Mitaka Manual (ver.1.2.4a)

Four-Dimensional Digital Universe Project (4D2U),
National Astronomical Observatory of Japan (NAOJ)

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Contents

Chapter 1

1.1 Introduction

The **Mitaka** software is developed by the "*Four-Dimensional Digital Universe (4D2U)*" Project. 4D2U has been supported by the National Astronomical Observatory of Japan (NAOJ) and other collaborating organizations including Research and Development for Applying Advanced Computational Science and Technology (ACT-JST) ["*Establishment and Application of Four-Dimensional Digital Space Data (led by Norio Kaifu, 2001 to 2004)*"], as well as the Ministry of Education, Culture, Sports, Science and Technology [Effective Promotion Program for Industry-Academia-Government Collaborative Research supported by Special Coordination Funds for Promoting Science and Technology – "*Establishment of Distribution System for Four-Dimensional Digital Video of the Universe (led by Shoken Miyama, 2004 to 2007)*"]. Research to improve Mitaka is ongoing. **Mitaka** users can seamlessly navigate through space, from the Earth to the edges of the known Universe, based on various observation data as well as theoretical astronomical models. In this way, they can see the locations of celestial bodies and various structures in the Universe. The **Mitaka** software is used for screenings at the 4D2U Theater of NAOJ and various mobile theaters.

1.2 System Requirements

Mitaka runs on Windows PCs. We recommend the following minimum hardware configuration:

Recommended Minimum Hardware Configuration	
OS:	Windows 8.1/8/7/Vista/XP (*)
CPU:	Pentium 4, 1.8 GHz or faster
Memory:	512 MB or more
Graphics Card:	GeForce 3 or better
Display Resolution:	1024×768 pixels or more
Hard Drive Space:	150 MB or more

To use the software with Windows XP, select `mitaka_VC.exe` as the executed file.

It is possible to run the program at a slower speed on a laptop PC by carefully modifying the default settings to reduce the texture resolution. (For details, see Chapter 5.)

Here is the hardware configuration of the 4D2U Dome Theater at NAOJ, Mitaka Campus.

Hardware Configuration of the 4D2U Dome Theater at NAOJ	
OS:	Windows 7 Professional
CPU:	Intel Xeon E5-1650v2 (3.5 GHz)
Memory:	16 GB
Graphics Card:	NVIDIA Quadro K5000
Display Resolution:	1920×1200 pixels

1.3 Downloading

Mitaka is available for download at the 4D2U website of NAOJ.

4D2U Project: URL `http://4d2u.nao.ac.jp/`
Mitaka Home Page: `http://4d2u.nao.ac.jp/html/program/mitaka/index_E.html`

1.4 Disclaimers

We provide Mitaka for no charge and without any warranty. You may use it for your personal enjoyment at your own risk. Please read the licensing agreement in section 1.9 before using it.

Let us know what you think of this software! We appreciate your feedback and will use it to improve future versions. Please send feedback to the address below:
`4d2u-web@cfca.nao.ac.jp`

1.5 Installing

There is no procedure for installing the software. Download it and decompress the .zip file in a directory of your choice.

To use Mitaka on a single PC, just double-click `mitaka.exe` to start it. To use the software on multiple PCs and synchronize the display, you must first edit the file `mitaka.ini` to change the default settings. Please refer to the following chapters for the appropriate settings.

1.6 Uninstalling

To uninstall, simply delete all the files in the Mitaka directory.

1.7 Directory Structure

The Mitaka directory contains the following folders:

Folder	Description
`data`	Object Position Data, etc.
`textures`	Surface Texture Files
`images`	Still Images
`spacecraft`	Spacecraft Data (models and trajectories)
`media`	Settings for Images and Movies
`title`	Data for the Titles and Credits

1.8 Acknowledgments

Tsunehiko Kato (member of the NAOJ 4D2U Group) designed and developed the Mitaka software, including its algorithms for image rendering, data processing, and its Japanese manual. Sorahiko Nukatani (cooperative engineer from RIKEN) worked on the aesthetic design, including title design and color tables. This version of the manual was translated by IVY International Corporation and edited by Ramsey Lundock (NAOJ). This manual is based in part on the original 4D2U English Manual developed by Catherine Ishida (NAOJ/Research Corporation of the University of Hawaii). We are grateful to the Public Relations Center, NAOJ for their kind support.

1.9 Terms and Conditions of Use

In order to use Mitaka, you are required to agree to the following Terms and Conditions of Use. You may use Mitaka only after you review and agree to these Terms and Conditions of Use.

Terms and Conditions of Use of the National Astronomical Observatory of Japan Program Software

The right to the Software, etc. is owned by the Inter-University Research Institute Corporation, National Institutes of Natural Sciences, National Astronomical Observatory of Japan (hereinafter referred to as the "Right Holder"). The installation, use, reproduction, and modification (hereinafter collectively referred to as the "Use") of the Software and any documents used for the Software, such as sample data and user manual (hereinafter referred to as the "Software, etc.") are only licensed to the individual or group who has agreed to the following terms and conditions (hereinafter referred to as the "User").

1. The use of the Software, etc. by the User under these Terms and Conditions shall be limited to the use for non-commercial purposes. In the case of the use for commercial purposes, the User is required to enter into a separate agreement with the Right Holder.

2. The Right Holder makes no representation and warranty, either express or implied, as to the fitness to any purposes of the Software, etc. The Software, etc. shall be provided on an as-is basis and the Right Holder makes no warranty as to its quality, performance, freedom from defects or computer viruses, freedom from infringement of a third party's rights, provision of support services, if any, and the details of such services, and the like.

3. The Right Holder shall not be liable for any damage incurred by the User due to the use of or inability to use the Software, etc., the provision or failure to provide the support services for the Software, etc., including, but not limited to, lost profits and any damage caused by business interruption, loss of business information, personal injury, and infringement of privacy. The same shall apply to the case where the Right Holder has been advised of the possibility of such damage in advance.

4. If the User causes damages to the Right Holder due to the use of the Software, etc., including, but not limited to, lost profits and any damage caused by business interruption, loss of business information, personal injury, and infringement of privacy, the User shall compensate the Right Holder for all such damages.

5. The User may reproduce the Software, etc. for personal use of the User. The User shall not distribute any reproduction of the Software, etc. to any third party.

6. The User may modify the Software, etc. only if the User informs in writing in advance the Right Holder of the portions to be modified and the nature of modification and obtains a written approval of the Right Holder; provided, however, that the User shall not distribute the modified Software, etc. to any third party.

7. At the time of the publication or disclosure of the byproducts generated using the Software, etc., the User shall expressly indicate that such byproducts are generated using the Software, etc. that is owned by the Right Holder. The User shall inform the Right Holder in writing in advance of the publication or disclosure thereof.

8. To the extent that the User complies with the terms and conditions indicated above, the User may use the Software, etc. without charge; provided, however, that the User shall not transfer or sublicense such right to use to any third party.

9. If the Right Holder deemed that the User has committed a wrongful or unjustifiable act, the Right Holder may restrict or refuse the use of the Software, etc. by the User.

10. These Terms and Conditions of Use shall be governed by the laws of Japan.

1.10 Current Project Structure (as of October 2014)

Official Project Name:

Four-Dimensional Digital Universe (4D2U) Project, Center for Computational Astrophysics (CfCA), National Astronomical Observatory of Japan (NAOJ)

Project Members:

Project Leader:	Eiichiro Kokubo	(NAOJ)
Project Advisor:	Hidehiko Agata	(NAOJ)
Core Members:	Yayoi Narazaki	(NAOJ)
	Hirotaka Nakayama	(NAOJ)
	Tsunehiko Kato	(NAOJ)
	Hinako Fukushi	(NAOJ)

Chapter 2

Controlling the Software

This chapter outlines how to issue commands in Mitaka. Commands can be input by using a mouse, a keyboard, or a game controller. For actual operations, read Chapter 3 Tutorial.

2.1 Game Controller

You can control Mitaka with a game controller. The default values in the current version support the following combination of devices:

Controller:	DualShock for Sony Play Station
USB adapter:	JC-PS201USV by ELECOM

In addition, we confirmed that the adapter SMART JOYPAD3 plus N by SKnet is also compatible. (However, it is necessary to alter the `mitaka.ini` file to assign new values. See Chapter 5 for details.) Read the instruction manual of the adapter for how to configure and use the adapter.

2.2 Space Mode and Planetarium Mode

The operations below are available in space mode as well as planetarium mode.

Figure 2.1: **Left**: Time control buttons; "+" runs time forward, while "−" runs time backward. **Right**: Zoom buttons; "+" zooms out, while "−" zooms in. A right click on any of these buttons opens a pop-up menu.

2.2.1 Mouse commands

Operations	**Actions**
Left-click & drag:	Move the view point (space mode) Change the view direction (planetarium mode)
Right-click & drag (back and forth):	Zoom out/in (space mode) Change view elevation down/up (planetarium mode)
Rotate the wheel:	Same as the right click & drag
Point mouse to an object:	Display the object information (space mode)
Double-click (left button):	Change the target (while pointing to an object); Move to the double-clicked point on an object's surface
Click "+" in the upper right corner:	Run time forward
Click "−" in the upper right corner:	Run time backward
Right click in the upper right area:	Open the pop-up menu for handling time
Click "+" in the lower right corner:	Zoom out
Click "−" in the lower right corner:	Zoom in
Right click in the lower right area:	Open the pop-up menu for scale selection
Push the wheel:	Land on or take off from a planet

The "+" and "−" buttons for time and zoom operations appear when you move the mouse cursor to the right upper corner or the right lower corner. See figure 2.1.

2.2.2 Keyboard and controller commands

Keyboard	Controller	Actions
`X`	◯	Open the menu
Arrows	Left stick	Move the point of view (space mode) Change the view direction (planetarium mode)
`1` + Arrows	L2 + Left stick	Rotate (space mode)
`PAGE UP`	Right Stick (Up)	Zoom in
`PAGE DOWN`	Right Stick (Down)	Zoom out
`4`	R1	Run time forward
`3`	L1	Run time backward
`Z + 4`	× + R1	Increase time increment (100 years max.)
`Z + 3`	× + L1	Decrease time increment (10 seconds min.)
`A`	□	Turn on/off object labels
`S`	△	Land or take off
`T`	(None)	Approach a target (space mode)
`Z + Arrows`	× + Left stick (side to side)	Change the magnification percentage of a planet
`Z + A`	× + □	Toggle city lights (space mode)
`W`	Start	Turn on tiles and credits (Advance with the `X` key or ◯ button)
`Q`	Select	Switch to the pointer mode
`ESC`	(None)	End the program or exit from the full screen mode
`ALT + ENTER`	(None)	Switch to the full screen mode
`C`	(None)	Capture a displayed image to save it in the file (`capture.png`)
`F`	(None)	Turn on/off the frame rate (fps) display
`Z + 1`	× + L2	Decrease the eye separation by 1 mm (for stereoscopic display)
`Z + 2`	× + R2	Increase the eye separation by 1 mm
`Z + 1 + 2`	× + L2 + R2	Set the eye separation to default (6.4 cm)

Note: A laptop keyboard often assigns `PAGE UP` and `PAGE DOWN` to "function key (`Fn`) + Up/Down arrows (↑ & ↓)"

While in the space mode, if the view point is near the surface of a planet or a satellite, the mode will be switched to "the surface exploration mode" and the table of operations below will be effective.

Keyboard	Controller	Actions
Arrows (↑ & ↓)	Left stick (Up/Down)	Move back and forth
Arrows (← & →)	Left stick (Left/Right)	Rotate counterclockwise or clockwise

2.3 Menu Operations

When you open the menu, you can perform the following operations:

Keyboard	Controller	Actions
X	◯	Select an item in the menu
Z	×	Close the menu
Arrows (↑ & ↓)	Left stick (Up/Down)	Move cursor within the menu
O, P	Right stick (Left/Right)	Move the menu side to side
PAGE UP/PAGE DOWN	Right stick (Up/Down)	Move the menu up and down

2.4 Operations While Playing a Movie

You can perform the following operations while playing a movie.

Keyboard	Controller	Actions
X	◯	Play/Pause the movie
Z	×	Exit the movie
1	L2	Move to the beginning
2	R2	Move to the end
3	L1	Move backward through a series of 'mile markers' dividing the movie into 10 sections
4	R1	Move forward through a series of 'mile markers' dividing the movie into 10 sections
O	Right stick (Left)	Move backward through a series of 'mile markers' dividing the movie into 50 sections
P	Right stick (Right)	Move forward through a series of 'mile markers' dividing the movie into 50 sections

Note: You can move backward and forward only while the movie is paused.

2.5 Operations While Displaying an Image or 3D Chart

The table below shows the operations available while you are displaying an image or a 3D chart.

Keyboard	Controller	Actions
Z	×	Exit image/3D chart
Arrows	Left stick	Move image/3D chart
PAGE UP/PAGE DOWN	Right stick (Up/Down)	Zoom in/out
4	R1	Change to the next image (image mode only)
3	L1	Change to the previous image (image mode only)

2.6 Operations in Pointer Mode

In the pointer mode, a small square that you can move freely will appear on the screen. This is useful when you describe objects during a live show. The operations in the table below are available.

Keyboard	Controller	Actions
Z	×	Exit the pointer mode
Arrows	Left stick	Move the pointer up/down and left/right
PAGE UP/PAGE DOWN	Right stick (Up/Down)	Move the pointer back and forth

Chapter 3

Tutorial: Let's Start

In this chapter we will describe the most basic operations in a step-by-step manner.

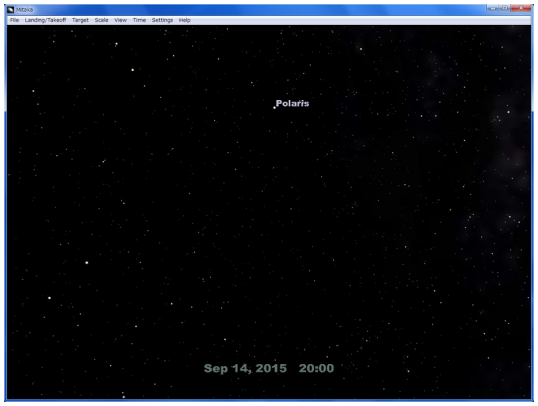
3.1 Tutorial for Single PC

Here we assume that you are using Mitaka on a single PC. When using multiple PCs, the basic operations are the same as for a single PC. In this chapter we describe the operations when using a mouse supplemented by occasional keyboard strokes. It is also possible to achieve these same results using a game controller or using the keyboard alone. (See Chapter 2 for the equivalent operations with a keyboard or controller.)

3.1.1 Starting and ending

To start Mitaka, double-click `mitaka.exe`. (If this doesn't work, try `mitaka_VC.exe`.) It may be helpful to create a shortcut in an easily accessible location in your computer. It takes a few dozen seconds for Mitaka to start up because of the large amount of data needed.

Once it starts up, a window like the one below will appear.



