COORDINATE SYSTEM USED IN GEODESY

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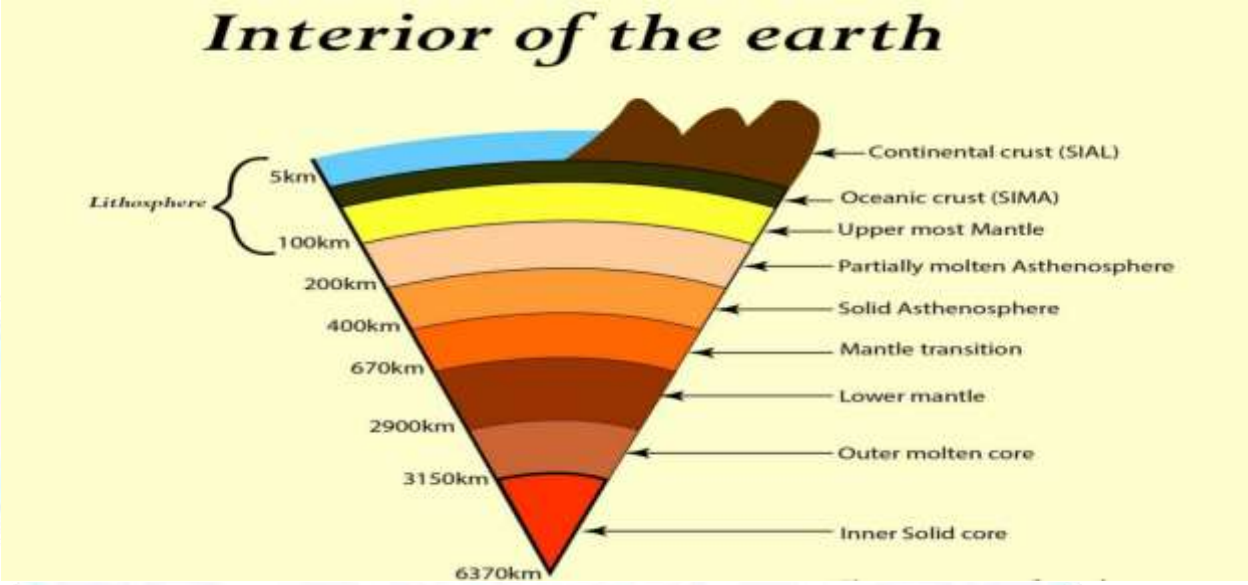
Abstract: This article provides information about the coordinate system used in geodesy nowadays, and it explains their advantages and disadvantages, as well as how they are divided when used in practice. It gives information about various types of coordinates used in geodesy, such as geographic astronomical, rectilinear, zonal rectilinear, geodetic coordinates, polar coordinates, and other types of coordinates.

Key words: Astronomical Latitude, Astronomical Longitude, Geodetic Coordinates, Geodesic Coordinates, Reference Ellipsoid, Latitude, Longitude, Ellipsoidal Height, Geodetic Datums,WGS84NAD83,Geographic Coordinate Systems, UTM (Universal Transverse Mercator), State Plane Coordinate Systems, GPS Positioning, Geodetic Control Networks, Cadastral Surveys, Geodetic Computations, Distance Calculations, Azimuth Calculations, Geodetic Transformations, Coordinate Transformations, Rectangular Coordinate System,Gauss Projection.Topographic Maps.

Аннотация:Эта статья содержит информацию о системе координат, используемой в геодезии в настоящее время, и объясняет их преимущества и недостатки, а также то, как они подразделяются при практическом использовании. В ней приводится информация о различных типах координат, используемых в геодезии, таких как географические астрономические, прямолинейные, зональные прямолинейные, геодезические координаты, полярные координаты и другие типы координат.

