Accepted version of article published in *Journal of Sksycape Archaeology* 9(2): 281-288.
https://doi.org/10.1558/jsa.28181

The Major Lunar Standstill Season is Here!

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All skywatchers appreciate the dance between the Sun and Moon: the rapid run of the Moon from opposition to the Sun to conjunction with it each month, along with its attendant phases. As the Sun swings on its annual cycle, the full Moon's position mirrors the pattern, with December full moons residing in the north and June full Moons in the south. But, unlike the Sun, the Moon doesn't rest at the solstices. Instead, it speeds through the full range of north to south and back every month. Compared with the stately annual motion of the Sun, the Moon's performance is a wild gyration. And this dance is about to reach its most exuberant with the Major Lunar Standstill season, peaking in 2024 and 2025.

The 5 degree tilt between the ecliptic and the Moon's orbit denies us eclipses every Dark and Full Moon but it also allows the Moon to transgress the ±23.5 north/south declination limits of the Sun. When the direction of the largest tilt aligns with the direction of the solstices, this tilt allows the Moon to achieve maxima of approximately ±28.5 degrees in declination (figure 1). We say approximately because these limits may be asymmetric and depend on the latitude of the observer on Earth because of parallax caused by the proximity of the Moon. The alignment between these two axes rotates slowly, with a period of 18.6 years. The phase where the orbital tilts align to cause extreme lunar declinations is dubbed the Major Lunar Standstill, whereas 9.3 years later, when the orbit tilts detract from each other and the Moon's north/south excursions are bounded by approximately ±18.5 degrees in declination, is the Minor Lunar Standstill (figure 1). This cycle is called the Cycle of the Regression of the Nodes – referring to the concurrent rotation of the points where the orbital planes intercept – but is also unofficially referred to as the Lunar Standstill cycle within archaeoastronomical circles. This cycle is not tied to a round number of synodic months and is different from both the 235 synodic-month Metonic cycle and the 223 synodic-month Saros cycle, even though all are 18-19 years and describe synergies of solar and lunar movements.

