PARAGONDAY SYSTEMS

A human timekeeping framework.

Technical Whitepaper v1.0
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ABSTRACT

Paragonday Systems is a human timekeeping framework. Its solar-relative time standard, Horizon Time, expresses where you are in the day relative to sunrise and sunset. Its labels express duration relative to the sun. In the daytime, how long until sunset is "tilset" and how long since sunrise is "pastrise". In the nighttime, how long since sunset is "pastset" and how long until sunrise is "tilrise".

UTC is the current mainstream time standard, built for industrial coordination, and it abstracts location away to do its job. Paragonday does the opposite in the layer where humans live. The answer to "what time is it?" now shifts across longitude and latitude, because it is grounded in a physical relationship between the observer and the sun.

Paragonday Systems operates as a translation layer over existing infrastructure such as GPS, atomic time, and solar position algorithms, converting uniform machine time into something experientially meaningful. Today, it sits on top of UTC, TAI, and other existing timescales, the way Celsius and Fahrenheit sit on top of Kelvin. We will eventually replace UTC with Horizon Time through solar-system scale location-based data. Time is relative; so too should our clocks be.

1. Introduction

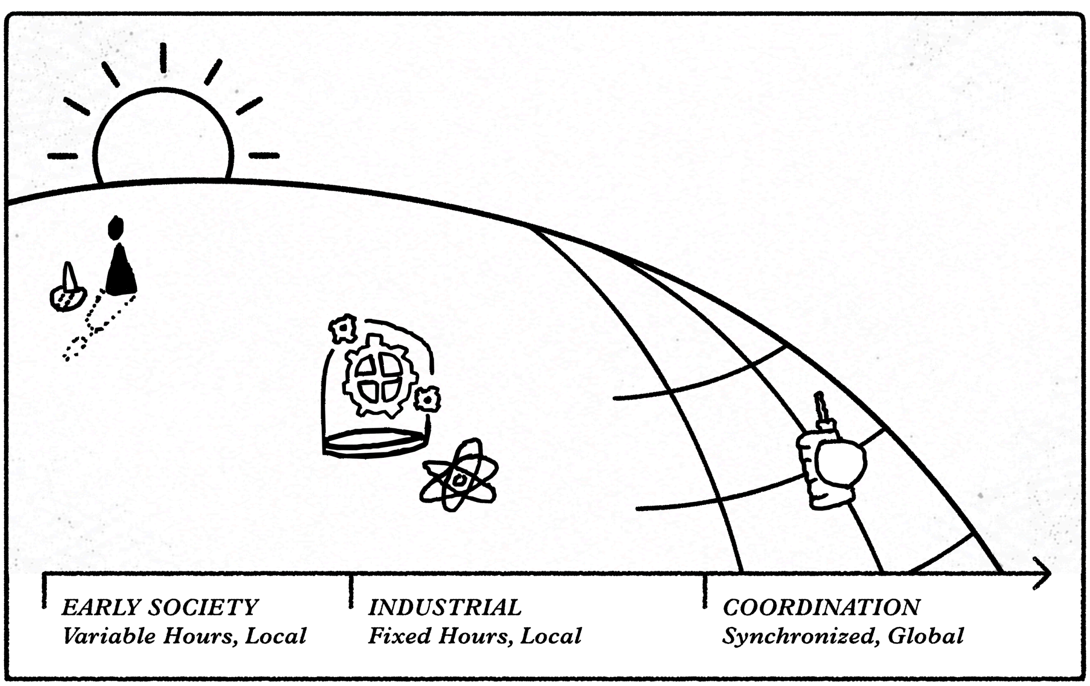
For most of human history, time was inseparable from the sky. Industrial tools first brought about the mechanical clock and timezones were later introduced as a result of coordination needs. 59 years ago, the General Conference on Weights and Measures (CGPM) redefined the second as 9,192,631,770 oscillations of a cesium-133 atom, over objections that doing so would leave the world with two definitions of time: one astronomical, one atomic.

Since then, leap seconds have patched the gap between atomic time and Earth's rotation. In 2022, the CGPM resolved to phase them out and in 2026 they are convening to re-discuss the definition of the second. While civil and machine time are leaving the sky in an evergoing effort for absolute time, Paragonday Systems is modernizing astronomical time for humans.

