Simulating an Orbit

Audience	Beginner
Length	30 minutes
Prerequisites	None
Script File	`Tut_SimulatingAnOrbit.script`

Objective and Overview

> **Note**
>
> The most fundamental capability of GMAT is to propagate, or simulate the orbital motion of, spacecraft. The ability to propagate spacecraft is used in nearly every practical aspect of space mission analysis, from simple orbital predictions (e.g. When will the International Space Station be over my house?) to complex analyses that determine the thruster firing sequence required to send a spacecraft to the Moon or Mars.

This tutorial will teach you how to use GMAT to propagate a spacecraft. You will learn how to configure **Spacecraft** and **Propagator** resources, and how to use the **Propagate** command to propagate the spacecraft to orbit periapsis, which is the point of minimum distance between the spacecraft and Earth. The basic steps in this tutorial are:

1. Configure a **Spacecraft** and define its epoch and orbital elements.
2. Configure a **Propagator**.
3. Modify the default **OrbitView** plot to visualize the spacecraft trajectory.
4. Modify the **Propagate** command to propagate the spacecraft to periapsis.
5. Run the mission and analyze the results.

Configure the Spacecraft

In this section, you will rename the default **Spacecraft** and set the **Spacecraft**'s initial epoch and classical orbital elements. You'll need GMAT open, with the default mission loaded. To load the default mission, click **New Mission** ( ) or start a new GMAT session.

Rename the Spacecraft

1. In the **Resources** tree, right-click **DefaultSC** and click **Rename**.
2. Type **`Sat`**.
3. Click **OK**.

Set the Spacecraft Epoch

1. In the **Resources** tree, double-click **Sat**. Click the **Orbit** tab if it is not already selected.
2. In the **Epoch Format** list, select **UTCGregorian**. You'll see the value in the **Epoch** field change to the UTC Gregorian epoch format.
3. In in the **Epoch** box, type **`22 Jul 2014 11:29:10.811`**. This field is case-sensitive, and must be entered in the exact format shown.
4. Click **Apply** or press the **ENTER** key to save these changes.

Set the Keplerian Orbital Elements

1. In the **StateType** list, select **Keplerian**. In the **Elements** list, you will see the GUI reconfigure to display the Keplerian state representation.
2. In the **SMA** box, type **`83474.318`**.
3. Set the remaining orbital elements as shown in the table below.

Table 1. Sat Orbit State Settings

Field	Value
ECC	**`0.89652`**
INC	**`12.4606`**
RAAN	**`292.8362`**
AOP	**`218.9805`**
TA	**`180`**

4. Click **OK**.
5. Click **Save** (). If this is the first time you have saved the mission, you'll be prompted to provide a name and location for the file.