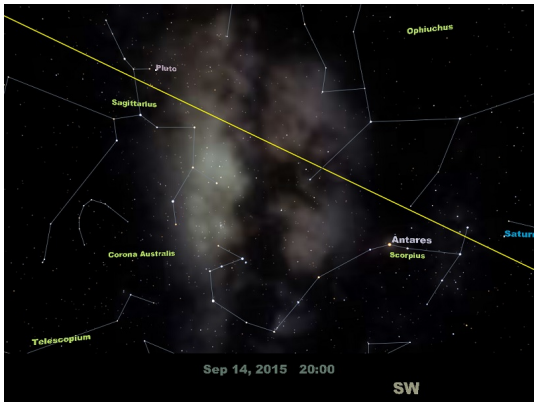
This window can be moved or resized just like any other window. To end Mitaka, either click the "Close" (×) button in the upper right corner of the window or in the menu bar select [File] - [Exit] . You can also end the program by pressing `ESC`.

3.1.2 The sky as seen from the Earth

When you start up the program, you will be in planetarium mode, in which you see the night sky of Earth. The time starts out set to 20:00 of the current day.

You can move the point of view freely by clicking the left mouse button and dragging the mouse in the window. You can also change the view angle by clicking the right button of the mouse and dragging the mouse, or by rotating the wheel of the mouse if it has one.

Pushing the `A` key displays/hides the star and constellation labels, including the constellation lines.



You can also change the various display settings from [View] on the menu bar.

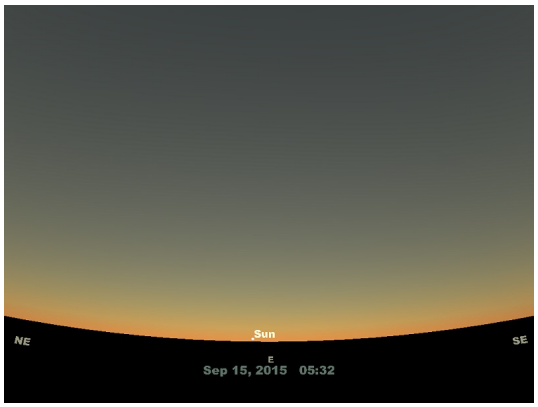
3.1.3 Move back and forth through time

Let's try moving forward and backward through time.

Move the mouse cursor to the upper right corner of the window. The "−" and "+" buttons should appear as shown in the figure below.

When you push the "+" button, you can move forward through time. When you push the "−" button, you can move backward through time. These buttons will disappear when you move the cursor out of the upper right corner.

When you click and hold the "+" button, time advances and the starry sky exhibits diurnal motion. If you continue holding it, you can see the morning come with the Sun rising in the east.



The time increment is initially set to 10 minutes. To change it, move the mouse cursor to the upper right corner where the "−" and "+" buttons appear and make a right-click. The pop-up menu shown in the figure below will appear and you can select one of the increments ranging from 10 seconds to 100 years. You can also specify the target date and time directly by choosing "Set Time" in the menu.

3.1.4 Taking off

So, let's take off from the Earth and begin exploring outer space.

Set the time back to 8:00 PM and face north. Once you set the time and the direction, either select "Landing/Takeoff" - "Landing/Takeoff" on the menu bar or push the mouse wheel. The point of view will change to a point flying in space (this is called "space mode") instead of the planetarium mode.

The figure below shows the window just after you go into space mode.

You are a few kilometers up in the sky above Mitaka[1], Tokyo and looking in the same direction as you had been while you were on the ground. You see the dim surface of the Earth at the bottom of the window.

3.1.5 Zooming in and out

You can rise up into space by zooming out when you are near the ground. You can zoom out by using one of the following procedures. (These also work for zooming in.)

1. Move the mouse upward while pressing the right button.
2. Rotate the wheel of the mouse toward you.
3. Push the `PAGE DOWN` key.
4. Use the Zoom in/out buttons that appear in the lower right corner of the window.

Let's try method (4) the Zoom in/out buttons. Move the mouse cursor to the lower right corner of the window. The green "−" and "+" buttons will appear, similar to the ones which appear for changing the time. (Refer to Section 3.1.3).

Click the "+" button to zoom out and the "−" button to zoom in.

3.1.6 Fly into space

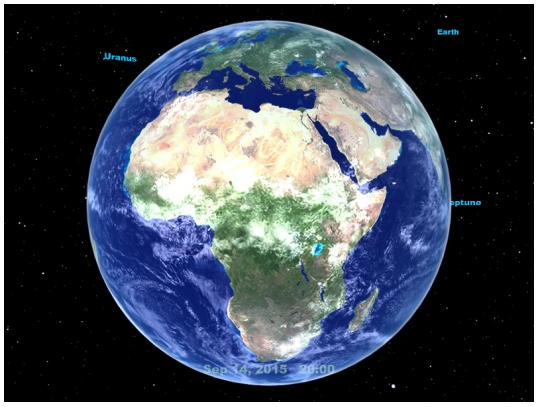
Click and hold the "+" to fly into space. As you go up, you will see the islands of Japan outlined by their city lights.

As you continue flying up, the whole Earth will come into view.

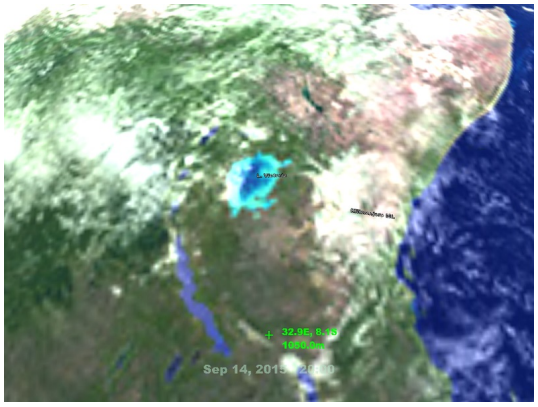
[1]The Mitaka software takes its name from the region of Tokyo where the Headquarters of the National Astronomical Observatory of Japan is located.

The only thing you will be able to see clearly is the label "Japan" in the window. This is what you are looking at on the Earth while you are high up in the sky of Tokyo. It is dark because you are on the night side. (If no labels are displayed, they have been turned off. Push the `A` key to display the labels.)

In space mode, you can move your view point around an object (target) by left-clicking and dragging the mouse. If the target is a planet, you can move to a point above a certain location on the surface by double-clicking on the location. Let's move to the day side of the Earth by left-clicking and dragging the mouse. The figure below shows what you will see when you have moved to the day side of the Earth.



Use either the "−" button in the lower right corner or the wheel of the mouse zoom in on the Earth, thus appearing to approach it.

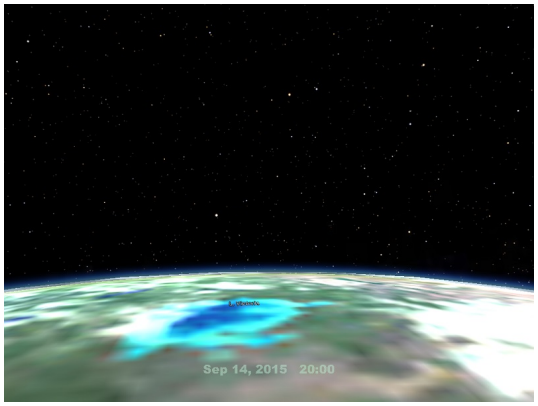


If you come close enough to the surface, you will see a green cross (a pointer) on the surface. The latitude and the longitude of the location are displayed[2] to the right of the green cross.

[2]If topographic data are available, the approximate altitude will also be displayed.

In addition, any registered place-names will be displayed if they are within your field of view.

Furthermore, as you keep zooming in, your sight line will be directed toward the horizon, similar to how it was oriented when you first took off.

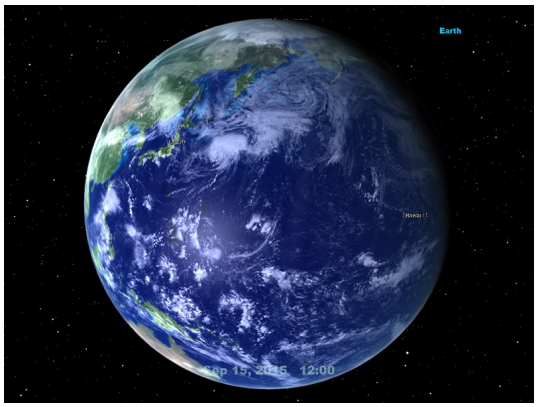


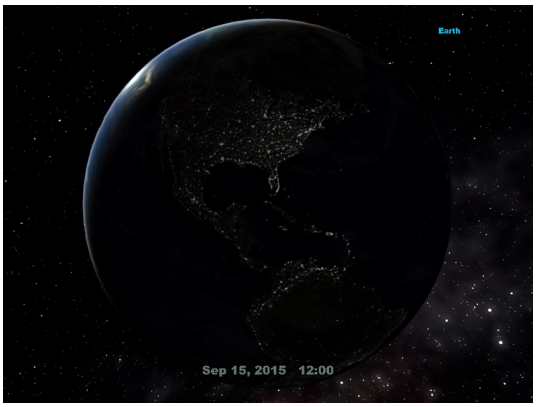
Now, you can land there by either selecting "Landing/Takeoff" from the menu bar or by pushing the mouse wheel. Let's land here. Because you landed on the day side, you can see the blue sky. Now if you move time forward, you watch night fall and see the starry sky.

So, let's take off again to go into space. You can do so by pushing the zoom out button continuously. You can also jump to a set location a short distance from the Earth, by selecting "Target" - "Move to the Target" on the menu bar (or by pushing the `T` key).

3.1.7 Earth

Try looking at the Earth from various angles by clicking the left button and dragging the mouse. If you select "View" - "Planets" - "City Lights" from the menu bar, you can emphasize the city lights on the night side of the Earth as shown in the figure below.



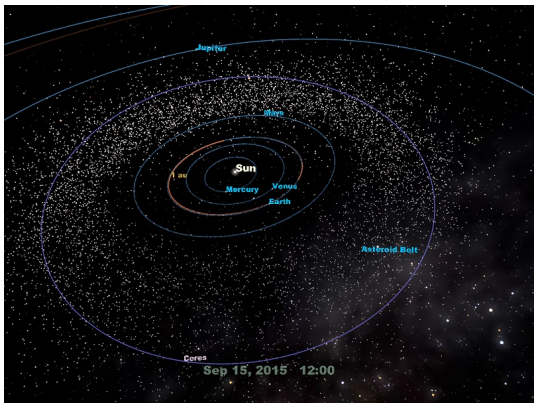


In addition, you can move time backward and forward in the space mode in the same way as in the planetarium mode. If you move time forward by pushing the "+" button in the upper right corner, you can see the daily rotation of the Earth.

3.1.8 Visiting the Solar System

Let's leave the Earth to explore the Solar System.

Click the zoom out button or rotate the mouse wheel to move farther and farther away from the Earth. As the Earth gets smaller, the Moon comes into view. If you continue to zoom out, the Earth will disappear and you will see only the stars. This gives you an idea how small the Earth is compared to the Solar System. As you continue to draw back, eventually you will see the inner Solar System.



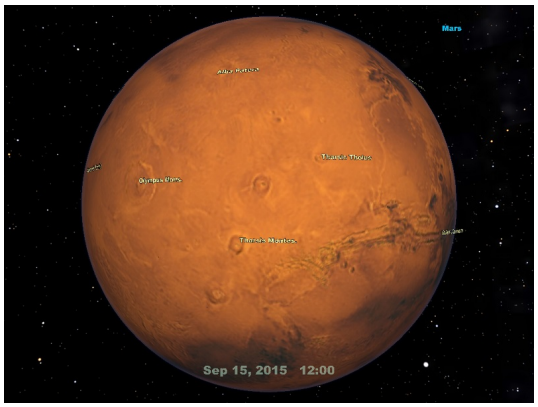
In this window, you see the Sun as well as Mercury, Venus, Earth, and Mars. If you look in the background you can also find Jupiter. The blue lines indicate the orbits of the planets. Red lines are used to indicate distances from the Sun. In this image, the red circle is 1 astronomical unit, the average distance between the Earth and the Sun. These red lines help you comprehend the size of what you are looking at is. The lines use one of two units as described below:

Units	**Description**
Astronomical unit (au):	The average distance between the Earth and the Sun. One au is equal to approximately 150 million kilometers.
Light-years (ly):	The distance that light travels in a year. One ly is equal to approximately 9.5 trillion kilometers, or 63 thousand au.

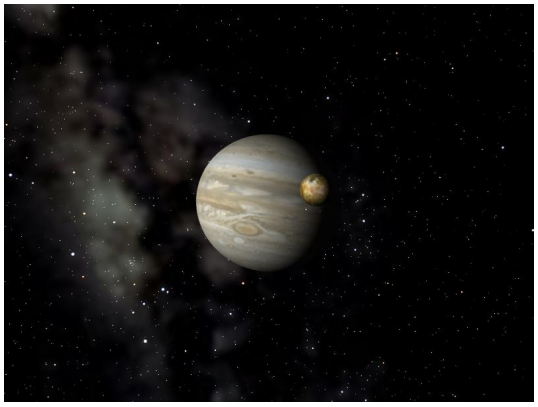
So far we have remained centered on the Earth. So, now let's focus on Mars. To select Mars as your target, move the mouse cursor onto Mars' label when it appears. The label will turn green and immediately display information about Mars. (When you place the cursor over another object's label, you see the information for that object.)

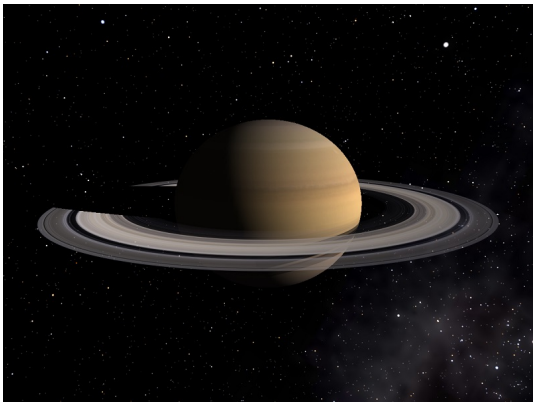
When you double-click there, you make Mars your target. For major planets, you can also use the menu bar to make a planet your target by selecting "Target" - "Solar System" - "your target planet (Mars in this case)."

Now, select "Target" - "Move to the Target." Mars will appear in the center of the window. This way, you can zoom in/out as well as land on it. When you use right-click and drag or the mouse-wheel to zoom in, you can see topographical information including place names.



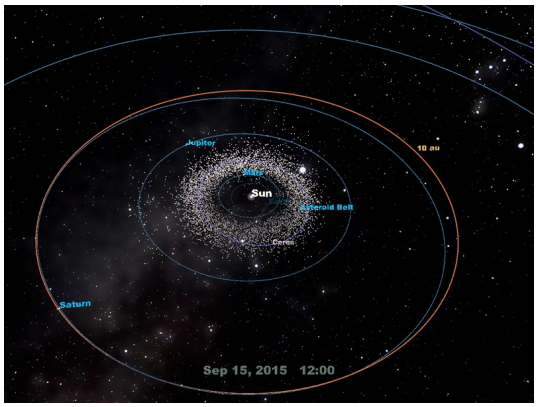
Similarly, you can make another object your target. Try Mars' satellites, Phobos and Deimos, as well as Saturn and Jupiter.





