Orbital Solver & Visualizer

USER MANUAL, EXAMPLES, AND RESULTS

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Quick Steps

- You will find attached to this manual ten .m files and one .fig file. Eight .m files are functions that are being used in the main code. The main GUI code is “gui_total_2.m” and its .fig file.

- Place all the attached files in the same folder and set it as your path directory in Matlab. Run the “gui_total_2.m” file.

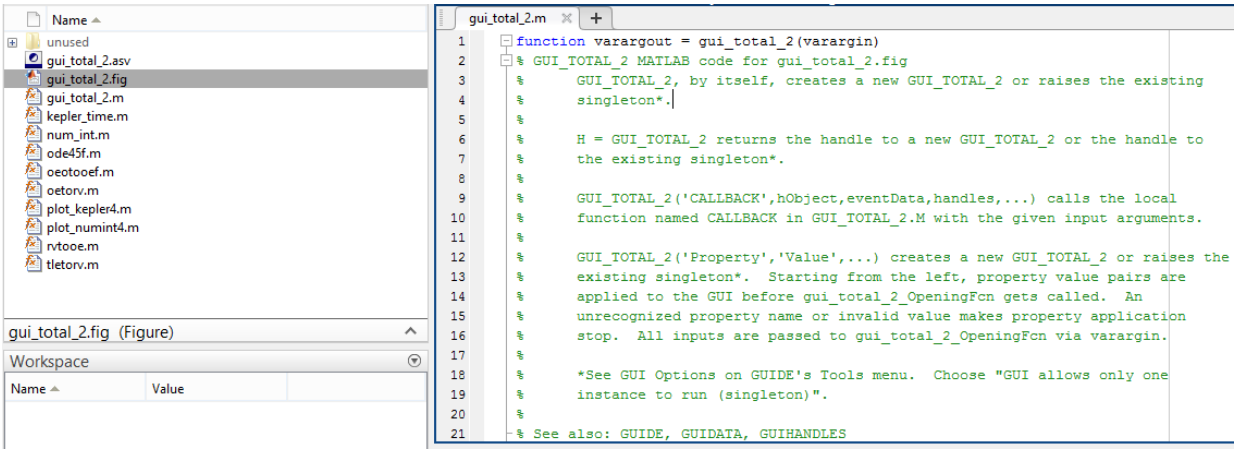
- From the radio button group on the top left corner, you need to choose your preferred input method.
1) For direct r and v vectors, input the vector in this form “rx ry rz” and “vx vy vz” replacing these symbols with your values and discarding the quotation marks of course.
2) For orbital elements input method, you need to input all your elements in the specified boxes, then click “calculate r & v” button.
3) For the two line element method, you need to input the two line element set in the text box, then click “calculate r & v” button.

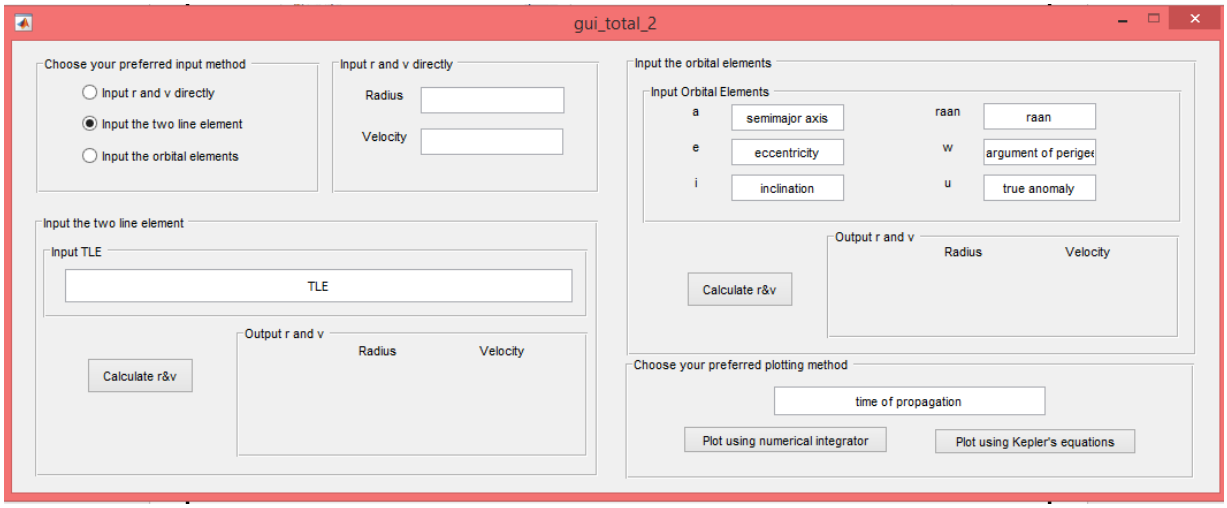
- Then enter the desired time of propagation in the text box on the bottom right corner, and click on the pushbutton that says “Plot using the numerical method” or “Plot using Kepler’s equation” based on your preference.

- The window will close and a new window with the plot will appear. The satellite will propagate for the specified time, then it will stop and the final r and v vectors will appear on the graph.

Walkthrough

- Running the gui_total_2.m code

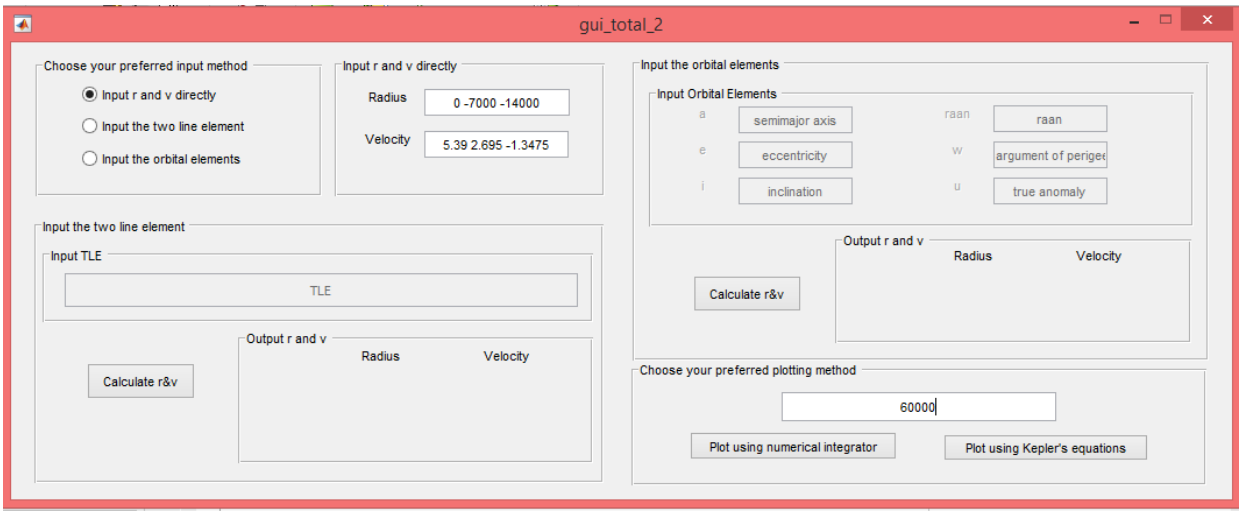




- Select your preferred input method from the radio buttons on the top left corner.

