Section 1

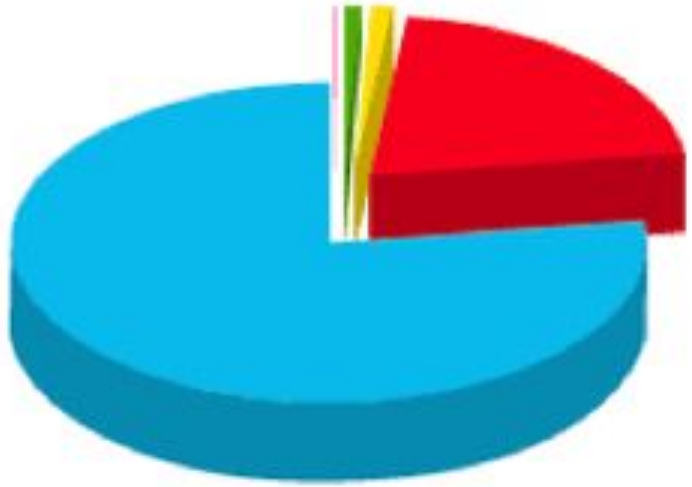
The Atmosphere

A. The **atmosphere**, a layer of gases surrounding Earth

B. The atmosphere is composed of gases, water and other liquids, and microscopic particles of solids.

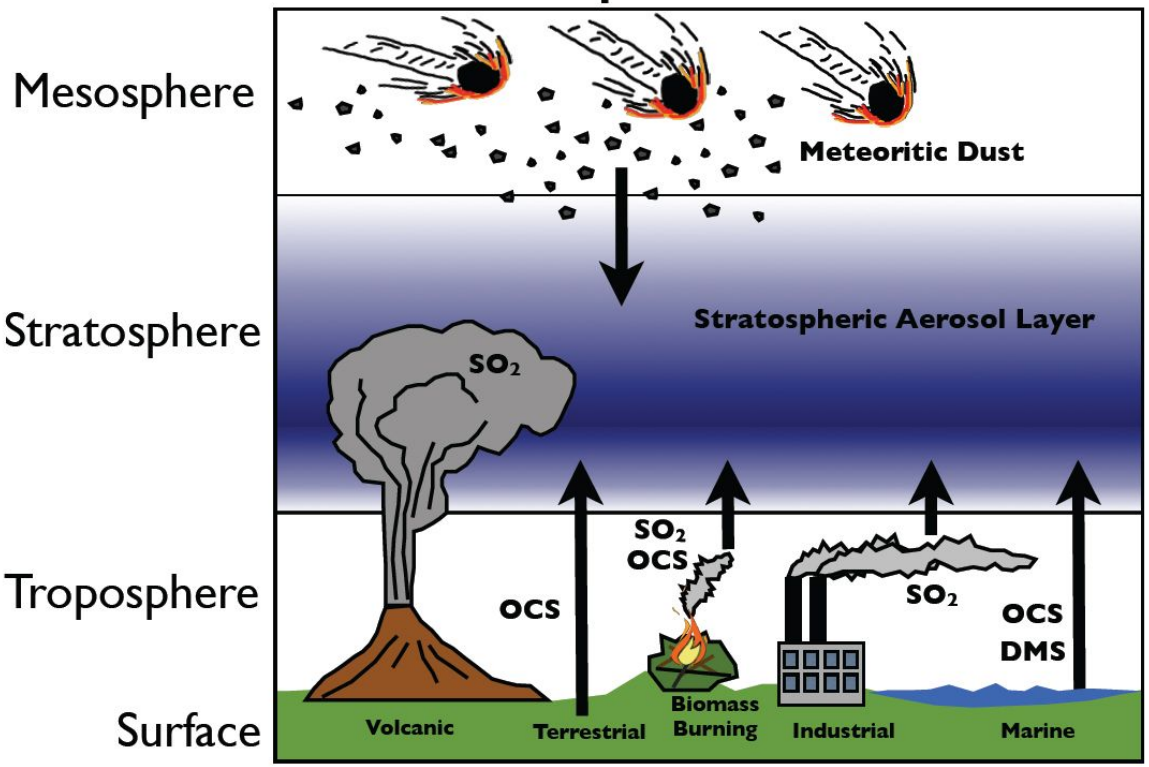
1. Many gases are in the atmosphere.
   a. Nitrogen makes up 78%
   b. Oxygen makes up 21%
   c. Water vapor is responsible for clouds and precipitation.
   d. Carbon dioxide keeps Earth warm and is used by plants to make food.
2. **Aerosols**—solids such as dust, salt, pollen, and tiny acid droplets in the atmosphere