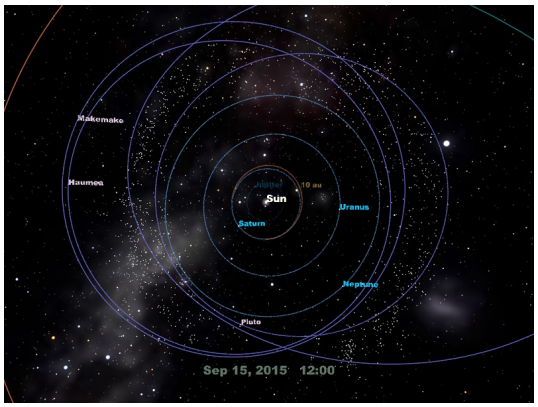
You can also make an object outside the Solar System your target, but for now let's stay within the Solar System for more exploration.

Select "Target" - "Solar System" - "Earth" to make the Earth your target again. Then, resume zooming out. You will find Jupiter beyond the asteroid belt and Saturn about 10 au from the Sun.



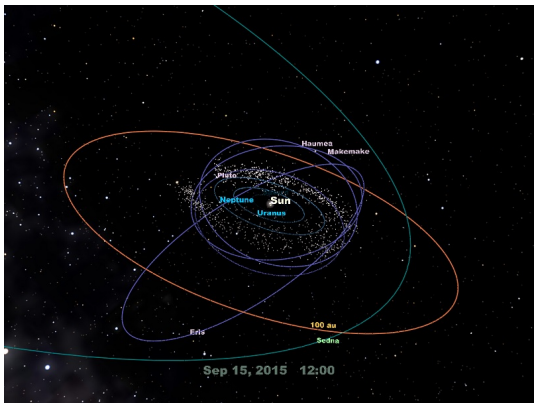
The planets are so small compared to the orbit sizes that you cannot see their shapes while their names are displayed. If you miss them, you can enlarge them by selecting "View" - "Planets" - "Magnification Rate" in the menu bar.

If you continue to zoom out, you can see the orbits of Uranus and Neptune. These eight planets out to Neptune comprise all of the Solar System Planets under the current definition. (The definition of a planet was reviewed at the General Assembly of the International Astronomical Union in 2006; Pluto, which had previously been treated as a planet, was reclassified as a "dwarf planet.")



In this window, you can see a group of small celestial bodies forming a ring a little beyond the orbit of Neptune. These small bodies consist mainly of ice and are known as Trans-Neptunian Objects (sometimes called the Kuiper Belt Objects). Pluto is considered a typical representative of these objects.

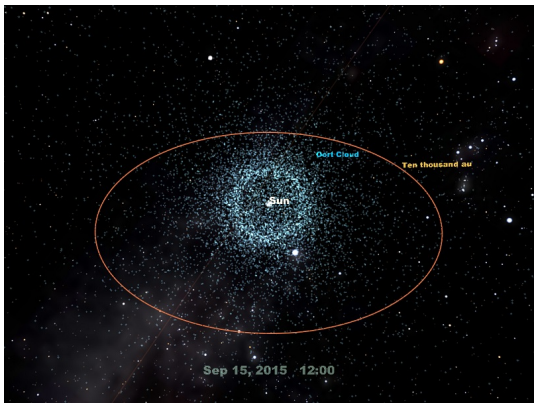
Zooming out farther reveals the view shown below.



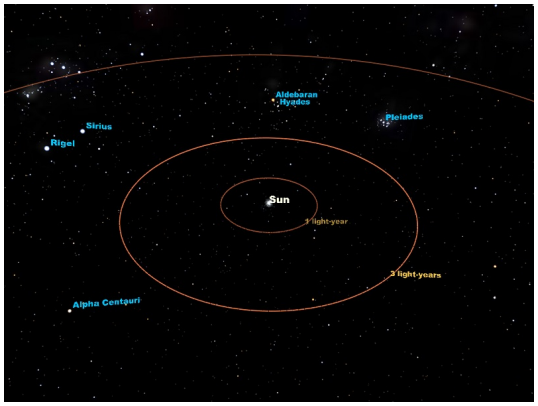
Far beyond the orbit of Pluto, you can see objects labeled Eris and Sedna. These are large Trans-Neptunian Objects that were discovered recently. They are believed to be mainly made of ice. Eris is possibly a little larger than Pluto; this triggered the revision of the definition of a planet. Eris is believed to take about 560 years to orbit the Sun. Sedna is a little smaller than Pluto and believed to take more than 10,000 years to orbit the Sun in a highly elliptical orbit. Sedna is about 90 au away from the Sun at present, and it can be up to about 850 au away at the aphelion.

3.1.9 Set out to the limits of the observable Universe

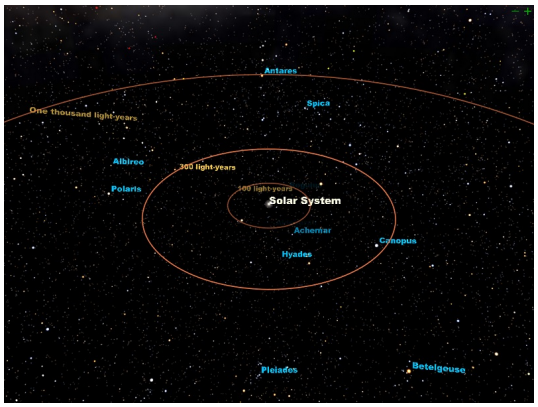
Now it is time to leave the Solar System to set out to the edge of the known Universe. Keep zooming out farther and farther by pushing the zoom-out button or the mouse wheel. As the orbits of the planets, Eris, and Sedna shrink and disappear, the “Oort cloud” comes into view; this is the hypothetical home of comets. (The Oort cloud has not been confirmed by observations so Mitaka Displays a conceptual image.)



Then, you can see a world of stars spreading out beyond the 1 light-year circle.

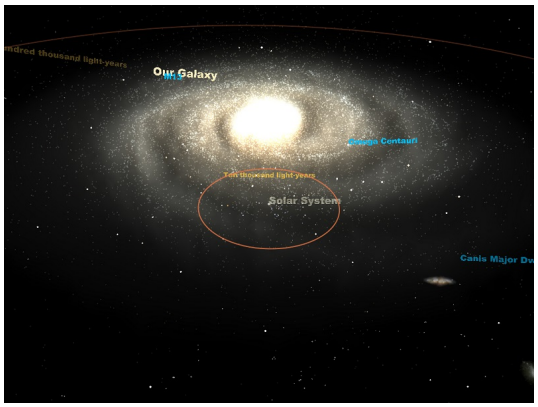


In this window, you will see Alpha Centauri (the closest star to the Sun, about 4.3 ly away) and Sirius (the brightest star as seen from the Earth, about 8.6 ly away). Then, familiar stars making up the constellations will come into view as you travel farther and farther away.



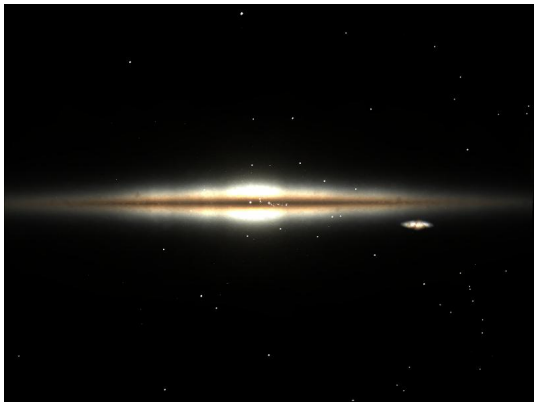
The locations of these stars were determined through the measurements of the Hipparcos satellite. However due to the limitations of the measurement accuracy, only the stars within about 3,000 ly are determined precisely. Thus, only the stars within this range are available in this program; however, this includes almost all the starts visible in the night sky.

If you continue to zoom out, you will see our Galaxy. Since current observations have not yet been able to definitively determine the full structure of the Galaxy, Mitaka displays a 3D model constructed from a combination of observations and theoretical predictions.



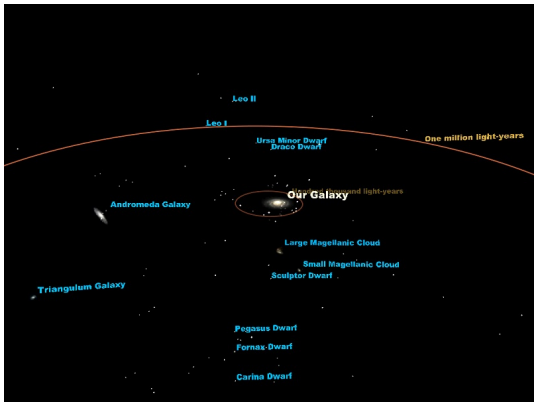
The Galaxy is believed to be a giant collection of approximate 200 billion stars distributed in the shape of a disk with a 100,000 ly diameter. You may have noticed that our Solar System is located rather far away from the center of the Galaxy. A giant group of stars is generally called a galaxy. Our Galaxy is an example of the barred spiral variety of galaxies.

When you look at the Galaxy from the side, you will notice that the stars are distributed in a rather flat disk.

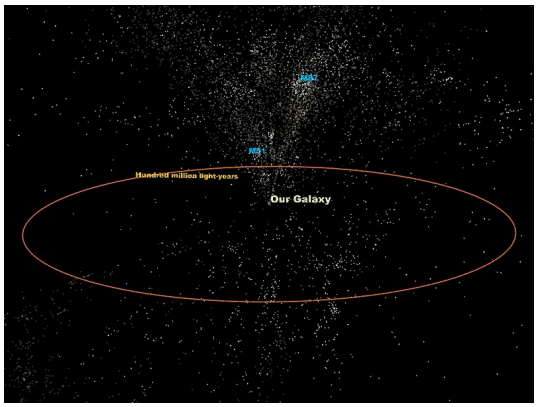


The so-called "Milky Way" that we see from the Earth is how the stars of the Galaxy appear when viewed from within the Galaxy itself. Thus, our Galaxy is called "the Milky Way Galaxy."

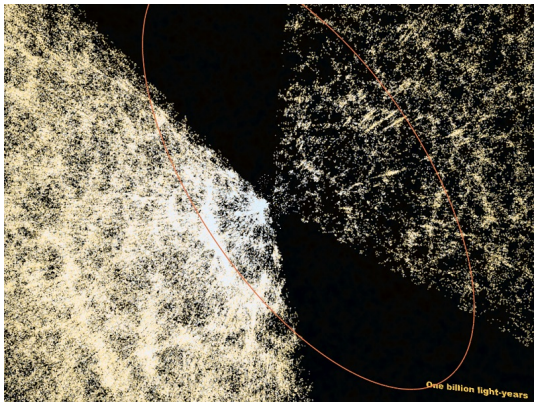
As you continue zooming out, you will notice there are countless other galaxies like the Milky Way in the Universe. The "Local Group" is a group of galaxies containing the Milky Way and more than 30 other galaxies, including Andromeda, the Large Magellanic Cloud, and Small Magellanic Cloud.



As you keep on zooming out, you will notice a distinct structure, with galaxies being crowded in some locations and distributed sparsely in others.



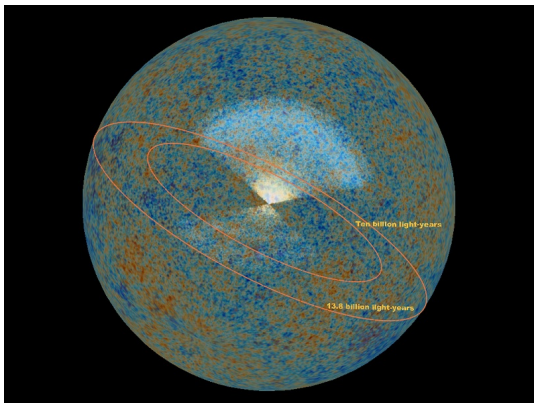
Further zooming out provides you with the latest observational results for galaxies from SDSS (the Sloan Digital Sky Survey).



The window above shows fan-shaped wedges of galaxies, but this shape is an artifact of the observations that have been conducted thus far. Actually, the uncharted parts of the Universe must also be full of galaxies.

You have probably noticed that each fan-shaped slice has a series of galaxies making a mesh, and that this mesh includes "voids," regions with almost no galaxies. This structure is called "the large-scale structure of the Universe." It is believed that this structure arose from extremely small "minute variations" in the very early Universe.

When you further zoom out, you will find the distribution of quasars obtained by SDSS. Beyond the quasars, an extended shell map of the Cosmic Microwave Background as observed by the Planck satellite, as well as a circle delineating 13.8 billion light years, will come into view.



The map of the Cosmic Microwave Background reflects temperature fluctuations in the early Universe, namely about 400,000 years after the birth of the Universe. Although the observed fluctuations are very small, on the order of parts per hundred thousand, it is thought that they acted as the seeds giving rise to the large-scale structure of the Universe.

Because the Universe is thought to be about 13.8 billion years old, the circle of 13.8 billion light years indicates the edge of the observable Universe (in the sense that it is theoretically impossible for light or other information to have reached Earth from beyond that range).

This concludes the outline of the hierarchical structure of the Universe that has been obtained by astronomy to date.

So, let's return to Mitaka, Tokyo on the Earth. You can go back there either by back tracking along the same way you came, or selecting "Landing/Takeoff" - "Landing on Mitaka" from the menu bar will bring you back in an instant.

3.2 Other Features

3.2.1 Saving an image

You can save an image of the current display to a file by selecting "File" - "Save Image As..." from the menu bar. Specify the file name and the format in the dialog box. The available formats include JPEG (*.jpg), PNG (*.png) and BMP (*.bmp).

If the graphics adapter of your system supports "pBuffer" by OpenGL, you can use an arbitrary size. To use this option, select "File" - "Save Image with Arbitrary Size..." on the menu bar. When you follow this procedure, a dialog box appears. In the dialog box enter the target size and click "Save." In the next dialog box, specify the file name and the format. (If your system doesn't support "pBuffer", you cannot use this procedure.)

In addition, you can capture what is currently being displayed by pushing `C` on the keyboard. In that case, only the PNG format can be used and the file name will be "`capture.png`."

3.2.2 Full screen mode

The full screen mode is available by pressing `ALT + ENTER`. If you want to go back to the previous mode, press `ALT + ENTER` again or press `ESC`.

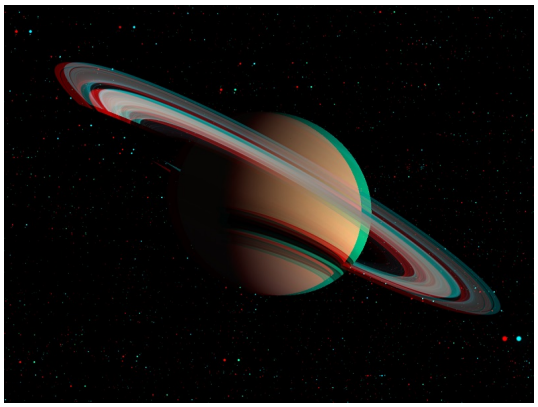
3.2.3 Stereoscopic display in anaglyph mode

Mitaka supports an anaglyph stereoscopic display mode.

Please obtain a pair of "red and blue glasses" that uses red cellophane for the left eye and light blue (cyan) for the right eye to enjoy the screen of Mitaka in three dimensions. (Red and blue glasses are commercially available for a price equivalent to a few US dollars per pair.)

To enter the anaglyph mode, select "Settings" - "Display Mode" on the menu bar. You can choose either "Anaglyph (Mono)" or "Anaglyph (Color)." The former runs slower because it requires a monochrome process; while the latter runs a little faster, an object whose color is close to the cellophane colors (red and light blue) becomes more difficult to see in three dimensions.