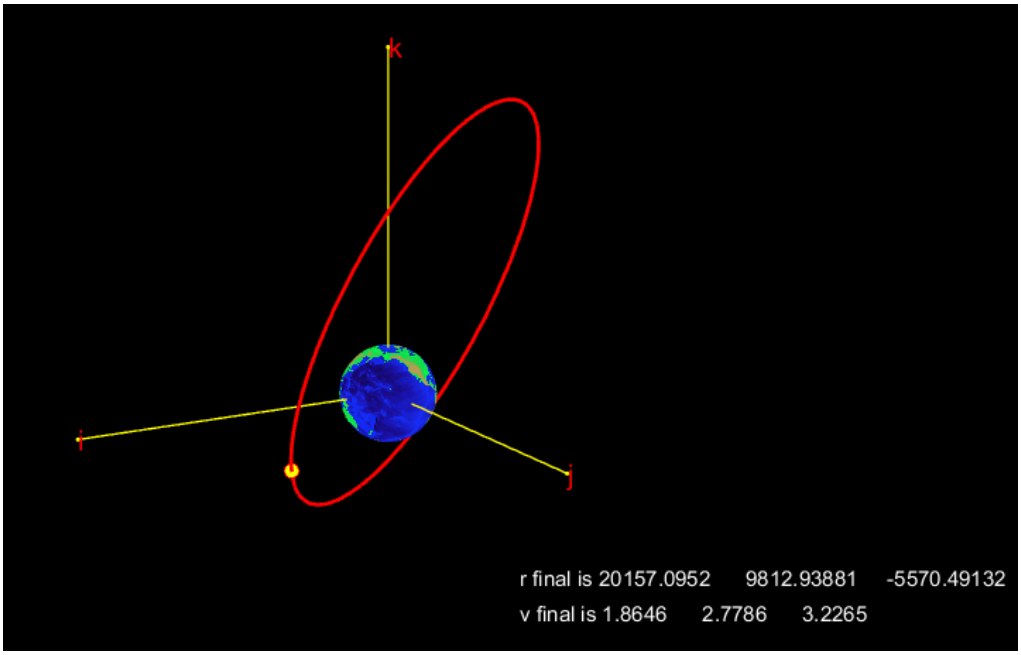
INPUT R AND V DIRECTLY:

- Here we will use a Molniya orbit as an example of r = [0 -7000 -14000] and v = [5.39 2.695 -1.3475]. Type r and v vectors in km and km/s respectively in the edit fields as shown, and the time of propagation wanted in seconds (60000).



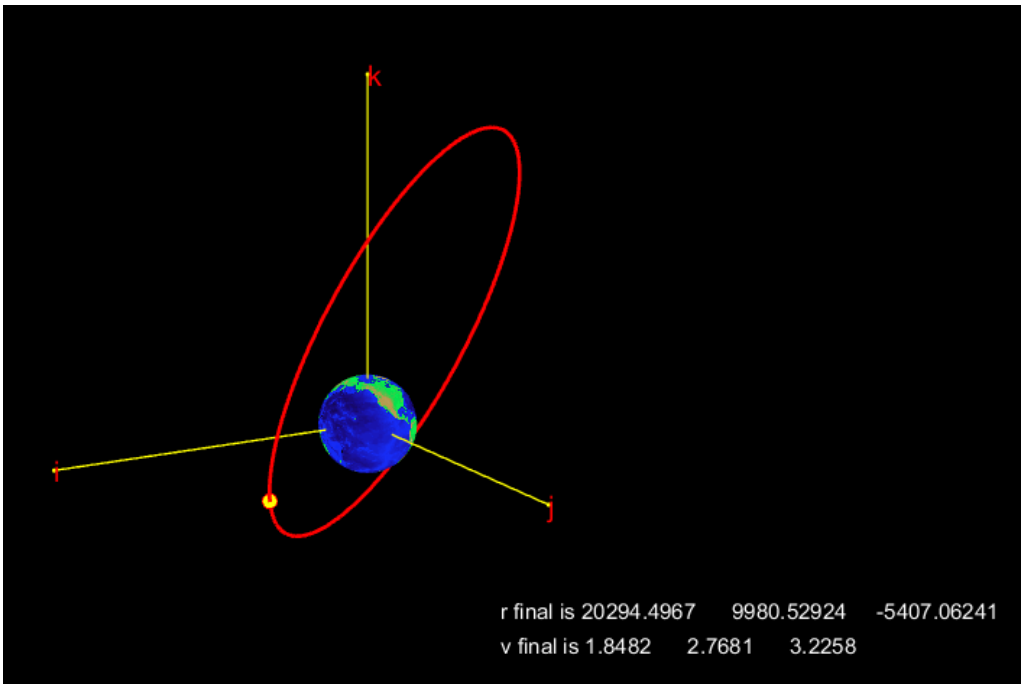
- Click plot using numerical integrator or Kepler's equations based on your preference. The window will close and a new window will open showing your plot. The satellite will orbit Earth for the specified time and will stop showing the final r and v vectors on the graph.

A) Using numerical integrator:



B) Using Kepler equation:

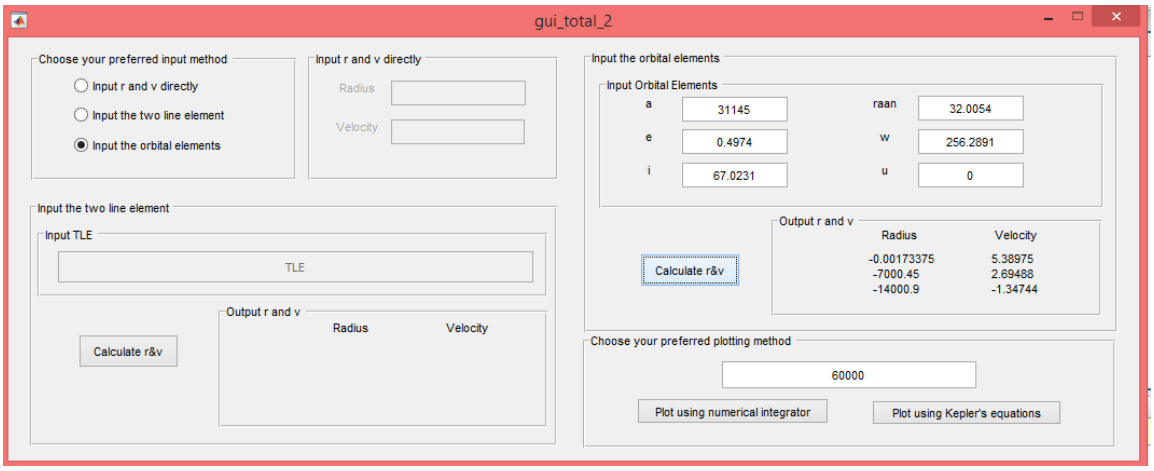
We run the code again and input the same inputs, but now we choose to plot using Kepler's equations. This method is slower, so we will have to wait a while and then the plot will show.