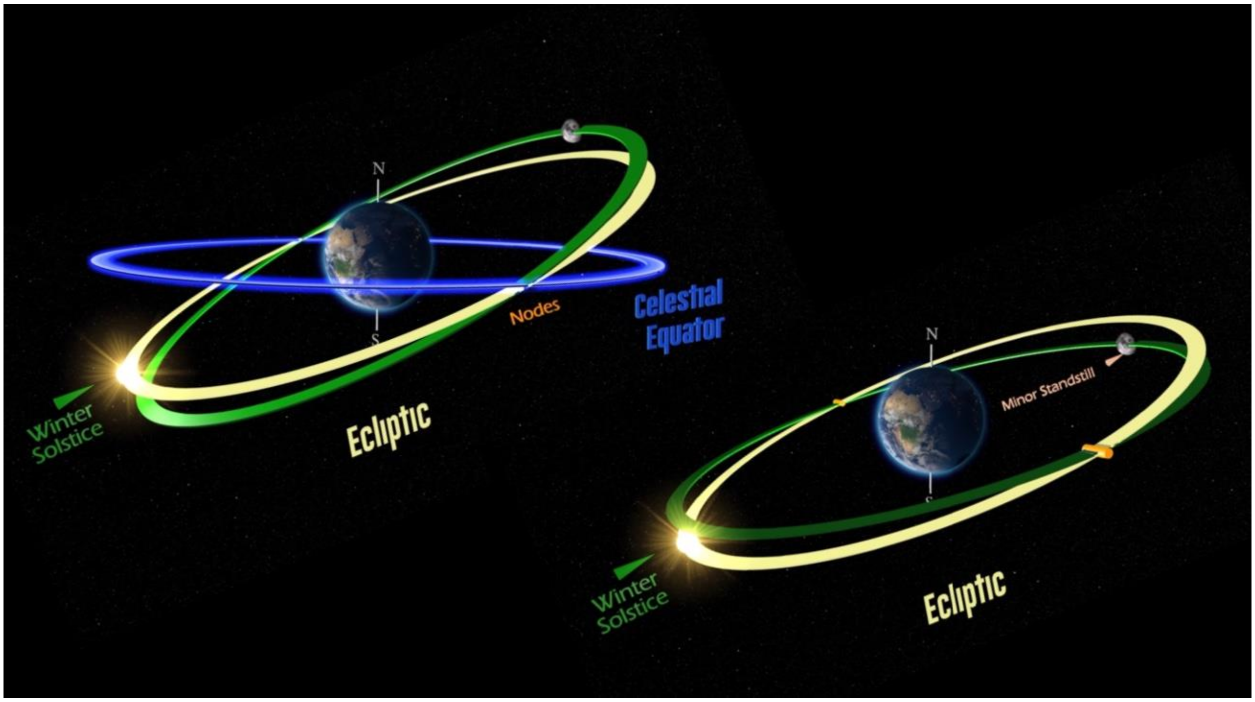

Figure 1. (Left) Major Lunar Standstill with the Full Moon observed near the winter solstice. The greatest northern inclination of the lunar orbit combines with the northern solstice position to create a northern extreme. Six months later the Full Moon will be in its southern extreme position (Right) Minor Lunar Standstill, 9.3 years later when the orbits have twisted 180 degrees around, no longer combining to create an extreme position. The moon stays within the solar and all previous lunar limits.

The most observable phenomena of the Major Lunar Standstill season are the Moon's movement through its most northern position when it approaches the direction of the June solstice on the ecliptic (i.e. ecliptic longitude 90 degrees), and its most southern position near the December solstice's position on the ecliptic (ecliptic longitude 270 degrees). Each of these happen at intervals slightly less than a sidereal month, with the Moon approaching closer and closer to the most extreme north/south positions as the orbital tilts align. As the Standstill season progresses, the phases at subsequent extrema move backwards through the lunar cycle, with northern extrema happening at Dark Moon in June, third quarter in September and Full Moon near the December solstice (figure 2). The southern patterns are reversed, with the Full Moon southern extreme near summer solstice. The lunar nodes, the intercepts between the solar and lunar paths, lie at right angles to the standstill directions. Eclipse seasons during both Major and Minor Lunar Standstill years thus occur near the equinoxes creating another potentially observable pattern.

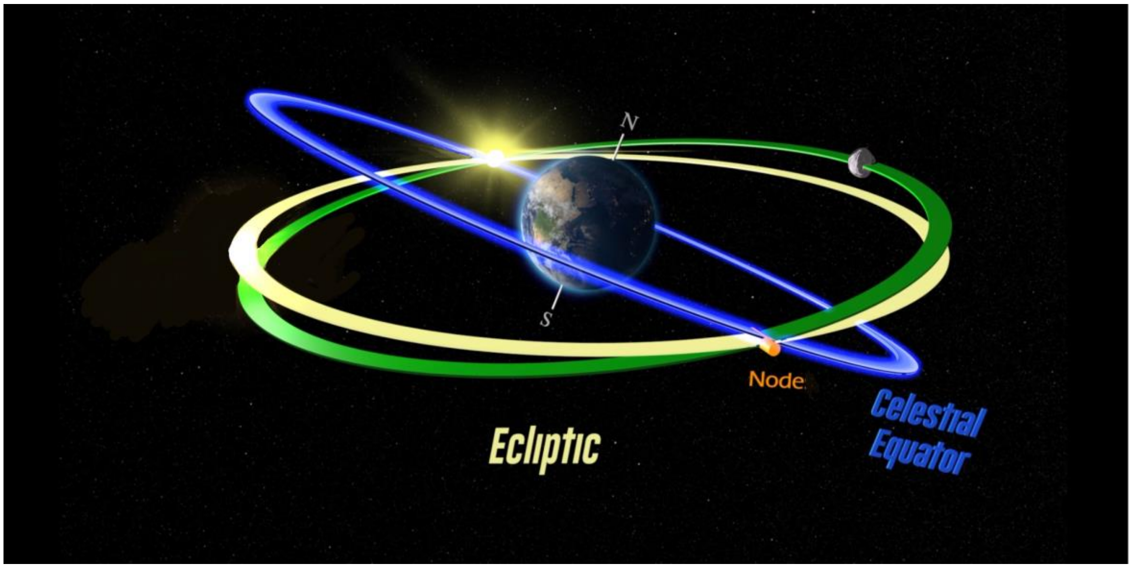

Figure 2. Schematic showing the apparent position of the Moon at its northernmost position near the autumn equinox during the Major Lunar Standstill season. The moon passes through this position approximately every sidereal month. Near the September equinox, this configuration will occur when the Moon is near the 3rd quarter phase.

