

Astroclock, the Astronomical Clock

The astronomical clock is unlike any other clock. At first glance you'll find it has similar functions of a standard clock, however the astronomical clock can offer much more:

- The current time, Zodiac sign, months and weeks
- Time of the sunset, sunrise, dusk, dawn, golden hour
- Rise and set time of the moon and planets
- Lunar phases
- Sun height, sun azimuth and moon or planet location

Current Time

The clock has only one hand – the hour dial, which is the thick pink hand with the golden sun attached to it. The dial shows the current **standard time** according to your time zone – read the golden number it points to as you would a normal clock. Since the astronomical clock is 24 hours, each number is presented twice, once for am (usually on the left), once for pm (usually on the right). Midnight is marked with a point as “12.”



Sunset and Sunrise

Now touch and drag the sun clockwise or counter clockwise to the point where the yellow and brown backgrounds meet. When the sun is on the left side, the phone will display “Sunrise (attach)” on top of the clock; the sun on the right side displays “Sunset (attach)”. The dial shows the standard time of the sunrise (or the sunset) of the day according to your

location. In this case it is 8:20 p.m.

If you release the sun at the point of sunrise (or sunset) a miniature gray sun dial will be attached to the clock as a reminder of the sunrise (sunset) time. It is useful for future reference as well as accuracy, as your finger may obstruct it.

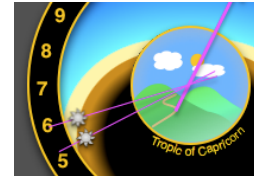
If you want to remove the gray sun entirely, drag it off of the screen.



In this example, the gray sun in the picture reminds you of the time of sunset (8:20pm), shown on the right side where the yellow and brown backgrounds meet.

Twilight, Dusk and Dawn

You might prefer to know when it gets dark, rather than the actual times of the sunset and the sunrise. Giving you the opportunity to still do outdoor activities after the sunset, during the twilight hours.



Similarly as with the sunset drag the sun to the point, where the brown background starts merging with the black. The phone displays “Dusk (attach)”, when the sun is on the right side; or displays “Dawn (attach)” when the sun is on the left side. If you release the sun at an attach point, it will stay attached there for future reference. In this example, the gray sun on the left side where the brown background starts merging with the black, reminds you of the time of dawn (5:15am in the picture). The example also shows the time of sunrise (6am), for comparison.

Golden Hour

The golden hour is especially useful with photography, when the natural light is soft and yellow. Usually, it is referred to as an hour before sunset (an hour after sunrise). However, the length differs for different latitudes. In higher latitudes in the winter the golden hour can last the entire day. Therefore, the clock shows the start of the golden hour as well as the end.



This time drag the sun to the point where the blue and yellow backgrounds meet, the phone displays “Golden hour begins (attach)” when the sun is on the right side; or displays “Golden hour ends (attach)” when the sun is on the left side. You can attach gray sun reminders as before, the picture shows a clock reminding you of the beginning of the golden hour (7:15pm), sunset (8:10pm) and dusk (9pm).

Astronomical Night

Astronomical night is the time when the sun is so far below the horizon that its light does not interfere with the stars. Drag the sun to the place, where the background is completely black to see its start and end. The phone displays “Night begins (attach)” or “Night ends (attach)” alternatively.

At higher latitudes there are days of the year when the astronomical night (or even dusk, dawn, sunrise or sunset) does not occur. In those days, the appropriate reminders cannot be seen, neither created nor removed.

Summary: The clock displays the current standard time. For the current day, the clock shows and can remind you of eight different times: the end of night, dawn, sunrise, the end of magic hour, the beginning of magic hour, sunset, dusk and the beginning of the night. However, if any of the times do not occur (i.e. in higher latitudes), naturally they are not shown.

Moon Phase

The clock can show the current moon phase. Press the (i) symbol, tap the "Settings" bar and switch the "Show the moon phase and its height over the horizon" ON and then tap on the "Done" button. You can see the moon phase and moon's relative position to the sun.



The moon phases are:

- | | |
|---|--|
|  New Moon |  Full Moon |
|  Waxing Crescent |  Waning Gibbous |
|  First Quarter |  Last Quarter |
|  Waxing Gibbous |  Waning Crescent |

Explaining the Horizon

Touch and drag the golden sun around the clock. When the background behind the sun is blue, the inner picture shows two hills for daytime and the phone displays "Day". Similarly, between dusk and dawn the phone displays "Dark" or "Night" and the two hills are pictured at nighttime. In between day and night, there is an inner image of a sunset/sunrise, when the sun is close to the horizon.