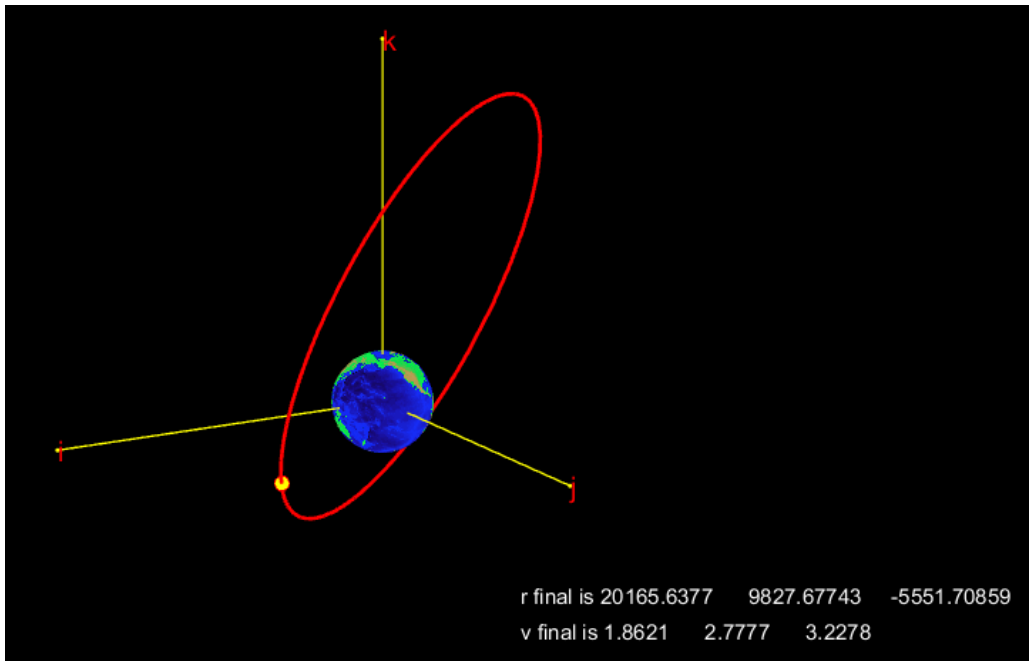
INPUT USING THE SIX ORBITAL ELEMENTS

For the same example using the orbital elements are:
Semimajor axis = 31145, eccentricity = 0.4974, inclination = 67.0231, raan = 32.0054, argument of perigee = 256.2891, true anomaly = 0.

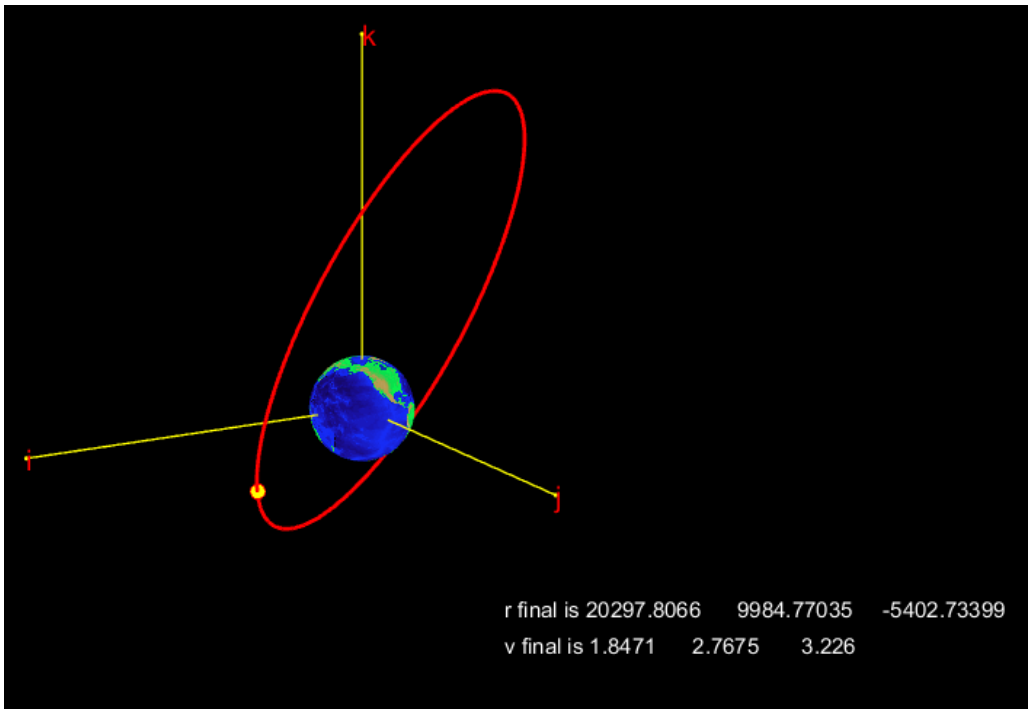
- Input the orbital elements and click "Calculate r & v", then enter the time of propagation and choose your plotting method.