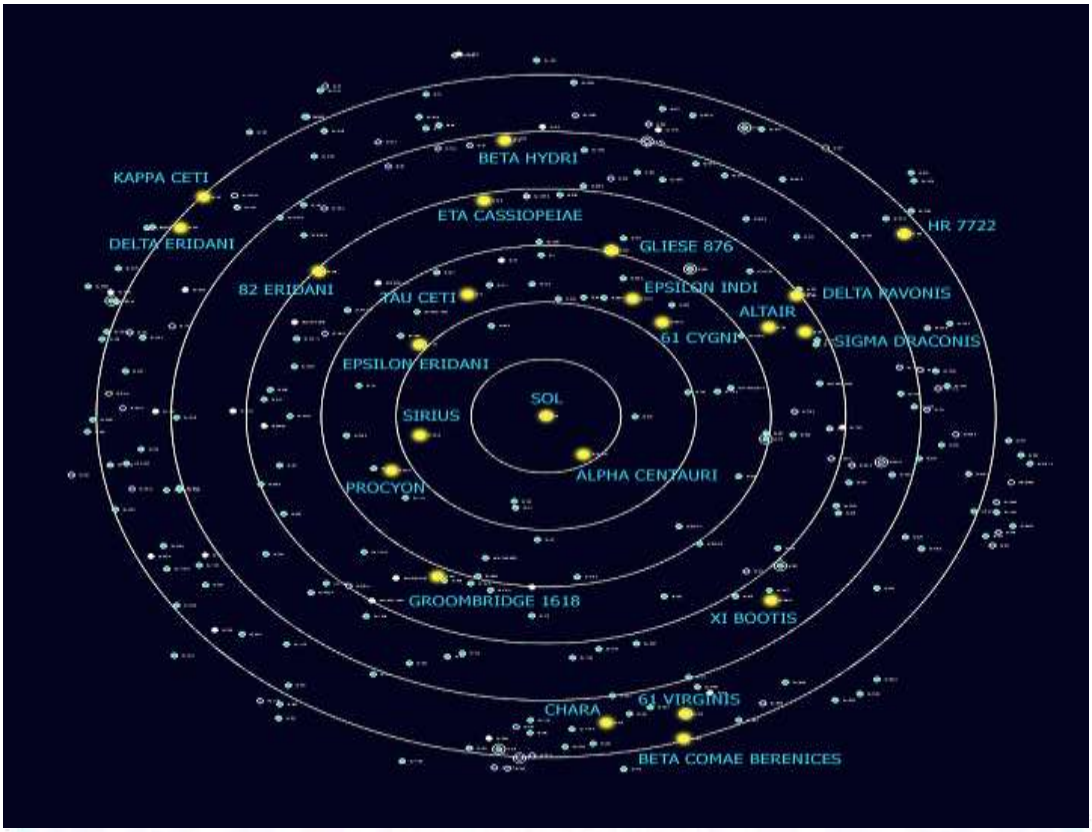
Ключевые слова:Астрономическая широта, Астрономическая долгота, Геодезические координаты, Геодезические координаты, Референц-эллипсоид, Широта, Долгота, Высота над эллипсоидом, Геодезические датумы, WGS84, NAD83, Географические системы координат, UTM (Универсальная поперечная проекция Меркатора), Системы координат штатных плоскостей, Позиционирование GPS, Геодезические контрольные сети, Кадастровые изыскания, Геодезические вычисления, Расчеты расстояний, Расчеты азимута, Геодезические преобразования, Преобразования координат, Прямоугольная система координат, Проекция Гаусса, Топографические карты,

The coordinate system used in geodesy consists of the following: geographical (astronomical coordinates), rectangular, zonal rectangular and polar. . Geographic coordinates are divided into two types - astronomical and geodetic coordinates. Geographical latitude is the angle formed between the plane of the equator and a vertical line drawn from a certain point on the earth's surface to the center of the earth. Angular latitude shows how far north or south a point on the Earth is from the equator. If the point is in the northern hemisphere, it is called northern, and if it is in the southern hemisphere, it is called southern. Points located at the equator have a width of 0, and those located at the poles have a width of 90. Geographical distance is the angle between the initial meridian plane and the meridian plane of a point on the globe.



