**Tutorial - Using Occult for (Total) Lunar Occultation prediction, reporting and analysis.**
Dave Gault

**Introduction**
There are many reasons to observe lunar occultations, and may include; a simple desire to observe stars disappear or reappear at the lunar limb as the Moon orbits the Earth, to have your observations added to the archive of lunar occultation observations – that dates from 1623, to observe double stars during lunar occultation and perhaps to test the accuracy of your equipment and technique.  Considering the latter case, it's much better to work the Gremlins out of your gear and techniques by observing lunar occultations, than to try and perhaps mess up a likely asteroid occultation.

Occult provides the means to create a list of predictions unique for your site and telescope for a night of observation, or a list of predictions for any time period desired.  It also offers the means to create and observation report and will give immediate indication of the accuracy of your observations.

This document does not however include methods to extract event times from recordings.

**Updating Occult**
This tutorial does not cover the installation of Occult, however the task of keeping Occult up to date is essential for accurate predictions and analysis, so I'll briefly mention it here.

Occult requires access to the internet to download various information from a host of different sites, and most of the required downloads can be found on the one form.

Click on the "Maintenance" tab, then Click on the "General downloads" button.

Shown here is the top of the form.
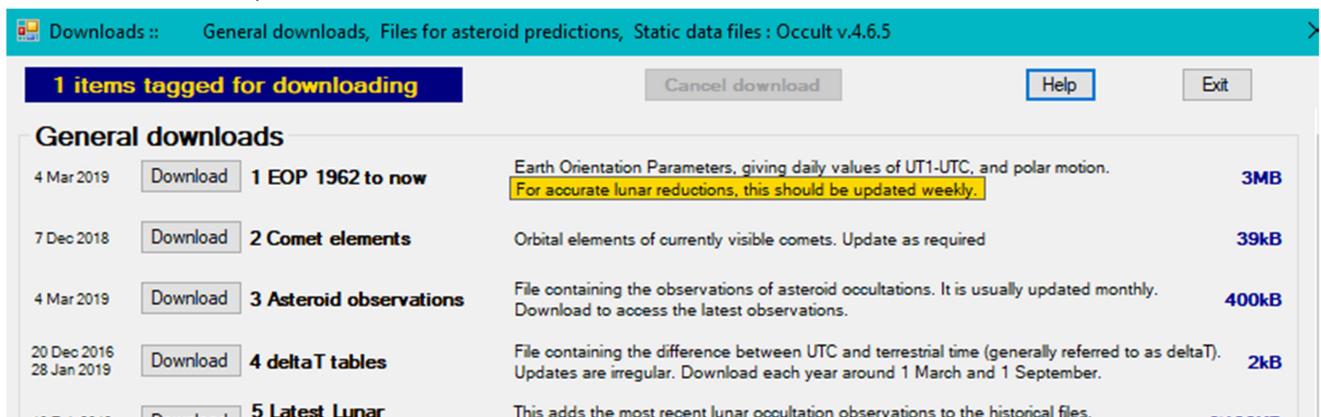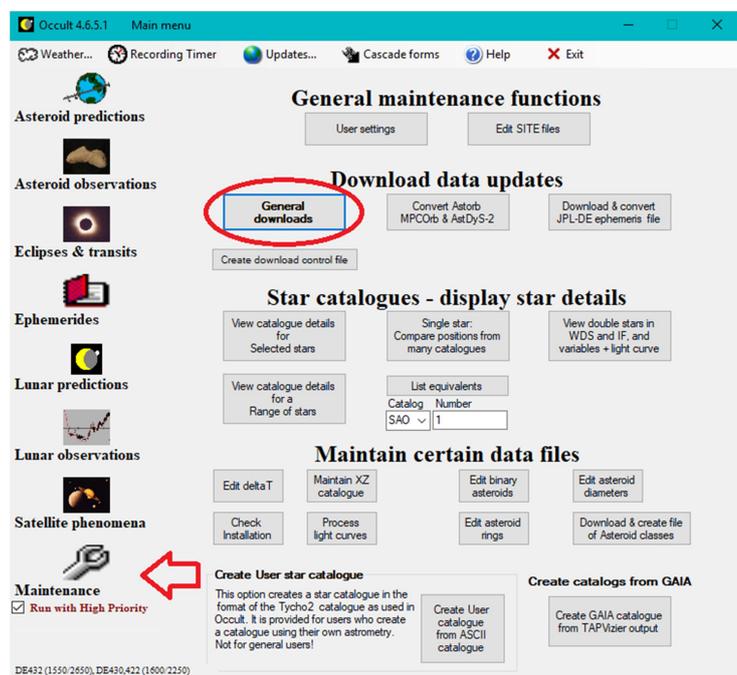




All items are numbered from 1 to 42.
On the left is the date of the last download, then the download button, the item#, the title of the download, a description, and finally the download size.
From time to time, you will see a **>>** symbol next to one or more items.  This means the file needs updating so it's best to do so straight away.
The items required for lunar occultations are #1, 4, 5, 12, 14, 15, 16, 17, 26, 27, 28, 31, 33, 34.