A) Using the numerical integrator method



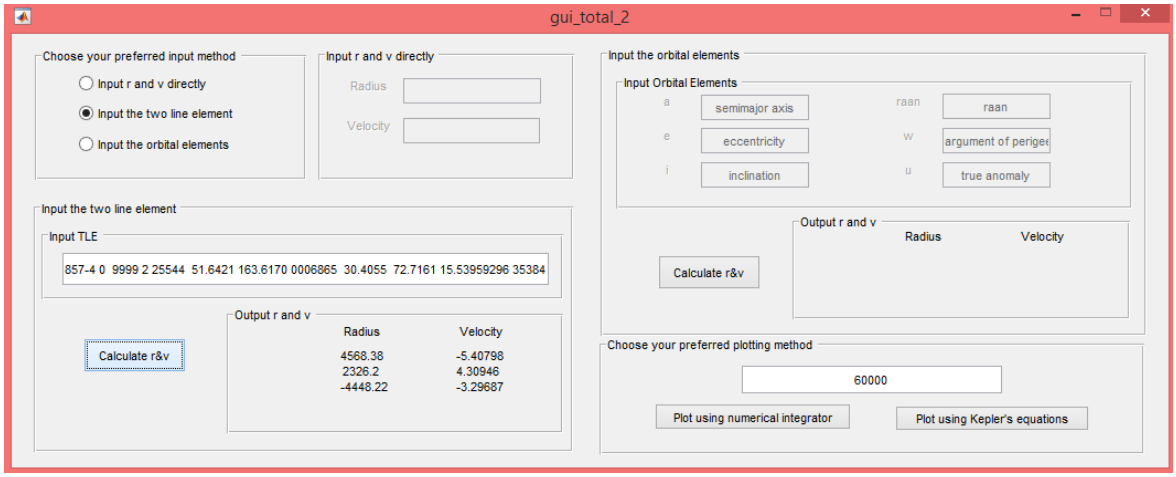
B) Using Kepler's Equations



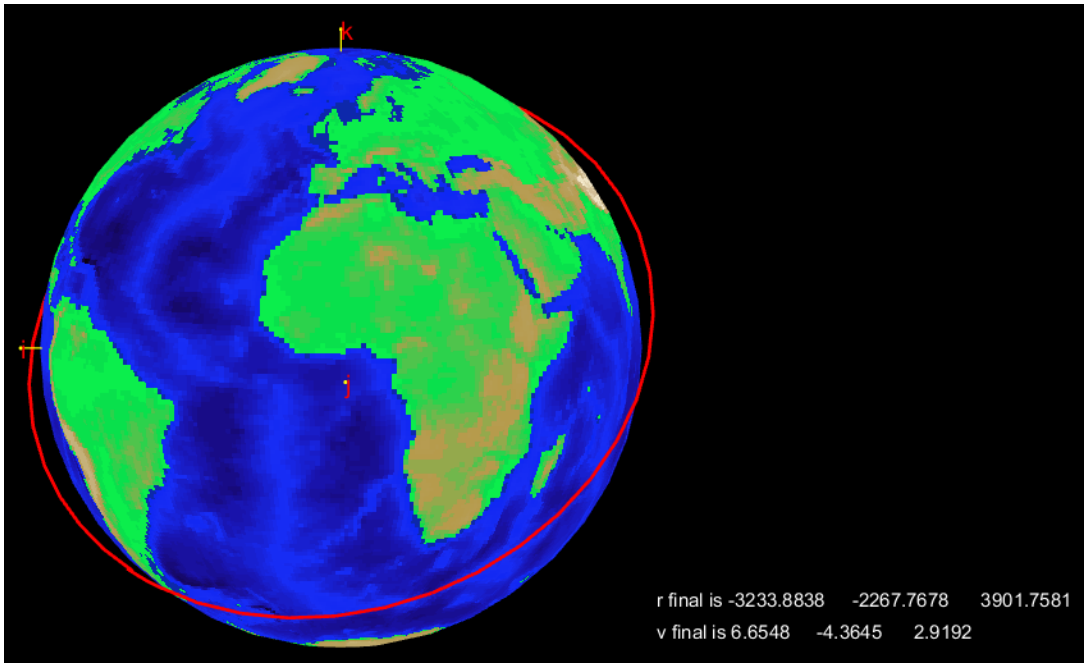
INPUT USING THE TWO LINE ELEMENT SET

Here, we will use a different example as we didn't find the two line element set for the exact same example we were using. The example we will use is "1 25544U 98067A 16364.61781196 .00002076 00000-0 38857-4 0 9999 2 25544 51.6421 163.6170 0006865 30.4055 72.7161 15.53959296 35384".

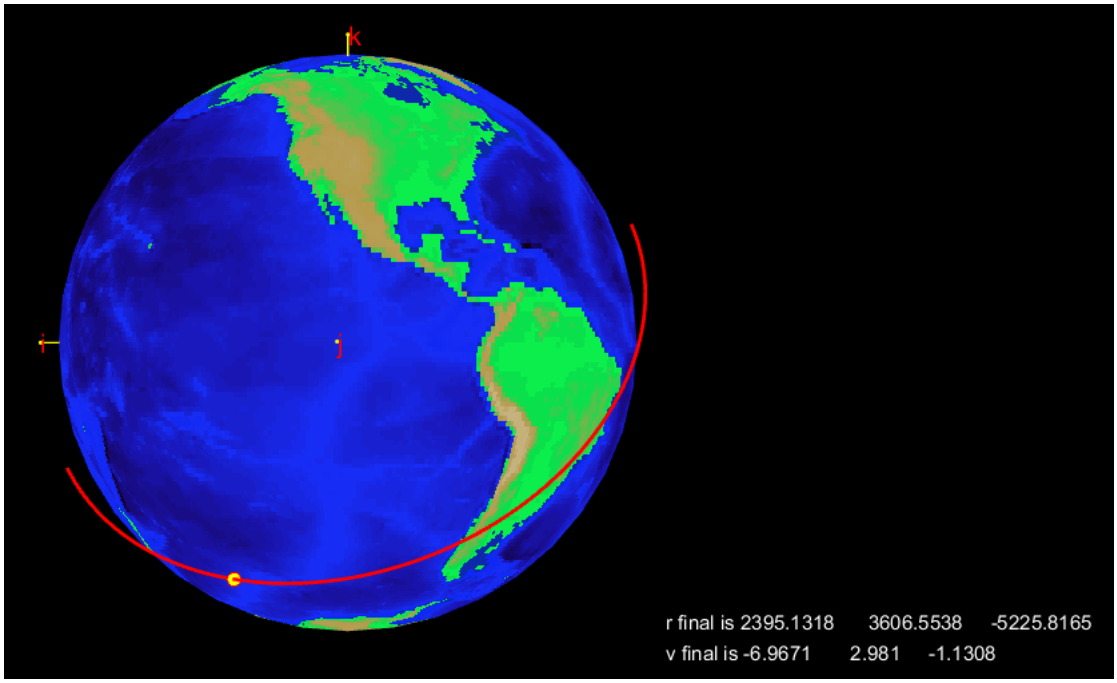
Input this two line element in the TLE edit box, and click "Calculate r & v". After that, enter the propagation time and plot using your preferred method.



