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Ancient Observatories –
Timeless Knowledge

See also the Stanford Solar Center: http://solar-center.stanford.edu/AO/

Here is a collection of sites, prehistoric and otherwise, that include artifacts related to tracking the Sun and often the stars. This is not an exhaustive list, just a sampling. Because few written records exist, we can only surmise from the evidence what purpose these sites might have served for their builders. The sites are listed in approximate chronological order.

Before Current Era

Goseck Circle
Location: In the current area of Saxony-Anhalt, Germany
Date Constructed: 4900 BCE. Functional for about 200 years, then abandoned.
Latitude: 51d 11m 54s N
Longitude: 11d 51m 53s E
Observed equinox¹: Mar 17-18; Sep 24-25

¹ For an explanation of the observed equinox, see the section on Calculating Equinoxes.
Construction:
Discovered from aerial surveys in 1991, Goseck Circle may be the oldest and best known of a series of circular enclosures associated with the Central European Neolithic period. It also may be one of the oldest solar observatories in the world. It was apparently created by Europe's first civilization, long before the cultures of Mesopotamia and the pyramids of Egypt.

The original consists of a set of four concentric circles, a mound, a ditch, and two palisade rings (fences or walls made by wooden stakes or tree trunks) containing gates in places aligned with sunrise and sunset on the solstice days. The palisades had three sets of gates facing southeast, southwest, and north. Archaeologists also found the remnants of ritual fires and decapitated human bones suggesting that the circle was not just for observation but also for human sacrifice.

The site has been restored and opened to the public on 21 December 2005, the winter solstice.

Alignments:
At the winter solstice, observers at the center would have seen the sun rise and set through the southeast and southwest gates. Archaeologists generally agree that Goseck circle was used for observation of the course of the Sun in the course of the solar year. Together with calendar calculations, it allowed coordinating an easily judged lunar calendar with the more demanding measurements of the solar calendar\(^2\).

Curiously, A 3,600 year old bronze disc, the Nebra Sky Disk, was discovered just 25 kilometers away from the site and is considered to be the oldest concrete representation of the cosmos. It shares a striking similarity with Goseck Circle.

A note on alignments: Goseck Henge is considered to be the oldest official solar observatory in the world. It lies on the same latitude as Stonehenge, just over 1' minute (approx. 1000m) longitude further north, and very close to the latitude of the Majorville Medicine Wheel in Alberta and the Newgrange monument in Ireland. These sites lie on the exact latitude at which the midsummer sunrise and sunsets are at 90° to the Moon’s northerly setting and southerly rising. This particular phenomena is only possible within a band of less than one degree of which Stonehenge and Goseck lies in the middle-third. The sites also sit on one of two

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\(^2\) The solar calendar, based on Earth’s yearly orbit around the Sun, does not work out evenly with the lunar calendar, based on the Moon’s orbiting the Earth. Early cultures tried very hard to find ways correlate these two phenomena.
unique latitudes in the world where the full Moon passes directly overhead on its maximum zeniths. Coincidence?

See also: [http://www.ancient-origins.net/ancient-places-europe/goseck-circle-oldest-known-solar-observatory-003325#ixzz3oBYPxHXx](http://www.ancient-origins.net/ancient-places-europe/goseck-circle-oldest-known-solar-observatory-003325)

Nabta Playa

The dusty planes of Nabta in southern Egypt were once fertile and an oasis. There, ancient nomads stopped for a while to bask in the Nile's intense summer sunshine. Beneath the Tropic of Cancer, they erected stones that cast no shadows, aligned with the rising and setting of the Sun.

**Location:** A large basin known as Nabta Playa, located about 100 km west of Abu Simbel near the Egyptian-Sudanese border

*Date Constructed:* ~4500 BCE  
*Latitude:* 22 32 00N.  
*Longitude:* 30 42 00E  
*Observed equinox:* Mar 13-14; Sep 29-30

**Construction:** Though Nabta Playa is the oldest known astronomical site in the world, it was discovered only recently. Nabta Playa was once a large lush and internally drained basin in the Nubian Desert, located south of modern-day Cairo. The site, known as Nabta, is between 6,000 and 6,500 years old, or about 1,000 years older than Stonehenge. It appears to have been constructed by nomadic cattle-herders living in southern Egypt. By the 5th millennium BCE these peoples had fashioned what may be among the world's earliest known archeoastronomical devices. These include alignments of stones that may have indicated the rising of certain stars and a “calendar circle” that indicates the approximate direction of summer solstice sunrise.

**Alignments:** The complex isn't circular like Stonehenge. It is .8 miles wide and 1.8 miles long. It includes 10 slabs some 9 feet high, 30 rock-lined ovals, nine burial sites for cows, each under a pile of 40 to 50 rocks weighing up to 200 or 300 pounds apiece, and a "calendar circle" of stones. Many of these features line up in five radiating lines, one of
them running east-west. The calendar circle is a 12-foot-wide arrangement of slabs about 18 inches long, most of them lying down.

Because Nabta lies near the Tropic of Cancer, the noon Sun is at its zenith about three weeks before and three weeks after the summer solstice, preventing upright objects from casting shadows. "These vertical sighting stones in the circle correspond to the zenith Sun during the summer solstice," said Kim Malville, an archaeoastronomer at the University of Colorado. "For many cultures in the tropics, the zenith Sun has been a major event for millennia." Two pairs of upright stones stand directly across the circle from each other, defining a view that would have displayed sunrise at the summer solstice. The circle also contains two other pairs of standing stones that defined a north-south view.

See also:
- http://www.colorado.edu/APS/landscapes/nabta/

Image:
- Wiki Commons; http://www.museumofflight.org/files/NabtaPlaya.jpg

Note the scale
Newgrange

Location: Drogheda - County Meath, Ireland
Date constructed: ~3200 BCE
Latitude: 53d 41' North
Longitude: 6d 28' East
Observed equinox: Mar 17-18; Sep 25-26
Newgrange is a World Heritage site (http://www.worldheritageireland.ie/bru-na-boinne/built-heritage/newgrange/)

Construction: The Megalithic Passage Tomb at Newgrange was built about 3200 BCE. The large mound is approximately 80m in diameter and is surrounded at its base by a kerb of 97 stones. It was discovered in 1699 and was been excavated and rebuilt between 1962 and 1975. The kidney shaped mound covers an area of over one acre and is surrounded by the 97 kerb stones, some of which are richly decorated with megalithic art with solar motifs. The most impressive of these stones is the highly decorated Entrance Stone. Outside the tomb, 12 out of the original estimated 38 large boulders up to 8-feet high form a ring of about 340-feet in diameter. The stone circle was built about 1000 years later than the original structure, dating probably from the Beaker period (~2000 BCE). It is estimated that the construction of the Newgrange mound would have taken a work force of 300 laborers at least 20 years.