Atmospheric composition



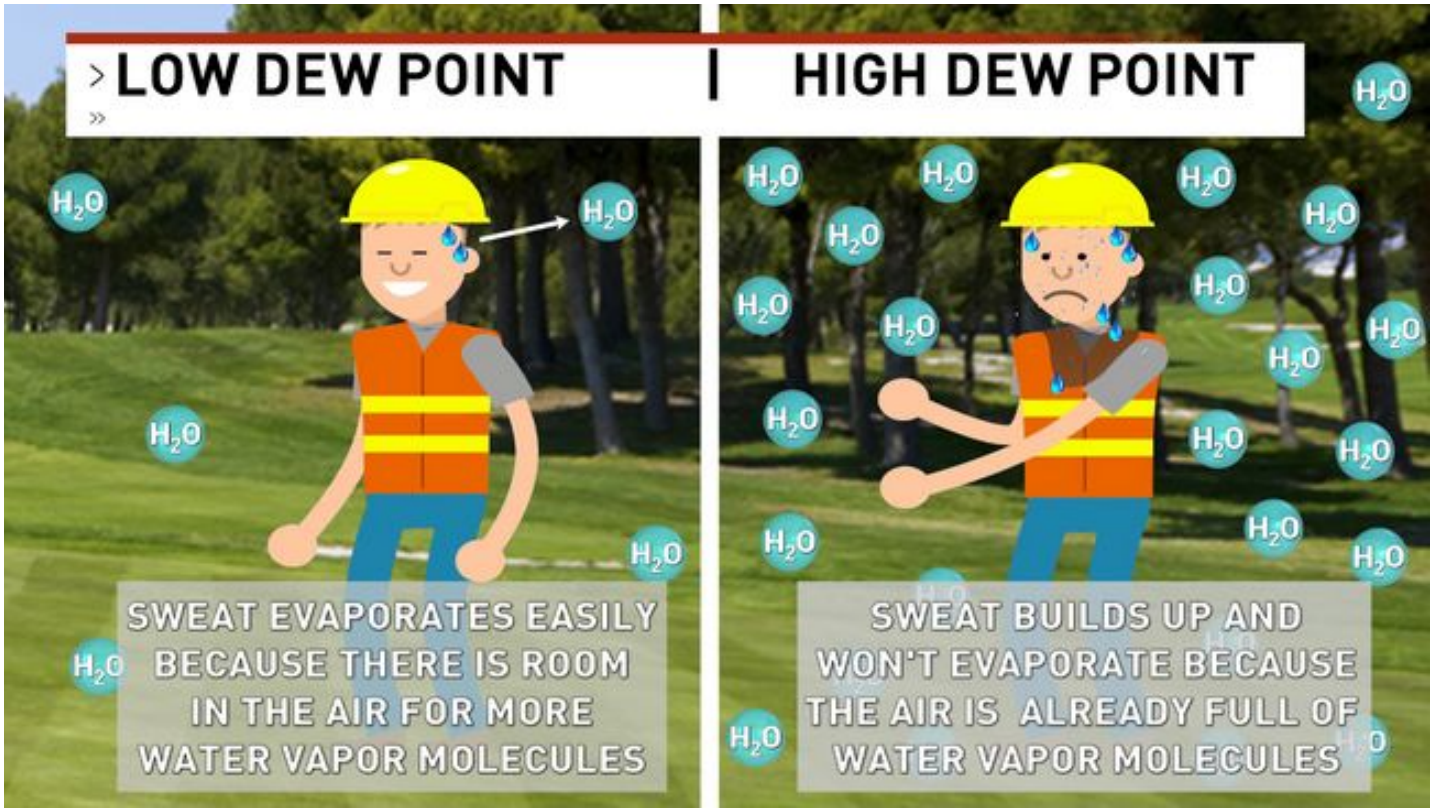
- Nitrogen (N_2), 78.09%
- Oxygen (O_2), 20.95%
- Argon (Ar), 0.93%
- Carbon dioxide (CO_2), 0.038%
- Minute traces of neon (Ne), helium (He), methane (CH_4), water vapor (H_2O), krypton (Kr), hydrogen (H), xenon (Xe), and ozone (O_3).