## Occult Site File

Occult needs to know your geographic location and basic information about your telescope, contained in a site file.

You can either choose to:-
- Modify an existing site file by adding an entry for your site
- Create a new site file completely with one site details or multiple site details – as many as you wish.
-

I'll choose to describe the first option.



Click on the "Maintenance" tab, then Click on the "Edit SITE files" button.
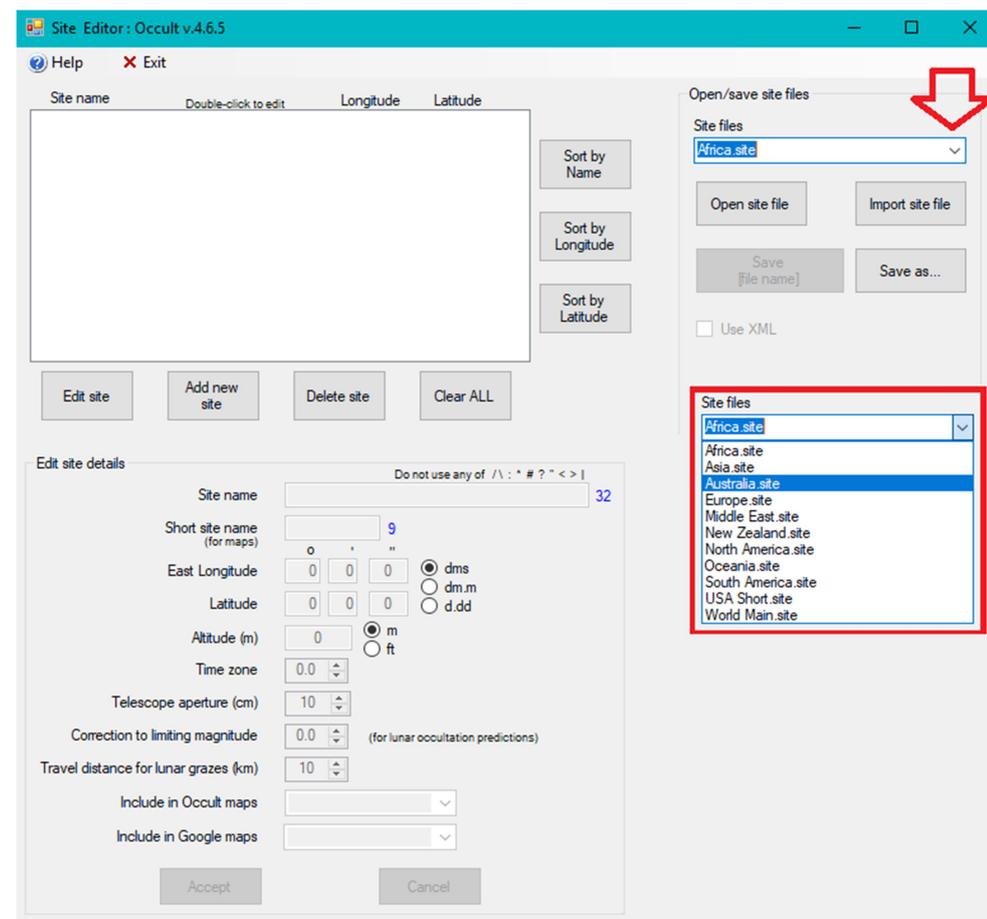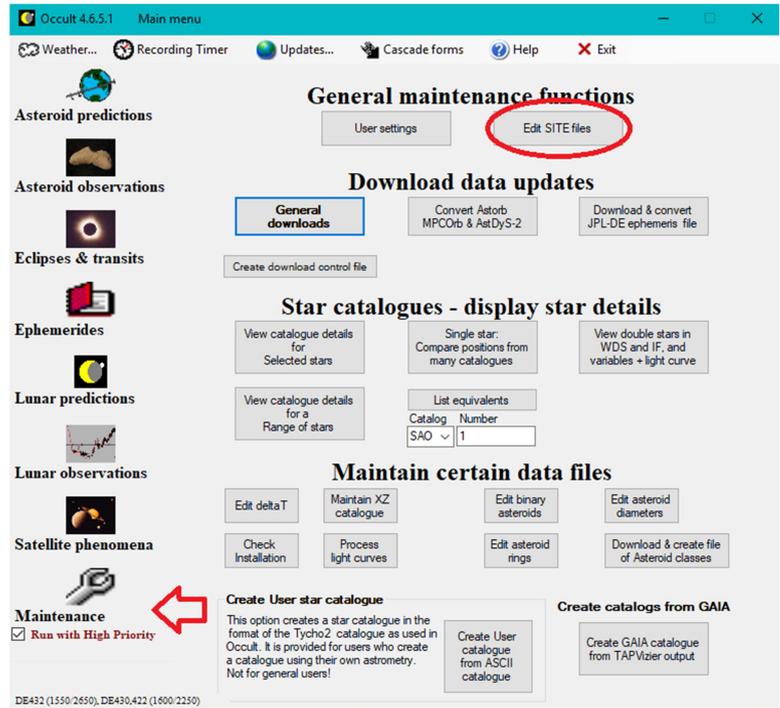


Click in the little check and a list of site files will appear.

