Observation of Moonrise
Along the Axis of Stonehenge
as Proxy for Neolithic Summer Solstice Sunrise

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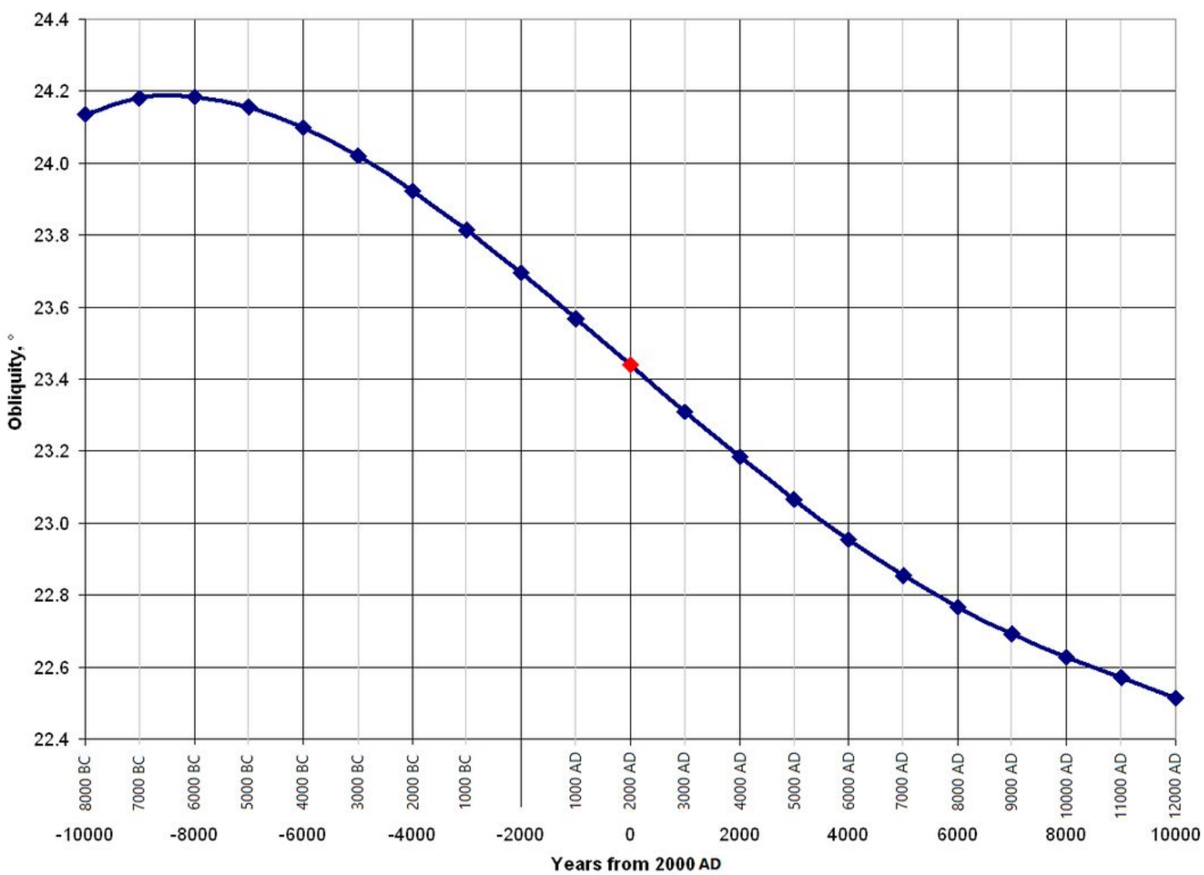
The orientation of Stonehenge toward the position of the rising sun at the summer solstice is widely accepted and much discussed. It is also known that the tilt of the Earth on its axis is less today than in the past. Currently the tilt of the Earth is 23.43667° and decreasing. In the Neolithic period, around 3000 BC when Stonehenge was built the value was just beyond 24° and this resulted in the sun rising further to the north than it does today.

