WebGeocalc (WGC)

https://wgc.jpl.nasa.gov:8443/webgeocalc (GUI only)
https://wgc2.jpl.nasa.gov:8443/webgeocalc (GUI and API)

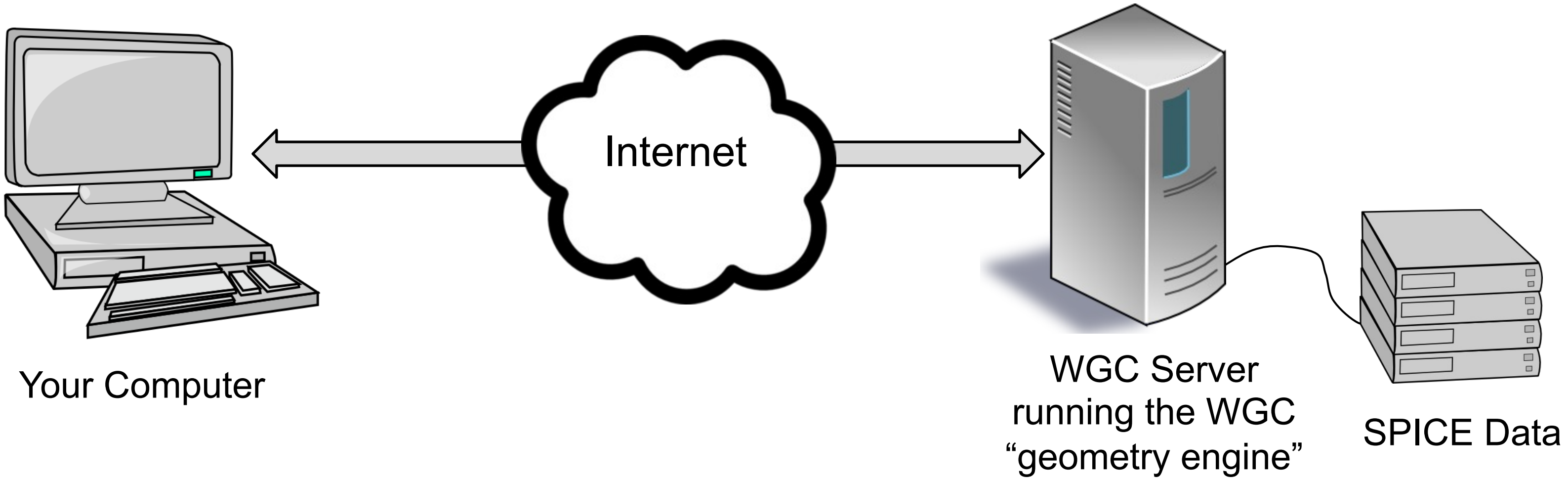
April 2023

Overview

- WebGeocalc (WGC) provides a graphical user interface (GUI) to a SPICE server running a geometry computation engine
  - The server has access to SPICE kernels containing ancillary data
- Some WGC installations also offer a programmatic(API) interface to the WGC SPICE geometry engine
- This tutorial covers mostly the GUI interface. The API interface is described in a link provided in the API-enabled version of WGC

Architecture

- **WGC uses a client-server architecture**
  - **The user needs only a computer running a web browser**
  - **The browser connects via Internet to a WGC "computation engine" running on a server**
    - **The WGC server has access to a variety of SPICE kernel files**



Using WebGeocalc

- **WGC makes it "easy" to do many kinds of SPICE computations**
  - You need not write a program using SPICE Toolkit software
  - Instead, open a web browser and use standard GUI widgets to:
    - » select the computation desired
    - » select the data to be used in your computation
    - » specify the computation details
    - » press the "CALCULATE" button
  - Your results, possibly including some plots, appear in your browser window
  - WGC has a good deal of built-in HELP
- **WGC computations are limited in scope: the tool cannot do nearly as much as an own-built program that uses SPICE Toolkit APIs**
  - But WGC can probably do a good deal more than you first realize!

Purpose

- WGC can support planetary science in several ways
  - Help a user check his/her own SPICE-based program under development (the “gold bar” check)
  - Help a user quickly solve a one-time space geometry problem
  - Allow those unable to write a SPICE-based program to nevertheless make some kinds of space geometry computations
  - Help a science data peer reviewer do spot checks of geometry parameters contained in an archive about to be submitted to an archive center

Computations

- **Three categories of SPICE computations are possible**

1. **Geometry Calculator**
   - » Compute a parameter value at a given time, or over a time range
     - Example: Compute the angular size of Phobos as seen from the SPIRIT Mars rover from 2009 March 10 12:00:00 to 2009 March 10 14:00:00
2. **Geometric Event Finder**
   - » Within a specified time bounds (the confinement window)…
     - Find time intervals when a particular geometric condition exists
       - Example: Find time intervals when Phobos is occulted by Mars as seen from Mars Odyssey within the period 2010 June 01 to 2010 June 02
     - Find time intervals when a geometry parameter is within a given range
       - Example: Find time intervals when the spacecraft altitude is between 300 and 400 km
     - Find time intervals when a geometry parameter has reached a local or global maximum or minimum
       - Example: Find time intervals when the angular separation of a satellite from a planet, as seen from a spacecraft, has reached its minimum value
3. **Time conversion calculator**
   - » Convert between various time systems and time formats

- **See the WGC "menu" on the next page for some details**

Computation Menu*

Geometry Calculator

State Vector	Calculate the position and velocity of a target with respect to an observer.
Angular Separation	Calculate the angular separation between two targets as seen from an observer.
Angular Size	Calculate the angular size of a target as seen from an observer.
Frame Transformation	Calculate the transformation between two reference frames.
Illumination Angles	Calculate the emission, phase and incidence angles at a point on a target as seen from an observer.
Phase Angle	Calculate the phase angle defined by the centers of an illuminator, a target and an observer.
Pointing Direction	Calculate the pointing direction in a user specified reference frame.
Sub-solar Point	Calculate the sub-solar point on a target as seen from an observer.
Sub-observer Point	Calculate the sub-observer point on a target as seen from an observer.
Surface Intercept Point	Calculate the intercept point of a vector or vectors on a target as seen from an observer.
Orbital Elements	Calculate the osculating elements of the orbit of a target body around a central body.

Geometric Event Finder

Position Finder	Find time intervals when a coordinate of an observer-target position vector satisfies a condition.
Angular Separation Finder	Find time intervals when the angle between two bodies, as seen by an observer, satisfies a condition.
Distance Finder	Find time intervals when the distance between a target and observer satisfies a condition.
Sub-point Finder	Find time intervals when a coordinate of the sub-observer point on a target satisfies a condition.
Occultation Finder	Find time intervals when an observer sees one target occulted by, or in transit across, another.
Surface Intercept Finder	Find time intervals when a coordinate of a surface intercept vector satisfies a condition.
Target in Field of View Finder	Find time intervals when a target intersects the space bounded by the field-of-view of an instrument.
Ray in Field of View Finder	Find time intervals when a specified ray is contained in the space bounded by an instrument's field-of-view.
Range Rate Finder	Find time intervals when the range rate between a target and observer satisfies a condition.
Phase Angle Finder	Find time intervals when the phase angle defined by the centers of an illuminator, target and observer satisfies a condition.
Illumination Angles Finder	Find time intervals when the illumination angles at a target surface point satisfy a condition.

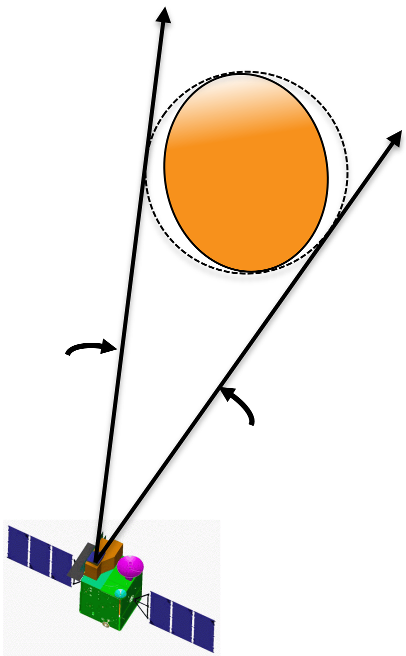
Time Calculator

Time Conversion	Convert times from one time system or format to another.

