Equinox

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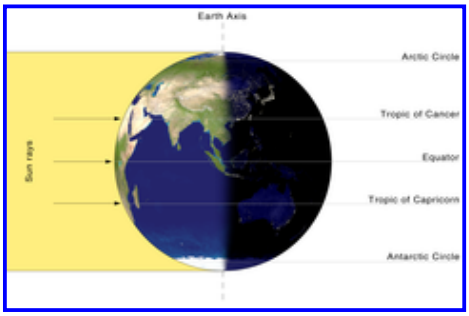
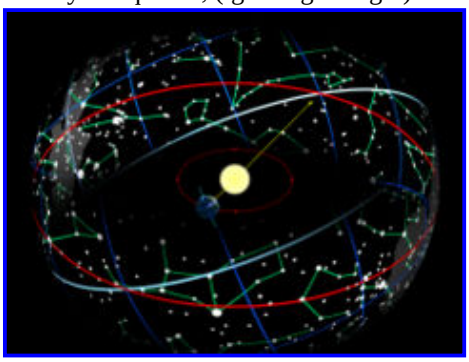
For other uses, see Equinox (disambiguation).



Illumination of the Earth by the Sun on the day of equinox, (ignoring twilight).



The Earth in its orbit around the Sun causes the Sun to appear on the celestial sphere moving over the ecliptic (red), which is tilted on the equator (blue).

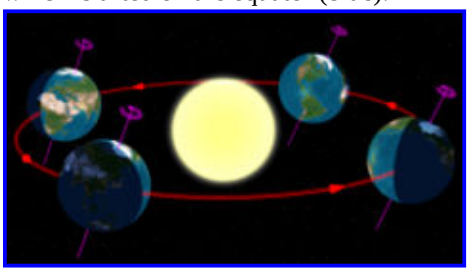


Diagram of the Earth's seasons as seen from the north. Far right: December solstice

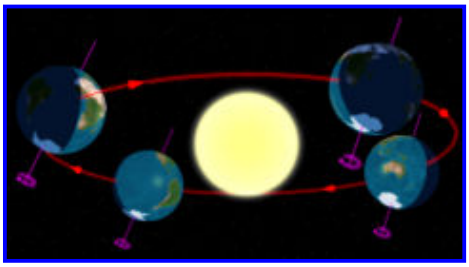
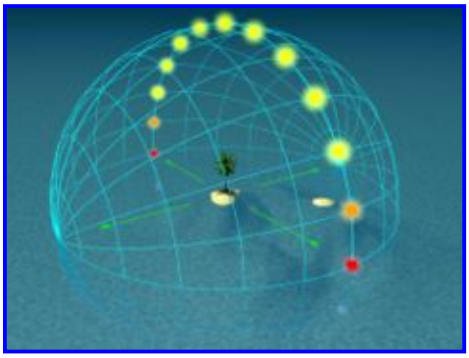


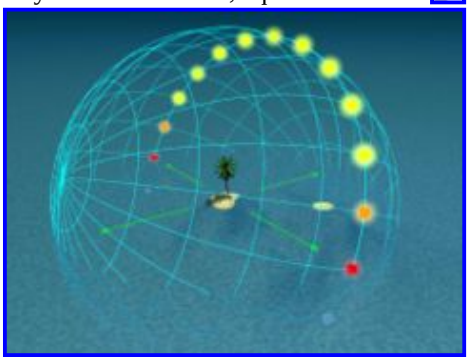
Diagram of the Earth's seasons as seen from the south. Far left: June solstice

