

3D View

3D View
Multimission

Tutorial

Multimission

V2



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2 INTRODUCTION

3DView Multimission is a tool for scientists that offers immediate 3D visualization of position and orientation of spacecrafts and planetary ephemerides.

It is a versatile, lightweight and interactive software, intended to be intuitive and easy to use.

The following missions are included: CoRoT, Rosetta, Mars-Express, Venus-Express, Cassini, Galileo, Ulysses, Voyager1-2, Stereo, Cluster, ACE, Wind, Geotail, SOHO.

3 PREREQUISITES

To display the 3D view, you must have the Java Runtime Environment installed. The minimum version 1.6 must be installed.

You can find the JRE at the following address: <http://www.java.com>

To view the "Shadows" module you need a fairly recent graphics card. Currently, only certain integrated graphic card on low-end laptops are incompatible.

4 MAIN BROWSING

4.1 GENERALITIES

This part is made of CGI for orbit and attitude files selection and a 3D display which is an application launched via Sun java tool (java web start).

4.2 BROWSING

The home page has direct access to selection page:

3DView Multimission

Spacecrafts: COROT, Rosetta, Mars-Express

Time range (UT): Start: 2009/05/21 12:06:35, Stop: 2009/05/28 12:06:35

Coordinate system: EMEJ2000

Central body: SUN

Mode: Automatic

Submit

Once the settings are done use the **Submit** button to view available data:

AVAILABLE ORBIT DATA					
File name	Start UT	Stop UT	Center	Object	Select
mex/ORMM_090401000000_00586.BSP	2009/03/31 23:50:20	2009/04/30 23:58:43	MARS	Mars-Express	<input type="radio"/>

AVAILABLE ATTITUDE DATA			
File name	Start UT	Stop UT	Select
mex/ATNM_P060401000000_00586.BC	2006/03/31 23:58:54	2009/06/02 06:58:43	<input type="radio"/>
mex/MEX_SA_2009_V0021.BC	2009/01/01 00:00:00	2009/05/01 23:59:52	<input type="radio"/>

OBJECTS SELECTION	VIEW SETTINGS
Mars <input checked="" type="checkbox"/>	Tycho2 stars subset: all vm<6
Sun <input checked="" type="checkbox"/>	Step: 605
Phobos <input checked="" type="checkbox"/>	
Deimos <input checked="" type="checkbox"/>	
Earth <input type="checkbox"/>	

View

For any help or comment, please, send an [e-mail](#).

Once the results page displayed, additional bodies can be selected to be included in the 3D view as well as star background and time step.

A click on the **View** button will display the graphics 3Dviewer in a new window:

3DView multimission

File Media 3D view 2D views Science Shadows Help

Frame: 2018/2018 Go Step 25 frame/s Loop animation

The image shows a 3D simulation of Mars and its two moons, Deimos and Phobos. Mars is depicted as a reddish-orange sphere in the center. Deimos is the larger, more spherical moon, and Phobos is the smaller, more irregularly shaped moon. The Mars Express spacecraft is shown as a small blue and white object in orbit around Mars. The orbits of Deimos and Phobos are shown as white elliptical paths. The background is a dark space filled with stars.

Deimos

Mars Express

Phobos

Time: 2009-05-08T16:37:04 Distances (M_r = Mars radius = 3389,52661133km)

Frame = MSO
Center = Mars
Start = 2009-05-01T16:37:05
Stop = 2009-05-08T16:37:05

5 DATA SELECTION

This section allows to select data to display in 3D graphics.

5.1 FIRST SELECTION

The first selection concerns the following criteria:

- one or more artificial bodies (satellites)
- a time range
- a coordinate system
- a central body
- way of selecting orbit files

3DView Multimission

[Catalog](#) [Help](#)

Spacecrafts	Time range (UT)	Coordinate system	Central body	Mode
COROT Rosetta Mars-Express	Start: 2009/05/21 12:06:35 Stop: 2009/05/28 12:06:35	EMEJ2000	SUN	Automatic

If any change in the selection criteria, please submit again.

Submit

The **Submit** button allows to switch to the second selection (natural body additions, time step).

The **Help** link will display a help page in a new window.

The **Catalog** link provides an overview of missions and their data available time range.

5.1.1 Time range selection

Time must be given in UTC and in format YYYY / MM / DD HH: MI: SS.
By default, the range represents past 7 days.

5.1.2 Spacecraft selection

One or more spacecraft can be selected in the list.

To select more than one body in the same list the CTRL key must be kept pressed.

5.1.3 Coordinate system and central body selection

When a spacecraft is selected, a coordinate system and a central body for the mission are set by default. However, this selection can be changed.

Available coordinate systems are:

- EMEJ2000 Earth mean equator, dynamical equinox of J2000
- ECLIPJ2000 Ecliptic coordinates based upon the EMEJ2000 frame
- GSE Geocentric Solar Ecliptic
- MSO Mars Solar Orbital
- VSO Venus Solar Orbital
- GSM Geocentric Solar Magnetospheric
- SM Solar Magnetospheric

For EMEJ2000 et ECLIPJ2000 systems, following central bodies are available:

- Sun
- Venus
- Earth
- Mars
- Saturn

For GSE, GSM and SM, central body is Earth, for MSO it is Mars and for VSO, Venus.

5.1.4 Orbit/Attitude files automatic or manual selection

This feature allows to choose between having only the most appropriate orbit and attitude files (auto) or manual selection of files covering all the selected time range.

5.2 SECOND SELECTION

The second selection allows to choose natural bodies, star background and time step:

AVAILABLE ORBIT DATA					
File name	Start UT	Stop UT	Center	Object	Select
mex/ORMM_090401000000_00586.BSP	2009/03/31 23:50:20	2009/04/30 23:58:43	MARS	Mars-Express	<input type="radio"/>

AVAILABLE ATTITUDE DATA			
File name	Start UT	Stop UT	Select
mex/ATNM_P060401000000_00586.BC	2006/03/31 23:58:54	2009/06/02 06:58:43	<input type="radio"/>
mex/MEX_SA_2009_V0021.BC	2009/01/01 00:00:00	2009/05/01 23:59:52	<input type="radio"/>

OBJECTS SELECTION		VIEW SETTINGS
Mars	<input checked="" type="checkbox"/>	Tycho2 stars subset: <input type="text" value="all vm<6"/> <input type="button" value="v"/> Step: <input type="text" value="605"/>
Sun	<input checked="" type="checkbox"/>	
Phobos	<input checked="" type="checkbox"/>	
Deimos	<input checked="" type="checkbox"/>	
Earth	<input type="checkbox"/>	

For any help or comment, please, send an [e-mail](#).

The **AVAILABLE DATA** shows the list of selected orbit and attitude files and a list of bodies to be added to the graph. These bodies are the planets of the solar system when the central body is SUN.

If the central body is a planet, its satellites are available. Only main satellites are shown..

Here is a summary of natural bodies availability by time range :

Bodies	Start time	End time
Mercury, Venus, Earth, Mars, Moon	1950 JAN 01 00:00:41.183	2050 JAN 01 00:01:04.183
Mars, Phobos, Deimos	1976 JUN 01 00:00:47.184	2025 JAN 11 23:59:03.184
Jupiter, Io, Europa, Ganymede, Callisto, Amalthea, Thebe	1970 JAN 01 00:00:00.000	2025 JAN 01 00:00:00.000
Saturn, Mimas, Enceladus, Thetys, Dione, Rhea, Titan, Hyperion, Iapetus	1975 JAN 01 00:00:00.000	2025 JAN 01 00:00:00.000
Uranus	1980 JAN 02 00:00:51.183	2025 JAN 04 00:01:04.184
Neptune	1980 JAN 01 00:00:00.000	2025 JAN 11 23:59:03.184
Pluton	1965 JAN 01 00:00:41.183	2050 JAN 04 00:01:04.184

The selection of the body is done by checking the box for the desired natural body:

Phobos

The star catalog selection (Tycho 2 star subset) allows to choose the number of stars to display.

Ex: All $vm \leq 6$ show all the stars of visual magnitude less than or equal to 6 (corresponding to the vision of the human eye).

