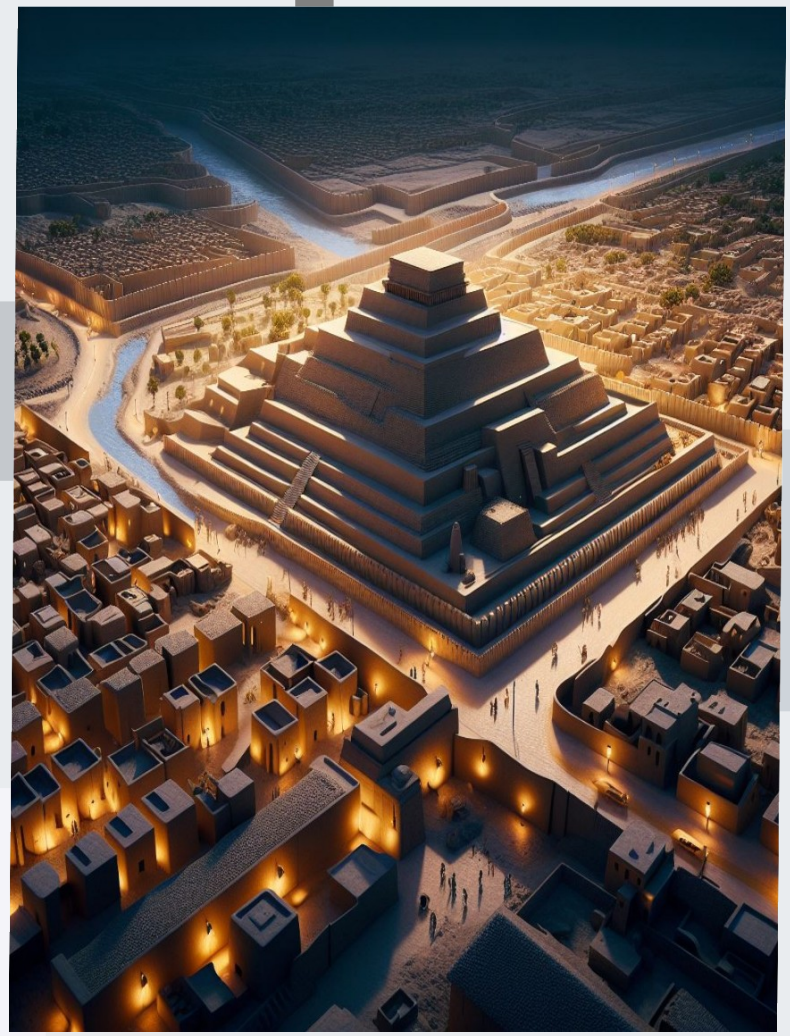
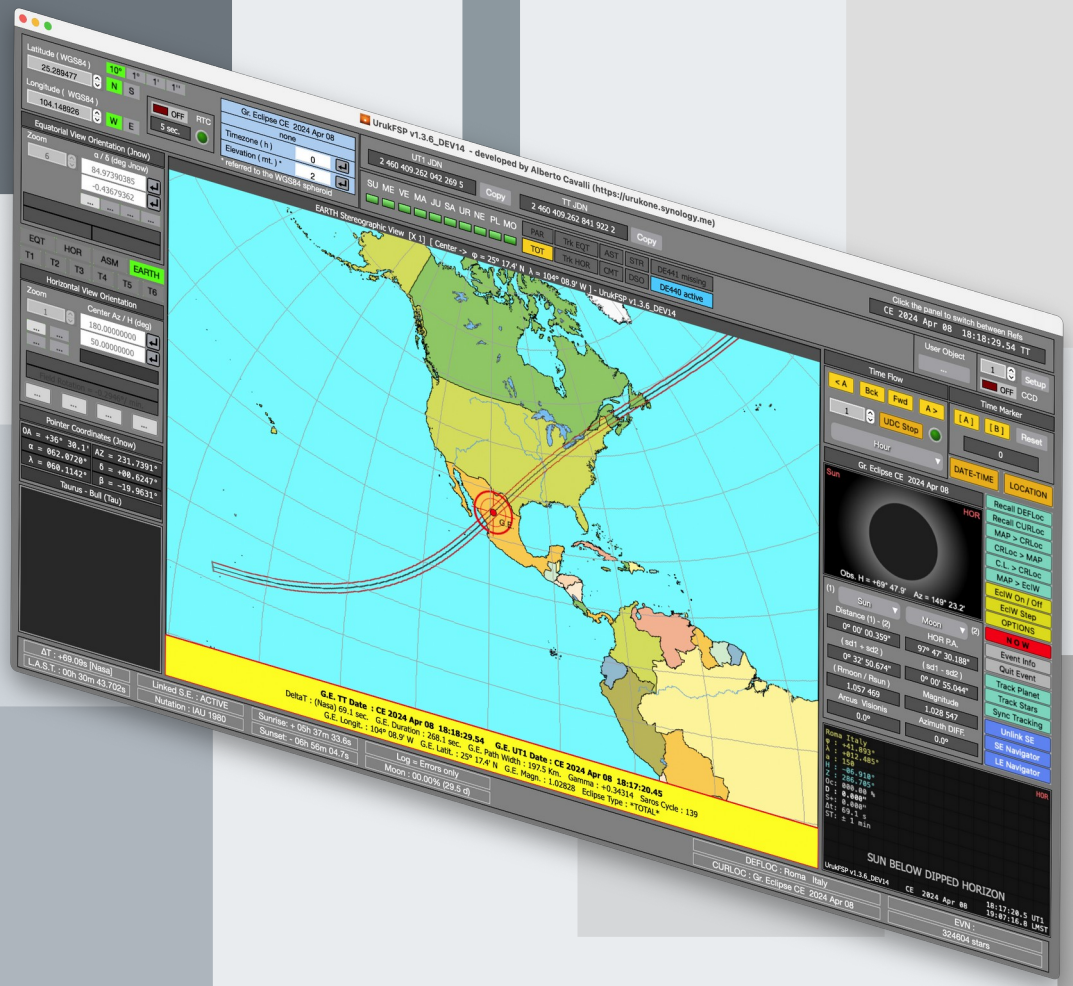




UrukFSP 1.4.1

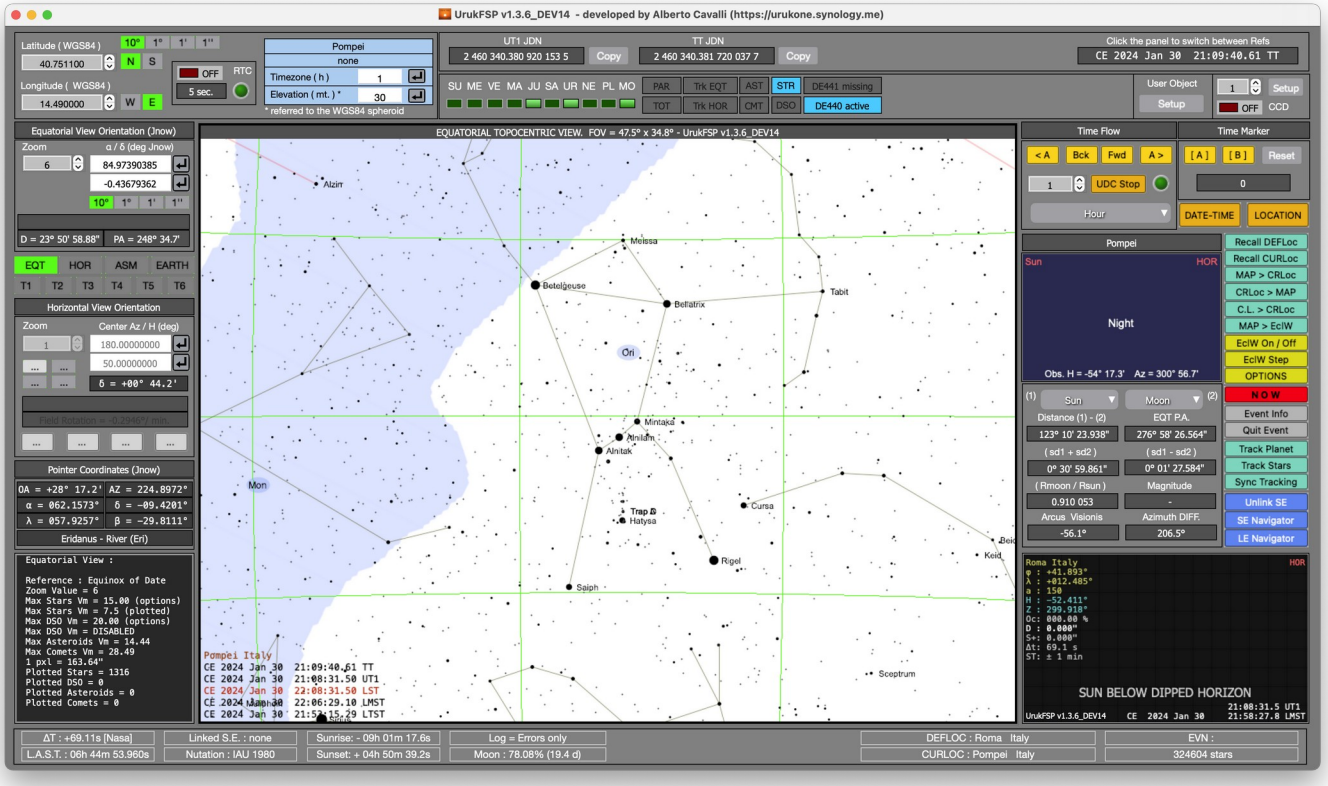
Tool for Archaeoastronomy

F*ree* **S***oftware* **P***roject*

Author : Alberto Cavalli

Project start : 2020

Hardware and OS requirements:



MacOS 64 bit
Linux 64 bit
Windows 64 bit

Display min. resolution:
1366 x 768 px

Minimum RAM:
4 Gb

CPU : >= Intel I3
HDD : SSD recommended
Disk space : 3-4 Gb

Freely downloadable from website : https://urukone.synology.me

Dynamic models used:

Solar System : Jet Propulsion Laboratory – Numerical Integrations DE440 and DE441

- Apparent Solar Orbit
- Earth
- Mercury
- Venus
- Mars
- Jupiter
- Saturn
- Uranus
- Neptune
- Pluto
- Moon
- Nutation Model IAU 1980
- Solar System Barycenter. (SSB)

DE440 - from 1649 CE to 2550 CE
DE441 – from 13000 BCE to 17000 CE (needs files downloaded from UrukFSP's website)

DE440 and DE441 represent the state of the art among the dynamic models describing the Solar System Planets' motion.

Comparison with NASA JPL Horizons at 9000 BCE:

UrukFSP 1.3.4 2023 Aug 18

9000 BCE GEOCENTRIC DE441
JANUARY 01
00 TT PROLEPTIC JULIAN

Horizons

Precession and Nutation models : IAU76 / IAU80

Object	Reference	RA ICRF J2000	DE ICRF J2000	RA Airless Apparent	DE Airless Apparent	Delta
Sun	COM	00 17 11.659437	+01 22 27.58316	14 05 14.186443	-13 08 54.58252	1.007 907 334 766
Mercury	COM / BAR	22 50 07.813476	-09 36 29.64194	12 32 44.187634	-04 47 33.23607	1.087 266 367 696
Venus	COM / BAR	21 55 56.084606	-12 26 00.44775	11 47 48.904627	+02 52 46.10857	1.191 750 469 305
Mars	BAR	02 00 33.746344	+11 17 47.15627	15 54 29.363504	-22 12 48.06110	2.412 595 490 796
Jupiter	BAR	20 53 34.993739	-18 18 37.98221	10 47 15.991389	+08 39 52.28958	5.670 329 906 185
Saturn	BAR	18 08 05.615195	-22 07 20.57388	08 16 29.150104	+23 11 59.96795	9.867 760 055 602
Uranus	BAR	23 18 46.449069	-05 27 42.57786	13 04 19.069608	-07 13 31.80496	21.120 961 222 678
Neptune	BAR	01 59 21.715437	+10 22 46.03737	15 51 12.345364	-22 48 26.09548	30.710 049 196 757
Pluto	BAR	01 50 27.232486	-06 37 05.68492	14 55 42.284672	-34 57 04.41141	48.908 296 545 952
Moon	COM	17 22 21.985986	-25 16 56.18555	07 29 35.852964	+21 43 55.52006	0.002 698 433 528

UrukFSP

Precession and Nutation models : Vondrak 2011 / IAU80

Object	Reference	RA ICRF J2000	DE ICRF J2000	RA Airless Apparent	DE Airless Apparent	Delta (apparent)
Sun	COM	00h 17m 11.659s	+01° 22' 27.58"	14h 05m 02.899s	-13° 07' 34.26"	01.007 905 470 740
Mercury	COM / BAR	22h 50m 07.813s	-09° 36' 29.64"	12h 32m 33.136s	-04° 46' 17.06"	01.087 266 331 235
Venus	COM / BAR	21h 55m 56.084s	-12° 26' 00.45"	11h 47m 37.571s	+02° 53' 55.73"	01.191 750 441 422
Mars	BAR	02h 00m 33.746s	+11° 17' 47.16"	15h 54m 17.021s	-22° 11' 39.37"	02.412 595 369 402
Jupiter	BAR	20h 53m 34.993s	-18° 18' 37.98"	10h 47m 04.212s	+08° 40' 48.92"	05.670 329 848 525
Saturn	BAR	18h 08m 05.615s	-22° 07' 20.57"	08h 16m 15.669s	+23° 12' 09.76"	09.867 760 282 904
Uranus	BAR	23h 18m 46.449s	-05° 27' 42.58"	13h 04m 08.004s	-07° 12' 12.76"	21.120 960 415 644
Neptune	BAR	01h 59m 21.715s	+10° 22' 46.04"	15h 50m 59.996s	-22° 47' 16.81"	30.710 047 651 385
Pluto	BAR	01h 50m 27.232s	-06° 37' 05.69"	14h 55m 30.003s	-34° 55' 47.28"	48.908 294 182 299
Moon	COM	17h 22m 21.985s	-25° 16' 56.24"	07h 29m 22.523s	+21° 43' 48.86"	00.002 698 693 810

