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Review Article

The "Flat Earth" Belief: The Scientific Evidence of its Inconsistency. A Narrative Review

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Abstract

The belief in a "flat Earth" has ancient roots and remained unchanged for several millennia, albeit with some differences in popular narrative tradition. With the flourishing of the scientific method in the fifteenth and sixteenth centuries AD, this belief increasingly lost ground, being labeled exclusively as a popular belief. Few articles in the scientific literature address this topic, and all equally confirm this conclusion. However, even today, starting in the twentieth century, thousands of people have returned to disbelief in anti-scientific theories, which underline conspiracy and religious sectarian movements and groups, consistent with subversive critical thinking. This narrative review analyzes the main tenets of this "false" belief and the scientific positions that refute it, to conclusively demonstrate its scientific and technical inconsistency.

The belief in the "Flat Earth" in ancient history

The "Flat Earth" is a belief about the shape of the Earth as a flat disk [1] or other similar figure [2], with features of the pattern varying according to time, place and author [3], but basically about the original conception found in Mesopotamian and Judeo-Christian cosmology, in which the inhabited world was believed to be a huge flat disk surrounded by the ocean [4]; same conceptualization also influenced the thinking of several literary and scientific exponents of Ancient Greece, such as Homer, Hesiod, Anaximander and Hecataeus of Miletus, although the idea was more articulated, with an ocean capable of supporting the earth's plane then resting in turn on several columns [5]. Even in Ancient China, the main belief for millennia was that the Earth was flat and square and the heavens were a sphere encircling it, with China at the center (a hypothesis, by the way, not questioned until the 17th century), while in Ancient India traditions said that the Earth was composed of four continents arranged like the petals of a flower around a central mountain (Mount Meru) and the whole surrounded by a great ocean [6]. Finally, similar concepts also appear in Iranian sources, such as the Bundaishn [7].

The concept of sphericity of the Earth in modern scientific thought

The sphericity of the Earth was first proposed in the 6th-5th centuries B.C. by Pythagoras, a disciple of Anaximander, or by Parmenides, a philosopher who lived a few decades after Pythagoras, but the idea did not meet with favor among the atomists Leucippus and Democritus, who rejected it as superstition or fantasy, since according to their idea atoms proceeded limitlessly in a vacuum and therefore the whole universe needed neither a support as in archaic cosmographies nor a spherical symmetry rendering the support itself useless, as reiterated by Aristotle [8]. The first real conception of a spherical Earth arose in Greece during classical antiquity, based on the observation that the height above the horizon of the stars measured in Greece was systematically lower than that measured by Babylonian and Egyptian astronomers. The first to propose the concept of sphericity was Pythagoras, who in the 6th century B.C.E., based on aesthetic canons and the observation of the sphericity of other celestial bodies [9], while Parmenides in the 3rd century B.C.E., according to some posthumous authors, was the true father of the theory, since a

geocentric system with a spherical Earth resulted in an isotropic scheme that made the hypothesis of a medium supporting it in space unnecessary and therefore the theory stood on its own without further specification [10]. Sphericity became a notion acquired by both Plato and Aristotle, although for Plato the most correct geometrical hypothesis was the dodecahedron [11], while for Aristotle it was the sphere, starting with some critical observations, such as that travelers going south would see the southern constellations rise higher than the horizon, and this was only possible if the horizon of those furthest south formed a certain angle with the horizon of those furthest north (thus concluding that the Earth's surface could not be flat) [12]; he also noted that the edge of the Earth's shadow on the Moon during the partial phase of a lunar eclipse was always circular, and it did not matter how high the Moon was above the horizon: this led to the realization that only a sphere always casts a circular shadow in all directions, while a disk casts an elliptical shadow in most directions, and therefore the Moon had to be spherical and, by similarity, the Earth as well [13]. Also in the third century BCE, Archimedes proved the sphericity of the oceans and indirectly the sphericity of the entire planet [14]. Eratosthenes used spherical coordinates to represent points on the Earth's surface to measure the circumference of the Earth to a good degree of approximation [15]. He knew that in Aswan of Egypt, on the day of the summer solstice, the Sun was at the zenith and the rays were vertical, while in Alexandria of Egypt they formed an angle of $1/50^{\text{th}}$ of a revolution (since sexagesimal degrees had not yet been officially introduced), corresponding to today's 7.2 sexagesimal degrees: one degree corresponded to 700 stadia, resulting in a circumference of 252,000 stadia [16]. Strabo, in the first century A.D., asserted that the spherical shape of the Earth was probably known to mariners throughout the Mediterranean Sea at least from the time of the poet Homer. He cited various phenomena observed at sea to suggest that the Earth was spherical; in particular, he observed that lights and highlands were visible to mariners at greater distances than at less elevated ones, stating that the cause of this was obviously the curvature of the sea [17]. In the second century B.C., however, the astronomer Tolomeus of Alexandria advanced many arguments in favor of the sphericity of the Earth, starting with the observation that when navigating to the mountains they appeared as if they were emerging from the water, thus assuming the curved surface of the sea; on this basis he drew his maps considering the Earth to be spherical and developing the system of latitude and longitude, still used today [18]. In late antiquity, the period when Christian theology was formed, knowledge of the earth's sphericity was well established, albeit with the presence of minorities who still debated the issue of a flat earth and the presence of life at the earth's poles [19]. Even in the Middle Ages, the belief that the Earth was spherical was not abandoned, and during the 19th century, the conception of the Middle Ages as a "dark age" gave much more prominence to the flat Earth model than it had historically [20]. Several Islamic authors also contributed evidence for the sphericity of the Earth, from the astronomers of Caliph Al-Ma'mūn during the eighth century CE, going so far as to calculate the Earth's circumference to a good approximation to the astronomers Al-Farghānī and Abu Rayhan Biruni who went so far as to estimate the Earth's diameter and radius, respectively, again to a fair mathematical approximation [21].