Sources of Stratospheric Aerosols

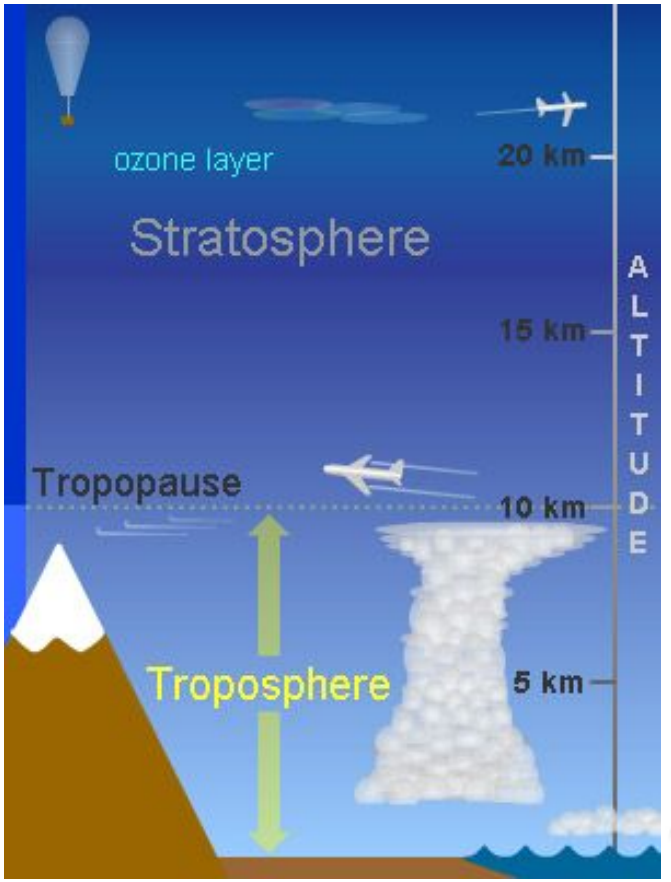


B. **Humidity**—the amount of water vapor in the air

1. Temperature affects how much moisture is in the air.
2. **Dewpoint**—when the air is holding as much water vapor as it can
3. **Relative humidity**—a measure of the amount of water vapor present compared to the amount that could be held at a specific temperature


LOW DEW POINT
HIGH DEW POINT
SWEAT EVAPORATES EASILY BECAUSE THERE IS ROOM IN THE AIR FOR MORE WATER VAPOR MOLECULES
SWEAT BUILDS UP AND WON'T EVAPORATE BECAUSE THE AIR IS ALREADY FULL OF WATER VAPOR MOLECULES