We need a human time that grounds us in natural rhythms. Paragonday Systems rests on three foundational claims:

- **Machines and humans need different times.** Sub-second accuracy matters for machines but humans don't perceive subsecond accuracy. We do however perceive the sun setting and rising.
- **Time and space are coupled for human experience.** A human-timekeeping device's job is to situate the observer in their physical environment. Location should be understood at the interface a person reads.
- **The sun cycle is the natural unit for a human time.** Sunrise to sunrise is the most readily observable, biologically relevant temporal boundary available to earthbound perception.

Figure A ***THE PERCEPTION OF TIME***



From these principles, Paragonday is constructed outward from the sun cycle, with the SI second and the Gregorian year adopted as pragmatic bridges to existing infrastructure where the cost of divergence would exceed the clarity gained.

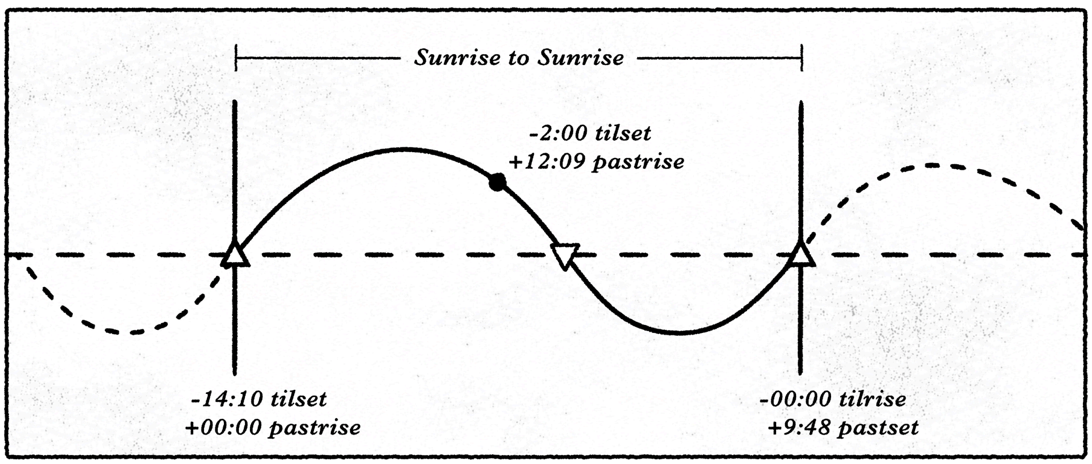
The sun rises. The sun sets. Between these observable events, we live. Paragonday Systems proposes that our everyday timekeeping interfaces should acknowledge this human experience.

2. Telling Time

A **sun cycle**, our synodic day, spans from one sunrise to the next. It is the fundamental temporal unit of Horizon Time. A sun cycle is divided by two phases: **daytime** and **nighttime**, demarcated by sunset.

During the daytime the clock labels are *tilset* and *pastrise*, and during the nighttime the clock labels are *tilrise* and *pastset*.

Figure B THE SUN CYCLE

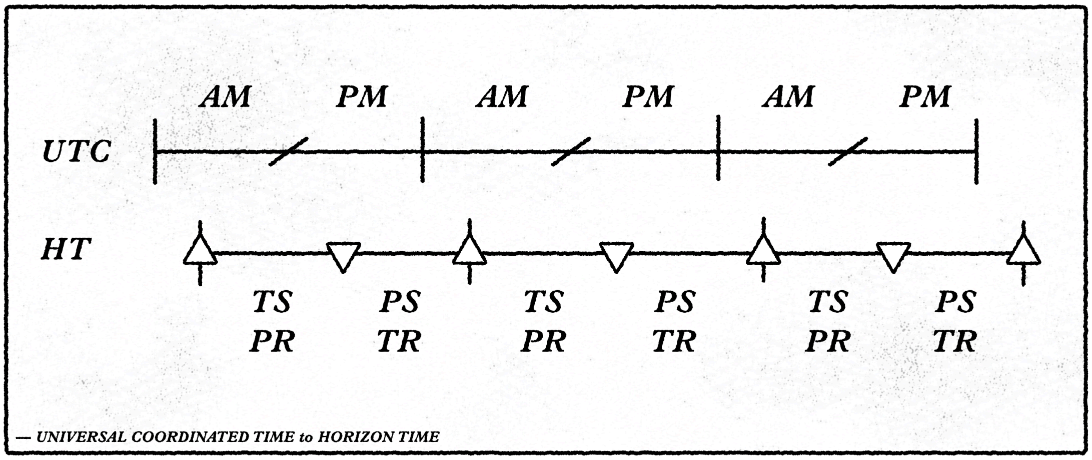


Horizon Time shifts the labeling emphasis of time to accurate solar position and horizon events. These four labels more accurately express the shift between day and night compared to the meridian labels of am and pm.