UTC Date and Time of Solstice and Equinox

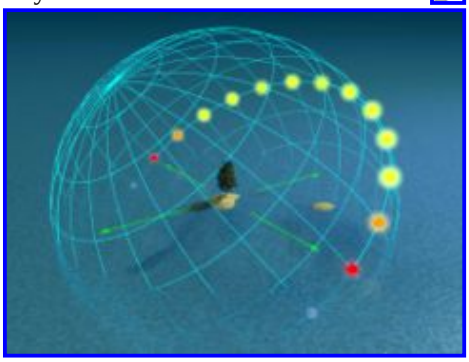
year	Equinox Mar		Solstice June		Equinox Sept		Solstice Dec	
	day	time	day	time	day	time	day	time
2002	20	19:16	21	13:24	23	04:55	22	01:14
2003	21	01:00	21	19:10	23	10:47	22	07:04
2004	20	06:49	21	00:57	22	16:30	21	12:42
2005	20	12:33	21	06:46	22	22:23	21	18:35
2006	20	18:26	21	12:26	23	04:03	22	00:22
2007	21	00:07	21	18:06	23	09:51	22	06:08
2008	20	05:48	20	23:59	22	15:44	21	12:04
2009	20	11:44	21	05:45	22	21:18	21	17:47
2010	20	17:32	21	11:28	23	03:09	21	23:38
2011	20	23:21	21	17:16	23	09:04	22	05:30
2012	20	05:14	20	23:09	22	14:49	21	11:11
2013	20	11:02	21	05:04	22	20:44	21	17:11
2014	20	16:57	21	10:51	23	02:29	21	23:03



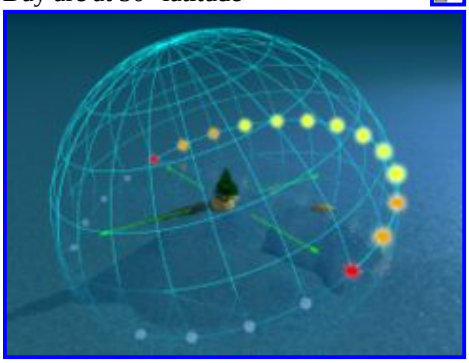
Day arc at 0° latitude, equator



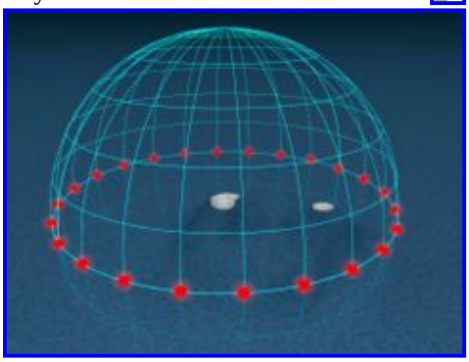
Day arc at 20° latitude



Day arc at 50° latitude



Day arc at 70° latitude



Day arc at 90° latitude, pole

An **equinox** in astronomy is the event when the Sun can be observed to be directly above the Earth's equator, occurring around March 20 and September 23 each year.The date (near September 22 in the northern hemisphere) when night and day are nearly of the same length and Sun crosses the celestial equator (i.e., declination 0) moving southward (in the northern hemisphere). In the southern hemisphere, the autumnal equinox corresponds to the center of the Sun crossing the celestial equator moving northward and occurs on the date of the northern vernal equinox. The autumnal equinox marks the first day of the season of autumn. More technically, the equinox happens when the Sun is at one of two opposite points on the celestial sphere where the celestial equator and ecliptic intersect. In a wider sense, the equinoxes are the two days each year when the center of the Sun spends an equal amount of time above and below the horizon at every location on Earth. The word *equinox* derives from the Latin words *aequus* (equal) and *nox* (night).

In theory, the day is longer than the night. Commonly the day is defined as the period that sunlight reaches the ground in the absence of local obstacles. From Earth, the Sun appears as a disc and not a single point of light; so, when the center of the Sun is below the horizon, the upper edge is visible. Furthermore, the atmosphere refracts light; so, even when the upper limb of the Sun is below the horizon, its rays reach over the horizon to the ground. In sunrise/sunset tables, the assumed semi-diameter of the sun is 16 minutes of arc (minutes referring to parts of a degree, not minutes of daylight) and the assumed refraction is 34 minutes of arc. Their combination means that when the upper limb of Sun is on the visible horizon its center is 50 minutes of arc below the geometric horizon, which is the intersection with the celestial sphere of a horizontal plane through the eye of the observer. These effects together make the day about 14 minutes longer than the night at the equator, and longer still at sites toward the poles. The real equality of day and night only happens at places far enough from the equator to have at least a seasonal difference in daylength of 7 minutes and occurs a few days towards the winter side of each equinox.