Comparison between DE431 and DE441 at 13000 BCE:

Julian Date Number (Terrestrial Time) : -3026826.5 (BCE 13000/01/01 0 TDT)

J2000 - Heliocentric geometric ecliptical coordinates. **JPL DE431**

Object	Longitude	Latitude	Distance from Sun(AU)
Earth	208° 36' 58.471"	+00° 06' 49.11"	01.016 844 827 730
Mercury	251° 25' 07.663"	-00° 44' 01.85"	00.459 804 791 574
Venus	276° 32' 58.310"	+00° 53' 14.29"	00.733 983 311 999
Mars	141° 01' 06.221"	+02° 13' 54.46"	01.581 960 485 275
Jupiter	226° 37' 53.320"	+01° 28' 26.57"	05.333 017 140 965
Saturn	346° 29' 53.496"	-00° 33' 24.81"	08.824 722 568 862
Uranus	125° 57' 39.119"	+00° 51' 35.41"	18.375 331 498 185
Neptune	292° 22' 18.202"	+00° 36' 23.74"	30.175 809 896 253
Pluto	342° 58' 00.634"	-13° 31' 23.59"	42.156 717 418 257
Moon (GEOCENTRIC)	216° 26' 02.249"	-05° 09' 06.96"	404969.063 Km

J2000 - Heliocentric geometric ecliptical coordinates. **JPL DE441**

Object	Longitude	Latitude	Distance from Sun(AU)
Earth	208° 36' 33.227"	+00° 06' 50.00"	01.016 843 384 563
Mercury	251° 23' 52.954"	-00° 43' 51.72"	00.459 817 918 288
Venus	276° 32' 16.999"	+00° 53' 16.21"	00.733 982 712 662
Mars	141° 00' 54.960"	+02° 13' 54.18"	01.581 966 493 493
Jupiter	226° 37' 53.051"	+01° 28' 26.56"	05.333 017 240 623
Saturn	346° 29' 52.517"	-00° 33' 24.77"	08.824 723 791 203
Uranus	125° 57' 53.781"	+00° 51' 35.57"	18.375 303 158 616
Neptune	292° 22' 51.322"	+00° 36' 22.92"	30.175 755 117 325
Pluto	342° 58' 34.931"	-13° 31' 27.11"	42.157 987 152 896
Moon (GEOCENTRIC)	213° 41' 32.318"	-05° 03' 55.44"	405045.155 Km

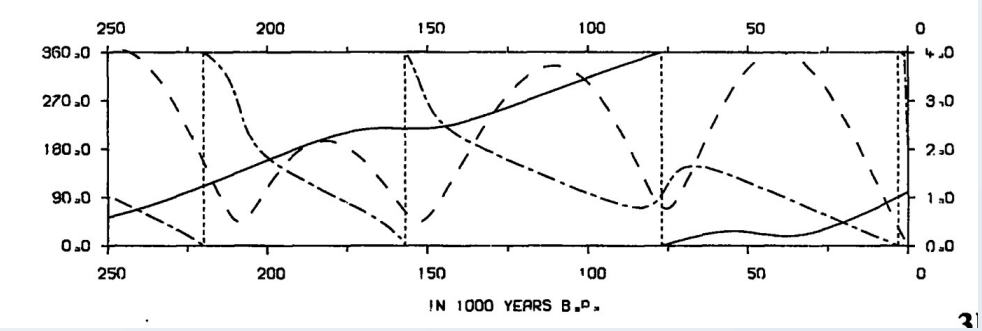
The difference in longitude of the moon (DE441 vs DE431) remains in the order of some arcmins until 3000 BCE. Then increases rapidly until it reachs about 3° at 13000 BCE. DE431 uses internally a value of Ndot (moon tidal acceleration) equal to -25.80”/cy², DE441 has been computed with Ndot equal to -25.936”/cy². This could explain the difference between the two orbits, being the difference in latitude of few arcmins (about 5’).

Other dynamic models:

- Precession of Equinoxes : Vondrak, Capitaine, Wallace (2011,2012)
- Stellar proper motion : compatible with IAU SOFA library (includes radial vel.)
- Inclination of Ecliptic (ε) : Vondrak, Capitaine, Wallace (2011,2012)
- Nutations (Δε) and (Δλ) : IAU 2000A IERS
- Sideral Time (ERA) : IAU2006 GST IERS Convention 2010 - Technical Note 36

- DeltaT : Nasa (2006) Espenak – Meeus calibrated to DE441 ndot (-25.936”/cy²)
- DeltaT : UK20A – Events based on recently published papers.
- DeltaT : Manual values can be inserted, in order to check new theories.

- Terrestrial orbit eccentricity – Bretagnon, useable within 2 millions years, centered on 1850 CE
- Terrestrial orbit mean Perihelion – Simon, Bretagnon, Chapront et al., with a linear change backwards 28 millennia from the present epoch.



Mean Earth’s Perihelion : Berger - 1976

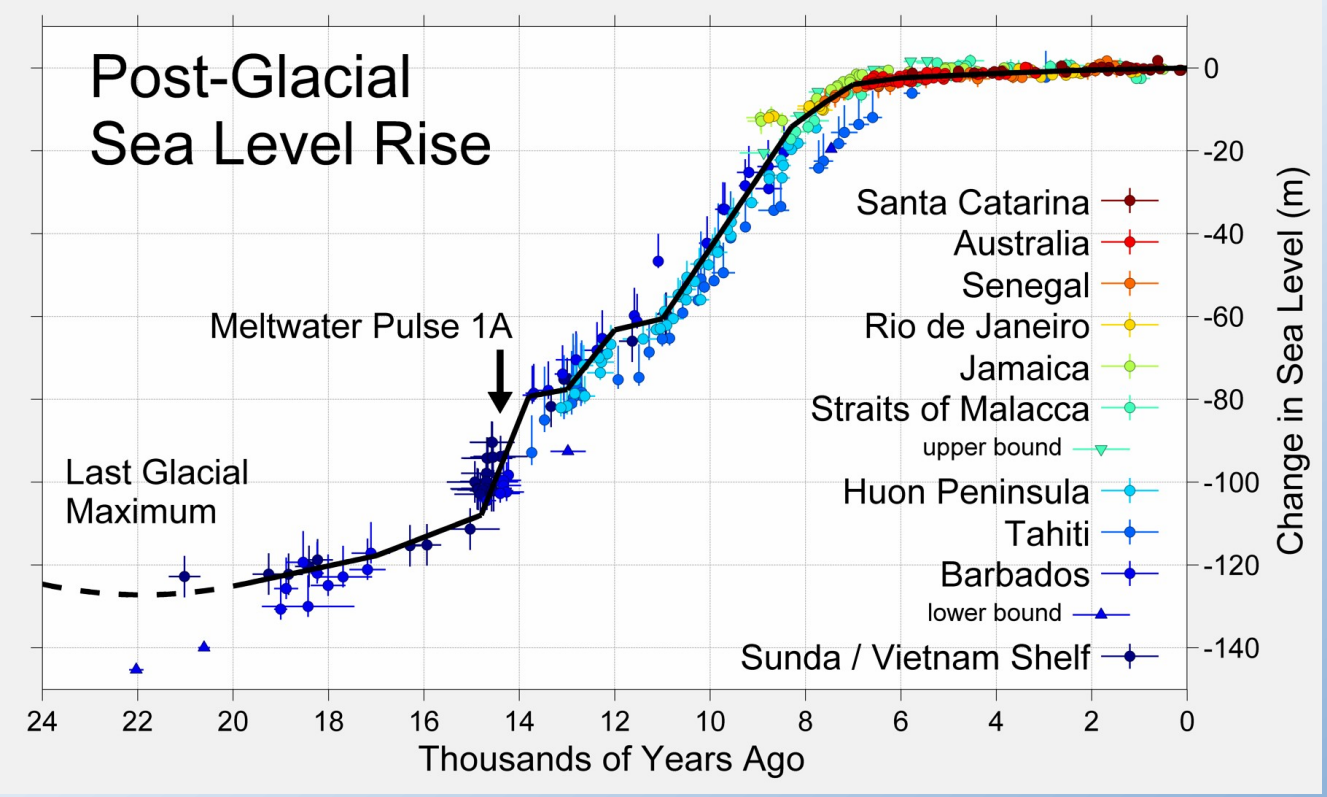
- Annual Aberration : depending on the two quantities shown above.

Deltat - Deceleration of the earth's rotation

- Tidal interactions of the Earth System - Luna
- Movements of the viscous Earth's mantle and the ferrous liquid nucleus
- Increase or decrease in the liquid mass of oceans water

Over the last 70,000 years, three main excursions of the Earth's magnetic field have occurred due to important movements of the Earth's fluid core: the Norwegian Sea-Greenland event, which occurred approximately 64,000 years ago, the Laschamps event between 42,000 and 41,000 years ago ago and the Mono Lake event, dating back about 34,500 years ago.

Change in level of the liquid mass of water



DeltaT – Earth's Rotation Slowdown (1)

- Before Calibration Point CP001 DeltaT is computed as [-20 + 31.987 * ((y - 1820) / 100)^2]
- From 1620 to 2021, A. Almanac (pages K8-K9) and IERS Bulletin A from https://datacenter.iers.org/eop.php
- From 2022 to 2031 NASA extrapolations. https://cddis.nasa.gov/archive/products/iers/deltat.preds
- From 2032 onwards, DeltaT is computed as [-71.8 + 31.987 * ((y - 1820) / 100)**2]

DeltaT RC Calibration Points (DE441/DE440)

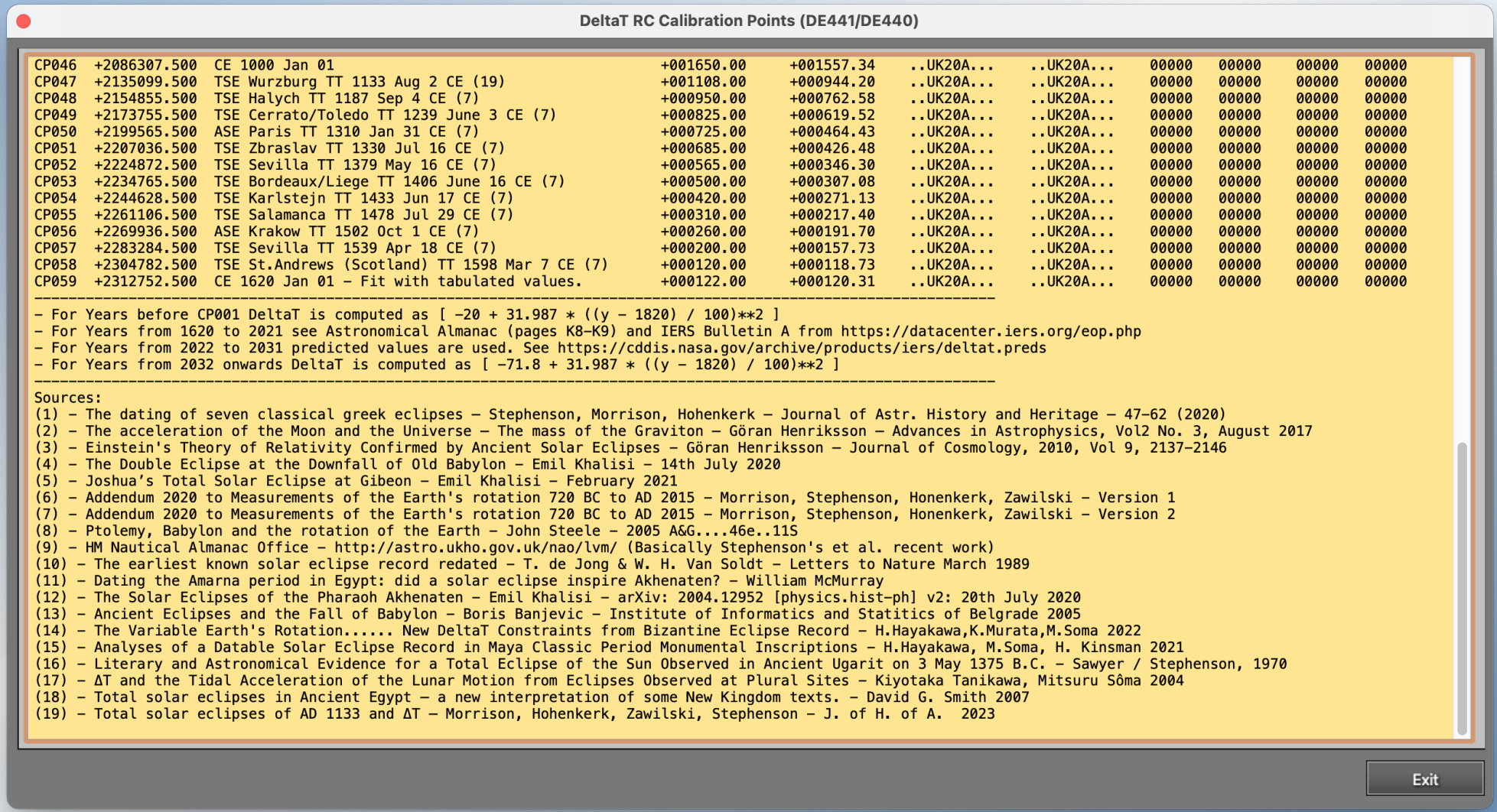
UK20A UrukFSP model – Takes in account the most recent studies on Ancient Eclipses. Events (CPxx) based.
Nasa (Espenak, Meeus 2006) calibrated with Ndot = −25.80"/cy²
UK24A2 second order UrukFSP model calibrated with Ndot = −25.80"/cy² [still under test]
UK24A2 third order UrukFSP model calibrated with Ndot = −25.80"/cy² [still under test]