Determining geographic latitude and longitude coordinates includes the starting meridian passing through the astronomical observatory in Greenwich (near London). The geographical distance of the points located west of the prime meridian is called the western distance, and the points located in the east are called the eastern distance.

Astronomical coordinates are coordinates determined by observing celestial bodies. Their accuracy will be very high. Astronomical coordinates consist of astronomical latitude (φ) and astronomical distance (λ).



Determination of astronomical coordinates

Astronomical latitude is the angle between the plane of a point's location and the plane of the equator, intersected by the center of Earth's gravitational force. This latitude is measured in degrees from **0° to 90°**, in an order from the equator towards the poles. Latitudes north of the equator are called **northern latitude**, and those to the south are called **southern latitude**.

Astronomical longitude is the angle between the meridian plane of a point's location and the plane of the Greenwich meridian. This measure is taken in degrees from **0° to 180°**, in an order from the Greenwich meridian towards the east and west. Longitudes east of the Greenwich meridian are called **eastern longitude**, and those to the west are called **western longitude**.

Geodetic coordinates are the coordinates of a location determined by geodetic measurements. They are known for their high accuracy.

Geodesic coordinates are defined with respect to a reference ellipsoid that closely approximates the Earth's shape. They consist of three primary components: latitude (φ), longitude (λ), and ellipsoidal height (h). Latitude measures the angle between the equatorial plane and a line perpendicular to the reference ellipsoid's surface at a given point. Longitude represents the angle between the Prime Meridian and a meridian passing through the point. Ellipsoidal height denotes the perpendicular distance from the point to the reference ellipsoid's surface along the normal

Geodesic coordinates are typically defined within specific geodetic datums and coordinate systems, which provide standardized reference frames for spatial measurements and computations. Common geodetic datums include WGS84 (World Geodetic System 1984) and NAD83 (North American Datum 1983), each characterized by a reference ellipsoid and a set of parameters defining its orientation and scale. Coordinate systems such as geographic, UTM (Universal Transverse Mercator), and state plane coordinate systems are widely used for various applications, each tailored to specific regions and purposes.

Geodesic coordinates find extensive applications in geospatial sciences and engineering disciplines. In navigation and surveying, they serve as the basis for GPS positioning, geodetic control networks, and cadastral surveys, enabling accurate location determination and spatial referencing. Geodesic coordinates also facilitate geodetic computations, including distance and azimuth calculations, geodetic transformations, and coordinate transformations between different reference frames.

Geodetic coordinates consist of geodetic latitude (B) and geodetic longitude (L). **Geodetic latitude** is the angle between the plane of a point's location and the plane of the equator. This latitude is measured in degrees from **0° to 90°**, in an order from the equator towards the poles. Latitudes north of the equator are called **northern latitude**, and those to the south are called **southern latitude**.

Geodetic longitude is the angle between the meridian plane of a point's location and the plane of the prime meridian. This measure is taken in degrees from **0° to 180°**, in an order from the prime meridian towards the east and west. Longitudes east of the prime meridian are called **eastern longitude**, and those to the west are called **western longitude**.

The difference between astronomical and geodetic coordinates is as follows: the determination of a point's astronomical coordinates is based on the plumb line directed towards the center of Earth's gravitational force. The equator and the Greenwich meridian planes intersect the center of Earth's gravitational force as a necessary condition;

Geodetic coordinates are measured based on the reference ellipsoid, which has been accepted as the basis for all geodetic measurements. The reference ellipsoid has its own geometric center. A normal (plumb line) is dropped from the point's location to this center. The equator and the Greenwich meridian planes intersect the geometric center of the reference ellipsoid;

- Astronomical coordinates are determined by measurement with the help of astronomical instruments;
- Geodetic coordinates are calculated based on the formulas of spheroid geodesy, a branch of higher geodesy. Thus, the main difference between the two

coordinate systems arises from the non-coincidence of the plumb line and the normal. Their average difference is about 3-4 mm.