Contents

[hide]

[edit] Names

- **Spring equinox** and **autumn** or **fall equinox**. These names can be used when one wants to relate the equinox to a season. The seasons of the northern hemisphere and southern hemisphere are opposites (the spring equinox of one hemisphere is the autumn equinox of the other) so these names can be ambiguous.
- **March equinox** and **September equinox**. An alternative to the previous set, but without the ambiguity for which hemisphere they are intended. These names are still not universal, however, as not all people on Earth use a solar-based calendar where the equinoxes occur every year in the same month (they differ in the Jewish calendar, for example). The names are also not useful for other planets (Mars, for example), even though they have seasons.
- **Vernal equinox** and **autumnal equinox**. These names are direct derivatives of Latin (*ver* = *spring*, *autumnus* = *autumn*), and as such more apt to be found in writings. Although in principle they are subject to the same problem as the spring/autumn names, their use over the centuries has fixed them to the viewpoint of the northern hemisphere. As such the vernal equinox is the equinox where the Sun passes from south to north, and is a zeropoint in some celestial coordinate systems. The name of the other equinox is used less often.
- **First point of Aries** and **first point of Libra**. Alternative names for the previous set, but removing the problem that the vernal equinox may be dependent on a specific hemisphere. One disadvantage is that due to the precession of the equinoxes the astrological signs where these equinoxes are located, do not correspond any longer with the actual constellations.
- **Pisces equinox** and **Virgo equinox**. Names to indicate in which constellations the two equinoxes are currently located. These terms are rarely used.
- **Northward equinox** and **southward equinox**. Names referring to the apparent motion of the Sun at the times of the equinoxes.

[edit] Solar terms in East Asia

Main articles: Chunfen and Qiufen

The traditional East Asian calendars divide a year into 24 solar terms (節氣). **Chūnfēn** (pīnyīn) or **Shunbun** (rōmaji) (Chinese and Japanese: 春分; Korean: 춘분; Vietnamese: Xuân phân; literally: "vernal equinox") is the 4th solar term. It begins when the Sun reaches the celestial longitude of 0° and ends when it reaches the longitude of 15°. It more often refers in particular to the day when the Sun is exactly at the celestial longitude of 0°. In the Gregorian calendar, it usually begins around March 20 and ends around April 4 (April 5 East Asia time). **Qiūfēn** (pīnyīn) or **Shūbun** (rōmaji) (Chinese and Japanese: 秋分; Korean: 추분; Vietnamese: Thu phân; literally: "autumnal equinox") is the 16th solar term. It begins when the Sun reaches the celestial longitude of 180° and ends when it reaches the longitude of 195°. It more often refers in particular to the day when the Sun is exactly at the celestial longitude of 180°. In the Gregorian calendar, it usually begins around September 23 and ends around October 8. The Chinese character 分 means division, so the vernal equinox and the autumnal equinox signify the middle of spring and autumn, respectively, unlike in Western cultures.

[edit] Heliocentric view of the seasons

The Earth's seasons are caused by the rotation axis of the Earth not being perpendicular to its orbital plane. The Earth's axis is tilted at an angle of approximately 23.44° from the orbital plane. This tilt is called the obliquity of the ecliptic. As a consequence, for half a year (from around 20 March to around 22 September) the northern hemisphere tips toward the Sun, with the maximum around 21 June, while for the other half year the southern hemisphere has this honour, with the maximum around 21 December. The two instances when the Sun is directly overhead at the equator are the equinoxes. Also at that moment both the north pole and south pole of the Earth are just on the terminator, and day and night are divided equally between the hemispheres.

