Solar System Simulator - Manual

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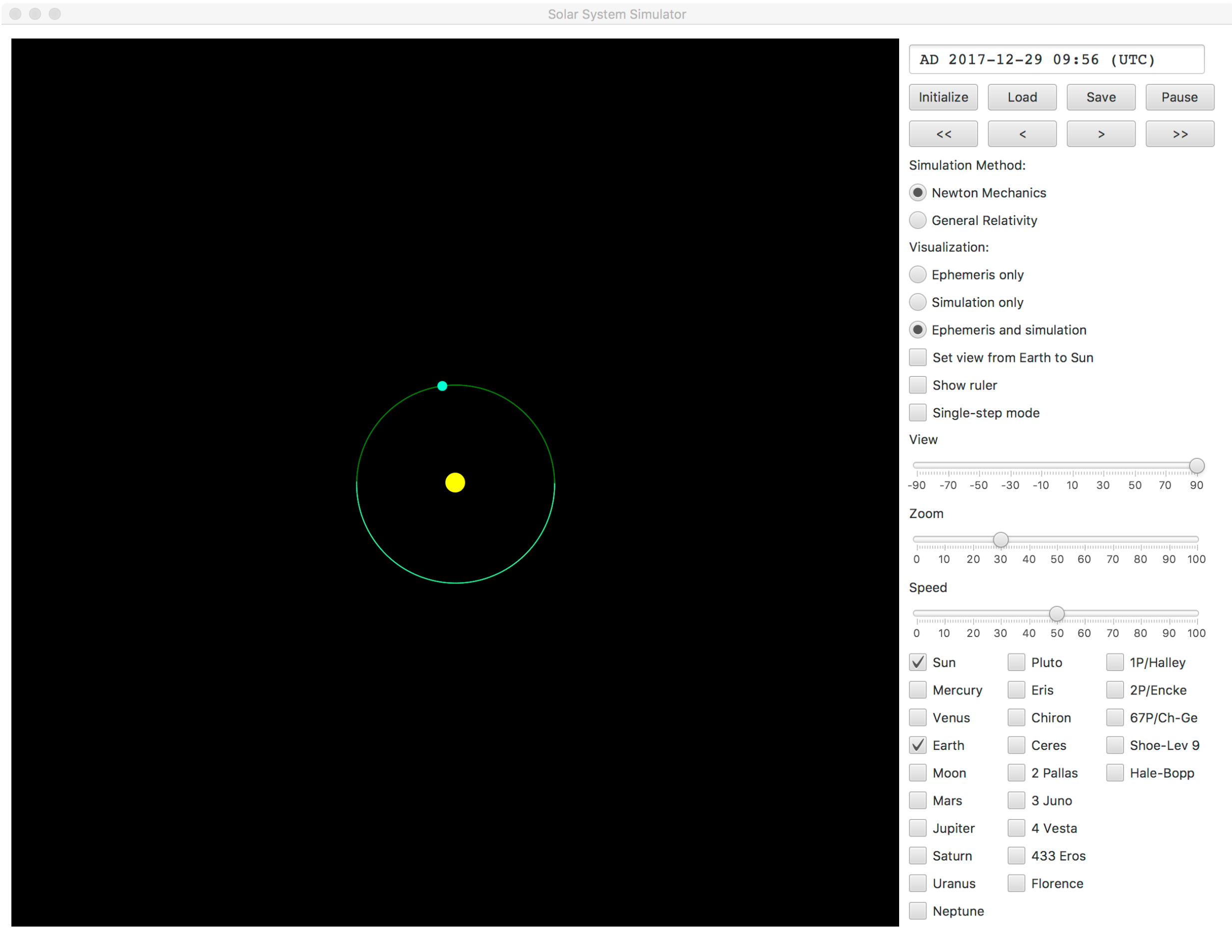
Introduction

The Solar System Simulator is written in Java. Positions and velocities of 24 solar system bodies are continuously updated using either Newton Mechanics or General Relativity. Initial positions and velocities are obtained from Nasa JPL's ephemerides. While simulating, both simulated positions and ephemeris data are visualised for comparison. Source code is made publicly availible under the MIT licence.

Manual



Set date and time

Enter date and time in the text box on the top-right and click Initialize. The state of the Solar System will be initialized to the entered date and time (Coordinated Universal Time).

Load/save simulation state

Click the Load or Save button to load a simulation state from file or save the current simulation state to file.

Pause and advance simulation
To pause a running simulation click the Pause-button. To advance click the > button and to advance fast click >>. The simulation goes backward in time when < or << is clicked. Check ‘Single step mode’ to advance 1 minute at a time when clicking < or >.

Simulation Method
Choose between Newton Mechanics and General Relatvity to advance the simulation. Although General Relativity is more accurate, usually Newton Mechanics is the best choice as it requires less computational effort to advance a single time step. Normally, a single time step is 1 hour, but when ‘Single step mode’ is checked, the time step is 1 minute.

Visualization
You can choose to show either the ephemerides data (orbits shown in green), simulation results (orbits shown in blue), or both. Check the Solar System bodies that you want to visualize in the right-bottom area. Check ‘Set view from Earth to Sun’ to view directly at the Sun from the surface of the Earh. This view should be used to observe a Mercury transit, Venus transit or a solar eclipse. Check ‘Show ruler’ to show a ruler at the left-bottom of the viewing area. The ruler indicates either km (normal view) or degrees/arc minutes (Earth-to-Sun view).

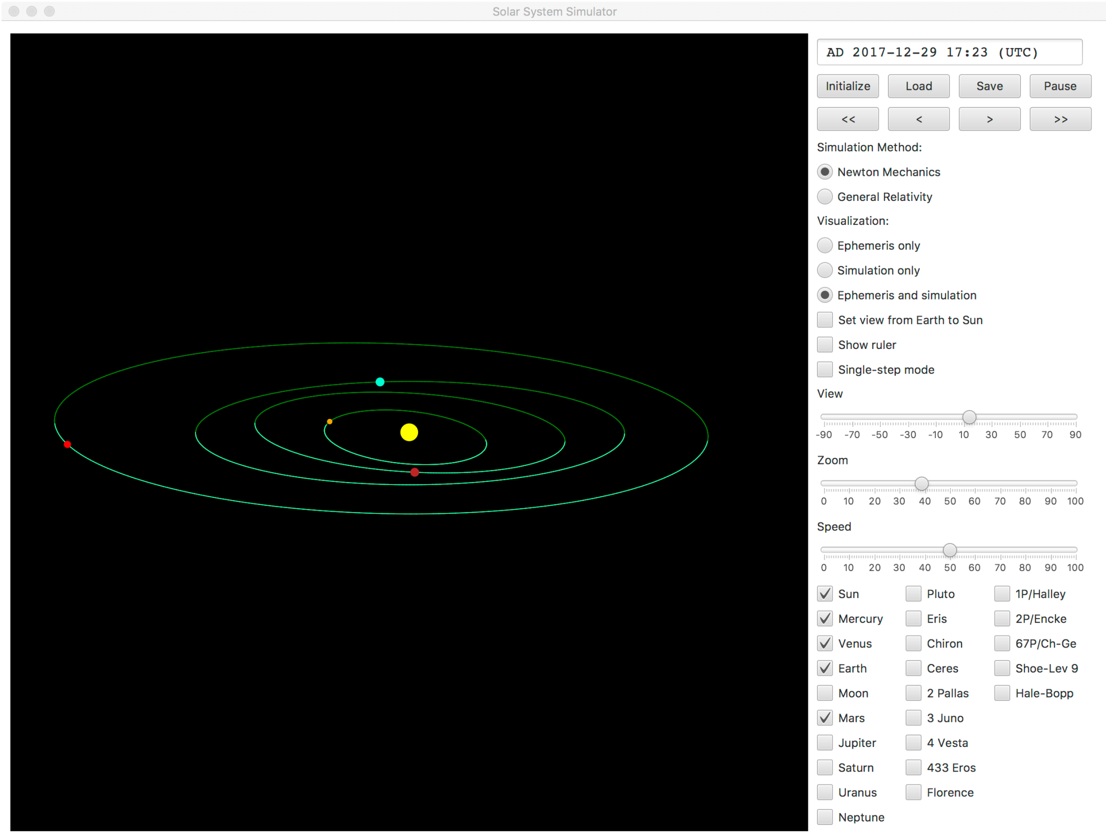
View slider
In Normal view, the Solar System bodies are viewed from ‘above’ when the slider set at 90 degrees and from the ‘front’ when the slider is set at 0 degrees. In Sun-to-Earth view, the slider can be used to indicate the latitude of the viewing position on the surface of the Earth. Note that in reality the Earth’s axis is tilted, which causes the seasons. This is not taken into account in the simulator and, therefore, the value at which the slider is set is not exactly the same as the lattitude of a viewing position.