						Models still under test		Referred to UK20A Model only	
No.	JDN TT	Julian Date TT	ΔT UK20A(sec)	NASA(2006)	UK24A2 [^2]	UK24A3 [^3]	Constr. DE431		Constr. DE441	
CP001	+0387450.786	TSE Eshnunna TT 3653 Oct 13 BCE (2)	+095730.00	+095196.61	+130744.89	+138901.44	94400	99500	94780	96680
CP002	+0501823.453	ASE Loughcarn TT 3340 Nov 01 BCE (P.Griffin)	+084800.00	+084606.87	+110893.04	+110675.24	00000	00000	00000	00000
CP003	+0536491.812	PSE Knowth TT 3245 Nov 01 BCE (2)	+081700.00	+081520.49	+105274.45	+103343.08	82600	83750	83120	84250
CP004	+0572726.117	PSE Knowth TT 3145 Jan 15 BCE (2)	+078500.00	+078357.16	+099602.17	+096240.94	80900	81900	81500	82500
CP005	+0651749.965	PSE 90% Eshnunna TT 2929 May 24 BCE (2)	+072500.00	+071673.50	+087929.81	+082586.01	72050	74100	73000	75100
CP006	+0752271.580	TSE Khafaje TT 2654 Aug 11 BCE (2)	+064760.00	+063600.10	+074469.77	+068453.28	61700	67750	62600	68050
CP007	+0818981.447	TSE Khafaje TT 2471 Apr 01 BCE (2)	+059600.00	+058508.43	+066397.19	+060792.98	59400	63300	59600	62900
CP008	+0933028.435	TSE (Baghdad) TT 2159 Jun 29 BCE (4)	+050800.00	+050298.55	+054189.87	+050275.30	00000	00000	45760	53720
CP009	+0941179.224	ASE (China) TT 2137 Oct 22 BCE	+050200.00	+049734.95	+053393.33	+049627.77	00000	00000	00000	00000
CP010	+1042557.602	TSE Babylon TT 1859 May 15 BCE	+043100.00	+042994.93	+044349.05	+042491.71	00000	00000	42900	45500
CP011	+1138561.269	TSE Ekemberg TT 1596 Mar 18 BCE (3)	+037275.00	+037064.98	+037245.78	+036887.40	34450	38950	34900	39650
CP012	+1152617.256	TSE Babylon TT 1558 Sep 11 BCE (3)	+036450.00	+036233.27	+036324.57	+036126.69	00000	00000	36300	36600
CP013	+1165257.212	PSE Thebe Egypt 98% TT 1523 Apr 20 BCE (IMCCE)	+035750.00	+035494.22	+035523.06	+035452.21	00000	00000	34320	35420
CP014	+1181735.103	TSE Thebe Egypt TT 1478 Jun 01 BCE (18)	+034800.00	+034540.45	..UK20A...	..UK20A...	00000	00000	34400	35450
CP015	+1208076.500	TSE Ugarit TT 1406 July 14 BCE – (16)	+033300.00	+033045.19	..UK20A...	..UK20A...	00000	00000	33020	34100
CP016	+1219327.032	PSE Ugarit 98% TT 1375 May 03 BCE – (16)	+032700.00	+032415.70	..UK20A...	..UK20A...	33500	34600	33850	34950
CP017	+1232852.370	TSE Amarna TT 1338 May 14 BCE (11)(12)	+032000.00	+031668.29	..UK20A...	..UK20A...	00000	00000	25500	35400
CP018	+1246022.951	TSE (China) TT 1302 Jun 5 BCE	+031200.00	+030947.79	..UK20A...	..UK20A...	00000	00000	00000	00000
CP019	+1272364.170	TSE Ekemberg TT 1230 Jul 18 BCE (3)	+029900.00	+029533.26	..UK20A...	..UK20A...	29550	33400	29900	33700
CP020	+1274786.312	PSE 94% Ugarit TT 1223 Mar 5 BCE (10)	+029700.00	+029404.11	..UK20A...	..UK20A...	30650	31470	30900	31700
CP021	+1292120.232	PSE 92% Anyang TT 1176 Aug 19 BCE	+029200.00	+028493.67	..UK20A...	..UK20A...	30500	31500	30620	31710
CP022	+1308598.252	TSE Gaza TT 1131 Sep 30 BCE (5)	+027900.00	+027641.30	..UK20A...	..UK20A...	00000	00000	27450	28300
CP023	+1393173.705	ASE ZhengZhou TT 899 Apr 21 BCE	+023600.00	+023466.72	..UK20A...	..UK20A...	00000	00000	20350	22000
CP024	+1442903.057	PSE 98% Nineveh TT 763 Jun 15 BCE	+021400.00	+021171.48	..UK20A...	..UK20A...	00000	00000	21900	23700
CP025	+1462659.060	TSE Qufu TT 709 Jul 17 BCE (13)	+020700.00	+020292.58	..UK20A...	..UK20A...	20170	21100	20250	21150
CP026	+1484837.057	TSE Thebes TT 648 Apr 06 BCE (1)	+019190.00	+019327.54	..UK20A...	..UK20A...	18430	20020	18550	20150
CP027	+1506866.432	PSE 93% Thasos TT 588 Jul 29 BCE (1)	+018200.00	+018393.64	..UK20A...	..UK20A...	00000	00000	16900	18100
CP028	+1507900.376	TSE Thasos TT 585 May 28 BCE (1)	+018130.00	+018350.29	..UK20A...	..UK20A...	17650	19620	17800	19750
CP029	+1543424.870	ASE Thebe TT 488 Sep 01 BCE (1)	+016610.00	+016849.93	..UK20A...	..UK20A...	00000	00000	18100	18100
CP030	+1546881.116	ASE Thebe TT 478 Feb 17 BCE (1)	+016470.00	+016685.57	..UK20A...	..UK20A...	15500	17200	15610	17320
CP031	+1552432.235	TSE Thasos TT 463 Apr 30 BCE (1)	+016250.00	+016426.03	..UK20A...	..UK20A...	13200	17000	12800	17500
CP032	+1564215.347	ASE Khultepe TT 431 Aug 03 BCE (1)	+015790.00	+015892.74	..UK20A...	..UK20A...	15000	15800	15030	15860
CP033	+1577740.031	ASE Tarsus TT 394 Aug 14 BCE (1)	+015270.00	+015312.87	..UK20A...	..UK20A...	00000	00000	14680	15970

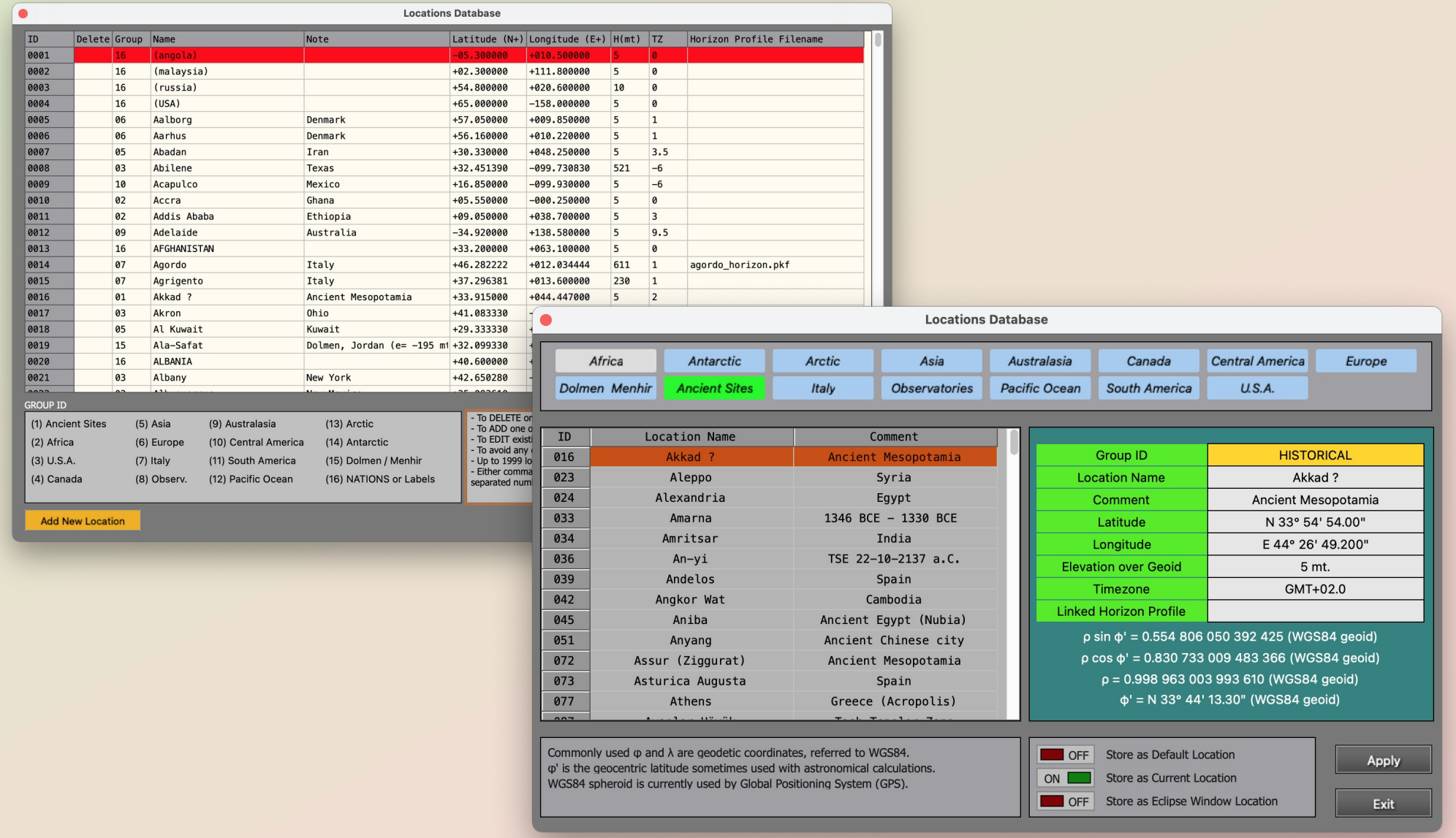
Exit

DeltaT – Earth's Rotation Slowdown (2)

19 Data Sources, mostly published papers, together make up the UK20A model core, not based on formulas but on event reports. As new articles are published, improving our knowledge of ancient eclipses, the model is enriched. The DeltaT value between 2 contiguous events is obtained by means of interpolation. Of course the more events we can collect, the more accurate UK20A model is. This means that this model is always in "work in progress" condition.



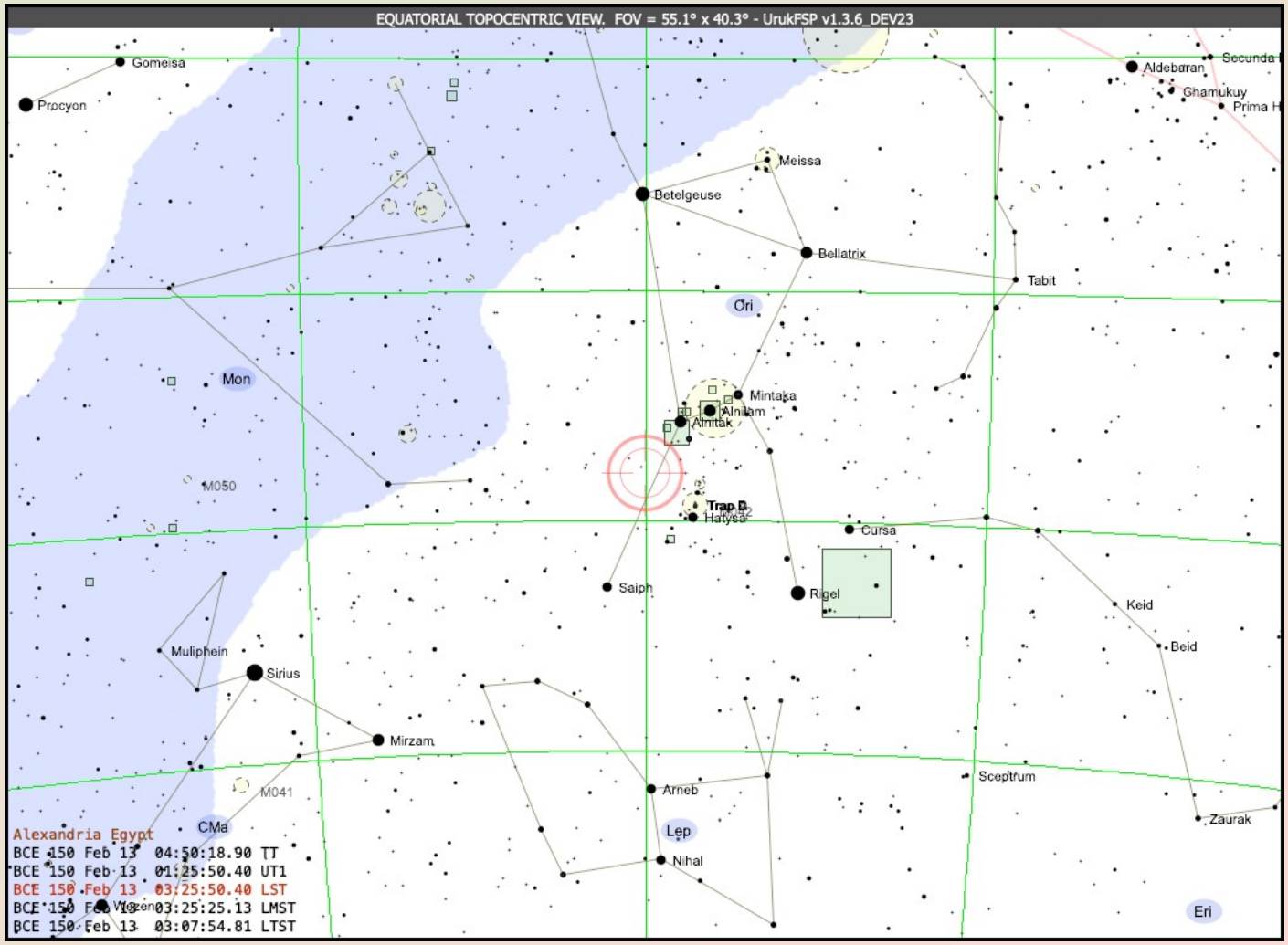
Locations Archive:



About 1200 locations categorized already present in the archive of 2000 slots available.