A) Using the numerical integrator

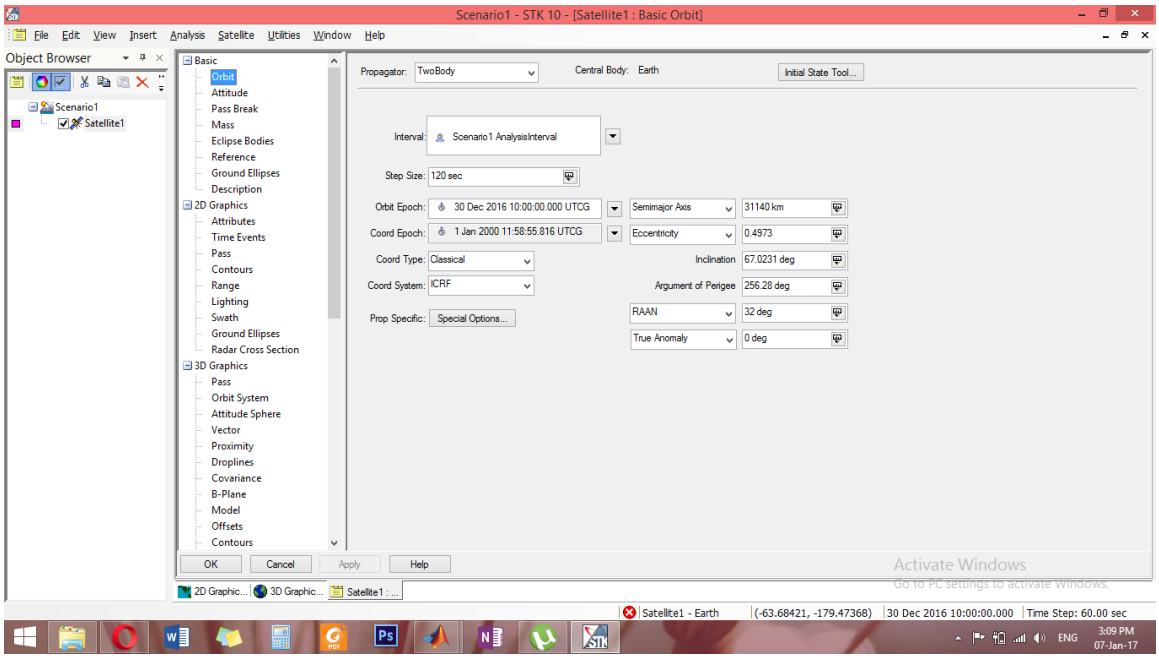


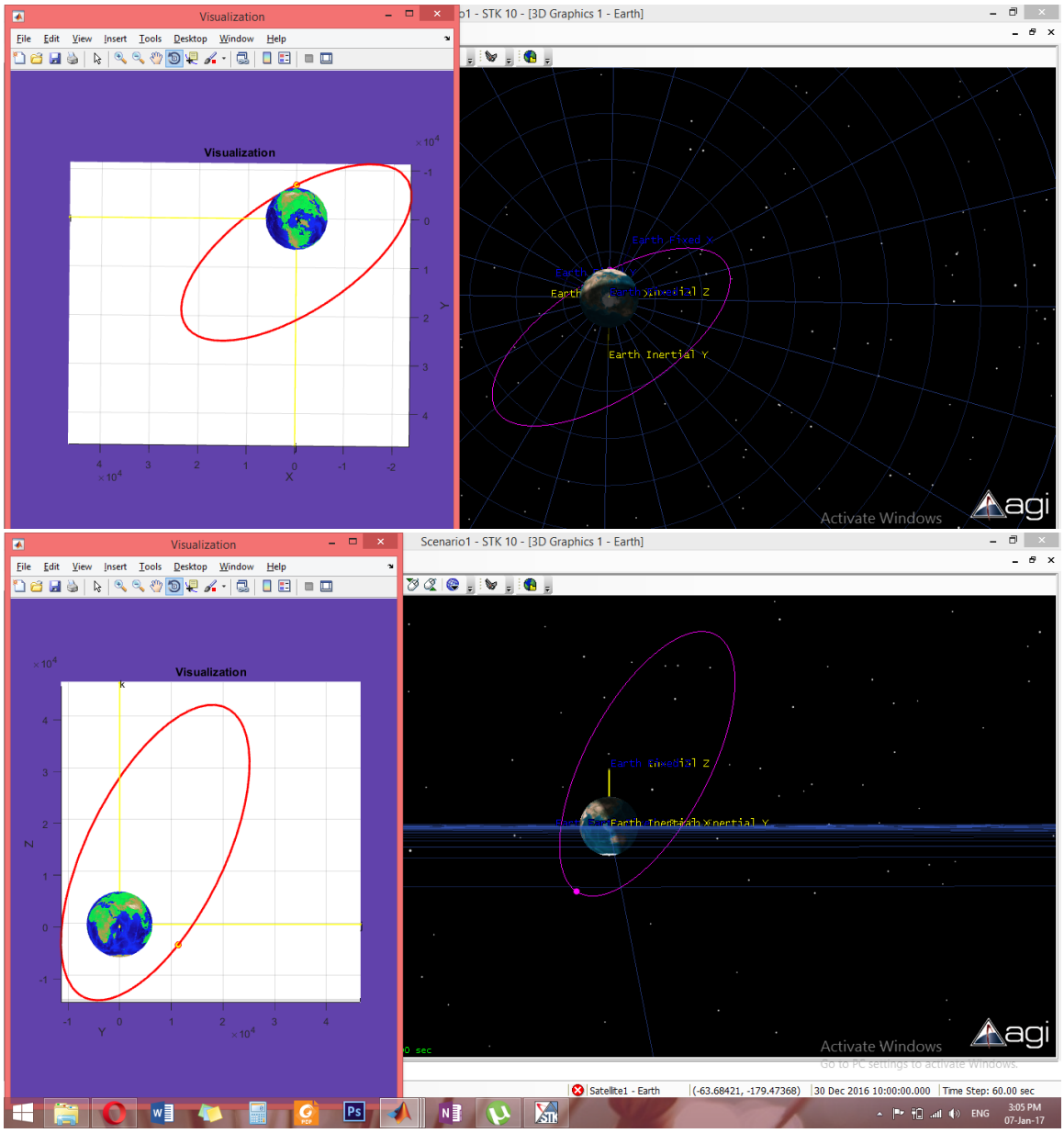
B) Using Kepler's equation



Comparing results to STK

EXAMPLE 1




Visualization
File Edit View Insert Tools Desktop Window Help
Visualization
Scenario1 - STK 10 - [3D Graphics 1 - Earth]
Earth Fixed X
Earth Inertial Z
Earth Inertial Y
Activate Windows
agi
Visualization
File Edit View Insert Tools Desktop Window Help
Visualization
Scenario1 - STK 10 - [3D Graphics 1 - Earth]
Earth Inertial Z
Earth Inertial Y
Activate Windows
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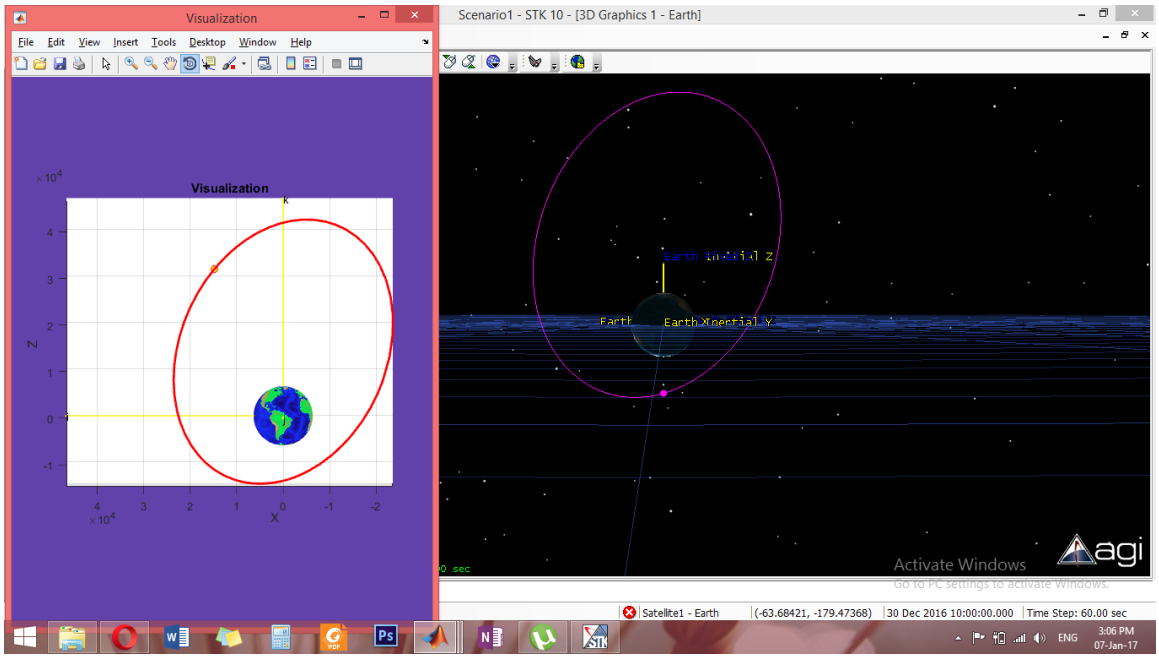
Satellite1 - Earth
(-63.68421, -179.47368)
30 Dec 2016 10:00:00.000
Time Step: 60.00 sec
ENG
3:05 PM
07-Jan-17