Zoom slider
Use this slider to zoom in to the center of the viewing area. All Solar System bodies are presented by colored disks that have a minimim size. However, if you zoom in, the disk may increase in size, especially for larger bodies such as the Sun and Jupiter. In the ‘Sun-to-Earth’ view the size of the disk corresponds to the apparent view as seen from the surface of the Earth (measured in arc minutes).

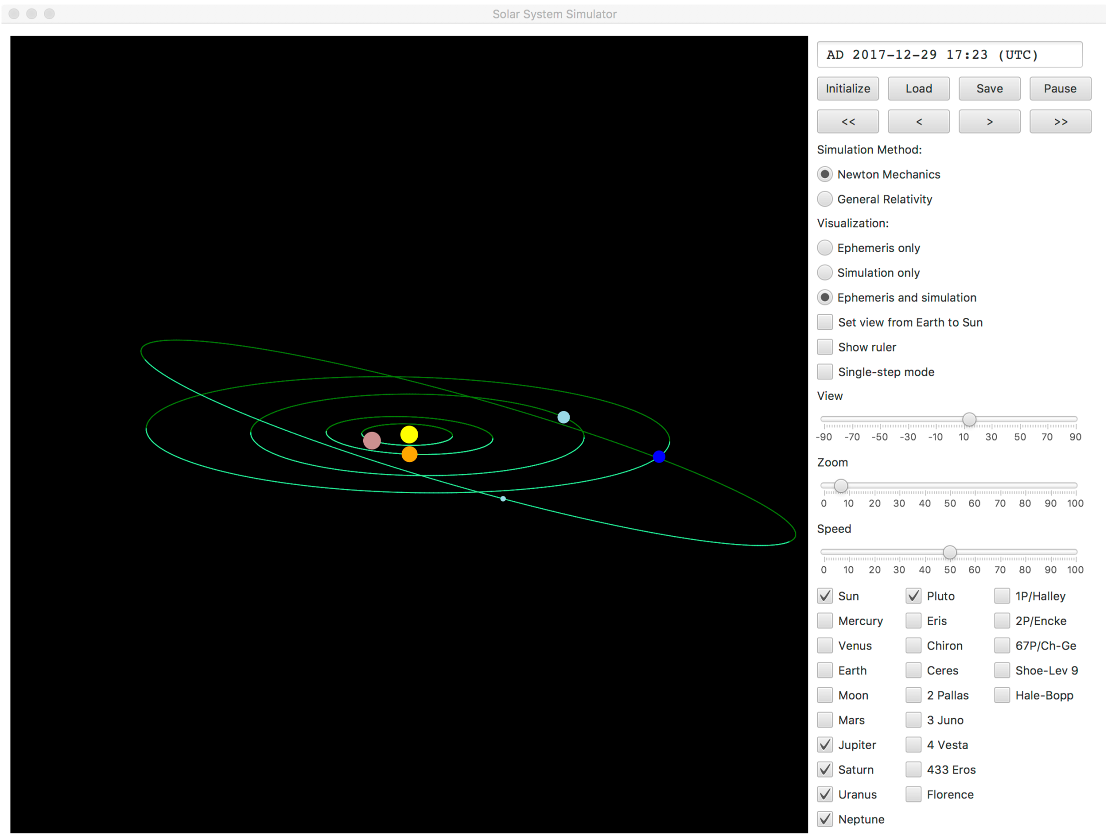
Speed slider
Use this slider to set the speed with which the simulation advances after clicking the < or > button. When ‘Single step mode’ is checked, this slider can be used to control the speed of the simulation after clicking << or >>.

Examples
On the next pages you will find some screenshots of the Solar System Simulator. When comparing these screenshots to other drawings and images of the same events, please note that the ecliptic plane in the Earth-to-Sun view is horizontal, whereas in real images it is somewhat tilted.

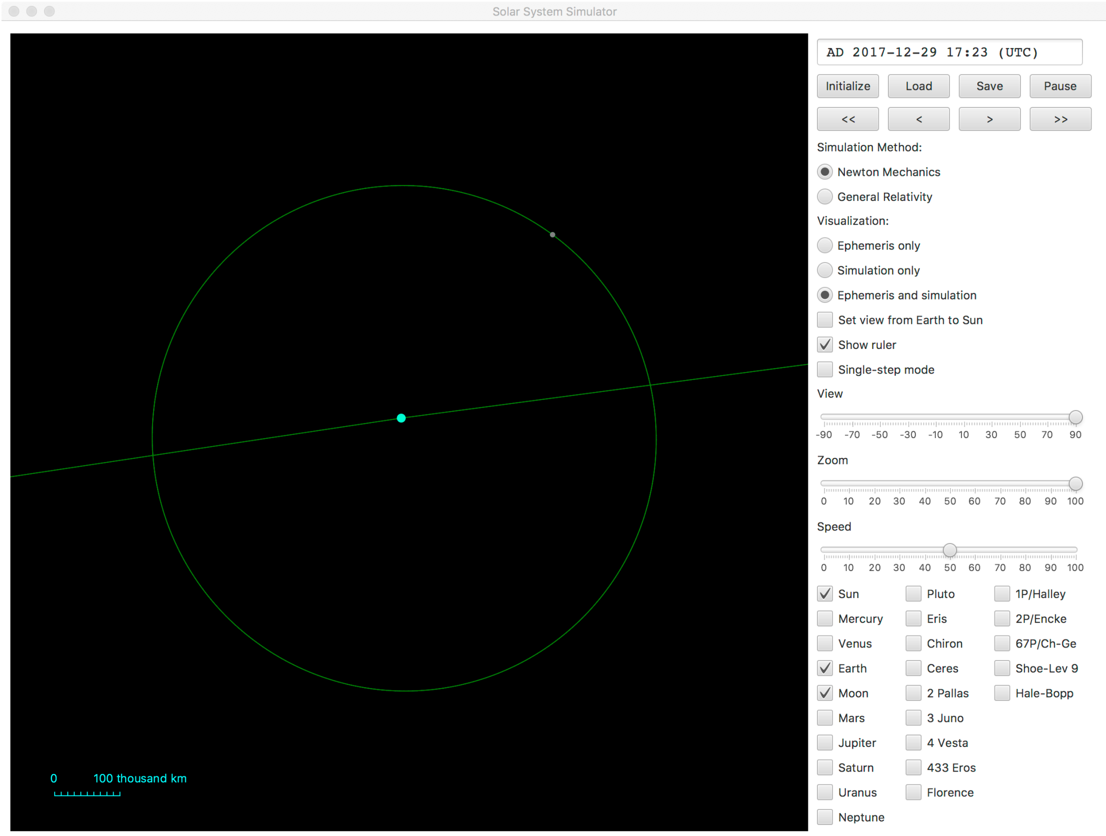
The inner planets of the Solar System (December 29, 2017)



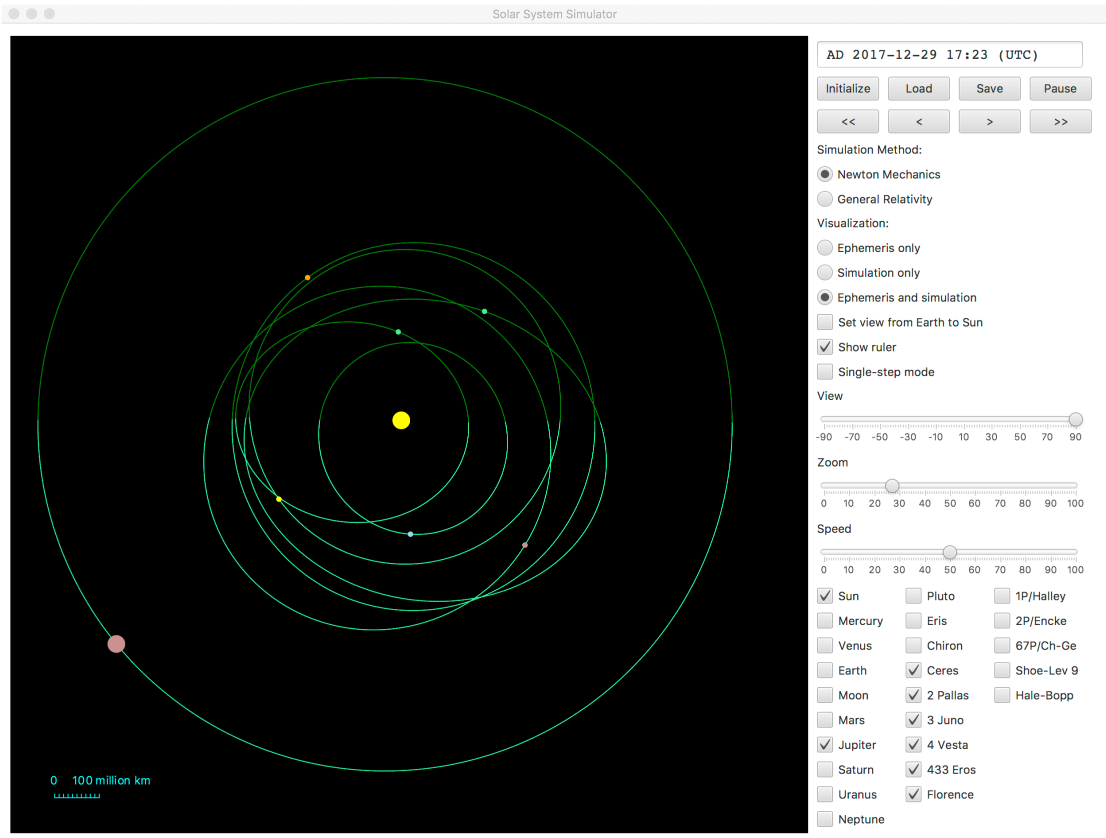
The outer planets of the Solar System (December 29, 2017):