The time step is automatically computed from the selected time range to have 1000 steps in the graph. It is possible to reduce the time step to get more precision in the 3D plot but it increases necessary memory resources.

If the center is SUN, a logarithmic scale representation can be selected in order to display all the planets of the solar system in a nice manner.

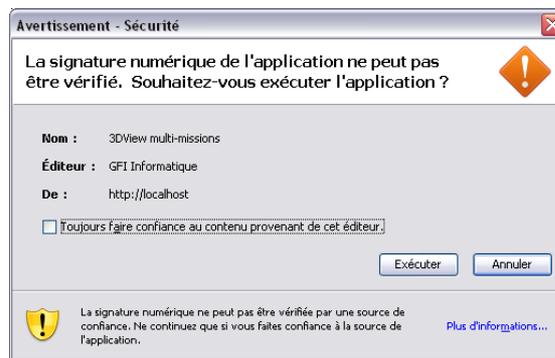
The **View** button launches the 3D display of selected data.

6 3D DISPLAY

Once the selection is submitted, the 3D display, a Java application, is open through the tool "Java Web Start" from Sun.

6.1 LAUNCH

At the launch, a security alert window will appear. It is due to the signing of java packages as 3Dview multimission require access to hard disk and therefore special rights. The certificate allowed to sign the main package has been generated to freely use the application without the certificate of a recognized authority. Therefore, a window appears at the launch of the application to indicate that the signature has not been recognized by an official body:



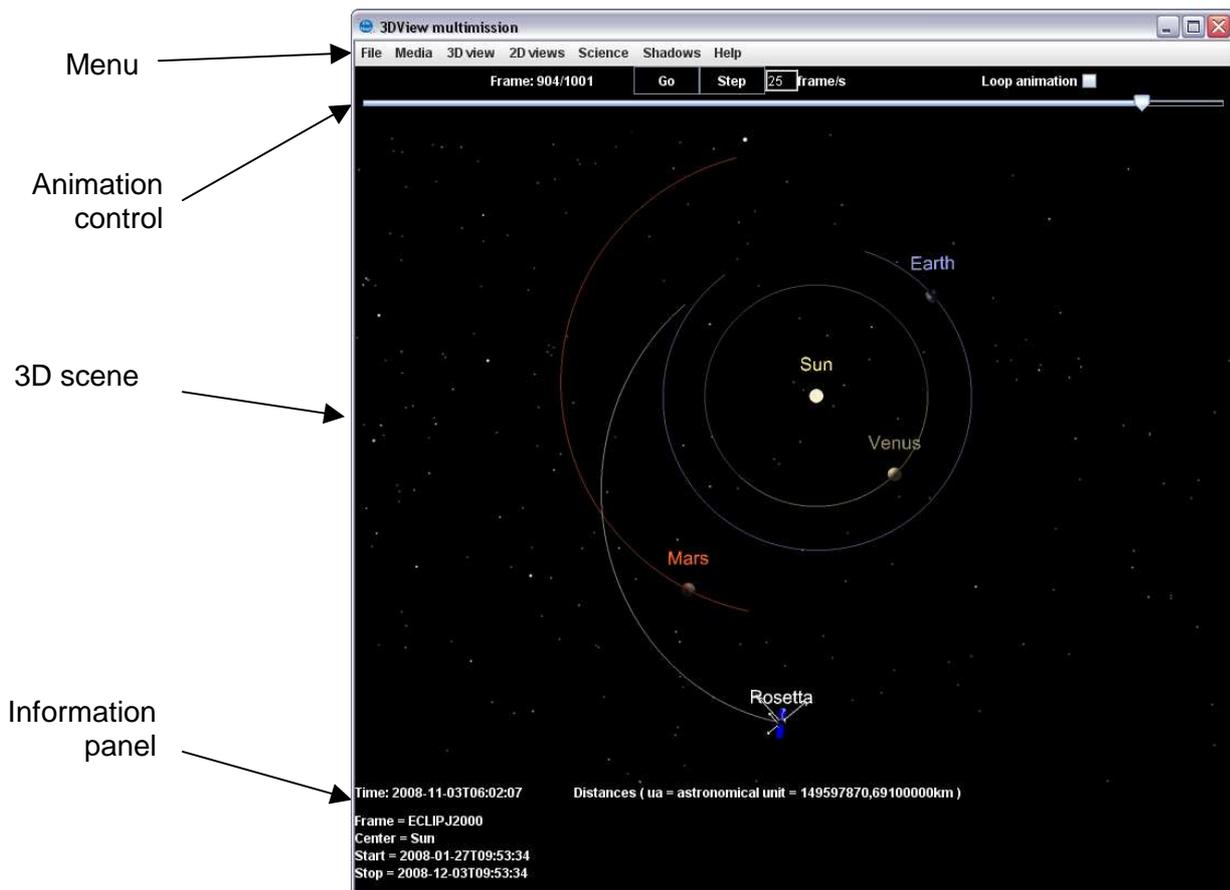
You have to accept to make it work.

6.2 3D WINDOW

6.2.1 Main view

3D display has 4 parts:

- Menu,
- Animation control,
- 3D scene,
- information panel,



6.2.2 Menu

It provides access to advanced features: change display settings, display models, save images, ...

6.2.3 Animation

You **can start or stop the animation** via the button Go / Stop.

The Step button allows to advance step by step.

The number of frames / s defines the animation speed (it can be modified to change the speed).

It is also possible to play the animation by changing the cursor position directly with the mouse.

The check box "Loop animation" allows to automatically and indefinitely restart the animation.

6.2.4 3D scene

The 3D scene is the main view of the application. It shows bodies selected in selection page and all other items added from menus (models, instrument views, ground traces,...).

You can navigate through the 3D scene using mouse and keyboard.

To **rotate 3D scene** around its center, you should click with the left mouse button and drag .

To **zoom** in and zoom out (or forward and backward), use left button and Shift key on the keyboard. The mouse wheel can also be used for this purpose.

To **move** left or right, use the left button and the Ctrl key.

Finally, to "**look around**", use right mouse button and drag.

6.2.5 Information panel

The information panel is divided into two parts.

On the left, static information are displayed (coordinate systems, time range, ...).

The right side is reserved for real-time display of distances.

6.3 FUNCTIONALITIES

6.3.1 File menu

This menu allows to save scene selection (save file), or open a previously saved scene (**Open file**).

It also helps to save orbit and attitude of spacecrafts and planets in an ASCII formatted file (**Save data**)

Finally, it allows to close application with **Exit** item.

6.3.2 Media menu

This menu allows to generate images and movies.

6.3.2.1 Images export

With the **Save image** and **Save high res image** menus, it is possible to take a snapshot of displayed 3D scene as an image in PNG format. The first menu will save the image as displayed on the screen while the second generates an image three times bigger or three times more accurate.

NB: Different graphics cards have a maximum size limit:

- Intel: 1024x1024
- ATI: 2048x2048
- Nvidia: 4096x4096

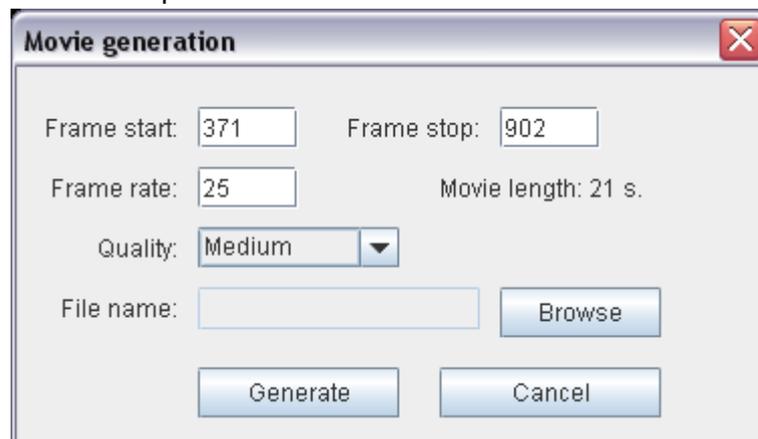
If any of these manufacturers is detected, the limit of 1024 is used.