* Current as of March 2023; more computations will be added in the future

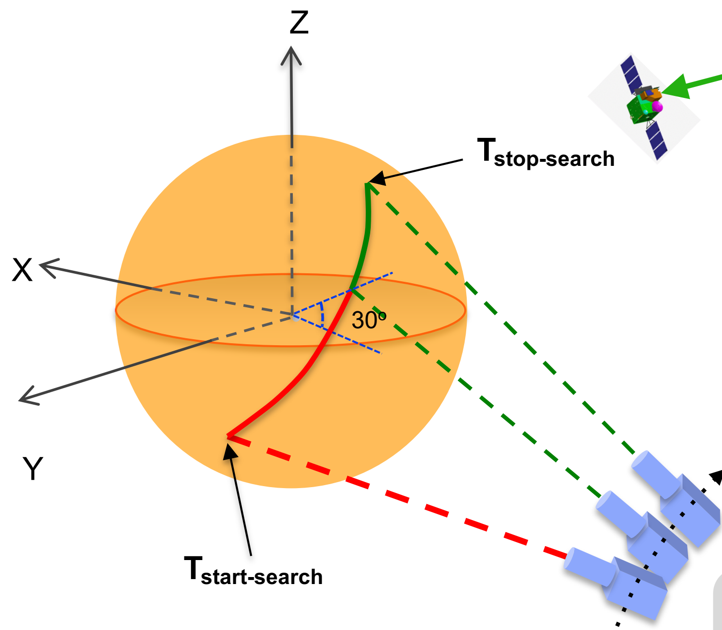
Illustrations of Three Available Computations

Navigation and Ancillary Information Facility



Geometry Calculator

Angular Size

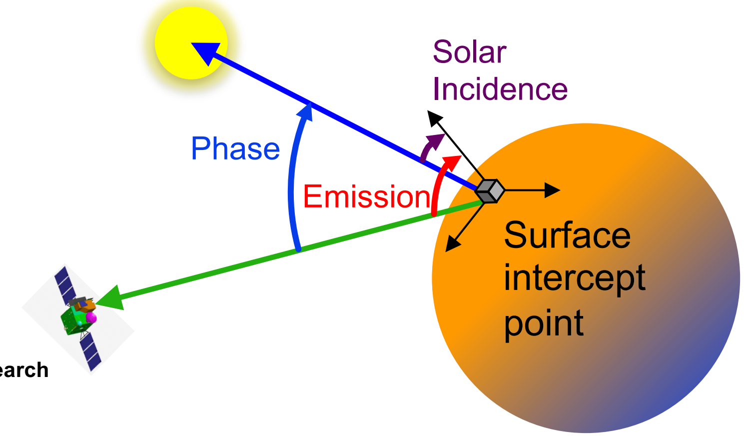


Camera scanning across the planet's surface

The **GREEN** trace shows when the latitude of the instrument boresight surface intercept is greater than 30 degrees, within the time range $T_{start\text{-}search}$ to $T_{stop\text{-}search}$.

Geometric Event Finder

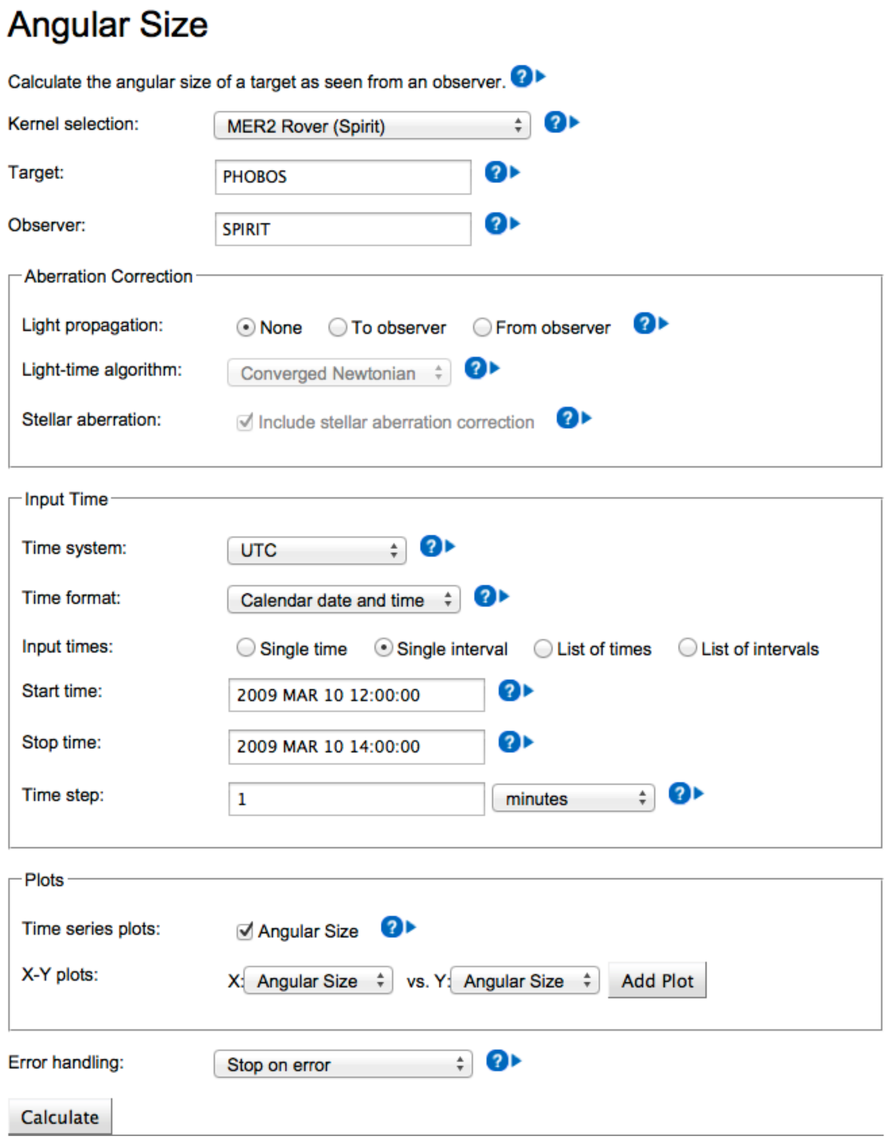
Surface Intercept Event Finder



Geometry Calculator

Illumination Angles

Typical Geometry Calculator Input



- Compute the angular size of Phobos as seen from the Mars rover “SPIRIT” over a two hour period on 2009 March 10.
- Use typical GUI drop-down menus, fill-in boxes, radio buttons and check boxes to specify the details of the computation you wish to make.

Typical Geometry Calculator Output

Navigation and Ancillary Information Facility

Input Values

Calculation type	Angular Size
Target	PHOBOS
Observer	SPIRIT
Light propagation	No correction
Time system	UTC
Time format	Calendar date and time
Time range	2009 MAR 10 12:00:00 to 2009 MAR 10 14:00:00, step 1 minutes

Summary of your input

Tabular Results

Click a value to save it for a subsequent calculation.

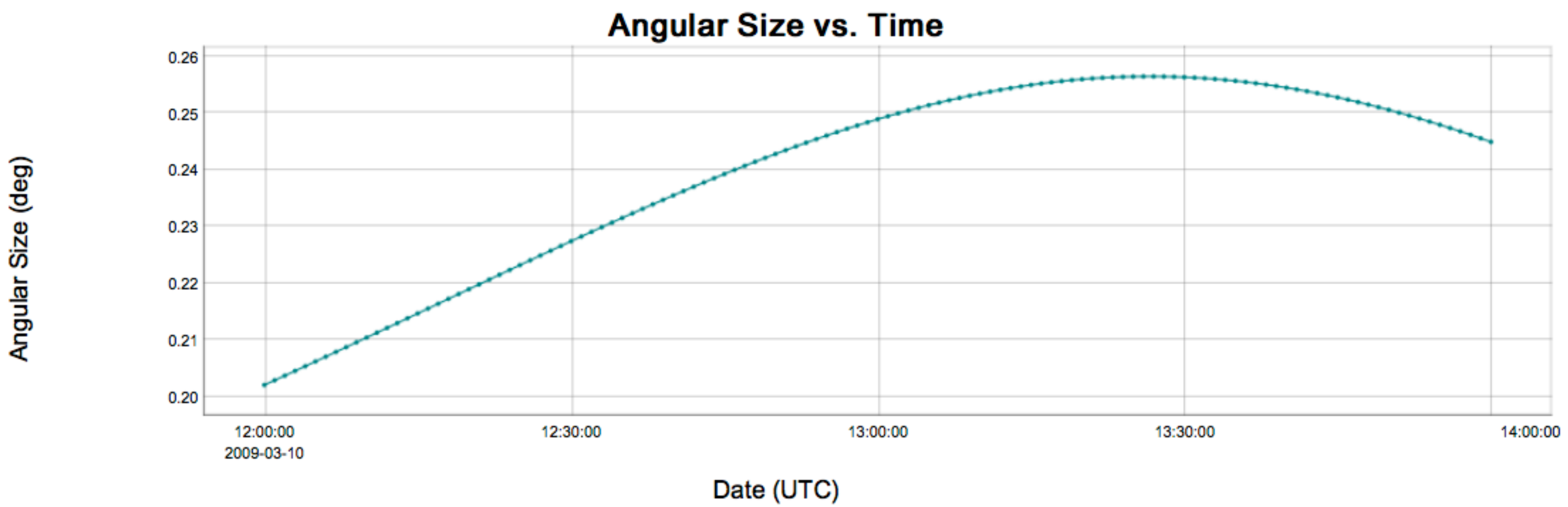
	UTC calendar date	Angular Size (deg)
1	2009-03-10 12:00:00.000000 UTC	0.20212256
2	2009-03-10 12:01:00.000000 UTC	0.20294481
3	2009-03-10 12:02:00.000000 UTC	0.20377024
4	2009-03-10 12:03:00.000000 UTC	0.20459871
5	2009-03-10 12:04:00.000000 UTC	0.20543007
6	2009-03-10 12:05:00.000000 UTC	0.20626418
7	2009-03-10 12:06:00.000000 UTC	0.20710088
8	2009-03-10 12:07:00.000000 UTC	0.20794000
9	2009-03-10 12:08:00.000000 UTC	0.20878138
10	2009-03-10 12:09:00.000000 UTC	0.20962484
11	2009-03-10 12:10:00.000000 UTC	0.21047019
12	2009-03-10 12:11:00.000000 UTC	0.21131725
13	2009-03-10 12:12:00.000000 UTC	0.21216581
14	2009-03-10 12:13:00.000000 UTC	0.21301567