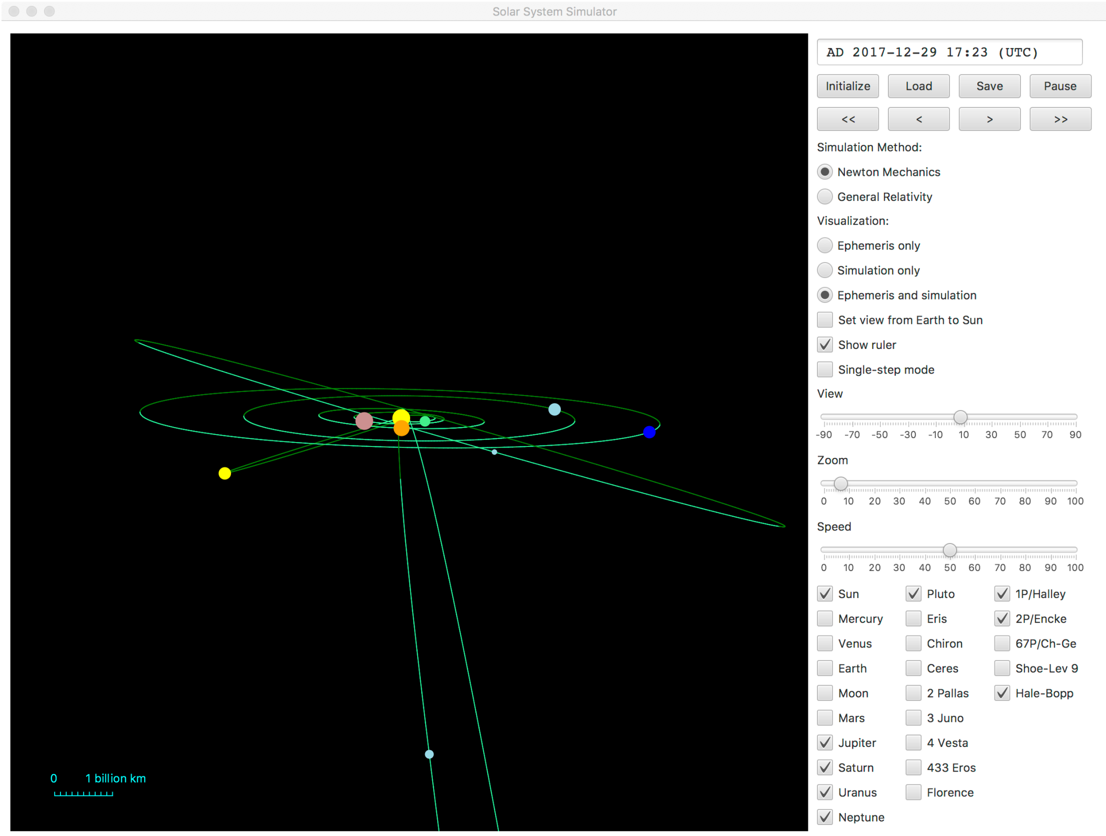
The Earth-Moon system as viewed from above (December 29, 2017):



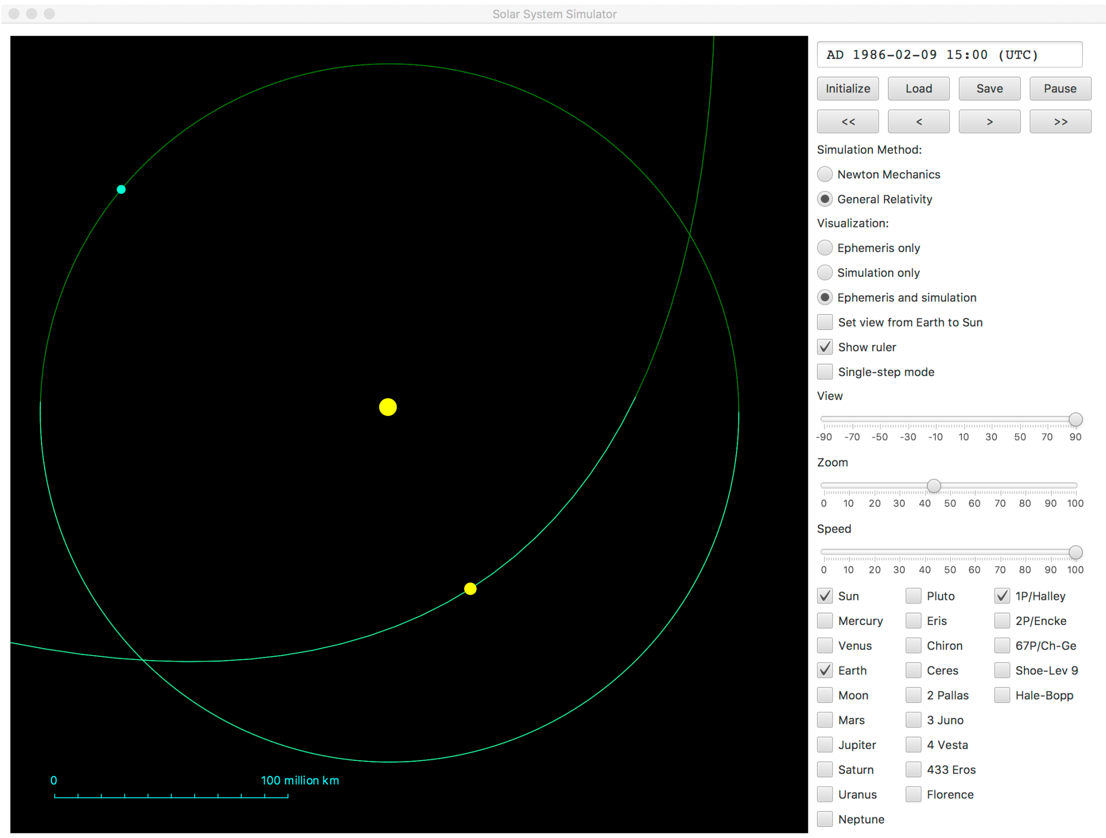
Jupiter and the asteroids as viewed from above (December 29, 2017)



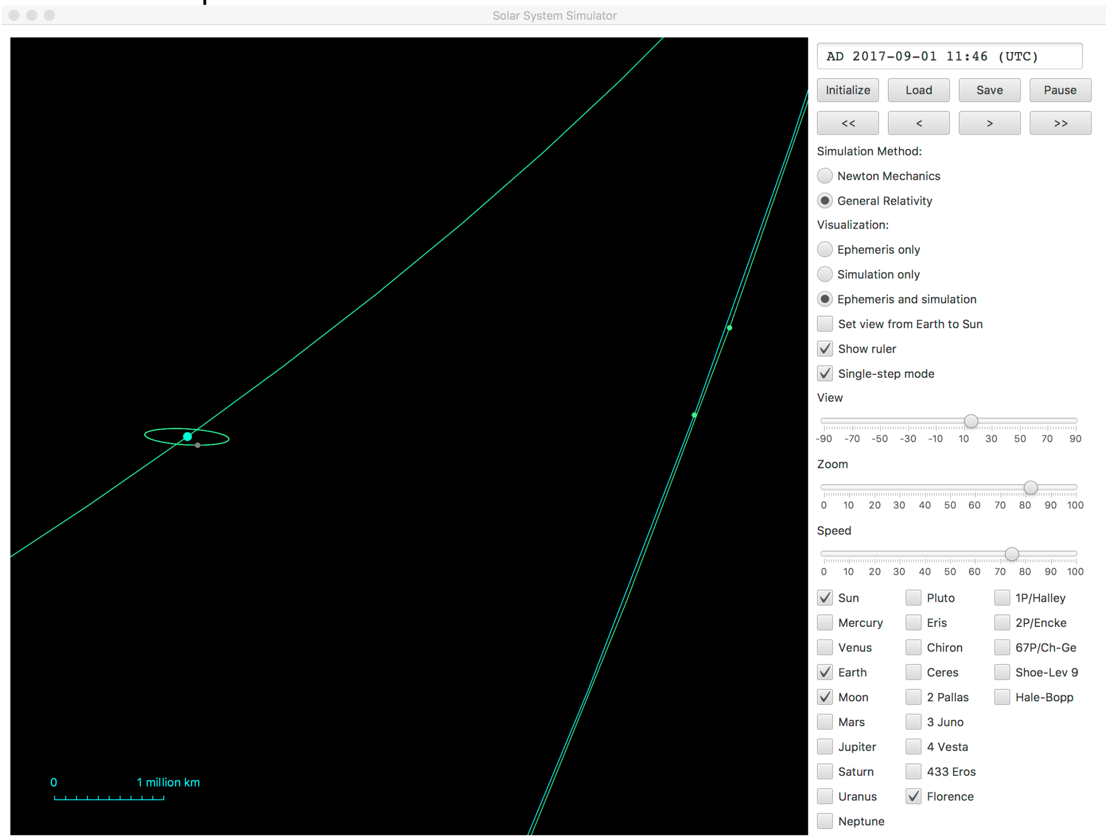
The outer planets and comets (December 29, 2017):



