

5 Of Earth's Surface

Earth

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Earth is the third planet from the Sun and the only astronomical object known to harbor life. This is enabled by Earth being an ocean world, the only one in the Solar System sustaining liquid surface water. Almost all of Earth's water is contained in its global ocean, covering 70.8% of Earth's crust. The remaining 29.2% of Earth's crust is land, most of which is located in the form of continental landmasses within Earth's land hemisphere. Most of Earth's land is at least somewhat humid and covered by vegetation, while large ice sheets at Earth's polar regions retain more water than Earth's groundwater, lakes, rivers, and atmospheric water combined. Earth's crust consists of slowly moving tectonic plates, which interact to produce mountain ranges, volcanoes, and earthquakes. Earth has a liquid outer core that generates a magnetosphere capable of deflecting most of the destructive solar winds and cosmic radiation.

Earth has a dynamic atmosphere, which sustains Earth's surface conditions and protects it from most meteoroids and UV-light at entry. It has a composition of primarily nitrogen and oxygen. Water vapor is widely present in the atmosphere, forming clouds that cover most of the planet. The water vapor acts as a greenhouse gas and, together with other greenhouse gases in the atmosphere, particularly carbon dioxide (CO₂), creates the conditions for both liquid surface water and water vapor to persist via the capturing of energy from the Sun's light. This process maintains the current average surface temperature of 14.76 °C (58.57 °F), at which water is liquid under normal atmospheric pressure. Differences in the amount of captured energy between geographic regions (as with the equatorial region receiving more sunlight than the polar regions) drive atmospheric and ocean currents, producing a global climate system with different climate regions, and a range of weather phenomena such as precipitation, allowing components such as carbon and nitrogen to cycle.

Earth is rounded into an ellipsoid with a circumference of about 40,000 kilometres (24,900 miles). It is the densest planet in the Solar System. Of the four rocky planets, it is the largest and most massive. Earth is about eight light-minutes (1 AU) away from the Sun and orbits it, taking a year (about 365.25 days) to complete one revolution. Earth rotates around its own axis in slightly less than a day (in about 23 hours and 56 minutes). Earth's axis of rotation is tilted with respect to the perpendicular to its orbital plane around the Sun, producing seasons. Earth is orbited by one permanent natural satellite, the Moon, which orbits Earth at 384,400 km (238,855 mi)—1.28 light seconds—and is roughly a quarter as wide as Earth. The Moon's gravity helps stabilize Earth's axis, causes tides and gradually slows Earth's rotation. Likewise Earth's gravitational pull has already made the Moon's rotation tidally locked, keeping the same near side facing Earth.

Earth, like most other bodies in the Solar System, formed about 4.5 billion years ago from gas and dust in the early Solar System. During the first billion years of Earth's history, the ocean formed and then life developed within it. Life spread globally and has been altering Earth's atmosphere and surface, leading to the Great Oxidation Event two billion years ago. Humans emerged 300,000 years ago in Africa and have spread across every continent on Earth. Humans depend on Earth's biosphere and natural resources for their survival, but have increasingly impacted the planet's environment. Humanity's current impact on Earth's climate and biosphere is unsustainable, threatening the livelihood of humans and many other forms of life, and causing widespread extinctions.

Earth's outer core

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Earth's outer core is a fluid layer about 2,260 km (1,400 mi) thick, composed of mostly iron and nickel that lies above Earth's solid inner core and below its mantle. The outer core begins approximately 2,889 km (1,795 mi) beneath Earth's surface at the core-mantle boundary and ends 5,150 km (3,200 mi) beneath Earth's surface at the inner core boundary.

List of sovereign states and dependent territories in South America

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There are 12 sovereign states and 3 non-sovereign dependent territories in South America. The continent is bordered on the west by the Pacific Ocean and on the north and east by the Atlantic Ocean. North America and the Caribbean Sea lie to the northwest. South America has an area of approximately 17,840,000 square kilometres (6,890,000 sq mi), or almost 3.5% of Earth's surface. As of 2018, its population is more than 430 million, according to estimates of population in The World Factbook. South America ranks fourth among all continents in area (after Asia, Africa, and North America) and fifth in population (after Asia, Africa, Europe, and North America).

The border between North and South America is at some point in the Isthmus of Panama. The most common demarcation in atlases and other sources follows the Darién Mountains watershed that divides along the Colombia–Panama border where the isthmus meets the South American continent (see Darién Gap). Virtually all atlases list Panama as a state falling entirely within North America and/or Central America.

Earth's inner core

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Earth's inner core is the innermost geologic layer of the planet Earth. It is primarily a solid ball with a radius of about 1,230 km (760 mi), which is about 20% of Earth's radius or 70% of the Moon's radius.