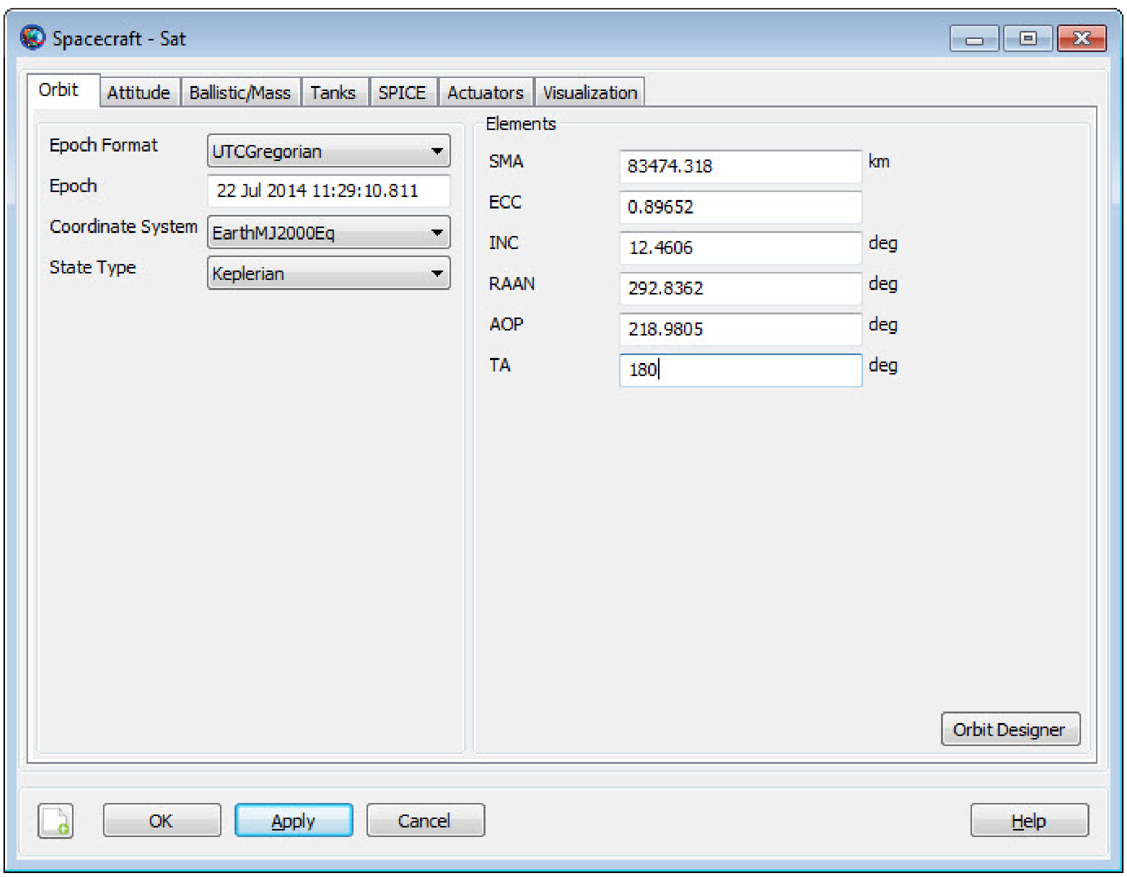

Figure 1. Spacecraft State Setup

Configure the Propagator

In this section you'll rename the default **Propagator** and configure the force model.

Rename the Propagator

1. In the **Resources** tree, right-click **DefaultProp** and click **Rename**.
2. Type **`LowEarthProp`**.
3. Click **OK**.

Configure the Force Model

For this tutorial you will use an Earth 10×10 spherical harmonic model, the Jacchia-Roberts atmospheric model, solar radiation pressure, and point mass perturbations from the Sun and Moon.

1. In the **Resources** tree, double-click **LowEarthProp**.
2. Under **Gravity**, in the **Degree** box, type **`10`**.
3. In the **Order** box, type **`10`**.
4. In **Atmosphere Model** list, click **JacchiaRoberts**.
5. Click the **Select** button next to the **Point Masses** box. This opens the **CelesBodySelectDialog** window.
6. In the **Available Bodies** list, click **Sun**, then click **->** to add **Sun** to the **Selected Bodies** list.
7. Add the moon (named **Luna** in GMAT) in the same way.
8. Click **OK** to close the **CelesBodySelectDialog**.
9. Select **Use Solar Radiation Pressure** to toggle it on. Your screen should now match Figure 2.
10. Click **OK**.

