Features of the Earth

Dr. Mateen Hafiz | August 18, 2020

Department of Geology,
Govt. Maulana Azad Memorial (MAM) College,
Jammu (India)

Features of the Earth

The Earth has been referred by several names, such as '*Tellus*' (the Roman goddess of the Earth and a symbol of fertility), '*Gaia*' (ancient Greek Earth goddess), and '*Terra*' (Latin meaning the Earth). The Earth is the third planet of our Solar System and is placed at a distance of about 150 million km from the Sun. The means that the distance between the Earth and the Sun is used to measure distances within our Solar System. This is called an Astronomical Unit (AU).

Some of the characteristics of the Earth are:

Mass	5976×10^{74} g
Density	1370×10^{6} km^3
Surface area	510 million sq. km
Land area	149 million sq. km

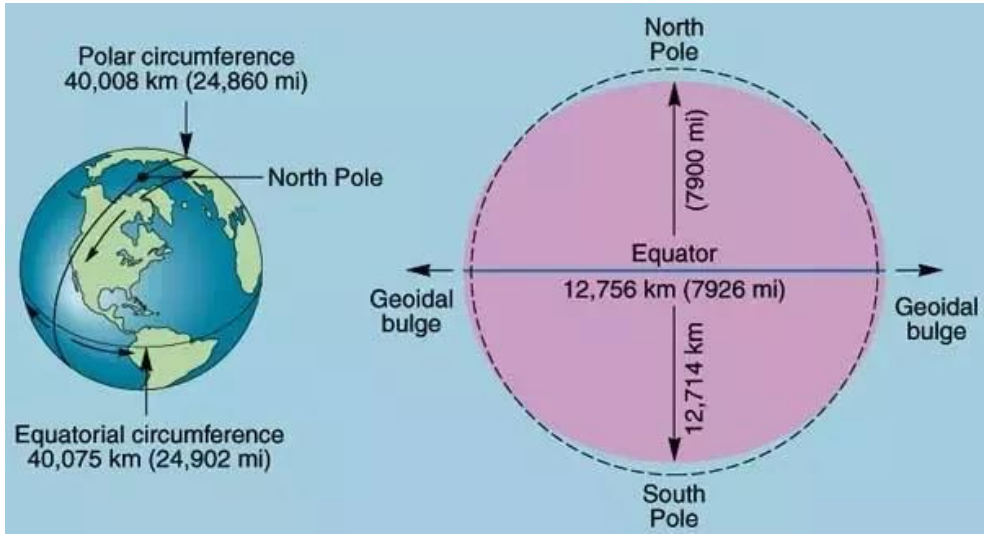
Our planet lies within the habitable zone of the solar system and only the Earth currently has water in liquid form. On planets closer to the Sun than the habitable zone, all water evaporates, and all water exists only as solid ice on planets farther away.

Diameter of the Earth

The distance from the North Pole to the South Pole is 12,714 km (Polar diameter) and 42 km shorter than the distance across the equator, which is 12,756 km (Equatorial diameter).