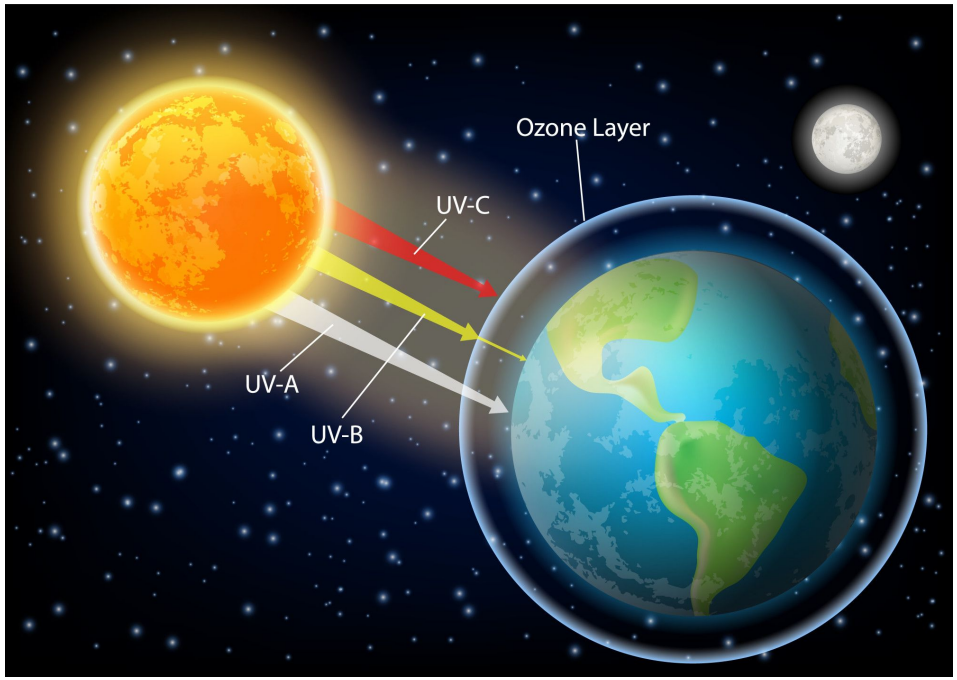

storm TRACK 7
Why Do We Sweat?
BODY TEMPERATURE
98.6°
Our bodies like to stay near 98.6°.
So when our body temperature rises...
...sweat is released from our skin.
The water from the sweat evporates...
...which draws heat out of the body through a process known as evaporative cooling.
WATER VAPOR
HEAT
SWEAT
On muggy days, sweat fails to evaporate from your skin, keeping you warmer and leaving you feeling 'sticky'.