Visualization
File Edit View Insert Tools Desktop Window Help
Visualization
Scenario1 - STK 10 - [3D Graphics 1 - Earth]
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Earth Inertial Z
Earth Inertial Y
Activate Windows
Satellite1 - Earth
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30 Dec 2016 10:00:00.000
Time Step: 60.00 sec
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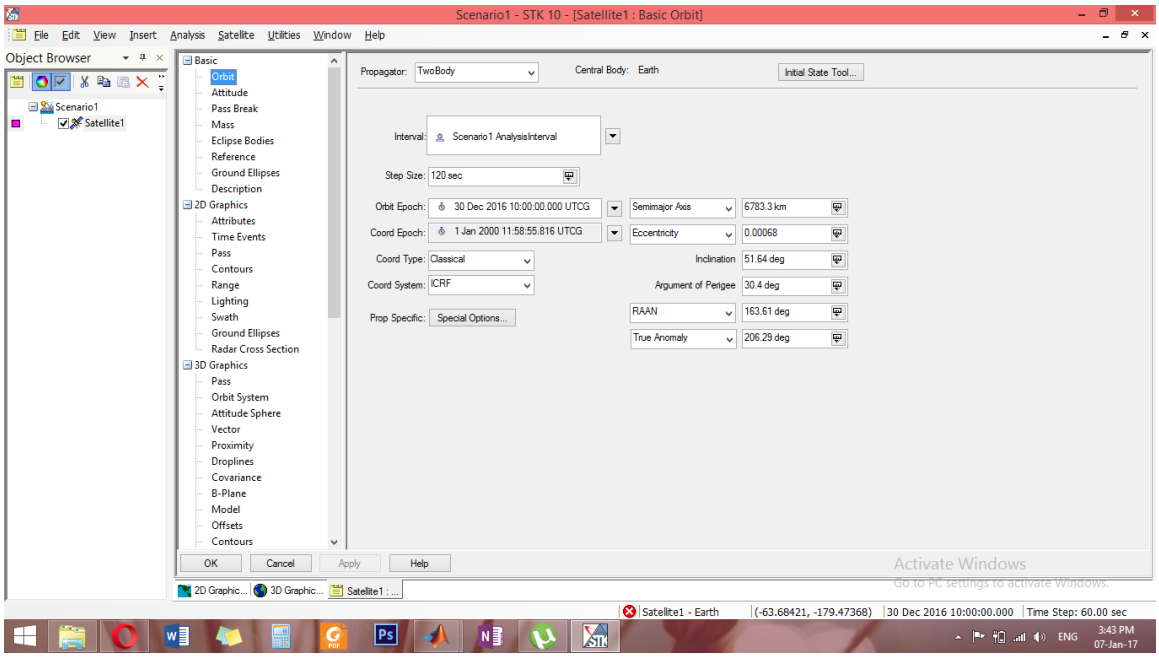
EXAMPLE 2


Scenario1 - STK 10 - [Satellite1 : Basic Orbit]
File Edit View Insert Analysis Satellite Utilities Window Help
Object Browser
Scenario1
Satellite1
Basic
Orbit
Attitude
Pass Break
Mass
Eclipse Bodies
Reference
Ground Ellipses
Description
2D Graphics
Attributes
Time Events
Pass
Contours
Range
Lighting
Swath
Ground Ellipses
Radar Cross Section
3D Graphics
Pass
Orbit System
Attitude Sphere
Vector
Proximity
Droplines
Covariance
B-Plane
Model
Offsets
Contours
Propagator: TwoBody
Central Body: Earth
Initial State Tool...
Interval: Scenario1 AnalysisInterval
Step Size: 120 sec
Orbit Epoch: 30 Dec 2016 10:00:00.000 UTCG
Coord Epoch: 1 Jan 2000 11:58:55.816 UTCG
Coord Type: Classical
Coord System: ICRF
Prop Specific: Special Options...
Semimajor Axis 6783.3 km
Eccentricity 0.00068
Inclination 51.64 deg
Argument of Perigee 30.4 deg
RAAN 163.61 deg
True Anomaly 206.29 deg
OK
Cancel
Apply
Help
Activate Windows
Satellite1 - Earth
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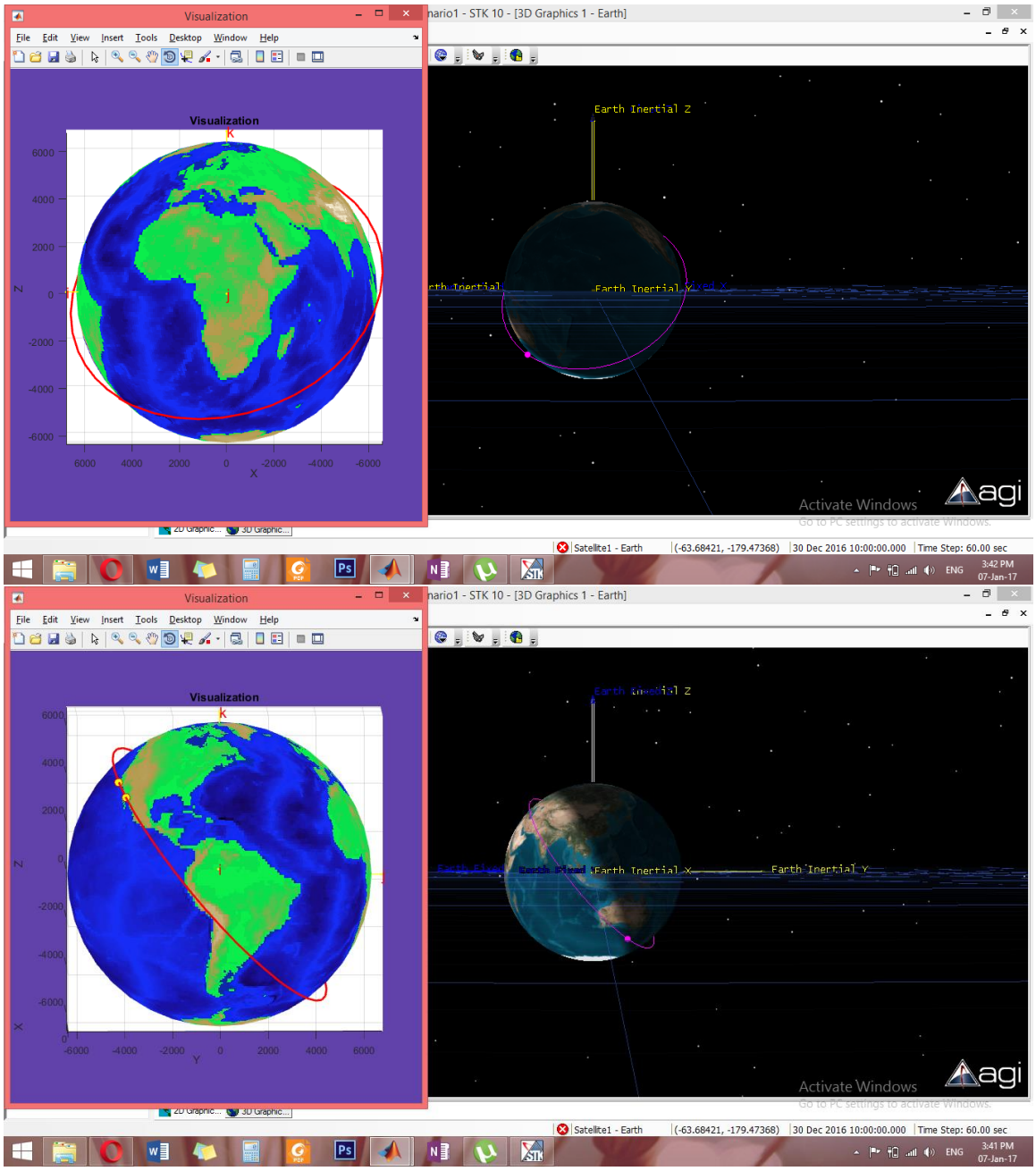
07-Jan-17


