

About Orbital Elements:

Planning to Observe Comets and Minor Planets with Deep-Sky Planner 4

Abstract

Calculating an accurate position for a comet or minor planet (asteroid) requires a set of parameters called [orbital elements](#). Since there is a set of these parameters for every cataloged comet and minor planet, and they change over time, the parameters must be managed to give accurate calculations. Understanding how to maintain accurate parameters is necessary if you expect to get accurate data for comets and minor planets.

Orbits of Solar System Bodies

Solar system bodies have orbits described by various conical sections: ellipses, parabolas and hyperbolas. The major planets have elliptical orbits that are well understood; they can be described accurately with a set of equations. Minor planets also have elliptical orbits, but since their masses are small, more massive objects disrupt their orbital paths easily. This disruption is called [perturbation](#) and the effect on orbital calculations is that the parameters present in the equations change in a brief time due to perturbation. The situation with comets is even more interesting because their orbits can be elliptical, parabolic or hyperbolic in shape and their orbits are perturbed.

Orbital Elements

To address the need for accurate parameters, astronomers must make astrometric observations of comets and minor planets, and reduce the observations to a set of new parameters for each comet and minor planet. There are hundreds of comets and thousands of minor planets involved in this process with more being added constantly. The Minor Planet Center ([MPC](#)) manages this effort and publishes the data for public use.

Managing Orbital Elements

Observers need to adopt a strategy for dealing with so much data changing on an irregular schedule. **Deep-Sky Planner** provides the capability to do so with its **Orbital Elements Manager**. The strategy that you employ really depends on which type of objects you want to observe.

Orbital Elements for Comets

Comets are divided into two groups where orbital elements are concerned: [commonly observed](#) and [newly discovered](#). The MPC makes both groups available.

Data for commonly observed comets is available in a file that can be downloaded and imported into **Deep-Sky Planner** using the **Orbital Elements Manager**. The number of comets represented in a typical file numbers in the hundreds.

When a new comet is discovered, it takes some time to collate observations and reduce them to a reliable set of orbital elements, and to assign the comet an official designation. During this period of time, the MPC makes elements for the new comet available on an individual basis rather than adding them to the well-studied, observable comets list. This data appears on the MPC's Comet Ephemeris pages accessible from <http://www.cfa.harvard.edu/iau/Ephemerides/Comets/index.html>. Elements for new comets must be entered manually using the **Orbital Elements Manager** in **Deep-Sky Planner**.

Once you have acquired elements, **Deep-Sky Planner** allows you to control which comets' elements are displayed in the **Orbital Elements Manager** (see below.) First click the **Comets** tab on the left edge of the **Orbital Elements** pane then click one of the buttons at the top of the pane:

- **All Objects** shows data for every comet in the database
- **Observable Comets** shows just the comets whose elements were downloaded from the MPC
- **My Objects** shows just the comets whose elements were added manually by you

Getting Orbital Elements for Commonly Observed Comets

Open the **Orbital Elements Manager (Options | Orbital Elements Manager)** and select the **Comets** tab on the left edge of the **Orbital Elements** pane.