The table above gives the dates and times of equinoxes and solstices over several years. A few remarks can be made about the equinoxes:

- The actual equinox is a single moment in time — it does not take the whole day.
- Because the Sun is a sphere and not a point source of light, the actual crossing of the Sun over the equator takes approximately 2 and 1/2 days. The equinox occurs halfway through the transit when the center of the Sun is directly over the equator.
- Disregarding atmospheric effect, that the Sun is not a point source of light and that the Earth's orbit is not perfectly circular, the equinox day will have 12 hours of daylight and 12 hours of nighttime.
- At the Equinoxes, the rate of change for the length of daylight and nightime is the greatest. At the poles, the Equinox marks the transition from 24 hours of nightime to 24 hours of daylight. High in the artic circle, Longyearbyen, Svalbard, Norway has an additional 15 minutes more daylight everyday around the time of the Spring equinox. Whereas, in Singapore, which lies virtually on the equator, the amount of daylight each day varies by just seconds.
- It is 94 days from the June solstice to the September equinox, but only 89 days from the December solstice to the March equinox. The seasons are not of equal length because of the variable speed the Earth has in its orbit around the Sun.
- The instances of the equinoxes are not fixed but fall about six hours later every year, amounting to one full day in four years, but then they are reset by the occurrence of a leap year. The Gregorian calendar is designed to follow the seasons as accurately as is practical. It is good, but not perfect. *Also see: Gregorian calendar#Calendar seasonal error*.
- Smaller irregularities in the times are caused by perturbations of the Moon and the other planets.
- Currently the most common equinox and solstice dates are 20 March, 21 June, 22 September and 21 December, the four year average will slowly shift to earlier times in the years to come. This shift is a full day in about 70 years (largely to be compensated by the century leap year rules of the Gregorian calendar). But that also means that as many years ago the dates of 21 March, 22 June, 23 September and 22 December were much more common, as older books teach and older people still remember.
- Note that the times are given in UTC, roughly speaking, the time at Greenwich (ignoring British Summer Time). People living farther to the east (Asia, Australia) whose local times are in advance, will see the seasons apparently start later, for example in Tonga (UTC+13) an equinox occurred on 24 September 1999; a date which will not happen again until 2103. On the other hand people living far to the west (America) have clocks running behind in time, and may experience an equinox occurring as early as 19 March.

[edit] Geocentric view of the seasons

The explanation given in the previous section would be useful for an observer in outer space. Seen from Earth, the explanation remains the same but the orientation changes. Now the Sun revolves in one year around the Earth. In the half year centred around June it rises and sets more towards the south, which means longer days and shorter nights for the northern hemisphere and shorter days and longer nights for the southern hemisphere. In the half year centred around December the Sun rises and sets more towards the south, and the day and night durations are reversed.

Also on the equinox day, the Sun rises, for every place on Earth (except at the poles), at 6:00 in the morning and sets at 18:00 in the evening local time. But these times are not exact for several reasons.

- Most places on Earth use a time zone which is not equal to the local time, differing sometimes up to an hour or more, and even two hours if Daylight saving time (Summer time) is included. In that case, the Sun can rise for example at 8:00 and set at 20:00, but there would still be 12 hours of daylight.
- Even those people fortunate enough to have their time zone just equal to the local time still will not see sunrise and sunset at 6:00 and 18:00, respectively. This is due to the variable speed of the Earth in its orbit, and is described as the equation of time. It has different values for the March and the September equinox (+8 and –8 minutes respectively).
- Sunrise and sunset are commonly defined for the upper limb of the solar disk, and not for its centre. The upper limb is already up for at least one minute before the centre appears, and likewise the upper limb sets one minute later than the center of the solar disk.
- Due to atmospheric refraction the Sun, when near the horizon, appears a little more than its own diameter above the position than where it is in reality. This makes sunrise more than another two minutes earlier and sunset the equal amount later. The two effects add up to almost seven minutes, making the equinox day 12h 7m long and the night only 11h 53m. In addition to that, the night includes twilight. When dawn and dusk are added to the daytime instead, the day would be almost 13 hours.
- The above numbers are only true for the tropics. For moderate latitudes this discrepancy gets larger (London, for example: 12 minutes), and close to the poles it gets very large. Up to about 100 km from both poles the Sun is up for a full 24 hours on equinox day.
- Height of the horizon on both the sunrise and sunset sides changes the day's length. Going up into the mountains will lengthen the day, while standing in a valley with hilltops on the east and the west can shorten the day significantly. This is why settlements in east-west running valleys are more favourable (daylight-wise) than north-south running valleys.