The alleged "real" shape of the earth

Geodesy is the discipline concerned with the measurement and representation of the Earth, its gravitational field, and geodynamic phenomena (polar motion, Earth's tides, and crustal motion), in three-dimensional space as time changes. It mainly concerns positioning and the gravity field, and the geometric aspects of their variations over time, but it also involves the study of the Earth's magnetic field. The shape of the Earth can be considered in at least two ways: as the shape of the geoid (in relation to the mean level of the oceans) and as the shape of the land surface of our planet (including that at the bottom of the sea). With increasingly accurate measurements by geodesy, it was first discovered that the shape of the geoid was not a perfect sphere but roughly an oblate spheroid, a specific type of ellipsoid. Spherical harmonics are often used to approximate the shape of the geoid/ellipsoid (Figure 1). The best set of best coefficients for spherical harmonics is EGM96, determined in the NIMA-led international collaborative project [22]. This form is determined by a proven experimental mathematical model shared by the scientific community, which at present represents the best hypothesis for analysis.

The return of the flat-earth belief

The common belief that, before the age of exploration, people believed that the Earth was flat entered the popular collective imagination with the nonfiction publication in 1828 Washington Irving that contained an erroneous reference to Christopher Columbus and the non-sphericity of the Earth, as disproved instead by the writings of several authors of the Early and Late Middle Ages, who held the majority thesis on sphericity, based on both the study of Arabic astronomy and the scientific contaminations of the European Renaissance. Reinhard Krüger, a professor of Romance literatures at the University of Stuttgart, Germany, later confirmed this thesis by pointing to more than one hundred authors between Late Antiquity and 1492, all of whom believed that the Earth was spherical [23]. The belief that the Earth was flat was eventually "rediscovered" and propagated systematically by Samuel Rowbotham (1816–1884), a self-taught Englishman who wrote under the pseudonym "Parallax", beginning in 1849 with writings related to some of his measurement experiments about the curvature of the surface of various lakes, and then demonstrated the Earth's non-sphericity. He also attempted, using perspective techniques, to explain why ships disappeared over the horizon before their mast [24]. Upon Rowbotham's death, the theme was taken up and recalled by William Carpenter (1830–1896), who wrote an essay on the hundred proofs that the Earth was not spherical, without any scientific substantiation [25]. This essay, however, aroused curiosity and interest in some representatives of biblical liberalism in the Universal Zetetic Society, such as the Protestant theologian Ethelbert William Bullinger and other evangelical clergymen, to such an extent that as early as 1898 it became into a full-fledged cultural movement and inspired other, more modern, organizations such as the Flat Earth Society, which also proposed a world map (Figure 2) based on the theory of the flat earth and equidistant azimuthal projection [26].

The evidence supporting the soundness of the “flat earth” belief and the scientific evidence disproving it

Evidence disproving the existence of a flat Earth is in the public domain, and the scientific community labels this belief as myth, superstition, or conspiracy, in relation to the associated movements or organizations that have been particularly depopulating in the last two decades, thanks in part to the global spread of the Web [27]. Yet, despite this

robust approach, thousands of people around the world still believe this belief, due to a number of cognitive distortions that facilitate it, such as the interpretative fideism of sacred scriptures (which in the literal tenor hint precisely at the flat shape of the Earth) or to personal theories tailor-made to their own religious or mystery beliefs, such as the rejection or lack of understanding of certain truths imposed by Science or Social Reason, according to a conspiracy logic (which uses preordained patterns, connects people and events randomly, there is widespread delusional or paranoid behavior in the