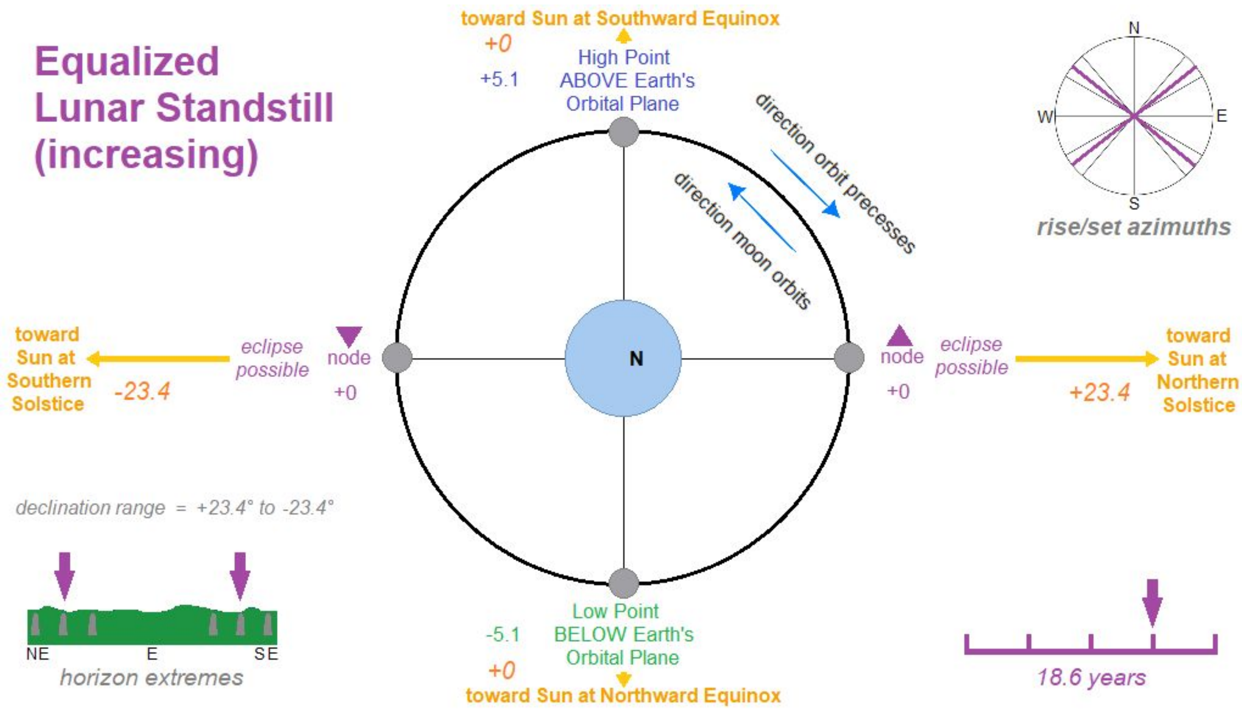


Graph of obliquity of the ecliptic vs time for +/- 10,000 years
https://commons.wikimedia.org/wiki/File:Obliquity_of_the_ecliptic_laskar.PNG
Graph: After Laskar, J. (1986), "Secular Terms of Classical Planetary Theories Using the Results of General Relativity" (date labels added)

At solstices the declination of the sun is equal to the angle of the tilt of the Earth's axis and this determines the position where it rises on the horizon. The sun no longer rises at the same point on the horizon at Stonehenge as it did when it was built when it would have been positioned further north (to the left) of the heel stone and more directly in line with the avenue.

The position of the moon on the horizon is also affected by the tilt of the Earth's axis, but as it orbits in a plane that is tilted 5.1° beyond the ecliptic, it can reach monthly maximum declination values both higher and lower than that of the sun and the range of these values changes slowly over the 18.6 year cycle between major lunar standstills when the most extreme declination values are attained. At two points in the cycle the values match the declination of the sun, and just before or after this the values will be slightly higher or lower.