This limit also applies to movies.

If the limit is reached, the application will reduce the size factor to reach the largest possible picture on the basis of capacity of the card.

6.3.2.2 Movies generation

Generate movies can record all or part of the animation.



The "start frame" and "stop frame" allows to define the range of the animation to be generated.

The "frame rate" adjusts the number of image per second during the movie (one image = one frame). The lower the frame rate is, the longer the movie is, but below 10 fps, the film will look jerky. Go beyond 25 is unnecessary because the eye does not see the difference.

The indication "Movie length" indicates, depending on frame start / stop / rate, the length of the generated movie.

The quality is used to adjust the movie size:

- Good: 2 times the screen size
- Medium: screen size
- Poor: 0.5 times the screen size

Choose a file in which to save the movie by clicking on "Browse", then start the recording via the "Generate" button.

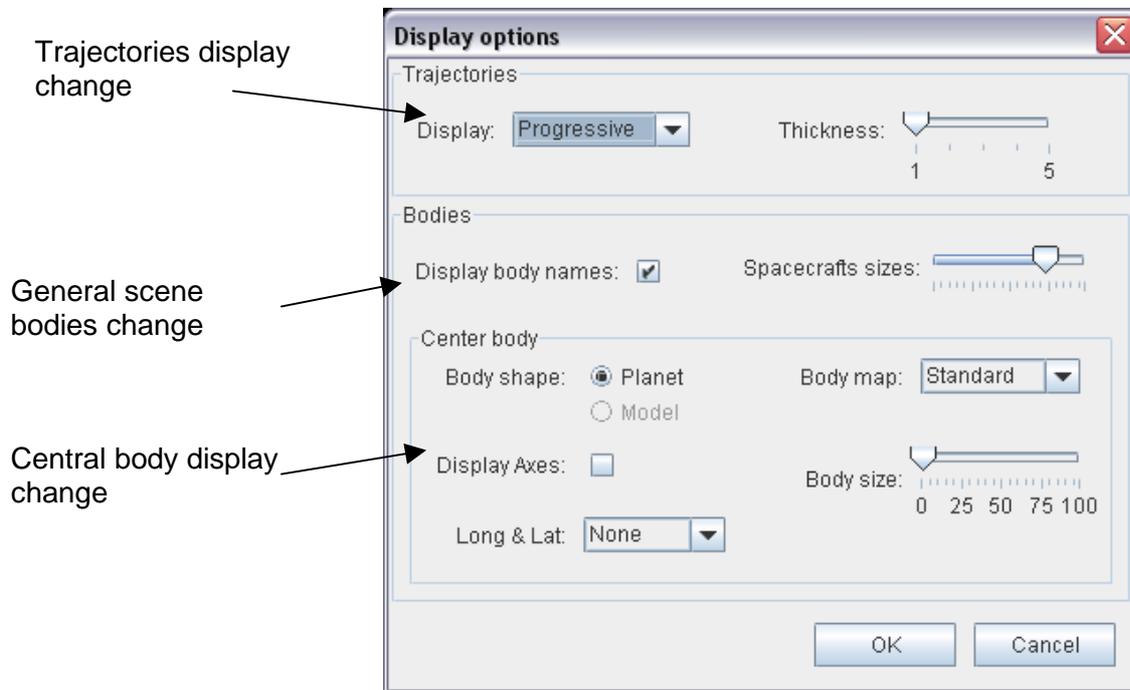
Attention, the generation of a movie may take some time and a lot of memory if a large time range and good image quality are selected.

6.3.3 3Dview menu

3Dview multimission menu allows to change the view of the 3D scene.

6.3.3.1 Display options

3Dview/**Display options** menu allows to change some display options:



6.3.3.1.1 Trajectories display

You can change the thickness and the display mode of bodies trajectories.

The following 3 options of display mode are available:

Full: all trajectories are shown completely independently of the state of the animation,

Progressive: trajectories of natural bodies (planets and satellites) are fully displayed while spacecrafts are shown as the progression of the animation,

None: no trajectory is shown .

6.3.3.1.2 Bodies display

In this part, the interface allows :

- to display or not the names of bodies,
- to modify the size of the spacecrafts. This is useful to adapt spacecraft size to display after a zoom.

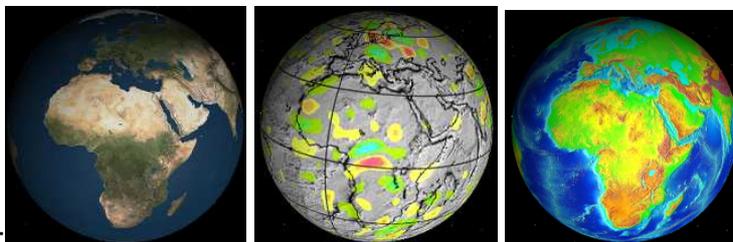
6.3.3.1.3 Central body display

The central body is always a natural body (planet, satellite, asteroid, ...)

Several options are available to change the display of the central body:

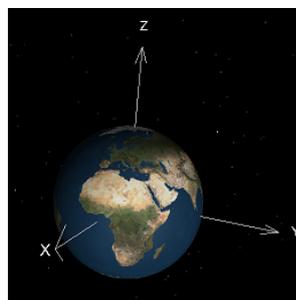
Body shape: to choose a sphere (Planet) or a 3D model (Model) to represent the body (only available for asteroids).

Body map: To view different map.



Earth samples:

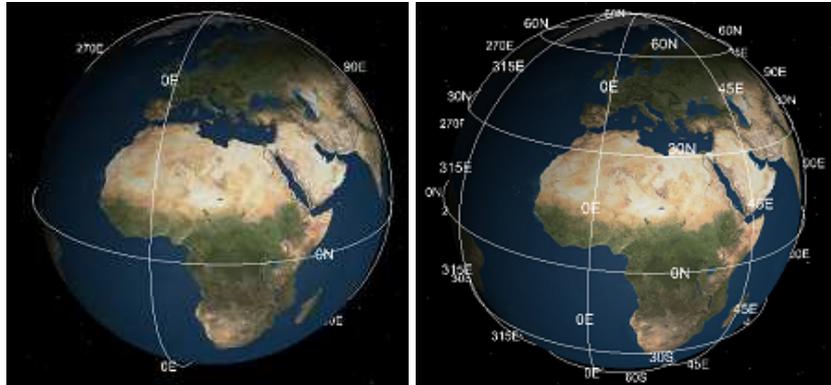
Display axes: displays the axes X, Y, Z on central body



Body size: changes the size of the central body. This is useful when flying over an asteroid, for example, where the difference between asteroid size and the fly-by distance does not allow to clearly distinguish the two objects in the same scene.

Long & Lat: Displays a grid representing the longitudes and latitudes.

Normal and Precise modes



6.3.3.2 XYZ planes

Two options allow to view the planes for the system of coordinates:

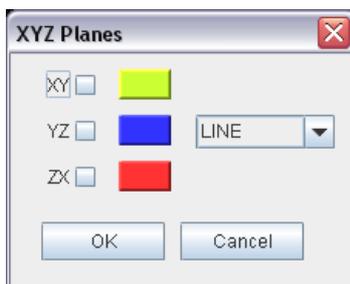
- view the planes,
- positioning the camera perpendicular to the plane to be viewed.

6.3.3.2.1 Set camera in plane axis

The first three menu items **XY View**, **ZY View** and **ZX View** set camera position in front of the selected plane.

6.3.3.2.2 Planes visualisation

The **XYZ planes** can be viewed as a shape of grids, points or translucent plans.