Shape of the Earth

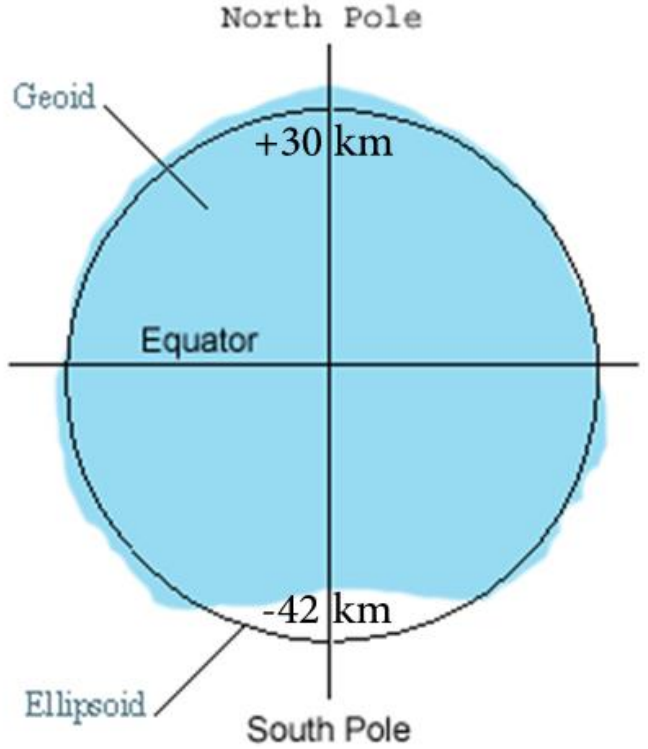
Earth-An Oblate Spheroid: Until 1687, the spherical-perfection model was a basic assumption of geodesy. In 1687, Sir Issac Newton postulated that Earth, along with other planets, could not be perfectly spherical. Newton reasoned that the more rapid rotational speed at the equator- the equator being farthest from the central axis of the planet and therefore moving faster- produces an equatorial bulge as centrifugal force pulls Earth's surface outward.



Newton was convinced that Earth is slightly misshapen into an oblate spheroid, or more correctly, "an oblate ellipsoid" ("oblate" means flattened), with the oblateness occurring at the poles. Because of equatorial bulge and polar oblateness, equatorial diameter is 12,756 km and polar diameter is 12,714 km.

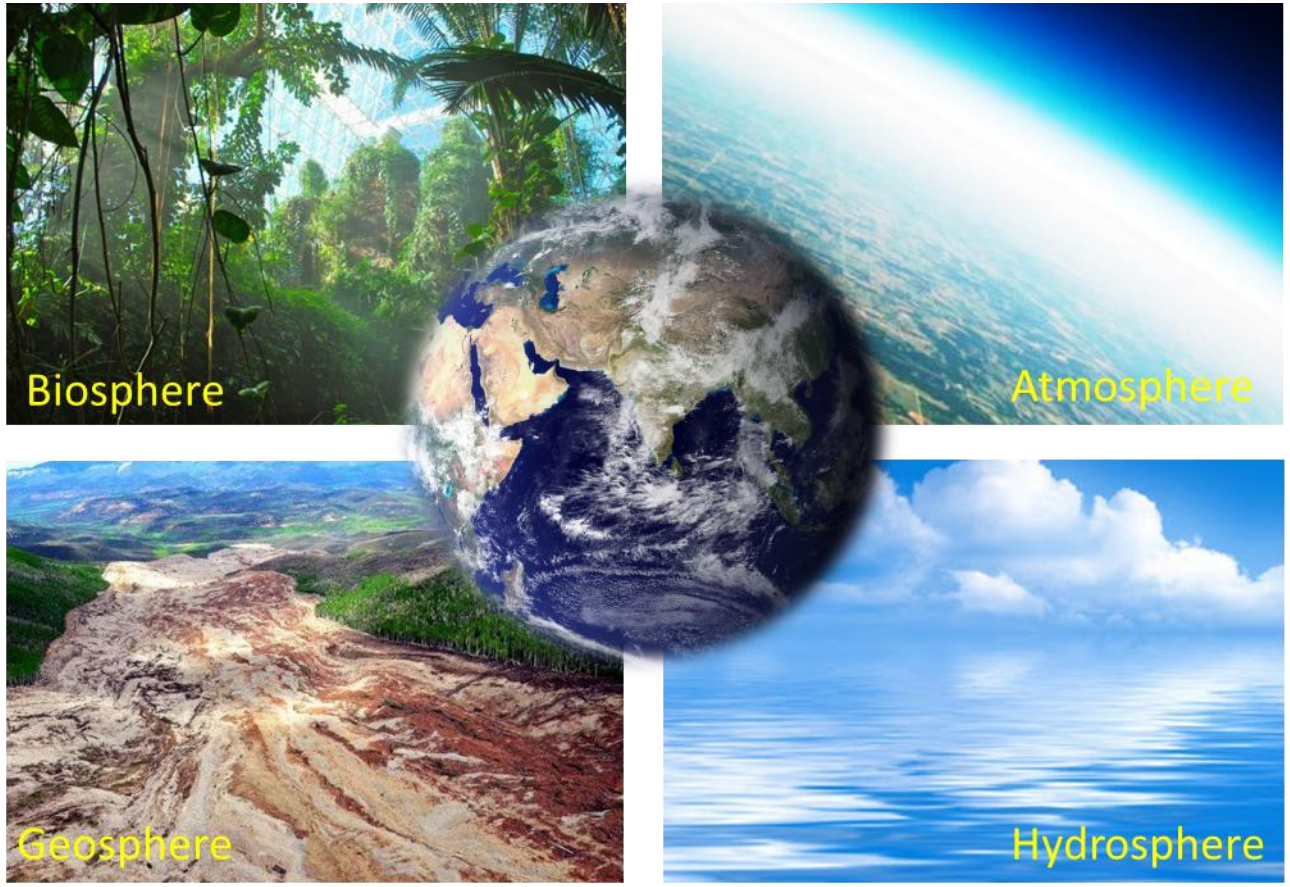
Earth as a Geoid: "Geoid" literally means 'Earth-like'. Imagine the Earth's geoid as a sea-level surface that extends uniformly worldwide, beneath the continents.