When considering horizon alignments, it is tempting to assign a single direction to represent the lunar position during the Major Lunar Standstill. Common schematics show the declination or azimuth for the rising and setting Major Lunar Standstill as targets for archaeoastronomers to consider, much like the solstice and equinox sun. Unfortunately, the term “standstill” belies the rapid movement of the Moon from day to day. It will be very rare for the Moon to actually pass through an extreme position on the celestial sphere at the very moment it crosses the horizon for a particular location. The positions of the lunar extrema thus should be considered outer limits for moonrise/set observations which, month by month and year by year, can vary in irregular patterns. When considering the potential for lunar standstill horizon alignments, researchers should consider how a single lunar direction would be decided upon and how far that might be from the calculated extreme position.

The lunar extremes are tethered to the solstice positions and so extreme Moons appear in steady company with specific stars. A lunar observer would know an extremum is approaching a few days in advance by viewing the position of the moon relative to these stars. Currently, Elnath in Taurus and Castor and Pollux in Gemini will present themselves to observers watching the extreme northern Moon. Antares and the center of the Milky Way lie near the southern extreme position. Precession will change these relations, however. For example, in 3500 BC, Regulus would have accompanied the northern extreme Moon and the southern Moon would appear in the constellation Aries.

To help readers identify dates to observe Major Lunar Standstill moonrises and moonsets, figures 3 through 6 present UT dates and declinations of the Moon’s extreme north and south positions for the current Major Lunar Standstill season, 2023-2025, as observed from four different locations (the lunar declination extremes vary with latitude and are asymmetric with hemisphere because of parallax). Values were calculated using the astronomical package skyscapeR (Silva 2021), which relies on swephR (Reijs and Stubner 2020) for ephemeris calculations. These can be used to further explore lunar standstill observables. Note that the Moon's declination changes quickly, and so the time and position of the Moon's appearance in a particular part of the sky must be adjusted according to the specific observational situation. Therefore, the best way to use these figures is to locate a date from the figure nearest to your latitude, and then use a moonrise/set calendar or planetarium software such as Stellarium (Zotti et al 2021) to identify the correct local date and time for relevant moon observations occurring within a 24hr period either side of the date given in the figure. Happy Moon-watching!