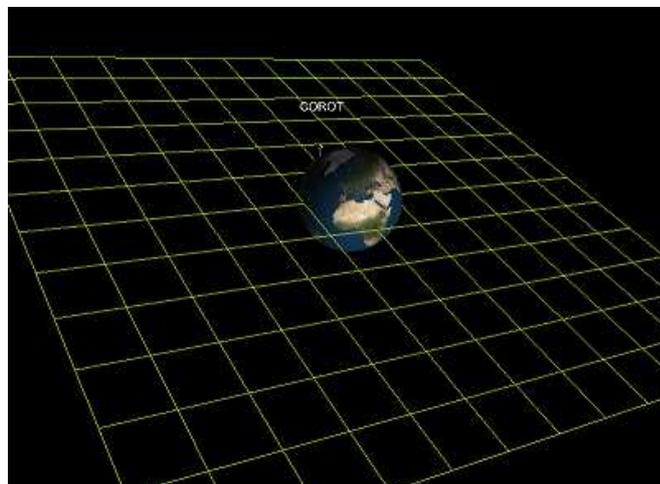


To view planes, check the boxes. The color can be changed by clicking on it. The selection box allows to select the plane display mode.

Points (POINT)

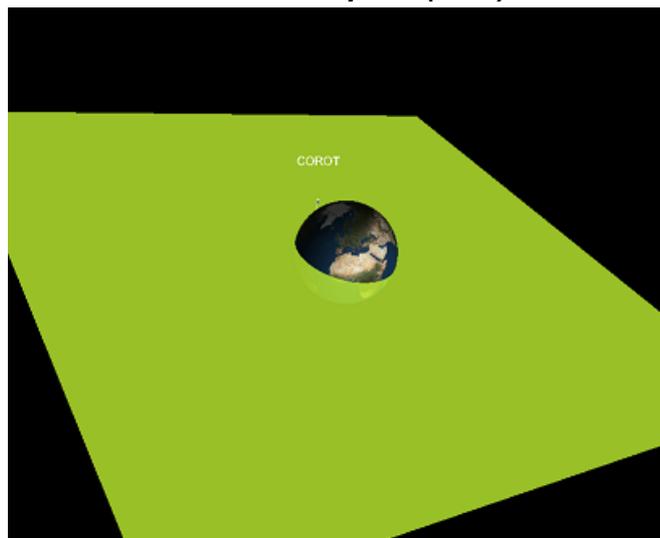


Matrix (LINE)



The width of the grid corresponds to the display unit (radius earth, Mars, astronomical unit, ...)

Translucent plane(FILL)

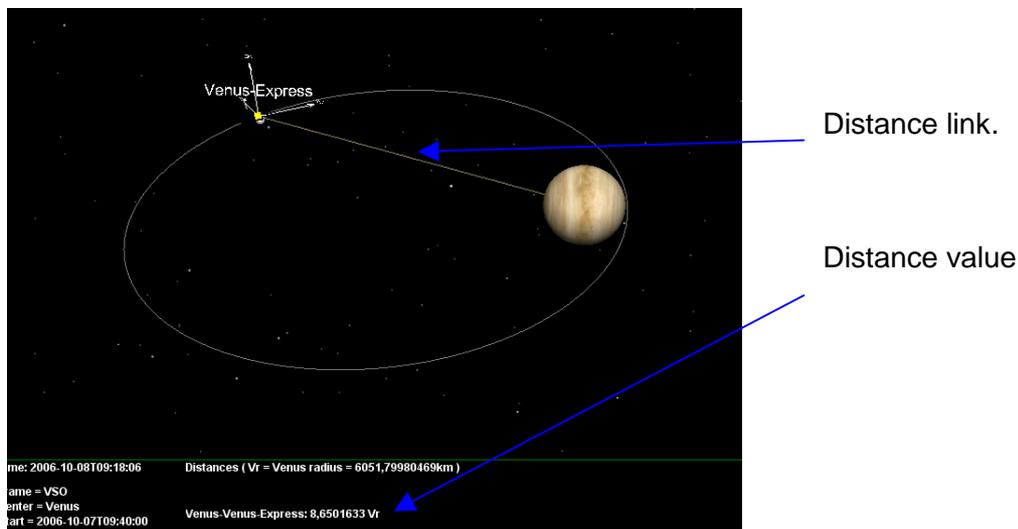


6.3.3.3 Link/Distance visualisation

To display a distance, it must first be defined. To do this, use the 3Dview/Define distance between two objects.

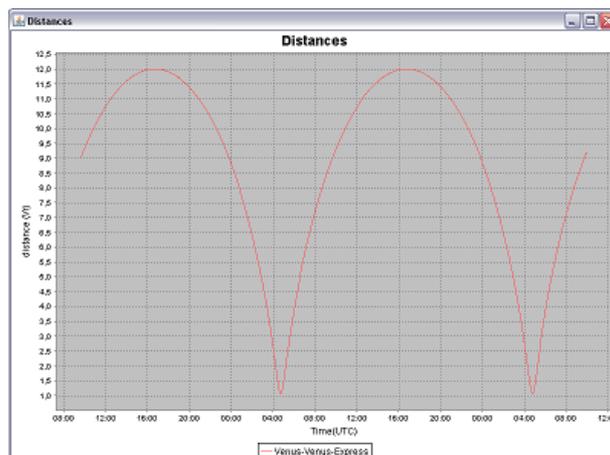


Checking the option **Draw link** provides a link between the selected two objects in the 3D scene. The distance value is displayed on the right of the information panel.



A 2D graphics is available to view the evolution of the distance in time. It is accessible via the menu "2Dviews/Distances".

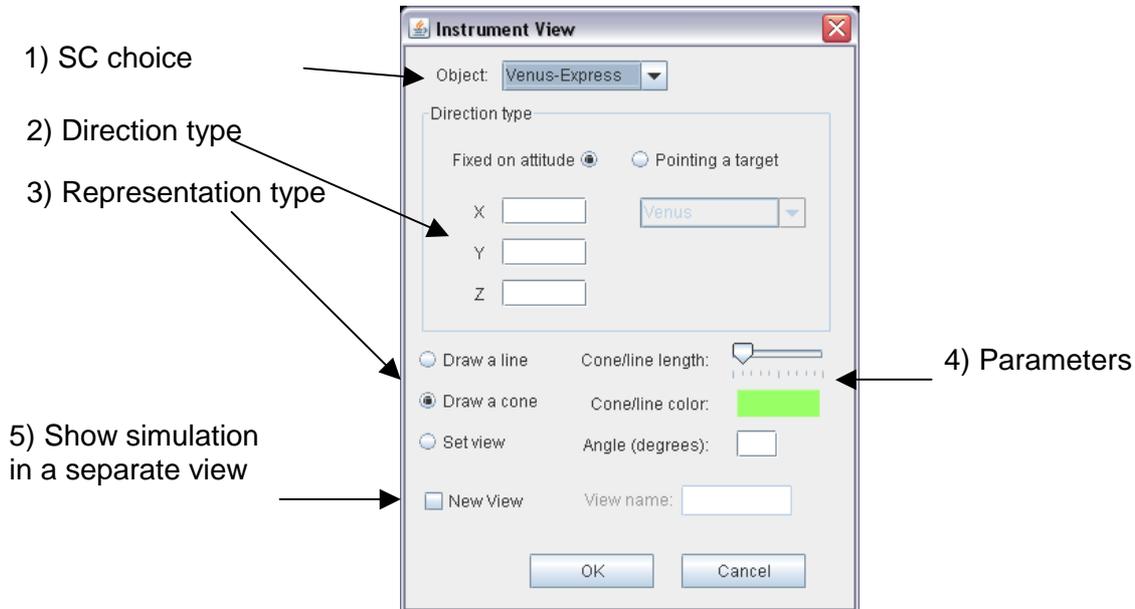
The first launch may last a little due to 2D package loading.



6.3.3.4 Instrument view

The menu 3Dview/View instrument direction simulates an instrument view. It may be useful to simulate a camera or a detector. It is possible to run several times this function to simulate different instruments simultaneously.

The configuration window appears:



6.3.3.4.1 SC choice

The list allows to choose a body among those displayed in the 3D scene.

6.3.3.4.2 Direction type

The type allows to choose between a **fixed direction** in the spacecraft coordinate system or a **target to point at**.

The first option allows to simulate an instrument while attitude data is available. You must enter the direction vector relative to spacecraft coordinate system. It is not necessarily normalized.