Click on an appropriate file. I live in Australia so that is appropriate for me. Your mileage will vary.

Then click the "Open site file" button.

Continued…

… Occult Site file – continued.
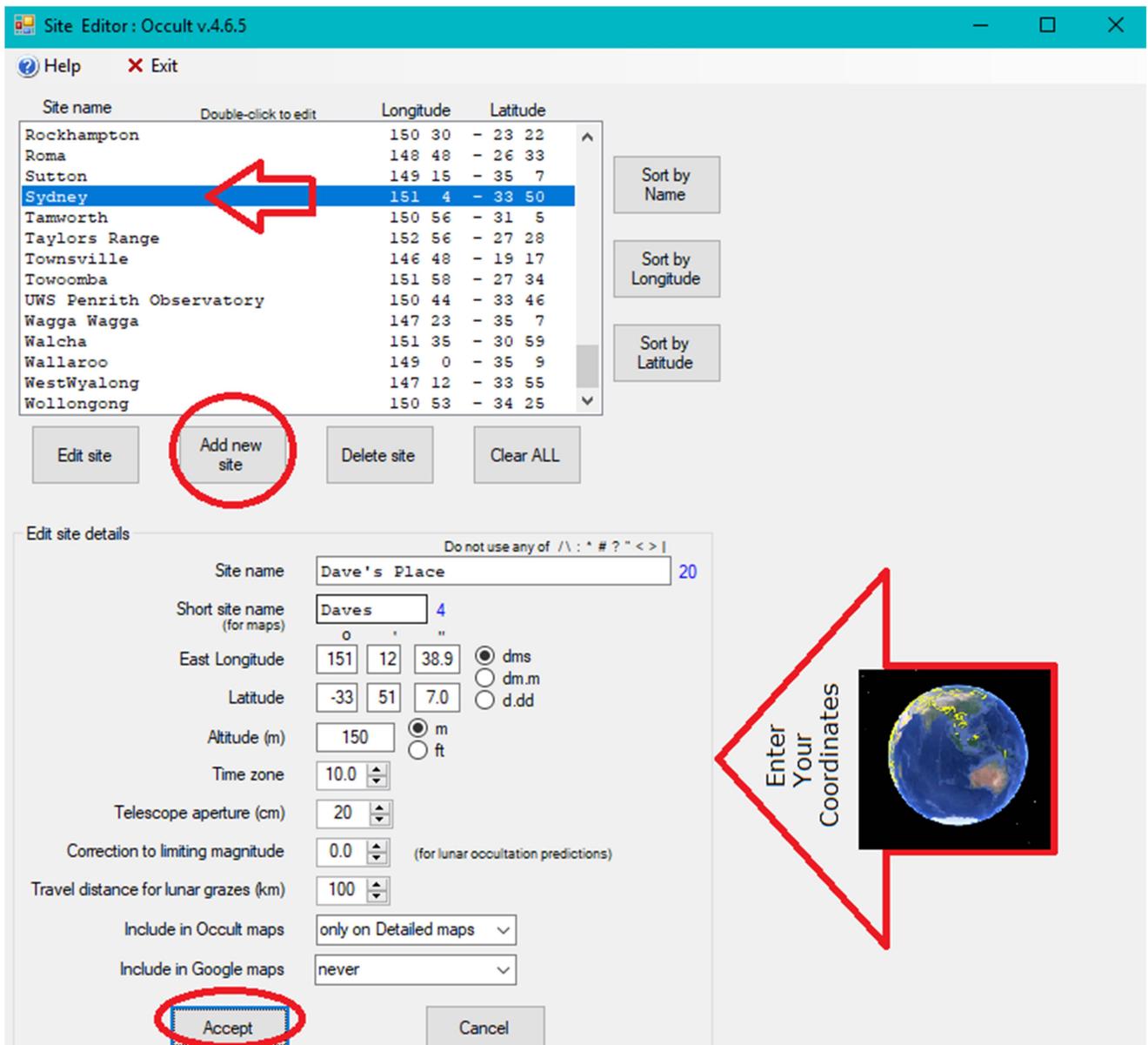


Search for a nearby town or city. You may be tempted to be satisfied choosing (in my case) Sydney, but we need to input your exact site coordinates (latitude, longitude and Altitude).

The Datum required is WGS 84 for latitude and longitude, and Mean Sea Level (MSL) for altitude. Luckily most GPS receivers have this set as default as does Google Earth.

