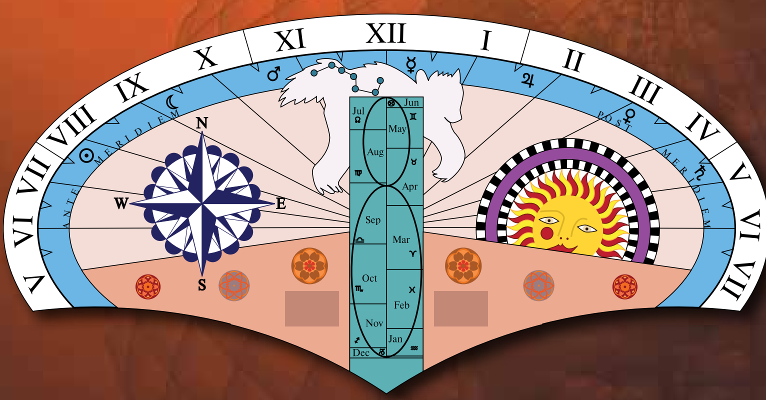
The Sundial

at Northwest Florida State College
Niceville, Florida



An Instructional Guide

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Instructional Guide

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The Sundial
at Northwest Florida State College

Sundials are one of the oldest of scientific instruments. They may, in fact, be the oldest of scientific instruments. There is evidence for their use as early as 1500 B.C. Sundials are "living objects", requiring no winding, batteries, or other power source. It is said that a clock or watch may keep time, but only a sundial can find time. Sundials allow us to tell time by the constant movement of a shadow that is cast by an object called a gnomon (*"know'-mon"*). Most gnomons are rods that are permanently fixed on the dial. But in some dials, the gnomons are re-positioned daily. This is the case for the dial at Northwest Florida State College, where you, as the observer, become the gnomon as you stand on the dial. The Sundial at NWF State College is called an analemmatic sundial (see page 11) and was created as an interactive artwork that combines science and art to promote an understanding of the Earth's movement in space and the concept of time. This instructional guide and a Sundial website (www.nwfsc.edu/sundial) are provided to help educators, students and the public to learn more. For additional questions or to schedule a group or class tour, contact Natural Sciences, NWF State College (850) 729-5376 or bryanj@nwfsc.edu.

The Sundial
at Northwest Florida State College

How to use the NWFSC Interactive Sundial—Basic Directions:

1) First, you must accept the fact that, in a very real sense, your watch, cell phone, or clock is hopelessly incorrect. All of these time keepers, no matter how sophisticated they are, simplify and approximate solar time. Only the Sun can give you the true time of day for the location you are at!

2) Second, ask yourself, “Is it a bright and sunny day today?” If the answer is “no”, do not bother trying to determine the time on the sundial. Sundials are notoriously stubborn about this, and refuse to work unless the Sun is out!

3) Third, if it is sunny, step up onto the Sundial and stand on the middle line of the Scale of Dates on the Sundial, with your feet together (the midline will run between your feet), along the proper month, and approximate day (days aren’t marked, but stand at beginning, middle, or end of month as best you can) (see **Figure 1** and **Figure 2**). See where your shadow is cast on the dial. If your shadow is too short to reach the Roman Numerals of the dial, try extending your hands upward to make a pointer over your head, or extend your shadow by pointing with your arm along the same direction as your body shadow. You may turn your body in the direction of your shadow, but be sure to keep your feet together on the center line. If your shadow is still too short (as it will be in midday during the summer months, for example), just visually project your shadow in a line from the top of your head until it would reach the Roman Numerals. You should be able to get a reading that is accurate to within about 10 minutes (some shadows are wide, some are narrow).

4) Fourth, consult the Standard Time Correction Chart (see back of this booklet). Determine the month and day, and read the time correction for that day. This chart tells you the difference between Sundial Time and Central Standard Time (the time on an accurate clock or watch) for any day of the year. Most of the numbers have a negative (-) sign in front of them. That means that Central Standard Time (on your watch, clock, or phone), will be behind (slower) than what the Sundial reads. In other words, for most days of the year, the Sundial “runs fast” compared to your watch. To understand why the Sundial and your watch almost never agree, keep reading!

5) Finally, if you are on Daylight Savings Time, you must also ADD an hour to your corrected Sundial time, if you want it to give the same time as your watch. Sundials DO NOT observe Daylight Savings Time—they never have, and they never will!

6) An instructional display is also located near the dial.

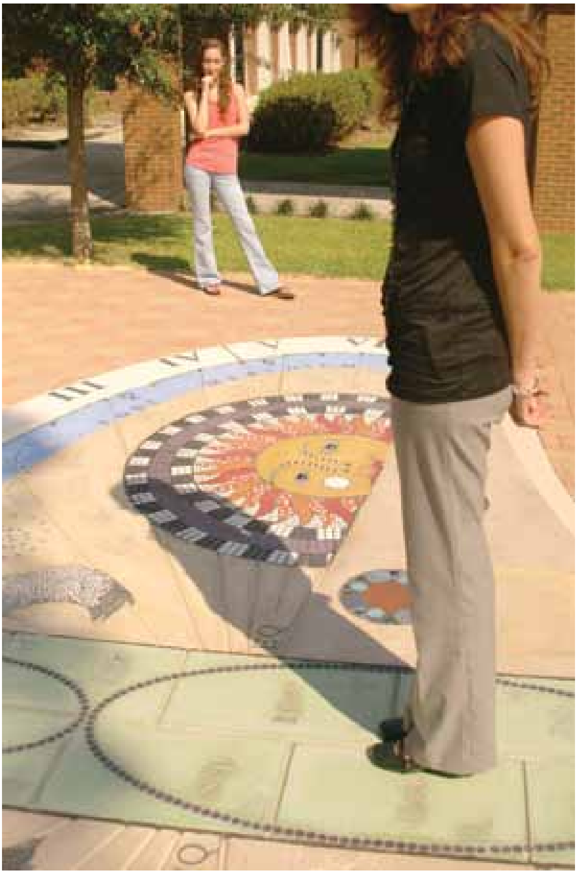


Figure 1

Figure 2

Understanding the Sundial

It's About Time

Time is a concept that has long perplexed philosophers and scientists. Time, space, matter, and energy are all bound together to make the fabric of our universe. We are embedded in time, and cannot think or speak without reference to time. The exact definition of time may be elusive, but we are all interested in measuring and marking time. So how do we tell time? How did our ancestors mark time? The science of timekeeping is called *horology*.