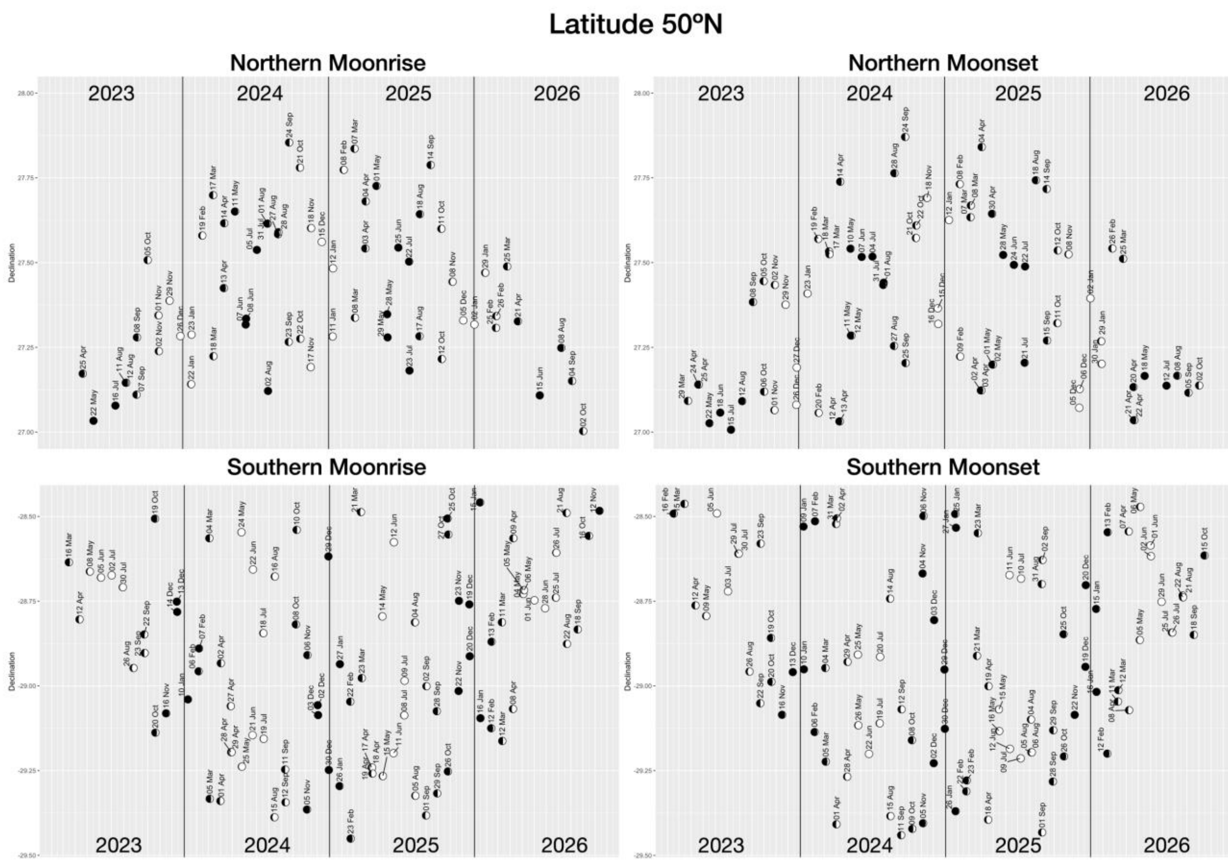

Figure 3. Extreme northern (top panels) and southern (bottom panels) moonrises (left panels) and moonsets (right panels) for the period 2023-2026 for latitude 50°N and longitude 0°. Shown for each instance is the lunar phase (icon) as well as the date.

