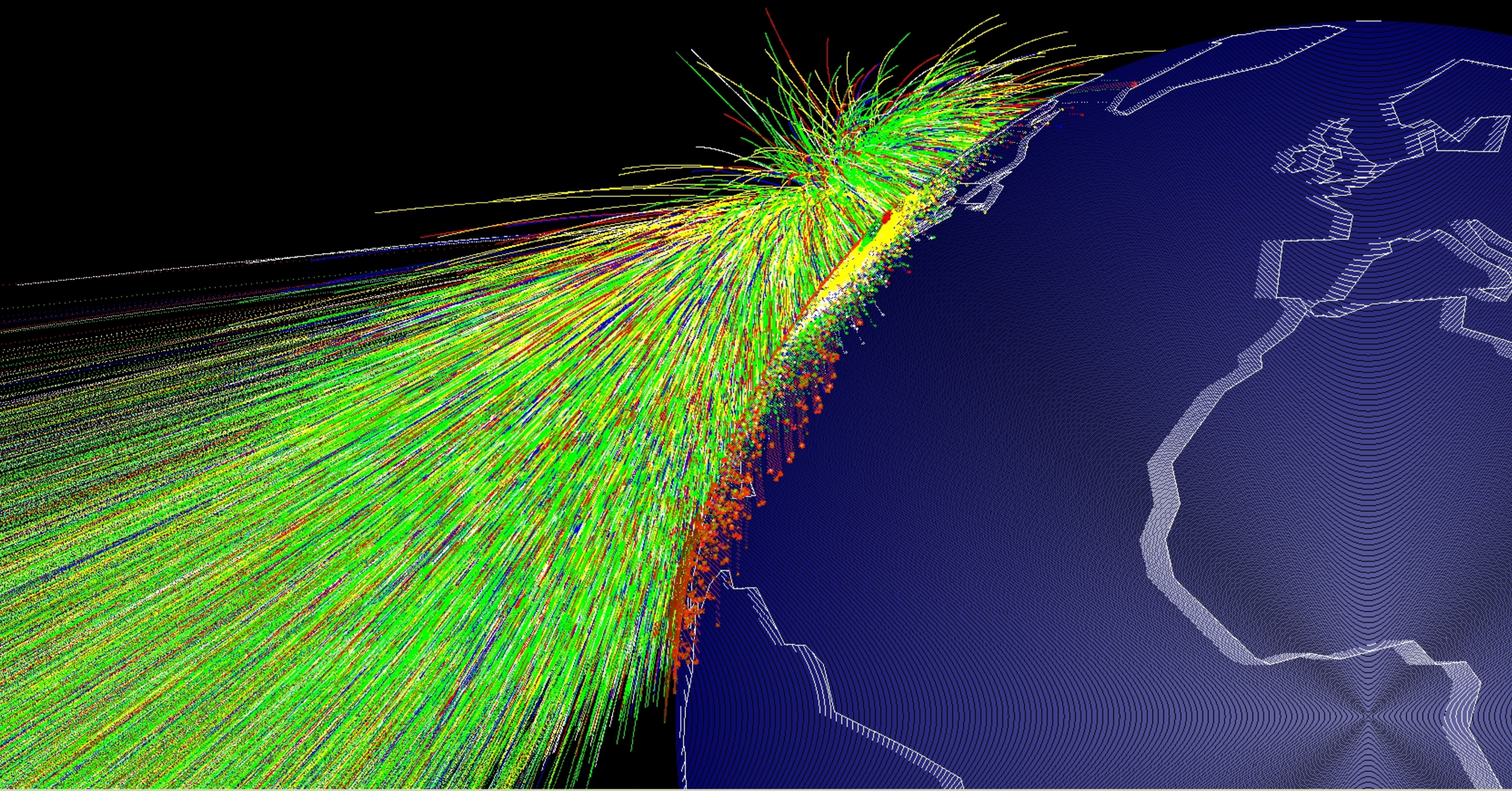
How much debris lands in the Carolina Bays area and forms mini craters depends on the size of the comet, the nature of the debris being tossed and the nature of the land it falls on. But a large comet forming Lake Michigan or the Saginaw crater COULD send debris that fits the size, speeds and impact angles required to form the Carolina Bays.

Some extra features in the program

p Impacts Visulization Program. (c) John Burgener 2021

of Swift Tuttle skip impacting at ~ 10 degrees, forming Lake Michigan and the Carolina Bays Time since Impact: 568 Seconds 9.4 Minutes .1 Hours

Optional ray paths show the flight paths of the debris

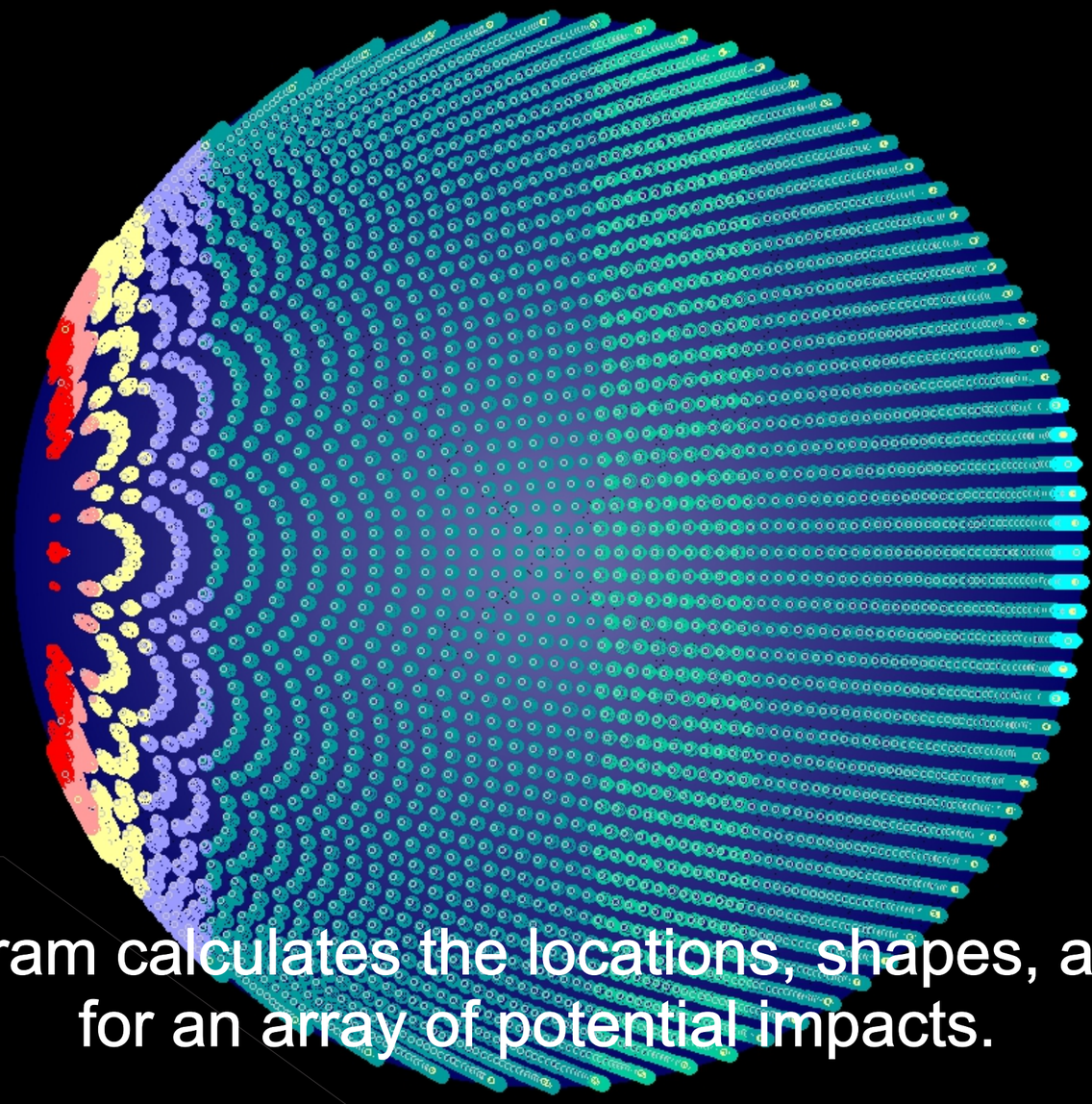


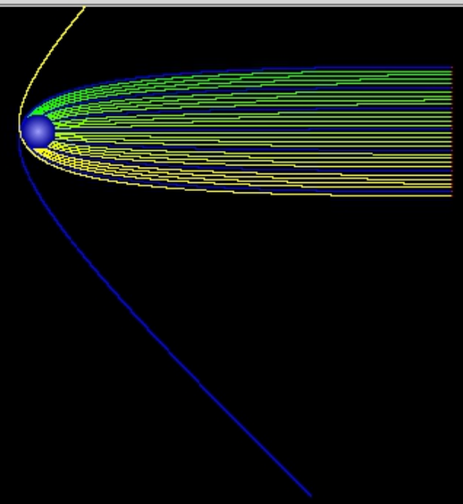
Pause End Program: 'Esc' Cursor Keys: Zoom/View F1-F5: 2D Skip Impacts F6: Craters are ON F7: Atmospheric Drag is OFF F8: Earth rotation is ON F9: Display Fires is ON F10: Display:Comet Sourc