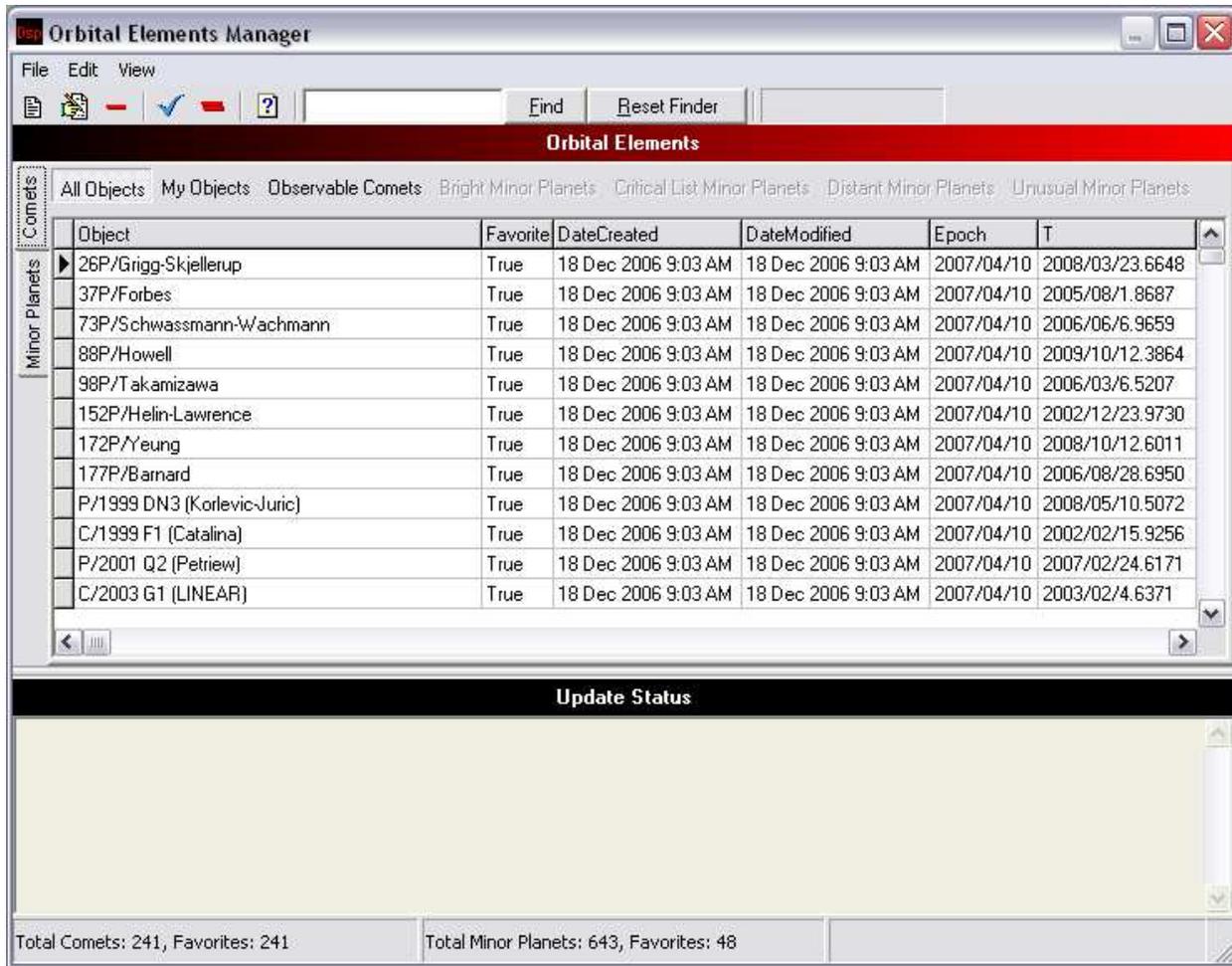


Figure 1: Orbital Elements Manager showing all comets

The **Epoch** column shows the date for which the parameters are correct. The MPC computes comet elements for a new Epoch about once a year, so if your elements are over a year old, you should download a new set of elements (see below.)

The **Date Modified** column shows the date that the parameters were added to or changed in the database. This tells you when you last updated elements for a specific comet.

The **T** column shows the date of perihelion – when the comet reaches its closest point to the sun.

The **Favorite** column shows whether a comet appears in the selection list of a Comet Ephemeris document, or whether it is included in a database search of a Comet Search document. Eliminating comets from a database search document improves

performance. You can use the **Favorite** item to retain a comet's orbital elements for future use while excluding the comet temporarily from database searches and ephemeris calculations.

If you want to [completely refresh comet elements](#), you should:

- Delete all displayed elements (**Edit | Delete All**)
- Download and import the latest elements from the MPC (**File | Update Comets (online)**)

If you want to [update only those elements that have been improved](#) while retaining unimproved elements, you should:

- Download and import the latest elements from the MPC – elements for comets that are no longer on the MPC Observable Comets list will remain in your database

[Adding Orbital Elements for Newly Discovered Comets](#)

From the **Orbital Elements Manager**, open the **Orbital Elements Editor (File | New)** and enter orbital elements for the new comet. Be sure to check **Favorite** if you want this comet to be included in comet ephemeris and search documents. Click **OK** to save the data.

You can modify the orbital elements for an object by right clicking on it in the **Orbital Elements Manager** and selecting **Edit** from the context menu.

Orbital Elements Editor

Object Name
C/2006 VZ13 (LINEAR)

Epoch of osculation (optional)
Year: 2007, Month: 4, Day: 10.0

Passage through perihelion (T)
Year: 2007, Month: 8, Day: 10.9066

Argument of perihelion (w) in degrees
174.11660

Longitude of ascending node (omega) in degrees
66.02760

Inclination (i) in degrees
134.79380

Eccentricity (e)
1.0001650

Mean absolute visual magnitude (g)
10.5

Perihelion distance (q) in AU
1.015316

Magnitude slope parameter (k)
4

Favorite

Note: Orbital elements are referred to the standard equinox 2000.0

OK Cancel Help

Figure 2: Orbital Elements Editor

Using the Comet Documents to Plan Observations

The two comet document types included in *Deep-Sky Planner* are for 2 distinct purposes.

When you know which comet(s) you want to observe, use the **Comet Ephemeris document** to select these objects and compute ephemerides. Instructions for using the Comet Ephemeris document are in the main help file for *Deep-Sky Planner*. You can open this help page by clicking the **Help** button as shown below.