The geoid is the Earth's actual shape calculated to take account of its mass, elasticity, and rate of spin. It follows mean sea level in the oceans and is slightly pear-shaped, with the North Pole 30 km further from the Earth's center than other places and the South Pole 42 km nearer.



The Earth's Atmosphere, Hydrosphere and Biosphere

There are several distinct components of Earth. Beneath the *atmosphere* (the gaseous envelope) lie the *hydrosphere* (surface and near-surface liquid water), the *cryosphere* (surface and near-surface ice and snow), the *biosphere* (the great variety of living organisms), and the *solid Earth*. Geologists refer to the combination of these components, and the complex interactions among them, as the **Earth System**.



- ***Geosphere***: It consists of the solid part of our planet. It can be seen as exposed rock, sediment, or soil. Most of it lies underground, in the internal layers of our planet.
- ***Hydrosphere*** consists of all liquid water at or near the surface of the Earth. It fills oceans, lakes, underground pores, and occurs as gas in the atmosphere.
- C***ryosphere*** consists of frozen water, mostly in glaciers.
- ***Biosphere*** consists of living organisms, from bacteria to whales.
- ***Atmosphere*** is the envelope of gas that encircles the planet. Flow in the air and sea transfer heat and water around the planet. Internal energy rising from the interior and external energy coming to the Earth from the Sun keep the Earth System dynamic, so that materials cycle from component to component over time.

Atmospheric layers based on temperature variation

While air pressure in the atmosphere decreases uniformly from sea level upward, air temperature does not. Elevations where temperatures stop decreasing and start increasing, or vice versa, divide the Earth's atmosphere into four main layers and the exosphere.

- ***Troposphere**:* The layer of air that lies between the surface of the Earth and an elevation of 5 km at the poles and 18 km at the equator is called the troposphere. Within this layer, the temperature decreases gradually from an average of 18°C at the surface to about −55°C at the top, a boundary called the *tropopause*. The name *troposphere* comes from the Greek *tropos*, which means turning, because air in the troposphere constantly undergoes *convection* as warm air rises in updrafts and cold air sinks in downdrafts.

- ***Stratosphere***: Beginning at the tropopause and continuing up for about 10 km, the temperature stays about the same. Then it slowly rises, reaching a maximum of about 0°C at an elevation of about 47 km, a boundary called the *stratopause*. The layer between the tropopause and the stratopause is the stratosphere, so named because it doesn't convect much and therefore remains relatively stable and stratified.