Label	Abbreviation	Meaning
tilset	TS	Countdown until sunset
pastrise	PR	Duration since sunrise
tilrise	TR	Countdown until sunrise
pastset	PS	Duration since sunset

Pairing a countdown to the next horizon event with the elapsed duration since the previous one gives temporal awareness within the phase. Together, the two values situate the observer completely within the current sun cycle phase at a given location.

Figure C ***LABEL SHIFTING***

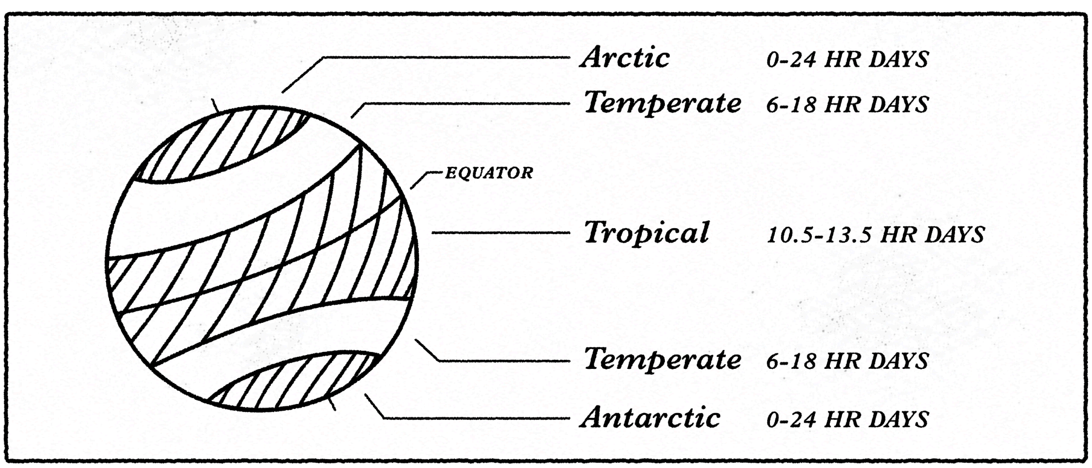


A sign prefix reinforces the direction of the labels: negative (−) for countdown, positive (+) for elapsed. For example, `-4:30 tilset (TS)` means 4 hours and 30 minutes until sunset; `+2:15 pastrise (PR)` means 2 hours and 15 minutes since sunrise.

Within a temperate latitude, the amount of hours in the daytime can swing between six hours in the winter to eighteen hours in the summer. Horizon Time's labels make these time swings viscerally expressive while UTC conceals these seasonal shifts.

At latitudes beyond the Arctic and Antarctic Circles (90° − 23.4359° = 66.5641° N/S, given Earth's axial tilt is currently 23.4359°), the sun remains above or below the horizon for 24 consecutive hours at least once per year. Meaning that for some span of the year, there is no sunrise or sunset. These are special cases, and Horizon Time considers the sun's reaching of the nadir point as a collapsed sunset and sunrise, which we call a **sundip**, to mark the start and end of a sun cycle.