The rectangular coordinate system is used for mapping small areas. In this system, the abscissa axis is accepted as the meridian direction, labeled as X, with positive values towards the east and negative values towards the west from the axis. The ordinate axis U, perpendicular to the X axis, follows the equator direction, with abscissa values… (Note: The user's message was cut off, so the translation is incomplete.

Components of Polar Coordinates: In polar coordinates, a point P is specified by its radial distance (r) from the origin and the angle (θ) formed between the polar axis and the line segment connecting the origin to point P. The radial distance r is typically measured in units such as meters or feet, while the angle θ is measured in radians or degrees, depending on the convention used.

Conversion from Cartesian Coordinates: Polar coordinates can be converted from Cartesian coordinates (x, y) using the following relationships: r=x2+y2r=x2+y2 θ=arctan⁡yxθ=arctanxy where r is the radial distance, θ is the angle in radians, and (x, y) are the Cartesian coordinates of the point.

Applications of Polar Coordinates: Polar coordinates find widespread applications in various scientific and engineering disciplines. In physics, they are used to describe the motion of objects in circular or rotational systems, such as celestial bodies orbiting around a central mass. In engineering, polar coordinates are employed in the analysis and design of mechanical systems with rotational components, such as gears and turbines. Additionally, polar coordinates are utilized in mathematics for solving problems involving symmetry, integration, and curve fitting

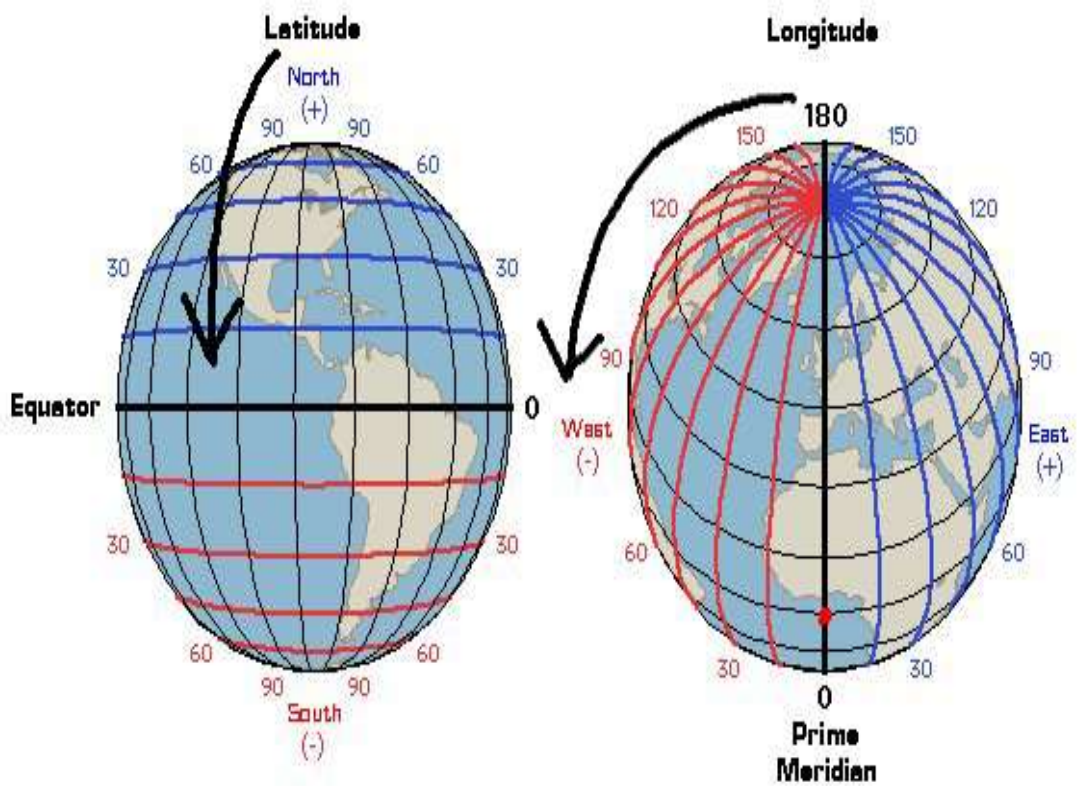
Polar Coordinate System: If only the X-axis and the origin point O are taken from the perpendicular X and Y axes in the right-angled coordinate system, the polar coordinate system is formed. In the polar coordinate system, the straight line (o R) is the polar axis, and the starting point of the coordinate (o) is accepted as the polar point. To determine the position of a point (M) relative to the polar point, the length of the line connecting this point to the polar point (o M) and the angle (θ) between the polar axis (o R) and the line oM are measured. The line oM is called the radius vector, and the angle θ is called the azimuth angle.