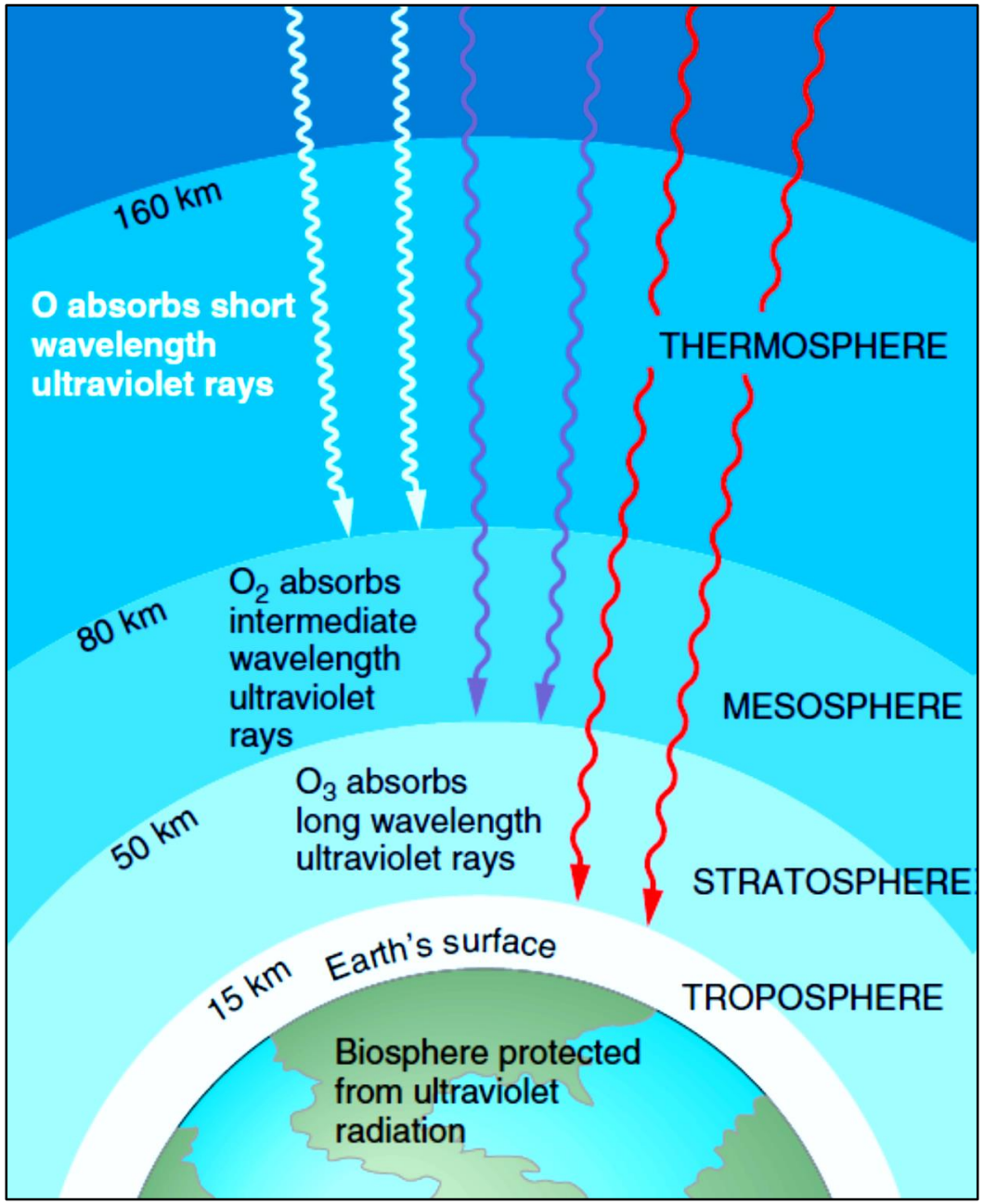
- ***Mesosphere**:* Temperature decreases in the layer called the mesosphere, which lies between 47 and 82 km. At the *mesopause*, the top of the mesosphere, the temperature has dropped to –85°C. The mesosphere does not absorb much solar energy, so it cools with increasing distance from the hotter stratosphere below. Most *meteors* (so-called shooting stars) begin burning in the mesosphere and have vaporized by the time they descend to an elevation of 25 km.