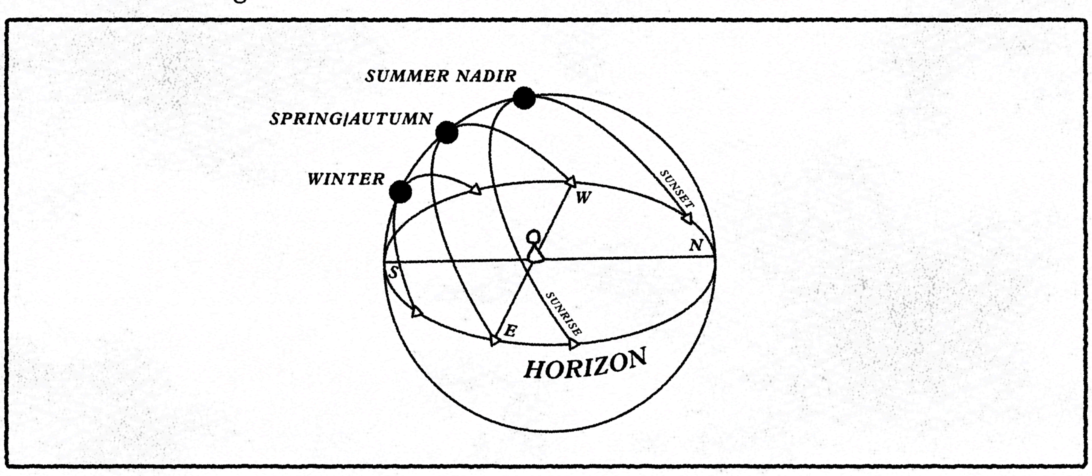
Figure D ***LATITUDE DAYTIME RANGES***



Horizon Time is shorthand for **Local Horizon Solar Time** (**LHST**). Paragonday Systems created this time standard to anchor the start of the human day on sunrise and express how solar events change time every day. LHST reformulates Local Apparent Solar Time (LAST) around the horizon rather than the meridian, making the horizon crossing events of sunrise and sunset the reference points rather than solar noon.

Time Standard	**Established**	**Author**	**Definition**	**Example Time** (Stonehenge, Summer Solstice 2026, one hour before Sunset)
LHST Local Horizon Solar Time	2020	Paragonday Systems	Time measured from the Sun's most recent horizon crossing and to its next, at the observer's location.	−1:00 tilset, +15:34 pastrise
UTC Coordinated Universal Time	1960–61	International Telecommunication Union / Bureau International de L'Heure	The time standard used worldwide for coordination. An atomic timescale (counted in SI seconds) manually kept within 0.9 s of Earth rotation (UT1) through occasional leap-second insertions.	19:26 UTC
TAI International Atomic Time	1958	Bureau International de l'Heure, later maintained by International Bureau of Weights and Measures	Continuous count of SI seconds from atomic clocks worldwide.	19:26:37 TAI
UT1 Universal Time 1	1928	International Astronomical Union	Earth's rotational angle relative to the stars, referenced to the Greenwich meridian.	≈ 19:26 UT1
LAST Local Apparent Solar Time	17th century	Ancient Origins	Time measured by the Sun's position in the sky where 12PM Noon is aligned to the zenith.	≈ 18:19 LAST

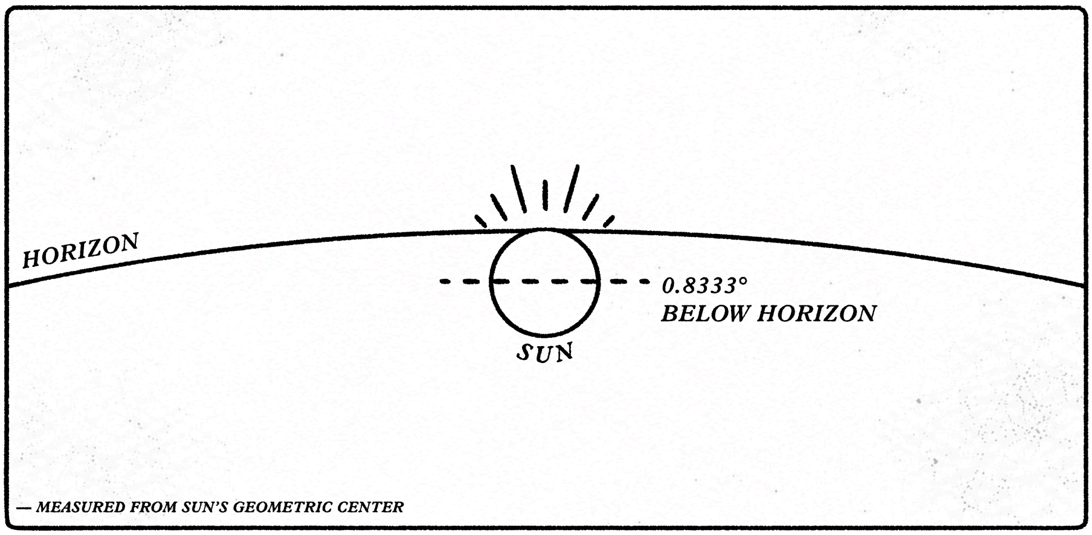
***Figure F* SEASONAL HORIZON CROSSINGS**



3. Calculating Time

Paragonday adopts the USNO convention: sunrise and sunset occur when the sun's geometric center is 0.8333° below the true horizon, combining standard atmospheric refraction (0.5667°) and the sun's angular semidiameter (0.2667°). Implementations may layer elevation corrections, measured atmospheric refraction, and local horizon obstruction on top of the reference, but these are display refinements rather than protocol changes.