There is a 58-foot long inner passage leading to an inner cruciform chamber. Above the entrance to the passage is a “roof box”, a small window-like opening that allows sunlight to fall into the passage at a certain time of year.

Alignments:
The passage and chamber of Newgrange are illuminated by the winter solstice sunrise. A shaft of sunlight shines through the roof box over the entrance and penetrates the passage to light up the chamber, highlighting spirals carved into the back wall. The dramatic event lasts for 17 minutes at dawn from the 19th to the 23rd of December. To the Neolithic culture of the Boyne Valley, the winter solstice marked the start of the New
Year-- a sign of nature’s rebirth and promising renewed life to crops, animals and humans. It may also have served as a powerful symbol of the inevitable victory of life over death, perhaps promising new life to the spirits of the dead.

See also:
http://www.newgrange.com/
http://www.knowth.com/newgrange.htm
http://www.worldheritageireland.ie/bru-na-boinne/built-heritage/newgrange/
http://sunearthday.nasa.gov/2005/locations/newgrange.htm

Images: Newgrange – Wiki Commons
Spirals - http://www.knowth.com/newgrange.htm
Majorville Medicine Wheel

Location: Vulcan County, Alberta, Canada
When Constructed: 3200 - 2500 BCE
Latitude: 50.585167N
Longitude: 112.410639W
Observed Equinox: Mar 17-18; Sep 25-26

Construction: The Majorville Medicine Wheel, the largest and oldest extant medicine wheel, consists of a central cairn that is linked to a surrounding stone circle by 28 spokes, and the cultural landscape that contains this monument. The designation encompasses 160 acres and is situated on a height of land with an expansive view of the surrounding prairie landscape west of the Bow River in southern Alberta. The central cairn is nine meters in diameter and is surrounded by a stone circle 27 meters across. About 28 spokes link the circle and central cairn. In 1971 an excavation yielded artifacts that were dated by stone tool style. This method and radiocarbon dating of bone place initial construction of the central cairn at some 4500 BP, although another source dates the initial site to 3200 BP. The tool finds indicate a succession of added material over the centuries. Archaeological studies indicate this site has been continuously used for the last 4,500 years, making this one of the oldest sacred sites in the world.

Alignments: Professor Gordon Freeman of Saskatchewan, an Oxford- and University of Saskatchewan- and McGill-trained scholar and Professor Emeritus at the University of Alberta studied Majorville from 1989 to 2006. Freeman found striking similarities between the surface geometry of Stonehenge and the stone patterns at Majorville. He
concludes that Majorville stones are really the remains of an open-air sun temple that predates both Stonehenge in England and the Pyramids in Egypt. According to Freeman, the Plains Indians used the temple to observe sunrise on the winter and summer solstices.

According to the Canadian Archaeological Association, “Majorville has associated with it outlying rock lines and cairns that accurately mark the Sun rise and set points on the solstices and on the observed equinoxes. The point of the Sun's first flash on the horizon is the rise position, and the point of the last flash on the horizon is the set position. These points move northward from December to June, then move southward again after the summer solstice. Near an equinox the Sun rise and set points at Majorville move along the horizon by 1.3 Sun diameters per day. Near a solstice it takes nine days to move the last diameter to the solstice position.

“We determine the Sun rise and set points photographically to within less than one Sun's diameter, and sometimes to within a fifth of a diameter, along alignments up to 2km long.

“Rock alignments at Majorville mark the Sun rise and set points three days before the [astronomically-defined] vernal equinox and three days after the [astronomical] autumnal equinox. [In ancient times, observers would observe the equinoxes as the two days a year when the Sun rises due east and sets due west. One these days, daylight and nighttime would be of almost exactly equal length. These east-west days are determined by latitude, hence they differ from the astronomically defined equinoxes: “the time at which the Sun crosses the celestial equator.” Hence Majorville reflects the equinox as observed by the people of the time, not as defined by modern astronomers.]

“These days [the observed equinoxes] are within two minutes of being exactly 12 hours long. The lens effect of the atmosphere causes the length of the solar equinoctial days to be about 12 hours and 10 minutes long at Majorville. The position of sunrise on the 12.00 hour day is marked by a spoke in the Medicine Wheel, which points to a large white limestone in the East House 61m away, and to a configured part of the eroded river bank 1100m away. Rocks have slid down the eroded bank from the sightline position. The Sun rises over the horizon about 30km distant.

“A more spectacular 12.00 hour day sunrise marker involves two V sights of rocks separated by 70m, on the west side of the Medicine Wheel hill. The sighting line is tangent to the Wheel. Because one is looking up the shaded side of the hill, the Sun becomes visible in the nested bottoms of the V's a half hour after the first flash on the distant horizon. Thus, one can observe the equinox sunrise even if the distant horizon is overcast to a depth of several sun diameters. The 12.00 hour day sunset is marked by a spoke of the Wheel which points to a small cairn on a hillock 1100m away and to a ripple on the horizon about 10km distant. The important part of the Majorville Medicine Wheel site covers 13km. It is 20,000 times larger than previously thought.”
See also:
- [http://canadianarchaeology.com/CAA/node/2628](http://canadianarchaeology.com/CAA/node/2628)
- [http://www.megalithic.co.uk/article.php?sid=22751](http://www.megalithic.co.uk/article.php?sid=22751)

Images:
Stonehenge

No one really knows what the creators of this monument had in mind when, over the course of three renovations spanning 1500 years, they built this famous ring of stones on a wind-swept hill.

**Location:** Salisbury, England  
**Date Constructed:** 3100 – 2000 BCE  
**Latitude** 51d 4’ North  
**Longitude** 1d 48’ West  
**Observed Equinox:** Mar 17-18; Sep 25-26  
Stonehenge, Avebury, and Associated Sites are a World Heritage Site

**Construction:** Stonehenge stood at the heart of a sprawling landscape of chapels, burial mounds, massive pits and ritual shrines, according to a recent survey of the ancient grounds. The researchers have found buried evidence of more than 15 previously unknown or poorly understood late Neolithic monuments: henges, barrows, segmented ditches, pits. These findings suggest a scale of activity around Stonehenge far beyond what was previously suspected.