[edit] Day arcs of the Sun

Some of the above statements can be made clearer when picturing the day arc: the path the Sun tracks along the celestial dome in its diurnal movement. The pictures show this for every hour on equinox day. In addition, also some 'ghost' suns are indicated below the horizon, up to 18° down. The Sun in this area still causes twilight. The pictures can be used for both the northern and the southern hemisphere. The observer is supposed to sit near the tree on the island in the middle of the ocean. The green arrows give the cardinal directions.

- On the northern hemisphere, north is to left, the Sun rises in the east (far arrow), culminates in the south (right arrow) while moving to the right and sets in the west (near arrow).
- On the southern hemisphere, south is to the left, the Sun rises in the east (near arrow), culminates in the north (right arrow) while moving to the left and sets in the west (far arrow).

The following special cases are depicted.

- The day arc on the equator, passing through the zenith, has almost no shadows at high noon.
- The day arc on 20° latitude. The Sun culminates at 70° altitude and also its daily path at sunrise and sunset occurs at a steep 70° angle to the horizon. Twilight is still about one hour.
- The day arc on 50° latitude. Twilight is almost two hours now.
- The day arc on 70° latitude. The Sun culminates at no more than 20° altitude and its daily path at sunrise and sunset is at a shallow 20° angle to the horizon. Twilight is more than four hours, in fact there is barely any dark night.
- The day arc at the pole. If it were not for atmospheric refraction, the Sun would be on the horizon all the time.

[edit] Coordinate systems

The vernal equinox, the one the Sun passes in March on its way from south to north, has a special significance in astronomy as it marks the origin of both ecliptic coordinates and equatorial coordinates, and also the start of the sidereal day. The autumnal equinox is at ecliptic longitude 180° and right ascension 12h. For Western tropical astrology, the same thing holds true; the vernal equinox is the first point (i.e. the start) of the sign of Aries. In this system, it is of no significance that the fixed stars and equinox shift compared to each other due to the precession of the equinoxes.

In Hindu astrology on the other hand, their 'vernal equinox' was fixed to the stars about 17 centuries ago, and has been drifting away from the seasons since then, now amounting to 22 days.

[edit] Cultural aspects

In the list below the terms March and September equinoxes are used when the celebration is fixed in time, while the terms spring and autumn equinoxes refer to those which are different in the two hemispheres.

- The calculation of Easter in the Christian church (first Sunday after the first full moon on or after the March equinox), uses its own definition for the equinox — it always falls on March 21. The earliest possible Easter date in any year is therefore March 22.
- The March equinox marks the first day of various calendars including the Iranian Calendar and the Bahá'í calendar.[1] The Persian (Iranian) festival of Norouz is celebrated then. According to the ancient Persian mythology Jamshid, the mythological king of Persia, ascended to the throne on this day and each year this is comemorated with festivities for two weeks. These festivities recall the myth of creation and the ancient cosmology of Iranian and Persian people. It is also a holiday for Azerbaijan, Afghanistan, India, Turkey, Zanzibar, Albania, and various countries of Central Asia, as well as among the Kurds.[2] As well as being a Zoroastrian holiday, it is also a holy day for adherents of the Bahá'í Faith, and the Nizari Ismaili muslims, commonly known as the Aga Khanis.
- The spring equinox marks the Wiccan Sabbat of Ostara (or Eostar), while at the autumn equinox the Wiccan Sabbat of Mabon is celebrated.
- In Japan, (March) Vernal Equinox Day (春分の日 *Shunbun no hi*) is an official national holiday, and is spent visiting family graves and holding family reunions. Likewise is (September) Autumnal equinox Day (秋分の日 *Shūbun no hi*).
- Tamil and Bengali New Years follow the Hindu zodiac and are celebrated according to the sidereal vernal equinox (14 April). The former is celebrated in the South Indian state of Tamil Nadu, and the latter in Bangladesh and the East Indian state of West Bengal.
- Earth Day was initially celebrated on March 21, 1970, the equinox day. It is currently celebrated in various countries on April 22.
- In many Arab countries, Mother's Day is celebrated on the March equinox.
- The September equinox was "New Year's Day" in the French Republican Calendar, which was in use from 1793 to 1805. The French First Republic was proclaimed and the French monarchy was abolished on September 21, 1792, making the following day the equinox day that year, the first day of the "Republican Era" in France. The start of every year was to be determined by astronomical calculation, (that is: following the real Sun and not the mean Sun as all other calendars).
- The harvest festival in the United Kingdom is celebrated on the Sunday of the full moon closest to the September equinox.