Angular size of Phobos as seen from the Mars rover "SPIRIT"

Tabular results

Typical Geometry Calculator Plot

- **Some Geometry Calculator computations offer optional plots**

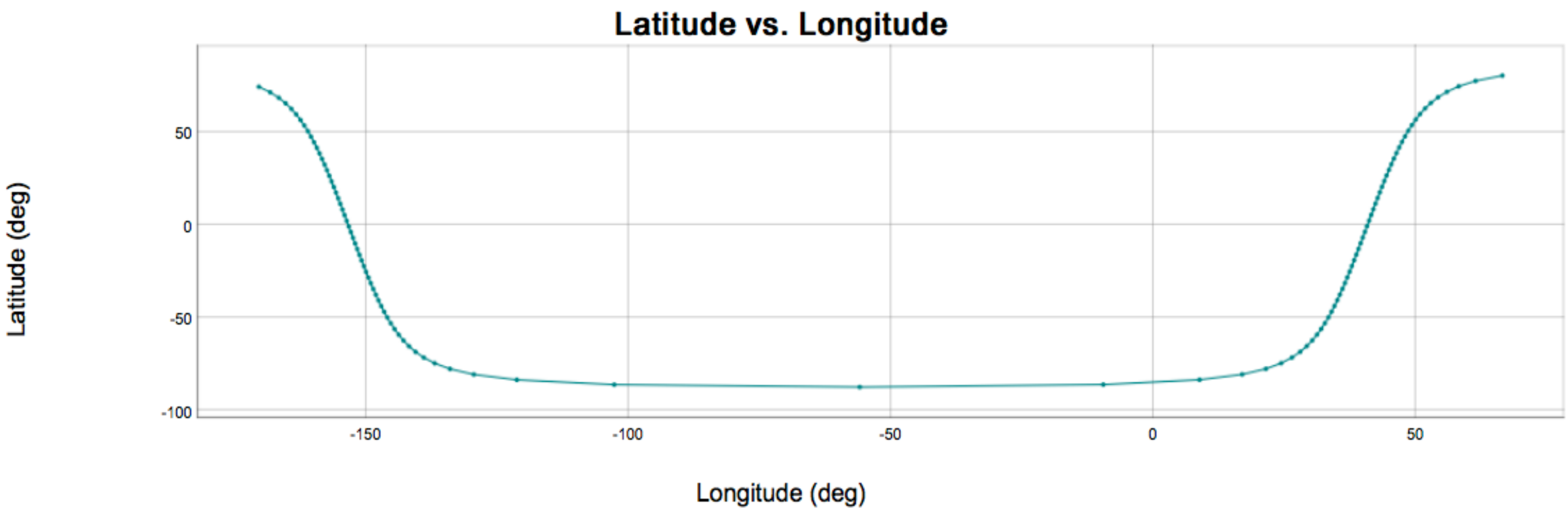


Angular size of Phobos as seen from the Mars rover "SPIRIT"

Another Geometry Calculator Plot

Navigation and Ancillary Information Facility

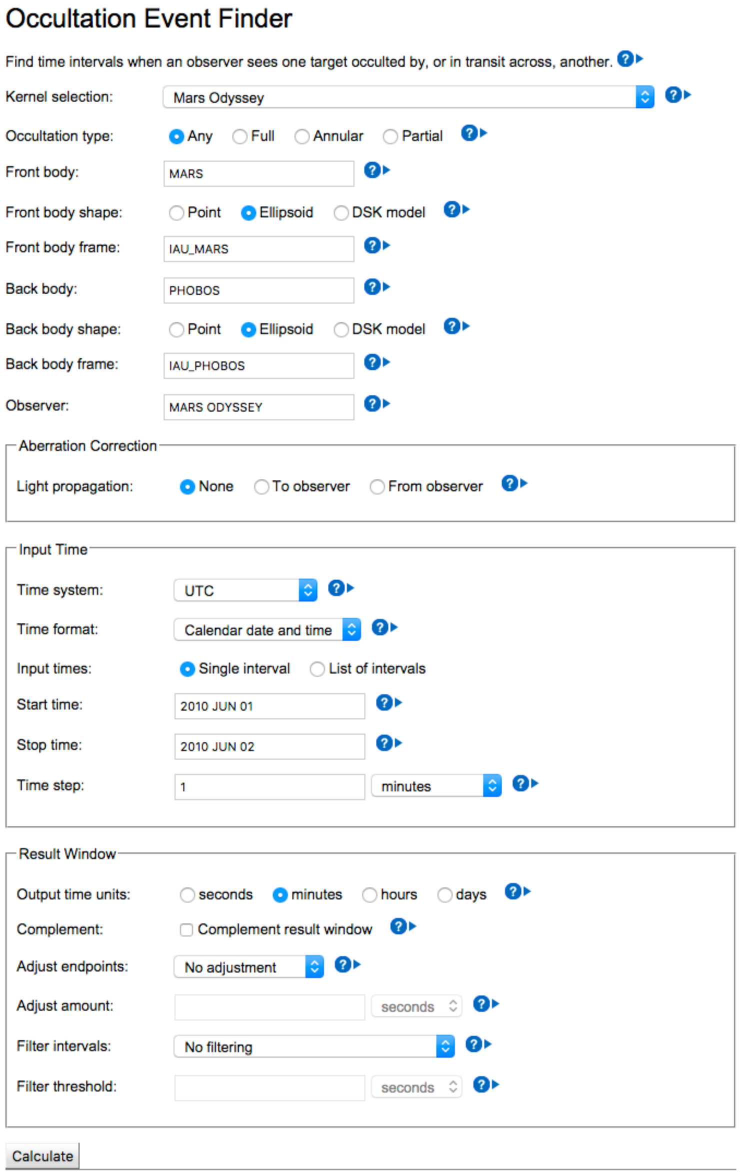
- **Some Geometry Calculator computations offer plots using other than time on the X axis**



Mars Global Surveyor sub-point on Mars

from 2008 JAN 1 00:10:00 to 2008 JAN 1 02:00:00

Typical Geometric Event Finder Input



- **Find the times when Phobos is occulted by Mars as viewed from the Mars Odyssey spacecraft, during the period 2010 JUN 01 to 2010 JUN 02.**
- **Use typical GUI drop-down menus, fill-in boxes, radio buttons and check boxes to specify the details of the computation you wish to make.**

Typical Geometric Event Finder Output

Navigation and Ancillary Information Facility

Input Values

Calculation type	Occultation Event Finder
Occultation type	Any
Front body	MARS
Front body shape	Ellipsoid
Front body frame	IAU_MARS
Back body	PHOBOS
Back body shape	Ellipsoid
Back body frame	IAU_PHOBOS
Observer	MARS ODYSSEY
Light propagation	No correction
Time system	UTC
Time format	Calendar date and time
Time range	2010 JUN 01 to 2010 JUN 02
Step	1 minutes
Output time unit	minutes
Complement result window	no
Result interval adjustment	No adjustment
Result interval filtering	No filtering

Summary of your input

When is Phobos occulted by Mars as seen from Mars Odyssey?

Tabular Results

Click a value to save it for a subsequent calculation.