Visualization
File Edit View Insert Tools Desktop Window Help
Visualization
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Activate Windows
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Satellite1 - Earth
(-63.68421, -179.47368)
30 Dec 2016 10:00:00.000
Time Step: 60.00 sec
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3:42 PM
07-Jan-17
Visualization
File Edit View Insert Tools Desktop Window Help
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nario1 - STK 10 - [3D Graphics 1 - Earth]
Earth Inertial Z
Earth Inertial X
Earth Inertial Y
Activate Windows
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Satellite1 - Earth
(-63.68421, -179.47368)
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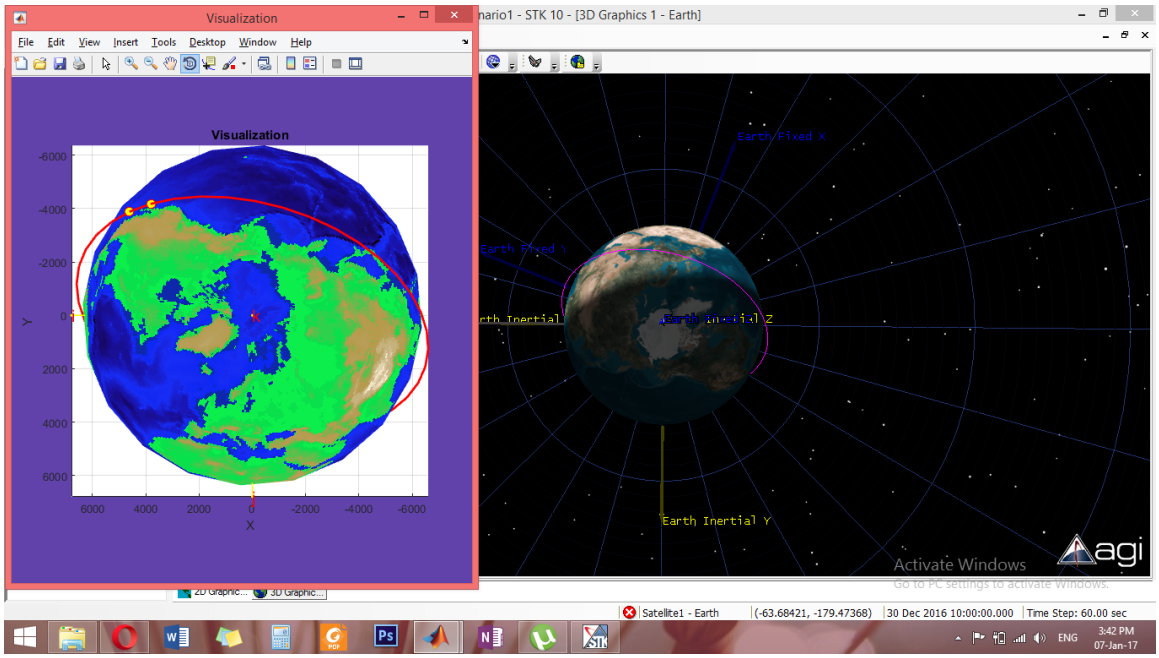
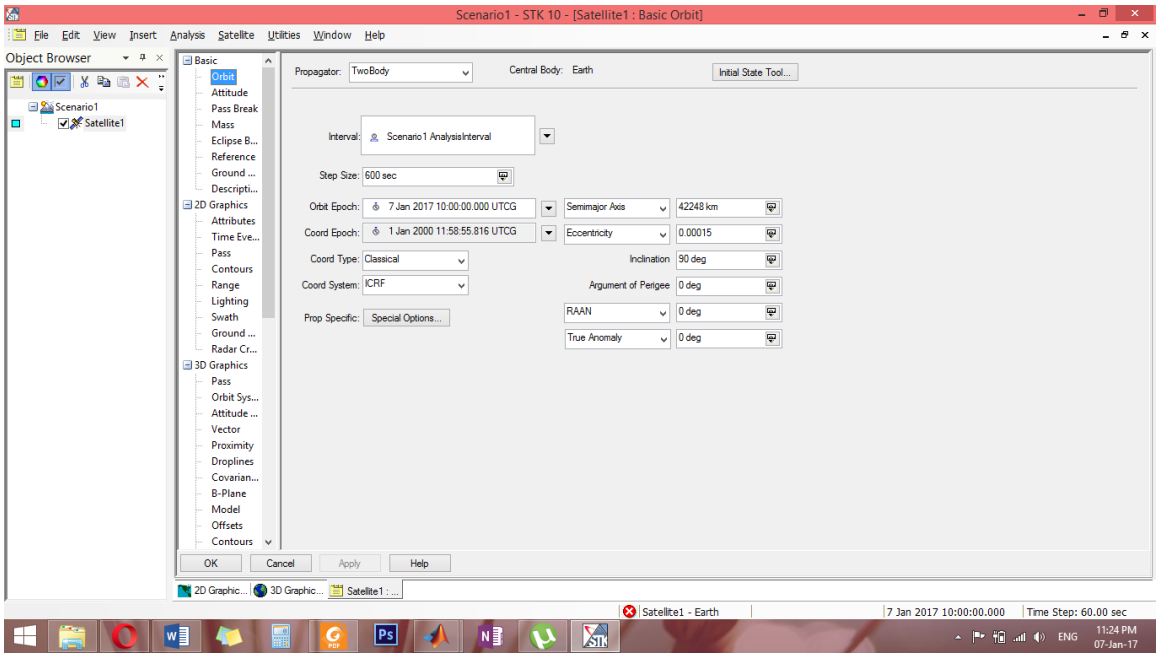
Time Step: 60.00 sec
ENG
3:41 PM
07-Jan-17


Visualization
File Edit View Insert Tools Desktop Window Help
Visualization
Earth Fixed X
Earth Fixed Y
Earth Inertial Z
Earth Inertial Y
Activate Windows
Satellite1 - Earth
(-63.68421, -179.47368)
30 Dec 2016 10:00:00.000
Time Step: 60.00 sec
ENG
3:42 PM
07-Jan-17

EXAMPLE 3


Scenario1 - STK 10 - [Satellite1 : Basic Orbit]
File Edit View Insert Analysis Satellite Utilities Window Help
Object Browser
Scenario1
Satellite1
Basic
Orbit
Attitude
Pass Break
Mass
Eclipse B...
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Ground ...
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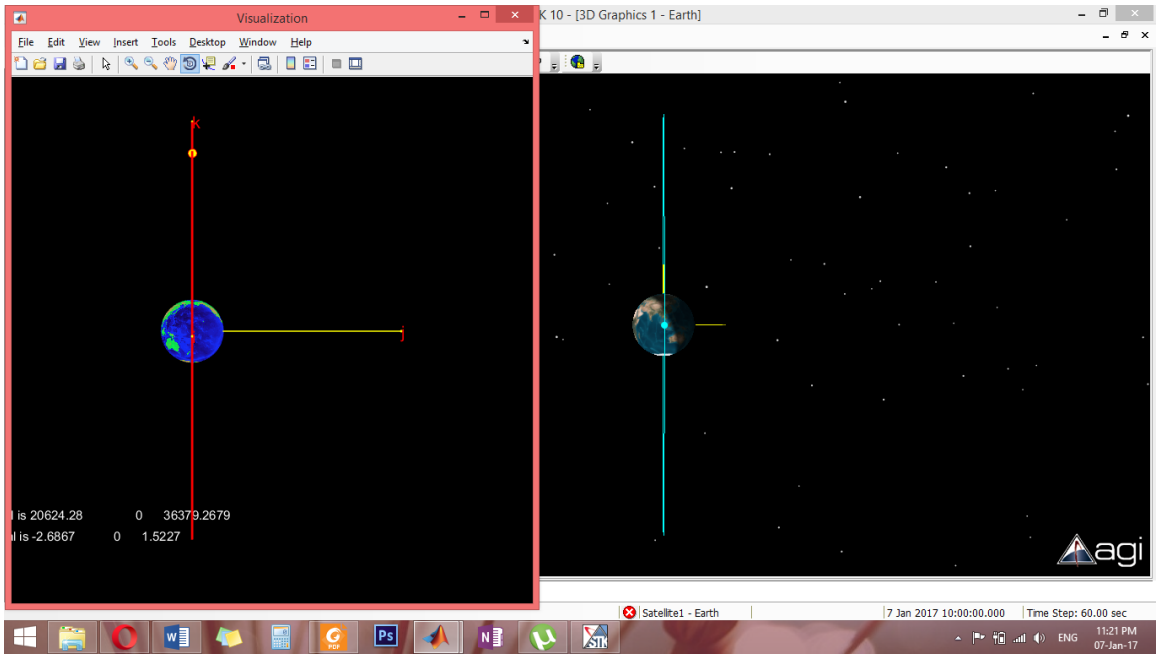
Orbit Sys...
Attitude ...
Vector
Proximity
Droplines
Covarian...
B-Plane
Model
Offsets
Contours
Propagator: TwoBody
Central Body: Earth
Initial State Tool...
Interval: Scenario1 AnalysisInterval
Step Size: 600 sec
Orbit Epoch: 7 Jan 2017 10:00:00.000 UTCG
Coord Epoch: 1 Jan 2000 11:58:55.816 UTCG
Coord Type: Classical
Coord System: ICRF
Prop Specific: Special Options...
Semimajor Axis 42248 km
Eccentricity 0.00015
Inclination 90 deg
Argument of Perigee 0 deg
RAAN 0 deg
True Anomaly 0 deg
OK
Cancel
Apply
Help
Satellite1 - Earth
7 Jan 2017 10:00:00.000
Time Step: 60.00 sec
ENG
11:24 PM
07-Jan-17