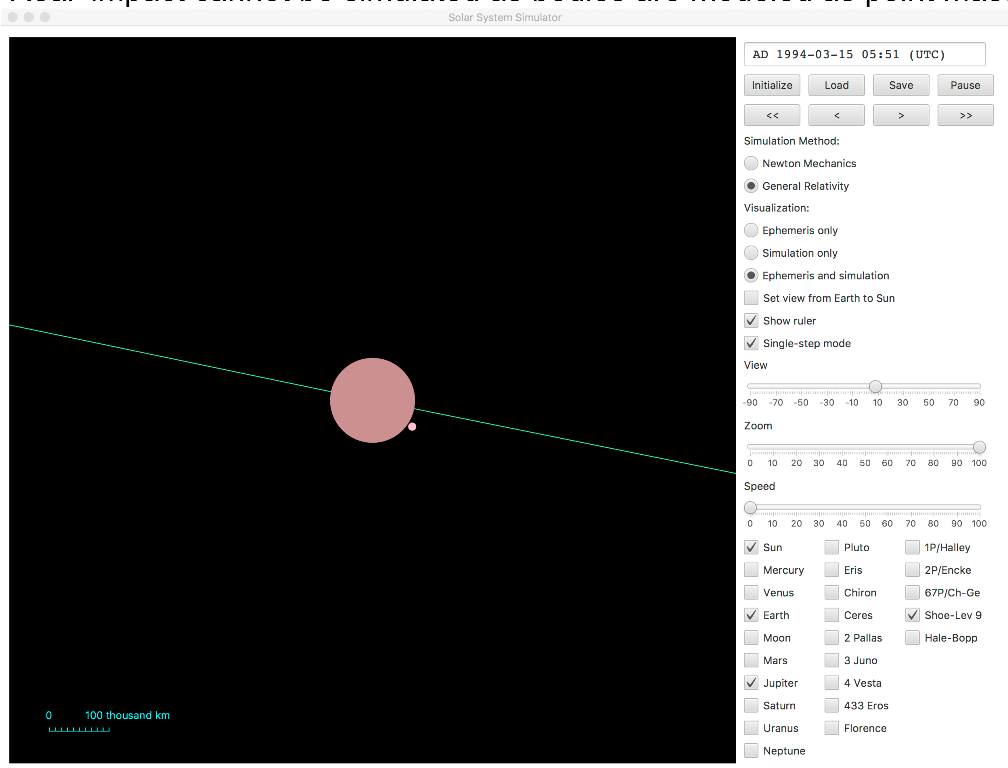
Earth and Halley's Comet at its perihelion (February 9, 1986):



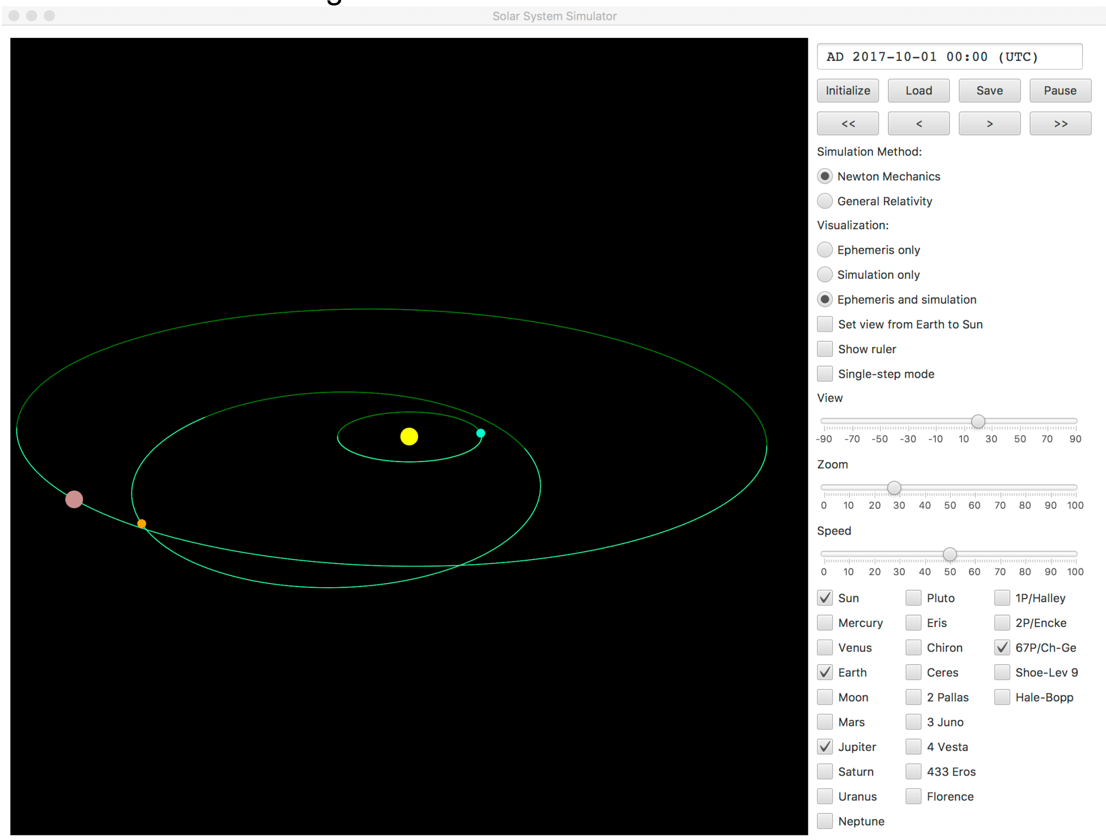
Earth, Moon and near-Earth asteroid Florence (September 1, 2017):
The orbit of Florence is influenced by the gravitational pull of the Earth. The two disks at the right both represent Florence. The top disk (green orbit) is the position as predicted by orbit parameters and the bottom disk (blue orbit) is the simulated position.



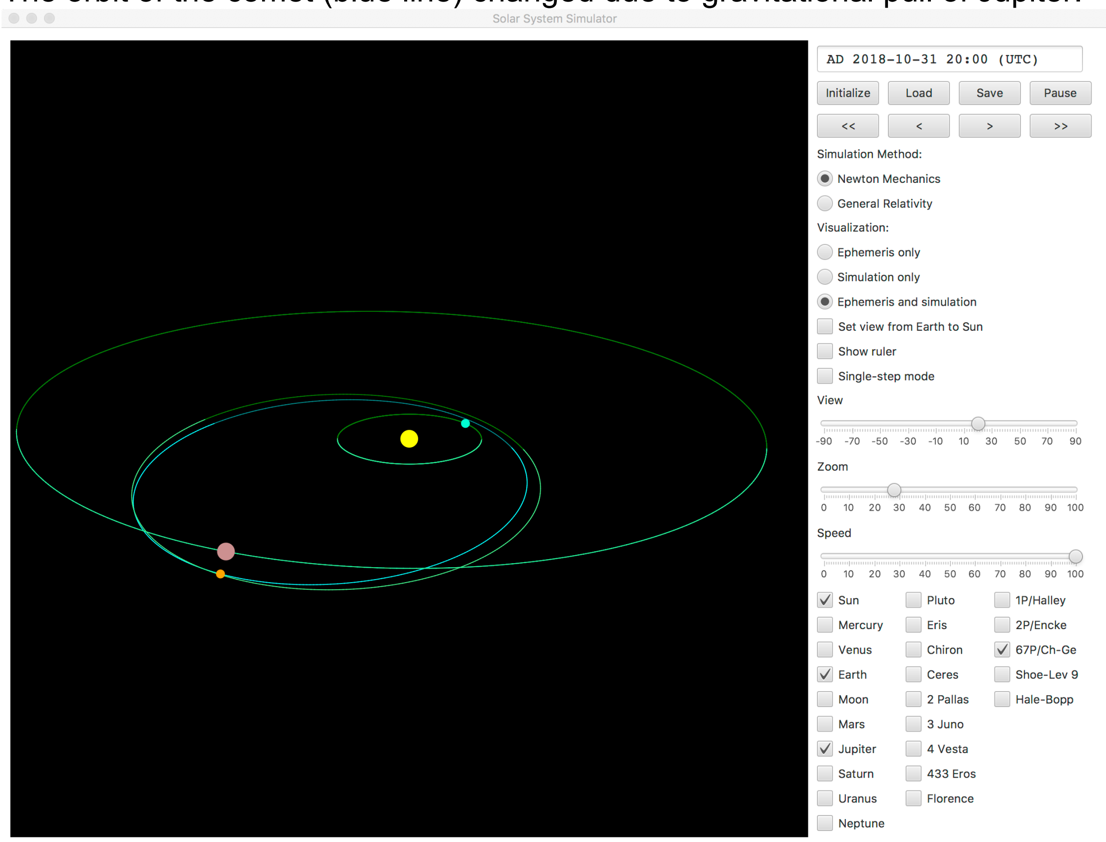
Jupiter and Shoemaker-Levy 9 before impact (March 15, 1994)
'Real' impact cannot be simulated as bodies are modeled as point masses.