This famous megalithic structure is only part of a vast collection of was apparently built in three stages beginning around 2950 B.C. and extending to 1600 B.C. During the first period of construction, it was a circular enclosure with two earthen banks and a ditch. During the second construction phase, about 2,000 BC, the inner circle of small bluestones, was set up, but abandoned before completion. The stones used in that first circle are believed to be from the Prescelly Mountains, located roughly 240 miles away. The bluestones weigh up to 4 tons each and about 80 stones were used, in all. Around 1600 BC, the outer ring of giant Sarsen Stones (as much as 50 tons each) were transported from the Marlborough Downs 20 miles to the north. It was originally thought that Stonehenge was built by ancient Druids, but the late-Neolithic Becker People were probably the builders. Ancient Druids worshiped in forest temples and, presumably, had
no need of stone constructions, according to some archeologists. In 2014 the University of Birmingham announced findings including evidence of adjacent stone and wooden structures and burial mounds, overlooked previously, that may date as far back as 4,000 BCE.

**Alignments:** On the longest day of the year, the June 21st summer solstice, observers within the monument can see the rising Sun appearing (slightly offset) behind the 'Heel Stone' - one of the main stones, creating the illusion that it is balancing on the stone. The Heel Stone sits along a wide lane called the Avenue, a wide road that measures nearly 3 kilometers, connecting Stonehenge with the River Avon. Recent research has suggested there were 2 Heel Stones, one long lost. If an observer stood on the Avenue looking **into**, rather than out of, the monument at dawn on the Summer Solstice (in 2400 BCE), the rays of the Sun would have shone straight through the heel stones to exactly strike the “alter stone” in the center.

Archaeoastronomers have also identified other stellar alignments with some of the other stones, however some controversy remains as to whether these stellar alignments were intended, or merely accidental.

See also:
- [http://www.smithsonianmag.com/history/what-lies-beneath-Stonehenge-180952437/#FuJz3qUtzRGkJto.99](http://www.smithsonianmag.com/history/what-lies-beneath-Stonehenge-180952437/#FuJz3qUtzRGkJto.99)
- [http://sunearthday.nasa.gov/2005/locations/stonehenge.htm](http://sunearthday.nasa.gov/2005/locations/stonehenge.htm)
- [http://arthistoryresources.net/stonehenge/stonehenge.html](http://arthistoryresources.net/stonehenge/stonehenge.html)
A mystical place marked by upright stones, and built by the labors of ancient people. Not even their bones remain to tell us who they were, and for what inscrutable reason they built this temple.

Location: Orkney Islands, Scotland  
Date Constructed: 2500 – 2000 BCE  
Latitude 59d 01' North  
Longitude 3d 8.1' East  
Observed Equinox: Mar 17-18; Sep 24-25  
The Heart of Neolithic Orkney is inscribed as a World Heritage site.

Construction: Considered to be the most awe-inspiring prehistoric site in Scotland, the Ring of Brodgar (Brogar) is located on a promontory between the Stennes and Harray Lochs in the Orkney Islands. The stone circle is 104 meters (341 ft) in diameter, and the third largest in the British Isles. The stones are set within a circular ditch with a diameter of 300 feet, up to 9 feet deep and 27 feet across, hewn out of the solid bedrock by the prehistoric constructors. The site is laid out very accurately in a perfect circle, with the stones approximately 6 degrees apart.

The surrounding area is full of other standing stones and Bronze Age round barrows, making a significant ritual landscape. The date of the ring's construction is uncertain as the site has yet to be fully excavated and scientifically dated. It was probably raised some
time between 2500 BCE and 2000 BCE. Twenty-seven stones remain of an original sixty in the Ring of Brodgar and set up on a slope facing east. They vary from 6 feet to 13 feet tall.

Alignment: The Brodgar and nearby Stennes rings were referred to by their traditional names until the early 1840's - the Ring of Brodgar being the "Temple of the Sun" and the Stenness stones the "Temple of the Moon". Observations suggest that several alignments with the Sun exist that relate to the solstices and the equinoxes as well as times such as Beltane (Old May Day). At winter and summer solstices, the sunrises and sunsets align with the stones and notches in the hills. At spring and autumn (astronomical) equinoxes, viewed from the Comet Stone, the Sun sets just glancing off the westernmost stone. It is unknown whether alignments have been checked at the observed equinoxes.²

See also:
http://sunearthday.nasa.gov/2005/locations/brodgar.htm

Images: https://simple.wikipedia.org/wiki/Ring_of_Brodgar;
http://www.northlinkferries.co.uk/your-holiday/guide-to-orkney/orkney-area-guide/ring-of-brodgar/

² See the section on Computing Equinoxes
To ancient Egyptians, the sun god Re was the bringer of light, and in other incarnations, the creator of the universe. The magnificent temple at Karnak celebrates this unity through its enormous pillars, designed in harmony with the Sun and stars over a span of nearly 2000 years.

**Location:** Egypt, northeast area of Luxor  
**Date Constructed:** 2055 BCE to 395 CE  
**Latitude:** 25.44 N  
**Longitude:** 32.36 E - 25.44N, 32.39E.  
**Observed Equinox:** Mar 14-15; Sep 27-28

**Construction:** Built by the Ancient Egyptians in several episodes of construction and enlargement from 2055 B.C to 395 A.D. It was originally surrounded by the famous city of Thebes, which was completely sacked in 667 B.C by the Assyrian ruler Ashurbanipal. Most of the original temple compound still lies under the city of Luxor and is inaccessible by archeologists. The major purpose of the temple complex at Luxor was to honor the god Amon-Re. The main function of the temple was for the Festival of Opet. A statue of Amon would be carried in a solemn procession from the main temple compound, down the Avenue of the Sphinxes, and into Luxor.

**Alignments:** The earliest axis included the famous Great Hypostyle Hall built by Ramses II on an east to west alignment. Sir Norman Lockyer (1836-1920) proposed a midsummer sunset alignment of the Main Axis of the Great Temple of Amon-Re (see *The Dawn of*
Astronomy, 1894). As Lockyer noted of Karnak, it was 'a scientific instrument of very high precision, as by it the length of the year could be determined with the greatest possible accuracy.' By some accounts, the temple at Luxor may have no less than four well-defined alignment changes involving stars. Unlike solar alignments which can generally last for thousands of years intact, stellar alignments are much more critical because of the precession of the equinoxes, and last only a few hundred years. Lockyer's measurements showed several Karnak temples had been altered over the centuries to match the precessional changes in their aligned stars.