This effect can create a situation where the moon can be used as a proxy to simulate the exact position of the sun in the past. Because the declination of the moon changes very quickly as it orbits the Earth, the monthly standstill positions when a maximum or minimum declination is reached before reversing are the best times to observe the moon at a specific declination. At these times there is relatively little change during a short observation, such as when the moon is at the horizon and rising. Although these conditions are met in general at two points in each 18.6 year cycle (separated by approximately 9.3 years), complexities in the lunar orbit can affect what declination values are passed through quickly and which values remain with little change over multiple months. Also the phase of the moon during which any value is reached can vary widely making certain moonrise or moonset events more difficult to observe when they occur in daylight as opposed to when the sun is below the horizon. Events that match ideal conditions become more rare further from the ideal points as it becomes less likely the moon will be on the local horizon at the time of a given target declination value.



http://www.exploreglobe.net/uploads/5/7/9/2/5792627/high-low-4-equalized-increase_orig.png

Diagram: After Loertscher 2020, description of how the position of the lunar nodes over the 18.6 year lunar cycle affect the declination of the moon during monthly standstills.

The points in the 18.6 year cycle when the moon reaches positions that match the sun at the solstices could be termed *equalized lunar standstills*, one with values *increasing* towards major lunar standstill, and another will values *decreasing* toward the minor lunar standstill. The year 2020 will see the moon matching modern values at various latitudes in turn due to lunar parallax, and then slowly attaining declination values comparable to periods in the past. The parameters for this year happen to allow for multiple opportunities to observe the moon at monthly standstill positions all the way through 2020 and on into 2021 at declinations very close to the value for the Neolithic period. Further, some of these events occur during brightly illuminated phases of the moon that rise at night at the northerly position that corresponds to the rising of the sun at Summer Solstice around 3000 BC when Stonehenge was built.

2020-2021 Northern Standstill Moonrise Events
corresponding to Summer Solstice Sunrise circa 3000 BC

Date	Rise Time	Rise Azimuth	Topocentric Declination	Geocentric Declination	Phase Illumination	Sun Horizon Position	Event Rating Value
Fri 9 Oct 2020	10:43 PM	49.55	23.7311	24.53	51% waning	below horizon	pre-alternate
Thu 5 Nov 2020	7:35 PM	48.99	24.0223	24.81	77% waning	below horizon	**excellent**
Wed 2 Dec 2020	5:31 PM	48.99	24.0248	24.81	93% waning	below horizon	**excellent**
Wed 30 Dec 2020	4:19 PM	49.07	23.9856	24.79	100% full	just below horizon	**excellent**
Tue 26 Jan 2021	2:07 PM	48.84	24.0917	24.89	95% waxing	above horizon	good
Mon 22 Feb 2021	11:55 AM	48.84	24.0939	24.89	75% waxing	above horizon	alternate
Tue 23 Feb 2021	12:49 PM	48.91	24.0682	24.87	84% waxing	above horizon	alternate
Sun 21 Mar 2021	9:46 AM	49.08	23.9715	24.75	49% waxing	above horizon	alternate
Mon 27 Sep 2021	9:44 PM	48.99	24.0097	24.78	61% waning	below horizon	good
Tue 21 Dec 2021	5:50 PM	48.93	24.0522	24.83	94% waning	below horizon	**excellent**

Dates/Times are local for Stonehenge with a range of values for multiple observations.
Target apparent declination is 24° but a few near values are included as alternates.
Difference between Topocentric Declination and Geocentric Declination is due to lunar parallax.
Rise times are for the upper limb of the moon, azimuth is for full lunar orb above horizon.

It is proposed that the opportunities to observe moonrise during the year 2020 and 2021 which correspond to the position of the sun at summer solstice during the Neolithic should be used to demonstrate the original alignment and perhaps to increase our understanding of the interaction of light and shadow along the avenue and among the stones of Stonehenge in a way much closer to the original situation than can currently be observed with sunlight in modern times. Although this phenomenon is understood and discussed, observing it in real time would add to our knowledge and increase awareness, understanding, and appreciation for this part of our ancient heritage that is Stonehenge and those that built it.

NOTE: Some lunar proxy events for the opposite alignment of the setting sun at winter solstice occurred in 2020 and there will be a few other opportunities in 2021 and onward through the standstill cycle.

