

Atmosphere

An **atmosphere** (from Greek ἀτμός (*atmos*), meaning 'vapor', and σφαῖρα (*sphaira*), meaning 'sphere'^{[1][2]}) is a layer or a set of layers of gases surrounding a planet or other material body, that is held in place by the gravity of that body. An atmosphere is more likely to be retained if the gravity it is subject to is high and the temperature of the atmosphere is low

The atmosphere of Earth is composed of nitrogen (about 78%), oxygen (about 21%), argon (about 0.9%) with carbon dioxide and other gases in trace amounts. Oxygen is used by most organisms for respiration; nitrogen is fixed by bacteria and lightning to produce ammonia used in the construction of nucleotides and amino acids; and carbon dioxide is used by plants, algae and cyanobacteria for photosynthesis. The atmosphere helps to protect living organisms from genetic damage by solar ultraviolet radiation, solar wind and cosmic rays. The current composition of the Earth's atmosphere is the product of billions of years of biochemical modification of the paleoatmosphere by living organisms.

The term stellar atmosphere describes the outer region of a star and typically includes the portion above the opaque photosphere. Stars with sufficiently low temperatures may have outer atmospheres with compound molecules.



Mars's thin atmosphere

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Pressure

Atmospheric pressure at a particular location is the force per unit area perpendicular to a surface determined by the weight of the vertical column of atmosphere above that location. On Earth, units of air pressure are based on the internationally recognized standard atmosphere (atm), which is defined as 101.325 kPa (760 Torr or 14.696 psi). It is measured with abарometer.

Atmospheric pressure decreases with increasing altitude due to the diminishing mass of gas above. The height at which the pressure from an atmosphere declines by a factor of e (an irrational number with a value of 2.71828...) is called the scale height and is denoted by H . For an atmosphere with a uniform temperature, the scale height is proportional to the temperature and inversely proportional to the product of the mean molecular mass of dry air and the local acceleration of gravity at that location. For such a model atmosphere, the pressure declines exponentially with increasing altitude. However, atmospheres are not uniform in temperature, so estimation of the atmospheric pressure at any particular altitude is more complex.

Atmospheric escape

Surface gravity differs significantly among the planets. For example, the large gravitational force of the giant planet Jupiter retains light gases such as hydrogen and helium that escape from objects with lower gravity. Secondly, the distance from the Sun determines the energy available to heat atmospheric gas to the point where some fraction of its molecules' thermal motion exceed the planet's escape velocity, allowing those to escape a planet's gravitational grasp. Thus, distant and cold Titan, Triton, and Pluto are able to retain their atmospheres despite their relatively low gravities.

Since a collection of gas molecules may be moving at a wide range of velocities, there will always be some fast enough to produce a slow leakage of gas into space. Lighter molecules move faster than heavier ones with the same thermal kinetic energy, and so gases of low molecular weight are lost more rapidly than those of high molecular weight. It is thought that Venus and Mars may have lost much of their water when, after being photo dissociated into hydrogen and oxygen by solar ultraviolet, the hydrogen escaped. Earth's magnetic field helps to prevent this, as, normally, the solar wind would greatly enhance the escape of hydrogen. However, over the past 3 billion years Earth may have lost gases through the magnetic polar regions due to auroral activity including a net 2% of its atmospheric oxygen.^[3]

Other mechanisms that can cause atmosphere depletion are solar wind-induced sputtering, impact erosion, weathering, and sequestration—sometimes referred to as "freezing out"—into thermophiles and polar caps.

Terrain

Atmospheres have dramatic effects on the surfaces of rocky bodies. Objects that have no atmosphere, or that have only an exosphere, have terrain that is covered in craters. Without an atmosphere, the planet has no protection from meteoroids, and all of them collide with the surface as meteorites and create craters.

Most meteoroids burn up as meteors before hitting a planet's surface. When meteoroids do impact, the effects are often erased by the action of wind. As a result, craters are rare on objects with atmospheres.

Wind erosion is a significant factor in shaping the terrain of rocky planets with atmospheres, and over time can erase the effects of both craters and volcanoes. In addition, since liquids can not exist without pressure, an atmosphere allows liquid to



be present at the surface, resulting in lakes, rivers and oceans. Earth and Titan are known to have liquids at their surface and terrain on the planet suggests that Mars had liquid on its surface in the past.

Composition

A planet's initial atmospheric composition is related to the chemistry and temperature of the local solar nebula during planetary formation and the subsequent escape of interior gases. The original atmospheres started with the radially local rotating gases that collapsed to the spaced rings that formed the planets. They were then modified over time by various complex factors, resulting in quite different outcomes.

The atmospheres of the planets Venus and Mars are primarily composed of carbon dioxide, with small quantities of nitrogen, argon, oxygen and traces of other gases.

The atmospheric composition on Earth is largely governed by the by-products of the life that it sustains. Dry air from Earth's atmosphere contains 78.08% nitrogen, 20.95% oxygen, 0.93% argon, 0.04% carbon dioxide, and traces of hydrogen, helium, and other "noble" gases (by volume), but generally a variable amount of water vapor is also present, on average about 1% at sea level.

The low temperatures and higher gravity of the Solar System's giant planets—Jupiter, Saturn, Uranus and Neptune—allow them more readily to retain gases with low molecular masses. These planets have hydrogen–helium atmospheres, with trace amounts of more complex compounds.