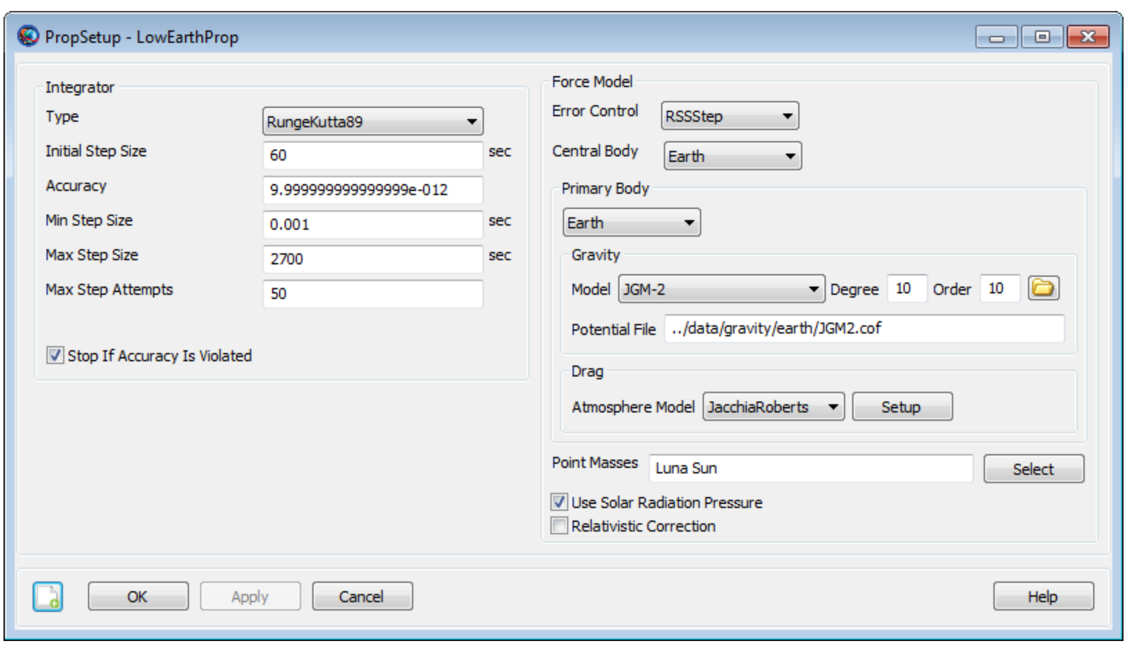

Figure 2. Force Model Configuration

Configuring the Orbit View Plot

Now you will configure an **OrbitView** plot so you can visualize **Sat** and its trajectory. The orbit of **Sat** is highly eccentric. To view the entire orbit at once, we need to adjust the settings of **DefaultOrbitView**.

1. In the **Resources** tree, double-click **DefaultOrbitView**.
2. In the three boxes to the right of **View Point Vector**, type the values **`-60000`**, **`30000`**, and **`20000`** respectively.
3. Under **Drawing Option** to the left, clear **Draw XY Plane**. Your screen should now match Figure 3.
4. Click **OK**.