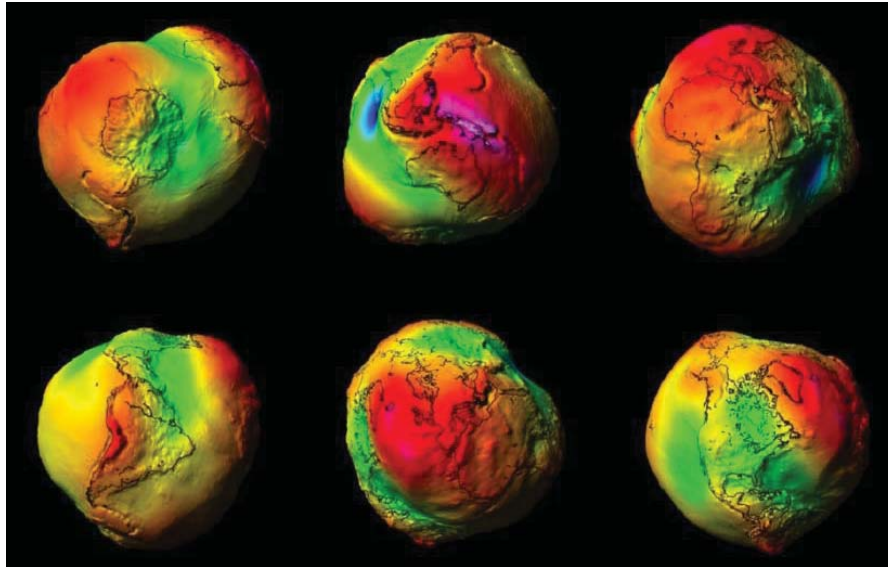


Figure 1: To represent the Earth "mathematically", geodesy tries to identify which geometric solid is most similar to the real shape of the Earth, so that it can be used in calculations on the Earth's surface. Each geometric solid has a respective formula to calculate its volume and surface area, but the Earth, on the other hand, has a shape that is too complex to be defined mathematically, so it is necessary to approximate it to a geometric solid, so that its dimensions can be calculated mathematically and the exact position of points on its surface can be determined; furthermore, the surface of the Earth is not perfectly smooth, but there are mountains and ocean depressions. The shape of the Earth is therefore unique and very irregular, and for this reason, the solid that best represents it is called a geoid; however, the geoid is very difficult to define mathematically, and there is no mathematical formula that defines its characteristics. Therefore, although very accurate, the geoid is too complex, and the shape of the Earth is represented by another solid: the rotation ellipsoid. Although the geoid is more similar to the real shape of the Earth, the rotation ellipsoid is often used to describe the Earth's shape because it is much simpler to define and approximates the shape of the Earth better than the sphere, as it takes into account the flattening at the poles and the bulging of the equator: the reference ellipse is the one with the equatorial semi-axis longer than the polar one. In fact, being simpler to define, it is possible to use the ellipsoid to make calculations and measurements of our planet. Source: <https://www.geopop.it/qual-e-la-vera-forma-della-terra-dalle-ellissoide-di-rotazione-al-geoide/>.

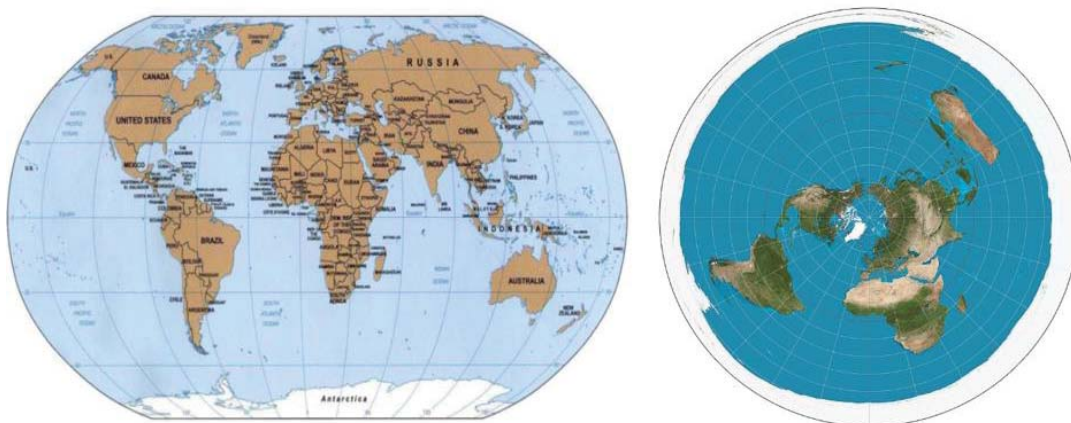


Figure 2: On the left side is the image representing the Terrestrial planisphere. Source: scuoladigitale.armandocurcio editore.it/la-rappresentazione-della-terra/. On the right side is the image representing the proposed flat earth of the Flat Earth map, based on the azimuth equidistant projection. Source: scientificamerican.com/article/the-most-accurate-flat-map-of-earth-yet/.

relevant community, and the intent of the "strong powers" is always negative), or again as the need to reframe reality according to an interpretive logic closer to one's own vision, anchoring one's belief in allegedly dissonant elements (in fact, the flat Earth belief stems as much from a lack of knowledge of physical laws and Science in general as from a marked deficiency or deficiency of the critical and judgmental faculty, in a personality that nevertheless has psychotic tendencies of the paranoid-delusional type not necessarily structured in an overt personality disorder) [28]. Just to dispel any doubts, the following are several cornerstones of Flat Earth thinking, and the scientific evidence to support the alternative viewpoint [28] (Table 1). Below is a schematization related to Table 1 (Table 2).

Conclusion

The cultural phenomenon related to the belief of the "Flat Earth", although it has ancient origins and has already been debunked for over two thousand years, persists today and there are movements and organizations that bring this alternative viewpoint back into vogue, which the Scientific Community strongly rejects, in relation to existing evidence, such as the use of mathematical models, empirical evidence determined by space missions, video-photographic evidence from Outer Space, and existing physical laws shared by the community. This review analyzes all the cornerstones of this "false" belief and the scientific positions that refute it, to conclusively demonstrate its scientific-technical inconsistency.

Table 1: List of the cornerstones of "Flat Earth" thinking and respective evidence to support the alternative viewpoint. Source: [15,24,25,28].