1) Once you have found you nearby town, click on it.
2) Click "Add new site" button. This will insert the selected town coordinates into the Edit site details area of the form – as a template.
3) Type over what's there with your details
    a. West longitude is negative
    b. South latitude is negative
4) Click accept.
5) Click Save "SiteFileName" button

Note:

If the site details you have just created is a site you'll use frequently, then the next section will describe how to set                                        that site as default "set home" and "use home".
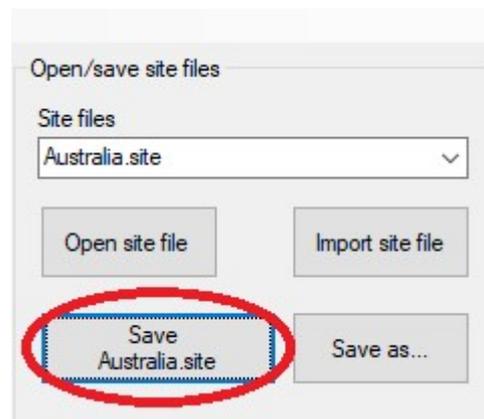
**Lunar Predictions – for single (your) sites**



Click the Lunar predictions tab
Click the Predictions for single sites button.
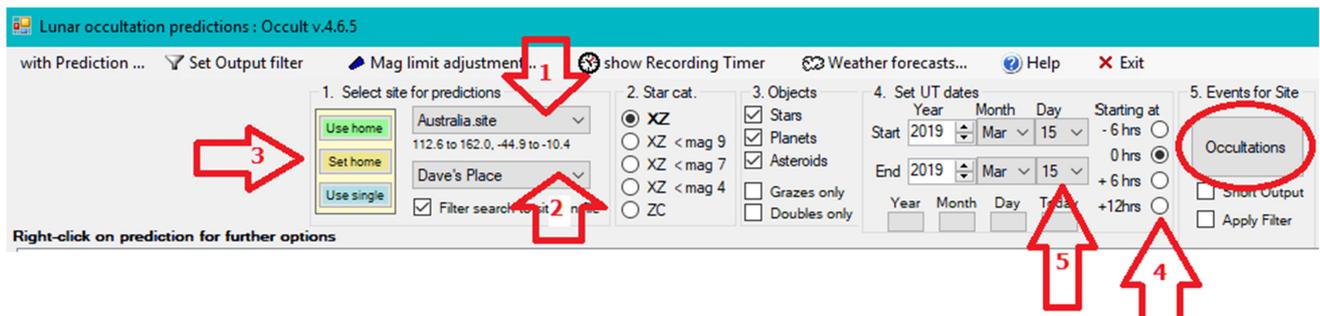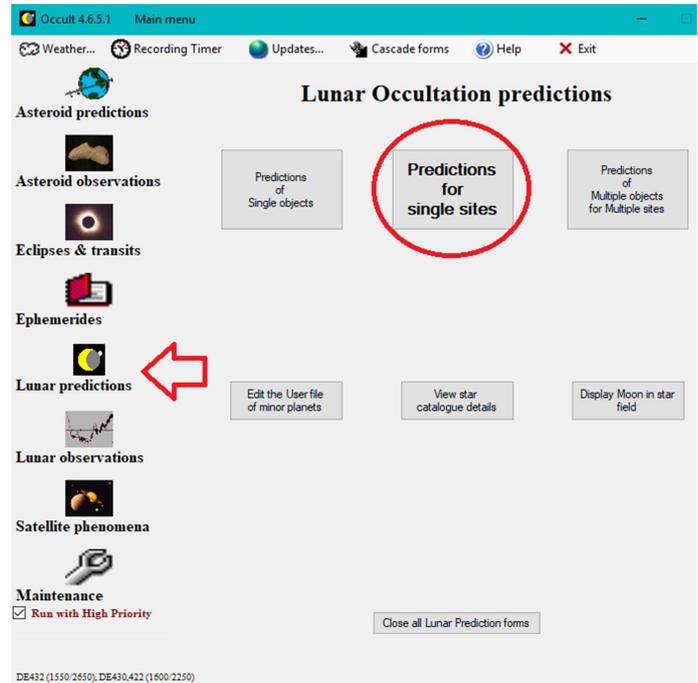


| Start Hour | Regions/countries |
|---|---|
| -6 | North and South America, including all of Canada, USA (except for Alaska and Hawaii), Mexico, Argentina, Brazil |
| 0 | Oceania (including Hawaii), Alaska, New Zealand, eastern states of Australia |
| 6 | Asia (including Japan), Western Australia, India, Iran |
| 12 | Europe, Africa, Middle East |