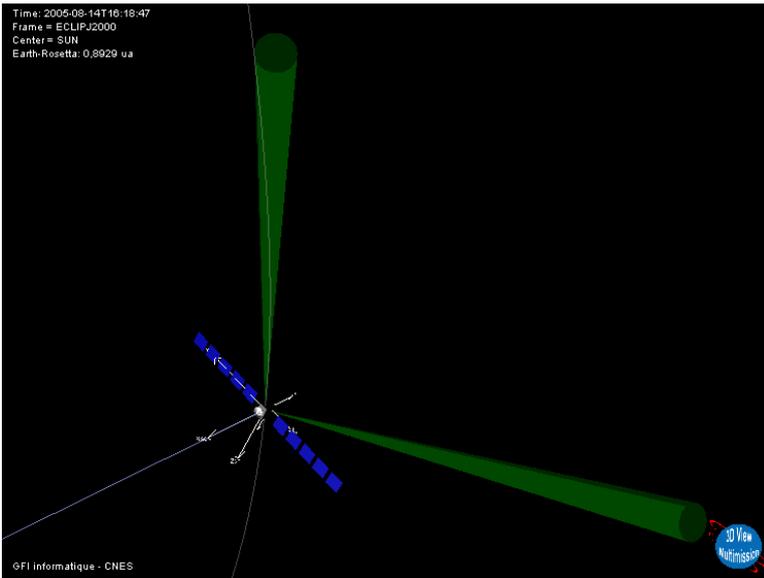
With the second option, you can choose to point instrument direction to an object in the scene. The right ascension / declination of the direction in EMEJ2000 will be displayed if the simulation is displayed in a separate view (New View).

6.3.3.4.3 Representation types

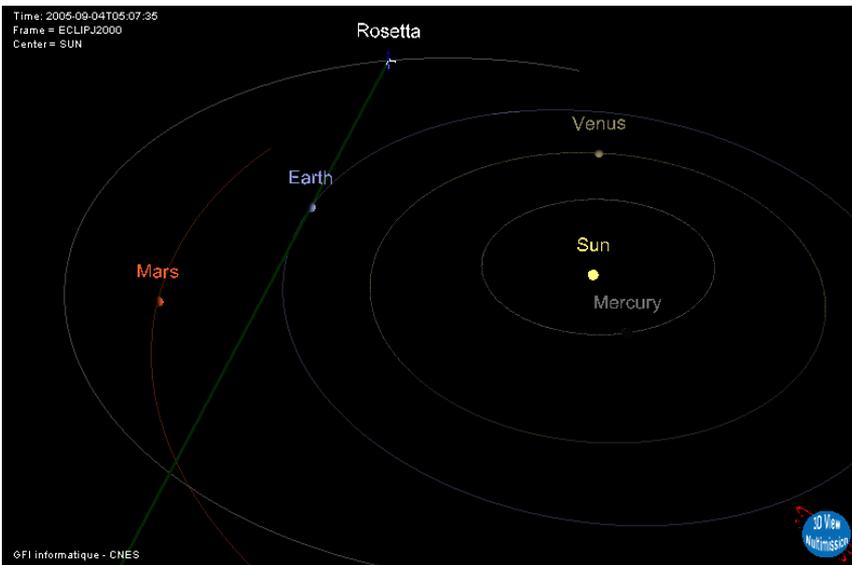
Three types of representation are available:

- **Draw a cone**
- **Draw a line**
- **Set view**

The first option allows to represent an instrument boresight with an angle such as a camera:



The second one draws a line in the axis of the entered vector.



The third is different from the previous ones: it places the user in place of the instrument so that he sees on the screen what the instrument sees. The view is centered on the spacecraft and follows the orbit and attitude. The navigation functions remains active but, except the zoom, any movement will loose the direction defined at the outset.

To return to the starting view, select the menu 3Dview/ZY plane.

6.3.3.4.4 Parameters

The slider allows to change the length of lines and cones.

The color of the line or cone is editable by clicking on the colored area.

If "Draw a cone" or "Set view" is selected, it is possible to enter a field of view (angle degrees).

6.3.3.4.5 Simulation view in separate window

It is possible to represent the instrument view by a cone and simulate at the same time the view of the instrument in a separate window.

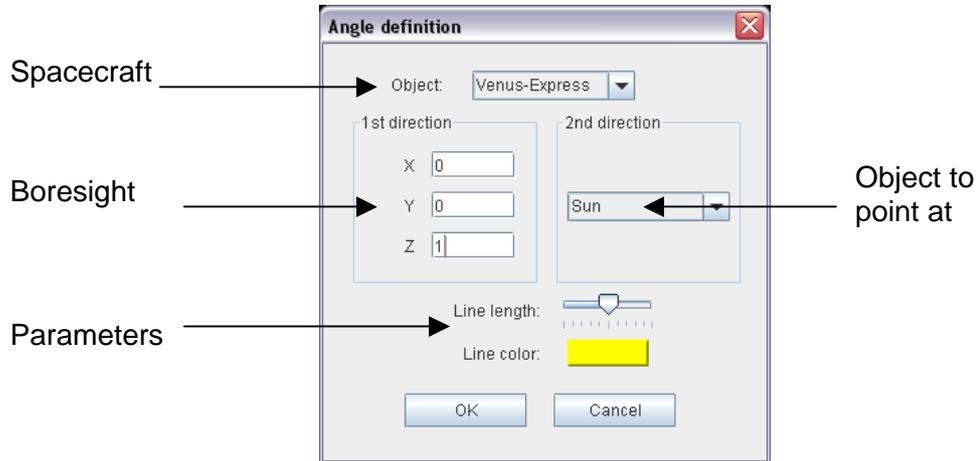
For this, check **New view**. A text box allows to name this window in addition to the information already recorded in the title.



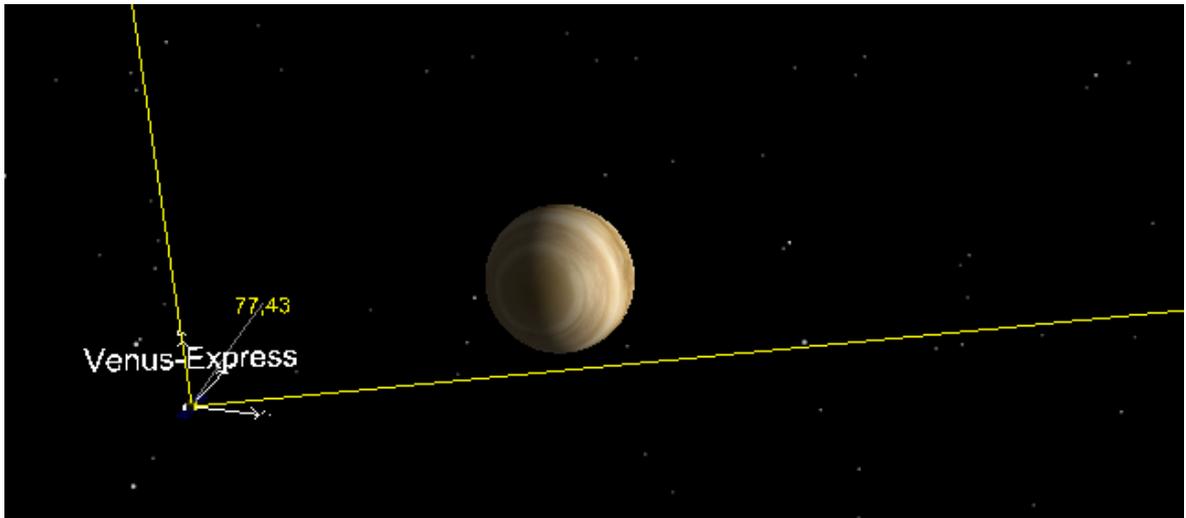
Closing the window automatically remove the cone in the main window.