To exit this mode to return to an ordinary mode, select "Settings" - "Display Mode" - "Normal" on the menu bar.



3.2.4 Stereoscopic view via side-by-side or top-and-bottom

Mitaka supports stereoscopic viewing through side-by-side and top-and-bottom divisions. You can enjoy stereoscopic viewing by connecting your PC to a 3D television that supports either one of the methods with an HDMI cable.

Start from “Settings” - “Display Mode” on the menu bar, and then select either “Side by Side” or “Top and Bottom” on the menu bar. Set the mode of the 3D television to the same mode as the PC.

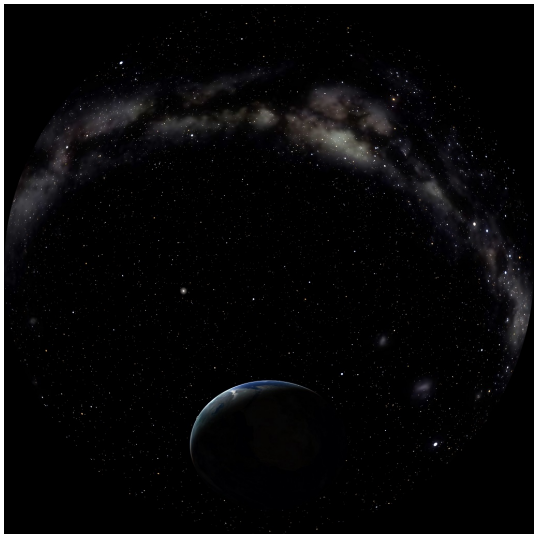
To exit the stereoscopic view mode and return the normal mode, select “Settings” - “Display Mode” - “Normal.”

3.2.5 Dome Master (fish-eye) view

Mitaka also supports a Dome Master display by using a fish-eye lens to display the images from Mitaka on the dome surface.

To use this display type, select “Settings” - “Display Mode” - “Dome Master” on the menu bar.

To exit the Dome Master mode to return the normal mode, select “Settings” - “Display Mode” - “Normal.”



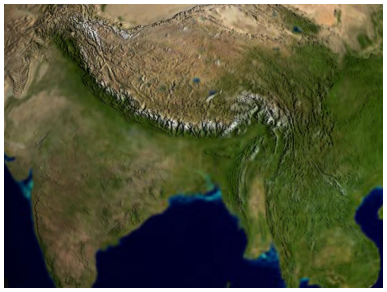
3.2.6 Look at the terrains of planets and moons

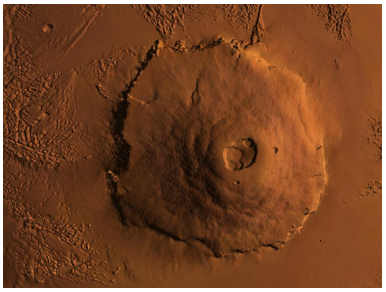
The terrains of the Earth, the Moon and Mars can be viewed if you have downloaded the additional topographic data later from Mitaka Home Page:

`http://4d2u.nao.ac.jp/html/program/mitaka/index_E.html`

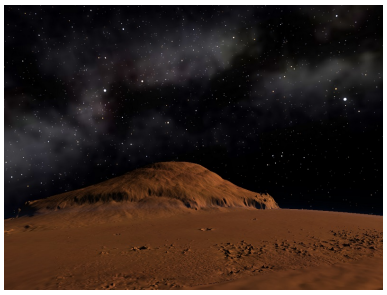
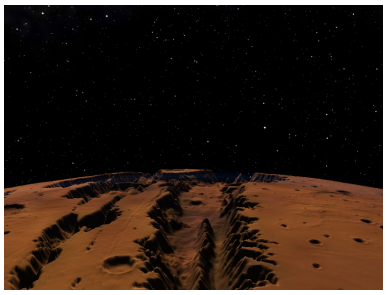
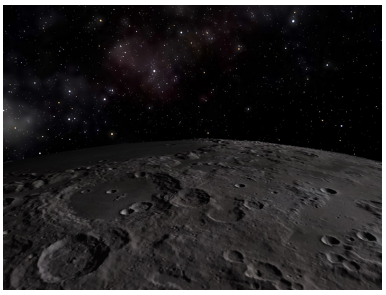
To use the topograpic data, first, unzip the downloaded file. Then, copy the file "`earth_topo.dat`," "`moon_topo.dat`," or "`mars_topo.dat`" in the unzipped folder into the `data` folder in the Mitaka folder. You can view the topography of the Earth, the Moon or Mars starting from the next time you launch Mitaka.

You can set the terrain magnification ratio from 1 (actual size) to 20.



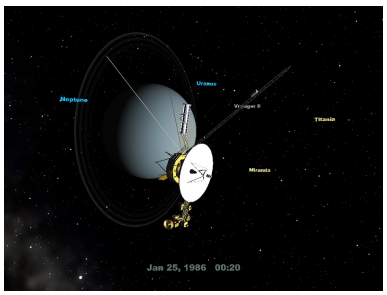


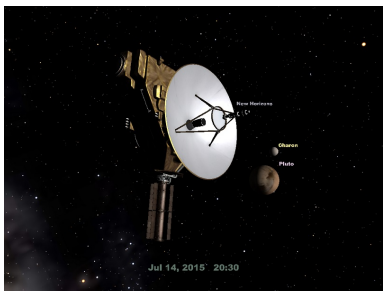
If you come close enough to the surface, the mode will switch to "the surface exploration mode" and you can fly around while looking at the terrains. For the operations available in the surface exploration mode, see Section 2.2.2.

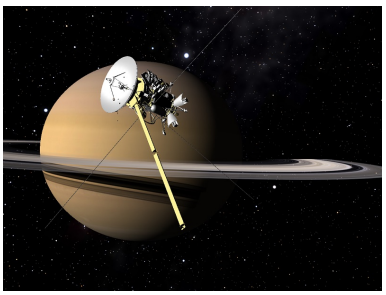




3.2.7 Chasing spacecraft trajectories

You can chase a spacecraft trajectory from launch by choosing a spacecraft as the target and moving time forward. At present, the following eight spacecraft are available in Mitaka: Pioneer 10 and 11, Voyager I and II, Cassini, New Horizons, Galileo, Hayabusa 2 (Hayabusa 2: only trajectory). Why not experience how these spacecraft approach a planet or make a swing-by. (Note that the spacecraft size will be displayed larger than the actual size for the convenience of drawing.)



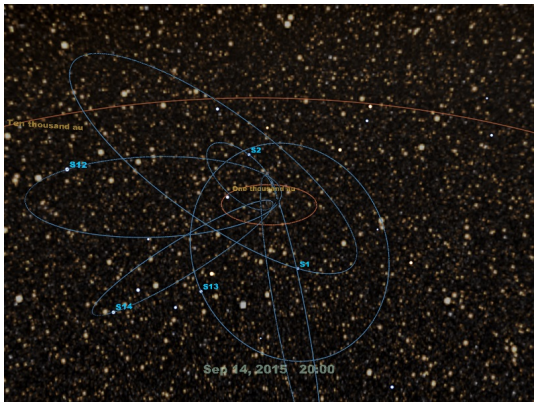


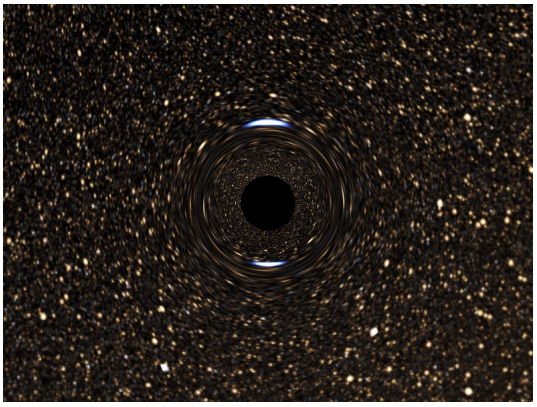


3.2.8 Giant black hole, gravitational lensing, and the movement of stellar systems

It is believed that there is a giant black hole, called Sagittarius A*, in the center of the Galaxy. When you choose "Sgr A*" or "Galactic Center" as the target and zoom in, you will

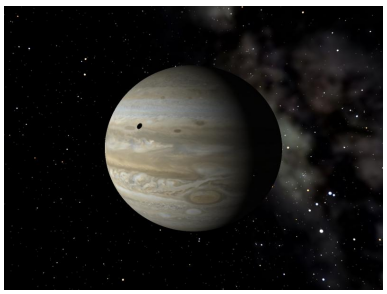
be able to see stellar systems orbiting around it. Of course the entire Galaxy, with all of its stars, rotates around this central point, but Mitika only includes the closest/fastest moving of these. You will also notice a gravitational lens caused by distortions in the space-time around the black hole. (Note that the appearance of the gravitational lens effect is based on the assumption of a Schwarzschild black hole. In addition, the apparent size of the black hole is shown twice as large as the actual size for the convenience of rendering. To create the stars in the background at the center of the Galaxy, we used a Monte Carlo method based on the same distribution model as was used to construct the overall shape of the Galaxy.)

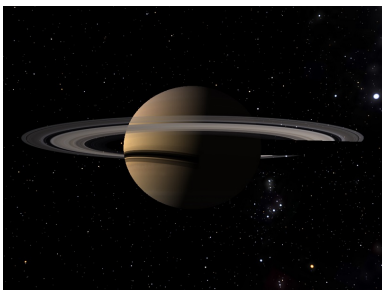




3.2.9 Shadows cast by satellites and rings

You can see the shadow of the Moon on the Earth (or vice versa) during eclipses. Similarly the shadows of Jupiter's four major satellites (Io, Europa, Ganymede and Callisto, also called the Galilean Satellites) track across the face of Jupiter. In addition, Mitaka can also display the boundaries of the shadows including umbrae and penumbrae. For Saturn and Uranus, it can display the shadows cast by the planets on the rings as well as the shadow of the rings on the planets.





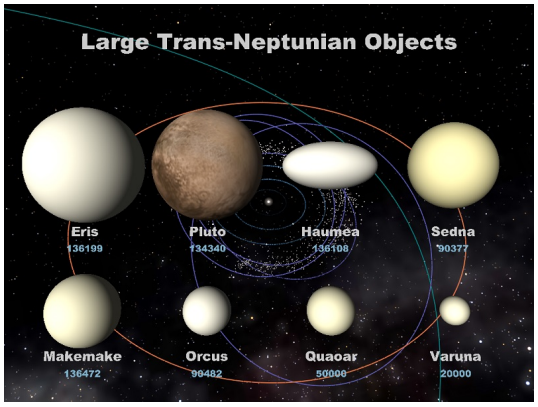
3.2.10 On-screen menus

In addition to the window menu bar, in Mitaka operations can also be accessed via on-screen menus. The on-screen menus are particularly useful during a live show using the full-screen mode (Section 3.2.2).

The on-screen menu can only be accessed from the keyboard or the game controller. For details, refer to Chapters 2 and 4.

3.2.11 Viewing 3D charts

You can also view 3D charts by selecting “3D Chart” from the on-screen menu. A 3D chart is a three-dimensional diagram to aid explanations. At present, three charts, including a list of planets, are available. You can change the location of the chart or zoom in/out using the keyboard or the game controller.



3.2.12 Real time mode

You can synchronize the time in Mitaka to the actual current time by selecting “Realtime Mode” on the menu for time settings and display it.

3.3 Simplified Settings for Synch Projection with Multiple PCs

You can use Mitaka for synchronized projection with multiple PCs. For example, stereoscopic projection using two PCs is possible if you prepare differing images: one for the right eye and the other for the left eye. The images are displayed simultaneously on the screen and polarizing filter glasses can be used to separate them.

The basic idea is that all of the PCs are connected via a LAN (TCP/IP network) and one of them works as a Controller PC. All operations are conducted through the Controller PC and the others synchronize and receive information via the network.

An ordinary LAN can be used for the network connection, but in this case each PC is required to use the TCP/IP protocol. In the case of only two PCs being used, you can connect them directly with the cross cable.

Before operating Mitaka with synchronized projection from multiple PCs (hereafter, referred as network mode) you will need to edit the setting files. Here we describe the most basic settings with the minimum configuration changes required.

First, determine the port number(s) for all PCs except the main Controller PC. This information is needed because Mitaka uses the TCP/IP network for communication. You can use any port number, as long as it is not used for other applications. In addition, multiple PCs can use the same port number.

The general settings are described in the file `mitaka.ini` that is included in the decompressed folder. Follow the instructions below to edit the files for the main Controller PC and other PC(s). Use a text editor for editing `mitaka.ini`.

3.3.1 Settings for the Controller PC

Open the `mitaka.ini` file on the Controller PC. Edit the line for `NetworkMode` under the [Network] section to match the following:

```
NetworkMode = 1
```

This indicates Mitaka is to be activated in the network mode. Then, in the same section edit the line for `Controler` as shown below:

```
Controler = 1
```

This indicates the PC is to be activated as the Controller PC.

Next, create a text file named "`servers.dat`" (If you find that a file by this name already exists, edit it). In this text file write a line containing the PC name (network name) and TCP/IP port for every PC except the Controller PC. For example, suppose you use two PCs, PC0 and PC1, and allocate PC0 as the Controller PC; and you use the port number, 50004 for the TCP/IP of PC1, then, you need to write the following line in `servers.dat`.

```
PC1 50004
```

3.3.2 Settings for other PCs

Open the `mitaka.ini` file for each of the other PCs. Similarly, edit the `NetworkMode` line in the `[Network]` section as shown below:

```
NetworkMode = 1
```

In the `Port` line, write the number of the TCP/IP port for that PC. This number should be the same as the number you wrote in the `servers.dat` file of the Controller PC. For example, if this PC uses the port 50004, the line should be edited to read:

```
Port = 50004
```

If the value of `Controler` has not been set to 0, edit it as shown below:

```
Controler = 0
```

3.3.3 Startup check

Now you are ready for a test startup. It is possible to proceed with the settings as is, however if possible, it would be better to adjust the relation between the projection geometry and the screen by editing the `[Window]` section in the `mitaka.ini` file. Refer to Chapter 5 for details.

Once you are ready, click on `mitaka.exe` on each PC to startup. In network mode, a special window will appear. This window lacks the normal window frame and is instead outlined with a black edge (margin area). (This means you cannot move the window.) Once Mitaka is activated on every PC, try some operations from the Controller PC. If other PCs function in a synchronized manner, the test is successful.

To exit network mode, select "End All" from "System Menu" in the menu. Thus, you can shut down all of the PCs. You can shut down each PC individually by pressing `ESC` on that computer.

Once you confirm that the program runs in network mode, go to Chapter 5 for the detailed settings. If you want stereoscopic projection, at a minimum you will need to specify the disparity.

Chapter 4

Menus

This chapter describes the important sub-menu items of the on-screen menu. Not to be confused with the window menu bar, the on-screen menu appears when you press the `X` key. Most of the operations described here can be done from the menu bar. (However, the menu bar is not displayed when you are in full screen mode or network mode.)

4.1 Movies

You can play movies synchronously on multiple PCs with Mitaka. From this menu you can select one of the movies registered in the configuration file. If there are no registered movies, this menu is not displayed. For detailed settings, refer to Section 5.5. For instruction on how to play a movie, refer to Section 2.4.