Two satellites of the outer planets possess significant atmospheres. Titan, a moon of Saturn, and Triton, a moon of Neptune, have atmospheres mainly of nitrogen. When in the part of its orbit closest to the Sun, Pluto has an atmosphere of nitrogen and methane similar to Triton's, but these gases are frozen when it is farther from the Sun.

Other bodies within the Solar System have extremely thin atmospheres not in equilibrium. These include the Moon (sodium gas), Mercury (sodium gas), Europa (oxygen), Io (sulfur), and Enceladus (water vapor).

The first exoplanet whose atmospheric composition was determined in 2013, a gas giant with a close orbit around a star in the constellation Pegasus. Its atmosphere is heated to temperatures over 1,000 K, and is steadily escaping into space. Hydrogen, oxygen, carbon and sulfur have been detected in the planet's inflated atmosphere.^[4]

Structure

Earth

Earth's atmosphere consists of a number of layers that differ in properties such as composition, temperature and pressure. The lowest layer is the troposphere, which extends from the surface to the bottom of the stratosphere. Three quarters of the atmosphere's mass resides within the troposphere, and is the layer within which the Earth's terrestrial weather develops. The depth of this layer varies between 17 km at the equator to 7 km at the poles. The stratosphere, extending from the top of the troposphere to the bottom of the mesosphere, contains the ozone layer. The ozone layer ranges in altitude between 15 and 35 km, and is where most of the ultraviolet radiation from the Sun is absorbed. The top of the mesosphere, ranges from 50 to 85 km, and is the layer wherein most meteors burn



The layers of Earth's atmosphere



Earth's atmospheric gases scatter blue light more than other wavelengths, giving Earth a blue halo when seen from space

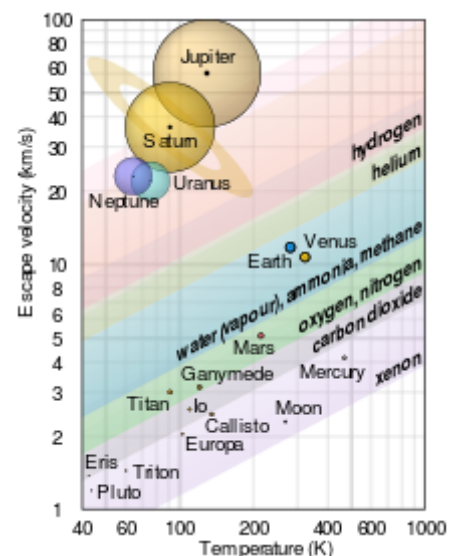
up. The thermosphere extends from 85 km to the base of the exosphere at 690 km and contains the ionosphere, a region where the atmosphere is ionised by incoming solar radiation. The ionosphere increases in thickness and moves closer to the Earth during daylight and rises at night allowing certain frequencies of radio communication a greater range. The Kármán line, located within the thermosphere at an altitude of 100 km, is commonly used to define the boundary between Earth's atmosphere and outer space. The exosphere begins variously from about 690 to 1,000 km above the surface, where it interacts with the planet's magnetosphere. Each of the layers has a different lapse rate, defining the rate of change in temperature with height.

Others

Other astronomical bodies such as these listed have known atmospheres.

In the Solar System

- Atmosphere of the Sun
- Atmosphere of Mercury
- Atmosphere of Venus
- Atmosphere of Earth
 - Atmosphere of the Moon
- Atmosphere of Mars
- Atmosphere of Ceres
- Atmosphere of Jupiter
 - Atmosphere of Io
 - Atmosphere of Callisto
 - Atmosphere of Europa
 - Atmosphere of Ganymede
- Atmosphere of Saturn
 - Atmosphere of Titan
 - Atmosphere of Enceladus
- Atmosphere of Uranus
 - Atmosphere of Titania
- Atmosphere of Neptune
 - Atmosphere of Triton
- Atmosphere of Pluto



Graphs of escape velocity against surface temperature of some Solar System objects showing which gases are retained. The objects are drawn to scale, and their data points are at the black dots in the middle.

Outside the Solar System

- Atmosphere of HD 209458 b

Circulation

The circulation of the atmosphere occurs due to thermal differences when convection becomes a more efficient transporter of heat than thermal radiation. On planets where the primary heat source is solar radiation, excess heat in the tropics is transported to higher latitudes. When a planet generates a significant amount of heat internally, such as is the case for Jupiter, convection in the atmosphere can transport thermal energy from the higher temperature interior up to the surface.

Importance

From the perspective of a planetary geologist, the atmosphere acts to shape a planetary surface. Wind picks up dust and other particles which, when they collide with the terrain, erode the relief and leave deposits (eolian processes). Frost and precipitations, which depend on the atmospheric composition, also influence the relief. Climate changes can influence a planet's geological history.

Conversely, studying the surface of the Earth leads to an understanding of the atmosphere and climate of other planets.

For a meteorologist, the composition of the Earth's atmosphere is a factor affecting the climate and its variations.

For a biologist or paleontologist, the Earth's atmospheric composition is closely dependent on the appearance of the life and its evolution.

See also

- Atmometer (evaporimeter)
- Atmospheric pressure
- International Standard Atmosphere
- Kármán
- Sky

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Further reading

- Sanchez-Lavega,, Agustin (2010) *An Introduction to Planetary Atmospheres* Taylor & Francis ISBN 978-1-4200-6732-3.

External links

- Properties of atmospheric strata - The flight environment of the atmosphere
 - Atmosphere - an Open Access journal
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