Time has been measured, divided, and subdivided into many units—nanoseconds, microseconds, milliseconds, seconds, minutes, hours, days, weeks, lunar months, solar months, seasons, years, decades, centuries, millennia, stages, epochs, periods, eras, and eons. Time has been marked by the crowing of roosters, sunrise, sunset, and midday. Many clever inventions have been devised to keep time, including sand glasses, water clocks, and graduated oil lamps. Then there were pendula clocks; and spring, battery, and electric clocks or watches. Today, precise time is kept by a number of atomic clocks at governmental agencies such as the U.S. Naval Observatory in Washington, D.C. Since 1967, an atomic second has been defined as the interval of time it takes a cesium-133 atom to "vibrate" (i.e., release radiation during electron transitions between energy levels) 9,192,631,770 times.

Atomic clocks were invented in an attempt to control for the variations in solar time. But even with their precision and constancy, it is still necessary to periodically add "leap seconds" to atomic clocks to compensate for the Earth's gradually slowing rotation (spin) and lengthening of the day (due to tidal friction), so that our clocks and calendars remain close together. On average, one leap second is added about every year to year and a half.

Motions of the Earth

To understand how sundials work, we must first know something about how the Earth is moving. In fact, the Earth is moving in a dizzying variety of ways. First, the stars of the Milky Way Galaxy (including the Sun and its satellites) are all moving like a pinwheel around the center of the galaxy. Over thousands of years, the Earth varies its orbital path around the Sun (eccentricity) from more elliptical to more circular, changes the inclination of its tilt axis (obliquity) from about 22° to 24.5°, and wobbles on its axis (precession) like a wobbling, spinning top. But there are two fundamental motions of the Earth that especially relate to time:

Rotation—the ***spin*** of the Earth. The Earth is rotating like a spinning top around an imaginary axis (spin axis) that runs through the Earth from the North Pole to the South Pole. The spin velocity is just over 1,000 mph at the Equator, and about 900 mph at Niceville, Florida. The Earth makes one full (360°) rotation in about 24 hours.

Revolution—the ***orbit*** of the Earth around the Sun. Earth's orbit varies in speed (moving faster when closer to the Sun, and slower when further from the Sun), but its average velocity is about 66,600 mph, and it completes one revolution in about 365.25 days, making one year. An additional day, February 29^{th}, is added to the calendar every 4 years to account for the annual 0.25 difference (a *leap year).*

Mapping the Earth

Second, to understand how sundials work, we must know how the Earth is mapped. Since ancient times, maps have been made by using simple "tic-tac-toe"-like grid lines. Grid lines allow us to easily locate points of interest. The entire Earth is mapped by "casting" a large, imaginary "net" of grid lines over the Earth. But because the Earth is a sphere, these map lines are actually curves, and curves are measured in degrees of a circle (also called *angular distance*). A circle or sphere is divided into 360 segments or degrees. The convention of dividing a circle into 360 degrees probably has its origins in ancient Babylonian calendars that used lunar cycles to mark the seasons, since there are 360 days in a lunar year (a lunar year is 12 cycles of New Moon to Full Moon phases of the Moon).

Grid lines that run east-west across the Earth, but divide north and south, are called ***latitude lines*** or ***parallels*** (**Figure 3**). The Equator is at 0° latitude and divides Earth into two hemispheres (north and south). Other important latitude lines are the Tropic of Cancer (23.5° N), Tropic of Capricorn (23.5° S), Arctic Circle (66.5° N), and Antarctic Circle (66.5° N). The United States-Canada border is at 40° North Latitude (the "40th Parallel").

Lines that run north and south across the Earth, from the North Pole to the South Pole, but divide east and west, are called ***longitude*** lines or ***meridians*** (**Figure 3**). The Prime Meridian* runs through Greenwich, England, and divides the Earth into eastern and western hemispheres. The International Date Line is on the opposite side of the Prime Meridian, at 180° E/W longitude (but it varies), and marks where the day changes. Each degree (°) of latitude and longitude is further divided into 60 minutes ('), and each minute of latitude and longitude is divided into 60 seconds ("). Both parallels and meridians are important in telling time, but meridians are especially important.

Does Anybody Really Know What Time It Is?

As the Earth rotates (spins), it creates the illusion that the Sun is moving across the sky. This apparent movement of the Sun relative to the Earth determines the length of day and night, and all other divisions of time that derive from the length of day (seconds, minutes, hours, weeks, months, years). This is ***solar time***. Solar time is simply the time indicated by the Sun.

The Earth rotates in a west-to-east motion (or counterclockwise, as seen if you were looking down on the Earth from over the North Pole). Because of this spin, our position under the Sun is constantly changing. The key to understanding time is that ***it is truly only the same time on the Earth along the same lines of longitude***. For example, it is Noon in Greenwich when the Sun is directly, vertically, over the Prime Meridian. At that moment, the Sun is at its highest point in the sky over Greenwich. When it is Noon in Greenwich, it is truly Noon only along the Prime Meridian. Only one longitude line can be directly under the Sun at the same moment.

But we cannot have 360 (or more) different times—one for each degree of longitude (or each minute, or each second). So we must simplify. Since the Earth makes one full rotation of 360° in about 24 hours, the Earth turns 15°

FOOTNOTE:

**Unlike the Equator, which naturally divides the Earth into northern and southern halves, there is no natural east-west divide. The location of the Prime Meridian at Greenwich, England, was decided in by international agreement in October of 1884 at the International Meridian Conference, convened in Washington, D.C. It was agreed to replace the several meridians then in use by a single, world meridian. Any principal meridian must extend from the North- to the South-Pole, but pass through one more designated point.*

Figure 3

of longitude every hour (360° divided by 24 hours = 15° per hour)*. For this reason, the Earth is divided into 24 hourly ***time zones***. In theory, each time zone consists of 15° of longitude, but in practice, actual time zone boundaries zig and zag around major cities, states, and countries. This is necessary to avoid major time conflicts. There are also variations and regional exceptions, actually creating more than 24 time zones.

The time that is used in each time zone is essentially the solar time along a ***Standard Meridian*** that passes roughly through the middle of the time zone. Standard Meridians are at 15° intervals from the Prime Meridian. So the first time zone, called Greenwich Mean Time (GMT; or Zulu Time, a military/nautical designation; or Universal Time, UT), extends 7 ½ degrees on each side (east and west) of the Prime Meridian (0° Longitude). In North America, our Standard Meridians are at 75° West (Eastern Standard Time), 90° West (Central Standard Time), 105° West (Mountain Standard Time), and 120° West (Pacific Standard Time) (**Figure 4**). Standard time zones were first used in United States by the railroads in 1883, and were established as law on March 19, 1918 (Standard Time Act). Niceville, Florida, is in the Central Standard Time Zone, which is 6 hours behind Greenwich Mean Time. In Niceville we use solar time at 90° West, the standard meridian for Central Standard Time.

But it gets more complicated. The solar-based GMT, also called Universal Time (UT or UT1) is variable due to irregularities in the Earth's orbit, and the length of day is slowly increasing due to a gradual slowing of the spin of the Earth. This variation is only in seconds, and may not seem to make much of a difference in normal day-to-day clock time around the world. But the differences do add up quickly. To avoid the complications of natural, astronomical variations of solar time, more stable atomic clocks were developed.

For most applications around the world, time is based on ***Coordinated Universal Time***, or UTC, which is a calculated time based on averaging the times of many atomic clocks around the world. Greenwich Mean Time is based on solar time at the Prime Meridian, which varies slightly due to irregularities in the Earth's orbit and spin. Of course, atomic-clock-based UTC is almost the same as the solar-based GMT, but there are slight differences that do make a difference in some scientific applications. By international agreement, UTC is not allowed to differ from GMT by more than 0.9 seconds. To keep these two times in-sync, a leap second is added to UTC about every 1.5 years.

FOOTNOTE:

**Or, the Earth turns one degree of longitude every 4 minutes (60 minutes divided by 15 degrees = 4 minutes per degree). In Niceville, you are moving eastward on the Earth about ¼ mile every second. This is nearly 900 mph!*

USA Time Zone Map

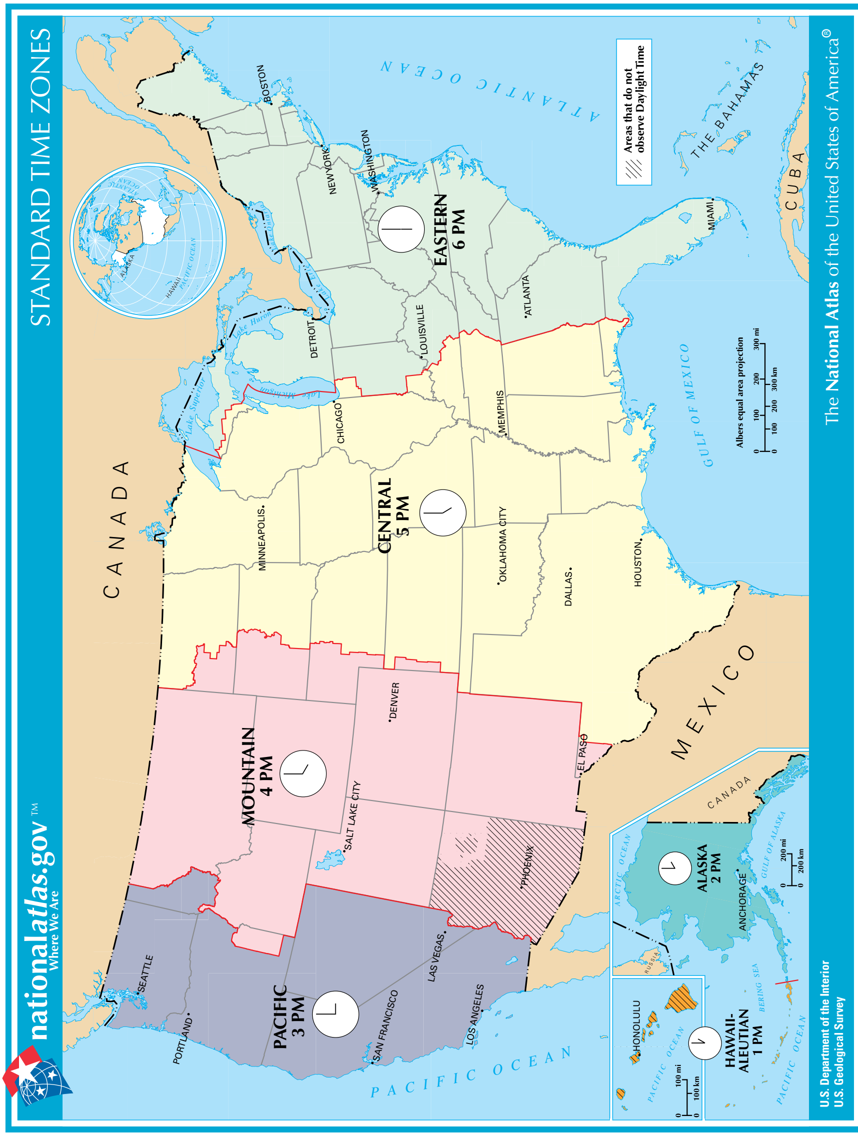


Figure 4

The Shadow Knows!

Sundials—The Oldest of Scientific Instruments

The use of standard time zones, GMT , and UTC, serves us very well. But Standard Time applies the solar time at a Standard Meridian to the entire time zone, which is around 15° (more or less) of longitude wide. This is necessary for practical use, but unless you are located directly on the Standard Meridian for your time zone, your watch time and your local solar time will not be in agreement. To use the sundial we must again remember that ***it is truly only the same time along the same lines of longitude (meridians)***. And to tell local, solar time, one needs a ***sundial***!

Sundials are one of the oldest of scientific instruments. They may, in fact, be ***the*** oldest of scientific instruments. There is evidence for their use as early as 1500 B.C. Sundials are "living objects", requiring no winding, batteries, or other power source. It is said that a clock or watch may keep time, but only a sundial can find time. Sundials allow us to tell time by the constant movement of a shadow that is cast by an object called a ***gnomon*** (*"know'-mon"*—"the one who knows"). The shape and position of a gnomon on a sundial varies depending on the type of dial, of which there are many. Most gnomons are rods that are permanently fixed on the dial. But in some dials, the gnomons are re-positioned daily. This is the case for the dial at Northwest Florida State College, where you, as the observer, become the gnomon as *you* stand on the dial.

It may be frustrating at first to discover that the time indicated on a sundial and the time indicated on a watch or clock, almost never agree. There are three basic reasons for this. The first is what may be called the ***longitude problem***, and it has already been alluded to. Most places in the world *do not* lie exactly on one of the Standard Time Meridians, so the local time by the Sun is not the same as the time used for the entire time zone. Niceville, Florida, is in the Central Time Zone, which uses the solar time of the 90° West Standard Meridian (90° West passes through New Orleans, Louisiana, and Memphis, Tennessee). But Niceville is located at 86.48° West Longitude (or, 86° 28' 29" West), which is 3.52° ***east*** of the Central Time Zone Principal Meridian of 90° West. Since the Earth turns 1° of longitude every 4 minutes, it is solar noon in Niceville 14.08 minutes ***earlier*** than indicated by an accurate clock set on Central Standard Time (4 x 3.52 = 14.08 minutes). So when the sundial shows Noon, an accurate watch would read 11:45:52 sec AM. And when your watch reads 12:00 Noon, the sundial would show 12:14:08 PM.

The second reason that the sundial only rarely agrees with an accurate clock has to do with the Earth's ***orbital velocity*** around the Sun, which varies throughout the year. The orbital path (***eccentricity***) around the Sun is slightly elliptical, and the Earth moves faster when it is closer to the Sun and slower when it is farther. This change in orbital velocity affects the actual length of days throughout the year, and can be as much as 16 ½ minutes difference (in early November) when compared to the length of an average day.

The third reason has to do with the Earth's axial tilt (***obliquity***), which is leaning about 23.5° from vertical, and causes slight variation in the time of noon throughout the year. The combined effect of Earths eccentricity and obliquity cause sundials to either "run fast" or "run slow" when compared to a standard-time clock. This daily difference is called the equation of time.

Equation of Time = Mean (standard) Time – Apparent (solar) Time

Figure 5 is a chart of the equation of time throughout the year indicating how much a dial is "fast" or "slow" when compared to an accurate watch or clock. Some very sophisticated sundials can partially correct for the Equation of Time, but most simply require the use of a chart with one simple time correction so that the dial and watch or clock can be compared.

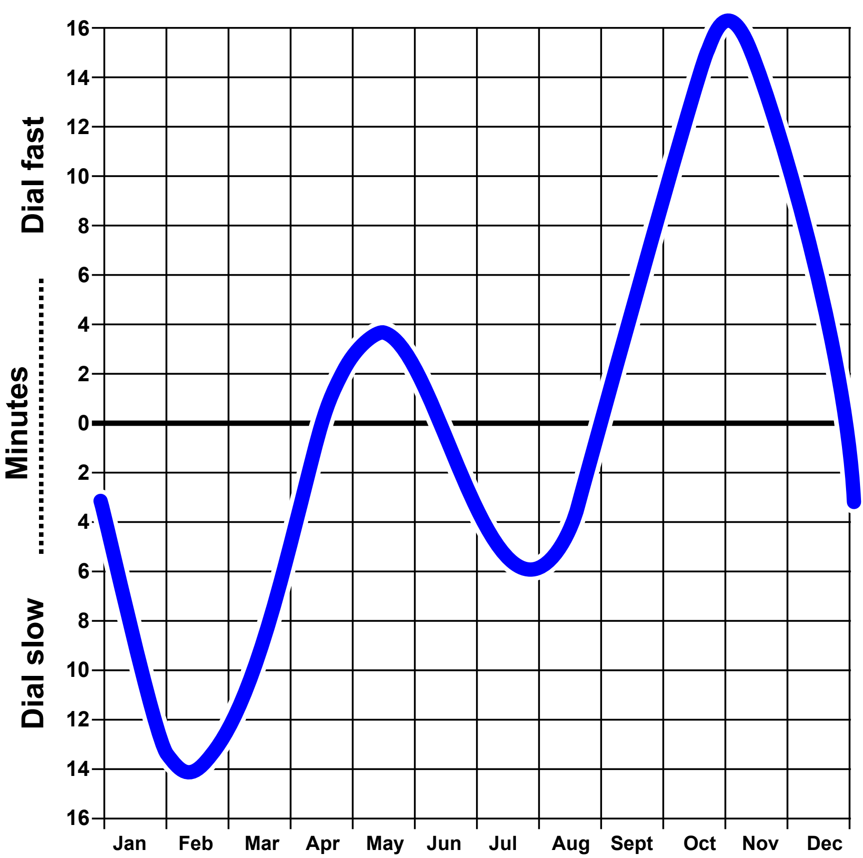


Figure 5

The Equation of time and the longitude problem are both accounted for in the Standard Time Correction Chart printed at the back of this booklet. To use the chart, use the month and day to find the time correction for that day. This chart tells you the difference between sundial time (Local Apparent Time or Solar Time) and Central Standard Time for any day of the year. Most of the numbers have a negative (-) sign in front of them. That means that Central Standard Time (on your watch, clock, or phone, if it is accurate), will be behind ("slower" than) what the sundial reads. In other words, for most days of the year, the sundial "runs fast" compared to your watch. (Only on a few days, from February 6th to 18th, does the sundial read slow, and that by only a few seconds, so it will not be noticeable on the dial. On these days, the Sundial and your watch will agree!). This difference in time can be as much as 30 minutes in parts of October and November.

There remains one additional, annoying, factor—Daylight Savings Time. If you are on Daylight Savings Time, you must ADD an hour to your corrected Sundial time to get the same time as your watch (or subtract an hour to begin with to make the comparison). Sundials do not understand Daylight Savings Time (nor should they).

What is an Analemmatic Sundial?

The Sundial at NWF State College is called an ***analemmatic sundial***. The word ***analemma*** is an ancient one, with various meanings. But as it is used today the analemma refers to the pattern made by the Sun in the sky, as seen over a year's time (**Figure 6**). In other words, if you were to take a photograph of the Sun, at the same place and same time of day, every two weeks or so, and then combine all of those photos into one image, you would see that the Sun follows a figure-8 path across the sky throughout the year. The reason for this path has to do with the changing position of the Earth relative to the Sun during its annual orbit.

Analemmatic sundials are a type of horizontal dial* that use a vertical gnomon, which is adjusted on the dial depending on the time of year (since the Sun changes its declination in the sky throughout the year—lower in the winter, higher in the summer). The oldest known analemmatic dial is still operational and is located at the Church of Brou, in Bourg-en-Bresse, France (about 230 miles southeast of Paris). This dial is reportedly as old as the church itself, which dates to 1506.

FOOTNOTE:

**Horizontal dials are oriented parallel to the ground, rather than parallel to the spin axis of the Earth (as in the majority of dials).*

Analemma

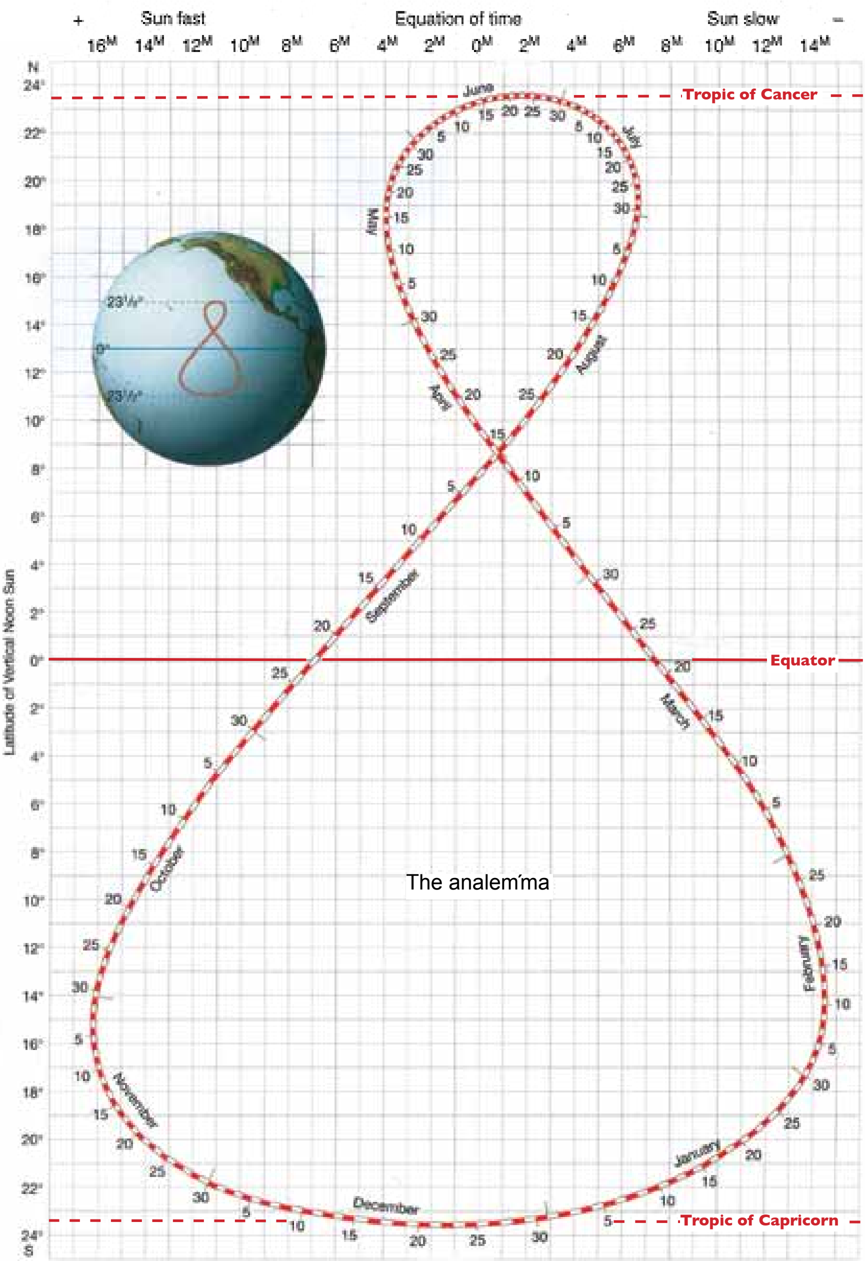


Figure 6

Symbols and Features on the NWFSC Sundial

There are several artistic and scientific symbols on the NWFSC Interactive Analemmatic Sundial. The hour marks of the elliptical dial are represented by **Roman Numerals**, representing 5:00 AM (V on the left) to 7:00 PM (VII on the right). Between each numeral are half-hour marks (wedge-shaped). ***Ante Meridiem*** (A.M.) and ***Post Meridiem*** (P.M.) mark the morning and evening hours, respectively. Also below the hour marks, starting at VIII on the left and extending to V on the right, are the astronomical symbols for the **7 "wanderers"** for which the days of the week are named. "Wanderers" were what the ancients called the Sun, Moon, and 5 visible (to the naked eye) planets. Unlike the stars, the wanderers move across the sky independent of the pattern and motion of the stars. The origin of this system is a bit complex, but basically each day was named for one of the wanderers.

☉ = Sunday—*Sun's Day*

☾ = Monday—*Moon's Day*

♂ = Tuesday—*Tiu's Day* (Tiu was the Anglo-Saxon counterpart of the Roman god, *Mars*)

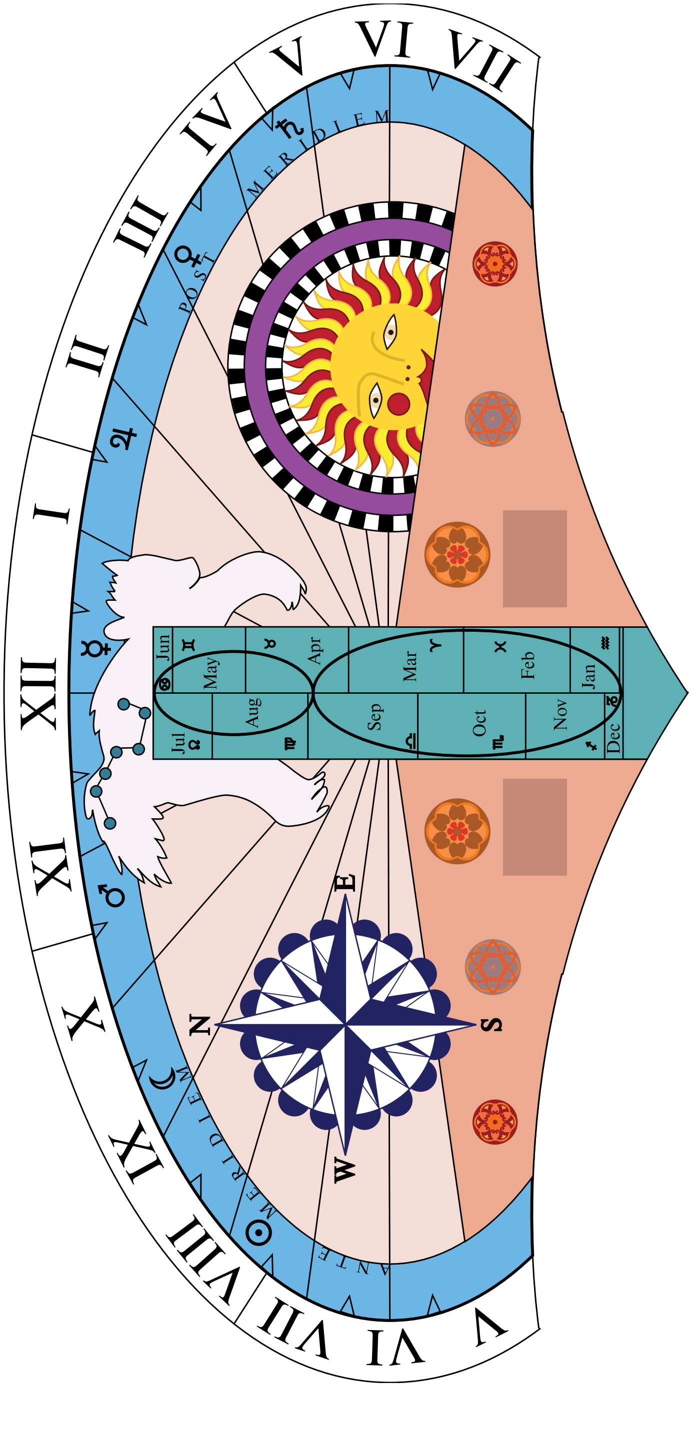
☿ = Wednesday—*Woden's Day* (Woden was the Anglo-Saxon counterpart of the Roman god *Mercury*)

♃ = Thursday— *Thor's Day* (Thor was the Norse counterpart of the Greek god *Jupiter*, or Roman *Jove*)

♀ = Friday—*Fria's Day* (Fria was the Norse counterpart of the Roman goddess, *Venus*)

♄ = Saturday –*Saturn's Day*

On the left side of the dial is the prominent ***compass rose***, which shows the directions of North, South, East, and West (it is critical that the sundial be perfectly oriented to the North Pole). On the right is the beautiful ***face of the Sun***, rising in the East. The bear represents the ***Great Bear*** constellation of the northern sky, ***Ursa major***. The Great Bear is one of the most ancient of constellations, and may have been inspired by the lore of prehistoric peoples. Within ***Ursa major*** proper is a sub-constellation (or ***asterism***) well-known to all as the ***Big Dipper***, which is in the back and tail of the bear. The two stars at the end of the "cup" of the dipper are called pointer stars because if you imagine a line and arrow formed by them, they point towards ***Polaris***, also known as the ***North Star***, which is represented just below the XII by a solar cell light so that it may be seen at night.



V
VI
VII
IV
III
II
I
XII
XI
X
IX
VIII
VII
VI
V
POST MERIDIEM
ANTE MERIDIEM
Jun
May
Apr
Mar
Feb
Jan
Jul
Aug
Sep
Oct
Nov
Dec
N
E
S
W

In middle of the dial is the long, rectangular, ***scale of dates***, on which the observer stands to casts a shadow on the dial. The ***months*** of the year are all recognized by a 3-letter abbreviation. Within the month boxes are peculiar symbols that represent the ***constellations of the zodiac***. The zodiac refers to 12 ancient constellations that lie within an 18° -wide band of sky called the *ecliptic*. The ecliptic is the path that the Sun, Moon, and planets follow in their courses across the sky. Technically, the ecliptic is the plane of the solar system. The beginning date associated with each constellation of the zodiac corresponds to the day in which the Sun begins to rise within that constellation in the eastern sky. Each zodiacal constellation occupies 30° of sky.

On the top and bottom of the scale of dates are the letters, ***Sol***, which stand for ***solstice***. On the ***summer solstice*** (on or near June 21st), the Sun is directly over the Tropic of Cancer (23.5° North latitude), marking the longest day of the year and the beginning of summer in the Northern Hemisphere. On the ***winter solstice*** (on or near December 22nd), the Sun is directly over the Tropic of Capricorn (23.5° South latitude), marking shortest day of the year and the beginning of winter in the Northern Hemisphere.

At the middle, right and left of the scale of dates are the letters, ***EQ***, which stand for ***equinox***. On the ***fall equinox*** (on or near September 23rd), the Sun is directly over the Equator, marking equal lengths of daylight and darkness on that day, and the beginning of autumn. On the ***spring*** (or, *vernal*) ***equinox*** (on or near March 21st), the Sun is also directly over the Equator, marking equal lengths of daylight and darkness on that day, and the beginning of spring. Were it not for the tilt of the Earth on its spin axis (presently tilted at 23.5°), there would essentially be only one season throughout the year (like spring or fall). Also on the scale of dates is the figure-8 pattern of the ***analemma*** (see discussion under "What is an Analemmatic Sundial?"). An analemma pattern can be used as part of an analemmatic sundial to correct for the equation of time (but it gets very complicated!). The analemma on the NWFSC dial is strictly artistic.

Symbol	Zodical Constellation (Latin)	(English)	Date when Sun Enters Sign	Season
♈	Aries	Ram	Mar. 20th	spring
♉	Taurus	Bull	Apr. 20th	spring
♊	Gemini	Twins	May 21st	spring
♋	Cancer	Crab	June 21st	summer
♌	Leo	Lion	July 23rd	summer
♍	Virgo	Virgin	Aug. 23rd	summer
♎	Libra	Scales	Sept. 23rd	autumn
♏	Scorpio	Scorpion	Oct. 23rd	autumn
♐	Sagittarius	Archer	Nov. 22nd	autumn
♑	Capricornus	Goat	Dec. 21st	winter
♒	Aquarius	Water bearer	Jan. 20th	winter
♓	Pisces	Fishes	Feb. 18th	winter

Plaques on the Sundial

Three bronze plaques are on the dial. On the lower left is the name and year of construction of the dial.

Interactive
Analemmatic
Sundial
Northwest Florida State College
2010

On the lower right is the first stanza of the second part of the poem, *The Rime of the Ancient Mariner*, by Samuel Taylor Coleridge:

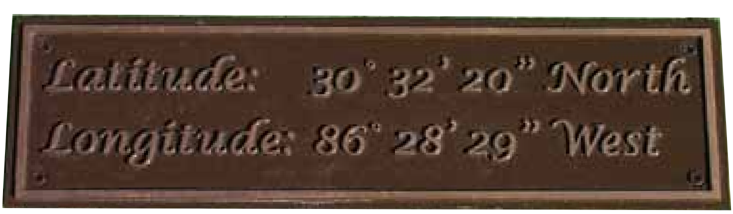
The Sun now rose upon the right:
Out of the sea came he,
Still hid in mist, and on the left
Went down into the sea.

Because sundials often conjure thoughts of the rapid passage of time, the shortness of life, the certainty of death, and other melancholy feelings, they have traditionally been adorned with special mottos, poems, or other inscriptions of a philosophical or religious nature. Several mottos were considered by the Sundial Committee, but the quote from *The Rime of the Ancient Mariner* was chosen for its literary excellence and for its appropriateness given the proximity of Niceville to the Gulf of Mexico.

At the lower, middle, pointed part of the dial is the latitude and longitude of NWFSC Sundial:

Latitude:.............................. 30° 32’ 20” North
Longitude: ....86° 28’ 29” West

The precise shape of the elliptical, analemmatic dial depends on latitude, and the Equation of Time depends on longitude. This is critical to the construction of any sundial. Theoretically, this dial could be used at 30° 32’ 20” North latitude anywhere around the world on this parallel.



How Did the NWFSC Sundial Come About?

From the initial planning to the final construction of the present Robert E. Greene, Jr. Science Building, there was a desire to complement the new structure with a sundial or some other decorative and artistic scientific object, to be located outside but near the building. In the summer of 2008, a Sundial Committee, composed of NWFSC science faculty, art faculty, other college staff, and one local community member, was formed to plan such a project in earnest.

The idea of an interactive sundial was first inspired by a similar dial called Keppel Henge, located near Georgian Bay, Ontario, Canada. After much research on the history and science of sundials, and consideration of other dials around the world, a conceptual design of a large, interactive, analemmatic sundial was drawn up by the committee. With a generous donation by long-time friend and benefactor of Northwest Florida State College, Ms. Dotty Blacker of Valparaiso, and additional contributions from the NWFSC Foundation, the committee was ready to move forward to make the dial a reality. The committee conducted a national search for an artist/sculptor to construct the dial, and selected Ms. Elizabeth Indianos of Tarpon Springs, Florida.

Ms. Indianos has extensive expertise with sculptures and other work with astronomical themes. Her ***Gainesville Solar Walk*** is a one-mile pedestrian walkway that features ten, 14-foot high sculptures, solar benches, and a Comet Halley Sculpture. Her ***Flashing Light Sculptures*** for the Hillsborough Area Regional Transportation Authority were inspired by the astronomers' star chart, and signal the arrival of the train at the Tampa Convention Center and Marriot Hotel. Elizabeth also constructed ***Fiber Optic Star Constellations*** for the Theater Lobby of Eastern Federal Fiber Optics Super Graphics of Gainesville. And she made the beautiful ***Birds Leaving the Earth*** hanging at Tampa International Airport. Elizabeth has received many grants, awards, and honors, and has prepared many other works and exhibits. She also teaches for St. Petersburg College in Tarpon Springs. Elizabeth Indianos was a perfect match for our project! See her statement about the project on page 20.

After many months of additional planning and consultation with Ms. Indianos, and the testing of small models of the dial, a final plan was agreed upon and construction was begun. The sundial was constructed at Elizabeth's studio in Gainesville, Florida, with the able assistance of personnel at Cement Precast Products, Inc., who have regularly assisted Elizabeth in artistic creations involving poured stone, and who delivered the dial to Niceville. Facilities personnel at NWFSC prepared ground, and poured and leveled the concrete foundation for the dial. The dial was transported to NWFSC in 8 large pieces by flatbed truck on 11 June 2010, and installation was on "Saturn's Day", 12 June 2010.

It was absolutely necessary to install the dial with the middle line of the Scale of Dates oriented to True North (towards the North Pole) not to magnetic North. To determine the precise direction of True North, the orientation of the shadow cast by a vertical pole at local solar noon was repeatedly marked during various sunny days in March, April, May, and June of 2010. The exact time of local solar noon was determined using calculations from the website www.solar-noon.com. For example, the noon shadow was marked on April 26th. On that day, it was precisely noon at 11 hours 43 minutes 49 seconds Central Standard Time (or 17 hours 43 minutes 49 seconds UTC). Using a cellular phone, this precise time was determined by calling Station WWV in Colorado (Phone: 1-303-499-7111), which announces UTC at the top of every minute, and counts the seconds by tick sounds for the duration of each minute. The voice said, "At the tone, 17 hours, 43 minutes, Coordinated Universal Time." After the "beep", 49 additional seconds were counted off listening to the ticks, then the noon shadow was marked on the ground with a second pole.

After installation, NWFSC Facilities personnel constructed the paver stone path and patio around the dial, and installed the nearby benches. Although Northwest Florida State College owns the dial as scientific instrument and artistic sculpture, the *image* of the sundial, as a creative object, is protected by copyright to Ms. Indianos.

The location of the sundial at the northeastern corner of the Science Building was chosen because of its convenient, central location with respect to foot traffic on the campus and minimal shading. Early in the morning and late in the afternoon, the sundial may be shaded by nearby buildings or trees, but this does not seriously affect the main hours of the day when the dial will get its maximum use. A "perfect" dial must be located in an open field that is not shaded by trees or any other objects. The committee considered a few, more open field locations, but they were all far removed from most foot traffic and areas of regular use. The present location was the recommendation of college architect David Alsop, and was judged by the committee to be optimal!

A Word from the Artist

The Sundial requires, insists that participants stand on the dial and establish "True North" in order to find their own relative position and time on the planet.

So, what is True North? Personally and on the larger, macro-cosmic human stage, is it a search for meaning, for oneness? Is it a destination or just a cool, non-digital clock?

For the ancients, it was the guiding light, the star they looked towards to align the Great Pyramids of Giza. Neolithic tribes used it to lay out Stonehenge. Babylonians calibrated True North into the creation of their still accurate calendar.

What about us? Do we have a True North that guides us? Have we drifted away from True North? More importantly, can we re-align, re-ascend and return back to it?

During the installation of the Sundial, a waitress took lunch orders from my crew and me and let us know that oily tar balls were beginning to show up on the beach. I wondered, could we, like the ancients, find our True North and "map" our way back from disaster? What is the latitude and longitude of compassion, the exact location and True North of the realization that we are all delicately connected to each other and to our home; to every ounce of that small, little blue dot in the Universe, Earth.

– Elizabeth Indianos

Acknowledgments

Special thanks are due to the NWFSC Sundial Committee, which included Science Faculty Jon Bryan, Anthony Russo, Allison Beauregard, and Darryl Ritter; Associate Faculty Elizabeth Ritter and Matthew Cox; Fine Arts Faculty Cliff Herron and Steve Phillips; Community Member Dotty Blacker, College Architect David Alsop, NWFSC Facilities Director Sam Jones, and Physical Plant Director John Rickard. Tony Russo and Jon Bryan constructed and tested an early mock-up of the dial. Bryan did most of the final design work, with assistance and input from the committee. Ms. Pamela Hynes, Reference Staff at the NWFSC Learning Resource Center, researched historical variations of the lyrics in the poetic stanza used on the bronze plaque from Coleridge's*, The Rime of the Ancient Mariner.*

Facilities Director Sam Jones constructed the foundation template, and his staff cleared the ground, prepared and poured the concrete foundation of the dial, and installed the paver stone walkway and patio, and installed the benches. Architect David Alsop designed the paver stone walkway and patio around the dial. John Rickard, Sam Jones, and their staffs will provide continual care and maintenance of the dial and surrounding area.

Elizabeth Indianos, along with Joe Stanford and others at Cement Precast Products, Inc., in Gainesville, worked extremely hard, and sometimes with little sleep, during the intense construction phase of the dial, which demanded continual attention to many details for several weeks. Rhonda Moronez of the NWFSC Graphic Services Department and Tami Van Dyke of the college bookstore assisted in the design and production of a sundial T-shirt.

More than anyone, Ms. Dotty Blacker is to be thanked for making this project possible. She donated generously to the project to get it jump-started. Ms. Blacker is especially interested in linking science with art, and using the dial for educational purposes—not only for college students, but for area schools and the community at large. Thank you, Dotty!

References

Mayall, RN, and Mayall, MW, 1994, *Sundials—Their Construction and Use.* Dover Publications, Inc., New York, 250 p.

Rohr, RRJ, *Sundials—History, Theory, and Practice.* Dover Publications, Inc., New York, 143 p.

Waugh, AE, 1973, *Sundials—Their Theory and Construction.* Dover Publications, Inc., New York, 228 p.

Recommended Websites

North American Sundial Society .... www.sundials.org

Northwest Florida State College .... www.nwfsc.edu/sundial

Standard Time Correction Chart

This chart (shown on next page) “corrects” for the two sources of “error” when reading the sundial (actually, these are adjustments to correct for the errors inherent in your watch!). This sundial almost always “runs fast” when compared to your watch.

This chart tells you the difference between Sundial Time and Central Standard Time (the time on an accurate clock or watch) for any day of the year. Determine the month and day, and read the time correction for that day. Most of the numbers have a negative (-) sign in front of them. That means that Central Standard Time (on your watch, clock, or phone, if it is accurate), will be behind (slower) than what the Sundial reads. So you must subtract the amount of time from the time shown on the sundial to get the correct Central Standard Time (only on a few days, from February 6th to 18th, does the sundial read slow, but only by a few seconds, so it will not be noticeable on the dial). It might be easier to think instead of this negative number as how “fast” the dial is compared to your watch.

A Note on Daylight Savings Time

If you are on Daylight Savings Time, you must **ADD** an hour to your corrected Sundial time (or subtract an hour from your watch to begin with) to get the same time as your watch. Sundials refuse to acknowledge Daylight Savings Time.

Standard Time Correction Chart

	Jan	Feb	Mar	Apr	May	Jun
1	-10:52	--0:31	-1:30	-9:56	-16:55	-16:29
2	-10:24	--0:23	-1:41	-10:14	-17:03	-16:20
3	-9:56	--0:16	-1:53	-10:32	-17:10	-16:10
4	-9:28	--0:09	-2:06	-10:50	-17:16	-16:00
5	-9:01	--0:03	-2:19	-11:07	-17:22	-15:50
6	-8:34	+0:01	-2:46	-11:24	-17:27	-15:40
7	-8:07	+0:05	-2:47	-11:41	-17:31	-15:29
8	-7:41	+0:09	-3:01	-11:58	-17:35	-15:18
9	-7:15	+0:11	-3:16	-12:15	-17:39	-15:07
10	-6:50	+0:13	-3:31	-12:32	-17:42	-14:55
11	-6:26	+0:14	-3:46	-12:48	-17:44	-14:43
12	-6:02	+0:15	-4:02	-13:04	-17:46	-14:31
13	-5:39	+0:14	-4:18	-13:20	-17:48	-14:19
14	-5:16	+0:13	-4:34	-13:35	-17:48	-14:07
15	-4:54	+0:11	-4:51	-13:50	-17:48	-13:54
16	-4:32	+0:08	-5:08	-14:05	-17:48	-13:41
17	-4:12	+0:05	-5:25	-14:19	-17:47	-13:28
18	-3:52	+0:01	-5:42	-14:33	-17:45	-13:15
19	-3:32	--0:03	-6:00	-14:47	-17:43	-13:02
20	-3:14	--0:09	-6:18	-15:00	-17:41	-12:49
21	-2:56	--0:15	-6:36	-15:04	-17:38	-12:36
22	-2:39	--0:22	-6:54	-15:25	-17:34	-12:23
23	-2:23	--0:29	-7:12	-15:37	-17:28	-12:10
24	-2:07	--0:37	-7:30	-15:49	-17:25	-11:57
25	-1:52	--0:46	-7:48	-16:00	-17:20	-11:44
26	-1:38	--0:55	-8:06	-16:10	-17:14	-11:31
27	-1:25	-1:05	-8:24	-16:20	-17:07	-11:19
28	-1:13	-1:16	-8:43	-16:30	-17:00	-11:07
29	-1:01	-1:22	-9:02	-16:39	-16:53	-10:55
30	--0:50		-9:20	-16:47	-16:45	-10:43
31	--0:40		-9:38		-16:37	

Standard Time Correction Chart

	Jul	Aug	Sep	Oct	Nov	Dec
1	-10:31	-7:48	-13:52	-24:09	-30:24	-25:15
2	-10:19	-7:51	-14:11	-24:28	-30:26	-24:53
3	-10:07	-7:55	-14:30	-24:47	-30:27	-24:30
4	-9:56	-8:00	-14:49	-25:06	-30:27	-24:06
5	-9:45	-8:05	-15:09	-25:24	-30:26	-23:42
6	-9:35	-8:11	-15:29	-25:42	-30:24	-23:17
7	-9:25	-8:18	-15:49	-26:00	-30:22	-22:52
8	-9:15	-8:25	-16:09	-26:17	-30:19	-22:26
9	-9:06	-8:33	-16:30	-26:34	-30:15	-22:00
10	-8:57	-8:41	-16:51	-26:50	-30:10	-21:33
11	-8:48	-8:50	-17:12	-27:06	-30:04	-21:06
12	-8:40	-8:59	-17:33	-27:22	-29:57	-20:38
13	-8:32	-9:09	-17:54	-27:37	-29:50	-20:10
14	-8:25	-9:20	-18:15	-27:51	-29:41	-19:42
15	-8:18	-9:31	-18:36	-28:05	-29:32	-19:13
16	-8:12	-9:43	-18:57	-28:18	-29:22	-18:44
17	-8:06	-9:55	-19:18	-28:31	-29:11	-18:15
18	-8:01	-10:07	-19:39	-28:43	-29:00	-17:46
19	-7:56	-10:20	-20:00	-28:55	-28:47	-17:17
20	-7:52	-10:34	-20:22	-29:06	-28:34	-16:47
21	-7:49	-10:48	-20:44	-29:16	-28:20	-16:17
22	-7:46	-11:03	-21:05	-29:26	-28:05	-15:47
23	-7:44	-11:18	-21:26	-29:35	-27:49	-15:17
24	-7:42	-11:34	-21:47	-29:44	-27:32	-14:47
25	-7:40	-11:50	-22:08	-29:51	-27:15	-14:17
26	-7:39	-12:06	-22:29	-29:58	-26:57	-13:47
27	-7:39	-12:23	-22:50	-30:05	-26:38	-13:17
28	-7:40	-12:40	-23:10	-30:10	-26:18	-12:48
29	-7:41	-12:57	-23:30	-30:15	-25:58	-12:19
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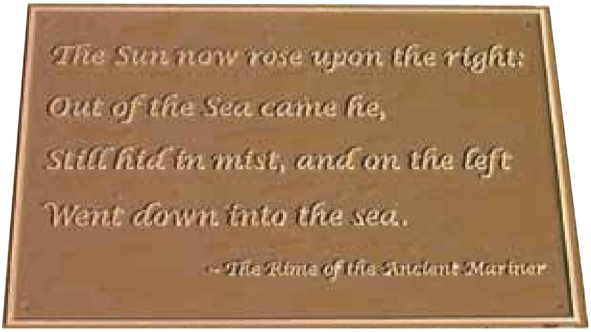
31	-7:45	-13:33		-30:22		-11:21



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