Each location can be associated with a horizon profile downloadable for example from Peakfinder.

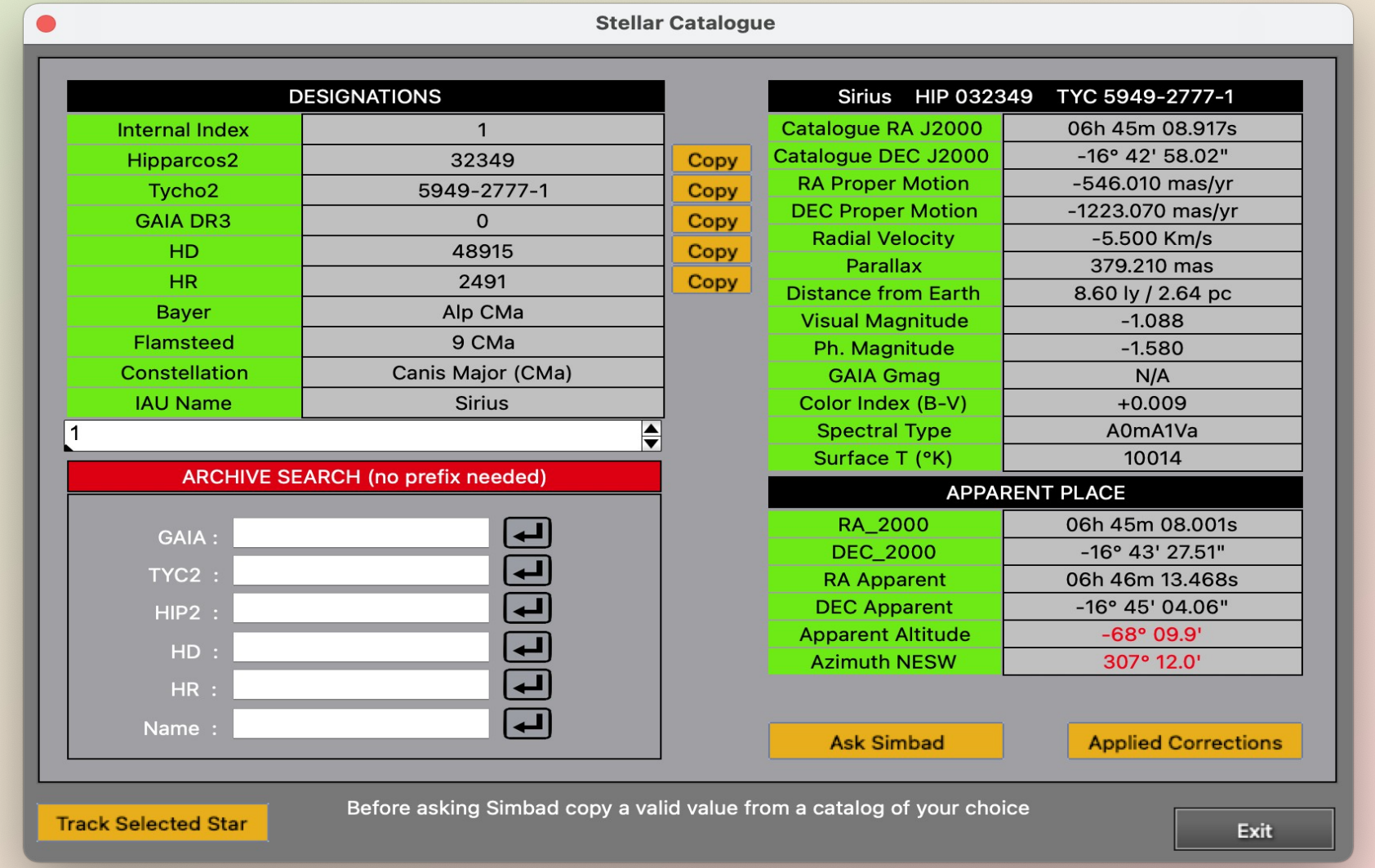
Stars Archive and Deep Space Objects



2,150,000 GAIA DR3, XHIP and Tycho2 stars.

10400 DSO objects coming from different catalogues (NGC, Messier, IC, UGC, 3C, etc.)

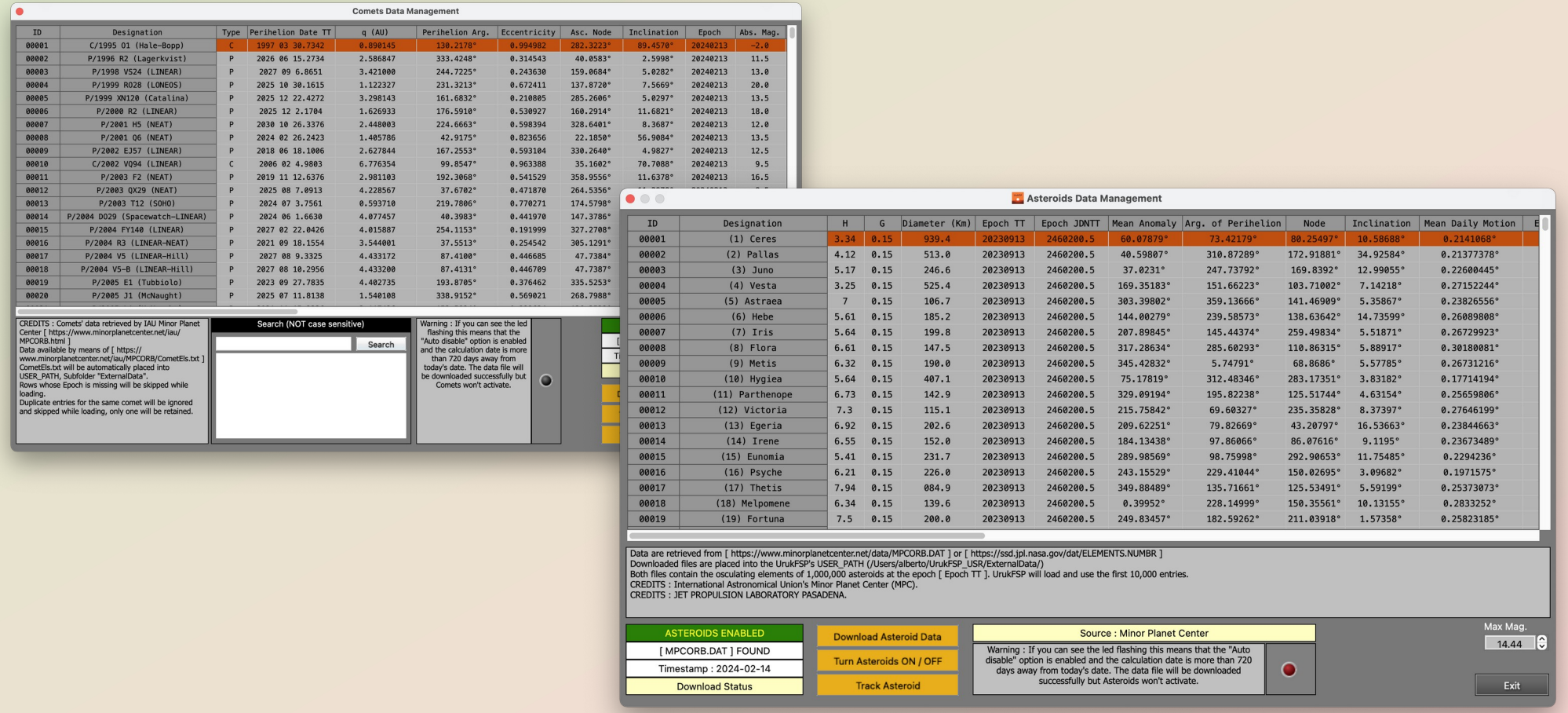
Stars Database



Every star can be accessed for reading and tracking on the sky

Access on the Simbad Platform for gathering further infos about stars

Comets and Asteroids

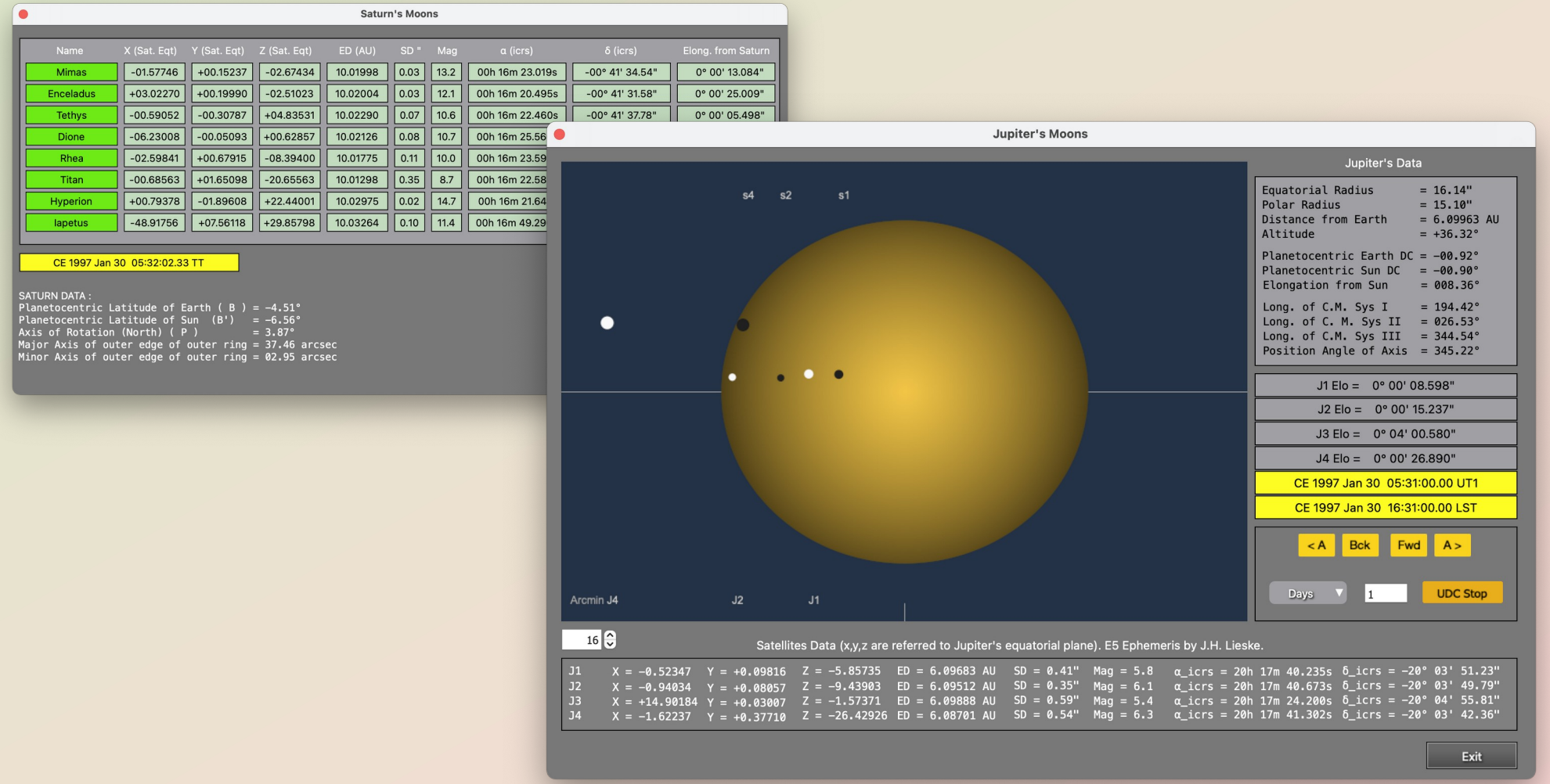


UrukFSP computes only the 10000 brightest asteroids.

Data are downloaded from Minor Planet Center or JPL

Positions are available for the recent epoch only.