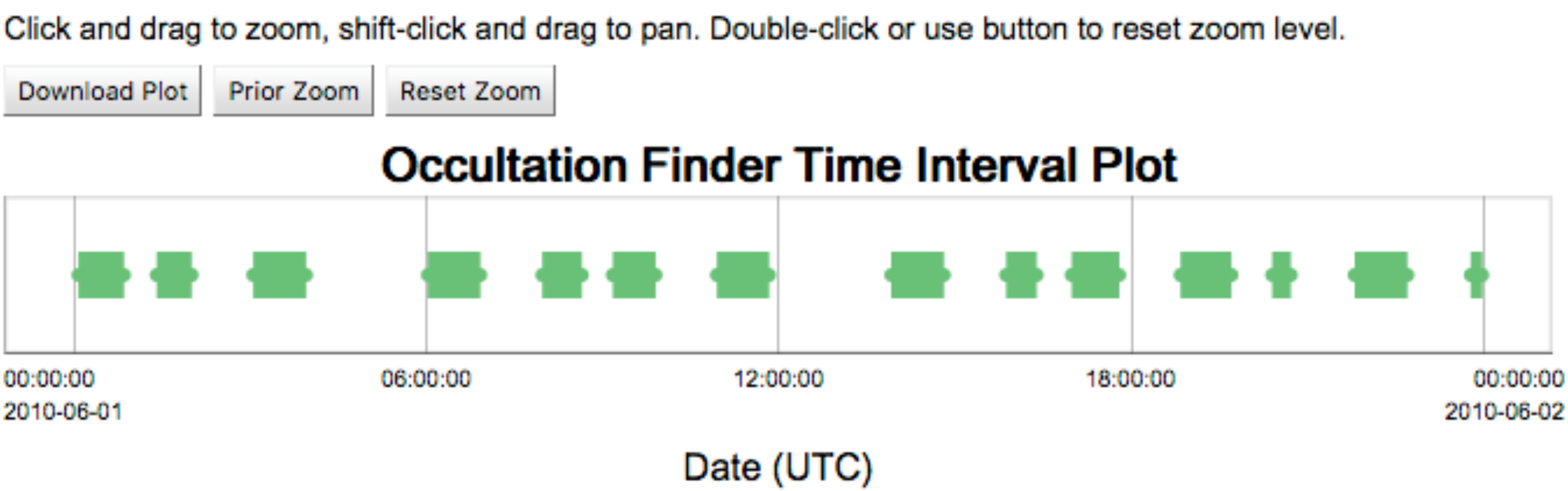
Save All Intervals

	Start Time	Stop Time	Duration (mins)
1	2010-06-01 00:04:26.044991 UTC	2010-06-01 00:51:10.243911 UTC	46.73664866
2	2010-06-01 01:24:29.583277 UTC	2010-06-01 02:00:24.436145 UTC	35.91421447
3	2010-06-01 03:03:10.426707 UTC	2010-06-01 03:57:18.102560 UTC	54.12793088
4	2010-06-01 06:01:49.759691 UTC	2010-06-01 06:55:34.702564 UTC	53.74904789
5	2010-06-01 07:58:43.124284 UTC	2010-06-01 08:39:21.185492 UTC	40.63435347
6	2010-06-01 09:10:48.850884 UTC	2010-06-01 09:54:44.464484 UTC	43.92689334
7	2010-06-01 10:57:18.650296 UTC	2010-06-01 11:50:49.315679 UTC	53.51108973
8	2010-06-01 13:55:36.207413 UTC	2010-06-01 14:49:37.807259 UTC	54.02666411
9	2010-06-01 15:53:04.681014 UTC	2010-06-01 16:24:27.102771 UTC	31.37369595
10	2010-06-01 17:00:06.171340 UTC	2010-06-01 17:48:55.450641 UTC	48.82132168
11	2010-06-01 18:51:22.483546 UTC	2010-06-01 19:43:35.606641 UTC	52.21871826
12	2010-06-01 20:25:04.776643 UTC	2010-06-01 20:44:18.007484 UTC	19.22051402
13	2010-06-01 21:49:30.118805 UTC	2010-06-01 22:43:33.989673 UTC	54.06451446

Tabular results

Typical Geometric Event Finder Plot

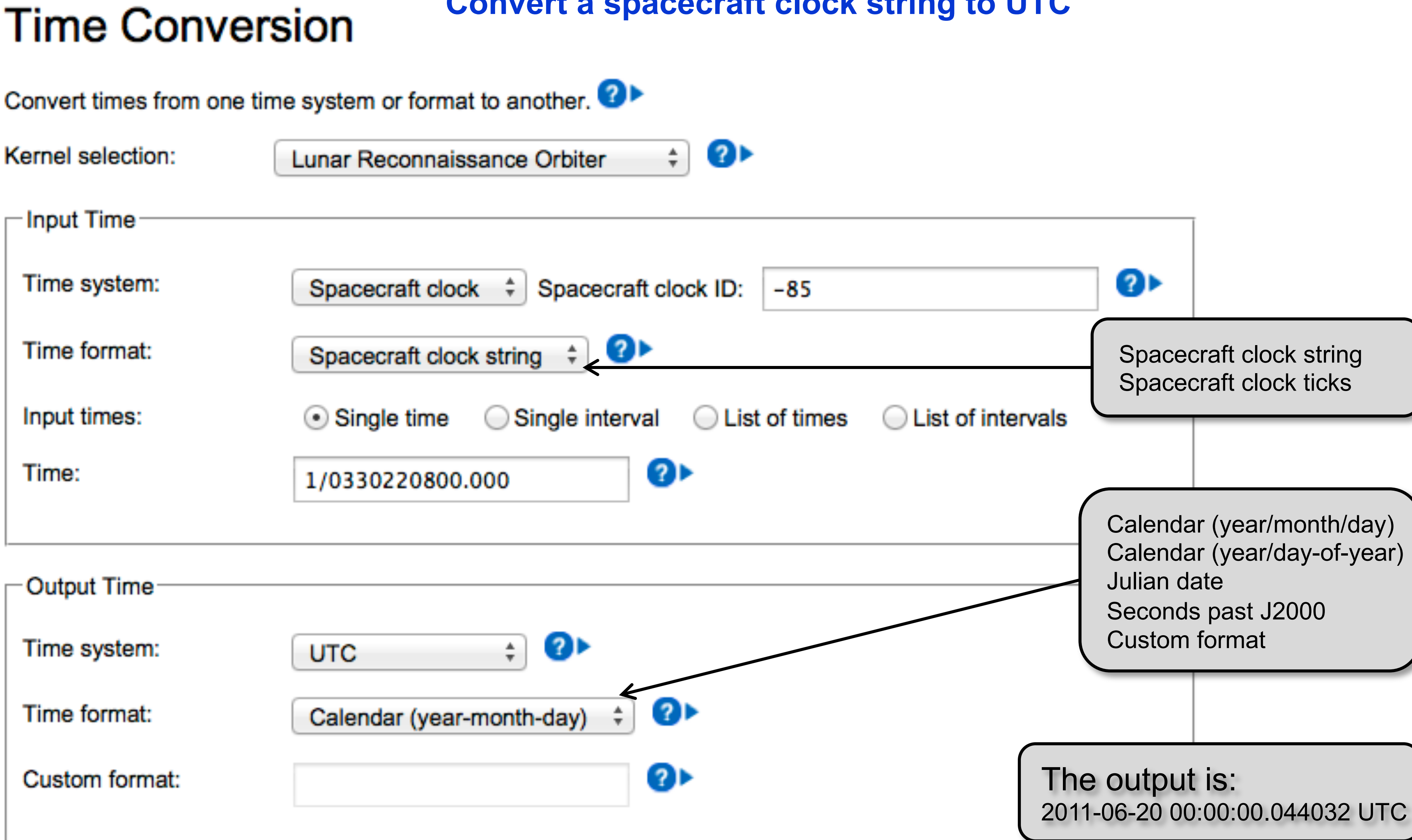
- **Geometric Event Finder computations all produce “plots” of the time intervals that satisfy your search computations**



Between June 1, 2010 and June 2, 2010, find times when Phobos is occulted by Mars, as viewed from the Mars Odyssey spacecraft