6.3.3.5 Angle between a fixed boresight and an object.

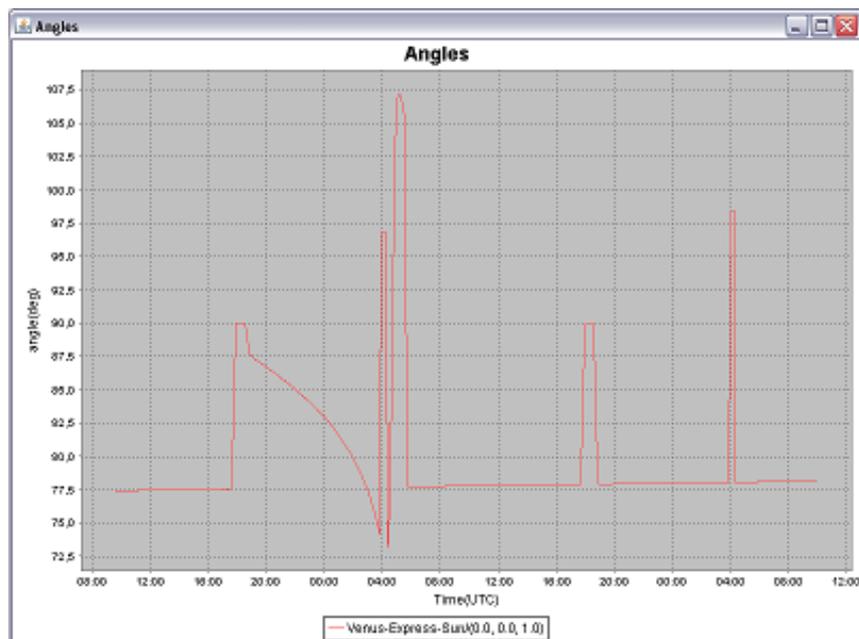
The menu 3Dview/**View instrument angle** allows to see an angle between one direction (referred to an instrument) and a body. This allows for example to get the angle between the sun and the boresight of a camera.



In the 3D scene, the following representation is obtained:



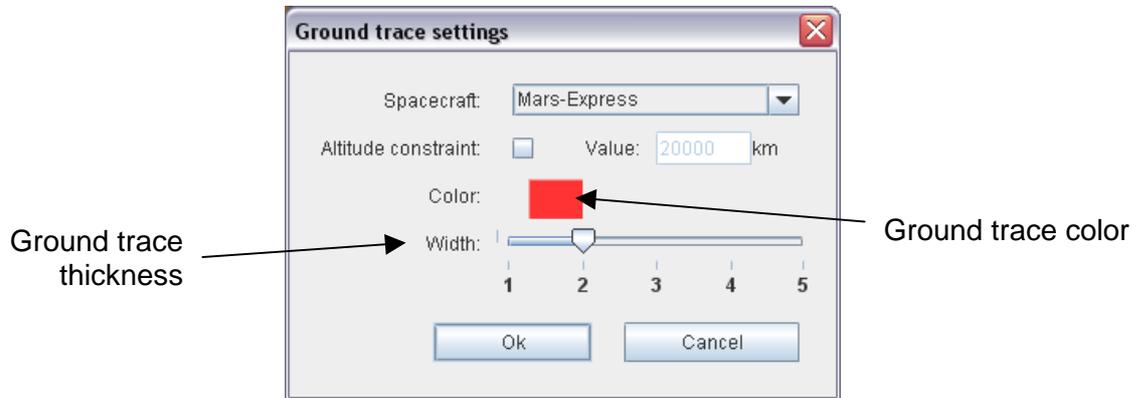
As distances, it is possible to view angle value as function of time through the menu **2Dview/angles**



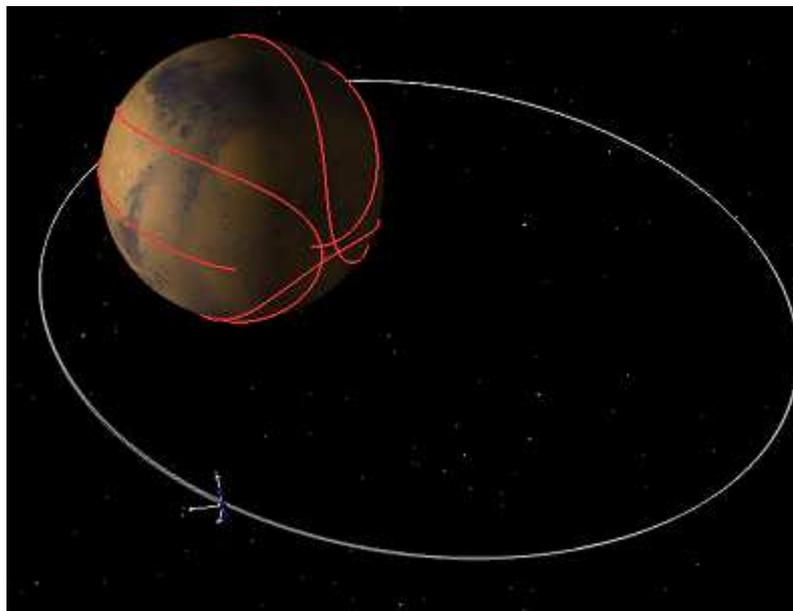
6.3.3.6 Ground trace visualisation

It is possible to represent the ground trace of a spacecraft on the central body.

To do this, select the menu 3Dview/View ground trace:

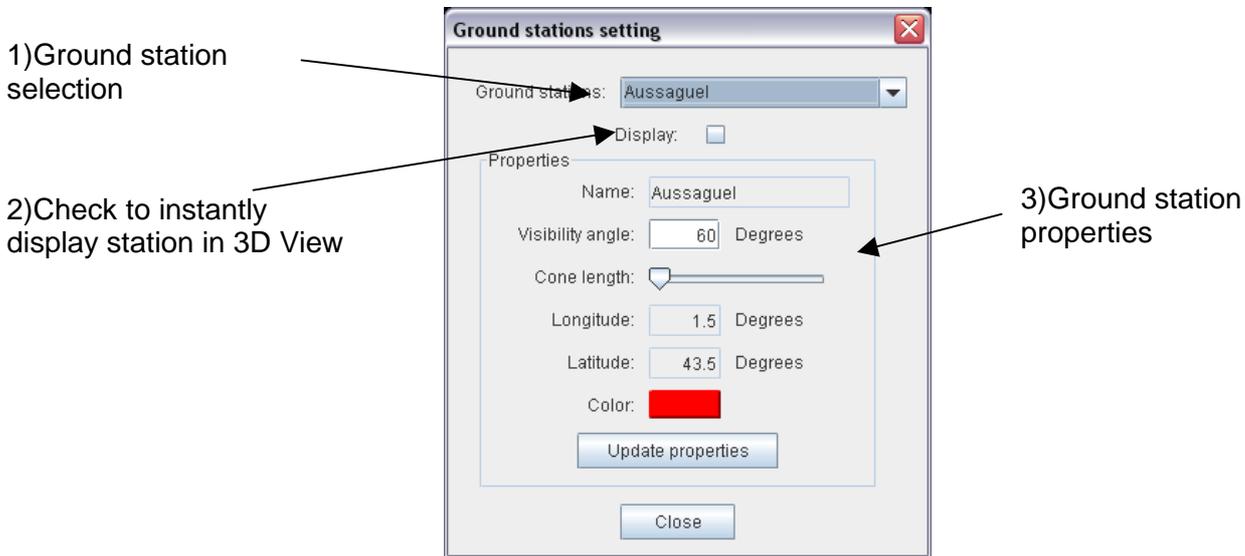


The maximum generation altitude of the ground trace allows to generate the ground trace only once the distance between the spacecraft and central body surface is below this limit.



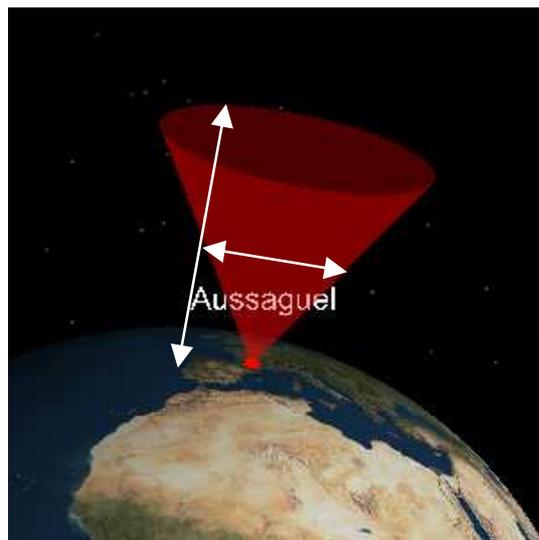
6.3.3.7 Ground stations setting

When the Earth is the central body, the menu 3Dview/View **ground stations** allows to visualize the location of ground stations and their zone of influence.