See also:  http://sunearthday.nasa.gov/2005/locations/elkarnak.htm  
https://en.wikipedia.org/wiki/Karnak  

Image:  http://k0k0.8m.com/egypt.htm  
Abu Simbel

Location: Egypt, 250 kilometers southeast of Aswan
Date Constructed: 1279 - 1213 BCE
Latitude 22° 20' 22" North
Longitude 31° 36' 97" East
Observed Equinox: Mar 13-14; Sep 29-30
The Abu Simbel temples are part of the “Nubian Monuments” World Heritage Site

Construction: The Abu Simbel temples are two massive rock temples at Abu Simbel, a village in Nubia, southern Egypt, near the border with Sudan. The twin temples were originally carved out of the mountainside during the reign of Pharaoh Ramesses II in the 13th century BC, as a lasting monument to himself and his queen Nefertari, to celebrate his domination of Nubia, and his piety to the gods, principally Amun-Re, Ra-Horakhty and Ptah, as well as his own deification.

The original temple was positioned on the bank of the Nile, but it was raised up 300 meters by an international relocation project supported by UNESCO between 1964 and 1968 to prevent the flooding of the temple by the rising waters of Lake Nasser caused by the new Aswan High Dam.

Alignments: The interior of the temple is inside the sandstone cliff in the form of a man-made cave cut out of the rock. It consists of a series of halls and rooms extending back a total of 185 feet from the entrance. As you walk to the rear
of the temple you come to the Holiest of Holies located at the back wall, where you will find four statues of: Ra-Harakhte, Ptah, Amun-Ra and King Ramses II. This temple is unique, since the Sun shines directly on the Holiest of Holies two days a year: February 21, the king's birthday, and October 22, the date of his coronation.

See also:
http://sunearthday.nasa.gov/2005/locations/abusimbel.htm
http://www.sis.gov.eg/En/Templates/Articles/tmpArticles.aspx?ArtID=1200#.VhV6u6J61pg
https://en.wikipedia.org/wiki/Abu_Simbel_temples
http://witcombe.sbc.edu/sacredplaces/abusimbel.html
http://www.ancient-wisdom.com/egytastronomy.htm

Images: External - https://www.youtube.com/watch?v=SiiET2wVK6Q
Internal - copyright-free; Graphics Catalog of Images: Jay Friedlander
Below - Wiki Commons
Gotland Grooves

Location: Gotland, Sweden
Date Constructed: ~1000 BCE
Latitude 57.64°N
Longitude 18.30°E
Observed Equinox: Mar 17-18; Sep 24-25

Construction: There are grooves carved into rock in many places in Europe, and some of them appear on the Baltic Sea island of Gotland. Thousands of grooves, scattered on stones throughout the island of Gotland seem to connect the scattered parts together into a vast timepiece. Aligned with the Sun, moon and stars, the grooves mark an ancient, human obsession with time and space over 3000 years ago.

Alignments: There are about 3600 known grooves on stones scattered throughout the island of Gotland. 700 are scored directly into the limestone bedrock, the rest are found on about 800 stones. The length of the grooves varies from about 0.5 to 1 meter. They are between 5 cm to 10 cm wide and 1 cm to 10 cm in depth. The most important feature of the grooves appears to be in their alignment. A recent study of 1256 grooves showed that they are aligned with certain positions of the celestial bodies, apparently the Sun or the Moon. Most of them are oriented east to west.

See also: http://sunearthday.nasa.gov/2005/locations/gotland.htm
https://en.wikipedia.org/wiki/Grooves_%28archaeology%29

Image: Wiki Commons.
Chankillo

Location: Ancash Region of current-day Peru
Date Constructed: ~300 BCE
Latitude: 9d 33m 24s S
Longitude: 78d 14m 9s W
Observed Equinox: Mar 31-Apr 1; Sep 10-11

Construction:
Chankillo is an ancient monumental complex in the Peruvian coastal desert. The complex was constructed from cut stone and include a fortified temple, a plaza, the nearby Thirteen Towers solar observatory, as well as residential and gathering areas. The Thirteen Towers have been interpreted as an astronomical observatory. The culture that produced Chankillo is unknown.

Alignments:
The Thirteen Towers of Chankillo could be the earliest known observatory in the Americas. The regularly-spaced Thirteen Towers were constructed on top of a ridge of a low hills running near north to south. They form a "toothed" horizon with narrow gaps at regular intervals. There are two possible observation points, to the east and west. From these vantage points, the 300m long spread of the towers along the horizon corresponds very closely to the rising and setting positions of the Sun over the year, albeit they are not all visible. On the winter solstice, the Sun would rise behind the leftmost tower of Chankillo and rise behind each of the towers until it reached the rightmost tower six months later on the summer solstice. Inhabitants of Chankillo would have been able to determine an accurate date, with an error of a day or two, by observing the sunrise or sunset from the correct tower.

See also:
http://wmf.org/project/chankillo

Images:
http://www.wmf.org/project/chankillo
They called it the Navel of the World, and for its inhabitants, Easter Island was the only inhabited scrap of land on an ocean planet. Even most of their enigmatic statues encircle the island with their backs to the sea.

*Location:* Rapa Nui / Easter Island, off the coast of Chile  
*Date Constructed:* 700-1100 CE  
*Latitude:* 27° 05', South.  
*Longitude:* 109° 20', West.  
*Observed Equinox:* Mar 23-24; Sep 18-19

*Construction:* Polynesian people most likely settled on Easter Island sometime between 700 to 1100 CE. 887 statues called moai can be found on this isolated island, located 2300 miles from the coast of Chile. The statues range in size from a few feet to over 30 feet, and weigh up to 150 tons. Each statue was hewn out of hard volcanic material from quarries near the Rano Raraku volcano. The statues are thought to honor their deity Make Make, or represent chieftains of the two or three tribes that inhabited this island.

Originally the island was heavily forested, but the rapid growth of the human population quickly denuded the island (imagine being the person to cut down the last tree on Easter Island). About 250 years ago, warfare between the two tribes of 'Easter Islanders' led to
the toppling of most of the statues. Very little is known about the earlier inhabitants whose very existence was not realized until 1774 when Captain Cook visited it and gave it its modern name.

**Alignments**: The vast majority of the moai are located on the beaches and face inland. However, there are seven moai at Ahu Akivi, a particular sacred place, built around 1460 CE that exactly face sunset during the Spring Equinox and have their backs to the sunrise during the Autumn Equinox. Such an astronomically precise feature is seen only at this location on the island. Each statue measures 14 feet tall and weighs 12 tons. They were restored in 1960 by archaeologists William Mulloy and Gonzalo Figueroa.

It is commonly said that the remarkable aspect of Ahu Akivi is that the moai also are the only ones that face out to sea. However, from their central location on the island, all sight-lines are towards the ocean and new research suggests they were meant to look out over a very large village which today is in ruins. Easter Island oral history from the fewer than 700 remaining natives does not indicate a deep interest in astronomical knowledge. Hieroglyphic writings have survived that might fill-in this information, but have yet to be translated.