Natural satellites of the planets of the Solar System



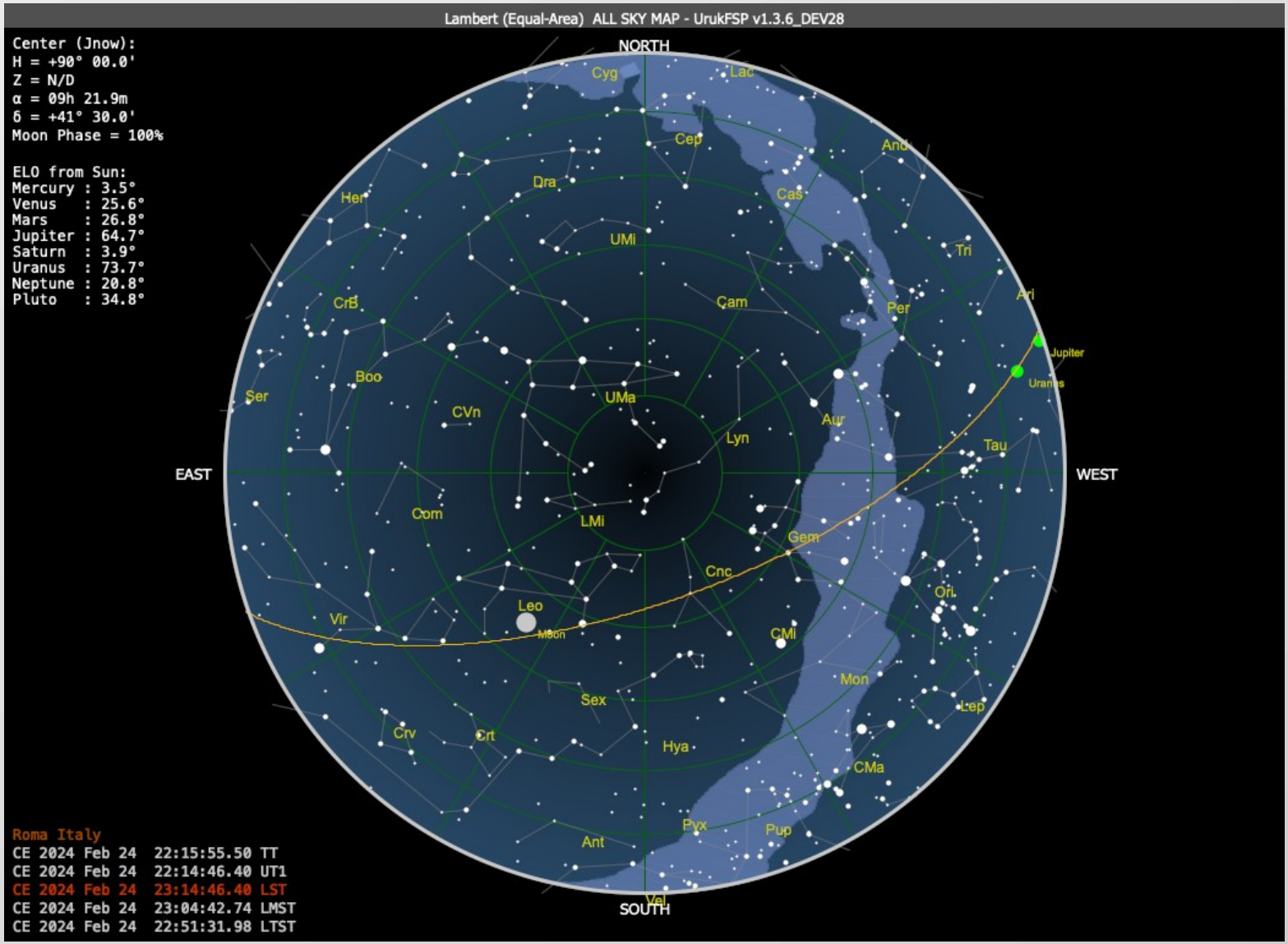
Only the main satellites of Jupiter and Saturn are processed

Saving and Loading Events (URUKFSP_User/Events)

- An instant situation of the sky on file is saved to be recovered.
- Given the type of asteroid and comet data, these object will not be considered in saving.
- Especially useful for saving sun and moon eclipse and particular planetary configurations.
- It is possible to associate work notes on the saved event.

Saving the graphic window on file (URUKFSP_User/Images)

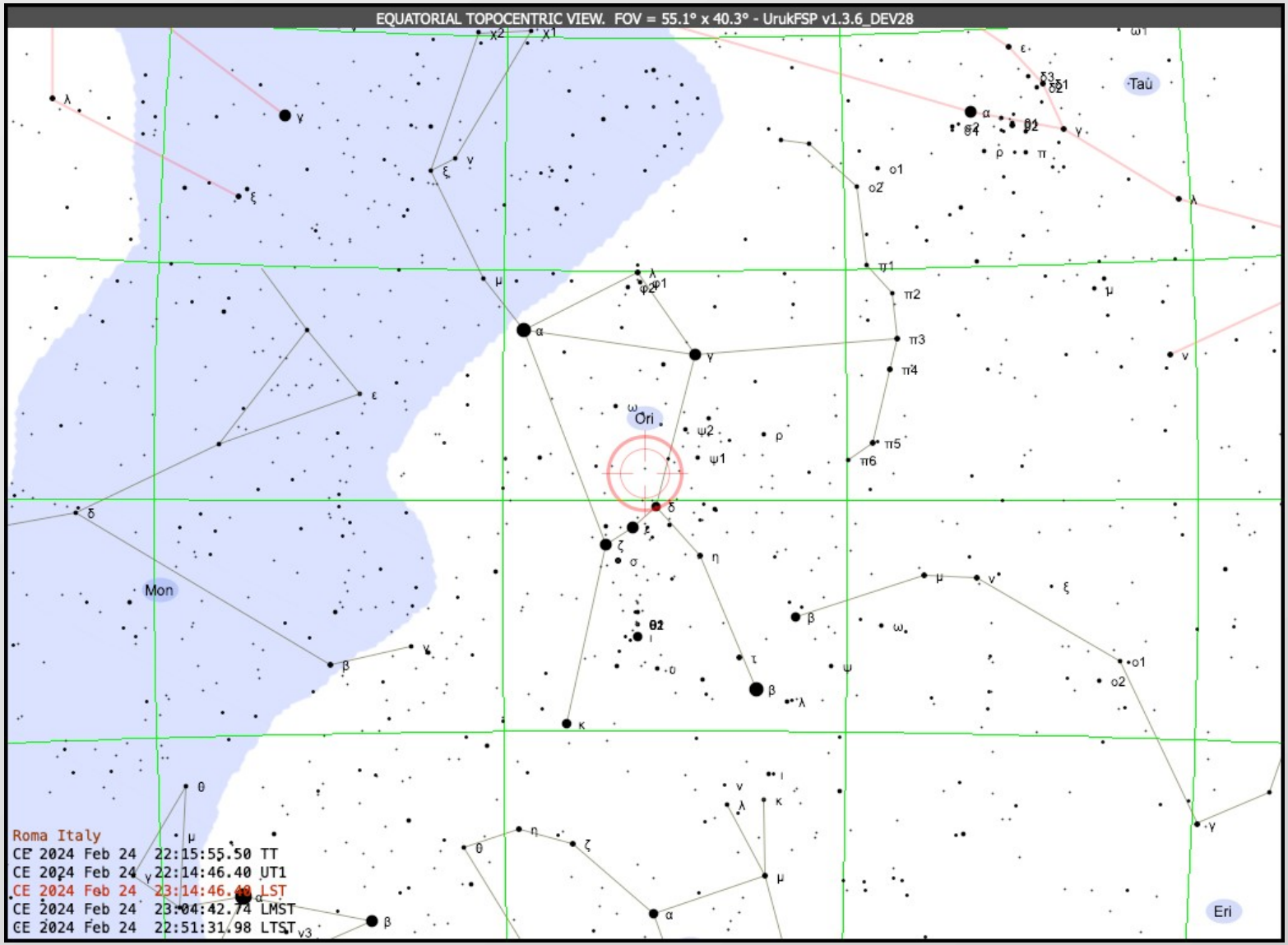
The content of the main graphic window can be saved on files in PNG or BMP format to be conveniently reported on a document on which we are working or possibly printed.



Example of All Sky Map saving to file.

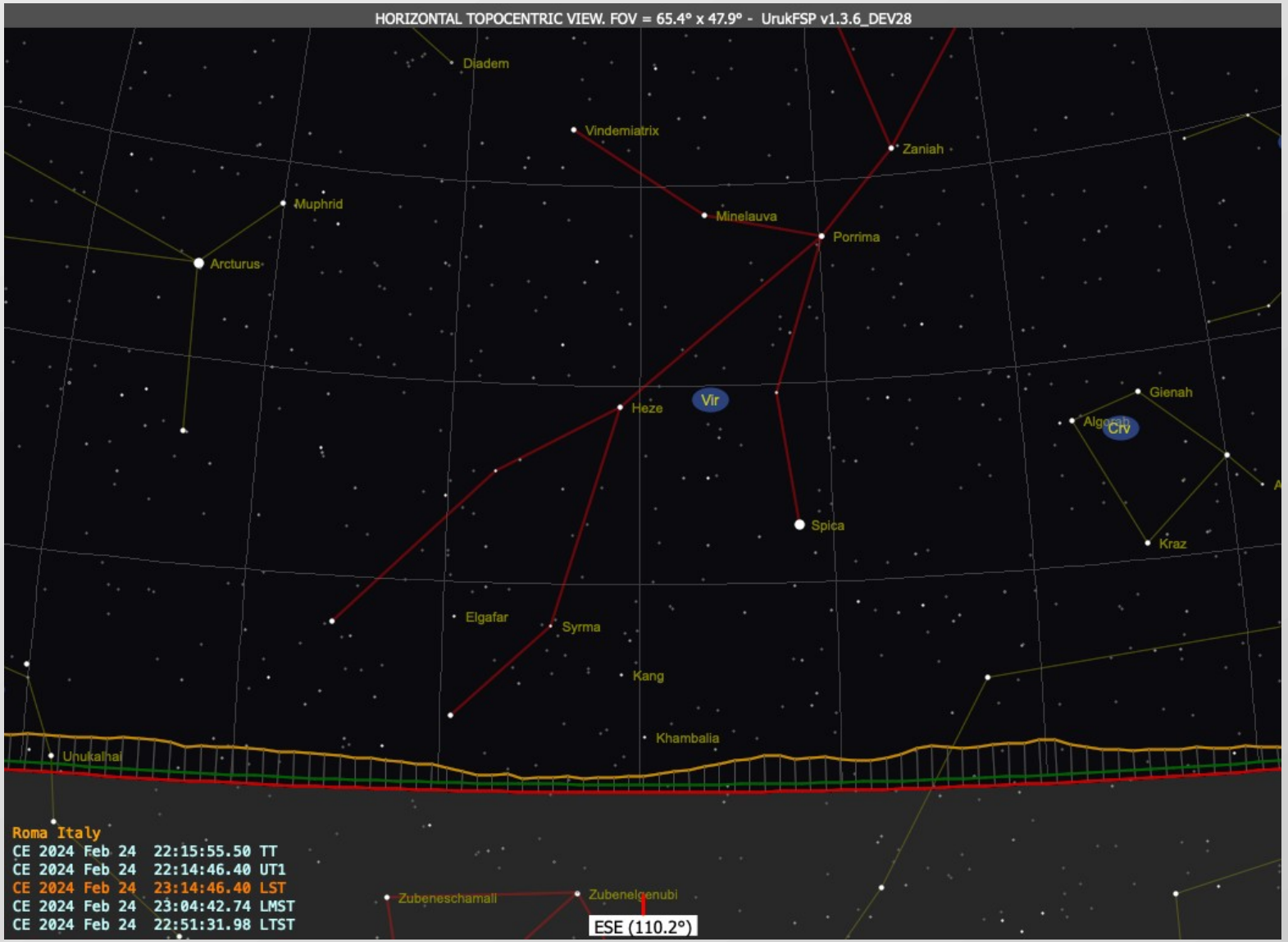
EQUATORIAL View

View in stereographic projection zoomable, referred to th equinox of the date. Normally with the north pole at the top. It can simulate the sky as seen by the southern hemisphere by applying the vertical and horizontal flips of the vision.