To view a ground station:

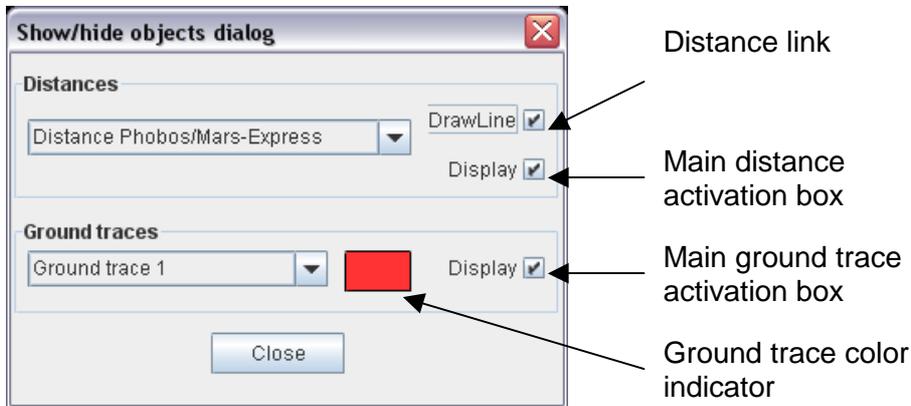
1. choose the desired station among those proposed,
2. activate its display in the 3D scene,
3. modify its properties (only the angle of the cone of vision, its length and its color can be modified),
4. validate changes in station properties. These changes will not be retained after a restart of the application.



6.3.3.8 Show/hide link/distances and ground traces

The menu 3Dview/**Toggle objects** allows to display or not certain objects.

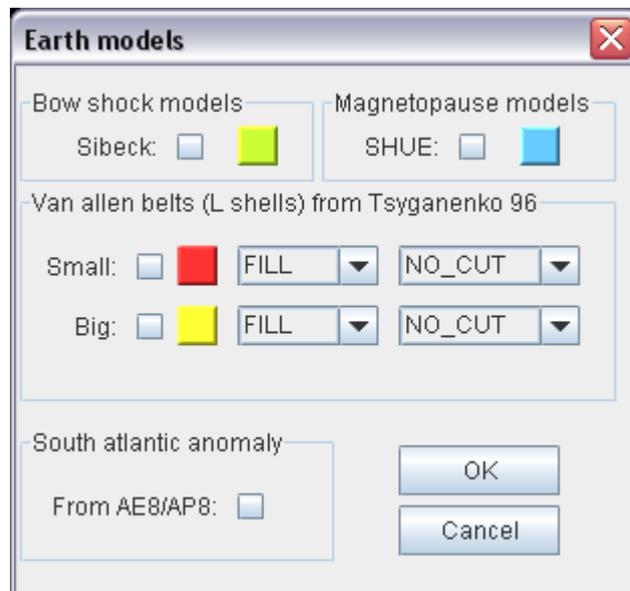
Simply check or uncheck the appropriate boxes:



6.3.4 Science functionalities

For some central body (Earth, Mars and Venus for the moment), static physical models are available. Here is the list of implemented models.

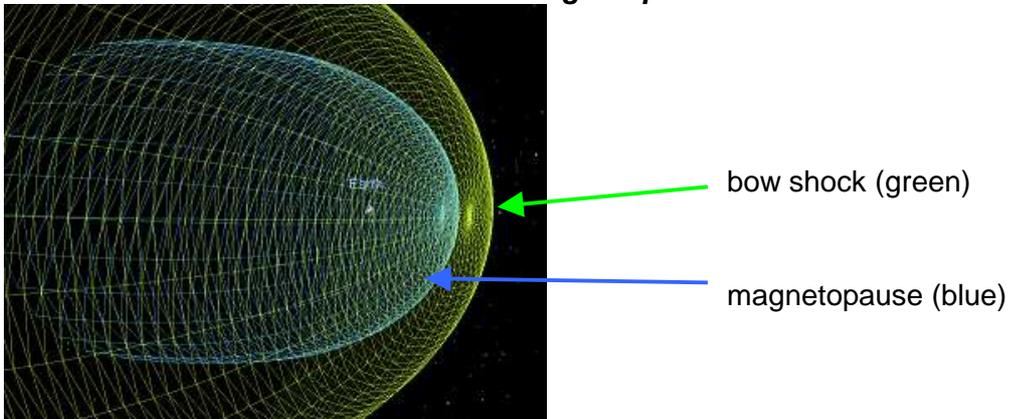
6.3.4.1.1 Earth models



For all models except the South Atlantic anomaly, it is possible to choose the color.

For each radiation belt, it is possible to select different display modes (point (POINT), wired (LINE) and full (FILL)) and cutting (no cutting, $\frac{1}{2}$, $\frac{1}{4}$, $\frac{3}{4}$). Here are some examples showing different models:

Earth magnetopause and bowshock



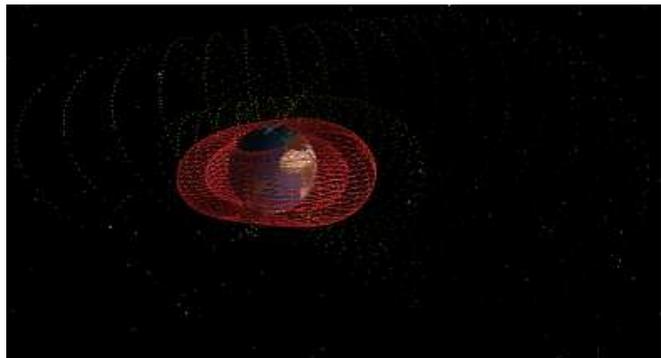
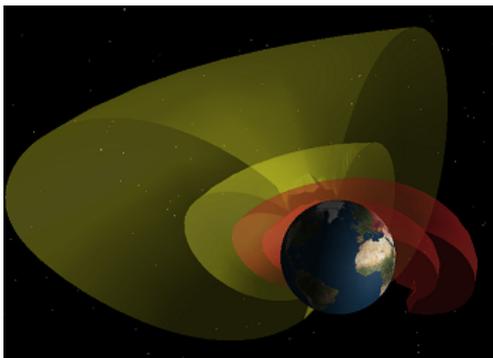
Van Allen belts

big fill mode / $\frac{1}{4}$

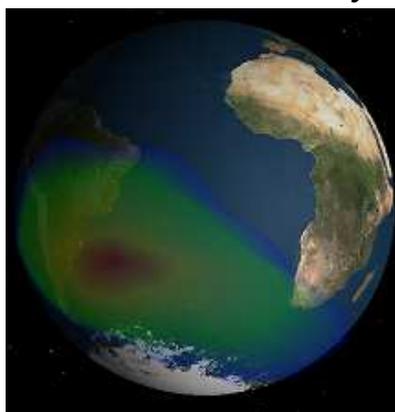
small fill mode / $\frac{1}{2}$

big point mode / $\frac{1}{2}$

small line mode / no cut



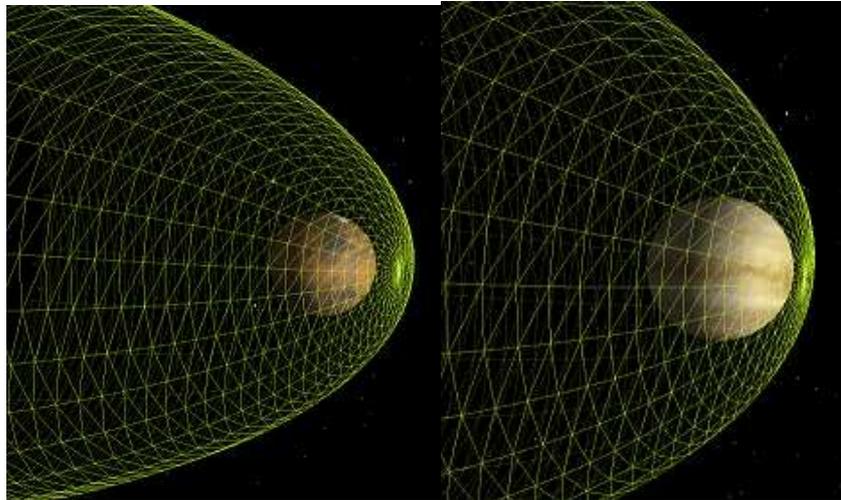
South atlantic anomaly



6.3.4.1.2 Mars and Venus models

For venus and Mars, only bowshock is available.