*See also:* [http://sunearthday.nasa.gov/2005/locations/easter.htm](http://sunearthday.nasa.gov/2005/locations/easter.htm)  
[https://en.wikipedia.org/wiki/Ahu_Akivi](https://en.wikipedia.org/wiki/Ahu_Akivi)  

*Image:* Wiki Commons  
Chaco Canyon / Sun Dagger

Location: New Mexico, USA
Date Constructed: 850 - 1150 CE
Latitude 36.06° N
Longitude 107.97° W
Observed Equinox: Mar 16-17; Sep 25-26
Chaco Canyon, along with Aztec Ruins and several smaller Chaco sites, are a World Heritage Site

Construction: For over 2,000 years, Pueblo peoples occupied a vast region of the southwestern United States. Chaco Canyon, a major center of ancestral Pueblo culture between 850 and 1250, was a focus for ceremonials, trade, and political activity for the prehistoric Four Corners area. Chaco is remarkable for its monumental public and ceremonial buildings and its distinctive architecture. The people there constructed massive stone buildings unlike any that had been built before. These structures soared to four or five stories and contained up to seven hundred rooms and dozens of kivas, underground rooms used for religious rituals. These Great Houses were feats of engineering and were connected to one another by lines of sight that would have enabled rapid communication. Often built along solar and celestial alignments, they included water-collection systems and were linked to outlying communities by an extensive network of roads. These elaborate buildings evidence a sophisticated and highly organized culture, with Chaco Canyon at its religious center.
Chaco was abruptly abandoned around 1150 CE. It's not completely clear why the people left Chaco Canyon, but climate change or civil unrest are possible explanations.

Alignment: Chaco Canyon is of great interest to archaeoastronomers. Evidence suggests that the Chacoans were expert sky watchers, with a clear knowledge of the cyclic and seasonal patterns of the Sun, Moon, and stars. This knowledge is reflected over and over again in the architecture and alignment of the great houses, and in various observational and ceremonial sites around the canyon. The most famous among these sites is the Sun Dagger, a petroglyph discovered by Anna Sofaer and crafted to mark the cycles of the Sun and possibly the Moon.

According to Anna Sofaer: “Near the top of an isolated butte in Chaco Canyon, New Mexico, three large stone slabs collimate sunlight in vertical patterns of light on two spiral petroglyphs carved on the cliff behind them. The light illuminates the spirals each day near noon in a changing pattern throughout the year and marks the solstices and equinoxes with particular images. At summer solstice a narrow vertical form of sunlight moves downward near noon through the center of the larger spiral. At equinox and winter solstice corresponding forms of light mark the spirals. The relationship between the shape and orientation of the slabs and the resultant light patterns on the cliff is a complex one and required a sophisticated appreciation of astronomy and geometry for its realization. The site is unique in employing the varying height of the midday Sun during the year to provide readings of solar declination. In this respect it is clearly different in concept from the many archeoastronomical sites throughout the ancient New and Old Worlds that tell the passage of the year by marking the rising and setting points of the Sun and Moon.” See [http://www.solsticeproject.org/science.htm](http://www.solsticeproject.org/science.htm)

See also:
http://www.solsticeproject.org/
http://chacomysterycontinues.com/About_the_Film/Anna_Sofaer/index.html
http://weather.msfc.nasa.gov/archeology/chaco.html
http://www.nps.gov/chcu/index.htm
https://en.wikipedia.org/wiki/Chaco_Culture_National_Historical_Park
http://www.exploratorium.edu/chaco/
http://www.angelfire.com/indie/anna_jones1/lost_dagger.html

Images: [http://www.elcamino.edu/faculty/eatherton/comparativereview1.html](http://www.elcamino.edu/faculty/eatherton/comparativereview1.html)
Chichen Itza

For a thousand years, the slanting rays of the setting sun have played a spectacular shadow game with this great Mayan pyramid. At the appointed hour, the shadow of the Feathered Serpent Kulkulkan slides down the northern stairway...and vanishes.

*Location*: Pyramid of Kulkulkan. (El Castillo; the ruins of Chichen Itza lie about midway between the towns of Cancun and Merida on the Yucatan Peninsula

*Date Constructed*: ~1000-1200 CE

*Latitude* 20°40'N

*Longitude* 88°32'W

*Observed Equinox*: Mar 13-14; Sep 29-30

Chichen Itza is a World Heritage Site

*Construction*: Chichen Itza was one of the largest Maya cities and it was likely to have been one of the mythical great cities, or Tollans, referred to in later Mesoamerican literature. The city may have had the most diverse population in the Maya world, a factor that could have contributed to the variety of architectural styles at the site. Kulkulkan is the Mayan name for the Feathered Serpent God (also known as Quetzalcoatl to the Aztecs). Kulkulkan plays a major role in the light show at Chichen Itza.

*Alignments*: Around 1000 – 1200 CE, the Mayans constructed a square-based, stepped pyramid approximately 75 feet tall, built directly upon the multiple foundations of previous temples. (It was mysteriously abandoned along with the surrounding city of Chichen Itza by 1400 AD.) The axes that run through the northwest and southwest corners of the pyramid are oriented toward the rising point of the Sun at the summer solstice and its setting point at the winter solstice. The pyramid is unique among all
known pyramids, worldwide, for its central role in a dramatic shadow and light display during the equinoxes.

At the appointed hour on the observed equinoxes\(^4\), the setting Sun casts a shadow of a serpent, presumably the honored Kulkulkan, writhing down the northern steps of the pyramid. The sunlight bathes the western balustrade of the pyramid's main stairway and causes seven isosceles triangles to form, imitating the body of a serpent 37 yards long that creeps downwards until it joins the huge serpent's head carved in stone at the bottom of the stairway. Each face of the pyramid has a stairway with ninety-one steps, which together with the shared step of the platform at the top, add up to 365, the number of days in a year. These stairways also divide the nine terraces of each side of the pyramid into eighteen segments, representing the eighteen months of the Mayan calendar.

Note that modern celebrations usually occur on the astronomically defined equinox, though the Mayas would have designed their pyramid for the observed equinox. This usually works since the shadows and light usually can be seen for several days.