[edit] Trivia, facts and fables

- For a Latin word like *nox* the plural is *noctēs*. Although this root is retained in English in the adjective: *equinoctial* — it is not commonly used for the plural, which is *equinoxes*, rather than *equinoctes*.
- One of the effects of equinoctial periods is their temporary disruptive effect on communications satellites. For most geostationary satellites, there is almost always a point when the sun is directly behind the satellite relative to Earth. The Sun's immense power and broad radiation spectrum overload the Earth station's reception circuits with noise and, depending on antenna size and other factors, temporarily disrupt or degrade the circuit. The duration of those effects varies but can range from an hour to a few minutes.
- Folk tales from various European countries claim that only on the March equinox day (some may add the September equinox day or may explicitly not), one can balance an egg on its point.[3][4][5] However you can balance an egg on its point any day of the year if you have the patience.
- Although the word "equinox" implies equal length of day and night, as is noted elsewhere, this simply isn't true. For most locations on earth, there are two distinct identifiable days per year when the length of day and night are closest to being equal. Those days are commonly referred to as the "equiluxes" to distinguish them from the equinoxes. Equinoxes are points in time, but equiluxes are days. By convention, equiluxes are the days where sunrise and sunset are closest to being exactly 12 hours apart. This way, you can refer to a single date as being the equilux, when, in reality, it spans sunset on one day to sunset the next, or sunrise on one to sunrise the next. As an example, for a city 45° N and 123°W (Portland, Oregon), the 2006 autumnal equilux was on September 25 when sunrise was at 7:01 am and sunset was at 7:02 pm. The 2006 autumnal equinox was on September 22 at 9:03 pm (all times in Pacific Daylight Time). For the Northern Hemisphere, the autumnal equilux lags behind the equinox, and the reverse is true in the spring. As one might suspect, the whole situation is reversed for the Southern Hemisphere.[6]
- It is perhaps valuable for people in the Americas and Asia to know that the equinoxes listed as occurring on March 21 that occurred frequently in the twentieth century and that will occur occasionally in the twenty-first century are presented as such using UTC, which is at least four hours in advance of any clock in the Americas and as much as twelve hours behind Asian clocks. Thus, there will be no spring equinox later than March 20 in the Americas in the coming century.[*citation needed*]

[edit] References

1. ^ Baha'i calendar
2. ^ Norooz
3. ^ Infernal Egguinox
4. ^ Standing an egg on end on the Spring Equinox
5. ^ Equinox Means Balanced Light, Not Balanced Eggs
6. ^ sci.astro equilux discussion

[edit] See also

- Cross-quarter day
- Setsubun - Japanese festival for the day before (February) cross-quarter day
- Precession
- Solstice

[edit] External links

- Details about the Length of Day and Night at the Equinoxes
- Calculation of Length of Day (Formulas and Graphs)
- Equinoctial Points - The Nuttall Encyclopaedia
- Java applet showing parts of the Earth in night and day
- Table of times for Equinoxes, Solstices, Perihelion, and Aphelion in 1992-2020
- Table of times of Spring Equinox for a thousand years 1452-2547
- Calculate the Time of Equinoxes in Excel, CAD or your other programs. The Sun API is free and extremely accurate. For Windows Computers.
- Groundhog Day and the Spring Equinox. *Landscaping*. About.com.
- Ancient Equinox Alignment. *Loughcrew, Ireland*.

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