4.2 Images

Similarly, you can display registered images from this menu. If no images have been registered, this menu is not displayed. For detailed settings, refer to Section 5.5 and for the operations while an image is being displayed, refer to Section 2.5.

4.3 Audio Files

This is similar to the menu for movies or images. You can play an audio file from this menu. For detailed settings, refer to Section 5.5. The operations available while a sound file is displayed are similar to those for movies. For details refer to the description for movies.

4.4 3D Chart

A 3D (three-dimensional) chart is a stereoscopic model "illustration." They are useful during live shows. At present, the following three charts are included.

Name	Description
Planets	The eight planets in our Solar System are displayed with accurate relative sizes.
Large TNOs	This is a size comparison for large Trans-Neptunian Objects (including Pluto) that have been detected as of 2015.
Color and Temperature of Stars	This illustrates the relationship between the colors and temperatures of stars.

4.5 Display Settings

You can specify the details of how objects are displayed from this menu.

Name	Description
Planets	Display preferences for planets
Satellites	Display preferences for natural satellites
Minor Planets	Display preferences for minor planets
Trans-Neptunian Objects	Display preferences for Trans-Neptunian Objects
Stars	Display preferences for Stars
Galactic Objects	Display preferences for objects inside the Galaxy
Extragalactic Objects	Display preferences for objects outside the Galaxy
Spacecraft	Display preferences for spacecraft
Constellations	Display preferences for constellations
Milky Way	Select which image of the Milky Way will be displayed on the celestial sphere
NGC Objects	Visibility of NGC objects (planetarium mode): ON/OFF
Grid	Visibility of equatorial coordinates, etc. or scale lines: ON/OFF
Reset View Angle	Return the point of view to the default angle in the planetarium mode
Headlight	Constantly emit light from the viewpoint side in space mode
Surface Pointer	Planetary surface pointer in space mode: ON/OFF
View Info	Display information about the viewpoint on the screen

The following sections describe the important sub-menus reached from the above menu.

4.5.1 Planets

The table below shows the options for planets.

Name	Description
Display	Turn on/off the visibility of the planets
Names	Turn on/off names
Orbits	Turn on/off orbits
Axis of Rotation	Turn on/off rotation axes
Atmosphere	Select atmosphere rendering options
Cloud	Select whether or not to display clouds on the Earth
City Lights	Select whether or not to display city lights on the Earth's night side
Shadow of Moon	Select whether to display the shadows of the Moon, the Earth, and Jupiter's four major satellites (the Galilean Satellites)
Zoom Rate	Specify the magnification factor for displaying planets. See below for optional values.
Amplification of Topography	Specify the magnification factor for displaying the topography of a planet, if topographical information is available for the planet. You can select the magnification from among 1, 2, 5, 10 and 20 time(s).
Landing Mode	Select how to approach a planet

For rendering the atmosphere, there are three options: "None," "Single Scattering" and "Multiple Scattering." We use the Rayleigh scattering model to calculate how to display the atmosphere; the last option uses the multiple scattering effects, while single scattering stops calculating after the first.

For displaying the shadows of the Moon (Luna), the Earth and the Jovian satellites, you can select whether to display the shadows as well as the boundary lines.

The table below shows the magnification factors in space mode.

Name	Planets & Luna	Sun	Luna Orbit
Real Scale	1	1	1
Zoom 1	500	1	25
Zoom 2	1000	25	50
Zoom 3	1500	50	70

The table below shows the magnification factors of planets in the planetarium mode.

Name	Planets	Sun & Moon
Real Scale	1	1
Zoom 1	20	1
Zoom 2	100	5
Zoom 3	200	10

In the "Landing Mode", you can select one of the following settings: "Horizontal" mode and "Surface View" mode. In the former mode, your line of sight angles towards the horizon when approaching the surface. In the latter mode, your line of sight is always directed to the center of the planet.

4.5.2 Satellites

The table below shows the options for natural satellites.

Name	Description
Display	Whether or not to display satellites
Names	Whether or not to display names
Orbits	Whether or not to display orbits
Selected Satellites Only	Whether or not to display minor satellites

Earth's Moon, Luna, uses the same magnification factor for topography as the planets, so you can specify its magnification factor from the "Amplification of Topography" menu for planets.

4.5.3 Minor planets

The table below shows the options for minor planets.

Name	Description
Display	Whether or not to display minor planets
Names	Whether or not to display names
Orbits	Whether or not to display orbits
Selected Object Only	Display only pre-selected minor planets

4.5.4 Trans-Neptunian Objects

The table below shows the options for Trans-Neptunian Objects.

Name	Description
Display	Whether or not to display Trans-Neptunian Objects
Names	Whether or not to display names
Orbits	Whether or not to display orbits
Selected Objects Only	Display only pre-selected objects
Oort Cloud	Whether or not to display the Oort Cloud

4.5.5 Stars

The table below shows the options for Stars.

Name	Description
Display Stars	Whether or not to display the stars
Proper Name	Whether or not to display proper star names
Selected Proper Name	Display only pre-selected star names
Bayer Name	Whether or not to display Bayer names
Flamsteed Number	Whether or not to display Flamsteed numbers
HIP Number	Whether or not to display HIP (Hipparcos catalogue) numbers
Orbit	Whether or not to display orbits
Brighten	Brighten stars
Darken	Darken stars
Default Brightness	Return star brightness to the default value
Mark	Mark stars with specific conditions; at present, you can mark binary stars or stars with planets.

The Bayer name and Flamsteed number are usually displayed with an abbreviation of the constellation to which the star belongs. The abbreviation will disappear when the constellation boundaries are displayed. (Note that "Selected Proper Name" also applies when globular clusters and nearby galaxies are displayed in the current version.) "Orbits" refers to the orbits of the stellar systems in the center of the Galaxy.

4.5.6 Galactic objects

The table below shows the options for Galactic objects.

Name	Description
Our Galaxy	Turn on/off our galaxy
Sgr A*	Turn on/off Sagittarius A* (the giant black hole in the Galactic Center.)
VERA Objects	Turn on/off VERA objects (star-forming regions and late-type stars)
Globular Clusters	Turn on/off globular clusters
Background of Galactic Center	Turn on/off the background image in the Galactic Center

4.5.7 Extragalactic objects

The table below shows the options for extragalactic objects.

Name	Description
Nearby Galaxies	Turn on/off nearby galaxies
SDSS Galaxies	Turn on/off distant galaxies from the SDSS catalog
SDSS QSOs	Turn on/off quasars from the SDSS catalog
Cosmic Microwave Background	Turn on/off the Cosmic Microwave Background radiation observed by Planck
Mark Galaxies in Virgo Cluster	Mark the galaxies belonging to the Virgo cluster in green

4.5.8 Spacecraft

The table below shows the options for spacecraft.

Name	Description
Display	Turn on/off visibility of spacecraft
Trajectory	Display the spacecraft trajectories

You can turn on/off the spacecraft and their trajectories. At present, the data are available for Pioneer 10 & 11, Voyager I & II, Cassini, New Horizons, Galileo and Hayabusa 2.

4.5.9 Constellations

The table below shows the options for constellations.

Name	Description
Names	Turn on/off constellation names
Lines	Turn on/off constellation lines
Illustrations	Turn on/off constellation drawings
Boundaries	Turn on/off constellation boundary lines

4.5.10 Milky Way

Select one of the options for how to display the Milky Way on the celestial sphere: "None," "Milky Way," "Bright Milky Way," or "Infrared Milky Way."

4.5.11 Grid

You can select whether to display the coordinates and/or the scale lines on the celestial sphere. For the coordinates, equatorial (J2000.0), ecliptic, horizontal coordinates, and galactic coordinates are available. In the case of ecliptic coordinates, the ecliptic plane is displayed in the space mode. There are two options for the scale lines: circular and square types.

4.6 Target

This menu allows you to select the target that will be at the center of your field of view in space mode. A target cannot be selected in planetarium mode. Select a target after entering outer space.

There are the following menu options:

Name	Description
Solar System Objects	Select a celestial body in the Solar System as the target.
Stars	Select a star as the target.
Galactic Objects	Select the Galaxy or a Galactic object as the target.
Extragalactic Objects	Select an extragalactic object, e.g., another galaxy as the target.
Spacecraft	Select a spacecraft as the target.
Go to the Traget	Move close to the currently selected target.

The following targets are available under each submenu:

Name	Description
Solar System Objects	Sun, Mercury, Venus, Earth, Mars, Jupiter, Saturn, Uranus, Neptune, Pluto, Ceres, Itokawa, Eris, Sedna, Moon (Luna), Io
Stars	Alpha Centauri, Sirius, Pleiades, Castor
Galactic Objects	Sgr A*, M13, Galactic Center
Extragalactic Objects	Andromeda Galaxy, Virgo Cluster (M87)
Spacecraft	Pioneer 10, Pioneer 11, Voyager I, Voyager II, Cassini, New Horizons, Galileo, Hayabusa 2

Note that each target has its own characteristic scale. In selecting a target, Mitaka will zoom out to the new target's characteristic scale if that scale is larger than the current one. If the current scale is larger, the display scale will not change. If you would like to move closer to the target, choose "Go to the Target" from the menu options. Mitaka will then zoom in (or zoom out) to the target's characteristic scale.

4.7 Time

This menu allows you to access the following settings for time:

Name	Description
Display Date	Turn on/off the on-screen current time display.
Set to Present Time	Change to the current time (according to your computer's clock).
Time Step	Set the time step increment between 10 seconds and 100 years.
Realtime Mode	Turn on/off real time mode.

Real time mode is an operating mode which keeps Mitaka synchronized to the current time. (The time obtained from your computer's clock.)

4.8 System

This menu accesses other functions that don't fit into the categories mentioned above.

Name	Description
Select Program	Choose a "program" to be used for guidance. This function is used to prepare for presentations at the 4D2U Theater. Changing programs switches the title, theme, and parts of the menu which appear when the `W` key is pressed.
Language	Choose the language for the display. The options are: Japanese with Kana Readings, Japanese (without Kana readings), and English.
Text Size	Choose a font size from "Largest," "Larger," "Middle," "Smaller," and "Smallest."
FullScreen Mode	Switch to full screen mode.
Subtitle Mode	This function is still in the experimental stage and not currently available.
Title	The title "Mitaka" is displayed on the screen.
Version Info	Brings up a display of information about this version of "Mitaka," such as the software version and the number of stars used in the displays.
Debug Info	Displays information to help when debugging the software.
Only Right Eye Image	Only the images from the PCs dedicated to the right eye images will be displayed.
Exit All	Exit the program. In network mode, this terminates the program for all PCs.

Chapter 5

Detailed Settings

5.1 Setting Files

In Mitaka, you can specify the details of the operation by editing setting files. For example, some changes will enable you to play movies, etc., synchronously via a network. Edit the setting files as necessary. The setting files consist of the following:

File Name	Description
`mitaka.ini`	Overall settings
`servers.dat`	Network settings between the PCs (only required if Mitaka is used in network mode)
`movies.dat`	Settings for movie files (only required if movies are used)
`images.dat`	Settings for still images (only required if still images are used)
`audio.dat`	Settings for audio files (only required if audio files are used)
`*.mvp`	File information for movies, still images, and audio files (only required if they are used)

Only `mitaka.ini` and `images.dat` are included in the archive for distribution. Create the other files as needed. The files `mitaka.ini` and `servers.dat` need to be placed in the extracted folder (in the same folder as `mitaka.exe`). The other 4 types of files should be created in the `media` folder.

5.2 Editing Setting Files

All the setting files are plain text documents. You can use any text editor, e.g., notepad, etc., to edit them. Make sure to use **single-byte characters** for everything (except string) in these configuration files.

For a detailed description of how to edit the setting files, read the following instructions:

5.3 Overall Settings: (The mitaka.ini File)

Overall settings are described in the `mitaka.ini` file. Use a text editor for editing.

The following is an example of one part of this file:

```
[System]
MultipleLaunch = 0
FullScreenInit = 0
Language = Default
```

```
VSYNC = 1
PBuffer = 0

[Network]
NetworkMode = 0
Controler = 0
...
```

Each item of the settings is indicated by a section name and a key. The section name appears first, enclosed by `[]`, followed by all of the keys which belong to that section. The value of each key is configured using the following format:

(Key name) = (Value)

In the example above, the values of the `MultipleLaunch` and `FullScreenInit`, which belong to the `[System]` section, are set to "0," while the value of `Language` is set to "`Default`." The configurations for `NetworkMode` and `Controler`, which belong to the `[Network]` section, are given below that.

Note that a default value is defined for each key, and Mitaka will revert to this default if there is no description or an invalid description for this key in `mitaka.ini`. The order of the descriptions doesn't matter as long as the section names and key names are assigned appropriately.

The setting values for the keys can be numbers, character strings, or colors. Numbers can be integers or real numbers. Colors are assigned by a `#` followed by three two-digit hexadecimal numbers to specify the RGB (Red, Green or Blue) values in the form `#RRGGBB`. For example, white is `#FFFFFF`, red is `#FF0000`, and light blue (cyan) is `#00FFFF`.

The following table lists the names and descriptions of each section used in the file `mitaka.ini`.

Section Name	Description
`System`	Settings for the operating mode, etc.
`Network`	Network related settings (TCP/IP)
`Configuration`	Settings for how the display or screen will be displayed
`Window`	Settings for the position and size of the window to be displayed
`Directory`	Settings for the directory used in Mitaka
`Mode`	Settings for each operating mode
`DomeMaster`	Settings for the Dome Master display mode
`Movie`	Settings for playing movies
`Performance`	Settings for optimizing the speed
`Display`	Settings for the display
`Mouse`	Settings for mouse operations
`Joystick`	Settings for the game controller
`Inertia`	Settings for the "inertia" during operation, e.g., eye-movement or zooming
`Lighting`	Settings for processing lighting
`Earth`	Settings related to displaying the Earth
`Sun`	Settings related to displaying the Sun
`Moon`	Settings related to displaying the Moon
`Star`	Settings related to displaying the stars
`Landing`	Settings for establishing the landing position
`TimeZone`	Setting the time zone for the time
`Title`	Settings for the theater title
`CreditRoll`	Settings for the credit roll
`ObjectInfo`	Settings for the astronomical information window opened by pointing the mouse
`Font`	Settings for the font used for the display
`Color`	Settings for coloring and line thickness
`Menu`	Settings for the screen menu display

(Note that the sections and keys mentioned here may vary significantly between versions of Mitaka as the software continues to be developed.)

The following tables describe the keys in each section.

5.3.1 [System] Section

Key Name	Type	Default	Unit	Description
`MultipleLaunch`	Integer	0	-	Determines if multiple session can be launched
`FullScreenInit`	Integer	0	-	Determines if Mitaka will launches in full screen mode
`Language`	String	`Default`	-	Determines the language to be used for string displays
`VSYNC`	Integer	1	-	Determines if vertical synchronization (VSYNC) is employed during rendering
`PBuffer`	Integer	0	-	Determines if the optional size for the image saving function is available

`MultipleLaunch`, `FullScreenInit`, `VSYNC` and `PBuffer` are all binary switches. Set the value to "1" for on and "0" for off. When `VSYNC` is off, the rendering rate might accelerate and

create a flicker. The `Language` key sets up the display language at launch. The following are the setting options:

String	Description
`Default`	Obtain the local setting information from the computer's operating system, select Japanese if the region is Japan. Otherwise, select English (default).
`Japanese`	Japanese
`Japanese_Ruby`	Japanese with Kana reading
`English`	English

The display language can also be changed from the menu after launching Mitaka.