Setup the Lunar occultation Prediction form:-
1) Choose the site file you just edited.
2) Choose the site you just created.
3) If this is a site you use frequently, you can set this as a default home site.
4) Select an appropriate "Starting at" button for your region of the globe.
Note:- Occult will remember these settings for the next time.
5) By default Occult will display the current UTC day date. Adjust as required.
6) Stand back, and click Occultations Button.
Occult will generate predictions unique for your site. Shown here is the form header.

```
Occultation prediction for Dave's Place
E. Longitude  151 12 38.9,  Latitude -33 51  7.0,  Alt.  150m;  Telescope dia 20cm;  dMag 0.0

      day  Time      P   Star  Sp  Mag  Mag    % Elon Sun  Moon   CA  PA  VA  AA Libration    A   B   RV   Cct durn  R.A. (Appnt)   Dec    Mdist   SV
y    m  d  h  m    s       No   D    v    r V  ill     Alt Alt Az   o   o   o   o  L    B    m/o m/o  "/s    o sec  h  m   s     o  m   s   Mm    m/s
```

The first time you list predictions, check the site coordinates are correct. Occult will then list event circumstances for every star viewable using your telescope.
- Event times are listed in UTC
- Star identifier is listed heiretically by ZC, SAO or XZ identifiers.
- You can adjust the list by selecting different buttons under the Star cat. Area, or by agjusting the Mag. limit adjustment menu, or by using the Set output filter menu.

You can print the list as-is, but before you do that, I'll show you what I do for a night's observing. Cont…

I think it is important to take out to the telescope a one page printout, that can be used to find the stars on the lunar limb, in the order that the events will occur.  You can use this form for notes, and for any calculations required to determine event times.  Here is what I do;