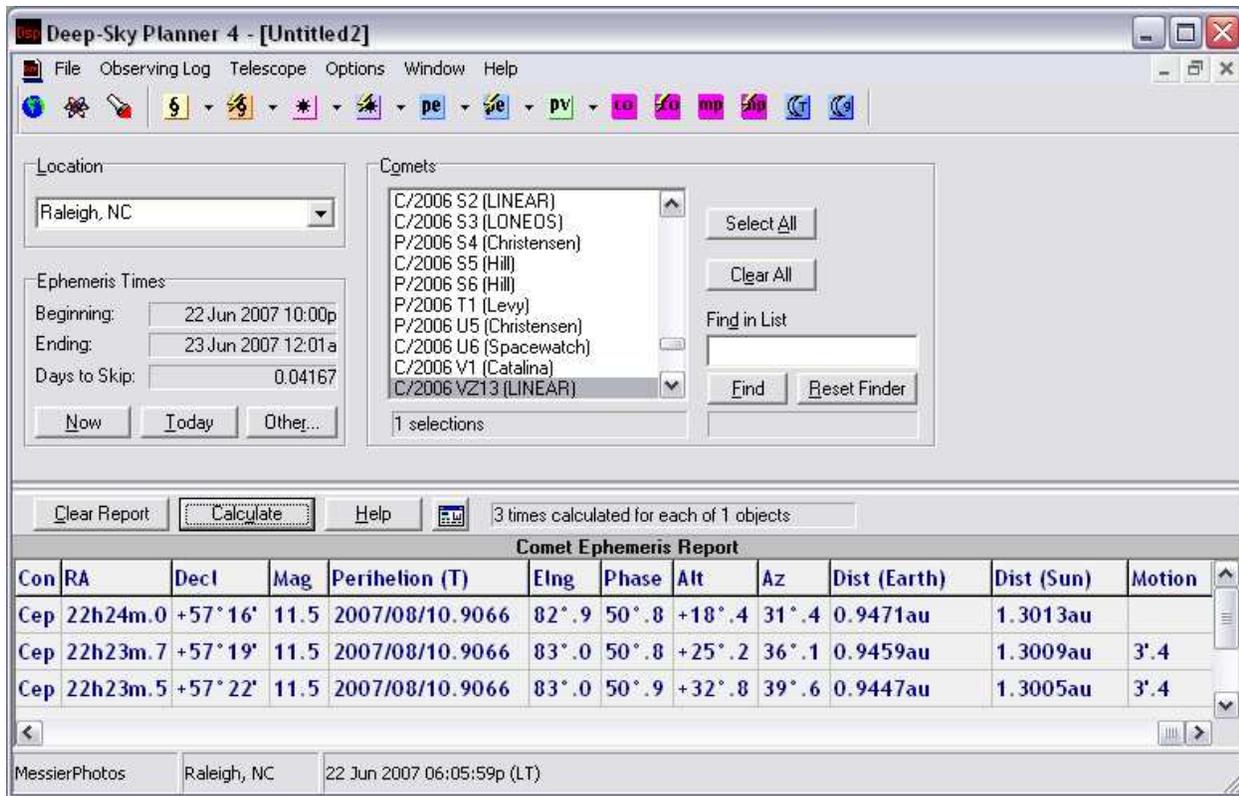
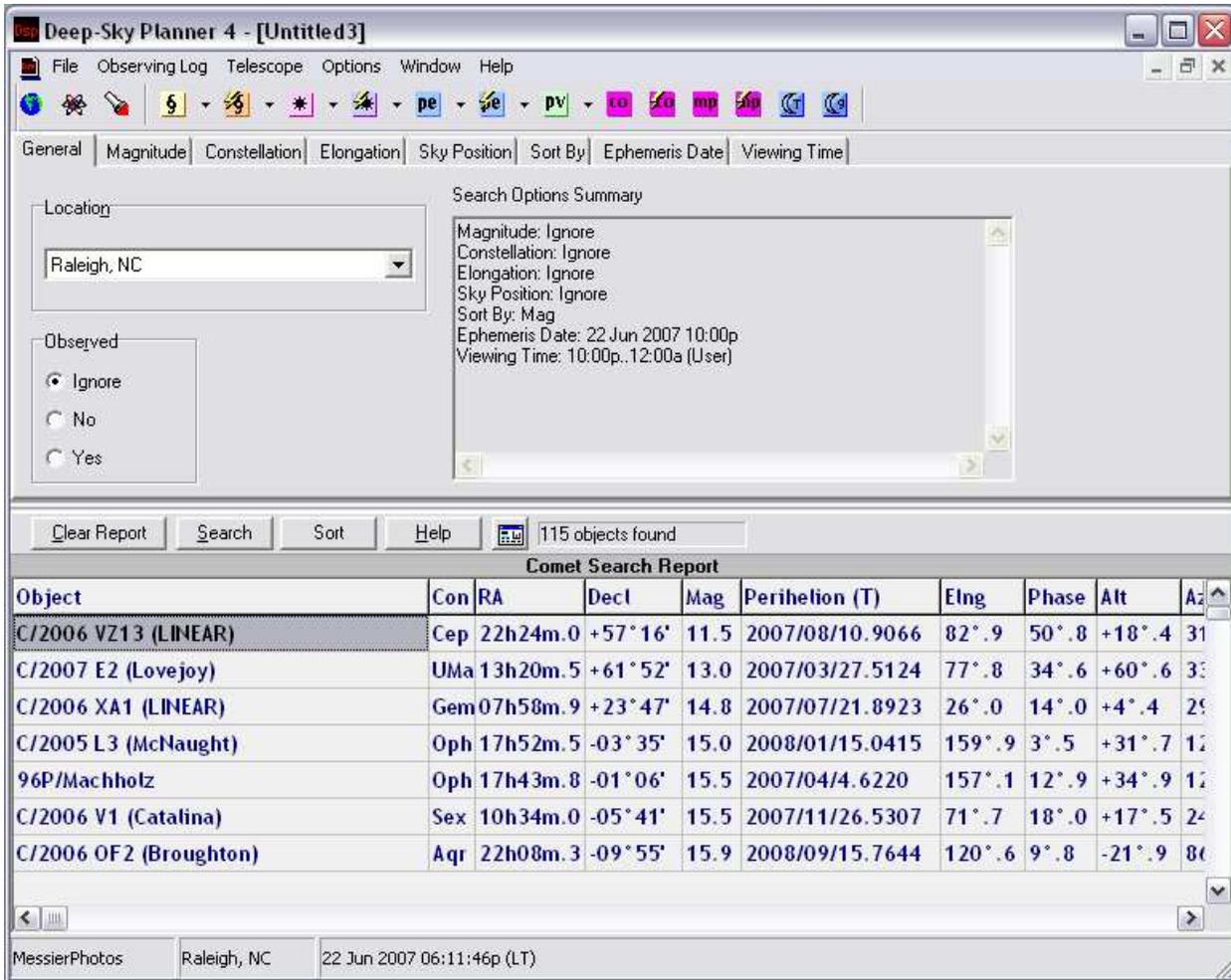