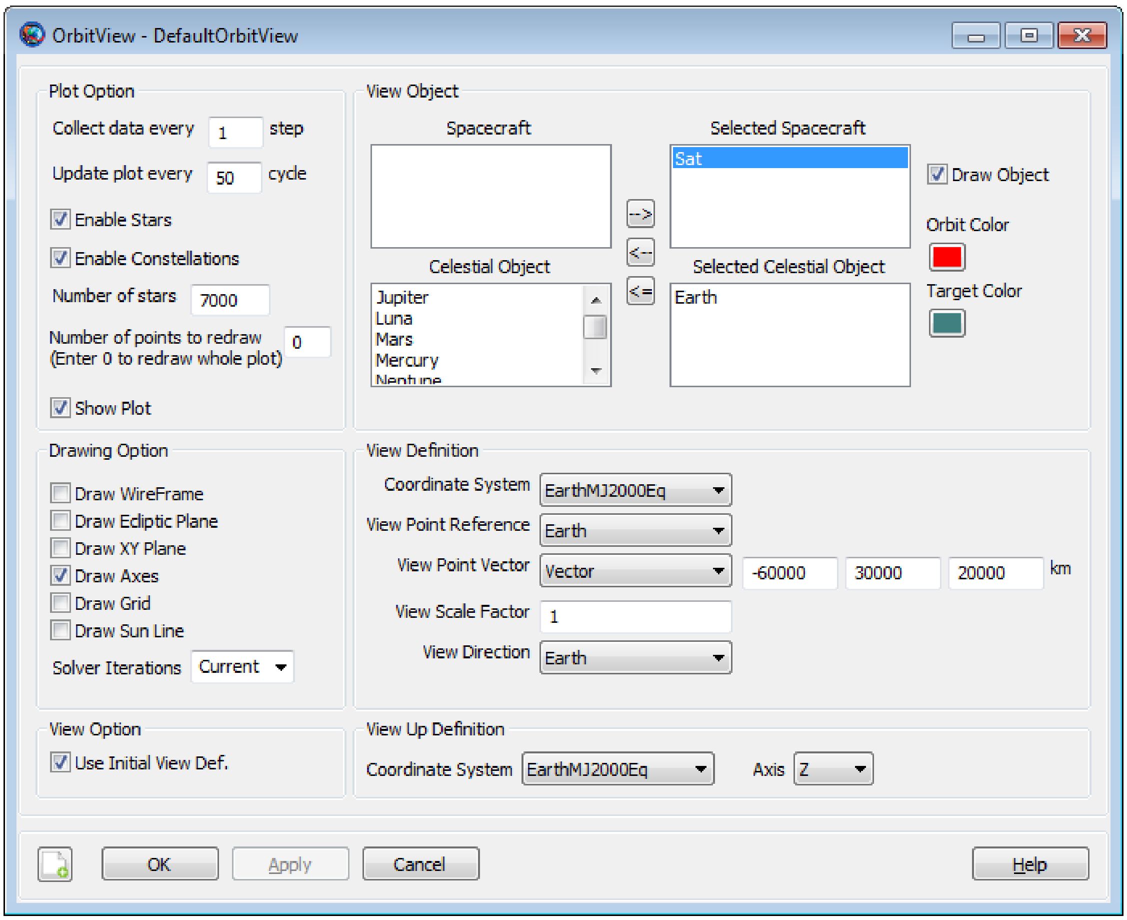

Figure 3. DefaultOrbitView Configuration

Configure the Propagate Command

This is the last step before running the mission. Below you will configure a Propagate command to propagate (or simulate the motion of) **Sat** to orbit periapsis.

1. Click the **Mission** tab to display the **Mission** tree.
2. Double-click **Propagate1**.

3. Under **Stopping Conditions**, click the (**...**) button to the left of **Sat.ElapsedSecs**. This will display the **ParameterSelectDialog** window.
4. In the **Object List** box, click **Sat** if it is not already selected. This directs GMAT to associate the stopping condition with the spacecraft **Sat**.
5. In the **Object Properties** list, double-click **Periapsis** to add it to the **Selected Values** list. This is shown in Figure 4.