5.3.2 [Network] Section

For synchronous projection involving several computers, e.g., stereoscopic projection, the network settings must be specified. Use the following keys to adjust the settings:

Key Name	Type	Default	Unit	Description
`NetworkMode`	Integer	0	-	Determines if Mitaka launches in network mode
`Controler`	Integer	0	-	Determines if this machine is the Controller PC
`Port`	Integer	50004	-	TCP port number to be used

`NetworkMode` and `Controler` are binary switches. Choose "0" or "1." In the `Port` key, write the TCP port number to be used. This value is only used by stand-alone machines other than the Controller PC. The Controller PC will ignore this value.

5.3.3 [Configuration] Section

To calculate 3D data images on your PC, the relative positions of the viewing location and the projected screen (or display) needs to be specified. Although the default settings will still work on a single PC, for stereoscopic viewing with parallax information, it is important to set these parameters carefully.

In reality, the viewer's position is not fixed and it will shift: multiple people will watch the images projected on the screen from different positions. In Mitaka, select one "representative viewing location" and determine the following parameters for the screen position based on that viewing point:

Key Name	Type	Default	Unit	Description
ScreenZ	Real	217.3	cm	Distance from the viewing location to the screen
ScreenW	Real	180.0	cm	The shortest dimension (width or height) of the screen
ObjZ	Real	400.0	cm	Apparent distance from the viewing location to the target object
Angle	Real	0.0	degree	The rotation angle of the screen where the image is rendered and the "forward direction"
EyeOffset	Real	0.0	cm	Offset between nominal view point and eye position (the right eye is positive)
EyeCLR	Character	C	-	Eye position (center, left, or right)
NearZ	Real	30.0	cm	Distance to the nearest clipping plane
MidZ	Real	25000.0	cm	Distance to the middle clipping plane
FarZ	Real	(MidZ × 8000)	cm	Distance to the farthest clipping plane
TitleWidthRatio	Real	1.0	-	The ratio of the length of the title image/text to the screen width
StereoEyeDist	Real	6.4	cm	Distance between the eyes in stand-alone stereoscopic vision (e.g., anaglyph, etc.)
EnableChangeEyeDist	Integer	0	-	Turns on/off the function to change parallax during operation

ScreenZ and ScreenW are the settings for the screen. The default values are set for the testing 4D2U Theater at NAOJ.

Mitaka adopts a method to fix the location of the targeted celestial body and move the view point to that location. The key name ObjZ is used to designate the apparent distance between the viewer and the object in question.

When the target object is projected on multiple screens by using multiple PCs, it is necessary to set how far to the left or right the screen for which that computer is responsible is rotated from the "forward direction" (i.e. the direction in which the target object is displayed). In Mitaka, this angle is measured from the line that connects the viewing location and the target object. The key name Angle should be set to the angle (in degrees) between the forward direction defined by this line and the normal vector of the screen. A positive value corresponds to a screen on the right side as seen from the viewing location, and a negative value corresponds to the left side. (For the screen facing the viewing location, the value should be zero.)

Furthermore, the viewing location should be modified according to the image for the right

eye or the left eye when using stereoscopic visualization with parallax. (The cardinal viewing location is situated midway between the left and the right eye.) This value (in centimeters) is designated by the key name `EyeOffset`. A positive value corresponds to the right eye side and a negative value corresponds to the left eye side. Normally, the values for the computer dedicated to the right-eyed and the left-eyed computer should have the same magnitudes but opposite signs[1]. Also, the distance between the eyes can be changed in 1 mm increments during operation. (Please refer to the "Controlling the Software.")

The key name `EyeCLR` specifies whether the images created by a particular computer are for the right eye view, the left eye view, or neither of them. The values `R` and `L` correspond to the right eye view and left eye view, respectively. The value `C` indicates that neither of them are used. (This information is used if the "Only Right Eye Image" mode is turned on, and the distance between the eyes is changed while the program is running. The eye position right after launching is designated by the key name `EyeOffset` regardless of this value.)

When creating 3D images, the objects that are either too close or too far from the viewing location will be ignored. While most software uses two "clipping planes," a nearby side and a distant side, to determine which drawings to ignore, Mitaka utilizes a two-step method to separate the nearby region and the distant region enabling it to show objects that are quite different in size (e.g., a spacecraft and a planet).

This requires defining three clipping planes by the key names `NearZ`, `MidZ`, and `FarZ`. (`MidZ` specifies the position for the boundary between the nearby region and the distant region.)

The key name `TitleWidthRatio` specifies the scale of enlargement for the title screen. This is mainly used when you would like to display the title across multiple screens in the theater, etc.

The key name `StereoEyeDist` sets the distance between the eyes in the stereovision mode on a stand-alone PC. It is possible to adjust this value while the program is running time by using a keyboard or game controller. (While the stereovision mode can be selected from the menu while the program is running, the `StereoMode` key in the `[Mode]` section can be used to instruct the program to launch in stereovision mode.)

The key name `EnableChangeEyeDist` is a binary switch. Please select "0" or "1."

5.3.4 [Window] Section

Specify the initial position and size of the window. This setting is particularly important in a theater setting, etc., where the relative positions of the projectors and screens are fixed.

Key Name	Type	Default	Unit	Description
`WinX`	Integer	0	pixel	The x-coordinate of the upper left corner of the window
`WinY`	Integer	0	pixel	The y-coordinate of the upper left corner of the window
`WinW`	Integer	768	pixel	The width of the display area of the window
`WinH`	Integer	768	pixel	The height of the display area of the window
`MgnW`	Integer	0	pixel	The width of the margin area
`MgnH`	Integer	0	pixel	The height of the margin area

The values of `WinX` and `WinY` are determined from the coordinate axes that define the upper left corner of the display as the origin. With these two values and the values of `WinW`

[1] Although a human eye-to-eye (or pupil-to-pupil) distance varies between individuals, it is said that the average is about 6.4 cm. We advise you to initially set the value as 3.2 for a right-eye view and -3.2 for a left-eye view.

and WinH, the screen image will be adjusted to be displayed in an appropriate position and size on the screen.

A black margin can also be shown around the display area in the network mode. The width and height of the margin can be designated with the key names MgnW and MgnH.

5.3.5 [Directory] Section

The locations of particular directories (folders) used in Mitaka can be designated.

Key Name	Type	Default	Description
Data	String	./data/	Data folder
Textures	String	./textures/	Texture folder
Media	String	./media/	Folder for configuration files for videos or still images
Spacecraft	String	./spacecraft/	Folder for spacecraft data
Title	String	./title/	Folder for theater title images and credit rolls

5.3.6 [Mode] Section

The default setting for each operating mode when the program is launched can be adjusted. The real time mode and display mode can be configured.

Key Name	Type	Default	Description
RealTimeMode	Integer	0	Determines if Mitaka starts in real time mode
DisplayMode	String	Normal	Display mode

RealTimeMode is a binary switch. Choose "0" or "1."

In DisplayMode, the following display modes can be specified.

Normal	Normal Mode (Default)
Anaglyph	Stereovision Mode Anaglyph (monochrome)
ColorAnaglyph	Stereovision Mode Anaglyph (color)
SideBySide	Stereovision Mode Right and Left Division Type
TopAndBottom	Stereovision Mode Top and Bottom Division Type
DomeMaster	Dome Master (fish-eye lens projection) Mode

To set parallax (the distance between the eyes) in a stereopsis mode, use the StereoEyeDist key in the [Configuration] section (Section 5.3.3). The details of the Dome Master mode can be set under the [DomeMaster] section (Section 5.3.7).

5.3.7 [DomeMaster] Section

Settings for the Dome Master (fish-eye lens projection) mode.

Key Name	Type	Default	Unit	Description
BufferSize	Integer	1024	pixel	Size of the virtual screen
CaptureSize	Integer	2048	pixel	Size of the capture image
MeshNum	Integer	50	-	Number of divided polygons in created images
ElevationAngle	Real	30	degree	Elevation angle of the front side
LabelMagnification	Real	2.0	-	Magnification ratio of the label
LineWidthFactor	Real	2.5	-	The magnification scale for the line widths

`BufferSize` specifies the size of the (square) virtual screen prepared internally to create Dome Master images. `CaptureSize` specifies the size of the (square) capture image of the screen saved when the `C` key pressed. `MeshNum` is the number of divided polygons used to create Dome Master images. `ElevationAngle` specifies the elevation angle (height above the horizon) of the forward direction in Mitaka. When "0" degrees is selected, the part below the Dome Master circle (the horizon) will appear in the forward direction. When "90" degrees is selected, the center of the Dome Master circle (the zenith) will appear in the forward direction.

5.3.8 [Movie] Section

Settings related to playing movies.

Key Name	Type	Default	Description
`Renderer`	String	`Windowed`	Specify a method to play the movie
`FadingDuration`	Real	1.0	Specify a fading duration when the movie is closed.

In `Renderer`, the following display methods are available:

`Windowed`	DirectShow Window mode
`WindowlessVMR`	Windowless VMR7
`WindowlessVMR9`	Windowless VMR9
`EVR`	EVR (Windows Vista or later)

5.3.9 [Performance] Section

Settings for optimizing speed. The following keys are currently available for configuration:

Key Name	Type	Default	Unit	Description
`Speed`	Real	1.0	-	Specify the movement (relative value) per frame. "1" is the standard value
`GalaxyRayNum`	Integer	6000	-	Specify the number of rays to be calculated when rendering the Galaxy
`GalaxyRayStepLength`	Real	40.0	-	The integral step size used to calculate the rays when rendering the Galaxy
`GalaxyStarNum`	Integer	2000	-	Number of the stars (dots) used to render the Galaxy
`TextureReduction`	Integer	1	-	The reduction ratio for textures
`DistantGalaxyThinning`	Integer	0	-	Setting for thinning distant galaxies and quasars
`EnableDrawLowRes`	Integer	0	-	Turns on/off the rendering of the ground while the point of view is moving in low resolution mode

`TextureReduction` sets the reduction ratio for textures at the time of loading.

For example, if you designate "`TextureReduction = 2`," the texture will be loaded after being reduced to half its original size. This is mainly used when the memory capacity of the video card is limited. In the case of "`TextureReduction = 1`," the texture will be loaded in its original size.

`DistantGalaxyThinning` designates the degree of thinning used for distant galaxies and quasars from SDSS. "0" displays everything, "1" displays 1/2 of the objects, "2" displays 1/4 of the galaxies or quasars, etc. This can be set as high as "10."

5.3.10 [Display] Section

Settings related to the display. The following setting is available:

Key Name	Type	Default	Unit	Description
`MagFactor`	Real	1.0	-	Magnification factor for line thickness, etc.

By setting the `MagFactor`, line thickness and dot size can be increased.

5.3.11 [Mouse] Section

Settings related to mouse operation. The following settings can be configured:

Key Name	Type	Default	Unit	Description
`ZoomReverse`	Integer	0	-	Reverses the zoom effect when right-click and drag is used
`HideTimeout`	Real	3.0	second	Time until cursor disappears

`ZoomReverse` is a binary switch, select "0" or "1." If "1" is selected, the zoom-in/zoom-out effects produced when right-click and drag is used will be reversed.

`HideTimeout` designates the duration in seconds after you stop moving the mouse that the mouse cursor in the window will disappear. If the value is set to a negative number, the mouse cursor will not disappear.

5.3.12 [Joystick] Section

Settings related to the game controller (game pad). These keys can be used to assign functions to the joysticks and buttons of the controller. With the standard (default) setting, JC-PS201USV by ELECOM operates normally. If your controller is configured differently, please refer to the following instructions then reset it. (The recommended settings for a variety of commercially available controllers are listed in Appendix A.1.)

The stick (joysticks) can be configured with the following keys. If your controller is assigned differently from the default settings, please replace the values accordingly.

Key Name	Type	Default	Description
`AXIS_X`	Integer	0	Right and left on the left stick
`AXIS_Y`	Integer	1	Up and down on the left stick
`AXIS_RZ`	Integer	2	Right and left on the right stick
`AXIS_Z`	Integer	3	Up and down on the right stick

The same procedure is used for setting the buttons. If your controller is assigned differently from the default settings, please replace the values accordingly.

Key Name	Type	Default	Description
BTN_TRI	Integer	0	△ button
BTN_CIR	Integer	1	◯ button
BTN_CRS	Integer	2	× button
BTN_SQR	Integer	3	□ button
BTN_L2	Integer	4	L2 button
BTN_R2	Integer	5	R2 button
BTN_L1	Integer	6	L1 button
BTN_R1	Integer	7	R1 button
BTN_START	Integer	8	Start button
BTN_SELECT	Integer	9	Select button
BTN_L3	Integer	10	A push down on the left stick (this function is currently unavailable)
BTN_R3	Integer	11	A push down on the right stick (this function is currently unavailable)
BTN_UP	Integer	12	The top of the directional pad (cross-shaped button)
BTN_RIGHT	Integer	13	The right of the directional pad (cross-shaped button)
BTN_DOWN	Integer	14	The bottom of the directional pad (cross-shaped button)
BTN_LEFT	Integer	15	The left of the directional pad (cross-shaped button)

Also, the response when the axis is tilted can be adjusted by the following parameter:

Key Name	Type	Default	Description
PowerIndex	Real	1.0	The index to decide the response when the stick is tilted (Please refer to the following)

When the actual degree of tilting the axis is assumed to be x (a value between 0 and 1), the converted value, e.g., x^{α} will be the inclination of the axis received by Mitaka (α represents the value specified by PowerIndex).

TimerInterval is the time interval used to obtain input from the controller and keys.

Key Name	Type	Default	Description
TimerInterval	Integer	5	Specifies the input time interval in milliseconds

5.3.13 [Inertia] Section

This sets the inertial movement accompanying movement of the point or view or zooming in, zooming out, etc. The amount of the inertial movement can be adjusted by changing the "amount of inertia (mass)" and the "amount of friction." The following options are available:

Key Name	Type	Default	Unit	Description
TrackballMass	Real	2.0	-	Inertial mass for movement of the point of view (in space mode)
TrackballFriction	Real	2.0	-	Amount of friction for movement of the point of view (in space mode)
PlntTrackballMass	Real	2.0	-	Inertial mass for movement of the point of view (in planetarium mode)
PlntTrackballFriction	Real	8.0	-	Amount of friction for movement of the point of view (in planetarium mode)
ZoomLeverMass	Real	2.0	-	Inertial mass for zooming-in or zooming-out
ZoomLeverFriction	Real	10.0	-	Amount of friction for zooming-in or zooming-out

5.3.14 [Lighting] Section

Settings related to the lighting methods. The following option is available:

Key Name	Type	Default	Unit	Description
`Ambient`	Real	0.1	-	Designates the degree of lighting on the night side of a surface, e.g., a planet, etc.