1	Elements of the "Flat Earth" belief	A wall of ice around the Earth's circumference
1	Element content	The North Pole is the center of the world, and the South Pole is a boundary line that surrounds and demarcates all known lands. Surrounding the circular Earth is an ice mountain range 400 km high and 72,000 km long. The flat Earth model is described as a fixed circular plane (in cartography, this projection is known as an equidistant azimuth projection) and sees the North Pole as the center of the Earth and the Antarctic Continent as an impassable boundary around it. A dome rises from the Antarctic ice, and the sky rotates concentrically around the North Pole star at its apex. The Sun and Moon become two celestial bodies of the same size (about 50 km in diameter) and rotate in circular orbits inside the dome.
	Scientific refutation	<p>The first direct evidence that the Earth is a real sphere was the circumnavigation of the globe by Ferdinand Magellan (1480-1521) between 1519 and 1522. Today, it is possible to circumnavigate the Earth by returning to the starting point without changing the angle of the horizontal orbit. Modern navigation assumes that the Earth is a sphere, and the fact that ships can be precisely positioned this way for more than a century means that the assumption is correct. The International Space Station also circumnavigates the Earth 15.5 times a day. Physics predicts that a sufficiently large and compact object (such as Earth) is spherical. All objects above a certain mass observed by telescopes are indeed spherical (they elongate at the equator if they rotate at a certain speed, another effect that physics explains). From the Moon (whose spherical shape is visible to the naked eye) to the planets, from the largest asteroid in the solar system to its moons and stars (whose shapes are now visible with sophisticated interferometric techniques), everything is spherical, just like the Earth, exactly as predicted by physics. The Earth rotates counterclockwise around its axis of rotation at a speed of 1,670 km/h at the equator. This rotation generates a centrifugal force perpendicular to the Earth's axis and directed toward space. This centrifugal force depends on the linear speed of rotation, which varies with latitude while the angular velocity remains constant, so that it is zero at the poles and maximum at the equator. The centrifugal force (F) is directly proportional to the mass (m), the square of the angular velocity (ω), and the distance from the axis of rotation (R):</p> $F = m\omega^2 R$ <p>Centrifugal forces reduce the effect of gravity on bodies directed toward the center of the Earth, moving their mass away from the axis of rotation and reducing their weight. Due to this force, the Earth flattens at the poles and expands at the equator, taking the shape of a flattened sphere or rotating ellipse. This is the solid obtained by rotating the ellipse 180° around its minor axis (the polar axis), whose semi-axis is the size of the Earth's semi-axis, and is the closest geometric solid to the true shape of the Earth. The shape and dimensions of an ellipsoid are defined if the length of the major semi-axis (a) and the flattening ratio, that is, the ratio of the difference between the two semi-axes to the major semi-axis, are known. Ocean ships gradually disappear behind the curvature of the Earth, which hides first the hull and then the top of the ship. This clearly shows that the ocean is convex along the gravitational isopotential surface of the Earth (which is precisely spherical). On a flat surface, nothing would prevent the observer from seeing distant landscapes. A spherical surface, on the other hand, has a horizon whose height depends essentially on the height of the observer. In theory, in the absence of obstacles, a person of average height can see 5 km ahead, while the same person standing atop the Eiffel Tower (273 meters) can see about 11 times that distance, depending on the weather.</p>
2	Elements of the "Flat Earth" belief	Earth curvature
	Element content	The curvature of the Earth does not exist. In the flat Earth paradigm, everything that disappears is due to the narrowness of the human eye, and optical zoom can "save" what sight cannot reach. This approach stems from the fact that the Earth has a flat surface and that the laws of atmospheric refraction and those of temperature change are wrong, since the difference in shadows is not due to the sphericity of the Earth but to the distance of about 5,000 km between the Earth and the Sun. Other evidence in support of the absence of curvature is the fact that technical architects and engineers have never considered that the Earth was curved in their designs, as is also the case with canals, railways, bridges, and tunnels, many miles long, where no curvature can be detected.
3	Scientific refutation	Since electromagnetic waves travel in a straight line, it should be possible to transmit images across continents and oceans if the Earth is flat. Since the curvature of the Earth prevents this phenomenon from occurring, it was first realized by the Telstar satellite in 1962. When approaching the coast, only the highlands are visible first, then the structures near the sea, and finally the sandy beaches. As altitude increases, the horizon drops (literally below eye level). From the mountain peaks, it is possible to photograph stars that cannot be seen at sea level.
	Elements of the "Flat Earth" belief	Gravity
	Element content	Gravity does not exist, and the concept of gravity was created solely to justify the sphericity of the Earth. The concept of gravity is replaced with that of density, whereby objects denser than air tend to move downward and objects less dense than air tend to move upward. Another proof of the nonexistence of gravity is that water does not bend, since the existence of a force large enough to chain together huge bodies of water, such as oceans, is denied, and the only logical explanation for huge bodies of water is a flat model. If the Earth were a sphere, the plane would have to follow a curved trajectory with the nose down to follow the curvature of the Earth. In addition, because of the Earth's rotational speed, a plane traveling from west to east would not have time to reach its destination before encountering a target coming from the west.