There are no samples of the core accessible for direct measurement, as there are for Earth's mantle. The characteristics of the core have been deduced mostly from measurements of seismic waves and Earth's magnetic field. The inner core is believed to be composed of an iron–nickel alloy with some other elements. The temperature at its surface is estimated to be approximately 5,700 K (5,430 °C; 9,800 °F), about the temperature at the surface of the Sun.

The inner core is solid at high temperature because of its high pressure, in accordance with the Simon-Glatzel equation.

Earth's magnetic field

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Earth's magnetic field, also known as the geomagnetic field, is the magnetic field that extends from Earth's interior out into space, where it interacts with the solar wind, a stream of charged particles emanating from the Sun. The magnetic field is generated by electric currents due to the motion of convection currents of a mixture of molten iron and nickel in Earth's outer core: these convection currents are caused by heat escaping from the core, a natural process called a geodynamo.

The magnitude of Earth's magnetic field at its surface ranges from 25 to 65 μT (0.25 to 0.65 G). As an approximation, it is represented by a field of a magnetic dipole currently tilted at an angle of about 11° with respect to Earth's rotational axis, as if there were an enormous bar magnet placed at that angle through the center of Earth. The North geomagnetic pole (Ellesmere Island, Nunavut, Canada) actually represents the South pole of Earth's magnetic field, and conversely the South geomagnetic pole corresponds to the north pole of Earth's magnetic field (because opposite magnetic poles attract and the north end of a magnet, like a compass needle, points toward Earth's South magnetic field.)

While the North and South magnetic poles are usually located near the geographic poles, they slowly and continuously move over geological time scales, but sufficiently slowly for ordinary compasses to remain useful for navigation. However, at irregular intervals averaging several hundred thousand years, Earth's field reverses and the North and South Magnetic Poles abruptly switch places. These reversals of the geomagnetic poles leave a record in rocks that are of value to paleomagnetists in calculating geomagnetic fields in the past. Such information in turn is helpful in studying the motions of continents and ocean floors. The magnetosphere is defined by the extent of Earth's magnetic field in space or geospace. It extends above the ionosphere, several tens of thousands of kilometres into space, protecting Earth from the charged particles of the solar wind and cosmic rays that would otherwise strip away the upper atmosphere, including the ozone layer that protects Earth from harmful ultraviolet radiation.

Internal structure of Earth

its mass. Astronomers can also calculate Earth's mass by observing the motion of orbiting satellites. Earth's average density can be determined through

The internal structure of Earth is the layers of the Earth, excluding its atmosphere and hydrosphere. The structure consists of an outer silicate solid crust, a highly viscous asthenosphere, and solid mantle, a liquid outer core whose flow generates the Earth's magnetic field, and a solid inner core.

Scientific understanding of the internal structure of Earth is based on observations of topography and bathymetry, observations of rock in outcrop, samples brought to the surface from greater depths by volcanoes or volcanic activity, analysis of the seismic waves that pass through Earth, measurements of the gravitational and magnetic fields of Earth, and experiments with crystalline solids at pressures and temperatures characteristic of Earth's deep interior.

Gravity of Earth

Earth's surface, the acceleration due to gravity, accurate to 2 significant figures, is 9.8 m/s^2 (32 ft/s^2). This means that, ignoring the effects of

The gravity of Earth, denoted by g , is the net acceleration that is imparted to objects due to the combined effect of gravitation (from mass distribution within Earth) and the centrifugal force (from the Earth's rotation).

It is a vector quantity, whose direction coincides with a plumb bob and strength or magnitude is given by the norm

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In SI units, this acceleration is expressed in metres per second squared (in symbols, m/s² or m·s⁻²) or equivalently in newtons per kilogram (N/kg or N·kg⁻¹). Near Earth's surface, the acceleration due to gravity, accurate to 2 significant figures, is 9.8 m/s² (32 ft/s²). This means that, ignoring the effects of air resistance, the speed of an object falling freely will increase by about 9.8 metres per second (32 ft/s) every second.

The precise strength of Earth's gravity varies with location. The agreed-upon value for standard gravity is 9.80665 m/s² (32.1740 ft/s²) by definition. This quantity is denoted variously as *g_n*, *g_e* (though this sometimes means the normal gravity at the equator, 9.7803267715 m/s² (32.087686258 ft/s²)), *g₀*, or simply *g* (which is also used for the variable local value).

The weight of an object on Earth's surface is the downwards force on that object, given by Newton's second law of motion, or *F* = *m* *a* (force = mass × acceleration). Gravitational acceleration contributes to the total gravity acceleration, but other factors, such as the rotation of Earth, also contribute, and, therefore, affect the weight of the object. Gravity does not normally include the gravitational pull of the Moon and Sun, which are accounted for in terms of tidal effects.

Atmosphere of Earth

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The atmosphere of Earth consists of a layer of mixed gas that is retained by gravity, surrounding the Earth's surface. It contains variable quantities of suspended aerosols and particulates that create weather features such as clouds and hazes. The atmosphere serves as a protective buffer between the Earth's surface and outer space. It shields the surface from most meteoroids and ultraviolet solar radiation, reduces diurnal temperature variation – the temperature extremes between day and night, and keeps it warm through heat retention via the greenhouse effect. The atmosphere redistributes heat and moisture among different regions via air currents, and provides the chemical and climate conditions that allow life to exist and evolve on Earth.