5.3.15 [Earth] Section

Settings related to the display method for the Earth. The following options are available:

Key Name	Type	Default	Unit	Description
`Specular`	Real	6.0	-	Reverberation strength on the surface of the sea
`Shininess`	Real	60.0	-	Reverberation spread on the surface of the sea (The smaller the value, the more it spreads.)
`AtmosphereIntensity`	Real	6.0	-	Brightness of the atmosphere (in space mode)
`AtmosphereIntensityPlanetarium`	Real	20.0	-	Brightness of the atmosphere (in planetarium mode)
`CityLights`	Integer	0	-	Determines whether or not city lights are displayed

`CityLights` is a binary switch. Please select "0" or "1."

5.3.16 [Sun] Section

Settings related to the display method for the Sun. The following options are available:

Key Name	Type	Default	Unit	Description
`GlareSize`	Real	5.0	Solar radius	Specifies the size of the glare displayed around the Sun
`GlareColor`	Color	`#FEF2FE`	-	Specifies the glare color

5.3.17 [Moon] Section

Settings related to the display method for the Moon. The following options are available:

Key Name	Type	Default	Description
`EclipseShadowR`	Real	0.3	The Moon color (red component) during a total lunar eclipse
`EclipseShadowG`	Real	0.0	The Moon color (green component) during a total lunar eclipse

The Moon color during a total lunar eclipse can be specified. Please designate the red and green components with values between "0" and "1." (Please note that this function doesn't exactly reproduce the brightness and coloration of the actual lunar eclipse.)

5.3.18 [Star] Section

Settings related to the display method for the stars. The following option is available:

Key Name	Type	Default	Unit	Description
`ImagePowIndex`	Real	0.3	-	Specifies the relations between the size and brightness of the stars in the picture when displaying the stars

`ImagePowIndex` designates the size of a picture of a star (a billboard) in proportion to its apparent magnitude. In the case that "`ImagePowIndex = 0.5`," the area of the picture will be proportional to the magnitude. The default value is a little smaller than this value.

5.3.19 [Landing] Section

This section specifies the location on Earth in the initial conditions. If "landing at xxx" is selected from the menu, it will land on the location specified by this section. `NameJ` (the name of the place chosen in Japanese mode) or `NameE` (in English mode) will be inserted into "xxx" as described below. The default value is the location of NAOJ's Mitaka Campus.

Key Name	Type	Default	Unit	Description
`NameJ`	String	三鷹	-	The name of the landing point (Japanese)
`NameE`	String	Mitaka	-	The name of the landing point (English)
`Lon`	Real	139.54	degree	Longitude (East longitude)
`Lat`	Real	35.67	degree	Latitude (North latitude)
`Mode`	String	Horizontal	-	Landing mode right after booting

The unit for "`Lon`" and "`Lat`" is degrees. To convert between degrees and minutes (arc minutes)/seconds (arc seconds), use 1/60 degree for 1 arc minute and 1/3,600 degree for 1 arc second.

For `Mode`, choose either "Horizontal" (horizon mode) or "SurfaceView" (surface viewing mode) mode.

5.3.20 [TimeZone] Section

This section indicates the time zone of the displayed time as a difference from Coordinated Universal Time (UTC). The value will be positive if it is ahead of UTC.

Key Name	Type	Default	Unit	Description
`DT`	Real	9	Hour	Time difference

Although Japan Standard Time is 9 hours ahead of UTC, you don't need to specify this, as it is set as the default.

5.3.21 [Title] Section

This section designates the title image used in the title mode and the display method.

Key Name	Type	Default	Description
`TitleImageJ`	String	None	Title image (in Japanese mode)
`TitleImageE`	String	None	Title image (in English mode)
`TitleDuration`	Real	0.6	Duration of animation
`TitleZPosIni`	Real	0.1	Initial position (in the direction of the depth, a positive value is towards the viewer.)

If the PNG format is used for the images, the transparent channel (alpha channel) is available. Also, the title image moves with a fade-in effect from the position assigned by `TitleZPosIni` to the standard position. The duration time for this movement is specified by `TitleDuration`.

5.3.22 [CreditRoll] Section

This section determines the settings for the credit roll.

Key Name	Type	Default	Unit	Description
`ScriptFileNameJ`	String	`credit_roll_J.txt`	-	File that describes the content to be used for the credit roll (in Japanese mode)
`ScriptFileNameE`	String	`credit_roll_E.txt`	-	File that describes the content to be used for the credit roll (in English mode)
`Width`	Real	`ScreenW` from `[Screen]`	cm	Width of the credit roll
`DY`	Real	0.0	cm	Displacement of the credit roll in the vertical direction (up is positive)
`Duration`	Real	10	-	Duration used to display the entire credit roll
`Angle`	Real	0.0	degree	The tilt angle of the entire credit roll (to the right and left around a rotation axis)

The contents of the credit roll are described in a text file. Although there are future plans to open the description method to the public so that it may be edited freely, these methods are currently still in development. For the time being, please use the files as is, without modifying them.

5.3.23 [ObjectInfo] Section

This section assigns the settings for the information windows which are displayed when the mouse is pointed at a celestial body in the window.

Key Name	Type	Default	Description
`Enable`	Integer	1	Turns information displays on/off
`Size`	Real	1.0	Specifies relative size of the information window

The key name "`Enable`" is a binary switch. Please choose "0" or "1."

5.3.24 [Font] Section

This section determines the font for the display. Mitaka uses two kinds of letters: half-width (single-byte) letters and full-width (a multi-byte) letters. The font for each type of letter can be assigned with the following keys:

Key Name	Type	Default	Unit	Description
`FaceNameSB`	String	“Arial Black”	-	Font (typeface) name for single-byte letters
`FaceNameMB`	String	“ＭＳ ゴシック”	-	Font (typeface) name for multi-byte letters
`Size`	Real	1.4	-	Size of the letters

The typeface name can be confirmed from “Font Setting” in the Windows “Control Panel.” Even typeface names containing spaces can be specified. Double quotation marks are used to delineate the entire typeface name.

e.g.,
```
FaceNameSB = "Times New Roman"
```

5.3.25 [Color] Section

This section determines colors, letter sizes and line thickness.

Key Name	Type	Default	Unit	Description
NameObject	Color	#00BFFF	-	Color for the name of a planet, star, galaxy, etc.
NameSpecialObject	Color	#FFFFDD	-	Color for the name of the Sun and the Galaxy
NameSatellite	Color	#F0E68C	-	Color for the name of the Moon and other natural satellite
NameDwarfPlanet	Color	#D8BFD8	-	Color for the names of a dwarf planet
NameSmallObject	Color	#98FB98	-	Color for the name of a minor planet or Trans-Neptunian Object
NameSpacecraft	Color	#A6A6B3	-	Color for the name of a spacecraft
OrbitPlanet	Color	#4682B4	-	Color of a planet's orbit
OrbitSatellite	Color	#8C916A	-	Color of a satellite's orbit
OrbitDwarfPlanet	Color	#6666CB	-	Color of a dwarf planet's orbit
OrbitSmallObject	Color	#008B8B	-	Color of the orbit for a minor planet or Trans-Neptunian Object
ObjectNameSize	Real	2.8	-	Letter size in the name of a planet, stars, galaxy, etc..
SpecialObjectNameSize	Real	3.8	-	Letter size in the name of the Sun and the Galaxy
SatelliteNameSize	Real	2.5	-	Letter size in the name of a natural satellite
DwarfPlanetNameSize	Real	2.6	-	Letter size in the name of a dwarf planet
SmallObjectNameSize	Real	2.4	-	Letter size in the name on a minor planet or Trans-Neptunian Object
LocationName	Color	#AAAAAA	-	Color for location names
LocationNameSize	Real	3.0	-	Letter size for location names
ConstellationName	Color	#AED75B	-	Color for constellation names
ConstellationNameSize	Real	2.6	-	Letter size for constellation names
ConstellationLine	Color	#778899	-	Color of constellation lines
ConstellationBoundary	Color	#434D56	-	Color of constellation boundaries
Scale	Color	#EB7847	-	Color of scale lines (circle)
ScaleText	Color	#EBBE47	-	Color of the scale line label (circle)
ScaleSquare	Color	#00FFFF	-	Color of scale lines (square)
ScaleSquareText	Color	#EBBE47	-	Color of the scale line label (square)
ScaleTextSize	Real	2.6	-	Letter size for scale line label
ScaleWidth	Real	1.4	-	Scale line width
OrbitWidth	Real	1.2	-	Width of the orbit line for a planet
Oort	Color	#87CEEB	-	Color of the Oort Cloud
QSO	Color	#5099DE	-	Color of quasars
Date	Color	#BCE9D0	-	Color of letters in the time display
DateRealTime	Color	#F3CDB1	-	Color of letters in the time display during real time mode
DateAlpha	Real	0.5	-	α value (opacity) of letters in the the time display
DateSize	Real	0.9	-	Letter size for the time display

5.3.26 [Menu] Section

This section designates the display method and color of the on-screen menu.

Key name	Type	Default	Unit	Description
`Visible`	Integer	1	-	Determines whether or not the PC displays the screen menu
`SystemMenu`	Integer	1	-	Determines whether or not the system menu is included in the screen menu
`PosAngle`	Real	0.0	-	Defines the direction of the menu
`RotateAngle`	Real	0.0	-	Defines the rotation angle of the menu
`TextSize`	Real	0.7	-	Defines the text size of the menu
`TextColor`	Color	`#A59FA5`	-	Text color in the menu
`SelectColor`	Color	`#DEDED3`	-	Text color used for the selected menu item
`TitleColor`	Color	`#EBBE47`	-	Text color for the title
`CornerR`	Real	0.5	text size	Defines the rounding radius of the corners of the menu
`BgColor1`	Color	`#464E64`	-	Menu background top color (a gradation is applied)
`BgColor2`	Color	`#000000`	-	Menu background bottom color
`BgAlpha`	Real	0.95	-	α (opacity) value of the menu background
`BdColor`	Color	`#3E4557`	-	Border color of the menu background
`BdWidth`	Real	1.0	pixel	Border width of the menu background
`HlColor1`	Color	`#599AE5`	-	Menu options background top color (a gradation is applied)
`HlColor2`	Color	`#2764D2`	-	Menu options background bottom color
`BehindAlpha`	Real	0.4	-	α value (opacity) of the menu background with respect to the layer behind it
`FadingRate`	Real	3.0	-	Fading rate of the menu with respect to the layer behind it (The smaller the value, the faster it fades)
`FadingDuration`	Real	0.15	second	Fading duration when opening a menu
`TriangleDy`	Real	-0.08	-	Fine tuning the y-coordinate of the triangle on the right side of menu items

Both "`Visible`" and "`SystemMenu`" are binary switches. Please choose "0" or "1."

5.4 Settings for Communication Among Multiple PCs (servers.dat)

When multiple PCs are synchronized using the TCP/IP network to project on the screen, the Controller PC needs the information for the PCs receiving commands. This information is written in the text file named "`servers.dat`," located in the extracted folder of the Controller PC. Use a text editor to edit this file. (This file is unnecessary if you don't employ network mode.)

The writing method is simple: write the computer name and TCP port number for each PC with a space between them. Enter the information for one PC per line. The information for the Controller PC itself doesn't need to be written. The following is an example of a configuration file for use with 5 PCs (PC1, PC2, PC3, PC4 and PC5) in addition to the Controller PC (6 PCs in total).

```
PC1 50004
PC2 50004
PC3 50004
PC4 50004
PC5 50004
```

Please make sure to match the port number listed above for each PC with the one written in "`mitaka.ini`" on that PC.

5.5 Settings for Movies, Still Images, and Audios Files

Mitaka can play movies, still images, or audio files while employing synchronization. Each PC reads these media files independently. (The media data is not sent over the network at the time of playing.)

Settings for movies, still images, and audio files are written in the files with the `.mvp` extension (hereafter, "mvp file"). The files `movies.dat`, `images.dat` and `audio.dat` are only set for the Controller PC.[2] All of these files are stored in the `media` sub-folders.[3] (These files are not mandatory. They can be created if there are any media files to play.)

While the information about individual movies, still images, and audio files is written in the mvp file, the relation between the mvp files and displayed menu is written in the files `movies.dat`, `images.dat`, and `audio.dat` files. As all the files mentioned above are text files, please use a text editor to edit them.

5.5.1 mvp files

The contents of the mvp files are the same for movies, still images, and audio files. They should be created in the `media` folder of the Controller PC. The contents of the files consist of the exact full path name of one media file, written one per line. Please note that the order they are written is important: **first, write the path information for each PC according to the order they appear in "`servers.dat`," and write the path information for the Controller PC last.** For the example configuration with 6 PCs mentioned above, a sample mvp file might be as follows: (This example is for a movie where the movie files are stored in the folder `c:\mitaka\movies\` on each PC.)

```
C:\mitaka\movies\movie_1.avi
C:\mitaka\movies\movie_2.avi
C:\mitaka\movies\movie_3.avi
C:\mitaka\movies\movie_4.avi
C:\mitaka\movies\movie_5.avi
C:\mitaka\movies\movie_0.avi
```

The first 5 lines contain the information for the PCs listed in `servers.dat` which receive communications (from the top PC1, PC2, PC3, PC4, and PC5), and the last line contains the information regarding the Controller PC.

Please create mvp files for all media files to be played.

[2] Although in previous versions of Mitaka the "movies.dat," "images.dat," and "audio.dat" files needed to be copied to all PCs, for the current version, these files should be stored only in the Controller PC. The setting details are sent from the Controller PC to other PCs via the network when Mitaka is launched.

[3] The folder position can be changed in the "mitaka.ini" file.

5.5.2 movies.dat, images.dat, audio.dat

The 3 files, `movies.dat`, `images.dat`, and `audio.dat`, describe the relation between the mvp files and the menu. If these files exist, the sub-menus "Movies," "Images" and "Audio" (respectively) will be added to the root menu.

The writing convention is the same for each: the information for one mvp file is written per line. For the content for each line, please write the following five items, separating them with spaces or tabs:

Item	Description
mvp file 1	mvp file to be used
mvp file 2	mvp file to be used (second one)
Media type	Indicates if the contents are a movie, a still image, or audio
Menu title	String to be displayed in the menu
Displayed title	Title to be displayed on the image if it is a still image

Please write the mvp file to be used on the "mvp file 1." "mvp file 2" is included for possible expansions in the future. For this version of Mitaka, please repeat the same name as appears for "mvp file 1." The media type is assigned with one letter. There are three types as follows:

Notation	Meaning
`M`	Movie
`I`	Still image
`A`	Audio

The menu title is the name displayed in the menu. Please specify a character string without any spaces. The title for display is used only for a still image. It is normally the same as the menu title, but it could be different. In Japanese, Kana readings can be also assigned.

For example, if there are 2 mvp files for movie, i.e., "`movie1.mvp`" and "`movie2.mvp`," the content of "`movies.dat`" might be as follows:

```
movie1.mvp movie1.mvp M movie1 movie1
movie2.mvp movie2.mvp M movie2 movie2
```

The two movies registered above can be executed by selecting "movie1" or "movie2", respectively, from the "Movies" menu.

Please write "`images.dat`" and "`audio.dat`" in the same way.

5.6 Settings for Location Information

By rewriting the text file "`place_name.dat`" in the `data` sub-folder, place names can be assigned on the Earth, the Moon and Mars. The file consists of the following content:

1. Assigned object
2. Display type definition
3. Location information

Please assign them as follows.