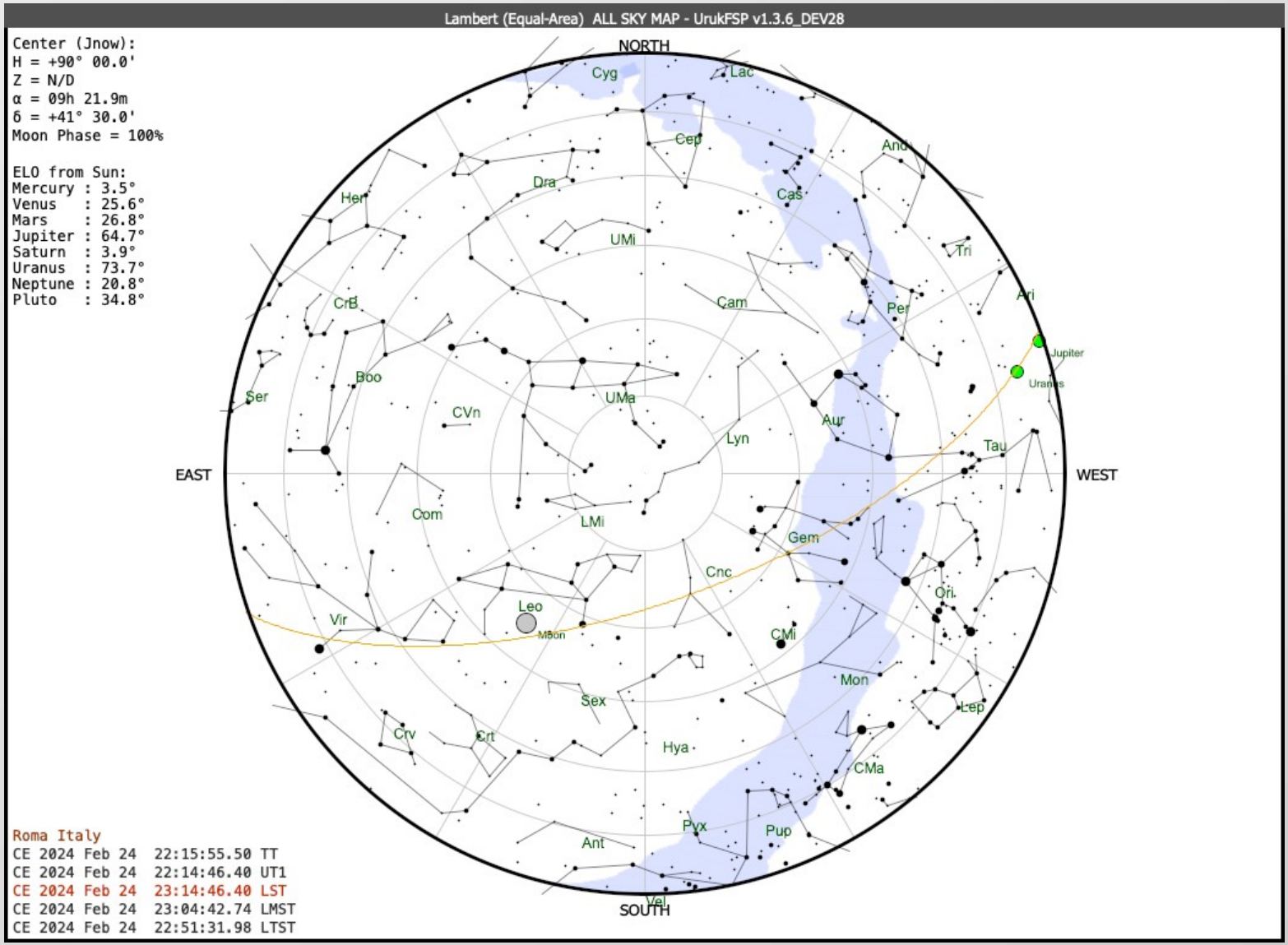
Horizontal View

Offers a horizontal view of the current location, with the possibility to load a horizon profile



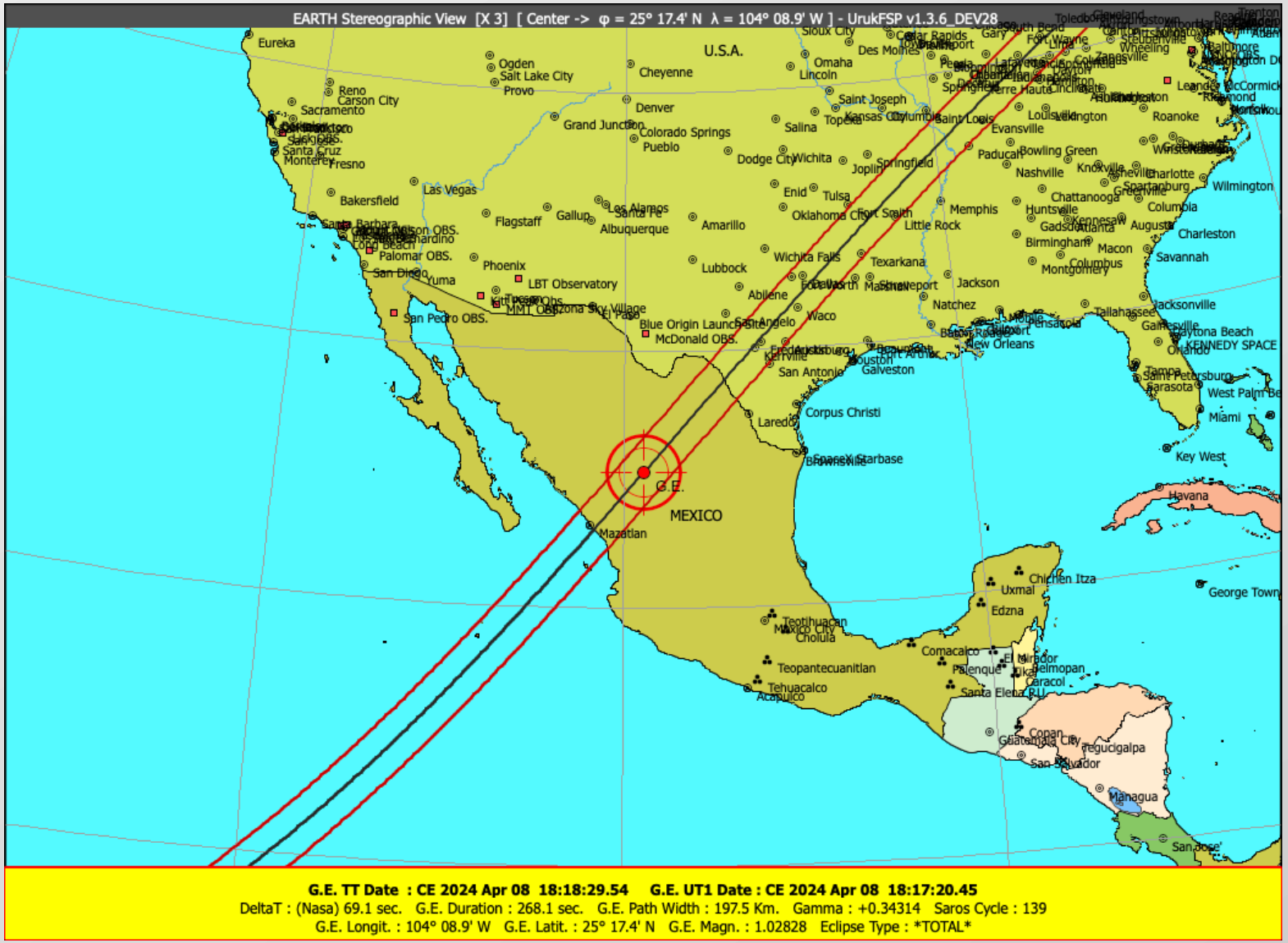
ALL SKY MAP View

All Sky Map View of the Current Location.



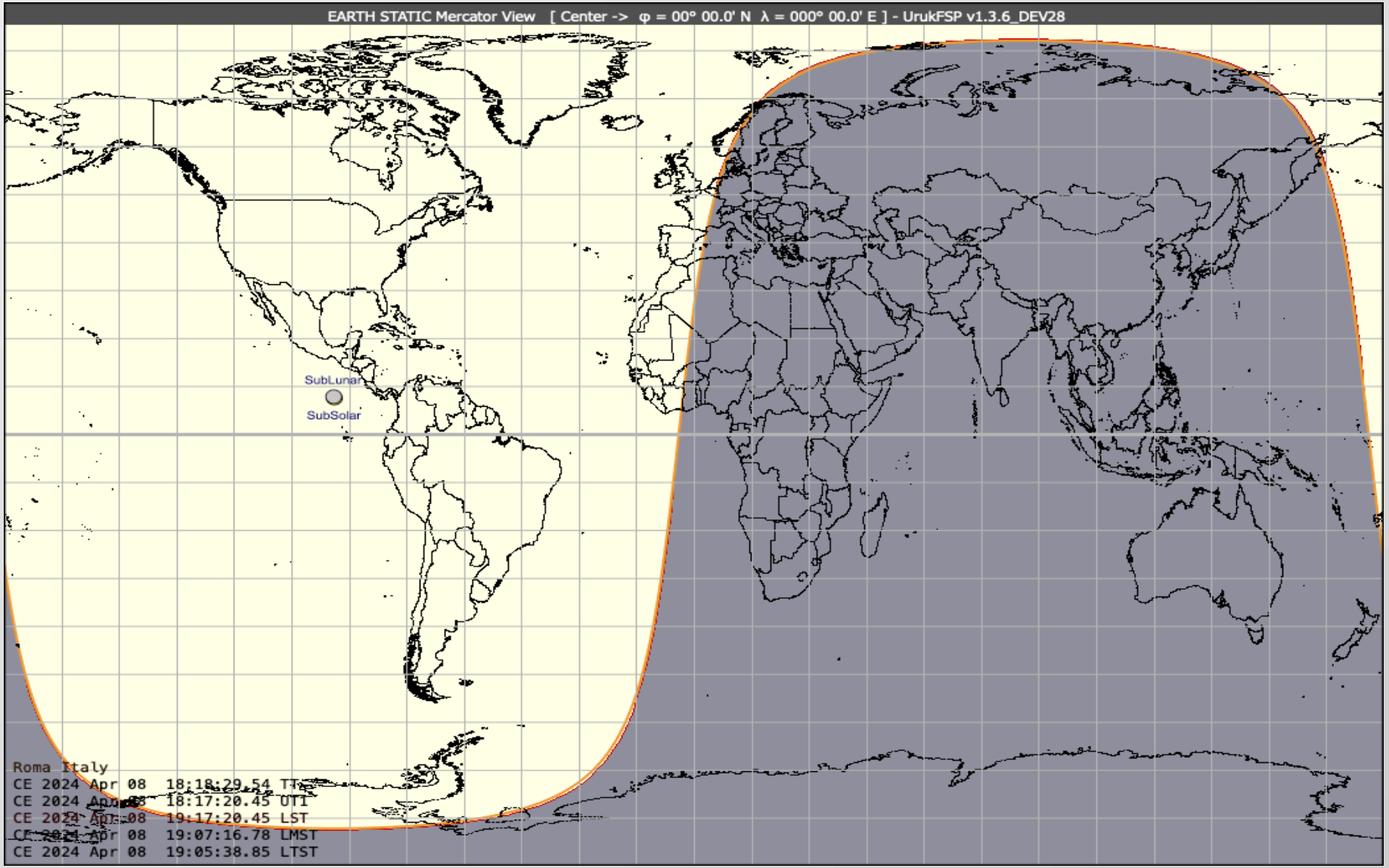
(EARTH Views)
Stereographic View

Explorable view of the Earth with archived locations. In case of solar eclipses, it shows the Path.



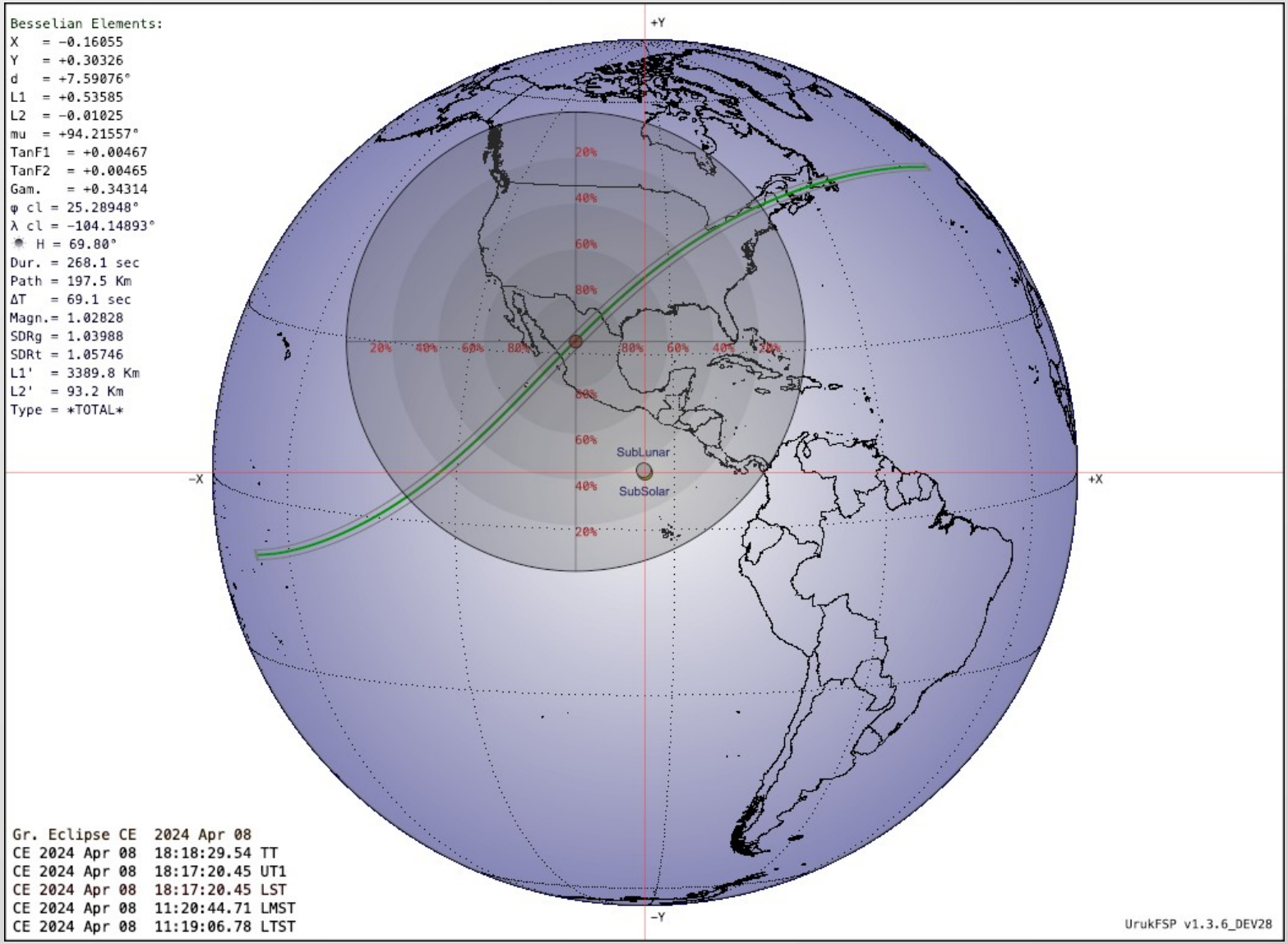
(EARTH Views)
Mercator Static View

It usually shows the Earth's day/night zone, the presence of the Moon and, in case of solar eclipses, the Path.