	Scientific refutation	In the spherical Earth model, gravity acts radially. This means that gravity attracts everything toward the center of the Earth. This means that all objects on the Earth's surface are attracted toward the center of the Earth. This force "glues" us to the ground, regardless of our position. Wherever we are, at the equator or at the poles, gravity acts uniformly toward the Earth's center of mass. Earth's spherical shape is a natural consequence of gravitational influence on a cosmic scale. Gravity tends to "flatten" matter and distribute it evenly in all directions. When celestial bodies are formed, particles are attracted toward the center of gravity (the center of the celestial body), but since the center of gravity has no preferred direction, matter is distributed spherically in equilibrium. This is why planets, stars, and celestial bodies are spherical (or, in the case of Earth, nearly spherical, since its poles are slightly flattened by rotation). The weight of an object does not change much from one place to another because of the force of gravity. In fact, gravity acts equally on the entire globe with respect to the radius of the sphere. This means that the directions of the vertical rays at different points on the Earth's surface are not parallel, as in a flat Earth, but converge at the center of the Earth.
4	Elements of the "Flat Earth" belief	Earth rotation
	Element content	Earth's rotation does not exist, and the phenomenon is described as another artifact invented to support the idea that the Earth is a sphere. A gyroscope is a device consisting of an axis around which a rotor rotates; the axis is connected to a movable circular support with orthogonal rotation that allows the gyroscope to move in three directions in space. Using the law of conservation of angular momentum and imparting a rotary motion to the rotor, it was observed that the axis always points in the same direction, even as the gyroscope moves through space. Thus, in a day, it is possible to observe a gyroscope rotating about an axis parallel to the Earth's axis. So, the Sun and Moon have two movements: one around the disk, which for the Moon is 24 h 50' 28", while the Sun makes a 24-hour lap around the Earth's disk simultaneously every day. Both move a few grades each day, following the parallels in a motion that combined describes a double spiral (going toward the North Pole and returning toward the edge of the disk). The sun describes an analemma in the sky throughout the year.
	Scientific refutation	<p>Large-scale atmospheric circulation, rich in phenomena such as jet streams, cyclones, and anticyclones, is determined by two main factors: The Sun's energy and the Earth's rotation. The latter causes unique deflections (Ferrell's law, Coriolis force) in all air masses moving in the N-S direction. This is recognizable, for example, in the characteristic counterclockwise spiral motion of cyclones in our hemisphere. The frequency of shooting stars. In complete darkness, we might see a certain number of meteors in the sky every night. If we take an interest in this phenomenon, we will find that, apart from the high meteor days associated with meteor showers, we see more shooting stars at the end of the night than at the beginning. What is the reason for this phenomenon? It is the occasional "wind" of meteors before sunrise, due to the Earth's rotation, which allows us to see the point at which the Earth rotates around the Sun and moves through space, as if we are "on the bow" to catch more meteor showers. Simultaneous evidence of the sphericity, rotation, and orbit of the Earth around the Sun. When we are in an unobstructed space, we realize that our gaze always covers the circular surface. This is called the visual or sensory horizon and is part of the surface that the observer sees. The apparent horizon, or horizon, is called the plane tangent to the earth's surface at the point where the observer is standing. The astronomical horizon, on the other hand, is the plane that passes through the center of the Earth and is parallel to the visible horizon. As the altitude increases and the observation point is an airplane or satellite, the horizon becomes wider and wider, is the radius and h is the height above mean sea level. Refraction due to layers of different densities in the atmosphere will cause the horizon to be wider than mathematically predicted.</p> $r_{(km)} = 3,57 \cdot \sqrt{h_{(m)}}$ <p>Foucault's pendulum experiment is a demonstration of the rotation of the Earth: an oscillating pendulum changes direction due to the rotation of the Earth, a phenomenon that does not occur on a flat surface. The rotation of the pendulum is an act of inertia, not force. Even though the planet is rotating, the pendulum is mostly loose, so there is very little friction, which causes a "lag" in rotation and a tendency to try to maintain the original position, which causes this lateral movement of the pendulum. Only at the North Pole and South Pole does the period of rotation of the pendulum correspond to one day, and it swings clockwise at the North Pole and counterclockwise at the South Pole. At the equator, there is no effect. Knowing this effect, we can determine the latitude of our position on the Earth's sphere".</p>
5	Elements of the "Flat Earth" belief	Alternation of seasons
	Element content	The model in which the Sun moves with the same circular motion all year round cannot explain the changing seasons, and therefore a theory has been proposed in which the radius of the circumference traced by the Sun is not constant but varies throughout the year, with a minimum at the Tropic of Cancer and a maximum at the Tropic of Cancer. This theory is also used to refute the global model, since it is believed that the hottest season in the northern hemisphere cannot occur at the time of maximum distance from the sun (summer solstice). The seasons would be due to the spiral movement of the Sun from north to south in the limits of the two tropics (Tropic of Cancer and Tropic of Capricorn). The Sun would be closest to the North Pole in June, while in the next six months it would move outward toward the ice sheet. In December, it would move back inward toward the Earth's disk and thus toward the North Pole. During the spring and fall equinoxes, the Sun would turn in a perfect circular path around the equator, casting light on half of the flat world at any given time. Of course, it is implied that in its movement toward the edge of the disk, the Sun should increase its speed, while it should decrease its speed as it approaches the North Pole, so that it always maintains the same speed and travels the entire circle of the disk in 24 h.
	Scientific refutation	The alternation of seasons is attributable to the tilt of the Earth's axis, which causes the Earth to receive different amounts of solar radiation at different times of the year. The tilt also causes that during the Earth's revolution around the Sun, the hemispheres face away from or toward the Sun, so that the seasons are mirrored between the two hemispheres. The Earth's inclination of 23.5° with respect to the elliptical plane (the imaginary surface formed by its nearly circular path around the Sun) implies, for example, that the northern hemisphere faces the Sun with maximized inclination at the end of June (the summer solstice). At that time, the amount of sunlight reaching the Northern Hemisphere was at its maximum. Conversely, at the end of December, the day of the winter solstice, the Earth's tilt away from the Sun is maximum, bringing the amount of sunlight reaching the northern hemisphere to a minimum. The seasons, of course, are reversed in the southern hemisphere.
6	Elements of the "Flat Earth" belief	Moon
	Element content	The Moon and the Sun are the same size, "visible to the naked eye". This phenomenon is explained by the synchrony of rotation and revolution around the Earth, which is also found in the moons of all the planets in the solar system and is attributed to the strong gravitational pull of the planets toward the Moon, which has a much smaller mass. Another assumption used to refute the spherical model is the claim that it is impossible to see the Moon at two antipodal points at the same time. This is possible under certain light conditions and at certain times of day. Not only is the Moon clearly self-luminescent (because it is made of phosphorescent material and is charged by the Sun when it passes near it) and shines its own light, but it is also mostly transparent. In fact, when the waning or crescent Moon is visible during the day, it is possible to see the blue sky directly through the Moon. And on a clear night, during a waning or rising cycle, it is even possible to see stars and "planets" through the lunar surface.