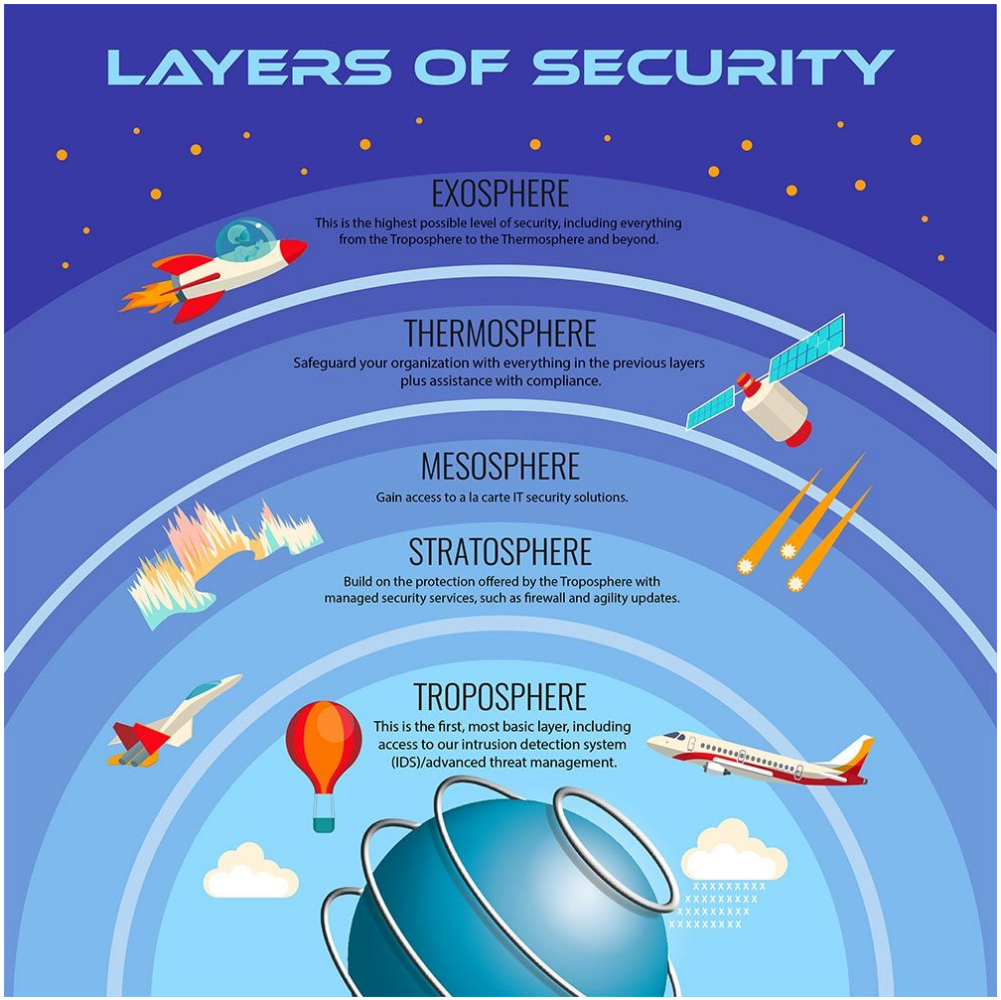


C. The atmosphere is divided into layers.

1. **Troposphere**—from surface to about 10 km
   - **a.** Contains most clouds and weather
   - **b.** Most of the troposphere's heat is from Earth.
   - **c.** Temperature cools about 6.5 degrees Celsius per kilometer of altitude.

2. **Stratosphere**—from 10 km to 50 km above Earth, this layer contains ozone that absorbs much of the Sun's ultraviolet radiation.





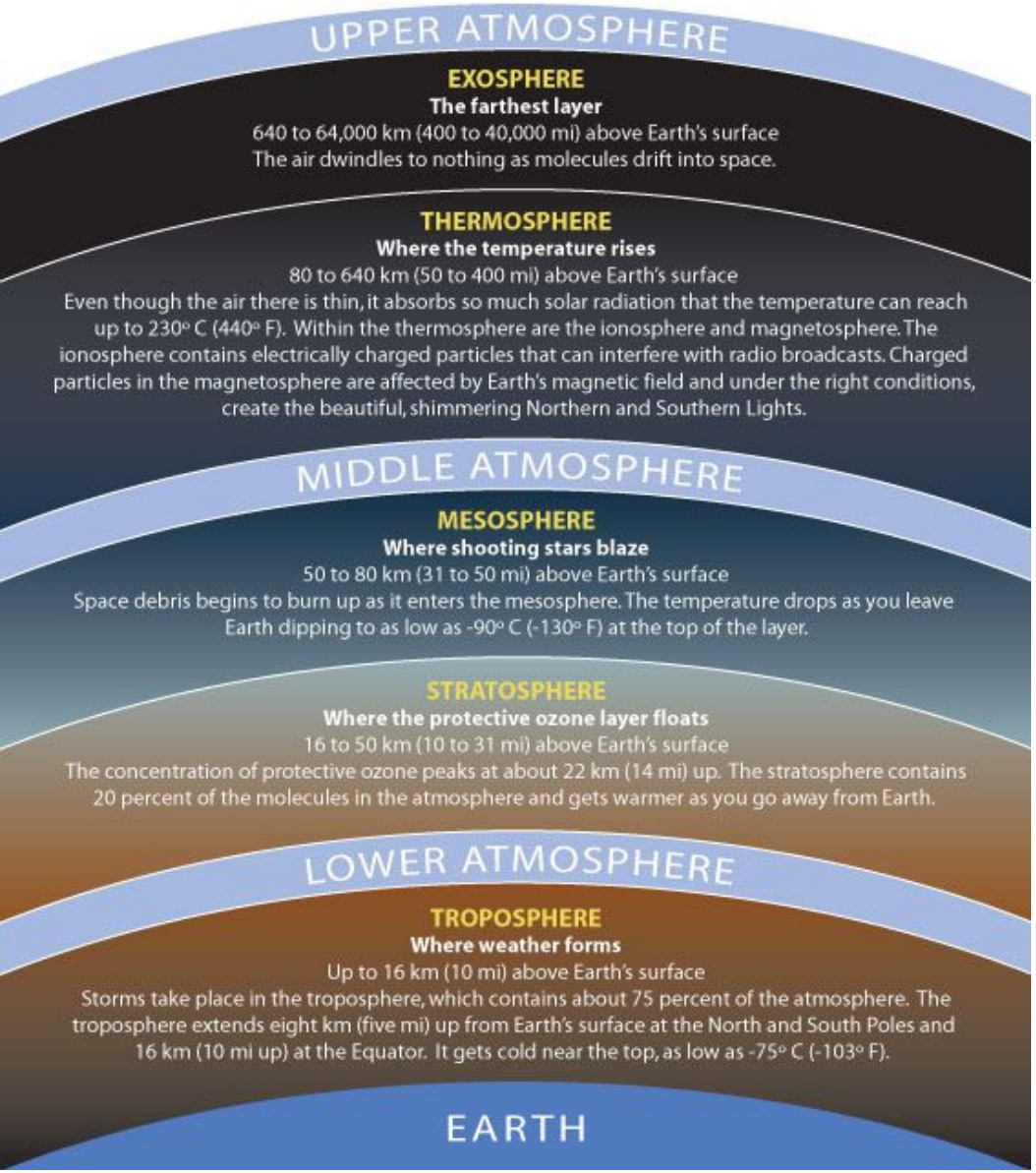
3. Upper layers include the mesosphere (50 to 85 km above surface), thermosphere (85 to 500 km above surface), and the exosphere.