Figure 3: Comet Ephemeris document showing hourly motion of C/2006 VZ13

When you don't know which comet(s) you want to observe, or you are trying to identify an object seen in the eyepiece or an image, use the **Comet Search document** to find object(s) that fit your circumstances. Instructions for using the Comet Search document are in the main help file for **Deep-Sky Planner**. You can open this help page by clicking the **Help** button as shown below.



Deep-Sky Planner 4 - [Untitled3]

File Observing Log Telescope Options Window Help

General Magnitude Constellation Elongation Sky Position Sort By Ephemeris Date Viewing Time

Location: Raleigh, NC

Observed: Ignore No Yes

Search Options Summary

Magnitude: Ignore
Constellation: Ignore
Elongation: Ignore
Sky Position: Ignore
Sort By: Mag
Ephemeris Date: 22 Jun 2007 10:00p
Viewing Time: 10:00p..12:00a (User)

Clear Report Search Sort Help 115 objects found

Comet Search Report

Object	Con	RA	Decl	Mag	Perihelion (T)	Elng	Phase	Alt	Az
C/2006 VZ13 (LINEAR)	Cep	22h24m.0	+57° 16'	11.5	2007/08/10.9066	82°.9	50°.8	+18°.4	31
C/2007 E2 (Lovejoy)	UMa	13h20m.5	+61° 52'	13.0	2007/03/27.5124	77°.8	34°.6	+60°.6	33
C/2006 XA1 (LINEAR)	Gem	07h58m.9	+23° 47'	14.8	2007/07/21.8923	26°.0	14°.0	+4°.4	29
C/2005 L3 (McNaught)	Oph	17h52m.5	-03° 35'	15.0	2008/01/15.0415	159°.9	3°.5	+31°.7	12
96P/Machholz	Oph	17h43m.8	-01° 06'	15.5	2007/04/4.6220	157°.1	12°.9	+34°.9	12
C/2006 V1 (Catalina)	Sex	10h34m.0	-05° 41'	15.5	2007/11/26.5307	71°.7	18°.0	+17°.5	24
C/2006 OF2 (Broughton)	Aqr	22h08m.3	-09° 55'	15.9	2008/09/15.7644	120°.6	9°.8	-21°.9	80

MessierPhotos Raleigh, NC 22 Jun 2007 06:11:46p (LT)

Figure 4: Comet Search document

Orbital Elements for Minor Planets (Asteroids)

The number of minor planets that are cataloged by the MPC with orbital elements available is in the hundreds of thousands. There is a comprehensive data set called the MPCORB that is a tens of megabytes in size and requires a separate FTP client to download. You can read about this at: <http://www.cfa.harvard.edu/iau/MPCORB.html>. **Deep-Sky Planner** can import this file, but because it is so large, performance of all tools becomes very slow. For this reason, Knightware suggests that you use any of the four smaller subsets that suit your interests. These can be downloaded and imported by **Deep-Sky Planner**. If you really want the MPCORB file, you can use it, but be advised that document performance will be quite slow.