  Most of the ozone in the Earth's atmosphere resides in the stratosphere; heating in the stratosphere happens because ozone absorbs ultraviolet radiation directly from the Sun.

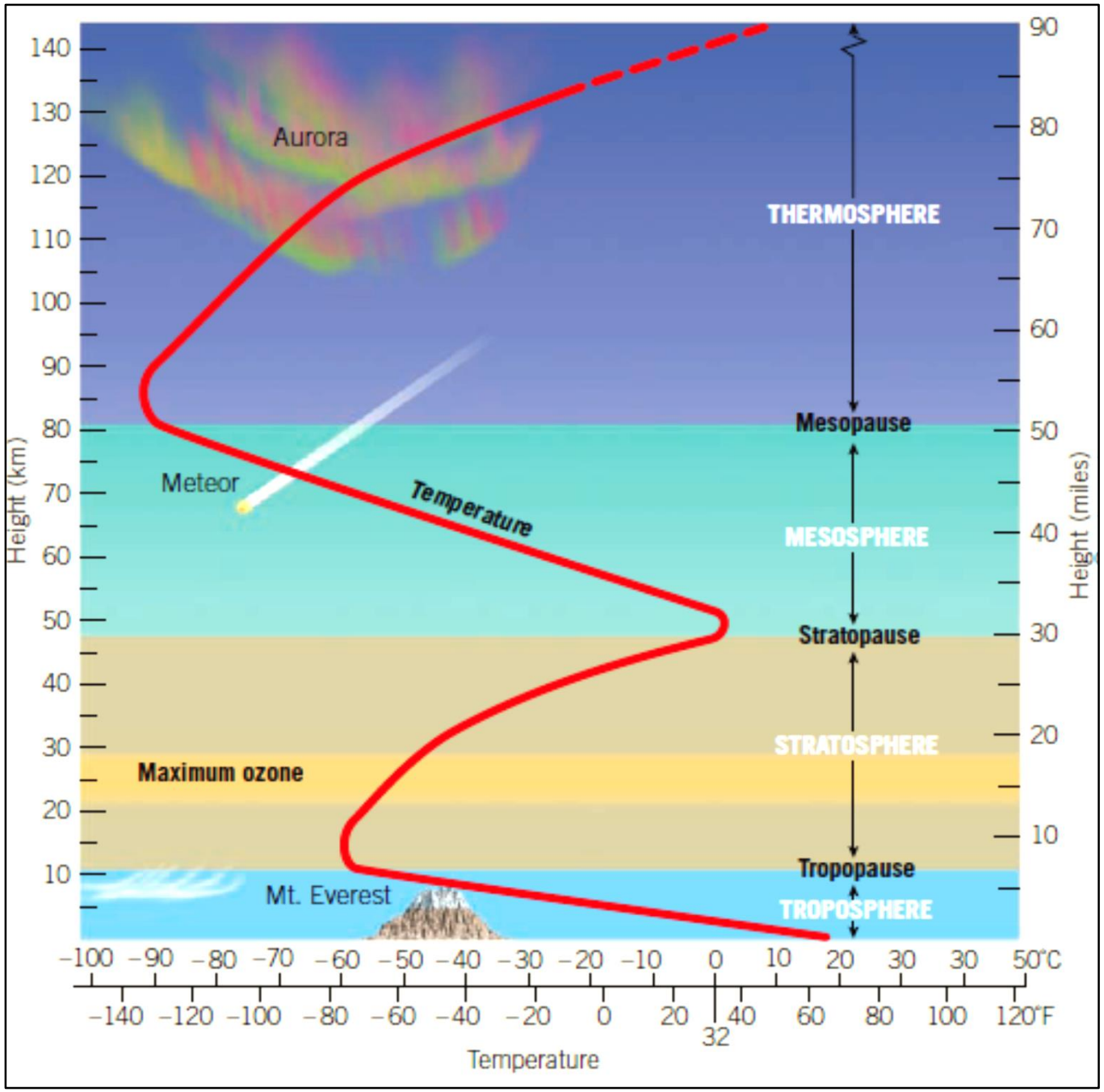
- ***Thermosphere**:* The outermost layer of the atmosphere, which lies between 82 and 700 km, is called the thermosphere. It holds less than 1% of the atmosphere's gas molecules. Temperature increases with elevation in this layer because its gases absorb short-wavelength solar energy. In fact, the temperature at the top becomes very high. But because the thermosphere has so little gas, it contains very little heat, so an astronaut walking in space at an elevation of 200 km doesn't feel hot.