Comet Skip Impacts Visulization Program. (c) John Burgener 2021

Comet Diameter: 40 km Initial Speed: 3 km/s Total # calculated: 5318 Impact Speed: 11.38 km/s Impact Angle: 77.93 approx # Comets in Calculation 9828

Impact Angles
0 - 2
2 - 5
5 - 10
10 - 15
15 - 20
20 - 30
30 - 40
40 - 50
50 - 60
60 - 70
70 - 80
80 - 90





40 km diameter comets,
Approach speed of 3 km/s

The new 3D program calculates the locations, shapes, and impact angles for an array of potential impacts.

		Skip	Elliptical			Slightly Elliptical			Near Circular				Circular							
	Missed	0-5	5-10	10-15	15-20	20-25	25-30	30-35	35-40	40-45	45-50	50-55	55-60	60-65	65-70	70-75	75-80	80-85	85-90	Totals	
# Impacts	1339	62	77	136	186	232	269	308	314	336	332	318	316	292	242	219	150	112	78	5318	# calculated
% Missed	25.29																				
% Impacted		1.5	1.9	3.4	4.6	5.8	6.7	7.7	7.8	8.4	8.3	7.9	7.9	7.3	6.0	5.5	3.7	2.8	1.9	3979	# Impacting

The images of this option show the planet covered with craters.

They are created by setting up an array of thousands of comets approaching Earth in a grid array, spaced several comet diameters apart. They are all started at selectable initial speeds, 200,000 km from Earth and allowed to have gravity pull them to Earth or past Earth.

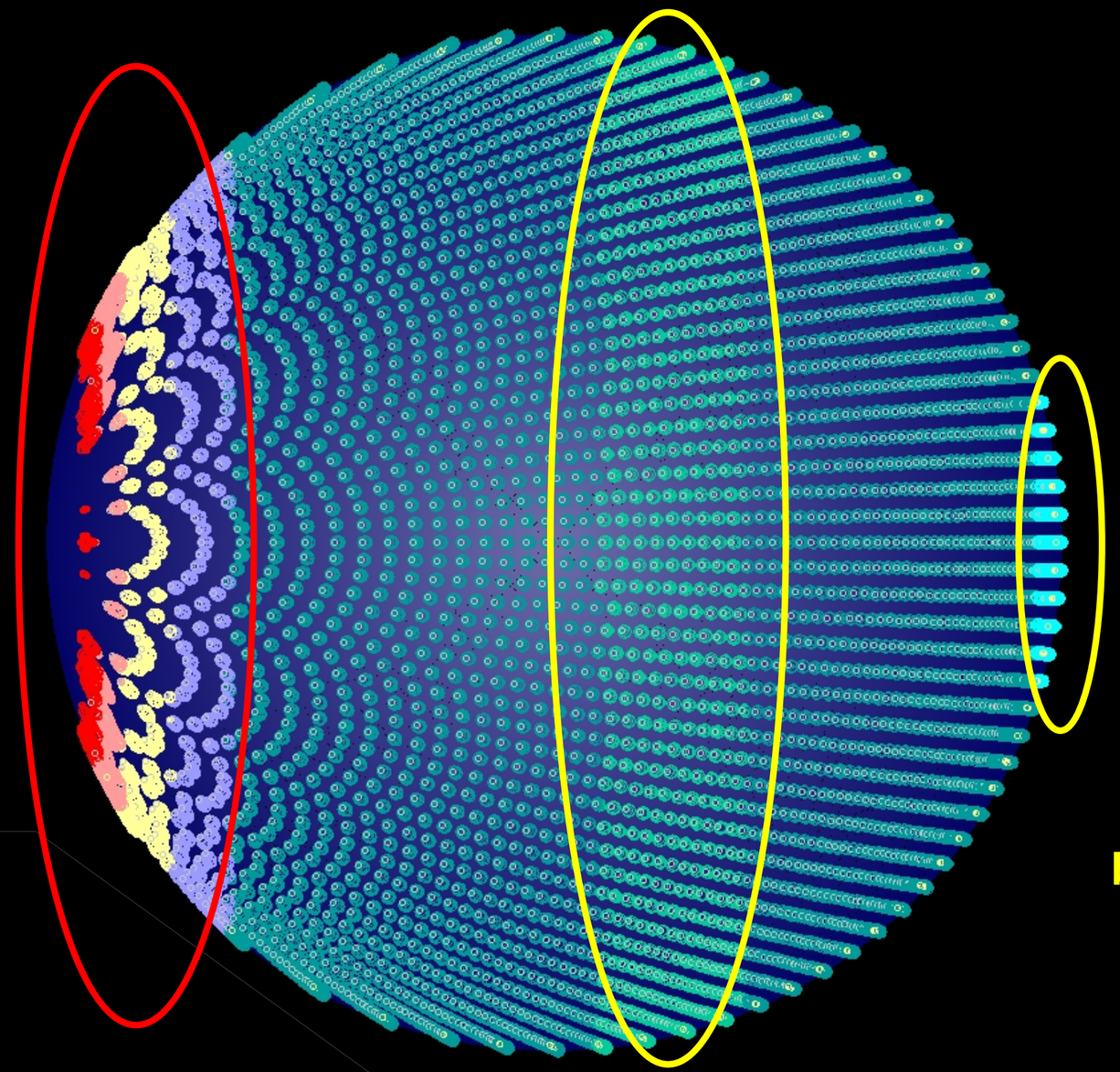
The result is a planet covered with craters with impact angles ranging from 0 to 90 degrees, and shapes from circles to long sausage shapes.

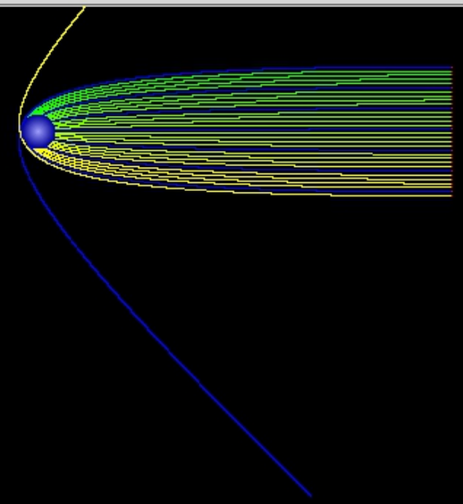
The craters are calculated as circles of twice the size of the portion hitting Earth during each calculation.

Comet Skip Impacts Visulization Program. (c) John Burgener 2021

Comet Diameter: 40 km | Initial Speed: 3 km/s | Total # calculated: 5318 | Impact Speed: 11.38 km/s | Impact Angle: 77.93 | approx # Comets in Calculation 9828

Impact Angles
- 0 - 2
- 2 - 5
- 5 - 10
- 10 - 15
- 15 - 20
- 20 - 30
- 30 - 40
- 40 - 50
- 50 - 60
- 60 - 70
- 70 - 80
- 80 - 90





Low Angle Impacts are seldom studied but are a significant portion of impacts.

90° and 40-50° impacts are the most studied, but are a small part of the potential impacts.