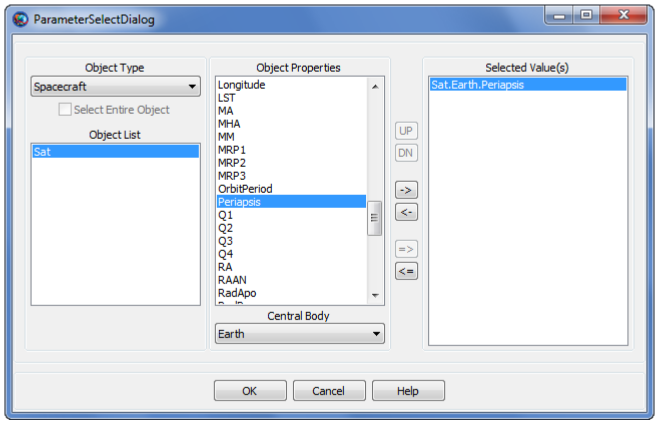

Figure 4. Propagate Command ParameterSelectDialog Configuration

6. Click **OK**. Your screen should now match Figure 5.
7. Click **OK**.

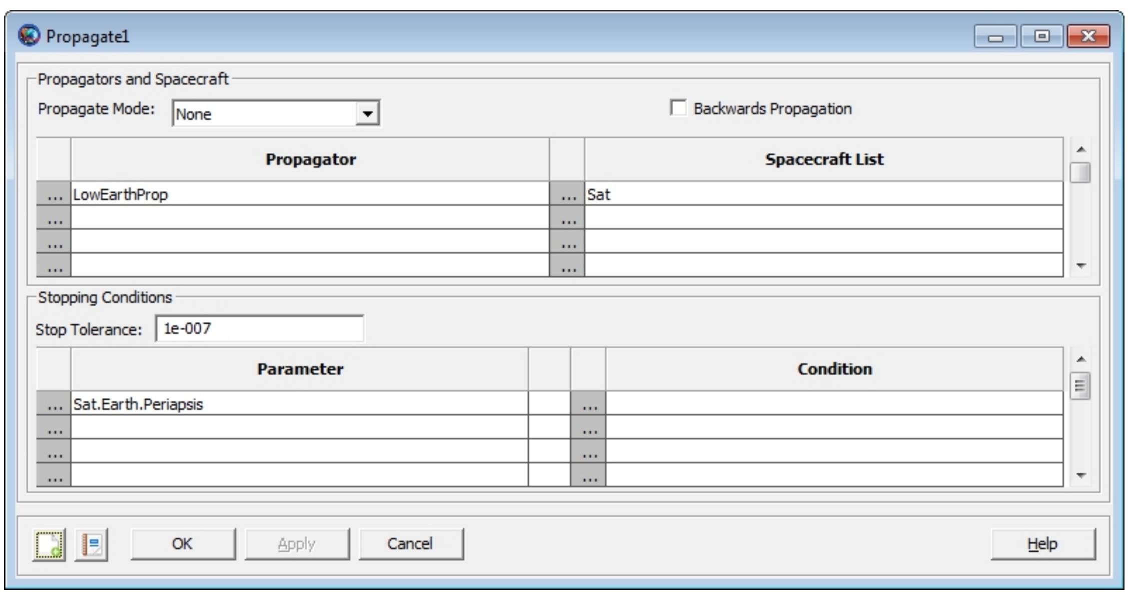

Figure 5. Propagate Command Configuration

Run and Analyze the Results

Congratulations, you have now configured your first GMAT mission and are ready to run the mission and analyze the results.

1. Click **Save** (💾) to save your mission.
2. Click the **Run** (▶).

You will see GMAT propagate the orbit and stop at orbit periapsis. Figure 6 illustrates what you should see after correctly completing this tutorial. Here are a few things you can try to explore the results of this tutorial:

1. Manipulate the **DefaultOrbitView** plot using your mouse to orient the trajectory so that you can to verify that at the final location the spacecraft is at periapsis. See ??? for details.
2. Display the command summary:
    1. Click the **Mission** tab to display the **Mission** tree.
    2. Right-click **Propagate1** and select **Command Summary** to see data on the final state of **Sat**.
    3. Use the **Coordinate System** list to change the coordinate system in which the data is displayed.
3. Click **Start Animation** (▶) to animate the mission and watch the orbit propagate from the initial state to periapsis.

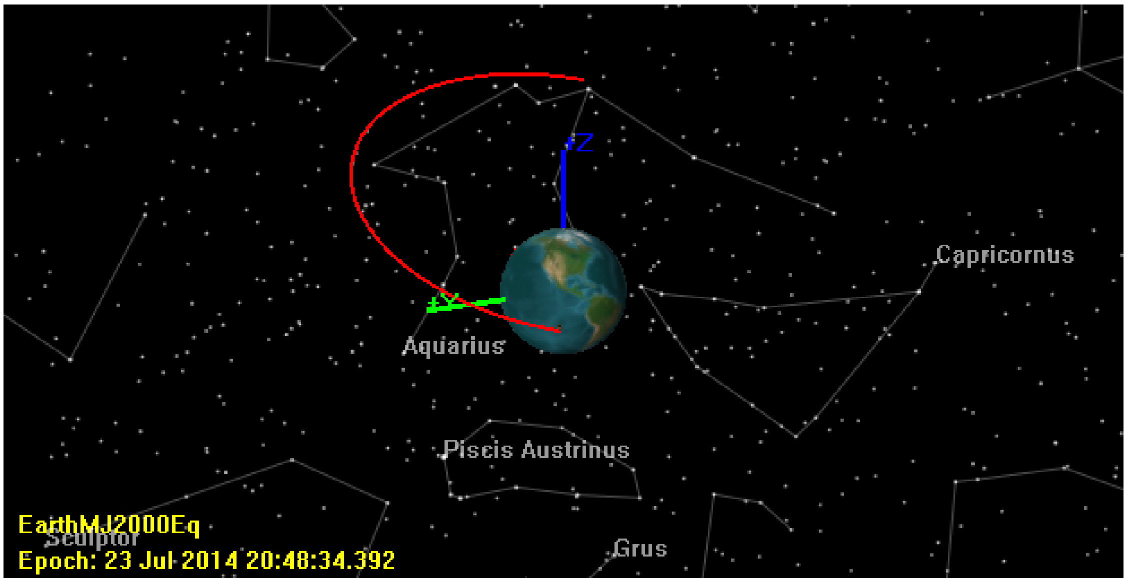

Figure 6. Orbit View Plot after Mission Run