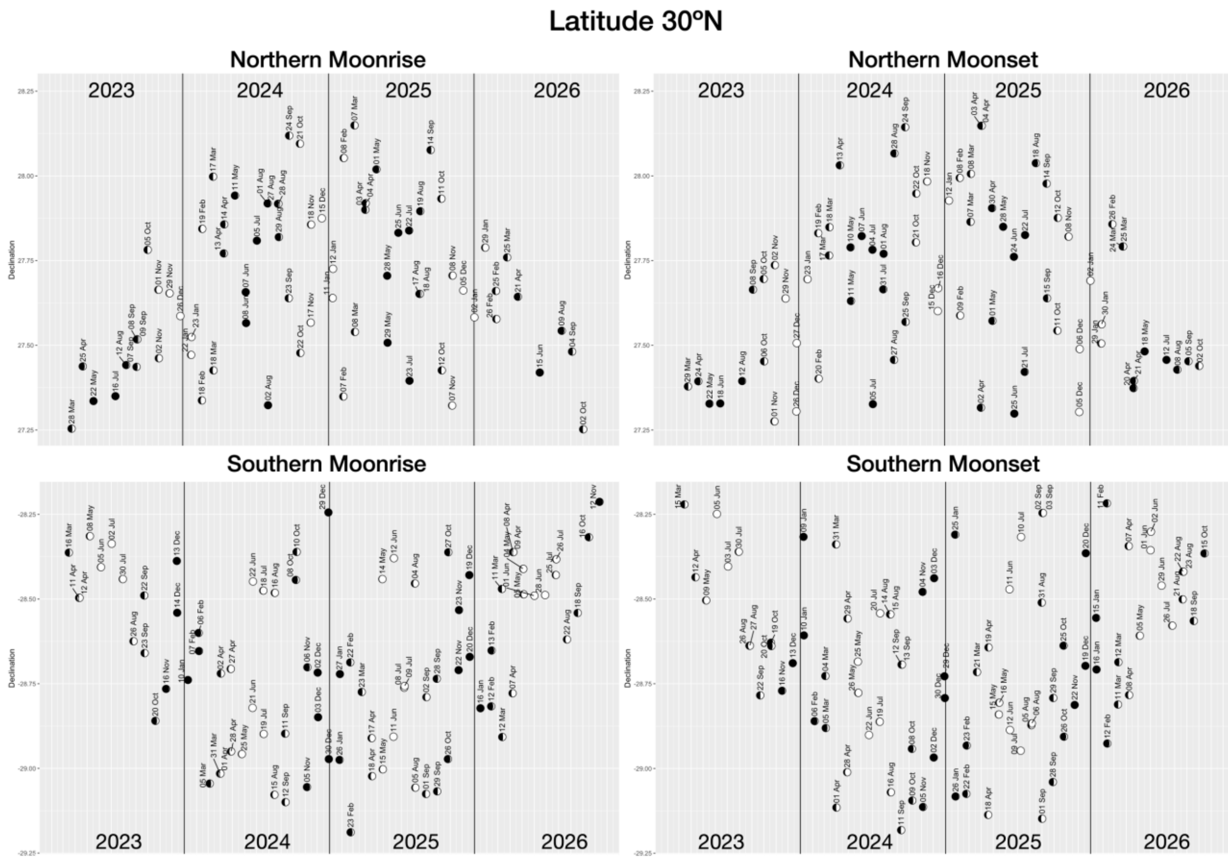

Figure 4. Extreme northern (top panels) and southern (bottom panels) moonrises (left panels) and moonsets (right panels) for the period 2023-2026 for latitude 30°N and longitude 0°. Shown for each instance is the lunar phase (icon) as well as the date.

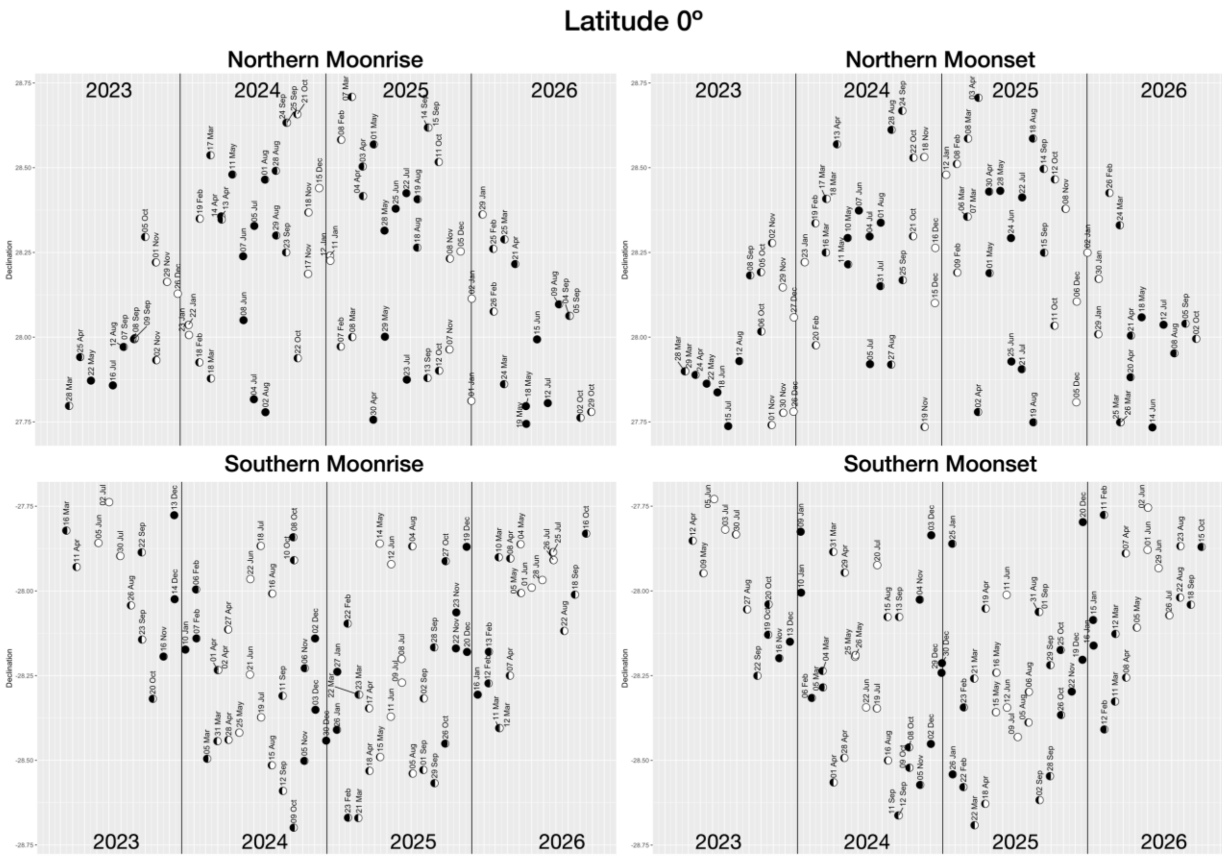

Figure 5. Extreme northern (top panels) and southern (bottom panels) moonrises (left panels) and moonsets (right panels) for the period 2023-2026 for latitude 0°N and longitude 0°. Shown for each instance is the lunar phase (icon) as well as the date.