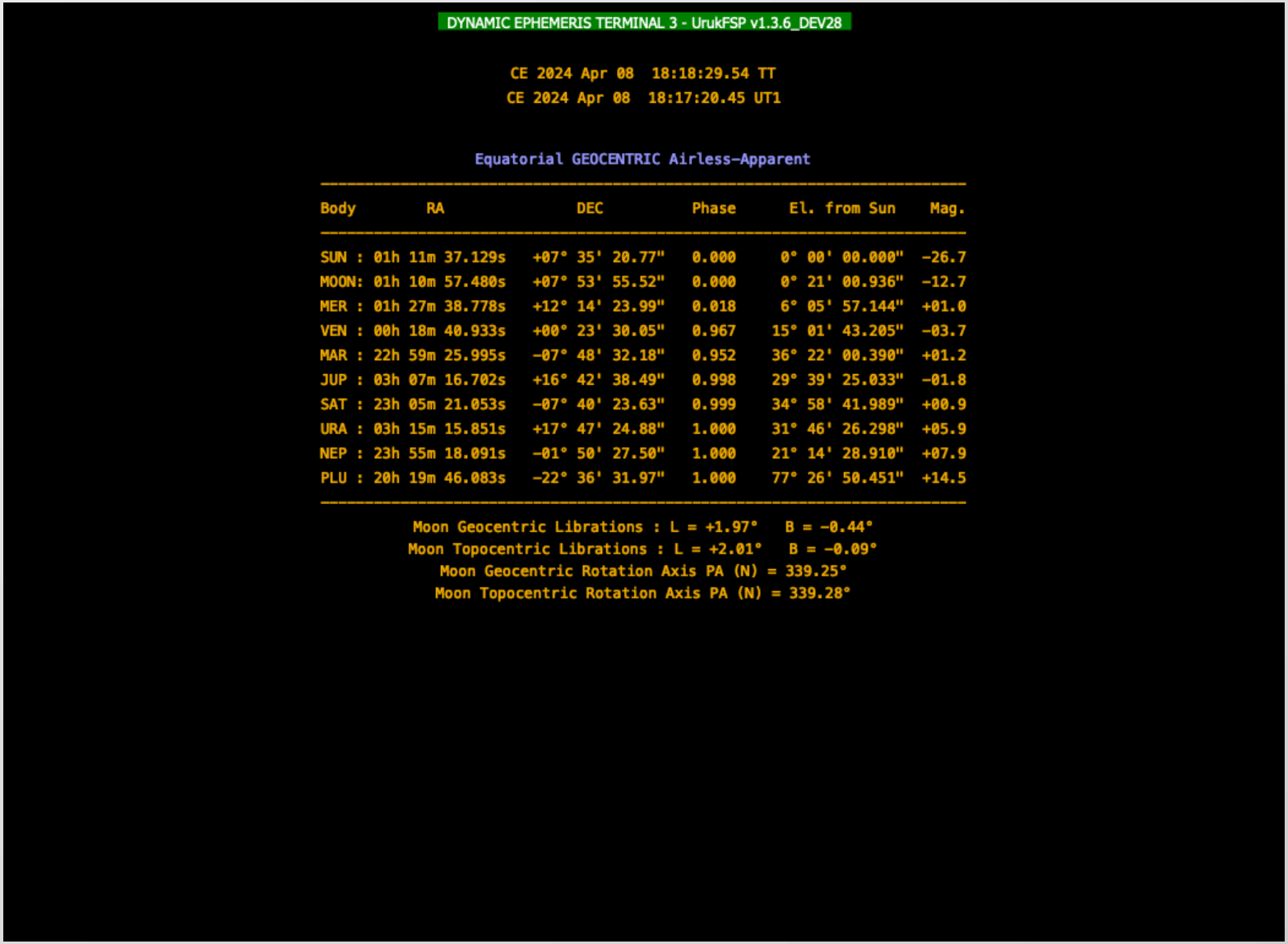
(EARTH Views)
Ortographic View centered on SUBSOLAR or SUBLUNAR points

If the SUBSOLAR point is selected, in case of a solar eclipse it shows the path of the umbra and penumbra.



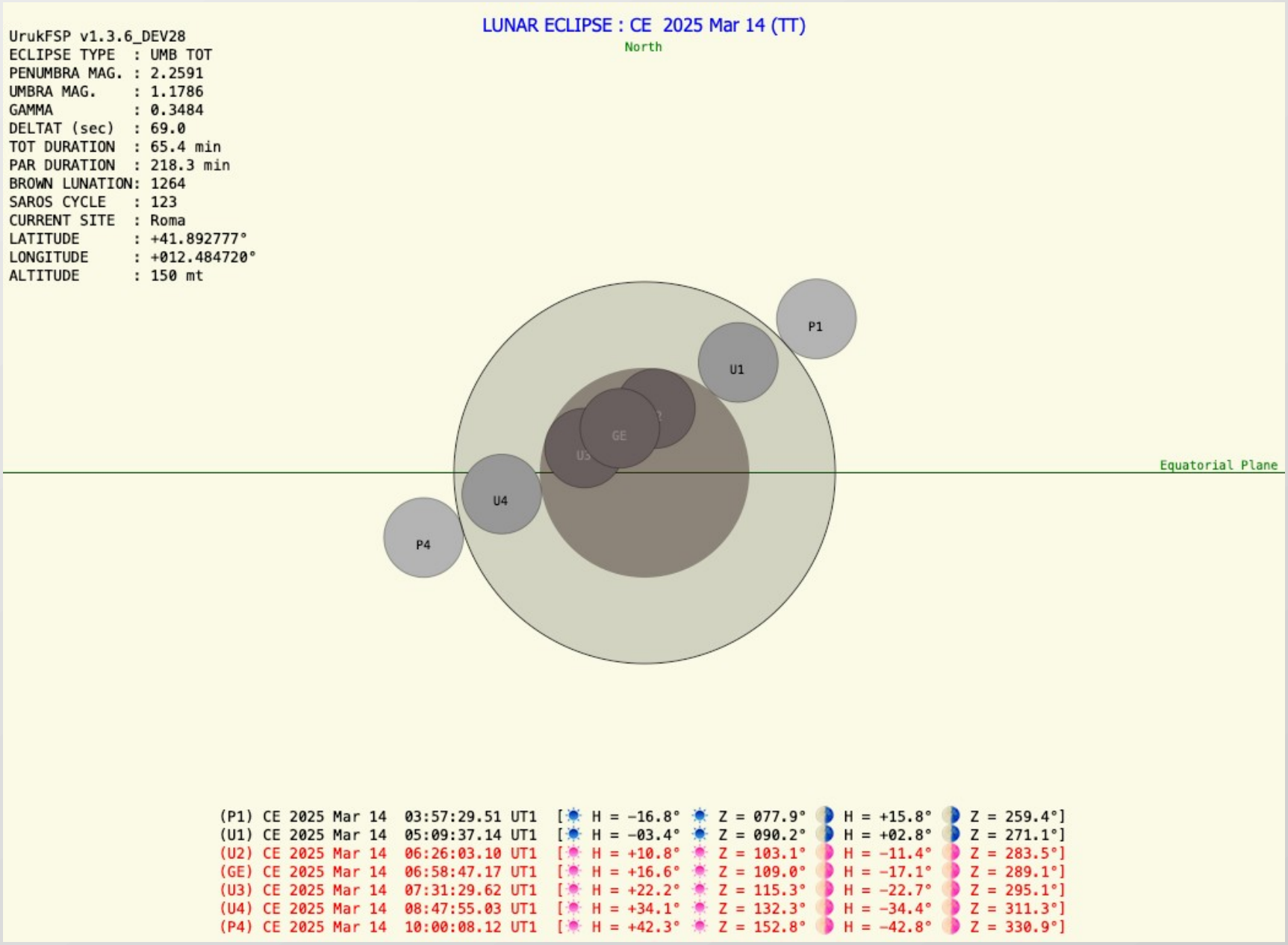
Dynamic Ephemeris – 4 terminals (T1 - T4)
Ecliptic, equatorial, geocentric and topocentric coordinates of the Planets of the S.S.

They are updated in real time with Time Flow commands or with the system clock.



Dynamic Analysis of a Lunar Eclipse – (T5)
Bessel Elements, Contact Functions and Real Time Analysis

Static analysis of a Lunar Eclipse – (T6)
Contact times and azimuthal coordinates referring to the Current Location



User folder (URUKFSP_User)

All files contained in the user folder are not changed following an application update.

Nome	Data di modifica	Dimensioni
Devices	26 maggio 2022 20:46	--
cameras_database.csv	13 febbraio 2023 11:12	1 KB
telescopes_database.csv	12 ottobre 2022 08:49	1 KB
Events	7 febbraio 2024 14:17	--
ExternalData	27 ottobre 2023 12:39	--
CometEls.txt	ieri 11:57	188 KB
ELEMENTS.NUMBR	16 novembre 2023 16:39	71.7 MB
MPCORB.DAT	ieri 11:57	273.9 MB
Horizons	12 febbraio 2024 12:47	--
Images	11 febbraio 2024 21:46	--
Jobs	5 novembre 2023 16:40	--
Locations	11 febbraio 2024 16:09	--
locations_database.csv	12 febbraio 2024 16:52	51 KB
Logs	oggi 08:07	--
urukfsp.log	oggi 07:16	194 byte

DEVICES : contains the telescope and sensor archives for simulating the sensor FOV.

EVENTS : contains event files created by the user.

EXTERNAL DATA : asteroids and comets data downloaded from the Internet are placed here

HORIZONS : repository of horizon profiles built by the user

IMAGES : repository of saved PNG or BMP map.

JOBS : jobs repository. Contains local solar eclipses computed by UrukFSP.

LOCATIONS : Local locations archives, modified by the user.

LOGS : application log.

Canon of events (v. 1.4.1)

SOLAR ECLIPSES : partial, total, annular, hybrid from 13000 BCE to 17000 CE

LUNAR ECLIPSES : umbral and penumbral from 13000 BCE to 17000 CE

MERCURY TRANSITS : from 13000 BCE to 17000 CE

VENUS TRANSITS : from 13000 BCE to 17000 CE

MUTUAL TRANSITS BETWEEN PLANETS : from 10000 BCE to 10000 CE

PLANETARY TRIOS : from 3000 BCE to 3000 CE within 5°

PLANETARY TRIOS + MOON: from 3000 BCE to 3000 CE within 5°

PLANETARY QUARTETS : from 3000 BCE to 3000 CE within 10°

PLANETARY QUINTETS : from 3000 BCE to 3000 CE within 20°

APPULSES : VE-MA, VE-JU, VE-SA,MA-JU,MA-SA,JU-SA (4000 BCE – 2500 CE)

- Least distances of Mars from Earth from 1600 CE to 2100 CE.
- Least distances of Jupiter from Earth from 1600 CE to 2100 CE.
- Least distances of Saturn from Earth from 1600 CE to 2100 CE.
- Least distances of Uranus from Earth from CE to 2100 CE.
- Least distances of Neptune from Earth from 1600 CE to 2100 CE.
- Least distances of Pluto from Earth from 1600 CE to 2100 CE.

- Max. Elongations of Mercury from 1000 BCE to 2500 CE
- Max. Elongations Venus from 2500 BCE to 2500 CE

- Perihelion, Aphelion and Node dei of the external planets of S.S. from 1600 CE to 2100 CE

All Canons computed by the DE440/441 engine of UrukFSP

Ephemeris of S.S. Planets. Pag. 1 of 5

```
UrukFSP v1.4.1
-------------------------------------------------------------------------------------------------------
Generated by UrukFSP. To export data from here use select, copy and paste functions.
Dates before 8 CE are Julian Proleptic.
Dates between 8CE and 1582/10/4 are Julian Dates.
Dates between 1582/10/15 and future values are Gregorian.
A Gregorian Proleptic Date conversion is present.
-------------------------------------------------------------------------------------------------------

Julian Date Number (Terrestrial Time) ..... : 2 460 585.325 648 765 3
Julian Date Number (Universal Time) ....... : 2 460 585.324 849 575 4
Terrestrial Time (TT) [ Y/M/D  H:M:S ] ..... : CE 2024 Oct 01  19:48:56.05
Civil Date (UT1) [ Y/M/D  H:M:S ] ......... : CE 2024 Oct 01  19:47:47.00
Civil Date (Local Standard Time) [ Y/M/D  H:M:S ] . : CE 2024 Oct 01  20:47:47.00
Civil Date (Local Mean Time) [ Y/M/D  H:M:S ] ..... : CE 2024 Oct 01  20:37:43.34
DeltaT (seconds) .......................... : +69.0
Day of Year ............................... : 275
Day of Week ............................... : Tuesday
Days to the Summer Solstice ............... : +103.0
Days to the Winter Solstice ............... : -80.6
Days to the Spring Equinox ................ : +195.7
Days to the Autumn Equinox ................ : +9.3
Gregorian Proleptic Date .................. : DATE ALREADY GREGORIAN UT1
Proleptic Julian drift with respect to equinoxes .. : 12.9 days
Proleptic Gregor. drift with respect to equinoxes . : 0.1 days

Current Illumination ...................... : Night

Location Name ............................. : Roma Italy
Latitude .................. ................ : N 41° 53' 34.00"
Longitude ................. ................ : E 12° 29' 04.992"
Timezone .................................. : GMT + 01.0
G.M.S.T. (Greenwich Mean Sidereal Time) ..... : 20h 31m 54.925s
L.A.S.T. (Local Apparent Sidereal Time) ..... : 21h 21m 51.112s

Earth Geoid : RHO_SIN_PHI ................. : +0.664 276 428
Earth Geoid : RHO_COS_PHI ................. : +0.745 526 688

Mean Ecliptic (Vondrak, Capitaine and Wallace 2011) :   23° 26' 09.813"
True Ecliptic ............................. :   23° 26' 19.516"
Nutation in longitude (See Preferences) ..... : -02.3818"
Nutation in obliquity (See Preferences) ..... : +09.7027"
Equation of Time ........................... : 637.3 sec
Equation of Equinoxes [ Eq = Δψ cos(ε) ]..... : -00.1457 sec
-------------------------------------------------------------------------------------------------------
```

Ephemeris of S.S. Planets. Pag. 2 of 5

2000 - Heliocentric geometric ecliptic coordinates.