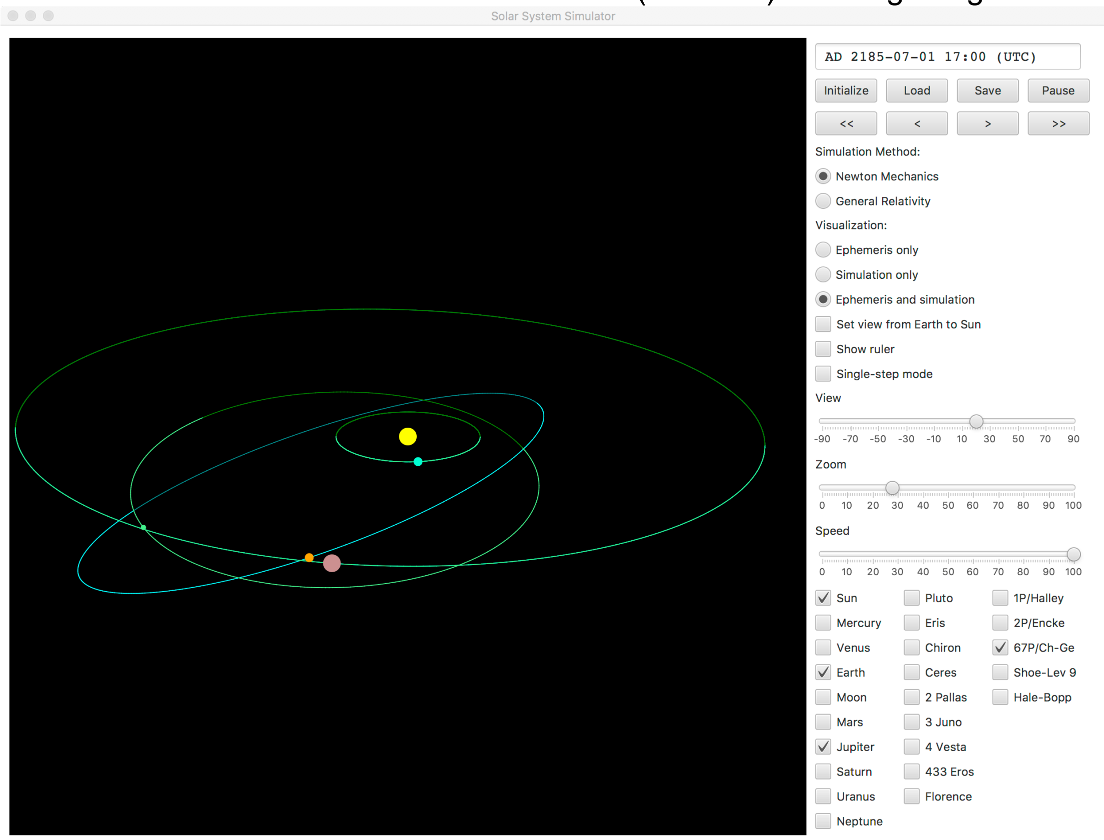
Jupiter and 67P Churyumov-Gerasimenko (October 1, 2017)
Start of simulation using Newton Mechanics.



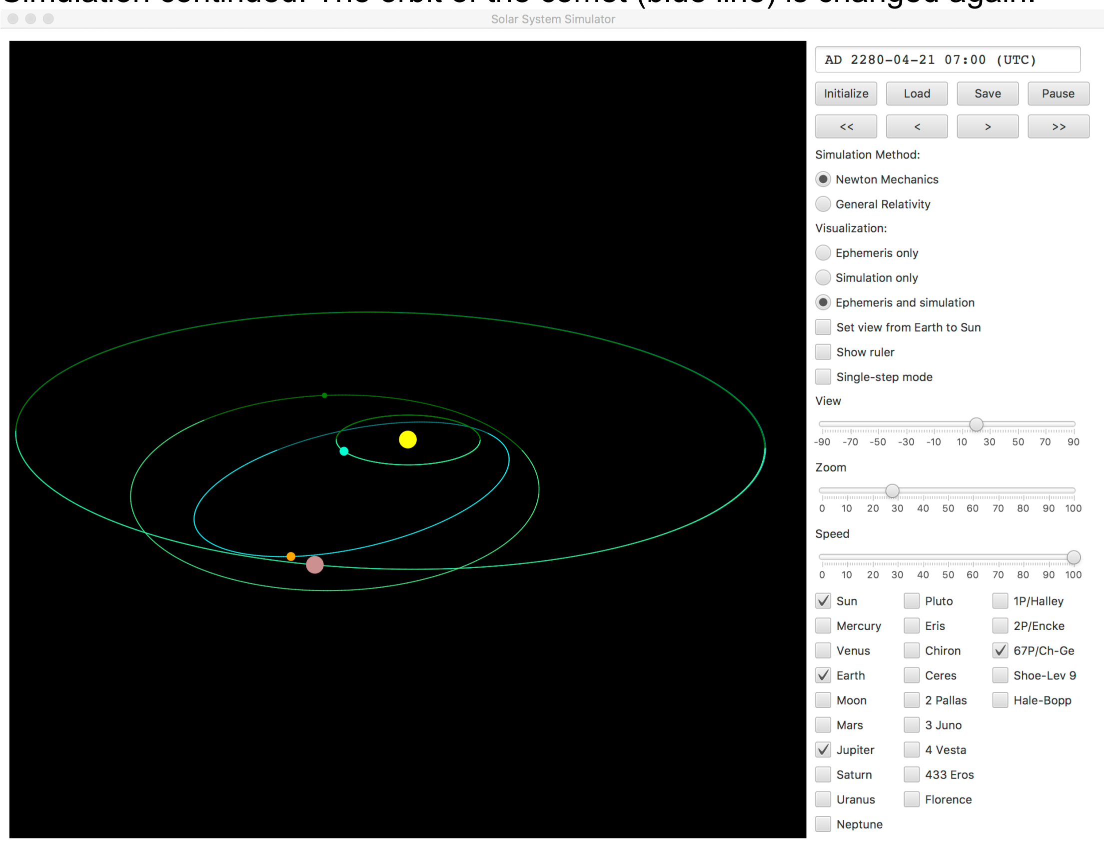
Jupiter and 67P Churyumov-Gerasimenko (October 31, 2018)
The orbit of the comet (blue line) changed due to gravitational pull of Jupiter.