Please note the border between the yellow and brown colors, in fact represents the horizon. When the sun, moon or planets have a brown or black background in the real world it is below the horizon. Conversely, if they have a yellow or blue background, in the real world they are above the horizon.

Moonset and Moonrise






Touch and drag the golden sun, as you would do to determine a sunset or a sunrise. You might have noticed, that the moon is moving together with the sun. Once the moon gets to the place where the yellow and brown backgrounds meet, you know that the thick pink dial with the golden sun shows the time of the moonset (or moonrise). In this case the moon sets around 10:40 pm and the inner picture (along with the background behind the sun) tells you it is night.



In conclusion, if the moon has a blue background, it is above the horizon, and could be visible. It could be day or night, however in daytime the sun shines stronger than the moon and will considerably affect the moon's visibility, even though it is above the horizon.

Planets

Similar to the moon, the same applies to the planets. Press the (i) symbol, tap the "Settings" bar and switch the "Show the planets and their height over the horizon" ON and then tap on the "Done" button. There are five major planets:

-  Mercury
-  Venus
-  Mars
-  Jupiter
-  Saturn

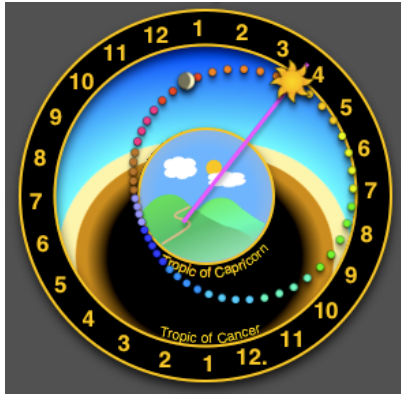


Mercury, Venus, Mars, Jupiter and Saturn. The clock shows the current position in the sky as well as the times when a planet sets or rises. Touch the sun and drag it to the point, where the planet touches the horizon, the place where the yellow and brown backgrounds

meet. If a planet has a blue background, it is above the horizon, and could be visible of course only at night.

The position of the planet on the clock corresponds to the planet's relative position to the sun (oppositions, conjunctions, elongations) as it appears in the sky. In this picture Jupiter is close to *opposition* to the sun, which is the perfect time for observation. However, the *conjunction* of the sun with Mercury does not allow for Mercury's observation. As seen here all the planets except Jupiter are above the horizon, but it is daytime hence no planet is visible.

Summary: The clock displays the moon in addition to its phases and the planets. For each of them, the clock shows the times of set and rise as well as the relative position to the sun.



Months and Weeks of the Year

Switch on the “Show the ecliptic, months and weeks of the year” on the Settings bar. Small solid circles display weeks of the year with different colors for each month. The sun’s position on the ring tells you the current week of the year, however it more likely can be used to get an idea of how the sun travels over the sky throughout the year. Months are color coded as follows:

- | | | |
|----------|--------|-----------|
| January | May | September |
| February | June | October |
| March | July | November |
| April | August | December |

Position on the Zodiac

Switch on the “Show the ecliptic, the Zodiac” on the “Settings” bar. The functionality is similar to the “Months and weeks of the year” with the exception that you can see the sun, moon and planets traveling on the Zodiac. Therefore you can read the current Zodiac sign, by seeing where the sun is.

You can also observe the zodiac sign where the moon or planets are, helping to trace the planet (or a zodiac constellation) in the sky.

The ecliptic can be shown at one time either with month markers or as the Zodiac. Months markers and the Zodiac are never shown together.