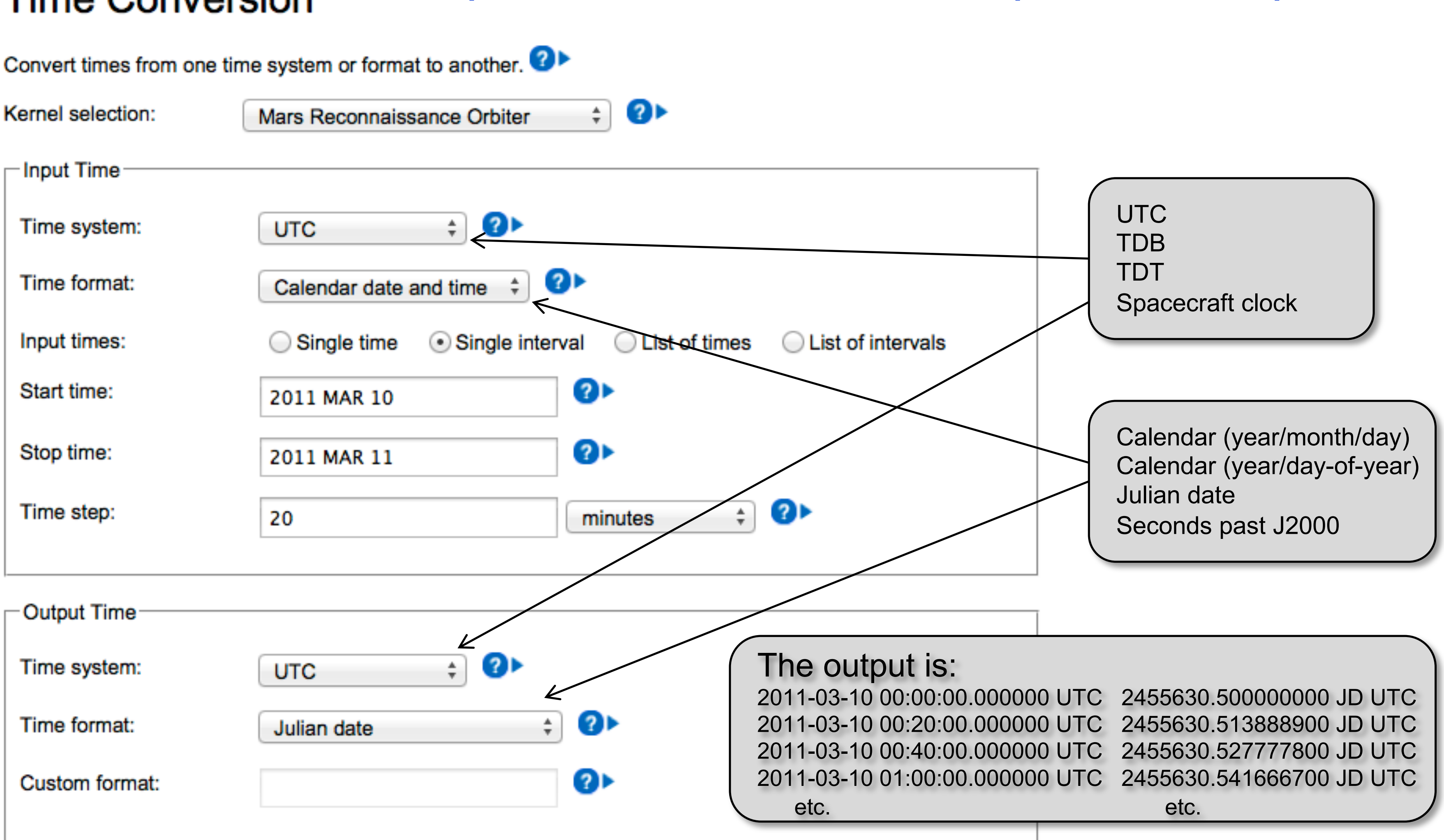
Example of Time Conversion

Convert a spacecraft clock string to UTC



Second Example of Time Conversion

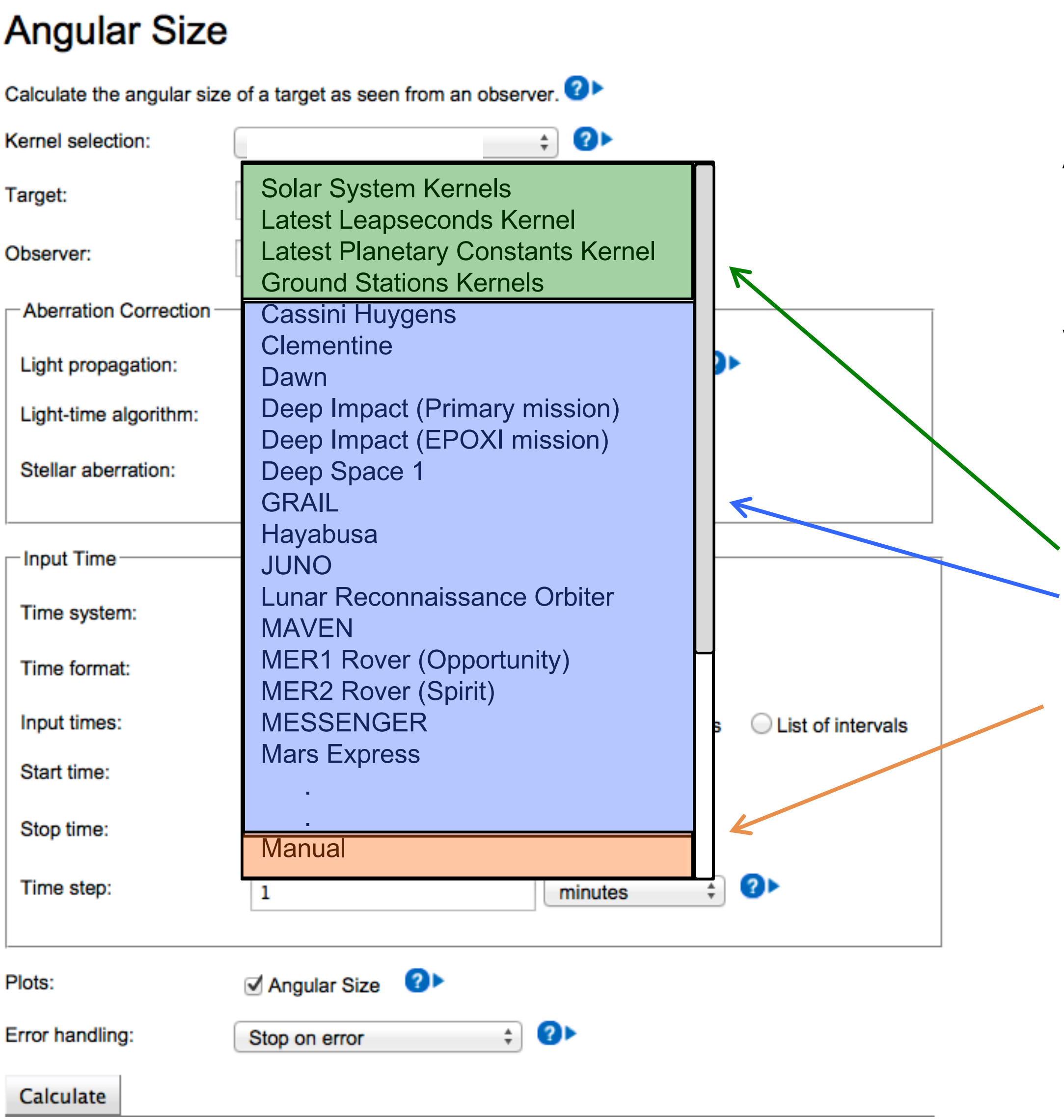
Compute a series of UTC times with a specified time step



Categories of Available Data

- **The JPL/NAIF Group is operating two WGC servers**
  - **These servers provide access to three categories of SPICE kernels**
    - » **Generic SPICE kernels, not specifically tied to a single planetary mission**
    - » **Archived SPICE kernels, from planetary missions that have been formally ingested into NASA's Planetary Data System**
      - **This includes a few non-NASA missions for which NAIF provides a shadow archive**
    - » **Operations SPICE kernels, for JPL-operated planetary missions, for three ESA planetary missions, and for a few past missions for which an archive does not exist**
      - **This category often includes some predictive data**
      - **This category is the most difficult to use because…**
        - **there are no meta-kernels for these collections**
        - **there is sometimes a large number of kernels from which you must choose the ones needed**
        - **there is little readily available information to help you make your kernel choices**
  - **VERY IMPORTANT: Read the "*About the data*" webpage provided within the tool for details**