- **Bright** minor planets reaching opposition during the current year – these are the most familiar and include Ceres, Pallas, Juno, Vesta, etc.
- **Critical List** – the MPC needs additional astrometric observations for these objects so that their orbits may be refined
- **Distant** – Centaurs and Transneptunian objects
- **Unusual** - including the fast moving Near Earth Objects (NEOs)

Elements for bright minor planets are shipped with **Deep-Sky Planner**. These should be updated at least once a year. The other three sets aren't shipped but can be downloaded and added to the database at any time. Each of these sets contains elements for hundreds of objects.

Like comets, when a new minor planet is discovered, it takes some time to collate observations and reduce them to a reliable set of orbital elements. Elements for new minor planets must be entered manually using the **Orbital Elements Manager** in **Deep-Sky Planner**.

Once you have acquired elements, **Deep-Sky Planner** allows you to control which minor planets' elements are displayed in the **Orbital Elements Manager**. First click the **Minor Planets** tab on the left edge of the **Orbital Elements** pane then click one of the buttons at the top of the pane:

- **All Objects** shows data for every minor planet in the database
- **Bright Minor Planets** shows just the objects whose elements were added from the MPC's Bright Minor Planets file
- **Critical List** shows just the objects whose elements were added from the MPC's Critical List Minor Planets file

- **Distant** shows just the objects whose elements were added from the MPC's Distant Minor Planets file
- **Unusual** shows just the objects whose elements were added from the MPC's Unusual Minor Planets file
- **My Objects** shows just the minor planets whose elements were added manually by you

Getting Orbital Elements for Minor Planets

Open the **Orbital Elements Manager (Options | Orbital Elements Manager)** and select the **Minor Planets** tab on the left edge of the **Orbital Elements** pane.

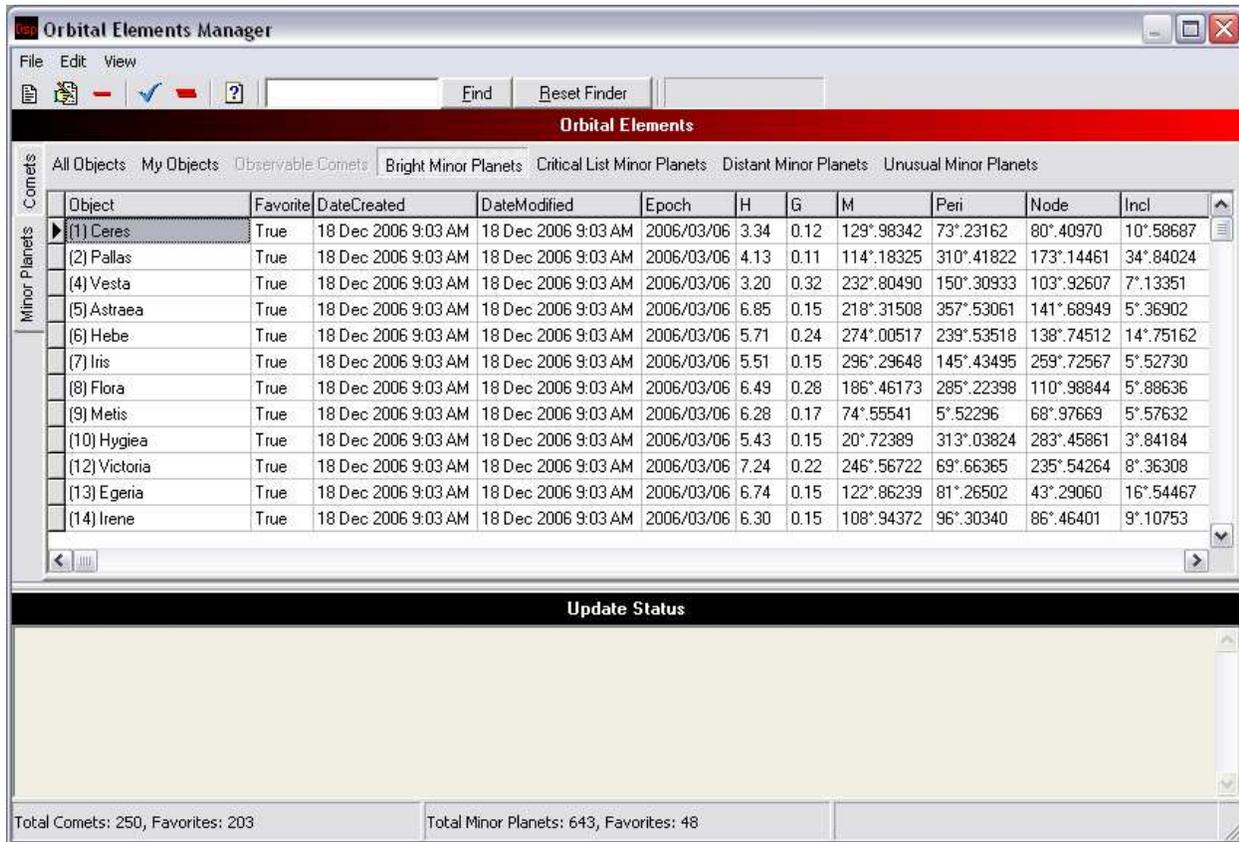


Figure 4: Orbital Elements Manager showing bright minor planets only

The **Epoch** column shows the date for which the parameters are correct. The MPC computes elements for a new Epoch about once a year, so if your elements are over a year old, you should download a new set of elements (see below.)