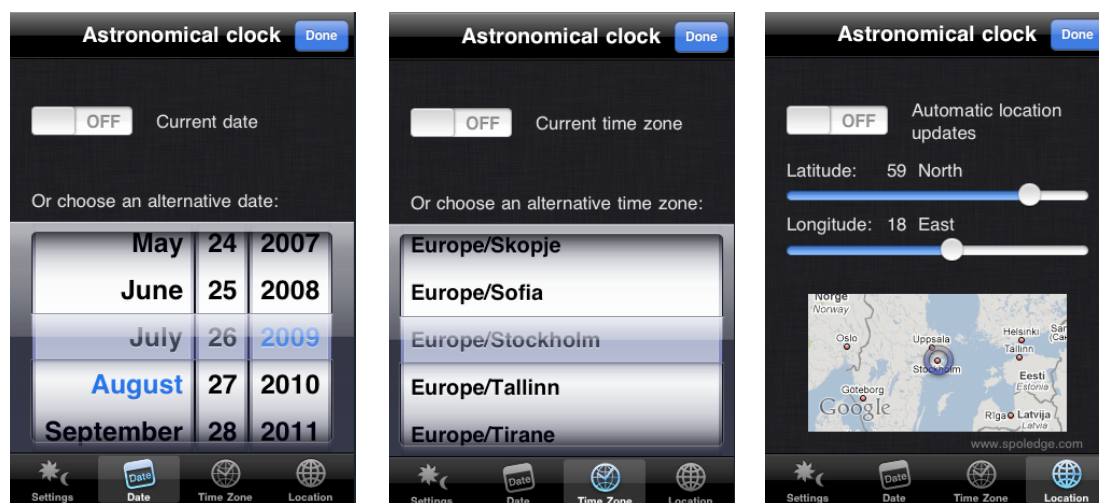


Where and When

By default, the clock shows data for your current location (retrieved automatically), the current date and current time zone, including daylight savings times (as provided by the phone). However, you can also set each of these in the application. For example, you can get information about the sunset time at your holiday destination in advance. If any of the values are manually set, the phone displays them above and below the clock.

To set another location press the (i) symbol, tap the “Location” bar. Choose by the slider “Automatic location updates” whether you

want automatic updates or you want to set the location manually. Manual settings can be done either by sliders or on the Google map. Choose your desired location by touching and dragging the map to where the centered blue ring meets your place.



For a different time zone or date tap the “Date” or “Time Zone” bars accordingly. Slider “Current date” or “Current time zone” allows you to use current internal iPhone values or set any date or zone of your choice.

A practical example, you can see the sky activity for San Diego while in London, under London’s standard time (by default) or manually switch to San Diego’s time zone.

Summary: The ecliptic is the curve where the sun, moon and the planets reside in the sky. The clock shows the ecliptic in two forms, as the ring made up of week markers and as the Zodiac ring. It also has shown how to set the clock for any location on the globe, for any time and time zone.

Unlocking the Hidden Features

Height of the Sun, Moon and Planets over the Horizon

This application shows the height of the sun, moon, or the planets. The height over the horizon is represented by the background color.

- 9 .. 90 degree
- 0 .. 9 degree
- -6 .. 0 degree (civil twilight)
- -18 .. -6 degree (astronomical twilight)
- -90 .. -18 degree

However, intuitively you would expect that the higher the sun (or moon) is in the sky, the closer the sun appears to the higher edge of the clock. This is valid only for latitudes north of the Tropic of Cancer, which are Europe, North America and a large part of Asia.

Between the Tropic of Cancer and the Tropic of Capricorn the sun and moon do not move in the sky during the year anywhere, you can find either at anytime in the belt, all around the world. Similarly the sun orbits between the tropics on the phone. The astrolabe on the phone, which is the colored background, shows the tropics as the inner edge (Tropic of Capricorn) and the outer edge (Tropic of Cancer). If you are in latitudes north of the Tropic of Cancer, the Tropic of Cancer is always higher in the sky than the Tropic of Capricorn. Therefore, the higher the sun is in the sky the closer the sun is to the outer edge. If you are in latitudes south of the Tropic of Capricorn, the Tropic of Capricorn is always higher. Thus the higher the sun is, the closer the sun is to the inner edge. Lastly, if you are in latitudes between the tropics, when the sun is at its highest path in the sky, you will find the sun on the phone somewhere inside the belt, depending on where you are.

Azimuth of the Sun

Does the application show the azimuth of the sun, moon or planets? At first glance it seems it does.

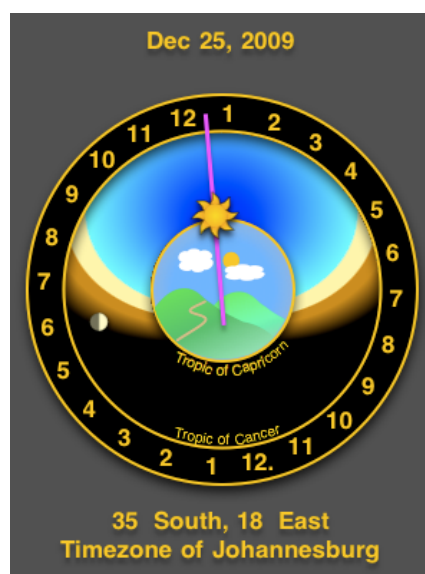
Not always. You might have realized that the sun on the clock makes the orbit in 24 hours, the same as the sun in the sky. We can also assume, that both movements are uniform, hence the angle of the sun from the vertical axis on the phone should correspond to the azimuth of the sun. However, on the equator the days are always 12 hours long, therefore the clock shows the sunrise always at 270 degrees; on the contrary the azimuth of the live sunrise will vary with the day of the year. Generally, the azimuth of the sun on the clock will be more accurate when you are in higher latitudes and the date is closer to the equinox. Therefore the margin of error could reach a maximum of 23.4 degrees; the same applies to the moon and planets.

Northern and Southern Hemispheres

Does the clock work in both hemispheres?

Of course it does. However, you could intuitively expect that the higher the sun is, the closer to the outer edge it would be. This does not apply to the southern hemisphere as has been previously explained in the section "Height of the Sun, Moon and Planets over the Horizon".

This picture shows midday at Cape Town on Christmas day, which is summer for the southern hemisphere when the sun is high in the sky, but the sun is low on the astrolabe. Also note the different appearance of the



astrolabe.

How can the time zone be independent from the location?

The time zone is usually connected to the location, however there are exceptions.

- You would like to know times of events at a remote place while in your time zone. As an example, I live in Prague and my sister-in-law lives in Arizona. I want to call her when it gets dark there, ensuring she is at home. Therefore I need to see Arizona's sky activity while in Prague's time zone.
- If you want to stay on your internal biorhythm clock while traveling to a different time zone.

Golden Hour

Golden hour is used in photography, when the natural light is soft and yellow. Usually it is referred to as an hour before the sunset (an hour after the sunrise). However, the length differs for different latitudes and the day of the year. Therefore, we have defined the "Golden hour" time, as when the sun is below 9 degrees. It will last approximately an hour in latitudes 40-50 degrees.

Solar time

The hand also shows the **solar time**. The solar time is measurable by a sundial and could significantly differ from the standard time. While the standard time is the same for the entire time zone, the solar time differs from location to location and tracks the actual movement of the sun across the sky. Noon at solar time is literally in the middle of the day while midnight is in the middle of the night. If the dial is vertically straight up, it is noon solar time; if the dial is straight to the right, it is 6pm solar time. The dial vertically down represents midnight in solar time and so on. The solar time is depicted by roman numerals shown here in the manual. The picture above shows about 11:10am standard time and about 10:00am solar time.



Accuracy and Requirements

Horizon

The application presumes a flat horizon at eye level for every location, which is the same as being on sea level and watching the horizon from shore. Standing in a valley the sunset is obviously earlier than being on the top of a mountain; however the application does not support these deviations. Therefore please note, that the surrounding **terrain might impact visibility** as well as **weather conditions**. Please consider the local conditions at any time.

Accuracy

Is it accurate enough? Sunset, dusk or dark are never a matter of seconds, they are rather a matter of minutes, and the clock is accurate similarly. It acts as a compass for daylight activities gradually shifting between light and dark like in the real world. Since the configuration changes over time, the clock is less accurate in the future or the past exceeding 100 years, especially for planet movements.

The underlying model is based on Kepler's formulas configured for epoch J2000,0. It takes into consideration a planet's elliptical orbit, the earth's precession (vernal point movement) and analemma (the variable length of a day throughout the year). The model omits for example the orbit's inclination, earth's nutation (axial tilt variability) and atmospheric refraction, which makes the sun a little higher over the horizon than in reality.

The clock was designed for everyday life, such as cycling, photography, camping, traveling etc. **It was not designed to be reliable in cases where the data interpretation can threaten life, cause injury or damage including environmental, financial or property.**

Requirements

Astrock works with iPhone 3GS, iPhone 3G, the original iPhone, and iPod touch. Astrock requires iPhone 3.0 operating system or later. The application uses three ways to determine its location: automatic updates, manually set using Google map or complete manual mode. Please note:

- iPod touch and the original iPhone do not have a GPS locator. Therefore automatic location updates on these devices depend on network coverage.
- Google map will not function outside network coverage.

Astrock does not use network connection other than for location determination and Google map.

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