5.6.1 Assignment of an object

This indicates the object (celestial body) for which the place name is defined. Location information specified on this line will be applied to this object. To assign the object, write "`OBJECT:`" at the start of the line, and assign one of the following object names:

Object Name	Celestial Body
`EARTH`	Earth
`MOON`	the Moon
`MARS`	Mars

e.g., to assign location information for the Earth, you would write
`OBJECT: EARTH`

To define place names for another object, write "`OBJECT:`" once again.

5.6.2 Display type definition

Font size, color, fade radius, etc., for displaying place names can be defined. This information will be referred to by the location information. Different settings can be defined for each "display type number." Start with "`TYPE:`" at the start of the list, and write the following:

`TYPE:` [Display type number] [Font size] [Fade radius 1] [Fade radius 2] [Filling color] [Outline color]

The following are the content for each item

Item	Type	Description
Display-type number	Integer	Type number used by the location information
Font size	Real	Font size of the place name
Fade radius 1	Real	Designates the radius where fading starts (in units of the planet's radius)
Fade radius 2	Real	Designates the radius where fading finishes (in units of the planet's radius)
Filling color	Color	Color to fill the characters, designated in the form `#RRGGBBAA`
Outline color	Color	Color to outline the characters, designating in the form `#RRGGBBAA`

"`AA`" of the color represents the degree of opaqueness (α value).

Example: To assign Display Type No. 0, it should be of the form:
`TYPE: 0 1.0  0.1  0.01 #AAAAAAFF #000000FF`

A display type can be rewritten. If it is rewritten, the newly defined display type will be applied to the information on the place names starting from the next line.

5.6.3 Location information

This defines the name, location, display type, etc. for a place. The celestial object to which the location information is applied is designated by "`OBJECT:`" A special assignment at the start of the line is unnecessary. Please write the location information for one place per line as shown in the following form:

[Display type number] [East longitude] [North latitude] [Display position] [“English name”] [“Japanese name”]

The following are the descriptions for each item

Item	Type	Description
Display type number	Integer	Display style defined by the “TYPE:”
East longitude	Real	East longitude of the location (degree)
North latitude	Real	North latitude of the location (degree)
Display direction	One character	Designates the display direction for the string
“English name”	String	Designates the place name (English) enclosed in double quotation marks
“Japanese name”	String	Designates the place name (Japanese) enclosed in double quotation marks

The following options can be assigned for the display direction:

Designation of the display direction	Description
R	Write the place name on the right side of the reference point
L	Write the place name on the left side of the reference point
D	Double-space and write the place name on the right side of the reference point
l	Double-space and write the place name on the left side of the reference point

West longitude should be converted to East longitude by adding a minus (−) sign. The same rule also applies to the south latitude. Both the English name and Japanese name enclosed in double quotation marks can include spaces.

Example: To define the North Pole with the display type No. 0, we could write
`0 0.0 90.0 R "North Pole" "北極"`

5.6.4 Comment

Any portion on each line to the right of a “%” will be considered a comment and ignored. Use this when a comment is necessary. (Note that a “%” in double quotation marks is regarded as a character.)

Chapter 6

Credits

6.1 Data Used

Mitaka uses the following data:

6.1.1 Position data

Solar System Planets
Planetary Orbital Elements, NASA JPL, Solar System Dynamics
(`http://ssd.jpl.nasa.gov/?planet_pos`)

Satellites in the Solar System
Planetary Satellite Mean Orbital Parameters, NASA JPL, Solar System Dynamics
(`http://ssd.jpl.nasa.gov/?sat_elem`)

Satellites of Pluto
The Orbits and Masses of Satellites of Pluto, Brozović, Showalter, Jacobson, and Buie 2015, Icarus 246, 317

The position of planets between 1900 and 2100
Ephemerides of planets between 1900 and 2100 (1998 update),
J. Chapront and G. Francou (1996, CDS VI/87)

Minor planets
Orbital Elements of Minor Planets 1998,
Yu.V. Batrakov and V.A. Shor (1997, CDS I/245)

Eris (2003UB313), Sedna (2003VB12), Trans-Neptunian Objects
Lists and Plots: Minor Planets, IAU Minor Planet Center,
(`http://cfa-www.harvard.edu/iau/lists/MPLists.html`)

Position and Spectral type of nearby stars
The Hipparcos and Tycho Catalogues (ESA SP-1200),
European Space Agency (1997)

Hipparcos, the New Reduction,
van Leeuwen (2007, CDS I/311)

The star systems around the supermassive black hole in the center of the Milky Way
Monitoring Stellar Orbits around the Massive Black Hole in the Galactic Center, Gillessen, Eisenhauer, Trippe et al. 2009, ApJ 692, 1075

VERA Objects (star-forming region and late-type stars)
Honma et al. 2012, PASJ 64, 136 and others
Courtesy of Mizusawa VLBI Observatory, NAOJ

Globular Clusters
Globular Clusters in the Milky Way,
W.E. Harris (1997, CDS VII/202)

Local Group of Galaxies
"*Milky Way Galaxy and the Universe of Galaxies*,"
Sadanori Okamura, University of Tokyo Press (1999)

Nearby Galaxies
Nearby Galaxies Catalogue,
R.B. Tully (1988, CDS VII/145)

Distant Galaxies and Quasars
SDSS Data Release 7 (2010), Astrophysical ResearchConsortium (ARC) and the Sloan Digital Sky Survey (SDSS) Collaboration
(`http://www.sdss.org/`)
Data source: Naoki Yasuda (University of Tokyo)

NGC Objects
NGC 2000.0,
Sky Publishing, ed. R.W. Sinnott (1988)

> **Credits:** The catalogue "NGC 2000.0, The Complete New General Catalogue and Index Catalogue of Nebulae and Star Clusters by J. L. E. Dreyer, edited by R. W. Sinnott." ©1988 by Sky Publishing Corporation.

Spacecraft Trajectories
HORISONS System, NASA JPL
(`http://ssd.jpl.nasa.gov/?horizons`)

Rotation of Ceres
Differentiation of the Asteroid Ceres as Revealed by its Shape, Thomas, Parker, McFadden et al. 2005, Nature 437, 224

Rotation of Itokawa
The Rubble-Pile Asteroid Itokawa as Observed by Hayabusa, Fujiwara, Kawaguchi, Yeomans et al. 2006, Science 312, 1330

6.1.2 Topographical data of celestial bodies

Earth's Topography
GTOPO 30, U.S.Geological Survey
(https://lta.cr.usgs.gov/GTOPO30)

> **Credits:** These data are distributed by the Land Processes Distributed Active Archive Center (LP DAAC), located at USGS/EROS, Sioux Falls, SD.
> http://lpdaac.usgs.gov

Moon's Topography
LRO LOLA Elevation Model 118m (LDEM GDR), Courtesy of the U.S. Geological Survey
(http://astrogeology.usgs.gov/search/details/Moon/LRO/LOLA/Lunar_LRO_LOLA_Global_LDEM_118m_Mar2014/cub)

Mars' Topography
Mars Global Surveyor Laser Altimeter Mission Experiment Gridded Data Record
Smith, D., G. Neumann, R. E. Arvidson, E. A. Guinness, and S. Slavney
NASA Planetary Data System, MGS-M-MOLA-5-MEGDR-L3-V1.0, 2003.

Itokawa's 3D Model
Gaskell model (R. Gaskell, et.al, the Image Processing Team at JAXA/AMICA)
Gaskell et al. (2006), AIAA paper 2006_6660, AAS/AIAA Astrodynamics Specialists Conf., Keystone, CO, Aug, 2006
(https://darts.isas.jaxa.jp/planet/project/hayabusa/shape_ja.pl)

6.1.3 Texture images

Earth
Blue Marble / Visible Earth, Courtesy of NASA
(http://visibleearth.nasa.gov/view_cat.php?categoryID=1484)
(Texture processing by Hirotaka Nakayama)

The Moon
Jimpage
(http://home.arcor.de/jimpage/)
Original Data: Clementine, U.S.Geological Survey/NASA
(http://pdsmaps.wr.usgs.gov/PDS/public/explorer/html/mmfront.htm)
(Texture processing by Tsunehiko Kato)

The Sun, Planets (Mercury, Mars, Saturn, Uranus, Neptune), Pluto and the ring of Uranus
JHT's Planetary Pixel Emporium
(http://planetpixelemporium.com/index.php)

Planets (Venus and Jupiter), Satellites (Io, Europa, Ganymede and Callisto) and Saturn's Rings
Björn Jónsson's collection
(http://www.mmedia.is/~bjj/)

Satellites (Phobos, Deimos, Mimas, Titan and Charon)
Solar System Simulator, NASA JPL
(http://maps.jpl.nasa.gov/)

Credits:
Caltech/JPL/USGS(Phobos, Deimos, Mimas)
JPL/Caltech (Titan)
David Seal(Charon)

Ceres
NASA/JPL, Images (`http://www.jpl.nasa.gov/spaceimages/`), Courtesy NASA/JPL-Caltech

Milky Way and Bright Milky Way
Axel Mellinger's All Sky Milky Way Panorama
(`http://home.arcor-online.de/axel.mellinger/`)

Infrared Milky Way
The Infrared Sky, IPAC, The Two Micron All Sky Survey
(`http://www.ipac.caltech.edu/2mass/gallery/showcase/allsky/index.html`)

Credits: Atlas Image obtained as part of the Two Micron All Sky Survey (2MASS), a joint project of the University of Massachusetts and the Infrared Processing and Analysis Center/California Institute of Technology, funded by the National Aeronautics and Space Administration and the National Science Foundation.

Cosmic Microwave Background
Planck, U.S. Data Center at IPAC (`http://planck.ipac.caltech.edu/`), Courtesy NASA/JPL-Caltech

Andromeda Galaxy, M32, M104, M100 and M82
NAOJ Public Relations and Dissemination Office

Large Magellanic Cloud (LMC) and Small Magellanic Cloud (SMC)
Photographed by Yoji Yanaka

Background for the Galactic Center
Created by Tsunehiko Kato

6.1.4 Images for still pictures

Pleiades (Subaru) and M13
NAOJ Public Relations and Dissemination Office

Andromeda Galaxy
Hiromitsu Kohsaka/HSC Project/ NAOJ

Orion Nebula, S106
Subaru Telescope, NAOJ

6.1.5 Theoretical models

Globular Clusters Model
4D2U Project, NAOJ
(Data: Eiichiro Kokubo, Visualization: Tsunehiko Kato)

Milky Way Galaxy Model
4D2U Project, NAOJ
(Pattern of Galactic Arm: Eiichiro Kokubo, 3D Model and Visualization: Tsunehiko Kato)

Giant Elliptical Galaxy Model
4D2U Project, NAOJ
(Visualization: Tsunehiko Kato)

Earth's Atmosphere
4D2U Project, NAOJ
(Visualization: Tsunehiko Kato)

Gravitational Lens Effect
4D2U Project, NAOJ
(Visualization: Tsunehiko Kato)

6.1.6 3D models of spacecraft

Cassini-Huygens
Solar System Simulator, NASA JPL
(`http://space.jpl.nasa.gov/models/`)
In Collaboration with Shota Hirasawa (Musashino Art University),
Modified by Yayoi Narazaki

Pioneer, Voyager
Created by Yuki Nakamura (Shonandai Children's Museum)

New Horizons
Created by Hirotaka Nakayama

Galileo
NASA 3D Resources
(`http://nasa3d.arc.nasa.gov/models/`)
Modified by Hirotaka Nakayama

6.1.7 Other data

Lunar Nomenclature
Gazetteer of Planetary Nomenclature: the Moon,
International Astronomical Union (IAU) Working Group for Planetary System Nomenclature

(WGPSN),
(http://planetarynames.wr.usgs.gov/Page/MOON/target)

Names of Stars
Bright Star Catalogue, 5th Revised Ed.,
D. Hoffleit and W.H. Warren Jr (1991, CDS V/50)

Stars with Extrasolar Planets
The Exoplanet Data Explorer, exoplanet.org
(http://exoplanets.org/)

> **Credits:** The data for exoplanets used in Mitaka has made use of the Exoplanet Orbit Database and the Exoplanet Data Explorer at exoplanets.org

Ref. "The Exoplanet Orbit Database," J.T.Wright et al. 2011, PASP, 123, 412

Constellation Boundaries
Constellation Boundary Data,
A.C. Davenhall and S.K. Legget (1989, CDS VI/49)

6.2 Libraries Used

Mitaka uses the following libraries:

- OpenGL (3D Graphics Rendering)
- DirectShow (Movie Playing)
- DirectInput (Input processing of the game pad)
- Winsock (Communication by TCP/IP)
- libjpeg 6b (Reading and Writing images in JPEG format)
  (the Independent JPEG Group: http://www.ijg.org/)
- zlib 1.1.4 (subsidiary library for reading and writing images in PNG format)
  (©1995-2002 Jean-loup Gailly and Mark Adler: http://www.gzip.org/zlib/index.html)
- libpng 1.2.2 (Reading and Writing images in PNG format)
  (©1998-2002 Glenn Randers-Pehrson: http://www.libpng.org/pub/png/libpng.html)
- glew 1.12.0 (Library to use the extended functions for OpenGL in Windows)
  (http://glew.sourceforge.net/)

Appendix A

A.1 Settings for Different Game Controllers

The following are some examples of the parameters used in the `[Joystick]` section of the `mitaka.ini` file based on the game controller used:

A.1.1 DualShock for Sony Play Station and ELECOM USB adapter, JC-PS201USV (Standard parameters)

```
AXIS_X = 0
AXIS_Y = 1
AXIS_RZ = 2
AXIS_Z = 3
BTN_TRI = 0
BTN_CIR = 1
BTN_CRS = 2
BTN_SQR = 3
BTN_L2 = 4
BTN_R2 = 5
BTN_L1 = 6
BTN_R1 = 7
BTN_START = 8
BTN_SELECT = 9
BTN_L3 = 10
BTN_R3 = 11
BTN_UP = 12
BTN_RIGHT = 13
BTN_DOWN = 14
BTN_LEFT = 15
```

A.1.2 ELECOM Wireless Game Pad, JC-U3412S

```
AXIS_X      = 0
AXIS_Y      = 1
AXIS_RZ     = 2
AXIS_Z      = 3
BTN_TRI     = 1
BTN_CIR     = 3
BTN_CRS     = 2
BTN_SQR     = 0
BTN_L2      = 6
```

```
BTN_R2      = 7
BTN_L1      = 4
BTN_R1      = 5
BTN_START   = 9
BTN_SELECT  = 8
BTN_L3      = 10
BTN_R3      = 11
BTN_UP      = 12
BTN_RIGHT   = 13
BTN_DOWN    = 14
BTN_LEFT    = 15
```

A.1.3 Logicool Wireless Gamepad F710 (Direct Input mode)/Logicool Rumble Gamepad F510/Logicool Logicool F310 Gamepad/Logitech Rumble Pad 2

```
AXIS_X = 0
AXIS_Y = 1
AXIS_RZ = 2
AXIS_Z = 3
BTN_TRI = 3
BTN_CIR = 2
BTN_CRS = 1
BTN_SQR = 0
BTN_L2 = 6
BTN_R2 = 7
BTN_L1 = 4
BTN_R1 = 5
BTN_START = 9
BTN_SELECT = 8
BTN_L3 = 10
BTN_R3 = 11
BTN_UP = 12
BTN_RIGHT = 13
BTN_DOWN = 14
BTN_LEFT = 15
```