- ***Exosphere**:* The layer between 700 and 10,000 km, known as the exosphere, represents a gradual transition between the atmosphere and beyond. At 10,000 km, the gas concentration becomes the same as interplanetary space.

The three types of oxygen protects us from harmful radiations



Layers of the atmosphere



Atmospheric Composition

Nitrogen (N_2) = 78.08%

Oxygen (O_2) = 20.95%

Argon (Ar) = 0.93%

All other gases, 0.04%

Carbon dioxide (CO_2) = 0.035%

Neon (Ne) = 0.0018%

Helium (He) = 0.00052%

Methane (CH_4) = 0.00014%

Krypton (Kr) = 0.00010%

Nitrous oxide (N_2O) = 00005%

Hydrogen (H_2) = 0.00005%

Ozone (O_3) = 0.000007%

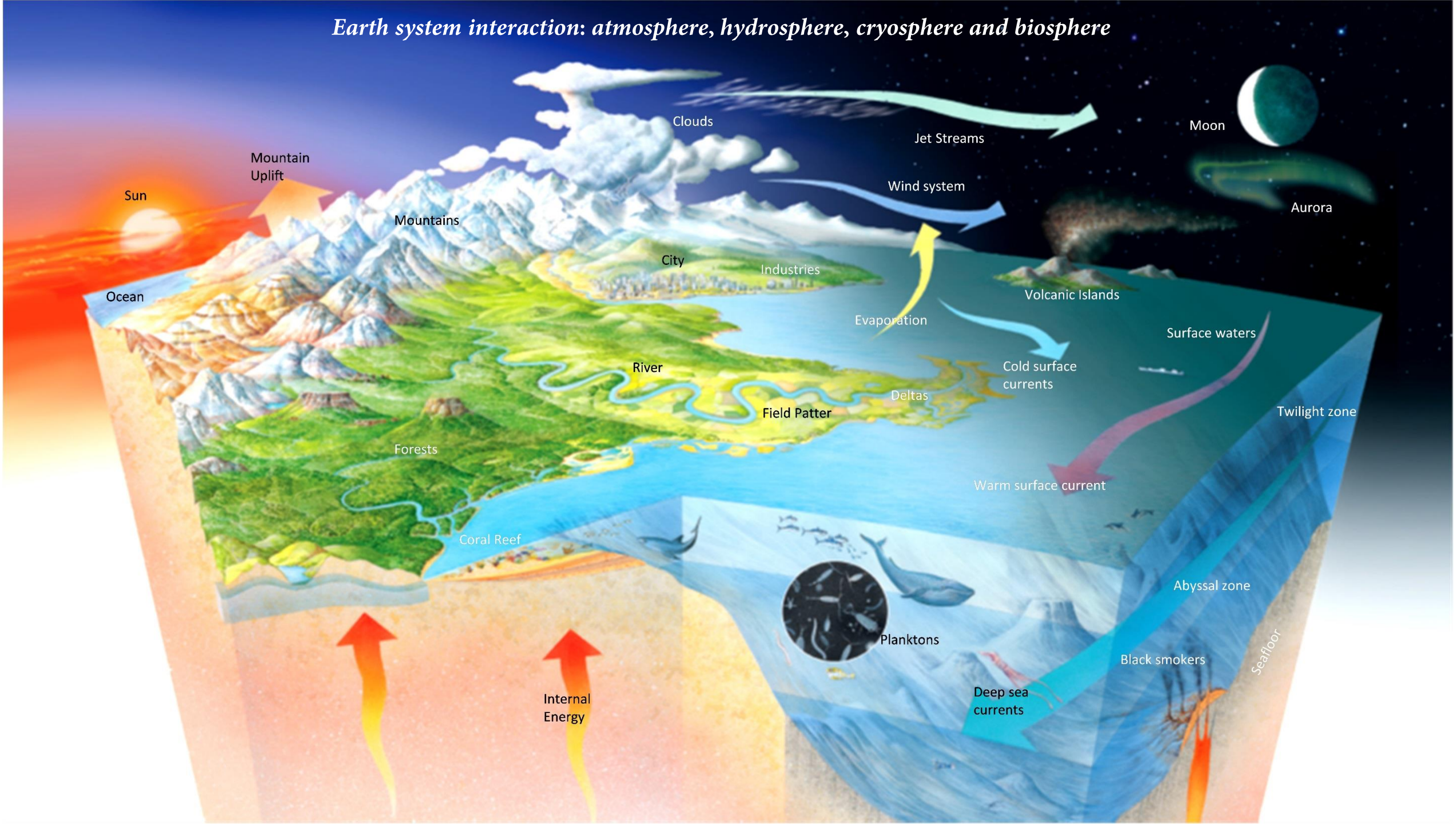
Atmospheric Layers based on Composition

The air in the lower three layers has essentially the same proportion of different gases regardless of location. For this reason, atmospheric scientists refer to the troposphere, stratosphere, and mesosphere together as the ***homosphere.*** In contrast, atoms and molecules in the low-density thermosphere collide so infrequently that this layer does not homogenize and is referred as the ***heterosphere.***

The term ***ionosphere*** refers to the interval between 60 and 500 km, so it includes most of the mesosphere and the lower part of the thermosphere. It received its name because in this layer, short-wavelength solar energy strips nitrogen molecules and oxygen molecules of their electrons and transforms them into positive ions. The ionosphere plays an important role in modern communication in that, like a mirror, it reflects radio transmissions from the Earth back down so that they can travel around the curve of the surface.