The **Date Modified** column shows the date that the parameters were added to or changed in the database. This tells you when you last updated elements for a specific object.

The **Favorite** column shows whether a minor planet appears in the selection list of a Minor Planet Ephemeris document, or whether it is included in a database search of a Minor Planet Search document. Eliminating objects from a database search document improves performance. You can use the **Favorite** item to retain a minor planet's orbital elements for future use while excluding it temporarily from database searches and ephemeris calculations.

If you want to [completely refresh elements for all minor planets](#), you must display all minor planets (click the **All Objects** button at the top of the **Orbital Elements** pane) and delete them before downloading new elements. If you want to [completely refresh elements for a single set of minor planets](#), you must display only that set of minor planets (click the appropriate set's button at the top of the **Orbital Elements** pane) and delete them before downloading new elements. The remaining discussion uses the Bright Minor Planets set, but the technique applies equally to any of the other three sets.

- Select the **Bright Minor Planets** button at the top of the **Orbital Elements** pane to display only those objects
- Delete all displayed elements (**Edit | Delete All**)
- Download and import the latest elements for bright minor planets from the MPC (**File | Update Minor Planets (online) | Bright Minor Planets**)

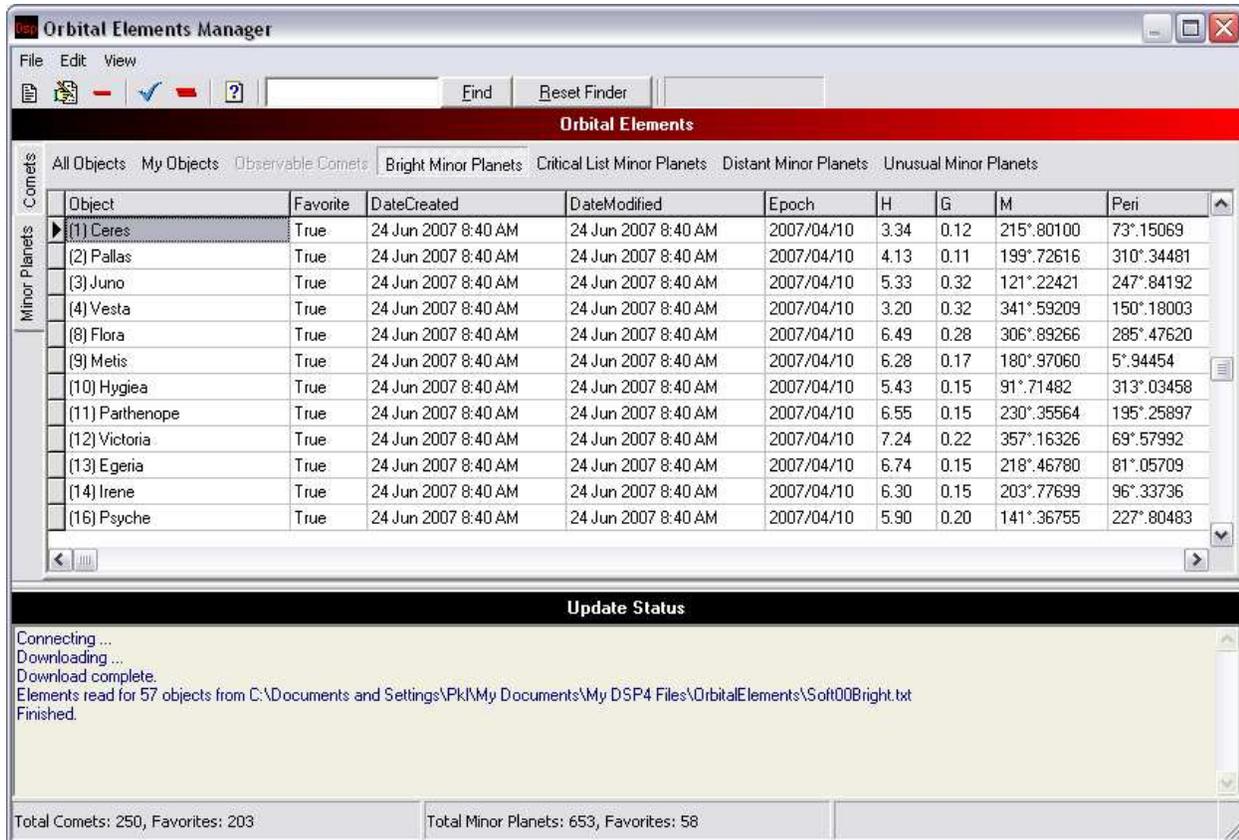


Figure 5: Results of updating only Bright Minor Planets

If you want to [update only those elements that have been improved](#) while retaining unimproved elements, you should:

- Download and import the latest elements from the MPC – elements for minor planets that are no longer in the MPC update file will remain in your database

[Adding/Editing Orbital Elements for Newly Discovered Minor Planets](#)

From the **Orbital Elements Manager**, open the **Orbital Elements Editor (File | New)** and enter orbital elements for the new minor planet. Be sure to check **Favorite** if you want this object to be included in minor planet ephemeris and minor planet documents. Click **OK** to save the data.

You can modify the orbital elements for an object by right clicking on it in the **Orbital Elements Manager** and selecting **Edit** from the context menu.

Orbital Elements Editor

Object Name
[433] Eros

Epoch of elements
Year: 2007 Month: 4 Day: 10.0

Mean anomaly at epoch (M0) in degrees
104.01106

Argument of perihelion (w) in degrees
178.67687

Mean motion (n) in degrees per day
0.55970372

Longitude of ascending node (omega) in degrees
304.38082

Semimajor axis (a) in AU
1.4582453

Inclination (i) in degrees
10.82906

Eccentricity (e)
0.2227452

Mean absolute visual magnitude (H)
11.16

Magnitude slope parameter (G)
0.46

Note: Orbital elements are referred to the standard equinox 2000.0

Favorite

OK Cancel Help

Using the Minor Planet Documents to Plan Observations

The two minor planet document types included in **Deep-Sky Planner** are for 2 distinct purposes.

When you know which minor planet(s) you want to observe, use the **Minor Planet Ephemeris document** to select these objects and compute ephemerides. Instructions for using the Minor Planet Ephemeris document are in the main help file for **Deep-Sky Planner**. You can open this help page by clicking the **Help** button as shown below.