Kernel Selection

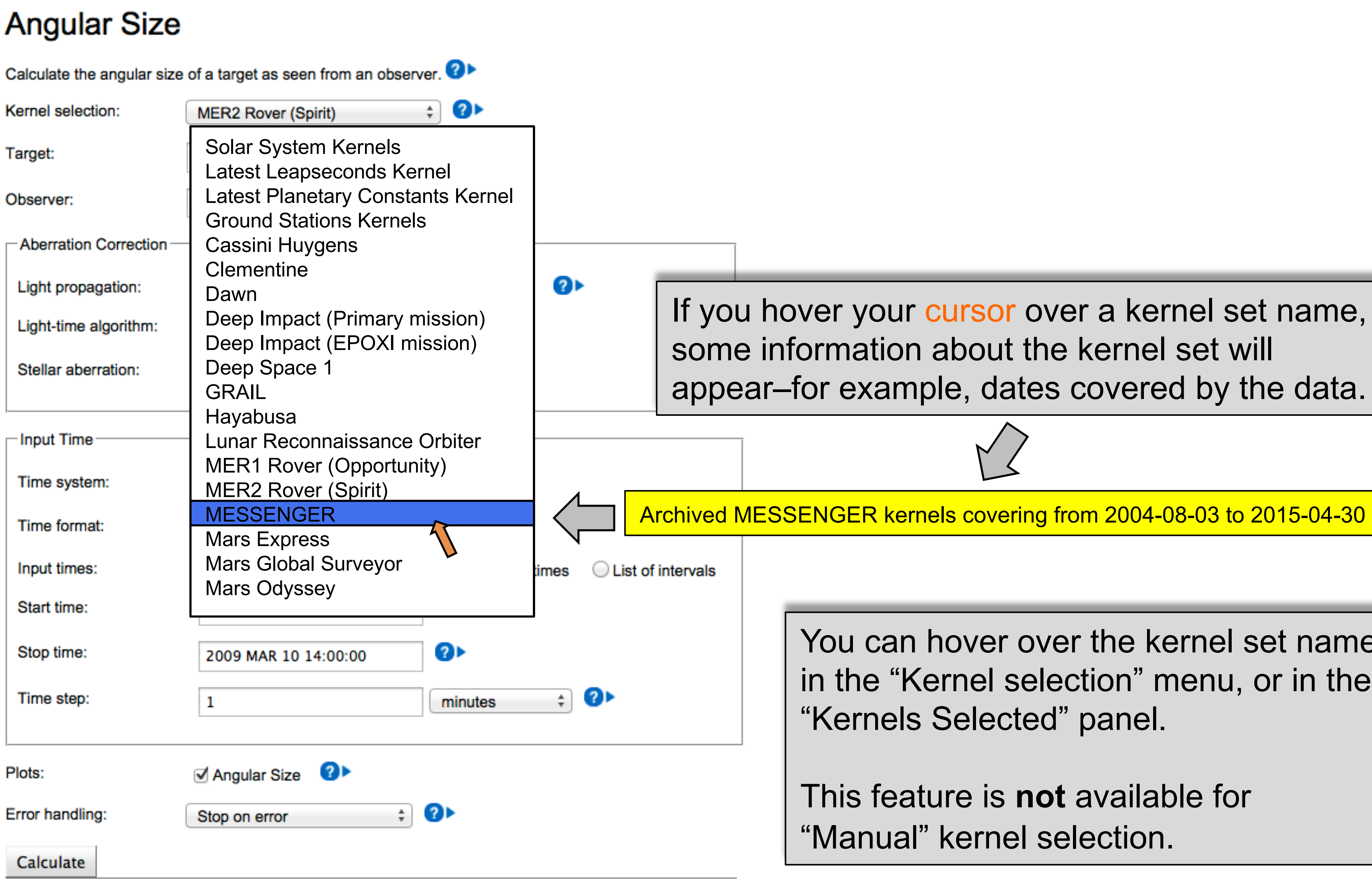


A scrollable drop-down menu is used to select the kernel set(s) to be used in your calculation.

Use the menu to select:
- **generic kernel sets**
- **archived mission kernel sets (includes relevant generic kernels)**
- **manual selection of individual kernels from operations collections**

"Tooltip" Feature

Navigation and Ancillary Information Facility



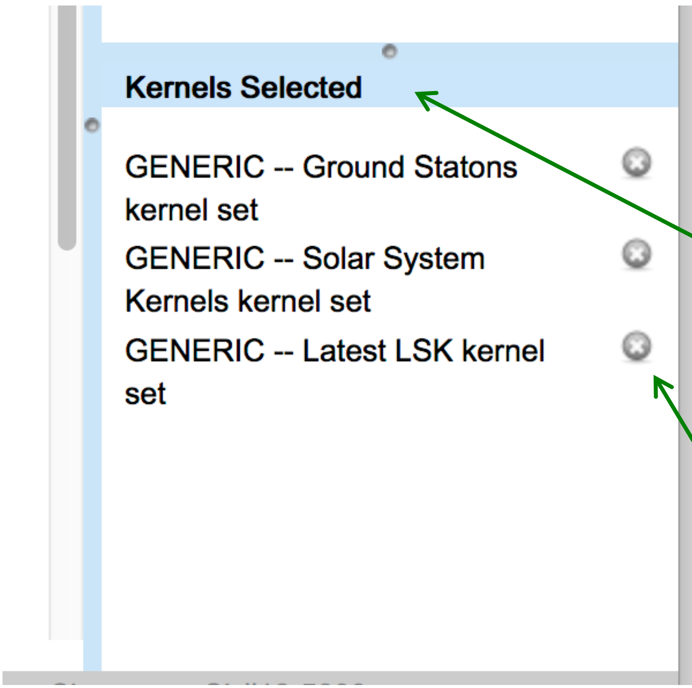
If you hover your cursor over a kernel set name, some information about the kernel set will appear–for example, dates covered by the data.

You can hover over the kernel set name in the "Kernel selection" menu, or in the "Kernels Selected" panel.

This feature is **not** available for "Manual" kernel selection.

Pre-load Feature

Navigation and Ancillary Information Facility



WGC automatically loads at startup (“pre-loads”) generic kernel sets that are often needed in WGC calculations.

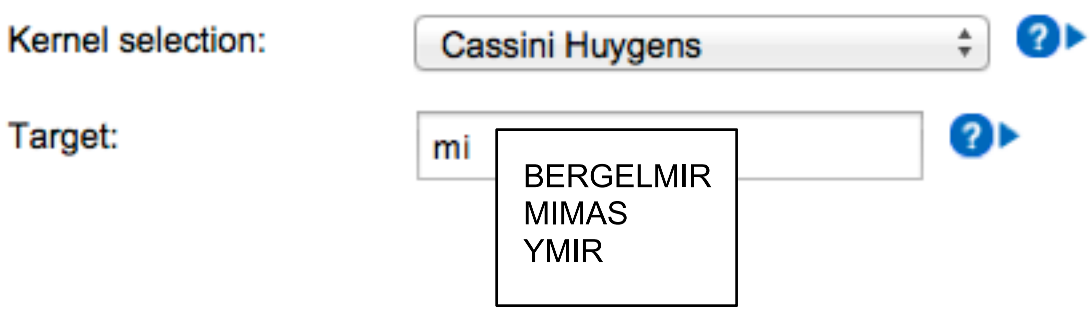
Pre-loaded kernel sets appear in the “Kernels Selected” area at the bottom-right of any WGC page.

Any of these pre-loaded kernel sets can be unloaded if desired using the (x) symbol appearing next to it

Auto-complete Feature

Navigation and Ancillary Information Facility

- **If you select any kernel set(s) other than “Manual”, many of the input widgets will be supplied with the names of all available selections**
  - **Just start typing the name you want and all items matching what you typed will appear in a drop down menu**
  - **Alternatively, simply type a “blank” and all items available within the kernel set(s) you selected will appear**
- **In the example below, using the Cassini Huygens archive, the user has typed “mi” in the “Target” selection box. The names of the three objects containing those letters are displayed for the user’s selection. (All three are satellites of Saturn.)**



Downloading Results

- You can download tabular results to your computer by clicking the “Download Results” button, then selecting the format desired:
  - Excel
  - Comma separated values
  - Plain text

- You can download any plots you've created by clicking on the “Download Plot” button
  - Plots are saved in PNG format with a transparent background
    - Easily pasted into a document or presentation

Saving Results for Use as New Inputs

Navigation and Ancillary Information Facility

- You can save a numeric output, or an event finder interval start or stop time, by clicking on the value
  - The saved value will appear in a “Saved Values” panel on the right side of your browser window
  - This value can then be dragged to an input widget in a subsequent calculation

- You can save a complete set of event finder output interval start and stop times by clicking the “Save All Intervals” button
  - These can then be used as part of the input for a subsequent geometric event finder computation if you select “List of intervals” for the “Input times” selection. Simply drag the list of saved intervals to the "List of intervals" box.