Visualization
File Edit View Insert Tools Desktop Window Help
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is 20624.28 0 36379.2679
is -2.6867 0 1.5227
K 10 - [3D Graphics 1 - Earth]
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Satellite1 - Earth
7 Jan 2017 10:00:00.000
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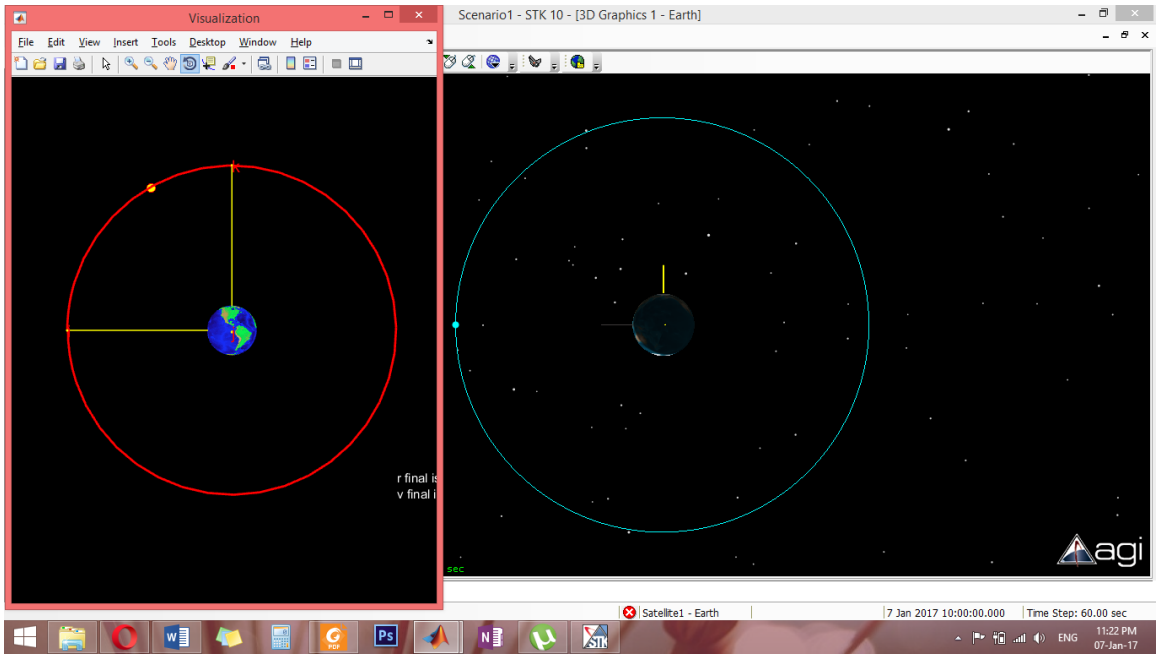
Visualization
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Scenario1 - STK 10 - [3D Graphics 1 - Earth]
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Satellite1 - Earth
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Time Step: 60.00 sec
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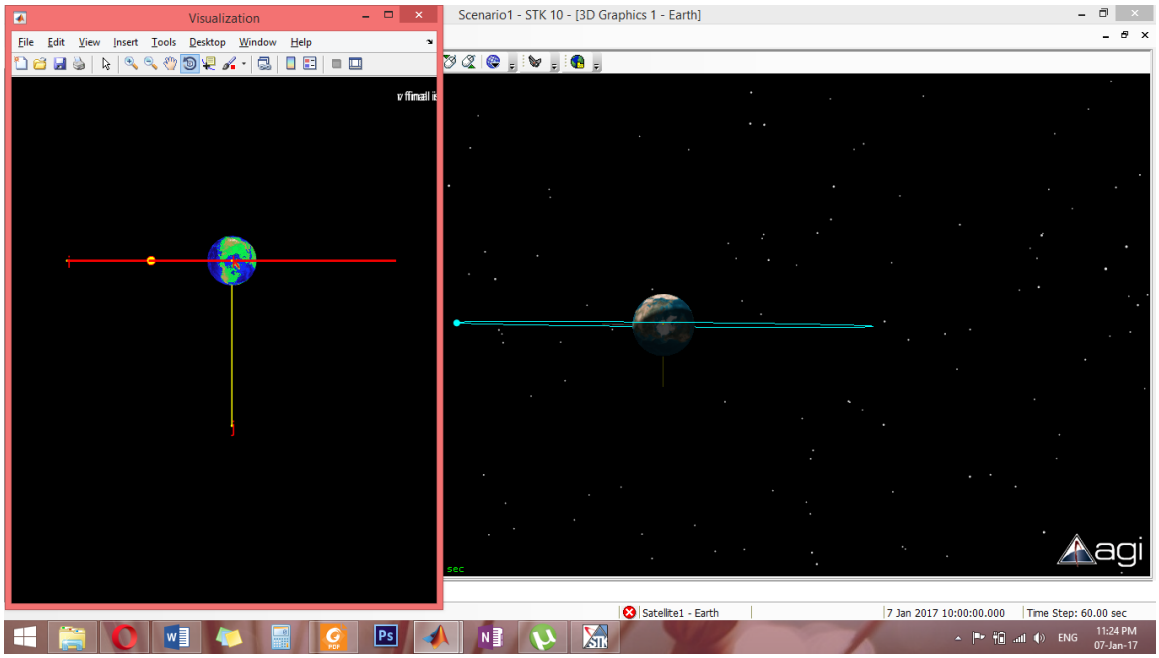
07-Jan-17


Visualization
File Edit View Insert Tools Desktop Window Help
Scenario1 - STK 10 - [3D Graphics 1 - Earth]
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7 Jan 2017 10:00:00.000
Time Step: 60.00 sec
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07-Jan-17