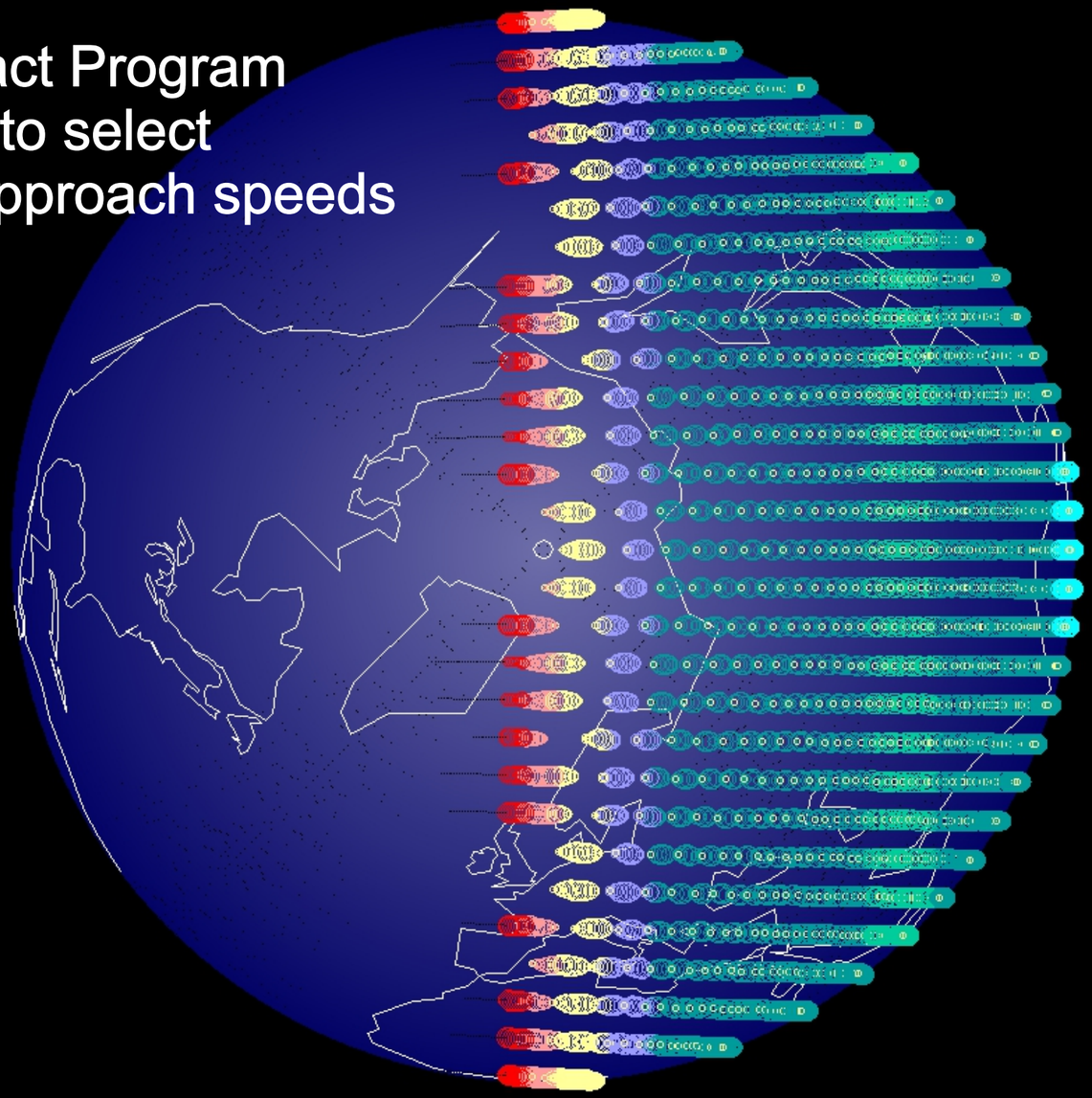
		Skip	Elliptical			Slightly Elliptical				Near Circular				Circular						
	Missed	0-5	5-10	10-15	15-20	20-25	25-30	30-35	35-40	40-45	45-50	50-55	55-60	60-65	65-70	70-75	75-80	80-85	85-90	Totals	
# Impacts	1339	62	77	136	186	232	269	308	314	336	332	318	316	292	242	219	150	112	78	5318	# calculated
% Missed	25.29																				
% Impacted		1.5	1.9	3.4	4.6	5.8	6.7	7.7	7.8	8.4	8.3	7.9	7.9	7.3	6.0	5.5	3.7	2.8	1.9	3979	# Impacting

Comet Skip Impacts Visulization Program. (c) John Burgener 2021

Comet Diameter: 60 km Initial Speed: 30 km/s Impact Speed: 31.94 km/s approx # Comets in Calculation 3813

Impact Angles
0 - 2
2 - 5
5 - 10
10 - 15
15 - 20
20 - 30
30 - 40
40 - 50
50 - 60
60 - 70
70 - 80
80 - 90

The Skip Impact Program
allows you to select
comet sizes and approach speeds

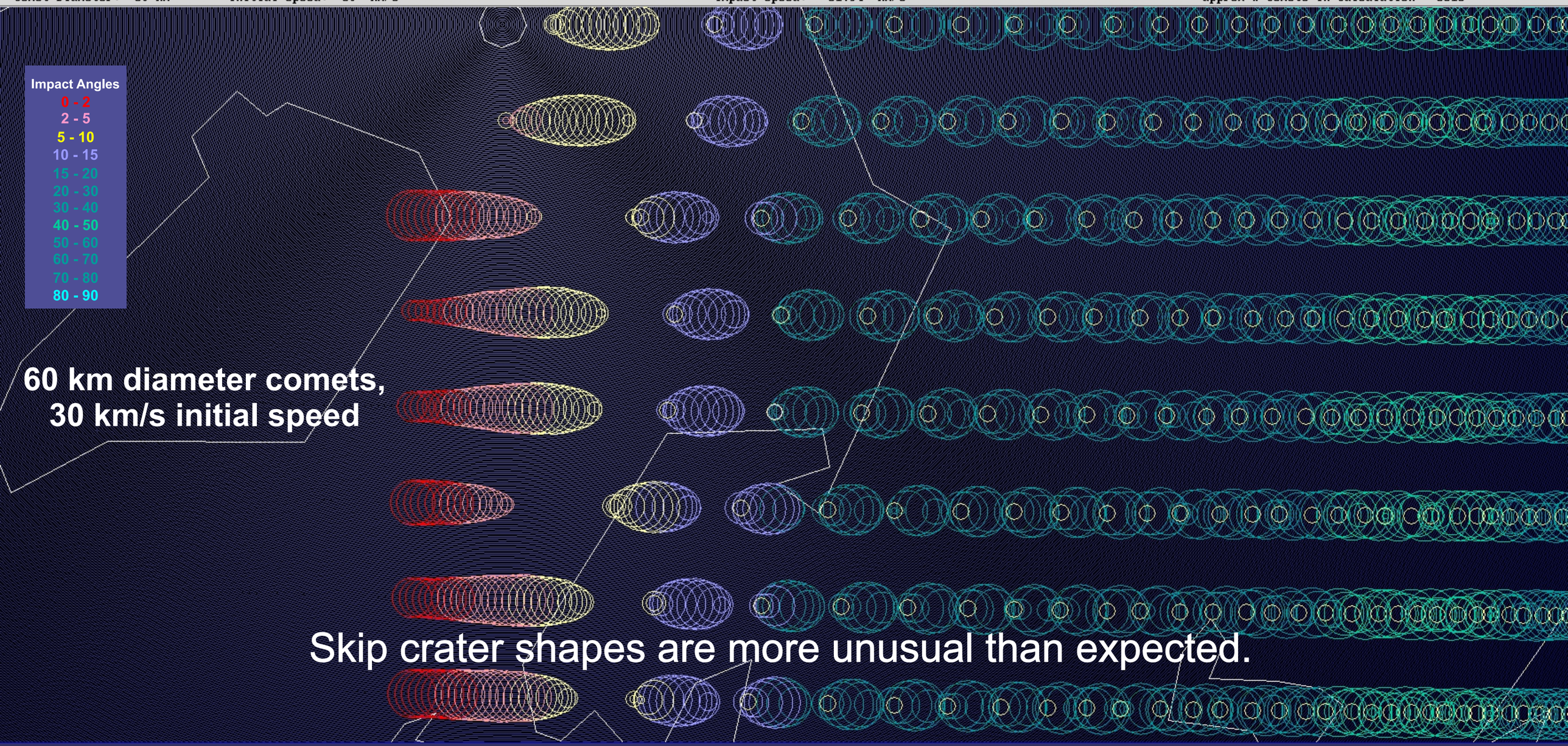


60 km diameter comets,
Approach speed of 30 km/s

		Skip	Elliptical		Slightly Elliptical				Near Circular				Circular							
	Missed	0-5	5-10	10-15	15-20	20-25	25-30	30-35	35-40	40-45	45-50	50-55	55-60	60-65	65-70	70-75	75-80	80-85	85-90	Totals	
# Impacts	1245	84	48	90	112	160	170	190	220	226	190	206	198	182	162	118	86	54	41	3782	# calculated
% Missed	32.91																				
% Impacted		3.3	1.8	3.5	4.4	6.3	6.7	7.4	8.6	8.9	7.4	8.1	7.8	7.1	6.3	4.6	3.3	2.1	1.6	2537	# Impacting