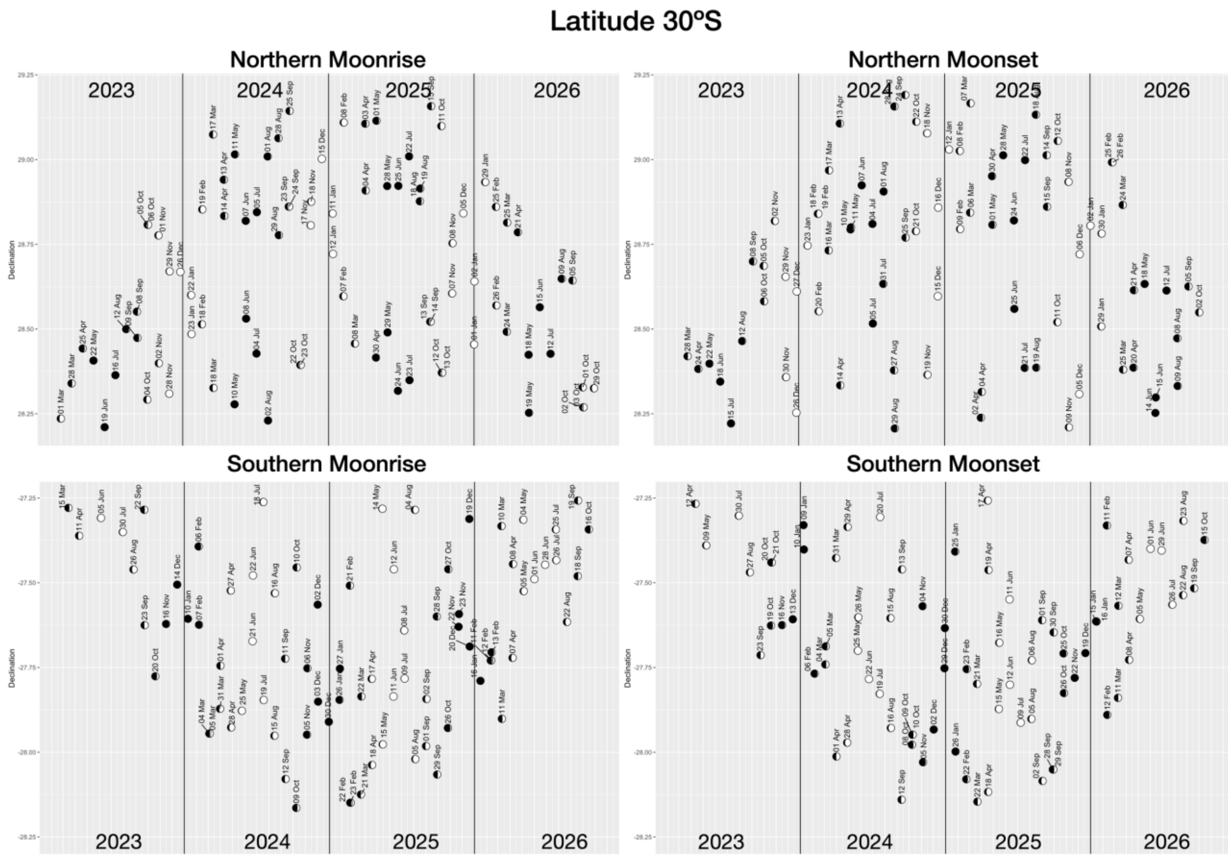

Figure 6. Extreme northern (top panels) and southern (bottom panels) moonrises (left panels) and moonsets (right panels) for the period 2023-2026 for latitude 30°S and longitude 0°. Shown for each instance is the lunar phase (icon) as well as the date.

References

Reijs, V., Stubner, R. (2020). Swiss Ephemeris: An Accurate Ephemeris Toolset for Astronomy and Astrology. *Journal of Skyscape Archaeology* 6(1): 150–154. DOI: 10.1558/jsa.42323

Silva, F. (2021). skyscapeR: Data Analysis and Visualisation for Skyscape Archaeology. *Journal of Skyscape Archaeology* 7(2): 325-326. DOI: 10.1558/jsa.22285

Zotti, G., Hoffmann, S.M., Wolf, A., Chéreau, F., Chéreau, G. (2021). The Simulated Sky: Stellarium for Cultural Astronomy Research. *Journal of Skyscape Archaeology* 6(2): 221–258. DOI: 10.1558/jsa.17822