	<i>Scientific refutation</i>	A lunar eclipse occurs at any time of day, that is, at any angle of rotation of the Earth, and since the outline of the shadow is always an arc of a circle, it can be concluded that the object casting the shadow, the Earth, is spherical. Identical objects at different latitudes cast shadows at different angles at the same time. If the Earth were flat, the angles would be equal. The rays passing tangent to points on the curved surface are the higher above the ground, the farther away they are. Although they are slightly bent due to refraction by the atmosphere, there is a distance known as the distance to the surface. This would not happen if the surface were flat. By looking at the Moon with a telescope and observing the shadows of the craters on the lunar surface, we can tell where the light that illuminates it comes from. This shows that the Moon cannot shine with its own light (not even be phosphorescent). Also, from the southern hemisphere, we can see the Moon upside down compared to the northern hemisphere.
7	<i>Elements of the "Flat Earth" belief</i>	Sun
	<i>Element content</i>	The Sun's motion is also circular and follows the same orbit as the Moon. Sunrise and sunset are nothing more than the appearance of the Sun above and below the horizon. The timing of the two solstices should be reversed in the spherical model (midnight in winter should coincide with noon in summer); flat models, on the other hand, are designed to avoid this problem and to roughly match perceived reality. Therefore, the explanation that the Earth's rotation of 361° per day compensates for the 180° needed for day and night not to change is to be rejected. If so, the Earth's axis would be parallel to the two solstices, making it impossible to point to Polaris in either case. It would then be impossible to calculate its parallax, ignoring the fact that Polaris is by definition "nearly aligned" with the Earth's axis and is 325 light-years from the Sun. The eclipse of the Sun, on the other hand, would occur since the Sun and the Moon would not be in the same plane of rotation, but the Moon would be slightly closer to the Earth on certain occasions, so there would be an eclipse of the Sun, that is, when the Moon is in alignment with the Sun. The Sun would not rise and set on the horizon but would shine like a beacon moving in a spiral throughout the day around the North Pole. So, what we perceive as sunrise and sunset would only be an effect of perspective. According to terraplatters, when the Sun sets, it would gradually shrink in our eyes and thus disappear from the horizon only because it has moved too far out of our field of view, whereas when it rises, the Sun would enter our field of view and then begin to enlarge, due to a perspective effect, as it gets closer to us. Refraction due to the atmosphere would produce the effect of the Sun "diving" into the sea at sunset.
	<i>Scientific refutation</i>	At sunrise and sunset, the sun can illuminate the clouds from below. This is because the sun is already above the horizon when seen from the cloud level, but it is still below the horizontal plane below the clouds. Obviously, in a "flat Earth" scenario, it would be impossible for the sun to illuminate the clouds from below. Considering two or more locations on the same meridian, sunset on the flat Earth would occur at significantly different times because of the different distances from the Sun, whereas in the spherical Earth model, they occur at about the same time and in both hemispheres. This proves that it is the Sun that moves around the Earth and that the proposed model of a Sun that would move along parallels is wrong. If one observes the Sun setting over the sea, it seems like "diving" into it. When it disappears, it is because its rays are now behind the radius of curvature. The effects of reflection or refraction do not justify this effect at all. The Sun, therefore, does not disappear because of perspective. The Sun does not appear smaller at sunset and sunrise, but obviously always remains the same size. The human eye is deceived by light that makes it appear to increase in size. Using a suitable filter and observing the Sun during the arc made in the sky, one notices that its size does not vary at all. In the Flat Earth model, they should vary due to perspective from hour to hour. At the equinox on the equator, the Sun appears to make an angle of exactly 180° in the sky from its rising to its setting. The observer standing exactly on the equator and looking north sees the Sun rising on his right and setting on his left. All this would be incompatible with the movement of the Sun in a Flat Earth. If the Earth were flat, it would be possible to observe the Sun at the equator even at night with a good telescope. On the contrary, this is impossible since the Sun at some point will disappear from the field of view due to the Earth's curvature. If the Sun were very small and was only 5,000 km high and moving above a flat earth when it approached, we would see it moving faster, while as it moved away, we would see it moving slower and slower.
8	<i>Elements of the "Flat Earth" belief</i>	Nature of water
	<i>Element content</i>	The physical nature of water is to find and maintain its level. If the Earth were a giant sphere that tilts, staggers, and spins in infinite space, its constant level could not exist. But since, in fact, the Earth is flat, the fundamental physical property of fluids is found and kept constant.
	<i>Scientific refutation</i>	Water does not "fall" off the Earth because of several physical laws, mainly related to gravity and fluid dynamics, according to the following principles: 1) The force of gravity acts on all objects with mass, including water. Gravity attracts water toward the center of the Earth, but does not cause water to fall freely into space. 2) Water tends to be in equilibrium under the influence of gravity. Atmospheric pressure and hydrostatic pressure play an important role in keeping water confined in oceans, rivers, and lakes. 3) Water on Earth moves through a continuous cycle (evaporation, condensation, precipitation), but remains within the atmosphere-earth system. Water does not leave the Earth significantly through this cycle. 4) The atmosphere acts as a kind of "barrier" that retains water in its liquid and gaseous forms. Changes in temperature and pressure affect the passage of water between phases without losing it to space. 5) The interactions between temperature, pressure, and volume of water follow the laws of thermodynamics, regulating its behavior. In summary, water remains on Earth due to the interaction of various physical forces and natural laws governing fluid behavior and gravity.
9	<i>Elements of the "Flat Earth" belief</i>	Planets and constellations
	<i>Element content</i>	The planets that we can observe in the sky are not planets, according to some, they would be holograms, according to others, wandering stars that, along with other stars, are produced by the interaction of the Earth's magnetic field with fluid space that resonates with a harmonic frequency (Schumann resonance) causing the formation by cavitation of bubbles that are ignited through sonar-luminescence. The stars and wandering stars (the planets) would all revolve around the pole star; the stars seen beyond the equator and to the south would be a reflection due to the atmosphere, which acts like a lens, and the dome.
	<i>Scientific refutation</i>	Constellations in our hemisphere, unlike those in the southern hemisphere, change in height as they move north or south. When we observe a star like Polaris, we can see that in our hemisphere, Polaris is at its zenith. Moving southward along the meridian, its height decreases and disappears below the horizon as it crosses the equator. However, if the Earth were flat, stars could be seen anywhere on the planet, and their angle with the horizon would remain constant. The constellations appear to move clockwise around Polaris in our hemisphere and counterclockwise around Sigma Octantis (unfortunately, not visible to the naked eye) in the southern hemisphere. If the Earth were flat, the rotation of the celestial sphere would be the same whether we were in Italy or Australia.
10	<i>Elements of the "Flat Earth" belief</i>	Space travel and moon landing
	<i>Element content</i>	Man would never go into space or to the moon. NASA (National Aeronautics and Space Administration) and other international space organizations would be part of a conspiracy designed to manipulate us to more easily exert control over our lives. In addition, around the Earth, positioned on the ice sheet, there would also be a kind of military control organized by all the powerful people on Earth on a very large scale that would prevent us from exploring the territories at the edge of the world by keeping it secret. The Antarctic Treaty is evidence of this plan.