Comet Skip Impacts Visulization Program. (c) John Burgener 2021

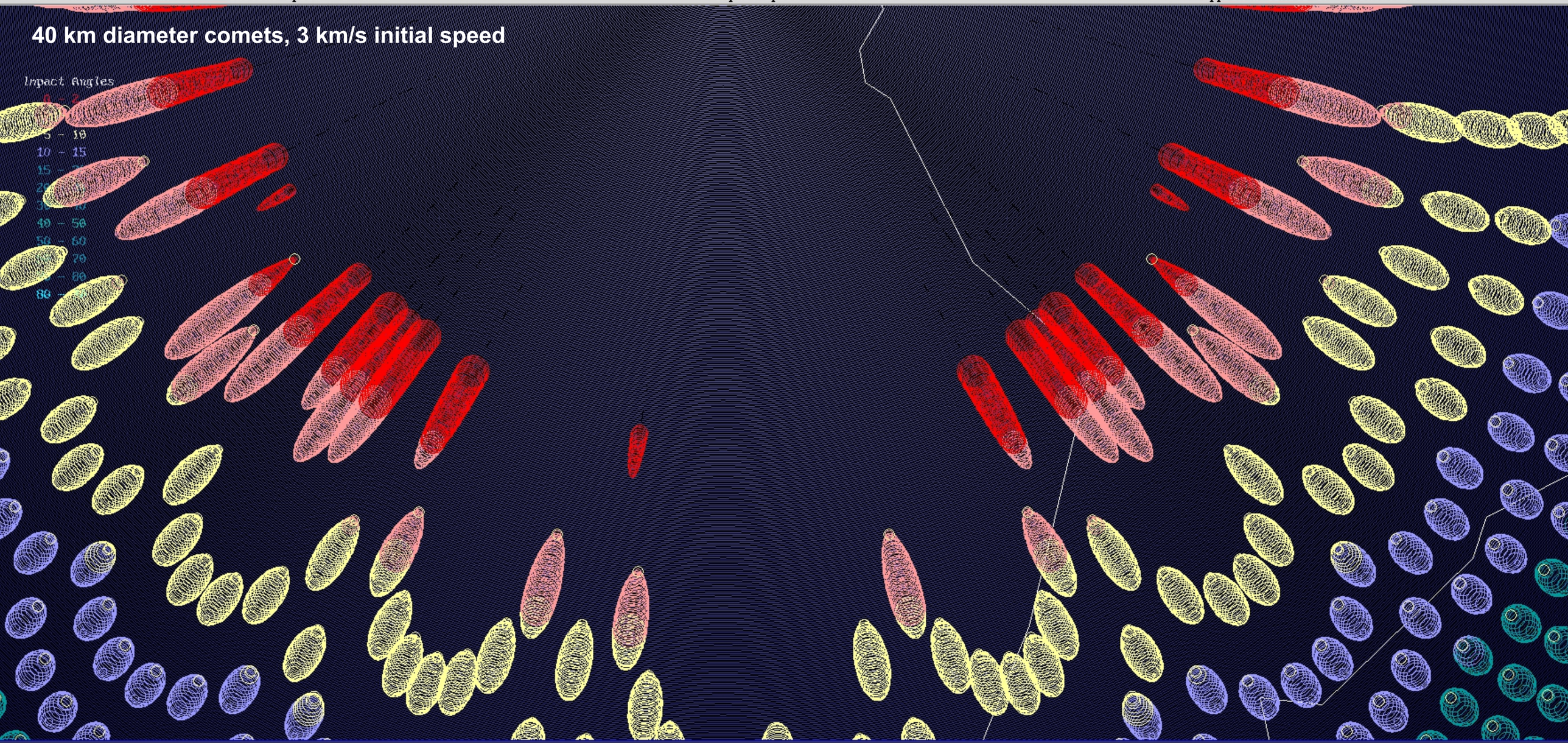
Comet Diameter: 60 km Initial Speed: 30 km/s Impact Speed: 31.94 km/s approx # Comets in Calculation 3813



		Skip	Elliptical		Slightly Elliptical			Near Circular				Circular								
	Missed	0-5	5-10	10-15	15-20	20-25	25-30	30-35	35-40	40-45	45-50	50-55	55-60	60-65	65-70	70-75	75-80	80-85	85-90	Totals	
# Impacts	1245	84	48	90	112	160	170	190	220	226	190	206	198	182	162	118	86	54	41	3782	# calculated
% Missed	32.91																				
% Impacted		3.3	1.8	3.5	4.4	6.3	6.7	7.4	8.6	8.9	7.4	8.1	7.8	7.1	6.3	4.6	3.3	2.1	1.6	2537	# Impacting

Comet Skip Impacts Visulization Program. (c) John Burgener 2021

Comet Diameter: 40 km Initial Speed: 3 km/s Impact Speed: 11.38 km/s approx # Comets in Calculation 9828



		Skip	Elliptical				Slightly Elliptical				Near Circular				Circular					
	Missed	0-5	5-10	10-15	15-20	20-25	25-30	30-35	35-40	40-45	45-50	50-55	55-60	60-65	65-70	70-75	75-80	80-85	85-90	Totals	
# Impacts	2652	106	146	270	348	438	510	566	596	626	612	584	574	512	432	360	248	164	84	9828	# calculated
% Missed	26.98																				
% Impacted		1.4	2.0	3.7	4.8	6.1	7.1	7.8	8.3	8.7	8.5	8.1	7.9	7.1	6.0	5.0	3.4	2.2	1.1	7176	# Impacting

Interactive Comet Craters:

Comet Skip Impacts Visulization Program. (c) John Burgener 2021

Comet Diameter: 80 km Initial Speed & Angle: 30 km/s 0° Impact Speed & Angle: 31.2 km/s 6.8° Start X: 15000 km Start Y: 6500 km Time: 248

Interactive Comet Craters:
Lets you set your own parameters,
and see the impact in progress.

Lower scene is the View from Above. Upper scene is the View from the side. Relative depth of crater is shown in red, indicating a comet particle hitting an Earth particle with no shock effects.

Space Bar: Pause Stop Program: 'Esc' 0-9 keys:Comet speed F6:Comet Radius F9: Shock Effect 2X or 4X F10: Show Flying Debris F11: Show Debris on Planet F12: Show Giant Comet Set X,Y: Press 'L'

Comet Skip Impacts Visulization Program. (c) John Burgener 2021

Comet Diameter: 80 km | Initial Speed & Angle: 30 km/s 0° | Impact Speed & Angle: 31.2 km/s .2° | Start X: 15000 km | Start Y: 6500 km | Time: 195

Interactive Comet Craters:

Impact Initial Settings

X Initial Position: km
15000

X Initial Speed: km/s
-30

Y Initial Position: km
6500

Y Initial Speed: km/s
.2

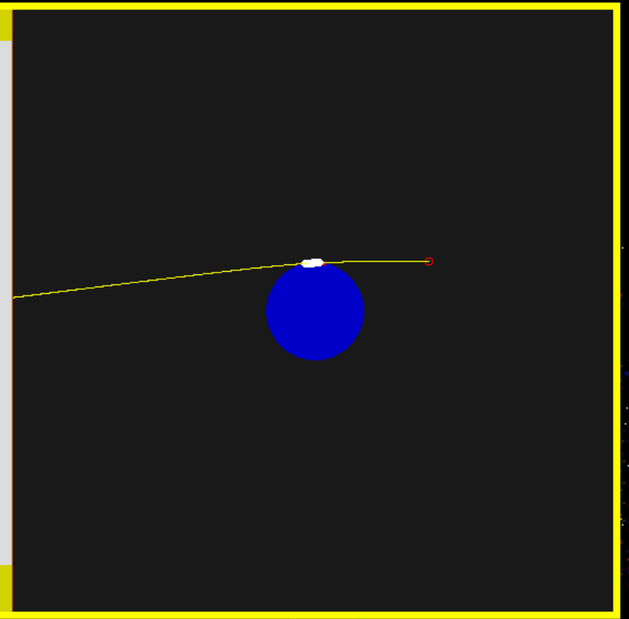
Comet Radius: km
40

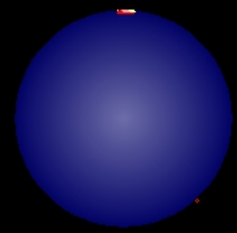
Impact at 7.9°

Change File Name for Screen Saves
D:/CometImages/

Cancel Settings | Run Selection

Use cursors to move or mouse to select
Press 'Return' to move down to next item

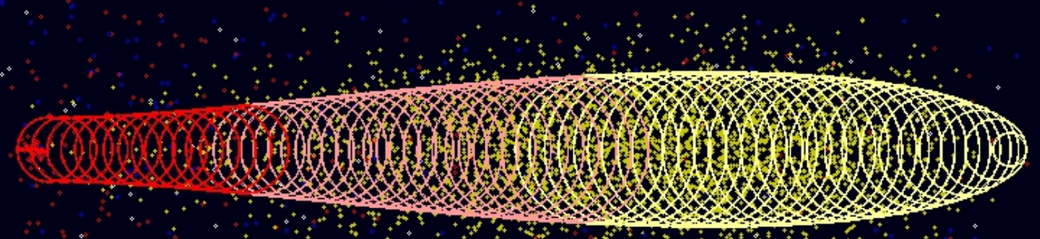




Menu to set comet size, position, speed

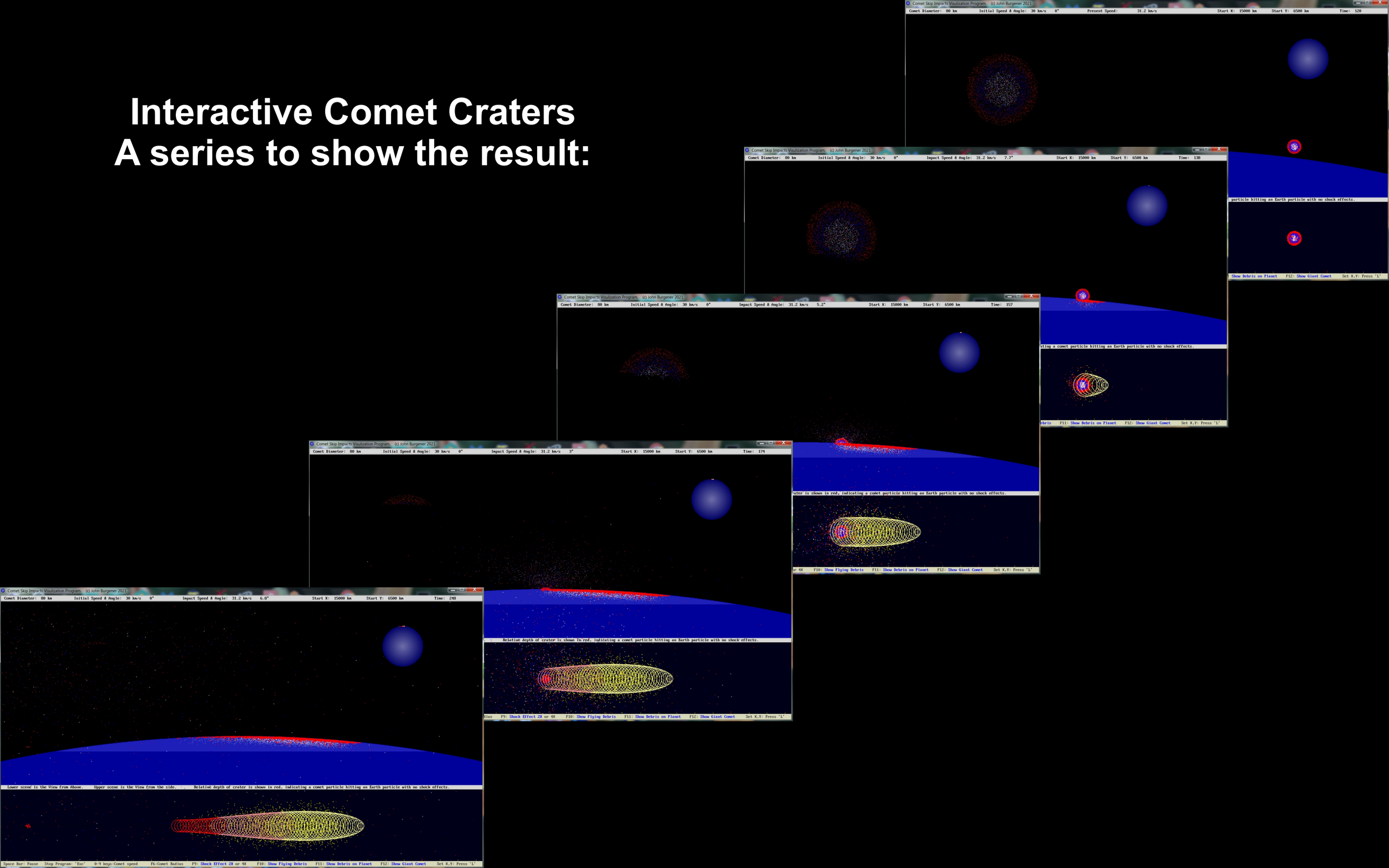
Display to show impact in progress and resultant crater

Lower scene is the View from Above. Upper scene is the View from the side. Relative depth of crater is shown in red, indicating a comet particle hitting an Earth particle with no shock effects.