See also:
http://whc.unesco.org/en/list/483
https://en.wikipedia.org/wiki/Chichen_Itza
http://sunearthday.nasa.gov/2005/locations/chichen_itza.htm
http://www.chichenitza.com/
Images: Wiki Commons

\(^4\) The observed equinoxes are not the same as the astronomically-defined ones. See the section on Calculating the Equinox
**Location:** Cambodia  
**Date Constructed:** ~1100 CE  
**Latitude** 13°25'48" N  
**Longitude** 100°54'00" E  
**Observed Equinox:** Mar 11-12; Sep 30-31

Angkor Wat is a World Heritage Site

**Construction:** Angkor Wat is a temple complex in Cambodia and the largest religious monument in the world. It was originally founded as a Hindu temple for the Khmer Empire, gradually transforming into a Buddhist temple toward the end of the 12th century. The builders of Angkor Wat were not interested in creating a temple merely to honor their deities. They created in its very structure and orientation, a reminder of the greater cosmic order, reflected in both the passage of time, and in the changing rays of the Sun at propitious times of the year.

**Alignments:** In 1976, University of Michigan researchers suggested that the architect of ancient Cambodia's Angkor Wat had encoded calendrical, historical, and cosmological themes into his architectural plan for the temple. Published in the journal Science, the study demonstrated how Angkor Wat's architect had established solar alignments between the temple and a nearby mountaintop shrine that took place during the summer solstice. For example, standing at Pre Rup, 6 kilometers away, at winter solstice, one would see the setting Sun over Angkor Wat. Standing near the southwestern corner in
Angkor Thom, the rising sun at the summer equinox will be visible through, or over, the eastern gate. Six months later, the alignment has shifted to its northern point of sunrise at winter solstice.

See also:
http://whc.unesco.org/en/list/668
https://en.wikipedia.org/wiki/Angkor_Wat
http://suneartday.nasa.gov/2005/locations/angkorwat.htm

Image: Wiki Commons
Hovenweep Castle

*Location:* Hovenweep National Monument straddles the southern Utah-Colorado border.  
*Date Constructed:* 1177 – 1277 CE  
*Latitude* 37d 23' 09N  
*Longitude* 109d 04' 49W  
*Altitude* 5,200 feet  
*Observed Equinox:* Mar 15-16; Sep 26-27

*Construction* Human habitation at Hovenweep dates to over 10,000 years ago when nomadic Paleoindians visited the Cajon Mesa to gather food and hunt game. These people used the area for centuries, following the seasonal weather patterns. By about 900 CE, people started to settle at Hovenweep year-round, planting and harvesting crops in the rich soil of the mesa top. By the late 1200s, the Hovenweep area was home to over 2,500 people who created terraces on hillsides, formed catch basins to hold storm run-off, built check dams to retain topsoil that would otherwise wash away, and constructed storage granaries under the canyon rims protected harvests of corn, beans and squash for later use. The masonry at Hovenweep is as skillful as it is beautiful. Even the cliff dwellings of Mesa Verde rarely exhibited such careful construction and attention to detail. Some structures built on irregular boulders remain standing after more than 700 years. Buildings at Hovenweep have a marked fortress-like appearance - they are often tower-shaped, with only small openings or "ports".

By the end of the 13th century, it appears a prolonged drought, possibly combined with resource depletion, factionalism, and/or warfare, forced the inhabitants of Hovenweep to depart. Ancestral Puebloans throughout the area migrated south to the Rio Grande Valley in New Mexico and the Little Colorado River Basin in Arizona. Today's Pueblo, Zuni and Hopi people are descendants of this culture.

*Alignments:* Long after the massive Hovenweep Castle building was created to shelter them, Native Americans evidently realized it could serve another purpose as well. Within an ancient room added almost as an afterthought, a shaft of light shines through an opening in massive wall and connects its dwellers with the Sun's springtime cadence. Tree-ring dating of timbers used in the construction of the 'Sun Room' suggest that it was added in 1277 CE about 100 years after the main structure, the Castle, was completed. Two ports, or windows, in the large tower admit the rays from the Sun into the interior room, and it has been proposed that this arrangement was used as a solar calendar. The equinox port points to the sunrise azimuth 4 days after the vernal equinox. One
explanation for this is that this is the consequence of a method for establishing the equinox azimuth by counting and halving the number of days between the winter and summer solstices. Or, the Hovenweep inhabitants were using the observance of equinox as the times when the Sun rose due east and set due west. This equinox observance would depend upon latitude, and results in a different equinox time than that defined by modern astronomy (“the time at which the Sun crosses the celestial equator”).

See also:
https://www2.hao.ucar.edu/Education/SolarAstronomy/hovenweep-castle
http://sunearthday.nasa.gov/2005/locations/hovenweep_castle.htm
http://www.nps.gov/hove/index.htm
http://darksky.org/idsp/parks/hovenweep/

Images:
https://www2.hao.ucar.edu/Education/SolarAstronomy/hovenweep-castle
http://snailhollow.cobabe.net/2013/05/hovenweep-is-fascinating-site-for-those.html
Scattered across the upper Great Planes and into Alberta, rings of stones bare mute testimony to ancient rituals and purposes long since lost in legend and folklore. For 4000 years, some have watched the passage of time and a million sunsets.

**Location:** Big Horn National Forest, Wyoming  
**Latitude** 44°49.6'  
**Longitude** 107°55.7'  
**Date Constructed:** 1200-1700 CE  
**Observed Equinox:** Mar 16-17; Sep 25-26

**Construction:** For centuries, the Bighorn Medicine Wheel has been used by Crow youth for fasting and vision quests. Native Americans also go to Bighorn to offer thanks for the creation that sustains them, placing a buffalo skull on the center cairn as a prayer offering. Prayers are offered here for healing, and atonement is made for harm done to others and to Mother Earth. A detailed account of ceremonial use of the Bighorn Medicine Wheel by the Arapaho was related in 1993 by Paul Moss in a landmark of Native American oral tradition.

The wheel has 28 spokes, the same number used in the roofs of ceremonial lodges. The wheel was built between 1200 and 1700 CE. The central cairn is the oldest part. Excavations have shown it extends below the wheel and has been buried by wind-blown dust. Alberta has about 66% of all known Medicine wheels (46) suggesting that Southern
Alberta was a central meeting place for many Plains tribes who followed Medicine Wheel ceremonies (usually on the Summer Solstice - June 21st).

Alignment: At the center of the wheel there is a raised central cairn, and several others on the periphery of the wheel. These have been alleged to have astronomical alignments. Astronomer John Eddy suggested that a line drawn between the central cairn and an outlying cairn at the Bighorn Medicine Wheel pointed to within 1/3 of a degree of the rising point of the sun at the summer solstice. The actual astronomical purpose of the design of these wheels remains controversial. The design may also have assisted in the performance of specific rituals and ceremonies that have been lost to us. The 28 spokes could indicate the lunar month, or the length of the female menstrual cycle.