- R-click on the first event listed a menu will appear.
- Choose menu item – Moon map.
  - Choose the orientation that suits.  I like South UP and non-mirrored. Your mileage may vary.
- R-click on the map and choose an appropriate number of stars to display.
- Using the "with Map" menu, choose Copy…
- And paste this into a horizontal formatted Word (or similar) Document
- Go back to the predicted list and using the "with Prediction" menu, choose Copy all…
- And paste into the document.  You may have to choose a small font to fit everything actoss the page.

This is taken to the telescope.  Here's what a typical observing run form looks like after LiMovie analysis.



This is what I do, and all my observations going back nearly 20 years are in ring binders for easy reference. The message here is not necessarily to copy what I do, best is to suit yourself but be systematic is the recomendation.

This neatly side steps the actual analysis of the video, which is outside this tutorial anyway.

However I use IOTA-VTI timestamped analogue video, mostly analysed using LiMovie for lunar events.  For the events listed, I used a Watec 910BD camera, which has a Instrument Delay (ID) which must be subtracted from the time-stamp.  Other cameras may have a different ID.

**Lunar Observations – Creating an observation report.**

Once you have your event timings, the next task is to create an observation report.



Click the Lunar Observations tab
Click the Add/Edit/Plot observed Lunar Observations button.
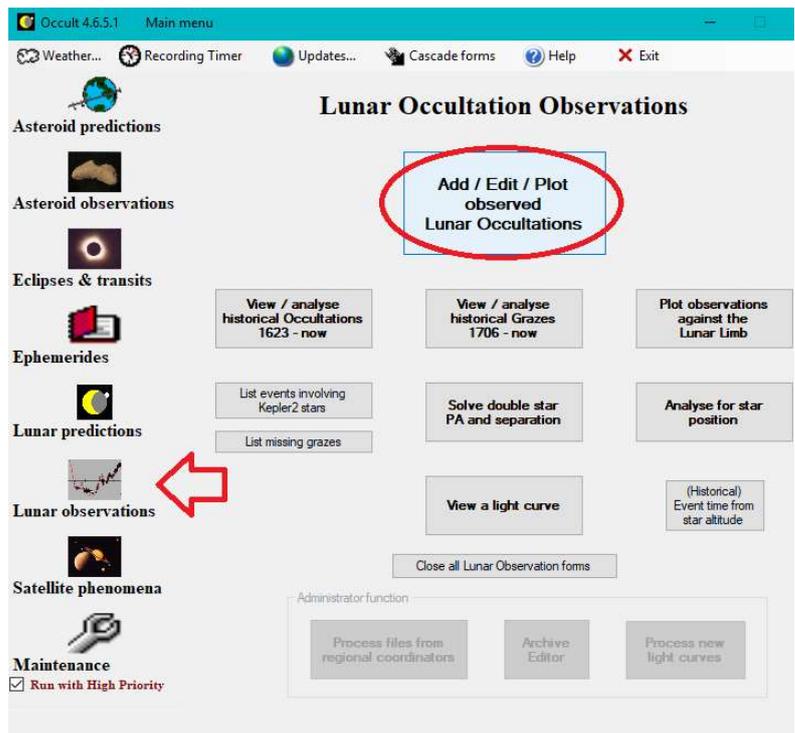
LunarObservatin Report - Header
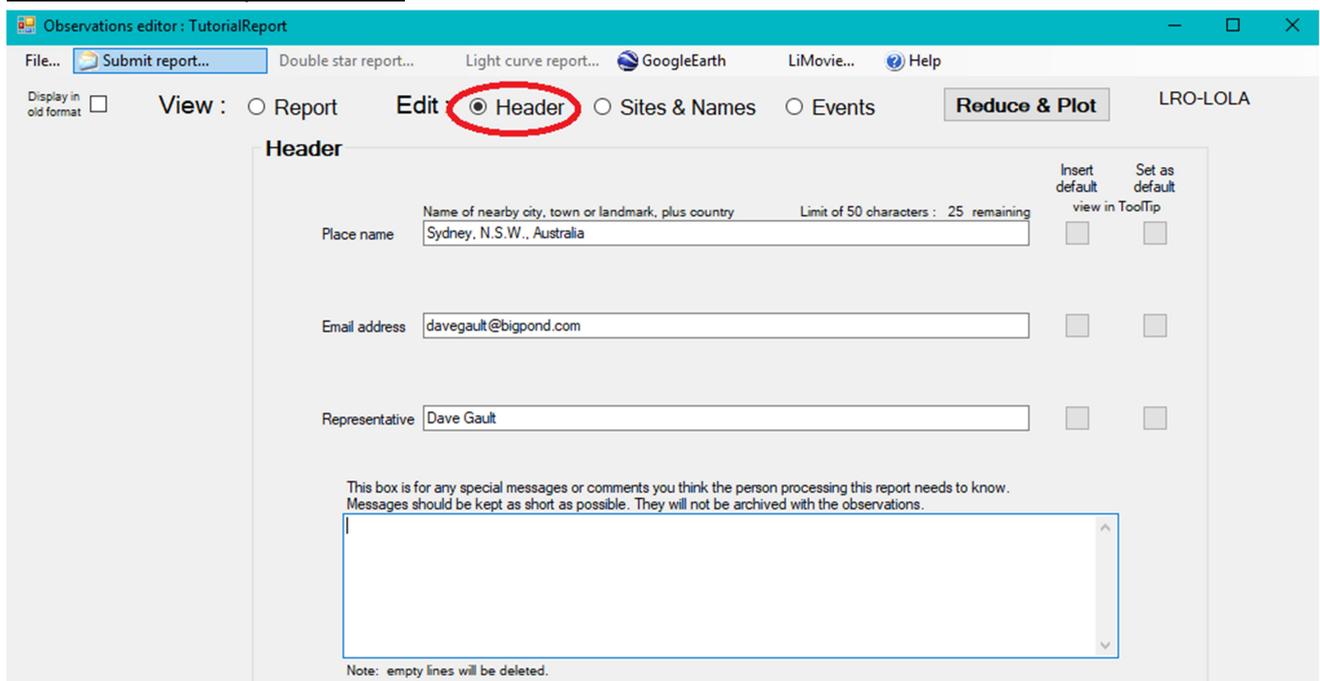