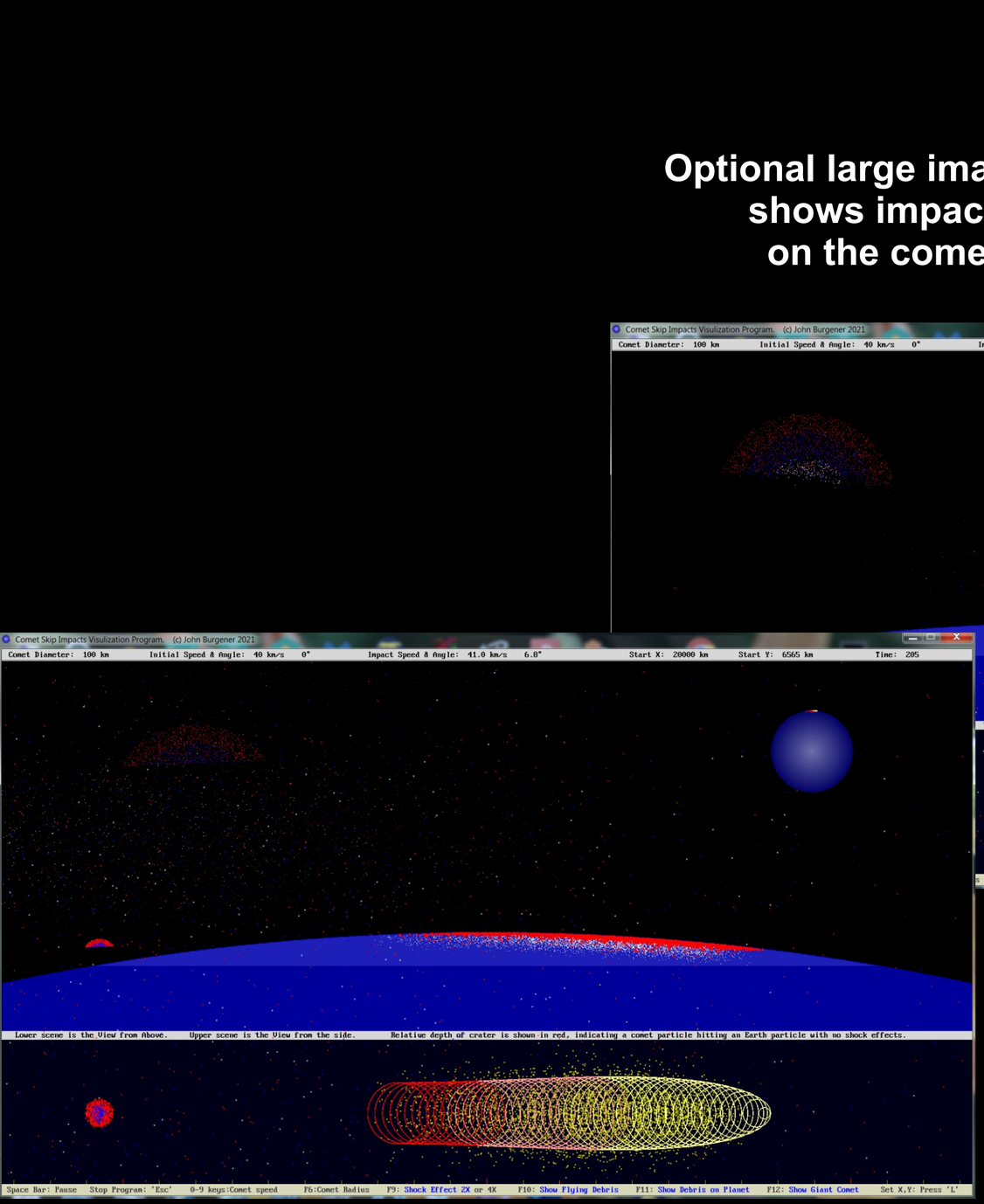


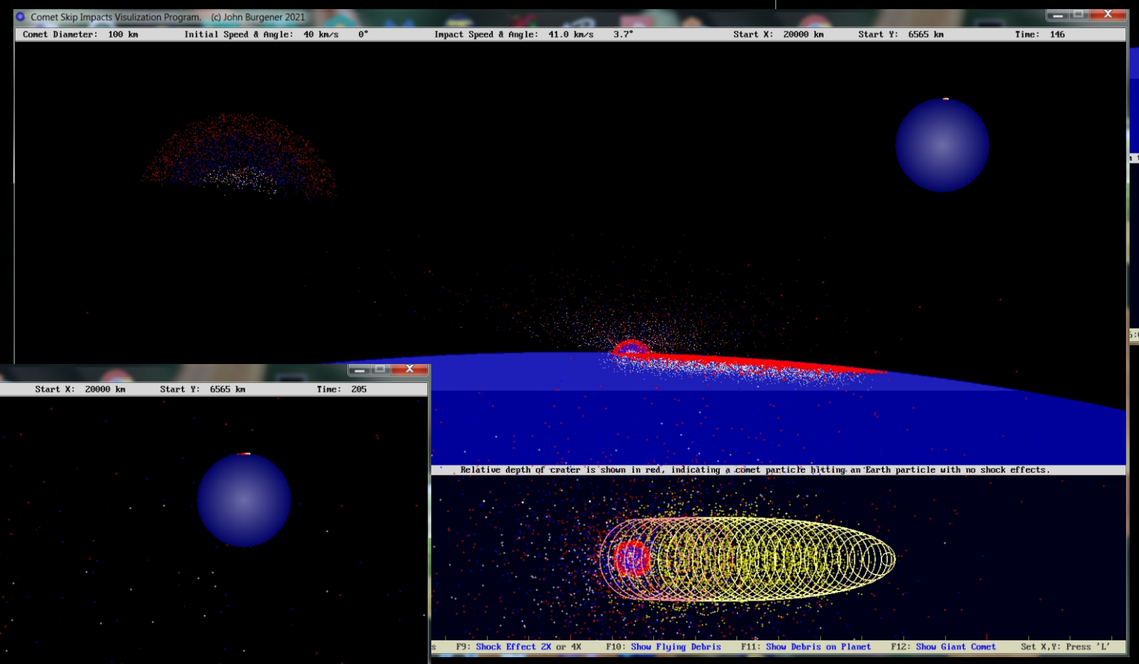
Space Bar: Pause | Stop Program: 'Esc' | 0-9 keys:Comet speed | F6:Comet Radius | F9: Shock Effect 2X or 4X | F10: Show Flying Debris | F11: Show Debris on Planet | F12: Show Giant Comet | Set X,Y: Press 'L'

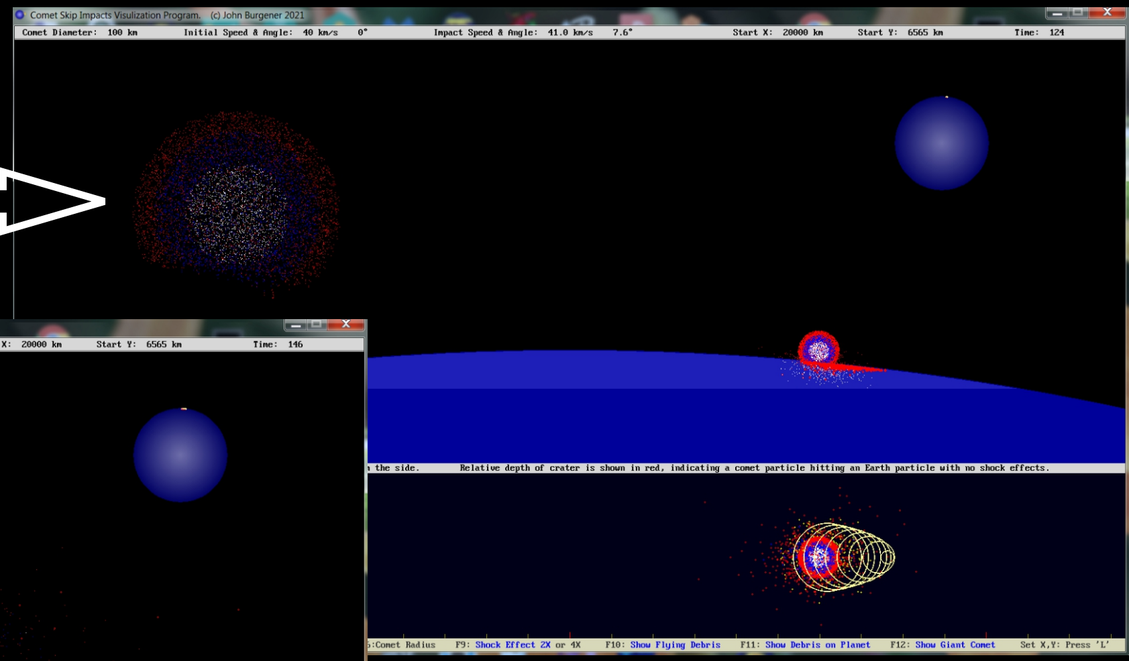
Interactive Comet Craters
A series to show the result:



Optional large image of comet shows impact action on the comet itself

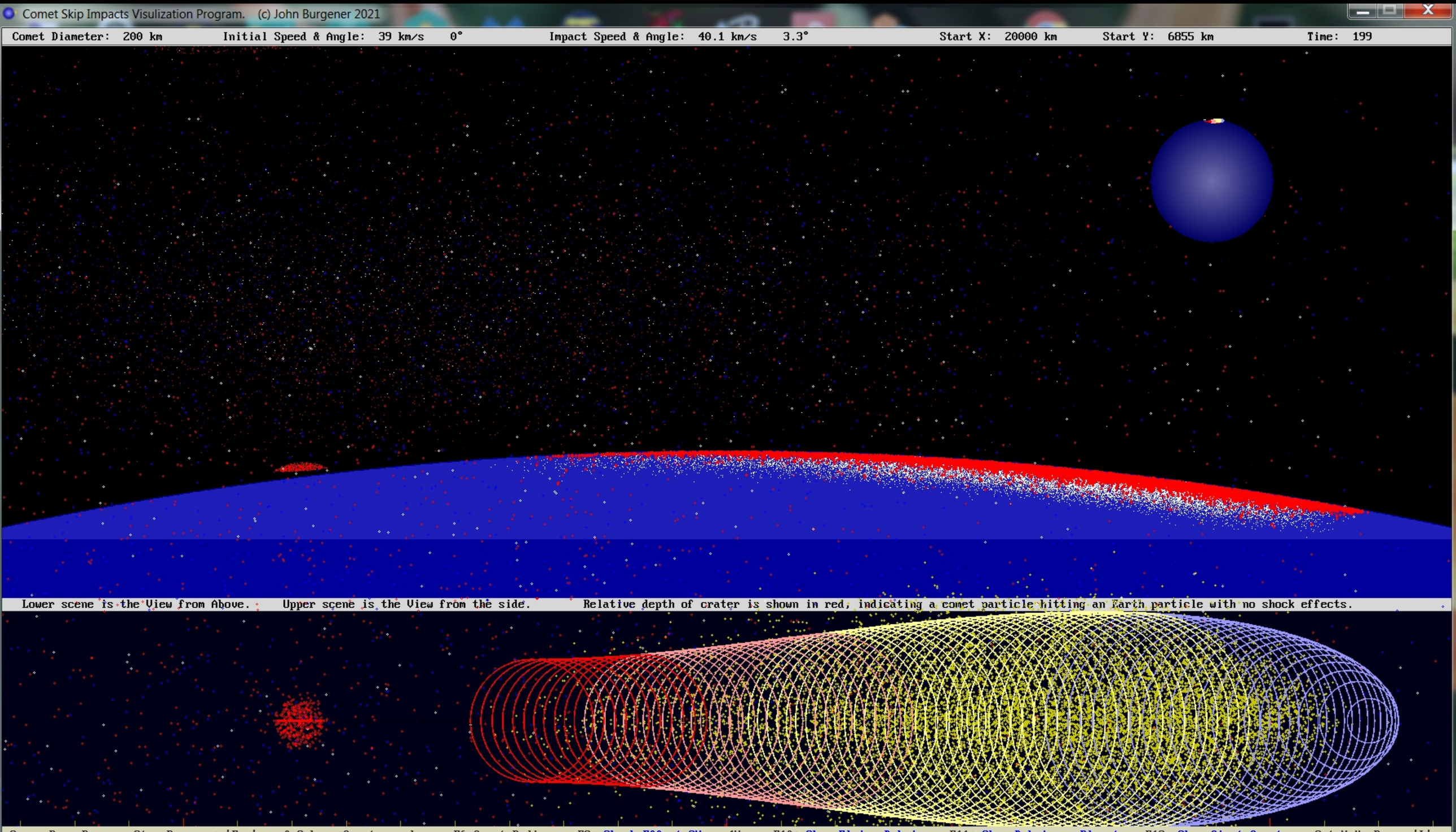






The resultant images are realistic, based on the part of the comet hitting Earth being torn away as it passes.

Are there any features on Earth or Mars that look similar?



Orcus Patera of Mars

−5000 −4000 Depth Scale −3000 −2000 meters

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.

t X: 20000 km Start Y: 6855 km Time: 199

Lower scene is the View from Above. Upper scene is the View from the side. Relative depth of crater is shown in red, indicating a comet particle hitting an Earth particle with no shock effects.

Space Bar: Pause Stop Program: 'Esc' 0-9 keys:Comet speed F6:Comet Radius F9: Shock Effect 2X or 4X F10: Show Flying Debris F11: Show Debris on Planet F12: Show Giant Comet Set X,Y: Press 'L'

Lake Michigan

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

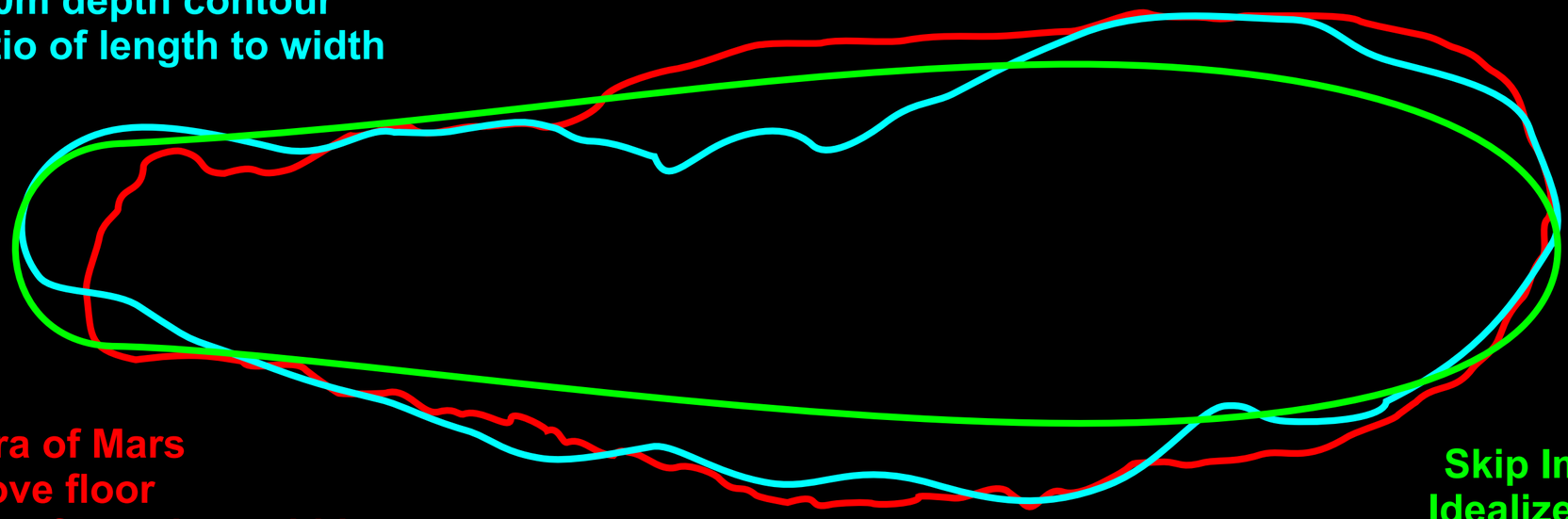
t X: 20000 km Start Y: 6855 km Time: 199

Lower scene is the View from Above. Upper scene is the View from the side. Relative depth of crater is shown in red, indicating a comet particle hitting an Earth particle with no shock effects.

Space Bar: Pause Stop Program: 'Esc' 0-9 keys:Comet speed F6:Comet Radius F9: Shock Effect 2X or 4X F10: Show Flying Debris F11: Show Debris on Planet F12: Show Giant Comet Set X,Y: Press 'L'

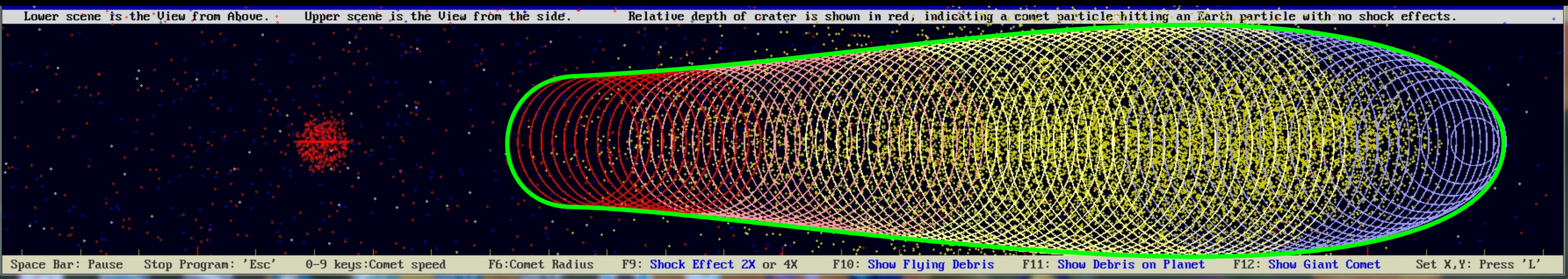
Lake Michigan, Orcus Patera and the Skip Impact Program outline are very similar. It is proposed that Lake Michigan is a skip impact crater.