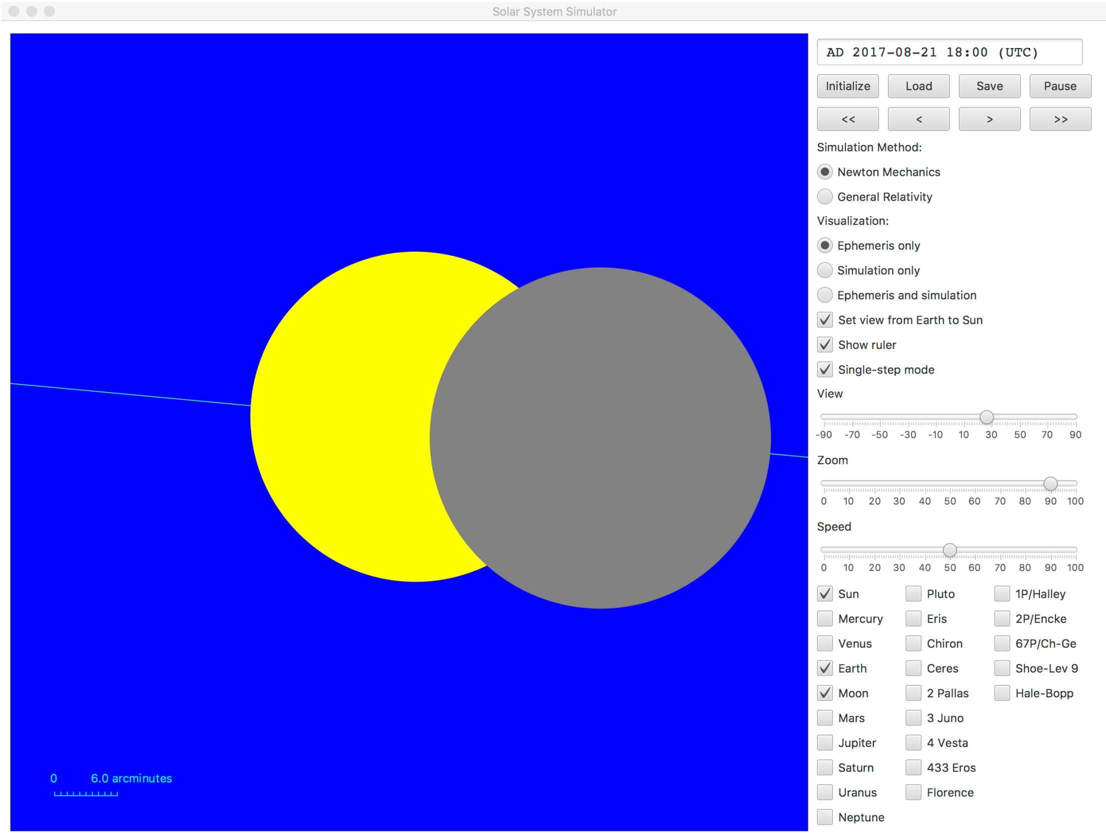
Jupiter and 67P Churyumov-Gerasimenko (July 1, 2185)
Simulation continued. The orbit of the comet (blue line) is changed again.



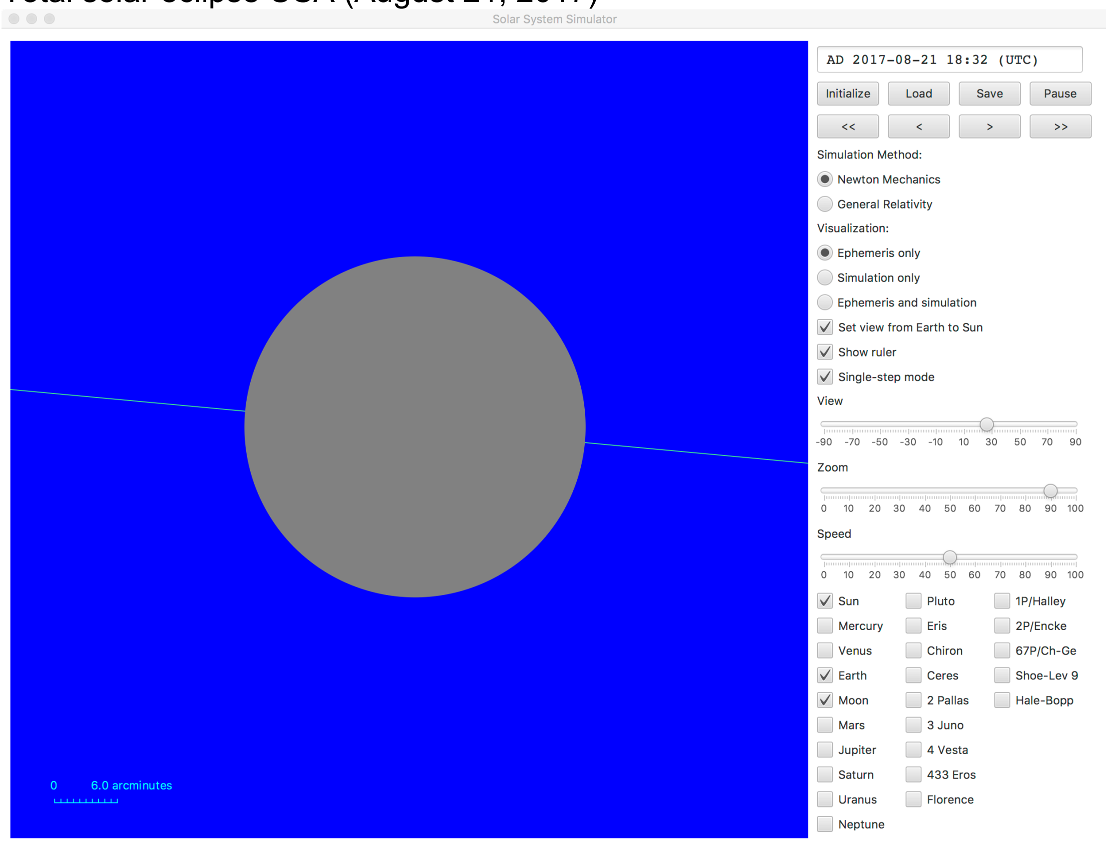
Jupiter and 67P Churyumov-Gerasimenko (April 21, 2280)
Simulation continued. The orbit of the comet (blue line) is changed again.



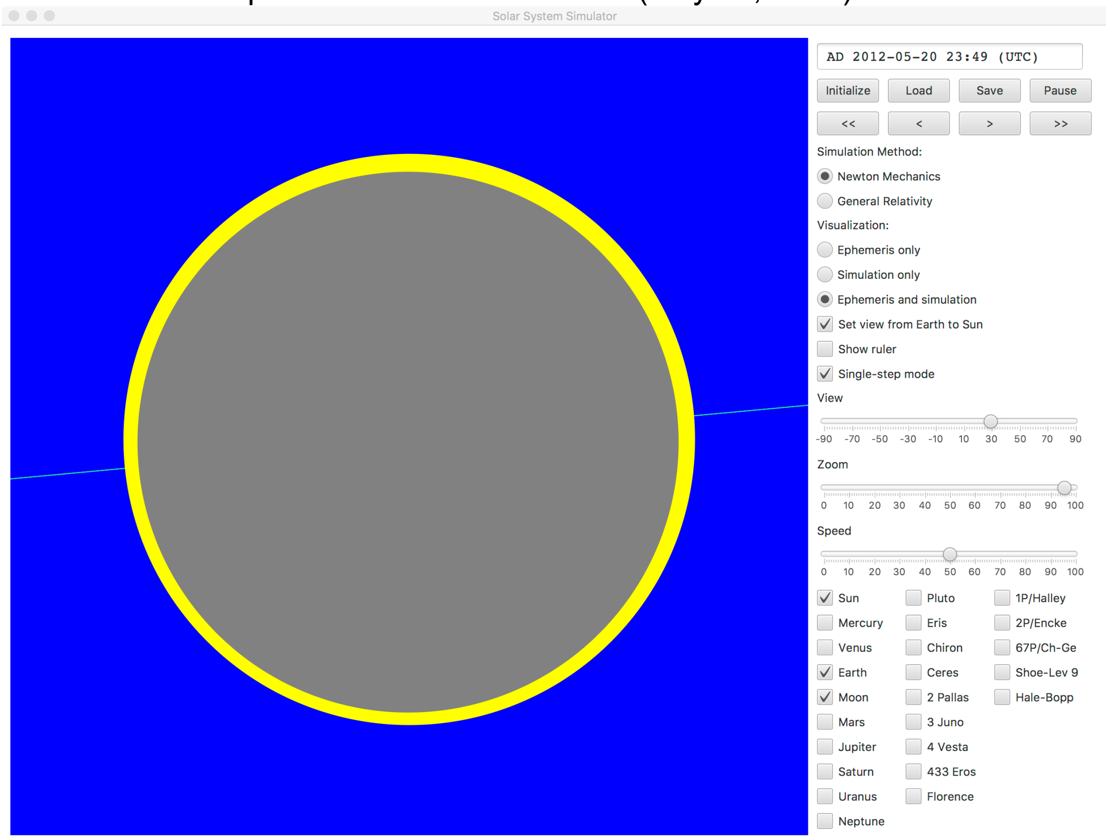
Start of total solar eclipse USA (August 21, 2017)



