Longitude and Latitude

Mankind makes use of coordinate systems for position determination on the surface of the earth for a long time. In the western world, the equator, the tropics of cancer and Capricorn and then longitude and latitude were used to specify positions on earth. Easterly cartographers like Phei Hsiu used different orthogonal (right-angled) systems already 270 years A.D.

The units used for measuring angles and distances changed often during history but the “meter” is connected with the measurement of lengths and angles. In the late 18 th. Century, the meter was defined as one ten millionth of the distance between the poles and the equator.
Today, the most widely used coordinate system is longitude and latitude. The prime meridian and the equator are the reference planes for the definition of longitude and latitude.

Latitude

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| Earth with longitude and latitude circles  |

For the following thoughts, lets assume that Earth is a perfect sphere and on first glance it looks like being one. Earth revolves around its axis once every 24 hours. To be precise, this rotation does define the axis. Thinking more figurative and assuming a physical axis, this axis would pierce the earth in two points. These points are the North Pole and the South Pole. These to Poles must not be confused with the magnetic poles as these are significantly displaced from the turning axis. This fact troubled and still troubles mariners. Precisely between the two poles, the equator is located. It is aligned perpendicular to the earth’s axis. This first circle of latitude is the origin for counting the circles of latitude.

Starting at the equator, the angle is measured in degrees to the north and to the south from 0 to 90. Doing this, more circles of latitude are created and a Position on Earth can be determined as being on a circle around the earth. It is still impossible to say where exactly you are knowing only the altitude but you are somewhere on this circle. The determination of the latitude is achieved quite easy and mankind knows about this at least since the 15 th. century using the position of the Sun in the sky.

Also, on the northern hemisphere, the Polar Star directly indicates the latitude. Standing at the equator, the Polar Star is at the horizon in the north, being at the North Pole, the star is directly overhead. Early discoverers did not dare crossing the equator because they feared if loosing the Pole Star beneath the horizon they would become lost since this star was their main navigational help. The fact that the Pole Star is positioned almost perfectly in line with the earths axis is impressively seen on photographic time exposures where all stars become visible as circles except the Pole Star.

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| Photographic time exposure with the Pole star in the centre  |

Earth’s radius is 6370 kilometers and the circumference is about 40000 km. From this, the distance between two whole-numbered latitude circles calculates to about 111 km. One degree divides into 60 arc minutes and one arc minutes consists of 60 arc seconds. The distance of one arc minute on Earth’s surface is 1.85 km and like a coincidence this is exactly the distance of one nautical mile. Of course this did not happen by chance, the nautical mile was defined being one arc minute and this makes it more comfortable to measure distances in maps with a scale in longitudes and latitudes.

Except for the equator and the poles there are a couple more “important” latitude circles. There is the Polar Circles. These latitudes are at 66.55° (66° 33’) N and S. They mark the transition between the moderate climatic regions and the polar regions. They also mark the latitude where the sun does not set in summer and does not rise in winter. This is caused by the earth being tilted by 23.45° relative to the axis on its path through space.

The other two important latitudes are the tropics. The northern tropic, also called tropic of cancer is at 23.45° north (23° 27’). At this latitude, at noon on June 21 st. (more or less) the sun shines from exactly the zenith. This date is midsummer and the tropic is called tropic of cancer because long time ago, sun was found at the constellation of cancer at this time of the year.

On the northern hemisphere, at this time of the year, days are longest and nights are shortest. Being more northern than the polar circle, the sun does not set at least on this day. It may not set for a longer period of time, depending how far north you are. The tropic in the south, at 23.45° south is the tropic of Capricorn. Midwinter or the winter solstice is at December 21 st.

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| View of the Earth from space at summer solstice (left) and winter solstice (right)  |

By the way, it should be noticed that this tilt or inclination of the earth’s axis is not always the same. It changes very slowly.

| **Year** | **Inclination of the Earth's axis** |
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| 1900 | 23° 27' 8.2" |
| 1978  | 23° 26' 21.0" |
| 2000  | 23° 26' 32.0"  |

This inclination must not be confused with the precession of the Earth’s axis. The precession, this wobbling of the axis around the Pole of the ecliptic or path around the sun takes about 25700 years and is maybe at least partially responsible for repeating ice ages.

Longitude

In addition to the latitude circles, longitude circles or meridians are being added. They are circles being orthogonal to the equator and they cross both poles. Different to the latitude, where the equator is a natural origin, there is no start or end for the longitude circles. As a consequence, there was more than one prime meridian in the past. As shortly ago as in 1883, on an international geodetic conference in Rome , the prime meridian was set to go through Greenwich in England . One reason why Greenwich was chosen is, that as a consequence, the international date line runs through the Pacific.

This is convenient since there do not happen to live many people. Since the rotation of the Earth does not have a start and an end, it took a very long time for mankind to be able to determine the exact longitude of their position. This brilliant feat became only possible after invention of clocks that were very precisely for longer periods of time and even on sea. By determination of time the sun reached its maximum height in the sky at an unknown position compared to the time of noon at the prime meridian, a precise determination of the longitude position became possible.

Longitudes are count easterly and westerly from 0 to 180° starting at the prime meridian in Greenwich . Instead of adding letters of direction to the longitude and latitude positions like N and S, E and W, often negative values are used for the south and west positions.

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| Ursprung der Begriffe Länge(ngrad) und Breite(ngrad) (Map: Google Earth)  |

It should also be said that the origin of longitude and latitude is found in the Mediterranean sea. This is were modern seafaring and with it modern navigation has its origins. The longitude is derived from the length or longness of the Mediterranean sea whereas the latitude is from the width. Latter is less clear to see, but the word lateral for sideways is a good hint for were the wording comes from. Because the length of the Mediterranean sea spreads from east to west and the width from south to north, the length and width of this sea became the origin for naming the longitudes and latitudes.

Degree values used for directions

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| Directions (compass rose). The large divisions are stops of 22.5°, the small ones stops of 5°.  |

The unit degree is not only used for temperatures, longitudes and latitudes but also for directions. A direction of 0 (degrees) is North but contrarily to mathematicians, navigators do count clockwise to 360°. Doing this, 90° is to the East, 180° is to the South and 270° is to the West.

There are four main intermediate values with names like NE (45°) and eight more intermediate values between them and the main directions like WNW (292.5°). These intermediate directions are best known from wind directions.