Figure E* *DEFINING SUNRISE & SUNSET



Determining the current time within a sun cycle requires knowing when the sun most recently crossed the observer's horizon and when it will next. These times can be derived in two ways: computed from an existing timescale given geographic coordinates and solar ephemerides, or observed directly from the sun's position in relation to the local horizon. The direct observation could be from satellites measuring the sun's angle in relation to Earth, for example.

Paragonday currently relies on established solar position algorithms. Most practical implementations trace their mathematics to Jean Meeus's *Astronomical Algorithms* (2nd ed., 1998), which distilled the previous astronomical literature into computable formulas for solar position, sunrise, sunset, and the equation of time.

Paragonday suggests the future use of satellites to directly observe the angle and travel of the sun, using that data to calculate the time. This would remove the need for UTC as well as any of these estimation algorithms and may require a network of satellites to always maintain visibility on the sun and spin of the Earth.

Algorithm	Role	Introduced	Accuracy	Coverage	Source
JPL DE 44x	Geometric planetary ephemeris	2021 (DE series since 1960s)	sub-arcsecond	DE440: 1550–2650; DE441: −13,200 to +17,191	NASA/JPL
NREL SPA	Self-contained solar position calculator	2003 (rev. 2008), NREL/TP-560-34302	±0.0003°	−2000 to 6000 CE	NREL TP-560-34302
NOAA Solar Calculator	Self-contained solar position calculator	NOAA web version mid-2000s; Meeus algorithms 1991/1998	±1 min	Best 1800–2100; usable −1000 to 3000	Meeus-derived
USNO NOVAS	Apparent-place reduction (uses JPL ephemerides for body positions)	1989 (Kaplan et al. AJ paper); v3.1 (2011)	sub-arcsecond	Limited by attached ephemeris (DE405, DE440, etc.)	USNO

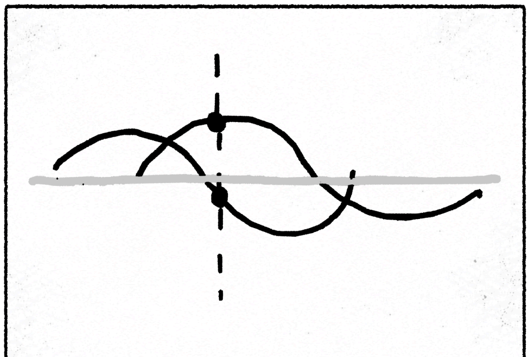
For now, Horizon Time is calculated using the following time stack:

1. UTC → TAI (Leap Second Lookup)
2. TAI → TT (Fixed Offset)
3. TT → TDB (Relativistic Correction)
4. TDB → Calculate Geocentric Solar Position
5. Gather Coordinates
6. Calculate the Topocentric Hour Angle via Sidereal Time
7. Calculate Altitude and Azimuth
8. Calculate Horizon Crossing (Sunrise and Sunset)
9. Determine Horizon Time Labels

The ideal time stack starts with step 5 and skips the foundation of UTC.

4. Coordination

Paragonday System's Horizon Time is locally-resolved. There is no one central time, as all instances of time are derived from your view of the solar system at your location. For example, two observers at different longitudes experience different tilset values at the same UTC instant.



— *COORDINATION ACROSS SPACE AND TIME*

Consider a call between Norm in Brooklyn, NY and Benji in Keeseville, NY on the summer solstice:

1. Norm says to Benji: "Let's have a call at −1:00 tilset"
2. Each participant's device knows their location
3. Each device knows their local sunset time
4. Each device can independently compute what UTC instant corresponds to Norm's local −1:00 tilset
5. Benji's device takes that UTC and converts to their Horizon Time. Benji reads "Let's have a call at −1:13 tilset"
6. They spend an hour and fifteen minutes together meeting at different Horizon Times but with this translation layer they still meet at the same moment of time

5. Theory of Change

To operate independently from UTC, Horizon Time needs direct solar measurement. To observe the sun's position directly without reference to GPS timing, atomic clocks, or precomputed ephemeris tables answers 'where is the sun?' from first principles. Horizon Time would then operate the way a sundial does, combined with a location input to produce time labels from observation rather than prediction.