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

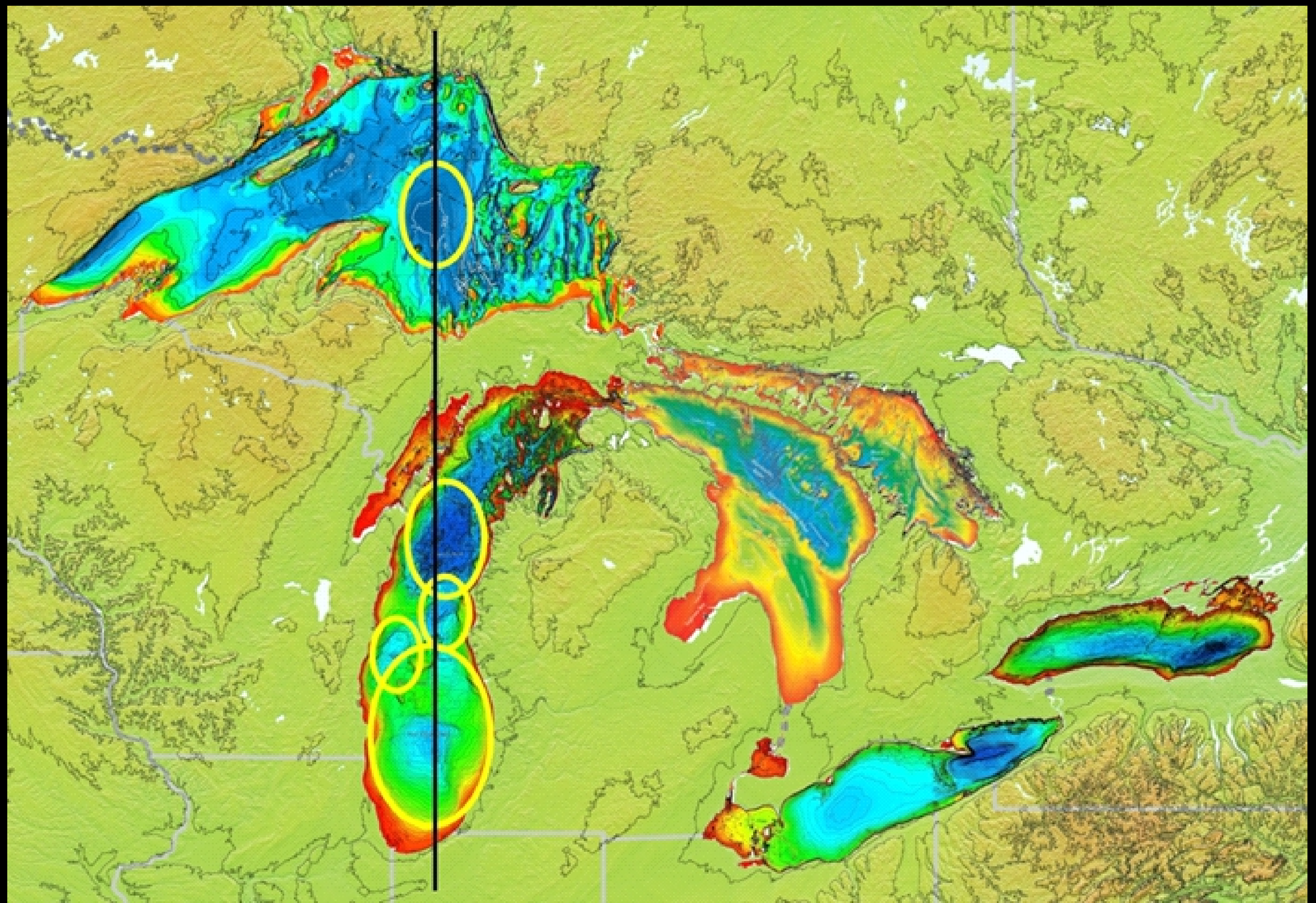


Orcus Patera of Mars
~1 km above floor
380:130km = 3:1 ratio of length to width

Skip Impact Program
Idealized similar crater



It is proposed that a recent impact formed Lake Michigan and formed the Carolina Bays as Secondary Craters



Low angle impacts forming Lake Michigan and hitting Lake Superior could form the Carolina Bays as secondary impact craters.

Ottawa

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

Conclusion:

The SkipImpact 3D software indicates that a skip impact by Comet Swift Tuttle could fit as the source of the Carolina Bays as secondary impacts from the impact debris, and would explain the distribution of the fireball orbits associated with the Perseid Meteor Shower. The program predicts that very low angle craters will be of unusual shapes and often not recognized due to their elongated and shallow shapes.

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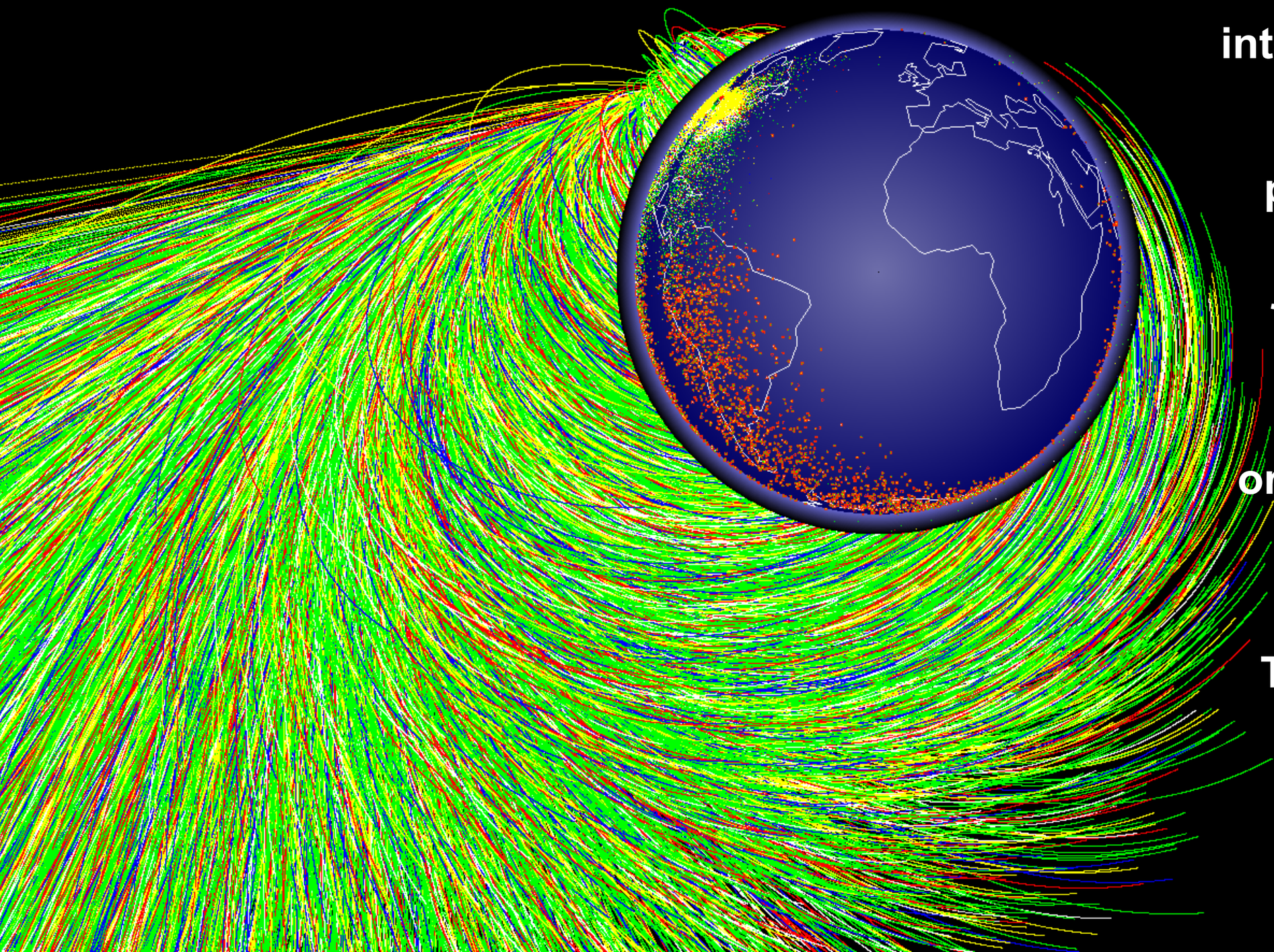
References:

[1]. Burgener (2022) SkipImpact.exe computer program simulating comet impacts in 3D with up to 90,000 points of debris being calculated in orbit over thousands of years. Available to download from www.craters.ca

[2]: Cooke, W. (2014-2021), NASA's All Sky Fireball Network daily charts of fireball orbits posted on www.spaceweather.com. Included fireball chart from Aug 2015: https://www.spaceweather.com/FIREBALL_PARSER/fireball_data.png?PHPSESSID=ik2r3o2g28eob2n25cpmlc49o4

[3]. Napier, W. P. (2019) "The hazard from fragmenting comets", MNRAS 488, 1822-1827 (2019). doi: 10.1093/mnras/stzl 769

[4] Davias, M., Harris, T. (2019) "An Incomprehensible Cosmic Impact at the mid Pleistocene Transition, Searching for the Missing Crater using Australasian Tektite Suborbital Analysis and Carolina Bay's Major Axes Triangulation"; GSA Annual Meeting in Phoenix, Arizona, USA. DOI: 10.1130/abs/2019AM-332326



For more information
and
interesting discussions

please email me at:

john@burgener.ca

or see my web pages:

www.craters.ca

The program is free
to download from
the web site.