NASA PUNCH Outreach: *Birthday Sunrises on a Chaco Canyon Horizon*

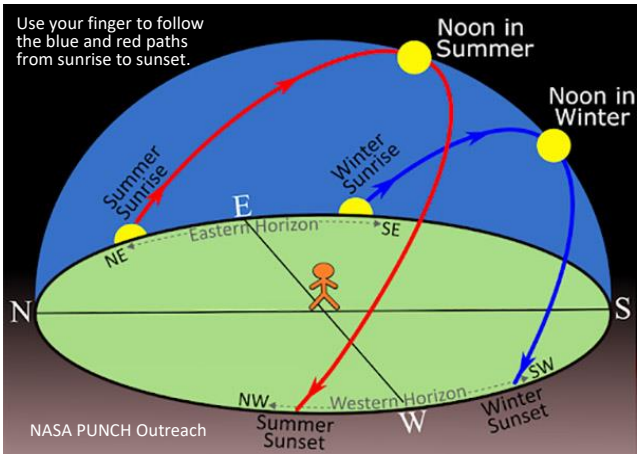
Guide for Self-Directed Engagement

1. What is a *Horizon Calendar*?

The location of sunrise (and sunset) on the horizon changes a little bit each day over the course of a year. There are no big jumps. Despite what you may have heard in school, the Sun rises directly in the east and sets directly in the west *only* near the days of Fall and Spring Equinoxes (~September 21st and ~March 21st). This is when the hours of daylight and darkness are equal.

In **Winter months**, the sunrises occur *south* of due east and travel lower daily paths across the sky (e.g., **blue arc**). The Sun's shorter time above the horizon leads to our lived experience of *fewer* daylight hours during the winter.

In **Summer months**, the sunrises occur *north* of due east and travel higher daily paths across the sky (e.g., **red arc**). The Sun's longer time above the horizon leads to our lived experience of *more* daylight hours during the summer.



The Sun's daily path traces 365 parallel arcs across the sky each year. Only two of these are shown as examples in the diagram. Imagine you are standing at the position of the little orange figure to watch the Sun rise on the Eastern Horizon. Notice how the location of sunrise on the horizon is different depending on the time of year. This seasonal difference also occurs at sunset.

Our Sun-watching ancestors could use these predictable changes to track time and seasons by making daily observations of sunrises or sunsets on a familiar horizon from a consistent viewing place. We call this using a *Horizon Calendar*. This ancient, nature-based technology helped (and still helps) to determine appropriate times for important seasonal activities.

2. The Kiva Poster: *Birthday Sunrises on a Chaco Canyon Horizon*

Before reading ahead, study the dates on the horizon calendar below and make **a first *estimate* of where the Sun rises on your birthday.** Then whatever your birth month is, make an estimate of **where the Sun rises in January.**

This is *not* a test, it is an exploration. You can change your answers as you learn more. Most of us have lost touch with this ancient knowledge, including leading researchers who study the Sun using spacecraft and computers. But all learners we have met appreciate recovering this knowledge of the natural world and using it in everyday life. **Please read on!**

3. Where is the *Horizon Calendar* in the poster located?

This horizon is in a **World Heritage Park** located within **Chaco Canyon** in northwestern **New Mexico** (yellow star on the map). The large, round, sandstone building is a ceremonial structure called a **Kiva** (pronounced KEE-vuh) built by Ancestral Puebloan people almost one thousand years ago. The Kiva is more than sixty feet wide and precisely aligned to the cardinal directions (E, S, W, N). Its architecture also interacts with solar and lunar cycles in ways still celebrated by contemporary people, including the descendants of the Chaco builders who continue to live in the southwestern US. We chose this marvel of ancient astronomical alignment in Chaco Canyon as a meaningful context to learn about horizon calendars. However, **anyone can create their own local horizon calendar closer to home**.

4. Does the Sun ever rise outside the Summer and Winter solstice extremes?

Nope. The *winter solstice* sunrise in December occurs at the *southernmost* extreme on the horizon and defines the days of the year with the *least amount of daylight*. In January, we begin to notice more hours of daylight again, and so the position of sunrise must have reversed course! Yes, the sunrise occurs at the winter solstice extreme for a few days, and then slowly moves back northward along the horizon causing the amount of daylight to slowly increase each day. **This is the "Return of the Light" that most cultures of the world celebrate in some way.**

The *summer solstice* sunrise in June occurs at the *northernmost* extreme on the horizon and defines the days of the year with the *greatest amount of daylight*. In July, we begin to notice fewer hours of daylight again, and so the position of sunrise must have reversed course! Yes, the sunrise occurs at the summer solstice extreme for a few days, and then slowly moves back southward along the horizon, causing the amount of daylight to slowly decrease each day.

The winter and summer solstices mark turning points where the sunrise position pauses and then turns back to proceed in the opposite direction. This means the sunrise positions during January are the same as for November, and sunrise positions during July are the same as for May. Now try pointing to approximate sunrise locations for ***all*** months of the year.

Start by pointing at the horizon location for September sunrise. Proceed to the right to *estimate* sunrise positions for October, November, and December (HINT: just divide the distance about evenly.) Then reverse course, for January (same as November), February (same as October), and see how March lands back in the same horizon location as September. Proceed to the left, estimating horizon positions for April, May, and June sunrises. Then reverse course for July (same as May), August (same as April), and back to September to complete the year.[1] **Does this change your answer for where the Sun rises on your birthday?**

[1] This "back-and-forth" behavior for sunrises along the horizon happens because of Earth's tilted rotation axis combined with Earth's yearly orbit of the Sun. We can study this too, but we do not need to understand it to use a horizon calendar effectively.