You can't tell someone the time without looking at a clock. From the kitchen clock, to the pocket watch, to the phone, to the clock tower, to the newsroom, all of these displays of time are necessary for a functioning society and will need to be reconfigured for human time. With 21st century advancements in technology, it is now possible to have a GPS in every clock, making Horizon Time functionally feasible.

Appendix A: Definitions

Term	Definition
Sun Cycle	Sunrise-to-sunrise period; the fundamental Paragonday temporal unit
Phase	Daytime (sunrise→sunset) or nighttime (sunset→sunrise) interval within a sun cycle
Tilset	Time until sunset; daytime label, negative sign
Pastrise	Time since sunrise; daytime label, positive sign
Tilrise	Time until sunrise; nighttime label, negative sign
Pastset	Time since sunset; nighttime label, positive sign
Zenith	Solar noon, when the sun is at its highest point in the Sun Cycle
Nadir	Solar midnight, when the sun is at its lowest point in the Sun Cycle
Sundip	Used in arctic circles when the sun dips to its lowest point. A combined sunset and sunrise moment to mark a change in Sun Cycle.
Paragonday	Built from *Paragon-* meaning ideal, and *-Day* meaning a period of time

Appendix B: Selected References

- International Conference Held at Washington for the Purpose of Fixing a Prime Meridian and a Universal Day. October, 1884. *Protocols of the Proceedings.* Washington, DC: Gibson Bros., 1884. https://www.gutenberg.org/files/17759/17759-h/17759-h.htm
- 13th General Conference on Weights and Measures (CGPM), Resolution 1 (1967). *Definition of the SI second.* BIPM, bipm.org/en/committees/cg/cgpm/13-1967/resolution-1
- Conférence Générale des Poids et Mesures. "Resolution 1: International Atomic Time, Function of CIPM." In *Comptes rendus de la 14e Conférence Générale des Poids et Mesures* (1971), 77–78. Sèvres: Bureau International des Poids et Mesures, 1972. Also published in *Metrologia* 8, no. 1 (1972): 32–36. https://www.bipm.org/en/committees/cg/cgpm/14-1971/resolution-1.
- International Telecommunication Union, Radiocommunication Sector. *Recommendation ITU-R TF.460-6: Standard-Frequency and Time-Signal Emissions.* Geneva: International Telecommunication Union, February 2002. https://www.itu.int/rec/R-REC-TF.460-6-200202-I/en.
- 27th CGPM, Resolution 4 (2022). *On the use and future development of UTC.* BIPM, bipm.org/en/cgpm-2022/resolution-4
- Comité International des Poids et Mesures. *Draft Resolutions for the 28th Meeting of the CGPM.* Version 3, updated March 2026. Sèvres: Bureau International des Poids et Mesures, March 30, 2026. https://www.bipm.org/documents/20126/284836054/CGPM-2026-Draft-Resolutions.pdf.
- Earth's spin, tilt and orbit. University of California Museum of Paleontology. https://ugc.berkeley.edu/background-content/earths-spin-tilt-orbit
- NASA JPL. *SPICE Time Subsystems.* https://naif.jpl.nasa.gov/pub/naif/toolkit_docs/C/req/time.html
- International Earth Rotation and Reference Systems Service (IERS). Bulletin C — leap second announcements. iers.org

- U.S. Naval Observatory. *Rise, Set, and Twilight Definitions.* aa.usno.navy.mil/faq/RST_defs
- Meeus, J. (1998). *Astronomical Algorithms,* 2nd ed. Willmann-Bell. The standard reference for practical solar position computation.
- Reda, I. and Andreas, A. (2008). *Solar Position Algorithm for Solar Radiation Applications.* NREL Technical Report TP-560-34302.
- Park, Ryan S., William M. Folkner, James G. Williams, and Dale H. Boggs. 2021. "The JPL Planetary and Lunar Ephemerides DE440 and DE441." *Astronomical Journal* 161, no. 3: 105. https://doi.org/10.3847/1538-3881/abd414.
- NOAA, Global Monitoring Laboratory. https://gml.noaa.gov/grad/solcalc
- *User's Guide to NOVAS Version C3.1,* Naval Observatory Vector Astrometry Software. https://aa.usno.navy.mil/downloads/novas/NOVAS_C3.1_Guide.pdf