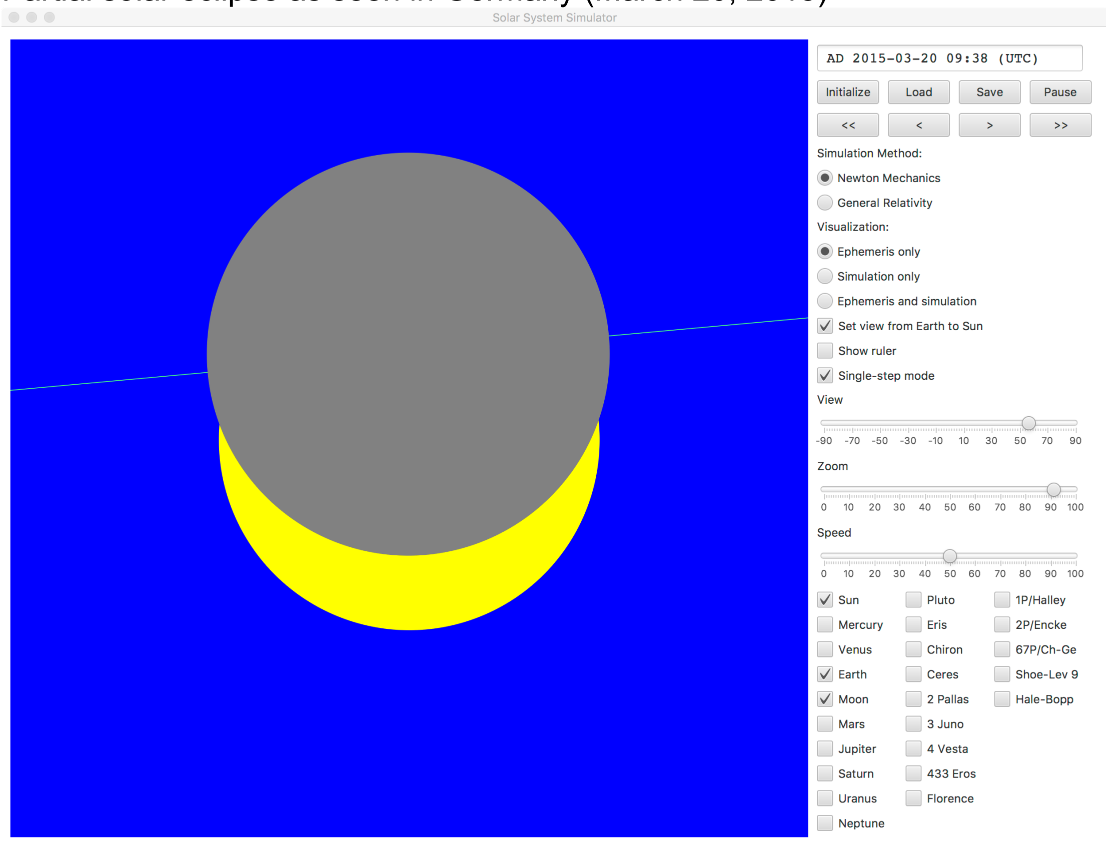
Total solar eclipse USA (August 21, 2017)



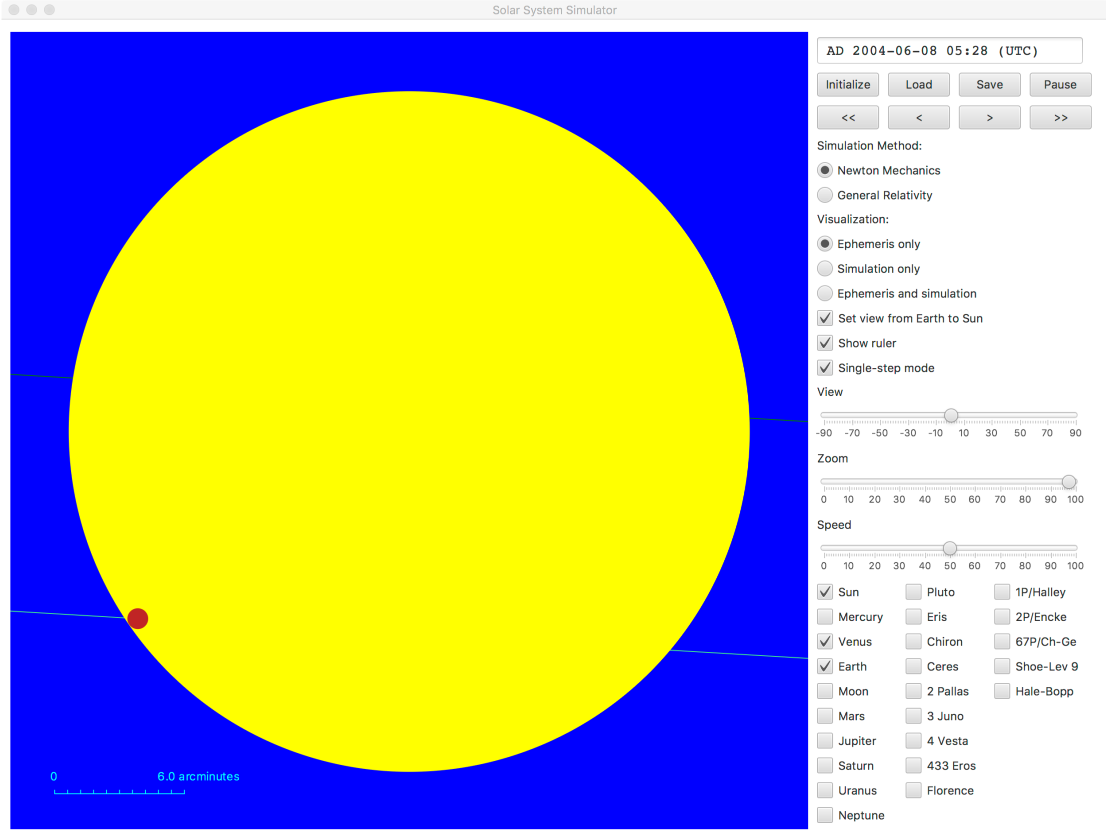
Annular solar eclipse as seen in Novosibirsk (May 20, 2012)



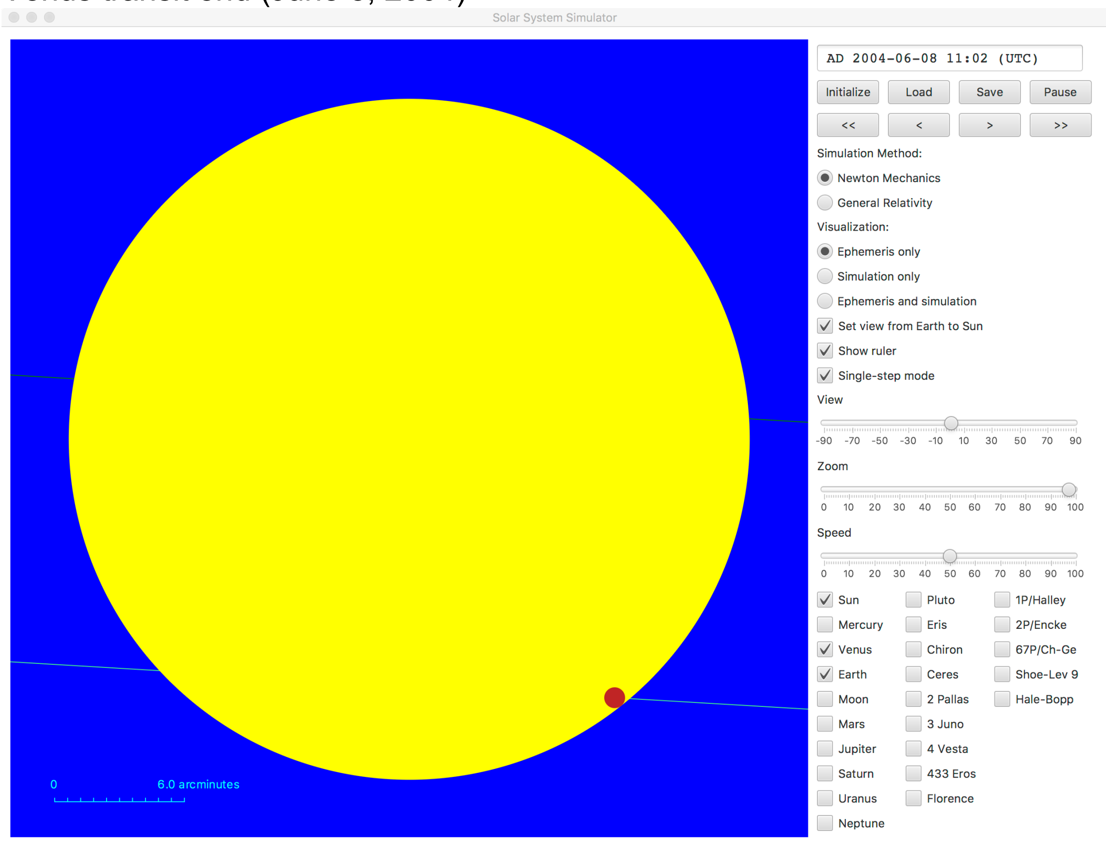
Partial solar eclipse as seen in Germany (March 20, 2015)