WGC Programmatic Interface

- **NAIF also offers a programmatic(API) interface to the WGC SPICE geometry engine**
  - To use this interface, one writes a program that constructs JSON payloads identifying the computation of interest, the kernel set(s) to be used, and the computation inputs, and submits them to the WGC server using RESTful URLs
  - The WGC SPICE geometry engine executes the computation and returns the results in JSON format
- **The "API Docs" link found near the top-right of a WGC installation having the API interface points to a page with complete details**
  - For the NAIF instance, that link is also provided here: https://wgc2.jpl.nasa.gov:8443/webgeocalc/documents/api-info.html

Getting Help

- WGC users must read the "*About the Data*" web page to understand the kinds of SPICE kernels (data) available to the WGC tool
- Each calculation and most GUI controls have associated HELP available by clicking the ? icon
- Most computation descriptions have an associated graphic depicting one or more examples of what may be computed
- Some GUI controls have a second-level, more extensive help description, available by clicking the "Read more…" text displayed in the first level help

Usage Rules

- The WGC program has a link entitled "*Rules of Use*"
  - WGC users must read and abide by these rules

- While easier than writing a SPICE-aware program, using WGC nevertheless requires some knowledge of space geometry and of NASA's SPICE system
  - The NAIF website provides much SPICE information:
    - https://naif.jpl.nasa.gov

Limited Capability

- **WGC does not provide all of the space geometry computational capability offered by the SPICE Toolkits**
  - **But WGC nevertheless provides substantial capability–likely more than is obvious at first glance**
- **More capability might be added if the user community finds this tool useful**

Feedback

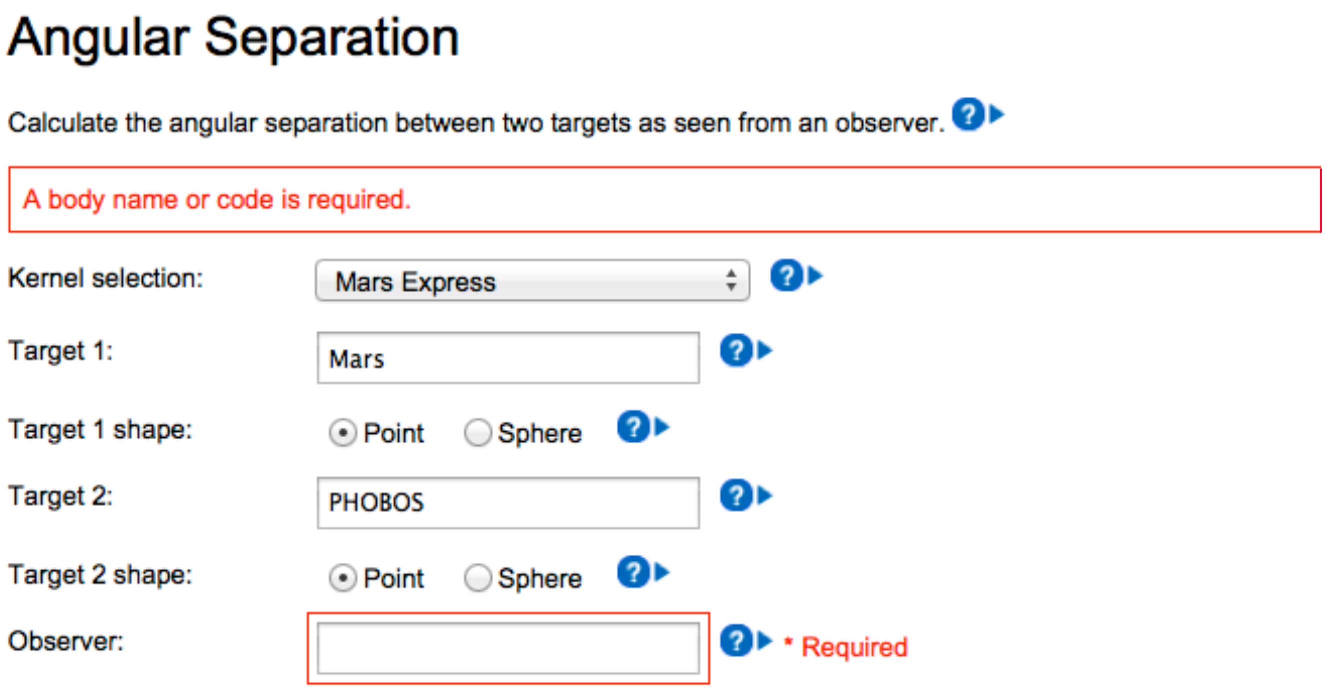
- **WGC includes a "*Feedback*" button, making it rather easy to provide the NAIF team with any sort of useful feedback…**
  - **What you like or don't like about WGC**
  - **What seems incorrect, incomplete or unclear**
  - **What features you would like to see added**
    - » **Caution: NAIF already has a long list of improvements we'd like to make, so we make no promises to act on any specific feedback**

Problems Using WGC

- **There are several limitations and errors you might encounter in using WebGeocalc**
  - See the next several pages for examples
  - Some of these conditions could be unique to the WGC installation at NAIF, and not exist with some other installation

Missing Input

- **WGC will alert you to missing inputs.**



Request is Too Large

- **WGC has limits set on computational resources.**
  - No more than 50,000 "Geometry Calculator" computations
  - No more than 10 million "Geometric Event Finder" time steps
  - No more than 3 minutes of wall clock time
- **If any of these limits will be (or have been) exceeded, you'll see a message saying so and your computation request will be terminated.**
- **Some examples:**

Too many data points. This version of WebGeocalc can only calculate 50000 data points in a single calculation, and the requested time inputs specify 631152010 data points. Either use a smaller time range or a larger time step. NAIF plans to remove this restriction in a future version of WebGeocalc.

Time step is too small. This version of WebGeocalc requires the time step to be at least 1.0E-7 times the size of the time window. The requested time step is only 9.506426208650559E-8 times the size of the window. Either specify a smaller time range or a larger time step.

SPICE Error Messages

- WGC will display a SPICE Toolkit error message when an underlying SPICE API is able to detect a problem.
- These SPICE error messages all begin with:

  “CSPICE_N00xx:”   followed by some text

- Refer to the remaining charts for some examples.

Unusable Time Tag(s) - 1

- Time tag processing within WGC makes use of SPICE Toolkit modules.
- These Toolkit modules offer a great deal of capability. But not every conceivable style of time tag, and not every time system, are acceptable.
- What to do?
  - Use the help icons ? next to any Time system or Time format input.
  - See Appendix 2 of the CHRONOS User's Guide for some details and many examples.
    - » https://naif.jpl.nasa.gov/misc/chronos_ug.html
  - See the Time Required Reading document for a full explanation of time treatment within SPICE.
    - » https://naif.jpl.nasa.gov/pub/naif/toolkit_docs/FORTRAN/req/time.html

Unusable Time Tag(s) - 2

Navigation and Ancillary Information Facility

- **A few examples of bad time tags and resultant error messages.**
  - Using UTC and Calendar format, and inputting: 2010:10:03 05:44:12

    CSPICE_N0065: CSPICE.str2et: SPICE(UNPARSEDTIME): [str2et_c --> STR2ET] The meaning of the integer <03> could not be determined: ' 2010:10:<03> 05:44:12'

    - » Would have worked using: 2010-10-03 05:44:12 or 2010/10/03 05:44:12
  - Using UTC and Calendar format, and inputting: 2455160.098304

    CSPICE_N0065: CSPICE.str2et: SPICE(UNPARSEDTIME): [str2et_c --> STR2ET] The meaning of the decimal number <2455160.098304> could not be determined: <2455160.098304>

    - » Needed to specify "Julian date" format
  - Using UTC and Calendar format, and inputting: 2010:10:03T05:44:12

    CSPICE_N0065: CSPICE.str2et: SPICE(UNPARSEDTIME): [str2et_c --> STR2ET] The input string uses the ISO "T" date/time delimiter but does not match any of the accepted ISO formats.

    - » Instead, use an ISO-defined format such as: 2010-10-03T05:44:12
      - (For separators, use dashes before the "T" and colons after the "T")

Unusable Time Tag(s) - 3

Navigation and Ancillary Information Facility

- **A few more examples of bad time tags and resultant error messages.**
  - Using UTC and Calendar format, and inputting: 2010-10-03 05:44:12 JD

    CSPICE_N0065: CSPICE.str2et: SPICE(UNPARSEDTIME): [str2et_c --> STR2ET] The meaning of the integer <12> could not be determined: ' 2010-10-03 05:44:<12> JD'

    - » 2010-10-03 05:44:12 is not a Julian date format: remove the trailing JD
  - Using TDB and Julian date format, and inputting: 2.4404005000000000 D+06

    CSPICE_N0065: CSPICE.str2et: SPICE(UNPARSEDTIME): [str2et_c --> STR2ET] The meaning of the integer <06> could not be determined: ' 2.4404005000000000 D+<06> JD TDB'

    - » "E" and "D" exponent notations are not allowed
  - Using Spacecraft clock and Spacecraft clock string format, and inputting: 81138762:563

    CSPICE_N0065: CSPICE.scencd: SPICE(KERNELVARNOTFOUND): [scencd_c --> SCENCD --> SCTIKS --> SCTYPE --> SCLI01] SCLK_DATA_TYPE_0 not found. Did you load the SCLK kernel?