Object	Longitude	Latitude	Distance from Sun(AU)	L.T.	Parallax
Earth	8° 46' 47.243"	-00° 00' 03.01"	01.000 994 846 238	+ 00h 00m 00.0s	0000.00"
Mercury	191° 23' 13.034"	+04° 13' 11.18"	00.404 111 365 510	+ 00h 11m 40.6s	0006.26"
Venus	266° 17' 53.277"	-00° 34' 18.42"	00.726 725 746 733	+ 00h 11m 17.8s	0006.48"
Mars	63° 30' 13.527"	+00° 26' 51.34"	01.503 883 703 522	+ 00h 10m 16.2s	0007.12"
Jupiter	70° 02' 02.935"	-00° 39' 40.94"	05.053 785 328 337	+ 00h 38m 43.3s	0001.89"
Saturn	346° 27' 03.528"	-01° 58' 57.77"	09.657 828 646 575	+ 01h 12m 41.7s	0001.01"
Uranus	54° 22' 02.625"	-00° 15' 35.41"	19.568 568 980 435	+ 02h 37m 02.0s	0000.47"
Neptune	358° 13' 53.682"	-01° 16' 59.12"	29.896 679 872 838	+ 04h 00m 27.9s	0000.30"
Pluto	300° 51' 10.490"	-03° 13' 44.86"	35.109 110 360 866	+ 04h 48m 58.3s	0000.25"
Moon (GEOCENTRIC)	178° 24' 40.716"	+00° 43' 45.67"	406 191.988 Km	+ 00h 00m 01.4s	3238.96"

J2000 - Geocentric ecliptic coordinates (corrected LT) (Moon is not affected by ABERR).

Object	Longitude	Latitude	Delta(AU)	SD(")	Mag.	Phase
Sun	188° 46' 26.765"	+00° 00' 03.01"	01.000 996 496 827	0958.27	-26.7	
Mercury	189° 31' 10.184"	+01° 12' 53.54"	01.403 991 100 564	02.39	-01.6	099.90%
Venus	220° 16' 12.309"	-00° 18' 17.72"	01.358 254 236 719	06.14	-03.8	084.72%
Mars	104° 56' 11.757"	+00° 32' 44.37"	01.234 814 494 943	03.79	+00.5	087.49%
Jupiter	80° 53' 52.019"	-00° 43' 03.99"	04.655 838 177 543	21.15	-02.2	099.10%
Saturn	343° 57' 13.293"	-02° 11' 26.46"	08.740 806 317 902	09.46	+00.6	099.95%
Uranus	56° 32' 11.070"	-00° 16' 09.35"	18.881 608 243 218	01.86	+05.7	099.96%
Neptune	357° 52' 02.310"	-01° 19' 36.04"	28.913 443 804 298	01.16	+07.8	100.00%
Pluto	299° 19' 10.730"	-03° 15' 45.37"	34.745 813 341 389	00.05	+14.4	099.98%
Moon	178° 24' 40.050"	+00° 43' 45.73"	406 191.978 Km	0882.61	-12.7	000.82%

J2000 - Geocentric Astrometric (corrected LT only)

Object	Right Ascension	Declination	Distance from Earth
Sun	12h 32m 15.740s	-03° 28' 48.43"	01.000 996 496 827
Mercury	12h 36m 53.942s	-02° 39' 17.28"	01.403 991 100 564
Venus	14h 31m 01.728s	-15° 11' 19.29"	01.358 254 236 719
Mars	07h 05m 06.724s	+23° 08' 41.42"	01.234 814 494 943
Jupiter	05h 20m 35.478s	+22° 24' 38.68"	04.655 838 177 543
Saturn	23h 04m 16.507s	-08° 20' 02.09"	08.740 806 317 902
Uranus	03h 37m 11.171s	+19° 07' 06.96"	18.881 608 243 218
Neptune	23h 54m 17.008s	-02° 03' 55.64"	28.913 443 804 298
Pluto	20h 08m 50.570s	-23° 28' 58.65"	34.745 813 341 389
Moon	11h 55m 20.976s	+01° 17' 56.25"	00.002 715 225 666

Ephemeris of S.S. Planets. Pag. 3 of 5

Heliocentric astrometric ecliptic coordinates - Mean Equinox of Date.

Object	Longitude	Latitude	Distance from Sun(AU)
Earth	9° 07' 11.514"	-00° 00' 00.20"	01.000 996 496 827
Mercury	191° 42' 11.543"	+04° 13' 18.33"	00.404 068 217 396
Venus	266° 37' 53.280"	-00° 34' 27.43"	00.726 724 983 723
Mars	63° 50' 44.497"	+00° 27' 01.75"	01.503 874 394 585
Jupiter	70° 22' 39.204"	-00° 39' 29.86"	05.053 777 194 011
Saturn	346° 47' 42.743"	-01° 58' 59.31"	09.657 843 712 927
Uranus	54° 42' 42.965"	-00° 15' 25.44"	19.568 587 157 373
Neptune	358° 34' 35.047"	-01° 16' 58.35"	29.896 684 231 809
Pluto	301° 11' 52.256"	-03° 13' 53.24"	35.108 973 868 418

Geocentric ecliptic coordinates - Apparent

Object	Longitude	Latitude	Delta(AU)	SD(")	Mag.	Phase
Sun	189° 07' 09.132"	+00° 00' 00.20"	01.000 996 496 827	0958.27	-26.7	
Mercury	189° 51' 32.311"	+01° 12' 50.59"	01.403 991 100 564	002.39	-01.6	099.90%
Venus	220° 36' 36.997"	-00° 18' 26.06"	01.358 254 236 719	006.14	-03.8	084.72%
Mars	105° 16' 52.306"	+00° 32' 55.09"	01.234 814 494 943	003.79	+00.5	087.49%
Jupiter	81° 14' 41.007"	-00° 42' 52.14"	04.655 838 177 543	021.15	-02.2	099.10%
Saturn	344° 18' 14.545"	-02° 11' 28.99"	08.740 806 317 902	009.46	+00.6	099.95%
Uranus	56° 53' 07.477"	-00° 15' 59.03"	18.881 608 243 218	001.86	+05.7	099.96%
Neptune	358° 13' 04.986"	-01° 19' 35.52"	28.913 443 804 298	001.16	+07.8	100.00%
Pluto	299° 40' 00.345"	-03° 15' 56.06"	34.745 813 341 389	000.05	+14.4	099.98%
Moon	178° 45' 22.564"	+00° 43' 45.00"	00.002 715 225 666	0882.61	-12.7	000.82%

Geocentric (left) and Topocentric (right) Equatorial coordinates - Apparent.

Object	Right Ascension	Declination	Right Ascension	Declination
Sun	12h 33m 30.698s	-03° 36' 51.78"	12h 33m 30.374s	-03° 36' 57.32"
Mercury	12h 38m 08.874s	-02° 47' 19.32"	12h 38m 08.638s	-02° 47' 23.33"
Venus	14h 32m 21.923s	-15° 17' 50.33"	14h 32m 21.597s	-15° 17' 54.20"
Mars	07h 06m 36.149s	+23° 06' 30.41"	07h 06m 36.363s	+23° 06' 24.33"
Jupiter	05h 22m 05.298s	+22° 26' 12.04"	05h 22m 05.386s	+22° 26' 10.61"
Saturn	23h 05m 34.857s	-08° 11' 56.69"	23h 05m 34.879s	-08° 11' 57.45"
Uranus	03h 38m 37.298s	+19° 12' 05.84"	03h 38m 37.323s	+19° 12' 05.54"
Neptune	23h 55m 34.248s	-01° 55' 32.98"	23h 55m 34.258s	-01° 55' 33.19"
Pluto	20h 10m 19.275s	-23° 24' 41.18"	20h 10m 19.271s	-23° 24' 41.41"
Moon	11h 56m 35.736s	+01° 09' 49.32"	11h 54m 56.011s	+00° 33' 39.41"

(TA) - True Altitude. Computed with no atmosphere. The observer lies at sea level
(OA) - Observed Altitude. Corrected for Refraction and Observer's Height above sea level

LOCATION : Roma Italy
Longitude: + 12° 29' 04.992"
Latitude : + 41° 53' 34.00"
Elevation: 150

Body	OA	Azimuth(NESW)
Sun	-32° 17.6'	298° 21.3'
Moon	-34° 54.4'	310° 38.1'
Mercury	-30° 54.6'	297° 58.0'
Venus	-18° 52.6'	266° 27.2'
Mars	-17° 28.5'	032° 31.9'
Jupiter	-04° 45.5'	053° 26.4'
Saturn	+34° 59.1'	148° 17.3'
Uranus	+10° 10.2'	072° 50.1'
Neptune	+34° 30.0'	131° 24.4'
Pluto	+23° 03.9'	197° 46.6'
J1	-04° 44.5'	053° 27.8'
J2	-04° 46.4'	053° 25.1'
J3	-04° 44.6'	053° 27.2'
J4	-04° 40.9'	053° 32.8'

PABL (Position Angle of the Bright Limb) referred to the Celestial Pole and Zenith:

Mercury	234° 27.7'	193° 17.4'
Venus	288° 44.7'	238° 22.0'
Mars	096° 36.2'	122° 24.3'
Jupiter	086° 28.5'	126° 47.1'
Saturn	242° 30.7'	265° 47.5'
Uranus	076° 56.3'	125° 48.2'
Neptune	239° 42.3'	273° 39.3'
Pluto	256° 23.3'	242° 02.9'
Moon	117° 25.1'	079° 06.3'

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Sub-solar, Sub-lunar and Sub-planetary points.

Body	Longitude (+ East)	Latitude
Sun	-119° 36' 01.210"	- 3° 36' 51.78"
Moon	-128° 49' 45.643"	+ 1° 09' 49.32"
UMBRA	+ 60° 23' 58.790"	+ 3° 36' 51.78"
Mercury	-118° 26' 28.581"	- 2° 47' 19.32"
Venus	- 89° 53' 12.844"	- 15° 17' 50.33"
Mars	+158° 40' 20.546"	+ 23° 06' 30.41"
Jupiter	+132° 32' 37.788"	+ 22° 26' 12.04"
Saturn	+ 38° 25' 01.175"	- 8° 11' 56.69"
Uranus	+106° 40' 37.792"	+ 19° 12' 05.84"
Neptune	+ 50° 54' 52.039"	- 1° 55' 32.98"
Pluto	- 5° 23' 52.554"	- 23° 24' 41.18"

Local Hour Angle and Declination

Body	Local HA	Dec
Sun	+132.0864°	-03.6159°
Moon	+141.7296°	+00.5609°
Mercury	+130.9270°	-02.7898°
Venus	+102.3730°	-15.2984°
Mars	-146.1885°	+23.1068°
Jupiter	-120.0595°	+22.4363°
Saturn	-025.9324°	-08.1993°
Uranus	-094.1925°	+19.2015°
Neptune	-038.4298°	-01.9259°
Pluto	+017.8827°	-23.4115°
SIRIUS	-141.0960°	-16.7455°
VEGA	+041.0192°	+38.8104°
ARCTURUS	+106.2696°	+19.0558°
RIGEL	-118.4713°	-08.1693°
CAPELLA	-119.1697°	+46.0211°
PROCYON	-154.6849°	+05.1639°
ALTAIR	+022.4640°	+08.9359°
SPICA	+118.8436°	-11.2888°
ANTARES	+072.7344°	-26.4872°
ALDEBARAN	-108.8756°	+16.5604°
POLLUX	-156.2428°	+27.9664°
DENEB	+009.8920°	+45.3725°
REGULUS	+168.0448°	+11.8481°
CASTOR	-153.5797°	+31.8332°
NUNKI	+036.2627°	-26.2667°
HAMAL	-071.6850°	+23.5810°
MARKAB	-026.0401°	+15.3410°
SCHEAT	-025.7855°	+28.2198°
ALCYONE	-096.7807°	+24.1823°
MIRA	-074.6917°	-02.8625°

Solar System Barycenter equatorial coordinates with respect to the JNOW equinox.
Values are in Solar Radius Unit (Haberreiter, Schmutz & Kosovichev (2008) = 695,660 ± 140 Km)
G is the distance of SSB from solar center of mass (COM), expressed in solar radii.
if G > 1 then the SSB lies out of the solar surface, not a rare event.
Max. value for G is 2.17. The most relevant contribution to the SSB erratic movement is given
by Jupiter, Saturn, Neptune and Uranus (49%, 27%, 15%, 8% respectively).

SSB X = -1.360 8229
SSB Y = -0.918 1400
SSB Z = -0.353 6923
G = 1.679

End of Part 1

Part 2 contains explanations about tools available