The ionosphere also hosts a spectacular atmospheric phenomenon, the *aurorae* (*aurora borealis* in the northern hemisphere and *aurora australis* in the southern), which look like undulating, ghostly curtains of varicolored light in the night sky. Aurorae appear when charged particles ejected from the Sun, especially when solar flares erupt, reach the Earth and interact with ions in the ionosphere, making them release energy. This interaction occurs primarily at high latitudes because the Earth's magnetic field traps solar particles and carries them to the poles.

Earth system interaction: atmosphere, hydrosphere, cryosphere and biosphere



Questions to Consider

The actual shape of the Earth is:

- ❑ Geoid
- ❑ Ellipsoid
- ❑ Spheroid
- ❑ Oval

Most of the shooting stars begin burning in the _____.

- ❑ Exosphere
- ❑ Thermosphere
- ❑ Mesosphere
- ❑ Stratosphere

The interaction of charged particles ejected from the Sun with ions in the ionosphere in the northern hemisphere produce a phenomena called:

- ❑ *Aurora*
- ❑ *Aurora borealis*
- ❑ *Aurora australis*
- ❑ All of the above

Most of the ozone in the Earth's atmosphere resides in the _____.

- ❑ Exosphere
- ❑ Thermosphere
- ❑ Mesosphere
- ❑ Stratosphere

Suggested Readings: Earth – Portrait of a Planet by Stephen Marshak

The atmosphere by Lutgens and Tarbuck

Earth's Dynamic Systems by Hamblin and Christiansen

Fundamentals of Physical Geology by Sreepat Jain

Text book of Engineering Geology by N. Chenna Kesavulu