Enter the following information
- Place name - the name of the closest town or city. You can enter something like Daves Observatory, so long as you also include a nearby town or city. This will be archived.
- Email address – for correspondence with the Regional Collector.
- Representitive – the name of the person responsible for this observation report. In the case of a graze observation report, then this will be the graze leader.

You can set and retrieve default information.

At this point you should save the file by giving it a name, eg. 201901Gault.txt – that is the observation report for events observed in January 2019.

LunarObservatin Report – Sites & Names



Enter the following information
- your observation site coordinates
- your telescope details – note:- in centimeters (cm)

Make sure you click - Add as new site
- your name in the format:-  G. Fnnnnn where G is your Given name and Fnnnnn is your Family name.
- your email address, it may be the same as that in the header, or it may be different.

Make sure you click – Add as new name.

Use the File menu and save the file.

A graze observation will have many site coordintates listed as well as well as observer names and their email addresses.

An observer can list their favourite sites that they observer from frequently, and set up a template form.

LunarObservatin Report – Events
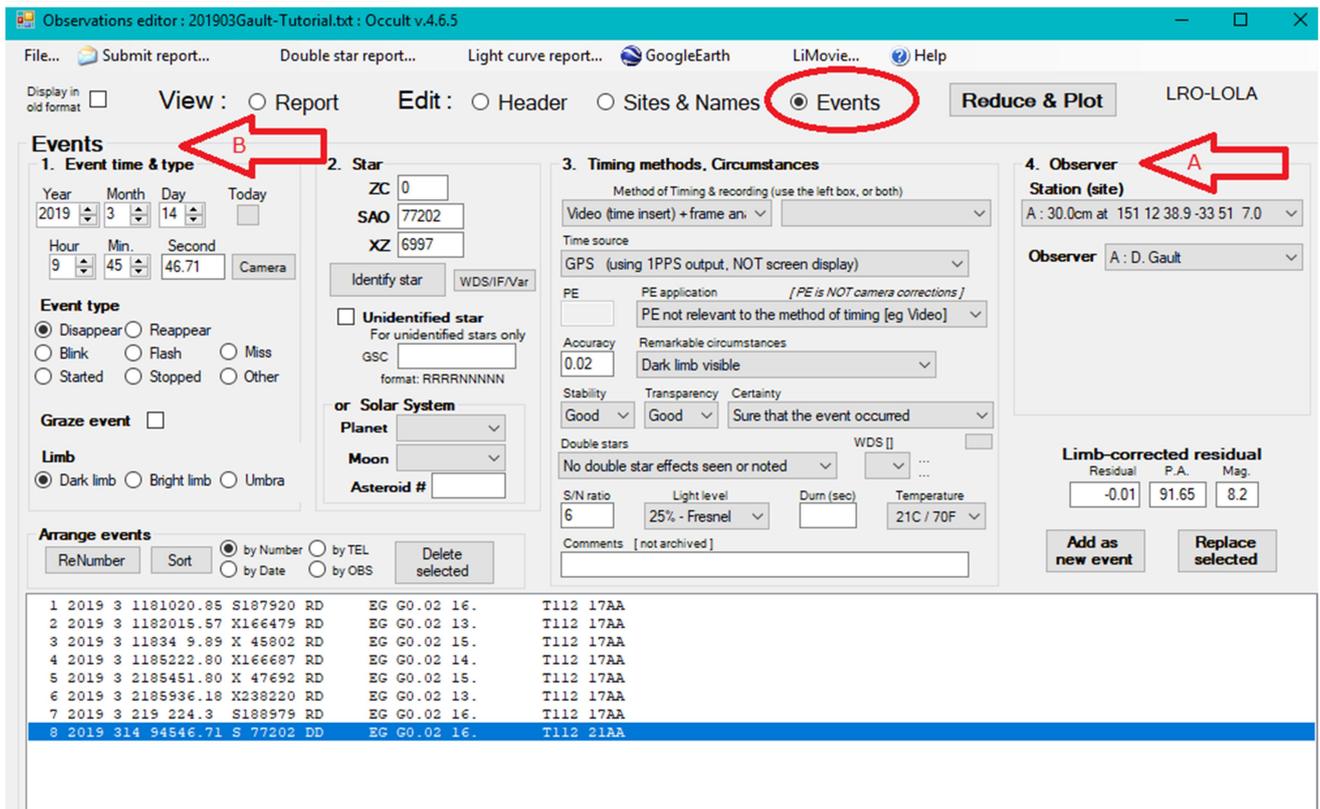


Shown here is a typical observation report. Note:

- Events 1-4 are four reappearance events observed on the 1st March
- Events 5-7 are three reappearance events observed on the 2nd March.
- The highlighted (blue) event is and event observed last night and has been just entered, that we will now discuss in detail.

A) Despite the layout of the form, it's best to set (or ensure it is correctly set) section 4) Observer Site and Name codes, created or edited on the previous Sites & Names form.

B) Move to section 1) Event time and type, and tab through the following steps:-
   a. enter the date If the UTC date is still current, click th Today button.
   b. Enter the time of the event with camera and VTI Instrument Delay(ID) already subtracted,
   c. Click on the Radio Button to select Event Type. Disappearance or Reappearance.
      i. Blink, Flash, Miss, Started, Stopped and Other are for Graze reports.
      ii. As is the Graze event check-box.
   d. Click on the Limb type Radio Button. Generally, Bright limb events have little scientific value, due to the glare present at the bright limb.

   Section 2) Star
   e. Enter the star identifier #. However, to prevent miss-typing errors, simply click on the Identify Star button. If the date, time and Event type (disappear or Reappear) are correct, Occult will list candidate stars. Double click on the appropriate star ID.

   Section 3) Timing Methods and Circumstances.
   f. Tab through to and use the menu pull-downs to enter information that best describes your timing equipment and event circumstances.
   g. When you are done, click - Add as new event
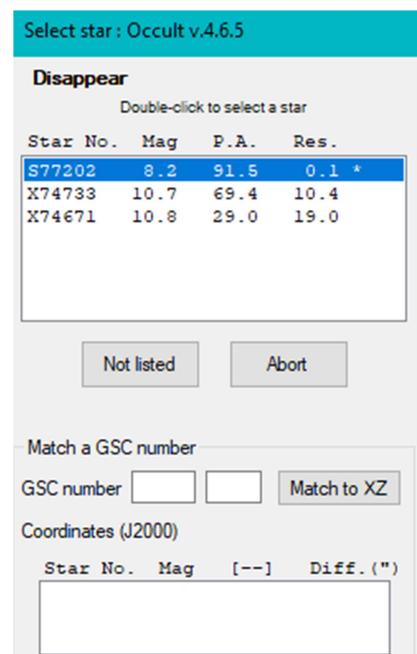
h. Any line can be edited by clicking on the line, correcting the information and then click – Replace selected button

C) Use the File menu and save the file.

   a. Note the Limb-corrected residual value. This will usually fall within the range +/- 0.10". Occassionally the Residual can be a little larger, usually caused by poor star positions, or associated with components of double stars. Values greater than 0.2" usually indicates; there is an error in the date or time, or in the star number; or if the star is a double star, that the reduction has not been corrected for the component; or the occultation was missed - usually as a result of the observing conditions.