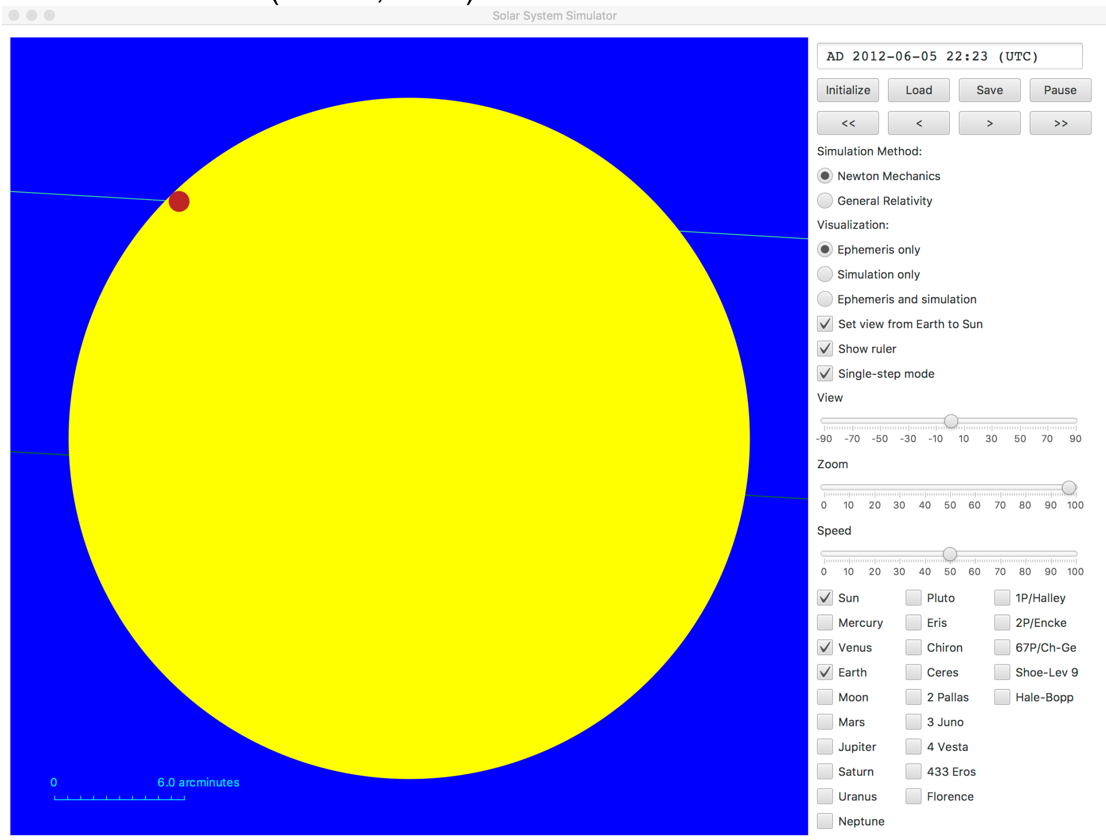
Venus transit start (June 8, 2004)



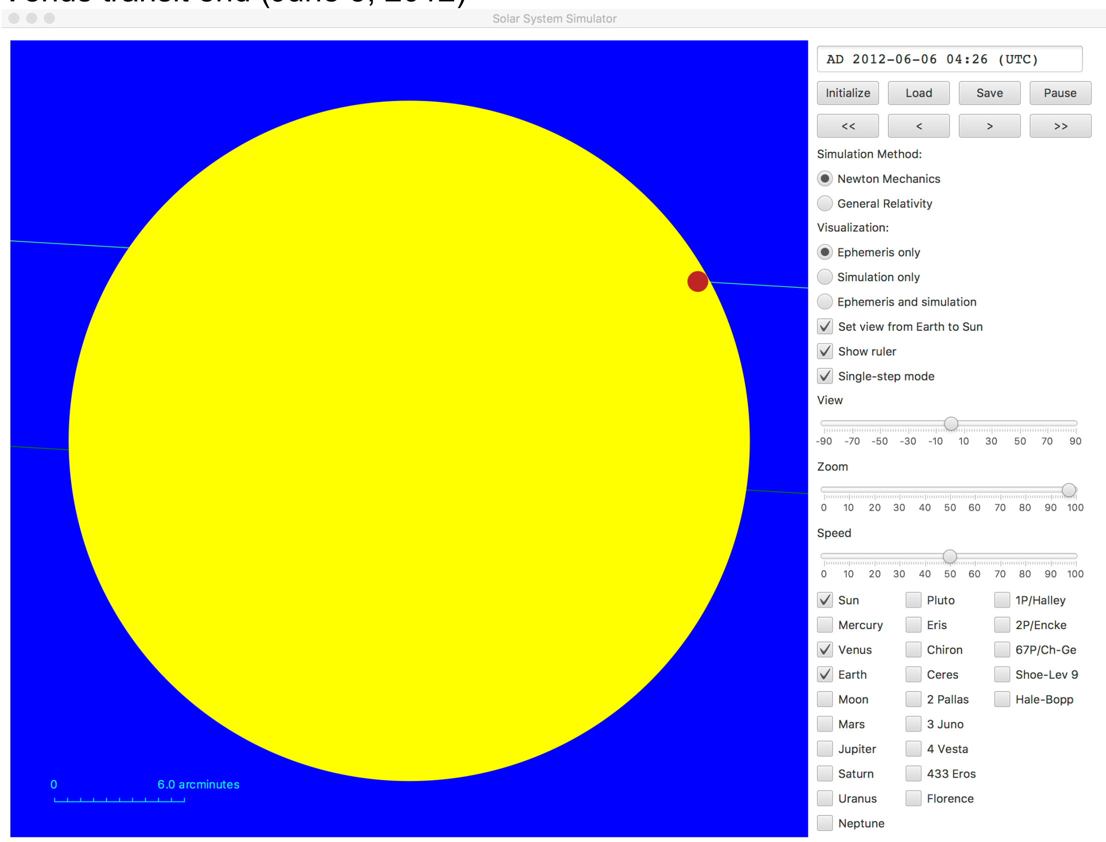
Venus transit end (June 8, 2004)



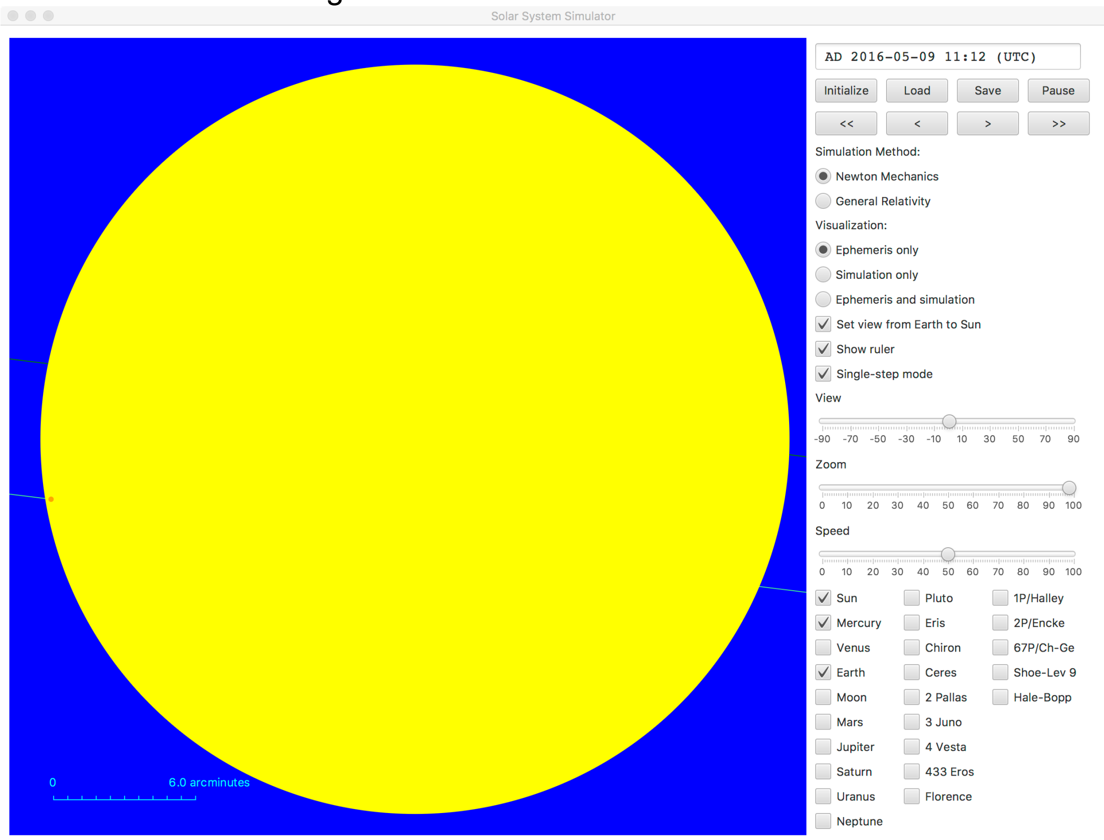
Venus transit start (June 5, 2012)



Venus transit end (June 5, 2012)



Mercury transit start (May 9, 2016)
Look for the small orange disk at the left.



Partial Mercury transit as viewed from New Zealand (November 15, 1999)
Look for the orange disk at the edge of the Sun near the top.