By mole fraction (i.e., by quantity of molecules), dry air contains 78.08% nitrogen, 20.95% oxygen, 0.93% argon, 0.04% carbon dioxide, and small amounts of other trace gases (see Composition below for more detail). Air also contains a variable amount of water vapor, on average around 1% at sea level, and 0.4% over the entire atmosphere.

Earth's primordial atmosphere consisted of gases accreted from the solar nebula, but the composition changed significantly over time, affected by many factors such as volcanism, outgassing, impact events, weathering and the evolution of life (particularly the photoautotrophs). In the present day, human activity has contributed to atmospheric changes, such as climate change (mainly through deforestation and fossil-fuel-related global warming), ozone depletion and acid deposition.

The atmosphere has a mass of about 5.15×10¹⁸ kg, three quarters of which is within about 11 km (6.8 mi; 36,000 ft) of the surface. The atmosphere becomes thinner with increasing altitude, with no definite boundary between the atmosphere and outer space. The Kármán line at 100 km (62 mi) is often used as a conventional definition of the edge of space. Several layers can be distinguished in the atmosphere based on characteristics such as temperature and composition, namely the troposphere, stratosphere, mesosphere, thermosphere (formally the ionosphere) and exosphere. Air composition, temperature and atmospheric pressure vary with altitude. Air suitable for use in photosynthesis by terrestrial plants and respiration of terrestrial animals is found within the troposphere.

The study of Earth's atmosphere and its processes is called atmospheric science (aerology), and includes multiple subfields, such as climatology and atmospheric physics. Early pioneers in the field include Léon Teisserenc de Bort and Richard Assmann. The study of the historic atmosphere is called paleoclimatology.

Earth's orbit

time Earth has traveled 940 million km (584 million mi). Ignoring the influence of other Solar System bodies, Earth's orbit, also called Earth's revolution

Earth orbits the Sun at an average distance of 149.60 million km (92.96 million mi), or 8.317 light-minutes, in a counterclockwise direction as viewed from above the Northern Hemisphere. One complete orbit takes 365.256 days (1 sidereal year), during which time Earth has traveled 940 million km (584 million mi). Ignoring the influence of other Solar System bodies, Earth's orbit, also called Earth's revolution, is an ellipse with the Earth–Sun barycenter as one focus with a current eccentricity of 0.0167. Since this value is close to zero, the center of the orbit is relatively close to the center of the Sun (relative to the size of the orbit).

As seen from Earth, the planet's orbital prograde motion makes the Sun appear to move with respect to other stars at a rate of about 1° eastward per solar day (or a Sun or Moon diameter every 12 hours). Earth's orbital speed averages 29.78 km/s (18.50 mi/s; 107,208.00 km/h; 66,615.96 mph), which is fast enough to cover the planet's diameter in 7 minutes and the distance to the Moon in 4 hours. The point towards which the Earth in its solar orbit is directed at any given instant is known as the "apex of the Earth's way".

From a vantage point above the north pole of either the Sun or Earth, Earth would appear to revolve in a counterclockwise direction around the Sun. From the same vantage point, both the Earth and the Sun would appear to rotate also in a counterclockwise direction.

Earth's internal heat budget

Earth's internal heat budget is fundamental to the thermal history of the Earth. The flow of heat from Earth's interior to the surface is estimated at

Earth's internal heat budget is fundamental to the thermal history of the Earth. The flow of heat from Earth's interior to the surface is estimated at 47 ± 2 terawatts (TW) and comes from two main sources in roughly equal amounts: the radiogenic heat produced by the radioactive decay of isotopes in the mantle and crust, and the primordial heat left over from the formation of Earth.

Earth's internal heat travels along geothermal gradients and powers most geological processes. It drives mantle convection, plate tectonics, mountain building, rock metamorphism, and volcanism. Convective heat transfer within the planet's high-temperature metallic core is also theorized to sustain a geodynamo which generates Earth's magnetic field.

Despite its geological significance, Earth's interior heat contributes only 0.03% of Earth's total energy budget at the surface, which is dominated by 173,000 TW of incoming solar radiation. This external energy source powers most of the planet's atmospheric, oceanic, and biologic processes. Nevertheless on land and at the ocean floor, the sensible heat absorbed from non-reflected insolation flows inward only by means of thermal conduction, and thus penetrates only a few dozen centimeters on the daily cycle and only a few dozen meters on the annual cycle. This renders solar radiation minimally relevant for processes internal to Earth's crust.

Global data on heat-flow density are collected and compiled by the International Heat Flow Commission of the International Association of Seismology and Physics of the Earth's Interior.

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