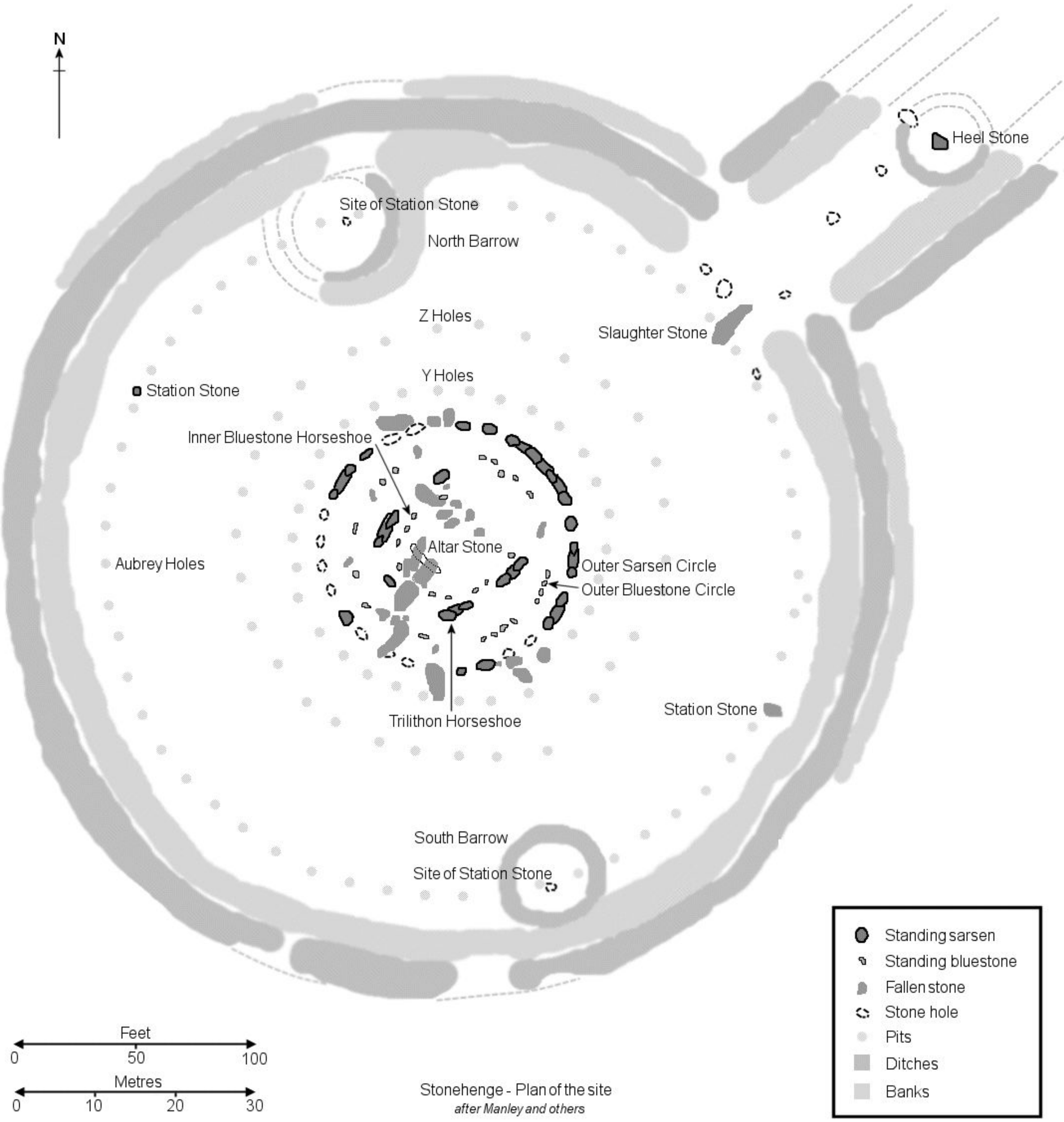


Illustration: After Manley and others

REFERENCE:

Stonehenge Plan: After Manley and others

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