D) Double Star events.

   a. A double star observed during lunar occultation will produce a stepped light curve.
   b. Times for each component can be obtained.
   c. A separate entry is then created listing the time for each component,
   d. Circumstances fields 'Double Stars' and 'WDS' are used to describe each component.
   e. In addition, a Double Star Report should be created and sent to the Double Star coordinator, (currently Brian Loader) however the creation of this report is outside the scope of this tutorial and should probably be a tutorial in it's own right.



150
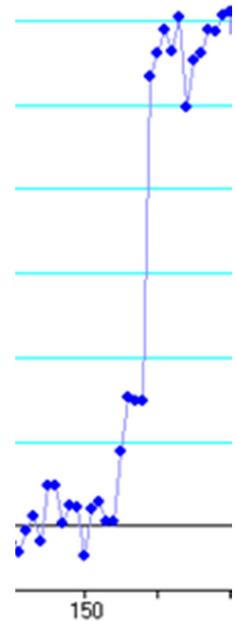
**Reduce and Plot**



Click the Reduce and Plot button at the top of the Observations Editor. Occult will process your observations and produce a List of occultation residuals form.
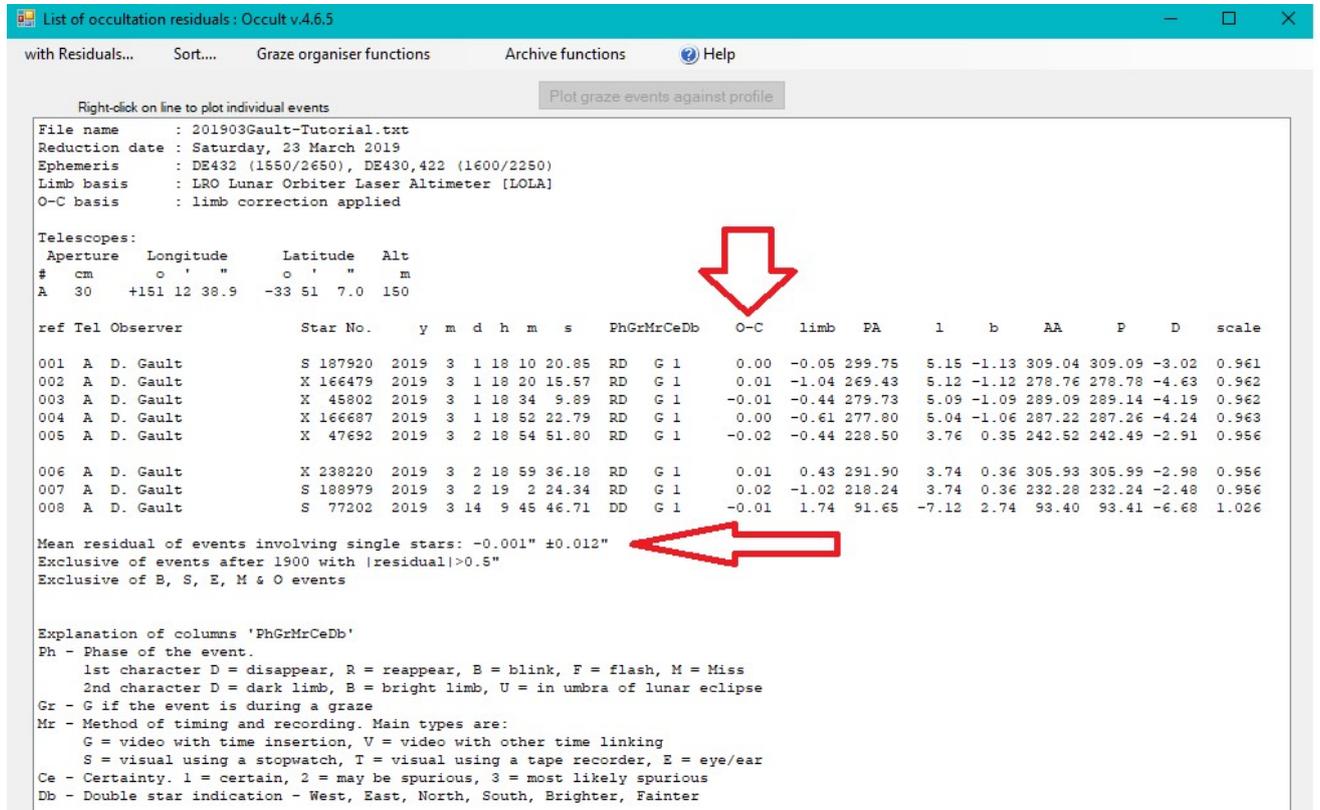


Take note of the O-C column.

If you have an individual event with a residual 0.2" (arc seconds) means that event probably has an error.

Take note of the statement:- Mean residual of events involving single stars.

A highly experienced visual observer typically has a mean (~50) residual of around 0.030" +/- 0.070"

A video observer typically has a mean (~40) residual of 0.010" +/- 0.010"

If you have Mean results larger than 0.030" (arc seconds) means you have serious errors in your equipment and/or technique.