See also:
http://sunearthday.nasa.gov/2005/locations/bighorn.htm

Images: http://frigg.physastro.mnsu.edu/~eskridge/astr102/week2.html
Medicine Wheel sunset photograph by Tom Melham. Used with permission.
Gaocheng

Location: About eight miles from Dengfeng - China  
Date Constructed: 1276 CE  
Latitude: 34° 30’ N  
Longitude: 113° 6’ East  
Observed Equinox: Mar 15-16; Sep 26-27  
Gaocheng is a World Heritage Site

Construction: Established in 1276 CE by the famous astronomer Guo Shoujing, it is the oldest of 27 ancient observatories in China. Built with bricks and stone, the building has two parts, the platform and the stone Chinese sundial. On the 28 foot high platform, there are two small cottages on each side. To the north of the platform is an entry and exit, which are symmetrically arranged. Linking the entry and exit to the platform are stairs and pathways. Between the two pathways is the 93 foot long stone Chinese sundial, which was paved by 36 slates. According to historical records, a total of 27 observatories were built in the Yuan Dynasty but only the one in Dengfeng is known to have survived. Gaocheng Observatory is the oldest facility of its kind in China.

Alignment: Ancient Chinese astronomers brooded over solar eclipses and sunspots to divine future events for The Emperor. Observatories were the launching pads for exploring the mystical ties between the mundane and the cosmic. Gaocheng was designed originally for use in predicting the time of the solstice each year. Astronomers at the site were able to calculate the actual length of the year to 365.2425 days some 300 years before Europeans managed to develop the Gregorian calendar.

See also:  
http://sunearthday.nasa.gov/2005/locations/gaocheng.htm  
https://en.wikipedia.org/wiki/Gaocheng_Astronomical_Observatory
Machu Picchu

Location: Northeast of Cusco in the district of Machu Picchu, Urubamba, Peru
Date Constructed: 1450 CE
Latitude: 13° 07 South
Longitude: 72° 35 West
Elevation: 7972 feet
Observed Equinox: Mar 27-28; Sep 13-14
Machu Picchu is a World Heritage Site

Construction: Machu Picchu is an Incan citadel set high in the Andes Mountains in Peru, above the Urubamba River valley. Built as an estate for the Inca emperor Pachacuti, (1438–1472), it was abandoned during the Spanish Conquest. It is renowned for its sophisticated dry-stone walls that fuse huge blocks without the use of mortar, its engineering feats of building draining into the mountain top, and intriguing buildings that play on astronomical alignments. Sunlight plays an important role in understanding the design of this fabled Inca city and its inhabitants who worshipped the Sun. Inca architects designed practical homes for Machu's residents. They also marked in their creations the ephemeral connection between time and space.

Alignment: A number of features distributed throughout the site are aligned with the June solstice azimuth of 65-245 degrees. The Sacred Plaza is enclosed on three sides but is open to the west with an alignment of 245 degrees. The Temple of the Three Windows, forming the easterly side of the plaza, opens to the plaza and faces the solstice sunset. The Intihuatana platform is oriented to 65-245 degrees with a shaped replica stone of Huayna Picchu in its center. The solstice alignment, and the importance of solstice ritual to the Inca, suggest they were primary ceremonial considerations of the site.

The Inti Watana stone is one of many ritual stones in South America. These stones are arranged to point directly at the Sun during the winter solstice. The name of the stone derives from Quechua language: inti means "sun", and wata-, "to tie, hitch (up)". The Inca believed the stone held the Sun in its place along its annual path in the sky. The stone is situated at 13°9'48" S. At midday on 11 November and 30 January, the Sun stands almost exactly above the pillar, casting no shadow. On 21 June, the stone casts the
longest shadow on its southern side, and on 21 December a much shorter shadow on its northern side.

The Temple of the Sun has an elliptical design similar to a Sun temple found at the Inca capital of Cuzco. It is a semi-circular building that sits above the Inti Mach’ay (below) and was built into the natural environment with a large stone forming the foundation of the structure. Only the priest and the Inca ruler could enter the Temple of the Sun. It is thought that the Temple of the Sun was used as a solar observatory, with the two windows in the structure related to the Summer and Winter solstice. The tower has several niches for placing offerings and a large rock in the center. During the Summer Solstice, the rising sun shines directly through one of the temple’s windows and onto the rock. Sculptures carved out from the rock bottom of the Sun temple are interpreted as "Water mirrors for observing the sky", that is, ways to track when the Sun (or stars?) might be directly overhead.

Architecturally, Inti Mach'ay is the most significant structure at Machu Picchu. It is a special cave used to observe the Royal Feast of the Sun, celebrated during the Incan month of Qhapaq Raymi. Entrances, walls, steps and windows are some of the finest masonry in the Incan Empire. The cave also includes a tunnel-like window unique among Incan structures, which was constructed to only allow sunlight into the cave during several days around the December solstice. For this reason, the cave was inaccessible for much of the year. The Royal Feast of the Sun was an Inca festival celebrated by the nobility around the December solstice. It began earlier in the month and concluded on the December solstice. On this day, boys of the nobility were initiated into manhood.

See also:
- https://en.wikipedia.org/wiki/Machu_Picchu
- http://www.machupicchutrek.net/machu-picchu-facts/

Images:
- http://www.machupicchu.org/
**Jantar Mantar**

*Location*: New Delhi, India  
*Construction Date*: 1738 CE  
*Latitude*: 28° 37', North  
*Longitude*: 77° 13'  
*Observed Equinox*: Mar 15-16; Sep 26-27

*Construction*: The great Indian astronomer-king Maharaja Jai Singh II of Jaipur built five astronomical observatories between AD 1724 and 1730 during the period generally known as the dark age of Indian history. He was inspired by the 15th-century Afghani ruler Ulughbek's observatory at Samarkand. They consist of brick and marble towers and pillars, with no telescopic elements at all, yet through solar shadow movements and careful sightings, the local time, and positions of the moon, stars and planets could be determined with great accuracy. The Jantar Mantar monument of Jaipur, Rajasthan is a collection of nineteen architectural astronomical instruments completed in 1738 CE. It features the world's largest stone sundial.

*Alignments*: The Jantar Mantar consists of a number of masonry instruments for predicting time, measuring the position of a celestial body and determining the latitude. These instruments include the Brihat Samrat Yantra, the Rama Yantra and the Jai Prakash Yantra. The Brihat Samrat Yantra, is a huge sundial that gives the local time in New Delhi very accurately. The Rama and Jai Prakash Yantras measure precise positions of celestial bodies in the night sky. When the sun is high in the sky, the pillar at the center of Rama Yantra casts a shadow either on the vertical well surrounding the pillar or the raised floor segments radiating from the pillar. These segments and the walls have fine graduations. The two pillars on the southwest of Mishra Yantra were designed to determine the shortest and longest days of the year. In December one pillar completely covers the other with its shadow while in June it does not cast any such shadow at all.