	Scientific refutation	In December 1968, William Anders first photographed the Earth from space from Apollo 8, and in December 1972, the Earth was photographed fully illuminated from Apollo 17. Since then, many probes and countless satellites have been sent into space, and images of Earth are sent back every day. Space exploration has provided irrefutable evidence that the Earth is a sphere: both satellite photographs and photographs of the Earth taken by satellites and astronauts, including those from the Apollo program and the International Space Station (ISS), clearly show that the Earth is a sphere. The quality and quantity of these images make it difficult to support the idea of a global conspiracy about the shape of the Earth.
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Table 2: Schematization related to Table 1. Source: [15,24,25,28].

Elements of the "Flat Earth" belief	Element content	Scientific refutation
Ice Chain and Poles	The North Pole is the center of the world, and the South Pole is a boundary line that surrounds and demarcates all known lands. Surrounding the circular Earth is an ice mountain range 400 kilometers high and 72 thousand kilometers long.	Possibility of circumnavigation of the Earth, Satellite images, and application of physical laws to Earth's rotation shaping the shape of the Earth.
Terrestrial curvature	Everything that disappears is due to the narrowness of the human eye, because on a flat surface, everything is visible.	Ocean ships gradually disappear behind the curvature of the earth, which hides first the hull and then the top of the ship. This clearly shows that the ocean is convex along the Earth's gravitational isopotential surface: on a flat surface, nothing would prevent the observer from seeing distant landscapes.
Force of gravity	Gravitational force does not exist, but there is density that brings objects down according to weight.	The gravitational force acts radially, drawing objects toward the center of the Earth.
Earth rotation	It is nothing but an artifact supporting the sphericity of the Earth.	The Earth's rotation also acts on a moving body: a demonstration of this is the Coriolis force, an apparent force caused by the Earth's rotation. A moving body will be moved to the right in the northern hemisphere and to the left in the southern hemisphere.
Alternation of seasons	The change in climate during the year is due to the change in the radius of the circumference drawn by the sun during the year.	Climatic changes due to the Earth's rotation: the changing seasons can be attributed to the tilt of the Earth's axis, which causes the Earth to receive different amounts of solar radiation at different times of the year. The tilt also causes that during the Earth's revolution around the Sun, the hemispheres face away or toward the Sun, so that the seasons are mirrored between the two hemispheres.
Moon	It completes an orbit in 25 hours only on a flat surface; impossible to predict a full rotation in 24 hours.	By looking at the Moon with a telescope and observing the shadows of craters on the lunar surface, we can understand where the light that illuminates it comes from. This shows that the Moon cannot shine with its own light (not even be phosphorescent). Also, from the southern hemisphere, we can see the Moon upside down compared to the northern hemisphere.
Sun	Sunrise and sunset are nothing more than the appearance of the Sun above and below the horizon: when the Sun sets, it shrinks in our eyes only because it has moved too far out of our field of vision, whereas when it rises, the Sun would enter our field of vision and then begin to enlarge, due to a perspective effect, as it gets closer to us.	The Sun moves around the Earth. At sunset, it disappears because its rays are now behind the radius of curvature. Effects of reflection or refraction do not account for this effect at all. The Sun, therefore, does not disappear because of the effect of perspective.
Nature of water	The physical nature of water is to find and maintain its level. If the Earth were a giant sphere that tilts, staggers, and spins in infinite space, its constant level could not exist. But since, in fact, the Earth is flat, the fundamental physical property of fluids is found and kept constant.	Water remains on Earth due to the interaction of various physical forces and natural laws governing fluid behavior and gravity.
Planets and constellations	Planets, according to some, would be holograms; according to others, wandering stars that, along with other stars, are produced by the interaction of the earth's magnetic field with fluid space that resonates with a harmonic frequency (Schumann resonance), causing the formation by cavitation of bubbles that are ignited through sonar-luminescence.	Constellations in our hemisphere, unlike those in the southern hemisphere, change in height as they move north or south. If the Earth were flat, stars could be seen anywhere on the planet, and their angle with the horizon would remain constant.
Space travel and moon landings	It completes an orbit in 25 hours only on a flat surface; impossible to predict a full rotation in 24 hours.	By looking at the Moon with a telescope and observing the shadows of craters on the lunar surface, we can understand where the light that illuminates it comes from. This shows that the Moon cannot shine with its own light (not even be phosphorescent). Also, from the Southern Hemisphere, we can see the Moon upside down compared to the Northern Hemisphere.

Author contributions

Giulio Perrotta conceived the approach and supervised; he also drafted the manuscript for the introductory and historical parts, defining the section on scientific evidence. Arianna Sellari wrote the paper. Giulio Perrotta took care of the nomination, revision, and publication of the manuscript. All authors have read and approved the final manuscript.