Bipolar Coordinate System: The bipolar coordinate system is used for determining targets with observation points connected to sound devices, radio-technical observations, and for identifying the boundaries of mined areas. In the bipolar coordinate system, the position of a point (M) relative to two points (M and A) can be determined by the lengths of the lines (AM and VM) from the polar points (A and V)

to the point being located, or by the angles (θ1 and θ2) or the angles (α1 and α2) between the line AV and the lines AM and VM (illustrated in figure 4).

Zonal Rectangular Coordinate System: To represent the Earth's surface on a plane, one first transitions from the natural shape of the Earth to its mathematical shape, accepted as the rotating ellipsoid or sphere surface, and then the mathematical surface of the Earth is represented on a plane. The Gauss projection is used to establish a relationship between the points on the Earth's surface with their geographic coordinates and their representation in the plane with right-angled coordinates. This system is often used to represent the Earth's surface on topographic maps. Here, the Earth ellipsoid is divided into zones of 60 or 30 degrees starting from the Greenwich meridian. The zones are projected onto the cylindrical surface along the meridians and spread out on the plane.

Please note that the technical terms and their applications are translated to the best of my ability based on the context provided. For complex technical documents, consulting a professional translator or subject matter expert is recommended for accuracy.



coordineted zones of the earth

Foundations of Geographic Coordinates: Geographic coordinates consist of two components: latitude and longitude. Latitude measures angular distance north or south of the Equator, ranging from 0° at the Equator to 90° at the poles. Longitude

denotes angular distance east or west of the Prime Meridian, with values spanning from 0° to 180° in both eastern and western hemispheres. Together, latitude and longitude provide a coordinate system that uniquely identifies any point on the Earth's surface.

Historical Evolution: The concept of geographic coordinates traces its roots to ancient civilizations, where celestial observations and rudimentary mapping techniques were employed for navigation and exploration. Over time, advancements in astronomy, mathematics, and cartography refined the understanding and application of geographic coordinates. The adoption of standardized meridians and parallels, culminating in the establishment of the Prime Meridian at Greenwich in the 19th century, solidified the modern framework of geographic referencing.

Applications across Disciplines: Geographic coordinates find widespread application in diverse fields. In cartography, they form the basis for map projections and spatial visualization, allowing cartographers to represent Earth's curved surface on two-dimensional maps accurately. In navigation, geographic coordinates facilitate route planning, vessel tracking, and GPS navigation systems, enhancing safety and efficiency in transportation. Furthermore, geographic coordinates support environmental monitoring, resource management, and disaster response efforts by providing precise location data for analysis and decision-making.

Conclusion: All types of coordinate system are very important in terms of importance and are very different from each other according to the purpose of use, and in the current development of mankind, all types of coordinate system have a great role, according to the above information, not only in the field of geodesy coordinates are also very necessary in other fields. Currently, three coordinate systems and other coordinate systems are widely used, and we think that this solves the problems that are used in human society not only in navigation, but also in all other fields and need to find a solution.

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