*See also*:  
*Images*:  
[Sun dial - http://www.tripadvisor.in/LocationPhotoDirectLink-g304555-d311635-i23345388-Jantar_Mantar_Jaipur-Jaipur_Rajasthan.html](http://www.tripadvisor.in/LocationPhotoDirectLink-g304555-d311635-i23345388-Jantar_Mantar_Jaipur-Jaipur_Rajasthan.html)
Calculating the Equinoxes

Most dictionaries *erroneously* define the equinox as: “the time or date (twice each year) at which the Sun crosses the celestial equator, when day and night are of equal length (about September 22 and March 20)”. However, there is no place on Earth where the day and night are of equal length on the given days.

**Latitude Determines Day Length**

In fact, **latitude** determines day length. Even if day and night aren’t exactly equal on the day of the equinox, there are days when day and night are both very close to 12 hours. However, this date depends on the location’s latitude, and can vary by as much as several weeks. The table shows approximate dates for when day and night are as similar as possible according to latitude.

<table>
<thead>
<tr>
<th>Latitude</th>
<th>March</th>
<th>September</th>
</tr>
</thead>
<tbody>
<tr>
<td>90° North</td>
<td>Sun rises ~Mar 19</td>
<td>Sun sets ~Sep 24</td>
</tr>
<tr>
<td>80° North</td>
<td>Mar 17-18</td>
<td>Sep 24-25</td>
</tr>
<tr>
<td>60° North</td>
<td>Mar 17-18</td>
<td>Sep 24-25</td>
</tr>
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<td>55° North</td>
<td>Mar 17-18</td>
<td>Sep 24-25</td>
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<tr>
<td>50° North</td>
<td>Mar 17-18</td>
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<td>Mar 16-17</td>
<td>Sep 25-26</td>
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<td>Mar 16-17</td>
<td>Sep 25-26</td>
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<td>Sep 26-27</td>
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</tr>
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<td>5° North</td>
<td>Feb 25-26</td>
<td>Oct 17-18</td>
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<td>Equator</td>
<td>No equal day and night</td>
<td></td>
</tr>
<tr>
<td>5° South</td>
<td>Apr 14-15</td>
<td>Aug 28-29</td>
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<td>15° South</td>
<td>Mar 28</td>
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<td>Sep 16-17</td>
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<td>25° South</td>
<td>Mar 24-25</td>
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</tr>
<tr>
<td>90° South</td>
<td>Sun sets ~Mar 22</td>
<td>Sun rises ~Sep 20</td>
</tr>
</tbody>
</table>
Geometry Affects Day Length
On the equator, the day and night stay approximately the same length all year round, but the day will always appear a little longer than 12 hours. On the equinoxes, the geometric center of the Sun is above the horizon for 12 hours, and you might think that the length of the day (hours of daylight) would be 12 hours too. However, ‘sunrise’ is defined as the moment the upper edge of the Sun's disk becomes visible above the horizon – not when the center of the Sun is visible. In the same sense, ‘sunset’ refers to the moment the Sun's upper edge, not the center, disappears below the horizon. The time it takes for the Sun to fully rise and set, which is several minutes, is added to the day and subtracted from the night, and therefore the equinox day lasts a little longer than 12 hours.

Refraction Affects Day Length
Another problem is that the Earth's atmosphere refracts, or bends, sunlight. This causes the Sun’s upper edge to be visible from Earth several minutes before the edge actually reaches the horizon. The same thing happens at sunset, when you can see the Sun for several minutes after it has actually dipped under the horizon. So, every day on Earth – including the days of the equinoxes – is at least 6 minutes longer than it would have been without this refraction. Making this even more complicated -- the extent of refraction depends on atmospheric pressure and temperature.


How Ancient Cultures Determined the Equinoxes
The peoples who built the great Medicine Wheels, Stonehenge, Chaco Canyon, Machu Picchu and the others did not have clocks to calculate minutes of daytime/nighttime. We have no idea whether that was even important to them or not. What these peoples did know was that the rising and setting points of the Sun moved, just slightly, each day during a year. Using standing stones, poles, notches on the horizon, whatever, they could easily tell when the Sun reached its most northern rising/setting points (Summer Solstice), and the most southern (Winter Solstice). They could also tell when the Sun rose exactly due east and set exactly due west. To them, this was their equinox, the time halfway between farthest north and farthest south, between Summer Solstice and Winter Solstice.

Hence applying the standard astronomical equinox dates to an ancient monument will not usually work. To know when an equinoctial alignment for a particular site is correct, one has to take into account latitude, and the chart above. True equinox dates have been added to the descriptions for each site. Note that the solstitial dates and locations will change over thousands of years, but the rising/setting of the Sun due east and west will not.

Other resources

Aboriginal Star Knowledge: how Native Americans observed the Sun and stars.
http://www.kstrom.net/isk/stars/starmenu.html

Ancient Japanese Lore and Astronomical History: 
http://www2.gol.com/users/stever/jastro.html#Astro%20Lore

Ancient Observatories – Timeless Knowledge: NASA's 2005 Sun-Earth Day Site
http://sunearthday.nasa.gov/2005/index.htm

Astronomer Unearths Evidence of Scientific Tradition in Africa:
http://scitation.aip.org/content/aip/magazine/physicstoday/article/59/4/10.1063/1.2207030
An article about Thebe Medupe, an ethno- and archaeo-astronomer and researcher at the South African Astronomical Observatory who has been exploring traditional African peoples' knowledge of astronomy. In his documentary film, Cosmic Africa, Medupe visits remote communities to learn about the form and significance that astronomy takes in their cultures.

Aztec “Sun Stone” or Calendar
http://www.crystalinks.com/aztecalendar.html

The Center for Archaeoastronomy – University of Maryland
http://terpconnect.umd.edu/~tlaloc/archastro/

Haleakala - "Path to the calling the Sun"


Sunpath in the Stars -- how the Lakota Sioux tracked the Sun's movement against the stars.  http://www.kstrom.net/isk/stars/starkno4.html
Modern Solar Observatories

A sampling

**Ground-based**
- Cerro Tololo Interamerican Observatory, Chile: [http://www.ctio.noao.edu/noao/](http://www.ctio.noao.edu/noao/)

**Satellites and spacecraft**
- NASA TRACE: [http://science.nasa.gov/missions/trace/](http://science.nasa.gov/missions/trace/)

*SDO image courtesy NASA*