    - » The Spacecraft clock ID value is 0, which is not a valid clock ID. Either you did not load an archival kernel set (containing the mission SCLK kernel) or you did not manually load a SCLK kernel.

Incorrect Use of or Interpretation of Time Tags

- Be aware that a time tag of this general form:

  2019 DEC 18 13:21:53.261

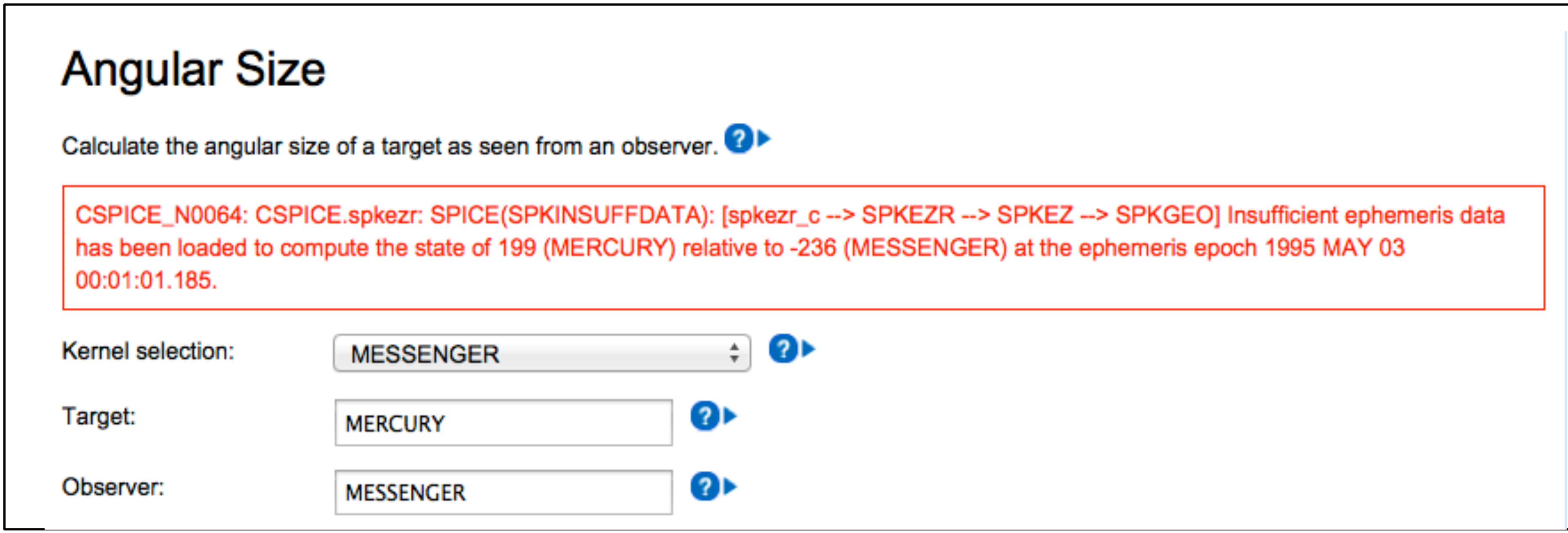
that you've taken from elsewhere, or that you have produced using SPICE–what we call calendar format–could represent a time in either the UTC or the TDB (a.k.a. ET) time system. Be sure you know which time system you are dealing with!

  – Refer to the "Time" tutorial for further information

- Spacecraft clock times occur as either a SCLK string or a double precision number of tics.
  – SCLK strings often appear like this: 53321876.214
  – The decimal character within this string is NOT a decimal point; rather it is simply a separator between the two parts of the clock string. See the "LSK and SCLK" tutorial for details.

Time out of Bounds - 1

- **WGC will display a SPICE error message when SPICE is able to detect a problem.**



- **In this example the user requested the position of Mercury relative to the MESSENGER spacecraft at a time outside the bounds of loaded SPK kernels. (In this case it was <u>before MESSENGER was launched</u>.)**

Time out of Bounds - 2

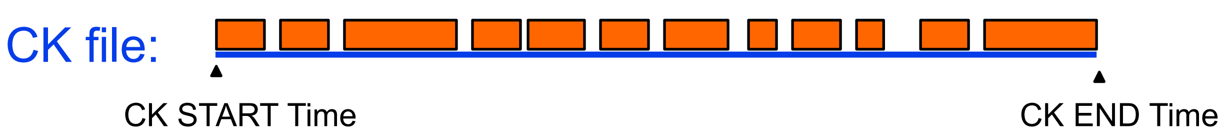
- **Users involved with mission planning often ask to make a computation for a future time that is not within the bounds of loaded time-dependent kernels (most usually SPKs and CKs).**
  - **Kernels available in SPICE archives cover only up to a date in the past. This can be seen using the Tool Tip displayed when you hover your cursor over the name of the archived kernel set.**
    - **Example for the Cassini archive as of October 2017:**

      Archived Cassini kernels covering from 1997-10-15 to 2016-12-31

  - **Some kernels available via MANUAL loading from NAIF's operations collections might contain "predict" data, but there is no guarantee, and it can be difficult for a person not familiar with the mission of interest to determine which kernel to load.**

Missing Data - 1

- **If you try to make a series of calculations (e.g. over a time interval, or at each of a set of times) it could be that some of the calculations can be made while others cannot due to data gaps or otherwise missing data.**
  - **A gap in a CK is the most likely culprit. This is usually caused by sparse or missing downlinked spacecraft attitude telemetry.**
  - **The graphic below represents a CK file.**
    - » **The orange bars are called "interpolation intervals" during which orientation can be determined.**
    - » **The white spaces between the orange bars are gaps during which orientation cannot be determined.**



- » **See the next page for some options to deal with this.**

Missing Data - 2

- When making "Geometry Calculator" computations you can control the action taken by WGC using the "Error handling" control found at the bottom of each "Geometry Calculator" web page.
  - The options are:
    - » Stop on error (the default setting)
    - » Report errors and continue (a more friendly but still safe option)
    - » Silently omit errors (dangerous; not recommended)
- However, when making "Geometric Event Finder" calculations you haven't any options: WGC will issue an error message and discontinue the computation, showing no interval results at all. ☹

CSPICE_N0064: CSPICE.gftfov: SPICE(NOFRAMECONNECT): [gftfov_c --> GFTFOV --> GFFOVE --> ZZGFSOLV --> ZZGFFVST --> PXFORM --> REFCHG] At epoch 3.1753086618393E+08 TDB (2010 JAN 23 15:01:06.183 TDB), there is insufficient information available to transform from reference frame 1 (J2000) to reference frame -82360 (CASSINI_ISS_NAC). Frame CASSINI_ISS_NAC could be transformed to frame -82000 (CASSINI_SC_COORD). The latter is a CK frame; a CK file containing data for instrument or structure -82000 at the epoch shown above, as well as a corresponding SCLK kernel, must be loaded in order to use this frame. Failure to find required CK data could be due to one or more CK files not having been loaded, or to the epoch shown above lying within a coverage gap or beyond the coverage bounds of the loaded CK files. You can use CKBRIEF with the -dump option to display coverage intervals of a CK file.

Incomplete Data

- Computations involving ephemerides (trajectories) or orientations often require the chaining–the stringing together–of multiple "chunks" of data to obtain needed positional information.
- Kernels containing ALL the needed "chunks" of data to complete the chain must be loaded into WGC.
  - This is rarely a problem when using a mission's archive since much care is taken to make the archive complete.
  - But incomplete data is often a problem when MANUALY loading individual kernels from a mission operations collection. The user may not understand what are the needed components of an ephemeris chain (SPK, FK) or an orientation chain (some of CK, FK, PCK).

Mixed Up Target and Observer

- **A user wants to find the sub-observer point on the moon using the Lunar Reconnaissance Orbiter (LRO) spacecraft as the observer.**
- **S/he selects the "Sub-Observer Point" calculation, loads the LRO kernel set, and specifies the Target as "LRO," the reference frame as "IAU_MOON" and the observer as the "MOON."**

CSPICE_N0065: CSPICE.subpnt: SPICE(INVALIDFRAME): [subpnt_c --> SUBPNT] Reference frame IAU_MOON is not centered at the the target body LUNAR RECONNAISSANCE ORBITER. The ID code of the frame center is 301.

  – **S/he mixed up what should be the observer and the target. Interchange these two items and the calculation will work.**

Limitation – One at a Time

- **WebGeocalc executes only one computation at a time.**
  - **Any computation requests received while one computation is in progress will be queued in the order received.**
    - » **A "queued" message will be displayed in your browser's window.**
    - » **Each request will automatically execute once having reached the top of the queue.**