References

1. Younker RW, Davidson RM. The myth of the solid heavenly dome. In: Klingbell GA, editor. He spoke and it was: Divine creation in the Old Testament. Pacific Press; 2015;31–56. Available from: <https://digitalcommons.andrews.edu/pubs/81/>
2. GMPE. Shape and dimensions of the Earth. 2024. Available from: <https://www.gmpe.it/geodesia/forma-dimensioni-della-terra>

3. Mondolfo R. The first affirmation of the sphericity of the Earth. In: Moments of Greek and Christian thought. Mondolfo Ed.; 1964. Available from: https://it.wikipedia.org/wiki/Sfericit%C3%A0_della_Terra
4. Palmieri EL, Parotto M. The Earth globe and its evolution. Zanichelli Ed.; 2023. Available from: <https://www.zanichelli.it/ricerca/prodotti/il-globo-terrestre-e-la-sua-evoluzione>
5. Moscarelli E. The four great Milesians. Liguori Ed.; 2006;296. Available from: <http://www.liguori.it/schedanew.asp?isbn=3887>
6. Cattaneo C. Ancient and modern India. The Perfect Library Press; 2015. Available from: <https://www.bookswagon.com/book/dellindia-antica-e-moderna>
7. West EW. The Bundahishn. Theophania Pub.; 2012. Available from: <https://www.wisdomlib.org/zoroastrianism/book/the-bundahishn>
8. Nony S, Giacomotto-Charra V. The flat Earth. Genealogy of a misunderstanding. Il Mulino Ed.; 2024. Available from: <https://www.mulino.it/isbn/9788815388810>
9. Mallinger J. Pythagoras and the mysteries. Atanòr Ed.; 1999. Available from: <https://www.maremagnum.com/it/libri-moderni/pitagora-e-i-misteri/136757194>
10. Colli G, Colli E. Gorgias and Parmenides. Adelphi Ed.; 2003. Available from: <https://www.adelphi.it/libro/9788845917745>
11. Sutton D. The laws of the Universe: the solids of Archimedes and Plato. Macro Ed.; 2014.
12. Lloyd GER. Aristotle: The growth and structure of his thought. Cambridge Univ. Press; 1968. Available from: https://assets.cambridge.org/97805210/94566/excerpt/9780521094566_excerpt.pdf
13. Aristotle. De caelo, 297b24–31. Available from: https://www.loebclassics.com/view/LCL338/1939/pb_LCL338.xxi.xml
14. Favaro A. Archimedes. Aurora Boreale Ed.; 2023. Available from: <https://www.treccani.it/enciclopedia/claudio-tolomeo>
15. Bede's Library. The myth of the flat Earth. [Internet]. 2024. Available from: <http://www.bede.org.uk/flatearth.htm>
16. Van Helden A. Measuring the Universe: Cosmic dimensions from Aristarchus to Halley. University of Chicago Press; 1985. Available from: <https://press.uchicago.edu/ucp/books/book/chicago/M/bo67988743.html>
17. Strabo. The Geography of Strabo, in eight volumes. Translated by Horace Leonard Jones. Loeb Classical Library edition; 1960. Available from: <https://catalog.perseus.org/catalog/urn%3AActs%3AgreekLit%3Atlg0099.tlg001.opp-grc8>
18. Ptolemy. Almagest, I.4, cited in: Grant E. A source book in medieval science. Harvard University Press; 1974. Available from: <https://www.mullenbooks.com/pages/books/148789/edward-grant/a-source-book-in-medieval-science>
19. Treccani. Ptolemy. [Internet]. 2024. Available from: <https://www.treccani.it/enciclopedia/claudio-tolomeo/>
20. Cardini F, Montesano M. Medieval history. Le Monnier University Press; 2019. Available from: <https://www.hoepli.it/libro/storia-medievale/9788800748155.html>
21. King DA. Astronomy in the service of Islam. Variorum Press; 1993. Available from: <https://www.worldcat.org/title/28417575>
22. Pavlis NK, Holmes SA, Kenyon S, et al. Gravitational potential expansion to degree 2160. IAG International Symposium, Gravity, Geoid, and Space Mission (GGSM2004), Porto, Portugal; 2004. Available from: <https://ui.adsabs.harvard.edu/abs/2008AGUFM.G22A..01P/abstract>
23. Eastwood B, Graßhoff G. Planetary diagrams for Roman astronomy in medieval Europe, ca. 800–1500. Transactions of the American Philosophical Society; 2004;94(3). Available from: <https://www.pennpress.org/9780871699435/planetary-diagrams-for-roman-astronomy-in-medieval-europe-ca-800-1500>
24. Rowbotham SB. Zetetic astronomy. Earth is not a globe! Legare Street Press; 2022. Available from: <https://www.gutenberg.org/ebooks/69892>
25. Rowbotham SB, Carpenter W. Testing the globe: A zetetic investigation. Rob Press; 2018. Available from: <https://www.amazon.in/Testing-Globe-Investigation-Samuel-Rowbotham/dp/1724119044>
26. Flat Earth Society (F.E.S.). The Flat Earth Society. [Internet]. 2024. Available from: <https://theflatearthsociety.org/home/index.php>
27. Pahuus K, Jørgensen MS, Wagoner B. Toward a cultural psychology of conspiracy theories: A life-narrative analysis of flat Earthers. Integr Psychol Behav Sci. 2024;58(4):1895–1913. Available from: <https://doi.org/10.1007/s12124-024-09857-5>
28. Sellari A. Flat Earth theory: Main hypotheses and analysis of psychopathological traits of flat Earthers. Master's thesis in Forensic Criminology. Forensic Science Academy; 2024.

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