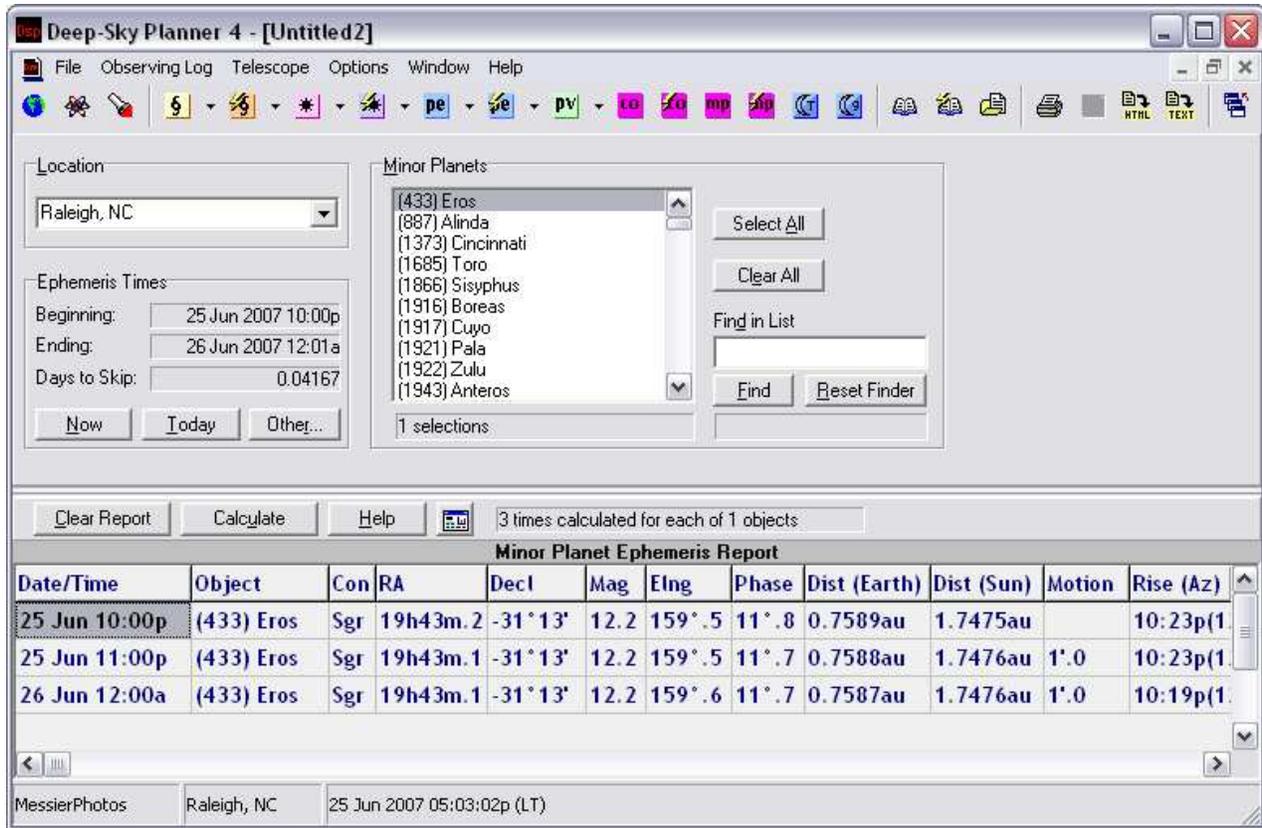


Figure 6: Minor Planet Ephemeris document for (433) Eros

When you don't know which minor planet(s) you want to observe, or you are trying to identify an object seen in the eyepiece or an image, use the **Minor Planet Search document** to find object(s) that fit your situation. Instructions for using the Minor Planet Search document are in the main help file for **Deep-Sky Planner**. You can open this help page by clicking the **Help** button as shown below.

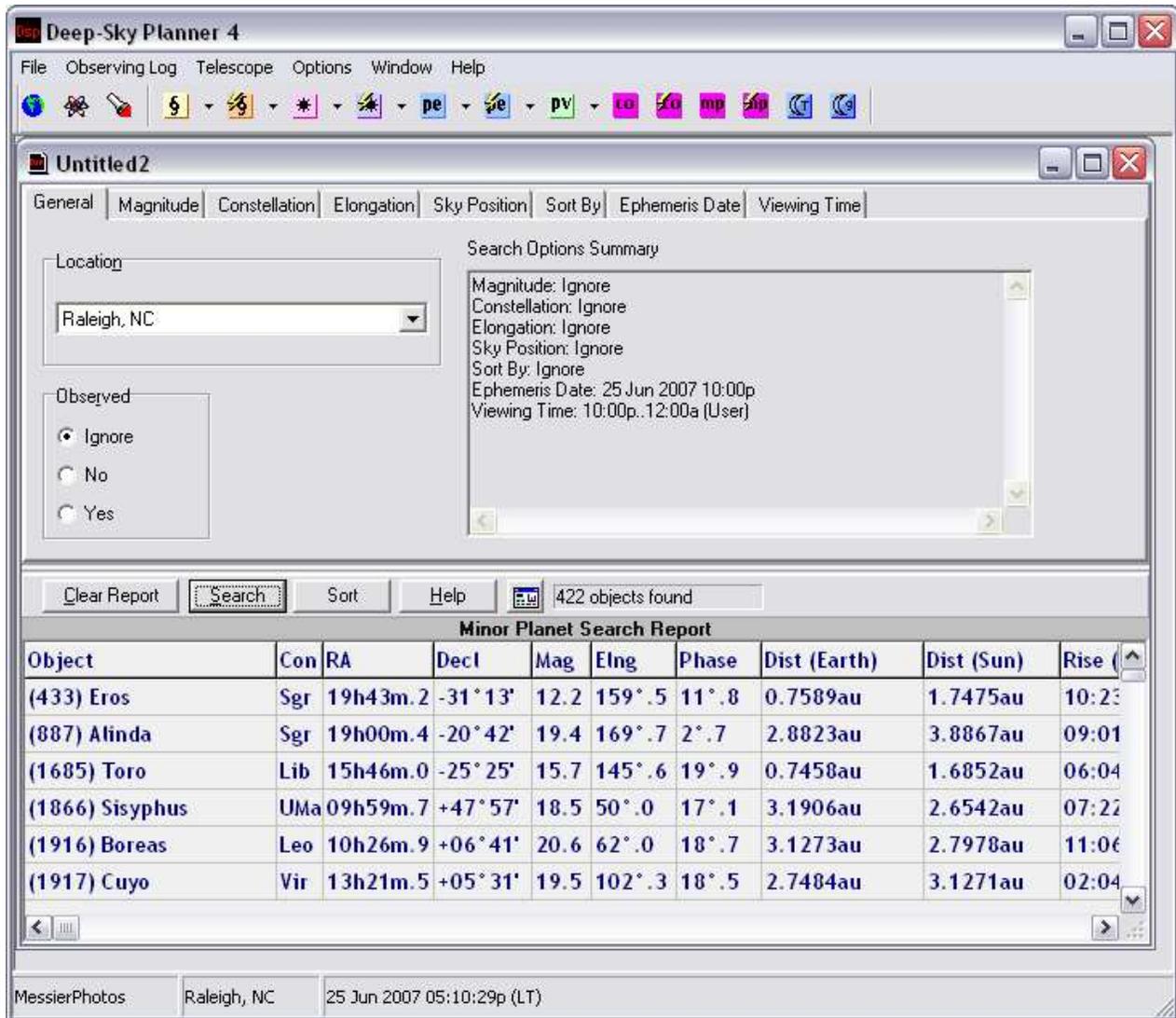


Figure 7: Minor Planet Search document