Bowshock on Mars and Venus

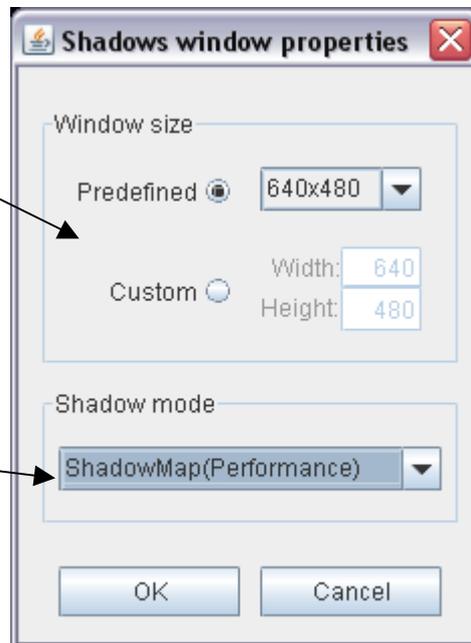


6.3.5 Shadows application

For Rosetta and COROT spacecraft, it is possible to observe the shadows in a separate application launched through menu Shadows / Launch:

Window size of shadows application

Shadows implementation algorithm



If a realistic 3D model (e.g. 3ds, vrml, x3d ...) could be provided for another spacecraft, Shadows option could be made available for it.

Two algorithms implementing the shadows are available: the shadow mapping and shadow volumes. Here are the advantages and disadvantages:

	Shadow mapping	Shadow volume
Most	Speed	Accuracy
The least	Effect of moiré on adjacent facets. Unclear	Slow Shadow inversion in certain camera positions.

The animation should be stopped before running the shadow application. When first launched, the authorization of the firewall may be displayed:



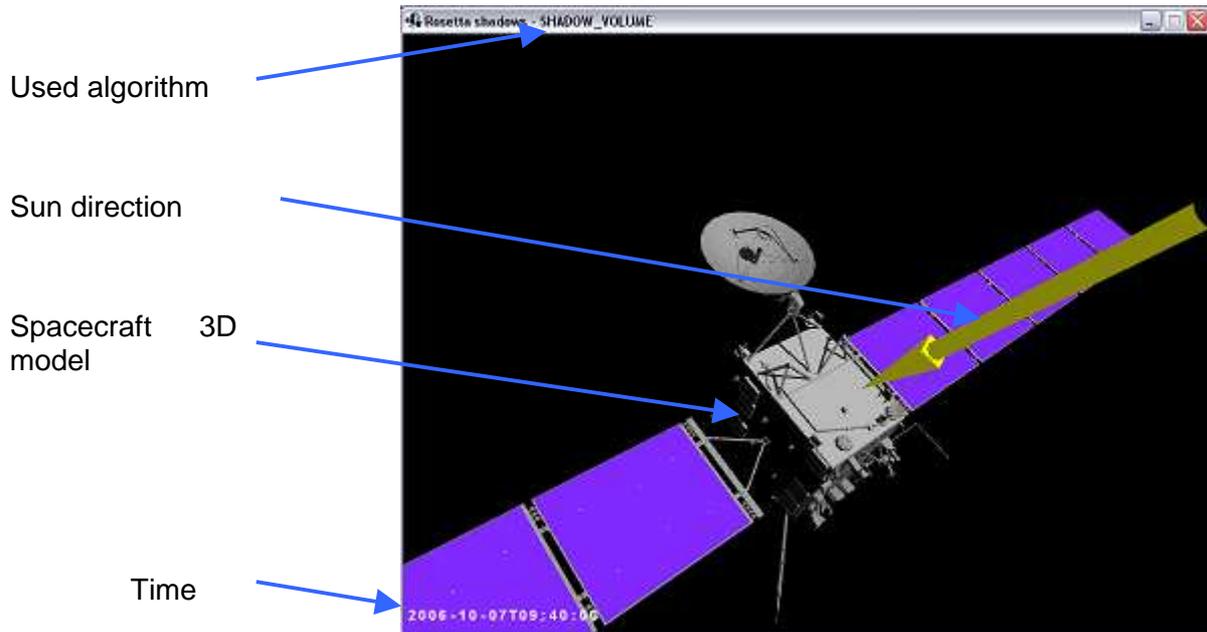
This is due to open communication between the main 3D application and the shadows. You can choose keep blocking because the connection does not require access to the network.

In the opening window are shown the spacecraft and the direction of the sun.

NB For ergonomy reasons, in shadow volume mode, shadows are not enabled. You have press 9 to activate them.

Navigation in the 3D scene is the same way as in the main application.

6.3.5.1 Global view



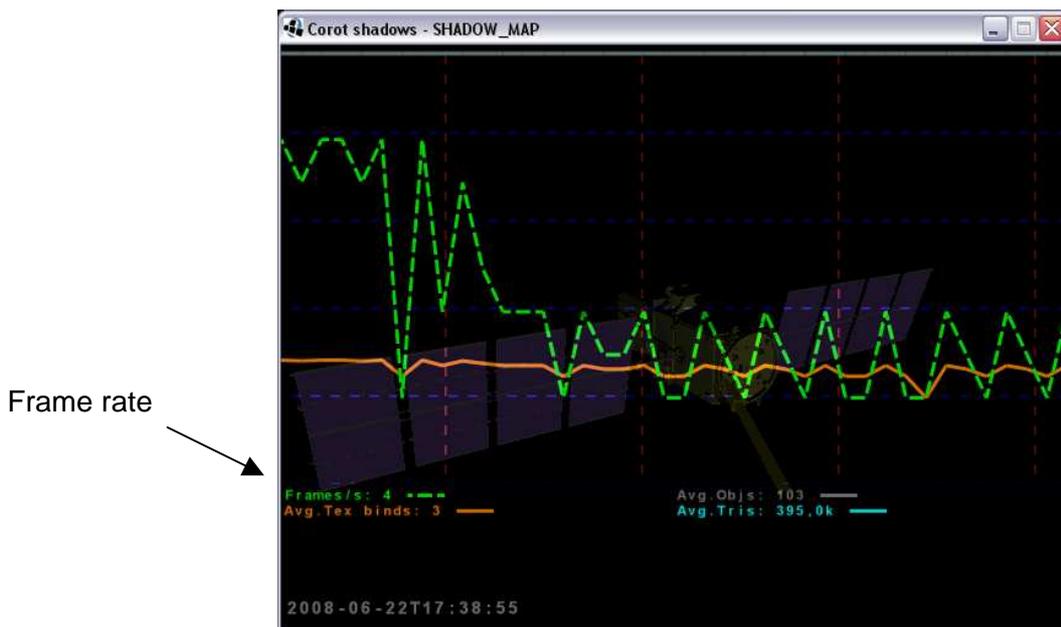
6.3.5.2 Synchronization of both views animation

To have a perfect synchronization of both views, a powerful graphics card is needed.

To start animation, use the controller in main application.

Depending on the size of the window, on the used algorithm and on the graphic card performance, the shadow window may be delayed compared to the main application.

You can adjust the speed of the animation to synchronize the two applications. To do this, press F4 in the shadows while the animation is running. This shows display performances:



On this example, average framerate is 4. Change the animation speed in the control bar to the same value to synchronize animation in both windows:



To disable shadow display and speed up rendering, press key 9. It can be useful to synchronize easily both windows when searching directly with animation slider.

6.3.5.3 Commands list

In the menu Shadows/Commands, you can get a list of shadow application commands:

