APPENDIX

GPS TERMINOLOGY

Almanac

Data transmitted by a GPS satellite which includes orbital information on all the satellites, clock correction, and atmospheric delay parameters. These data are used to facilitate rapid satellite acquisition. The orbital information in the almanac is less accurate than the ephemeris, but valid for a longer time (one to two years).

Ambiguity

The unknown integer number of cycles of the reconstructed carrier phase contained in an unbroken set of measurements from a single satellite pass at a single receiver.

Argument of Latitude

The sum of the true anomaly and the argument of perigee.

Argument of Perigee

The angle or arc from the ascending node to the closest approach of the orbiting body to the focus or perigee point, as measured at the focus of an elliptical orbit, in the orbital plane in the direction of motion of the orbiting body.

Ascending Node

The point at which an object's orbit crosses the reference plane (ie., the equatorial plane) from south to north.

Azimuth

A horizontal direction expressed as the angular distance between a fixed direction, such as north, and the direction of the object.

Bandwidth

A measure of the information-carrying capacity of a signal, expressed as the width of the spectrum of that signal (frequency domain representation) in Hertz (Hz).

Baseline

The three-dimensional (3D) vector distance between a pair of stations for which simultaneous GPS data has been collected and processed with differential techniques.

GPS Terminology (Continued)

Beat Frequency

Either of two additional frequencies obtained when signals of two frequencies are mixed. The beat frequencies are equal to the sum or difference of the original frequencies.

Bias

See Integer Bias Terms.

Binary Biphase Modulation

Phase changes of either zero or 180 degrees (representing a binary zero or one, respectively) on a constant frequency carrier . GPS signals are biphase modulated.

Binary Pulse Code Modulation

Pulse modulation using a string of binary numbers (codes). This coding is usually represented by ones and zeros with definite meanings assigned to them, such as changes in phase or direction of a wave.

Bluebook

A slang term derived from a blue NGS reference book. The book contains information and formats required by NGS for survey data that is submitted to be considered for use in the national network.

C/A Code

The Coarse/Acquisition (or Clear/Acquisition) code modulated onto the GPS L1 signal. This code is a sequence of 1023 pseudorandom binary biphase modulations on the GPS carrier at a chipping rate of 1.023 MHz, thus having a code repetition period of one millisecond. This code was selected to provide good acquisition properties.

Carrier

A radio wave having at least one characteristic (such as frequency, amplitude, phase) that may be varied from a known reference value by modulation.

Carrier Beat Phase

The phase of the signal that remains when the incoming Doppler-shifted satellite carrier signal is beat (the difference frequency signal is generated) with the nominally constant reference frequency generated in the receiver.

Carrier Frequency

The frequency of the unmodulated fundamental output of a radio transmitter. The GPS L1 carrier frequency is 1575.42 MHz.

Celestial Equator

The great circle that is the projection of the earth's geographical equator of rotation onto the celestial sphere. Its poles are the north and south celestial poles.

GPS Terminology (Continued)

Celestial Meridian

The vertical great circle on the celestial sphere that passes through the celestial poles, the astronomical zenith, and the nadir.

Chip

The length of time required to transmit either a one or a zero in binary pulse code. One chip of the C/A code is about 977 ns long, which corresponds to a distance of 293 m.

Chip Rate

Number of chips per second (e.g., the C/A code chip rate = 1.023 MHz).

Clock Offset

Constant difference in time readings between two clocks.

Code Division Multiple Access (CDMA)

A method of frequency reuse whereby many radios use the same frequency but with each one having a separate and unique code. GPS uses CDMA techniques with Gold codes for their unique cross-correlation properties.

Conventional International Origin (CIO)

Average position of the earth's rotation axis during the years 1900-1905.

Correlation-Type Channel

A GPS receiver channel that uses a delay-lock-loop (DLL) to maintain an alignment (correlation peak) between the replica of the GPS code generated in the receiver and the received code from the satellite.

Deflection of the Vertical

The angle between the normal to the ellipsoid and the vertical (true plumbline). Since this angle has both a magnitude and a direction, it is usually resolved into two components: one in the meridian and the other perpendicular to it in the prime vertical.

Delay-Lock-Loop

The technique whereby the received code (generated by the satellite clock) is compared with the internal code generated by the receiver clock.
The latter is shifted in time until the two codes match. Delay-lock-loops can be implemented in several ways, including tau dither and early-minus-late gating.

Delta Pseudorange

See Reconstructed Carrier Phase.

GPS Terminology (Continued)

Differential Processing

GPS measurements can be differenced between receivers, satellites, and epochs. Although many combinations are possible, the present convention for differential processing of GPS measurements ar eto first take differences between receivers (single difference), then between satellites (double difference), then between measurement epochs (triple difference).

A single-difference measurement between receivers is the instantaneous difference in phase of the signal from the same satellite, measured by two receivers simultaneously.

A double-difference measurement is obtained by differencing the single difference for one satellite with respect to the corresponding single difference for a chosen reference satellite.

A triple-difference measurement is the difference between a double difference at one epoch of time and the same double difference at the previous epoch of time.

Differential GPS solutions can be computed using either code phase or carrier phase measurements. In differential carrier phase solutions, the integer ambiguities must be resolved.

Differential (Relative) Positioning

Determination of relative coordinates of two or more receivers that are simultaneously tracking the same satellites. Dynamic differential positioning is a real-time technique achieved by sending code corrections to the roving receiver from one or more monitor stations. Static differential GPS involves determining baseline vectors between pairs of receivers.

Dilution of Precision

A description of the geometrical contribution to the uncertainty in a position fix, given by the expression DOP = SQRT TRACE (A^TA), where A is the design matrix for the instantaneous position solution (dependent on satellite-receiver geometry). The type of DOP factor depends on the parameters of the position fix solution. Standard terms for GPS applications include the following:

GDOP	Geometric DOP - three coordinates plus clock offset in the solution.
PDOP	Position DOP - three coordinates.
HDOP	Horizontal DOP - two horizontal coordinates.
VDOP	Vertical DOP - height only.
TDOP	Time DOP - clock offset only.

GPS Terminology (Continued)

RDOP Relative DOP - normalized to 60 seconds.

DoD

United States Department of Defense. The government agency that led the development, deployment, and operation of GPS.

Doppler Aiding

The use of Doppler carrier-phase measurements to smooth the code-phase measurements. Also referred to as carrier aided smoothing or carrier-aided tracking.

Doppler Shift

The apparent change in frequency of a received signal due to the rate of change of the range between the transmitter and receiver. See Reconstructed Carrier Phase.

Double-Difference Ambiguity Resolution

A method to determine the set of ambiguity values which minimizes the variance of the solution for a receiver pair baseline vector.

Dynamic Positioning

Determination of a timed series of sets of coordinates for a moving receiver, each set of coordinates being determined from a single data sample, and usually computed in real time.

Earth-Centered Earth-Fixed (ECEF)

Usually refers to a coordinate system centered at the center of the earth that rotates with the earth. Cartesian coordinate system where the X direction is the intersection of the prime meridian (Greenwich) with the equator. The X and Y vectors rotate with the earth. Z is the direction of the spin axis.

Eccentric Anomaly E

The regularizing variable in the two-body problem. E is related to the mean anomaly M by Kepler's equation. $M = E - e \cdot \sin(E)$, where e is the eccentricity.

Eccentricity

The ratio of the distance from the center of an ellipse to its focus to the semimajor axis. $e = (1 - b^2/a^2) - 1/2$, where a and b are the semimajor and semiminor axes of the ellipse.

Ecliptic

The earth-sun orbital plane. North is the direction of the system's angular momentum. Also called the ecliptic pole.

Elevation

Height above mean sea level or vertical distance above the geoid.

GPS Terminology (Continued)

Elevation Mask Angle

The elevation angle below which satellites are ignored. Normally set to ten degrees to avoid interference problems caused by buildings, trees, multipath, and atmospheric errors.

Ellipsoid Height

The measure of vertical distance above the ellipsoid. Not the same as elevation above sea level, because the ellipsoid does not agree exactly with the geoid. GPS receivers output position fix height referenced to the WGS-84 datum.

Ephemeris

A list of orbital parameters of a celestial object that can be used to compute accurate positions as a function of time. Available as broadcast ephemeris or as postprocessed precise ephemeris.

Epoch

Measurement interval or data frequency. For example, if measurements are made and reported every five seconds, then we have five second epochs.

Fast Switching Channel

A switching channel with a sequence time short enough to recover (through software prediction) the integer part of the carrier beat phase.

Flattening

A parameter used to define the shape of an ellipsoid.

$f = (a - b)/a = 1 - (1 - e^2)^{1/2}$, where

a = semimajor axis

b = semiminor axis

e = eccentricity

Frequency Band

A range of frequencies in a particular region of the electromagnetic spectrum.

Frequency Spectrum

The distribution of amplitudes as a function of frequency of the constituent waves in a signal.

Fundamental Frequency

The fundamental frequency used in GPS is 10.23 MHz. The carrier frequencies L1 and L2 are integer multiples of this fundamental frequency.

L1 = 154F = 1575.42 MHz

L2 = 120F = 1227.60 MHz

GPS Terminology (Continued)

GDOP

Geometric dilution of precision. See Dilution of Precision.
$GDOP^2 = PDOP^2 + TDOP^2$

Geocenter

The center of mass of the earth.

Geodetic Datum

A mathematical model designed to best fit part or all of the geoid. It is defined by an ellipsoid and the relationship between the ellipsoid and a point on the topographic surface established as the origin of datum. The relationship can be defined by six quantities, generally (but not necessarily) the geodetic latitude, longitude, and height of the origin, the two components of the deflection of the vertical at the origin, and the geodetic azimuth of a line from the origin to some other point.

Geoid

The particular equipotential surface which coincides with mean sea level, and which may be imagined to extend through the continents. This surface is perpendicular to the force of gravity at all points.

Geoid Height

The height above the geoid is often called elevation above mean sea level.

GPS

Global Positioning System, consisting of the space segment (up to 24 NAVSTAR satellites in six different orbital planes), the control segment (five monitor stations, one master control station and three uplink stations), and the user segment (GPS receivers).

NAVSTAR satellites carry extremely accurate atomic clocks and broadcast coherent simultaneous signals.

GPS ICD-200

The GPS Interface Control Document is a government document that contains the full technical description of the interface between the satellites and the user. GPS receivers must comply with this specification if they are to receive and process GPS signals properly.

Gravitational Constant

The proportionality constant in Newton's Law of Gravitation. $G = 6.672 \times 10^{-11}\ Nm^2/Kg^2$.

Greenwich Mean Time (GMT)

See Universal Time.

GPS Terminology (Continued)

HDOP

Horizontal dilution of precision. See Dilution of Precision.

HOW

Handover Word. The word in the GPS message that contains time synchronization information for the transfer from the C/A code to the P code.

Inclination

The angle between the orbital plane of a body and some reference plane (e.g. equatorial plane).

INS

Inertial Navigation System, which contains an Inertial Measurement Unit (IMU).

Integer Bias Terms

The receiver counts the radio waves from the satellite, as they pass its antenna, to a high degree of accuracy. However, it has no information on the number of waves to the satellite at the time it started counting. This unknown number of wavelengths between the satellite and the antenna is the integer bias term.

Integrated Doppler

A measurement of Doppler shift frequency or phase over time.

Ionospheric Delay

A wave experiences delay while propagating through the ionosphere, which is non-homogeneous in space and time and is a dispersive medium. Phase delay depends on electron content and affects carrier signals. Group delay depends on dispersion in the ionosphere as well, and affects signal modulation (codes). The phase and group delay are of the same magnitude, but opposite sign.

JPO

Joint Program Office for GPS located at the USAF Space Division at El Segundo, California. The JPO consists of the USAF Program Manager and Deputy Program Managers representing the Army, Navy, Marine Corps, Coast Guard, Defense Mapping Agency, and NATO.

Kalman Filter

A numerical method used to track a time-varying signal in the presence of noise. If the signal can be characterized by some number of parameters that vary slowly with time, then Kalman filtering can be used to tell how incoming raw measurements should be processed to best estimate those parameters as a function of time.

GPS Terminology (Continued)

Kinematic Surveying

A form of continuous differential carrier-phase surveying requiring only short periods of data observations. Operational constants include starting from or determining a known baseline, and tracking a minimum of four satellites. One receiver is statically located at a control point, while others are moved between points to be measured.

Keplerian Orbital Elements

Allow description of any astronomical orbit. The six Keplerian orbital elements are as follows:

a = semimajor axis

e = eccentricity

w = argument of perigee

Ω = right ascension of ascending node

i = inclination of orbital plane

To = epoch of perigee passage.

L1, L2

The L-band signals radiated by each NAVSTAR satellite. The L1 signal is a 1575.42-MHz carrier modulated with both the C/A and P codes and with the NAV message. The L2 signal is a 1227.60-MHz carrier modulated with the P code and the NAV message. Under anti-spoofing, the P code becomes the encrypted Y code for authorized users only.

Lane

The area (or volume) enclosed by adjacent lines (or surfaces) of zero phase of either the carrier beat phase signal, or of the difference between two carrier beat phase signals. On the earth's surface, a line of zero phase is the focus of all points for which the observed value would have an exact integer value for the complete instantaneous phase measurement. In three dimensions, this lane becomes a surface.

L Band

The radio frequency band extending from 390 MHz (nominally) to 1550 MHz.

Mean Anomaly

M = n(t - T), where n is the mean motion, t is the time, and T is the instant of perigee passage.

Mean Motion

n = 2/P, where P is the period of revolution.

Microstrip Antenna

A two-dimensional, flat, precisely-cut piece of metal foil glued to a substrate.

GPS Terminology (Continued)

Monitor Station

Any of a worldwide group of stations used in the GPS control segment to monitor satellite clock and orbital parameters. Data collected at these sites are linked to a master station where corrections are calculated and controlled. These data are uploaded to each satellite at least once per day from an uplink station.

Multichannel Receiver

A receiver containing many independent channels. Such a receiver offers the highest signal-to-noise ratio (SNR) because each channel tracks one satellite continuously.

Multipath

Interference similar to ghosts on a television screen, which occurs when multiple signals arrive at an antenna having traversed different paths. In GPS, the signal traversing the longer path will yield a larger pseudorange estimate and increase the error. Multiple paths may arise from reflections from structures near the antenna or from the ground.

Multipath Error

A positioning error resulting from interference between radio waves that have traveled between the transmitter and the receiver by paths of different electrical lengths.

Multiplexing Channel

A receiver channel that is sequenced through several satellite channels (each from a specific satellite and at a specific frequency) at a rate which is synchronous with the satellite message bit rate (50 bits per second, or 20 milliseconds per bit). Thus, one complete sequence is completed in a multiple of 20 milliseconds.

NAD-83

North American Datum, 1983

NAVDATA

The 1500-bit navigation message broadcast by each satellite at 50 bps on both the L1 and L2 signals. The message contains system time, clock correction parameters, ionospheric delay model parameters, and the satellite's ephemeris and health. This information is used by the GPS receiver in processing GPS signals to obtain user position, velocity, and time.

NAVSTAR

The name given to GPS satellites, which stands for NAVigation Satellite Timing and Ranging.

GPS Terminology (Continued)

Observation Session

The period of time over which simultaneous GPS data is collected by two or more receivers.

Outage

A point in time and space that the GPS receiver is unable to compute a position fix. This may be due to satellite signal blockage, unhealthy satellites, or a dilution of precision (DOP) value that exceeds a specified limit.

P Code

The protected or precise code modulated on both the L1 and L2 GPS signals. The P code is a very long (about 10^{14} bits) sequence of pseudorandom binary biphase modulations on the GPS carrier at a chipping rate of 10.23 MHz that does not repeat itself for about 38 weeks. Each satellite uses its own unique one-week segment of this code, which is reset each week. Under anti-spoofing, the P code is encrypted to form Y code. The Y code is only accessible by authorized users, as controlled by the U.S. DoD.

PDOP

Position dilution of precision, a unitless figure of merit expressing the relationship between the error in user position and the error in satellite ranges. Geometrically, PDOP is proportional to the inverse of the volume of the pyramid formed by lines running from the receiver to four observed satellites. Values considered good for positioning are small, such as 3. Values greater than 7 are considered poor. Small PDOP is associated with many or widely separated satellites, and large PDOP is associated with bunched up or few satellites. See Dilution of Precision

Parity Error

A digital message consists of ones and zeros. Parity is an exclusive-or sum of these bits in a word unit. A parity error results when a bit (or bits) is changed during transmission, so that the parity calculated at reception is not the same as it was when the message was transmitted.

Perigee

That point in a geocentric orbit when the geometric distance is a minimum. The closest approach of the orbiting body.

Phase-Lock-Loop

The technique of making the phase of an oscillator signal follow exactly the phase of a reference signal. This is accomplished by first comparing the phases of the two signals, and then using the resulting phase difference signal to adjust the reference oscillator frequency to eliminate phase difference when the two signals are next compared.

Phase Observable

See Reconstructed Carrier Phase.

GPS Terminology (Continued)

Point Positioning

Geographic positions produced from one receiver in stand-alone mode. At best, position accuracy obtained from a stand-alone receiver is 15 to 25 meters (without SA), depending on the geometry of the satellites.

Polar Motion

Motion of the instantaneous axis of the rotation of the earth with respect to the solid body of the earth. This motion is irregular but more or less circular with an amplitude of about 15 miles and a main period of about 430 days (also called Chandler Wobble).

Precise Positioning Service (PPS)

The highest level of military dynamic positioning accuracy provided by GPS, based on the dual frequency P code and having high anti-jam and anti-spoof qualities.

Prime Vertical

The vertical circle perpendicular to the celestial meridian.

PRN

Pseudorandom noise, a sequence of digital ones and zeros that appear to be randomly distributed like noise, but which can be exactly reproduced. The most significant property of PRN codes is that they have a low autocorrelation value for all delays or lags except when they are exactly coincident. Each NAVSTAR satellite has its own unique C/A and P pseudorandom noise codes.

Pseudolite

A ground-based GPS transmitter station that broadcasts a signal with a structure similar to that of an actual GPS satellite. Pseudolites are designed to improve the accuracy and integrity of GPS, particularly near airports.

Pseudorange

A measure of the apparent propagation time from satellite to receiver antenna, expressed as a distance. A pseudorange is obtained by multiplying the apparent signal propagation time by the speed of light. Pseudoranges differ from actual geometric ranges due to the satellite/receiver clock offset, propagation delays, and other errors. The apparent propagation time is determined from the time shift required to align (correlate) a replica of the GPS code generated in the receiver with the received GPS code. The time shift is the difference between the time of signal reception (measured in the receiver time frame) and the time of signal emission (measured in the satellite time frame).

GPS Terminology (Continued)

Range Rate

The rate of change of range between the satellite and the receiver. The range to a satellite changes due to both satellite and receiver motion. Range rate (or pseudorange rate) is determined by measuring the Doppler shift of the satellite signal's carrier frequency.

RDOP

Relative dilution of precision. See Dilution of Precision.

Reconstructed Carrier Phase

The difference between the phase of the incoming Doppler-shifted GPS carrier and the phase of a nominally constant reference frequency generated in the receiver. For static positioning, the reconstructed carrier phase is sampled at epochs determined by a clock in the receiver. The reconstructed carrier phase changes according to the continuously integrated Doppler shift of the incoming signal, biased by the integral of the frequency offset between the satellite and receiver reference oscillators. The reconstructed carrier phase can be related to the satellite-to-receiver range, once the initial range (or phase ambiguity) has been determined. A change in the satellite-to-receiver range of one wavelength of the GPS carrier (19 cm for L1) will result in a one-cycle change in the phase of the reconstructed carrier.

Relative Navigation

A technique similar to relative positioning except that one or both of the points may be moving. The pilot of a ship or an aircraft may need to know the vehicle's position relative to a harbor or runway. A data link is used to relay the error terms to the moving vessel to allow real-time navigation.

Right Ascension

The angular distance measured from the vernal equinox, positive to the east, along the celestial equator to the ascending node. Typically denoted by a capital omega (Ω). Used to discriminate between orbital planes.

RTCM

Radio Technical Commission for Maritime Services Commission set up to define a differential data link to relay GPS correction messages from a monitor station to a field user. RTCM SC-104 recommendations define the correction message format and 16 different correction message types.

SATNAV

A local term referring to use of the older TRANSIT system for satellite navigation. One major difference between TRANSIT and GPS is that the TRANSIT satellites are in low-altitude polar orbits with a 90-minute period.

GPS Terminology (Continued)

Selective Availability (SA)

A DoD program to control the accuracy of pseudorange measurements, whereby the user receives a false pseudorange which is in error by a controlled amount. Differential GPS techniques can reduce these effects for local applications. Under SA, the DoD guarantees unauthorized users an accuracy of 100 m 2DRMS at a 95% confidence level.

Semi-major Axis

One half of the major axis of an ellipse.

SEP

Spherical Error Probable, a statistical measure of precision defined as the 50th percentile value of the three-dimensional position error statistics. Thus, half of the results are within the 3D SEP value.

Sidereal Day

Time between two successive upper transits of the vernal equinox. One sideral day is just under four minutes shorter than one solar day.

Simultaneous Measurements

Measurements referenced to time-frame epochs that are either exactly equal or so closely spaced in time that the time misalignment can be accommodated by correction terms in the observation equation rather than by parameter estimation.

Slope Distance

The three-dimensional vector distance from station one to station two. The shortest distance (a chord) between two points.

Slow Switching Channel

A switching channel with a sequencing period that is too long to allow recovery of the integer part of the carrier beat phase.

Solar Day

Time between two successive upper transits of the sun.

Spheroid

See Ellipsoid.

Spread Spectrum

The received GPS signal is a wide bandwidth low-power signal (-160 dBW). This property results from modulating the L-band signal with a PRN code in order to spread the signal energy over a bandwidth that is much greater than the signal information bandwidth. This is done to provide the ability to receive all satellites unambiguously and to provide some resistance to noise and multipath.

GPS Terminology (Continued)

Spread Spectrum System

A system in which the transmitted signal is spread over a frequency band much wider than the minimum bandwidth needed to transmit the information being sent.

SPS

Standard Positioning Service, uses the C/A code to provide a minimum level of dynamic or static positioning capability. The accuracy of this service is set at a level consistent with national security. See Selective Availability.

Squaring-Type Channel

A GPS receiver that multiplies the received signal by itself to obtain a second harmonic of the carrier that does not contain the code modulation. Used in codeless receiver designs to obtain dual frequency measurements.

Static Positioning

Positioning applications in which the positions of static or near-static points are determined.

SV

Satellite vehicle or space vehicle.

Switching Channel

A receiver channel that is sequenced through a number of satellite signals (each from a specific satellite and at a specific frequency) at a rate which is slower than, and asynchronous with, the message data rate.

TDOP

Time dilution of precision. See Dilution of Precision.

TOW

Time of week, in seconds from midnight Saturday UTC.

TRAIM

Time Reciever Autonomous Integrity Monitoring. This is an algorithm that continuously monitors the integrity of the time solution by using redundant satellite measurements. This algorithm is only available on the UT Oncore. See the Time RAIM Setup and Status Message in Chapter 6.

Translocation

A version of relative positioning that makes use of a known position, such as an NGS survey mark, to aid in accurately positioning a desired point. The position of the mark, determined using GPS, is compared with the accepted value. The three-dimensional differences are then used in the calculations for the second point.

GPS Terminology (Continued)

Tropospheric correction

The correction applied to the measurement to account for tropospheric delay. This value is normally obtained from the modified Hopfield model, the parameters of which are broadcast by the satellites.

True Anomaly

The angular distance, measured in the orbital plane from the earth's center (occupied focus) from the perigee to the current location of the satellite (orbital body).

Universal Time

Local solar mean time at Greenwich Meridian. Some commonly used versions of universal time follow:

UT0	Universal time as deduced directly from observations of stars and the fixed numerical relationship between universal and sidereal time (3 minutes, 56.555 seconds).
UT1	UT0 corrected for polar motion.
UT2	UT0 corrected for seasonal variations in the earth's rotational rate.
UTC	Universal time coordinated; uniform atomic time system kept very close to UT2 by offsets. Maintained by the U.S. Naval Observatory (USNO)

GPS time is directly related to UTC by the following:

UTC - GPS = UTC offset (11 seconds in 1996)

User Range Accuracy (URA)

The contribution to the range measurement error from an individual error source (apparent clock and ephemeris prediction accuracies) converted into range units, assuming that the error source is uncorrelated with all other error sources.

UTM

Universal transverse mercator conformal map projection. A special case of the transverse mercator projection. Abbreviated as the UTM grid, it consists of 60 north-south zones, each six degrees wide in longitude.

VDOP

Vertical dilution of precision. See Dilution of Precision.

Vernal Equinox

One of two dates per year when the equator and ecliptic intersect along the line between the earth and sun. On these days, the day and night are each 12 hours long everywhere on earth, hence the term equinox, or “equal nights”. The vernal equinox corresponds to the spring equinox in the Northern Hemisphere.