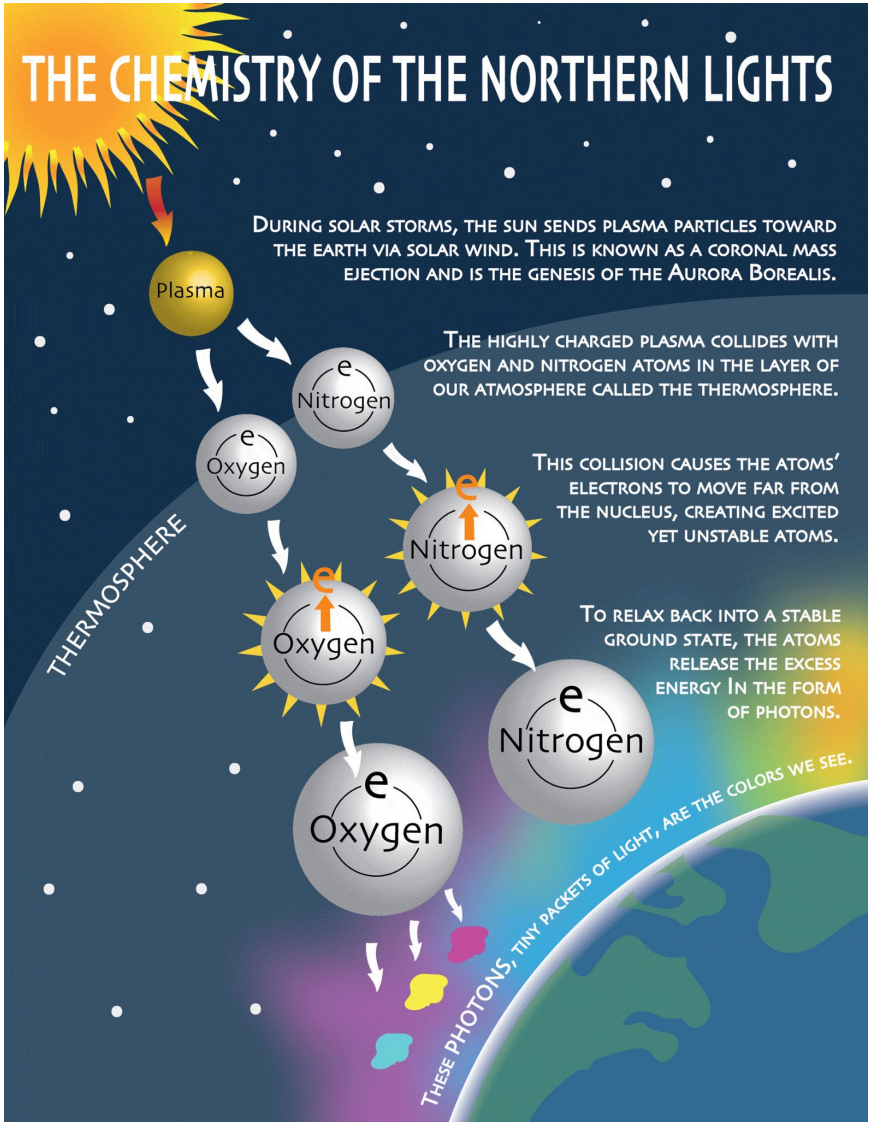
   a. Mesosphere—coldest layer with little ozone

   b. Thermosphere—warms as it filters out X-rays and gamma rays from the Sun

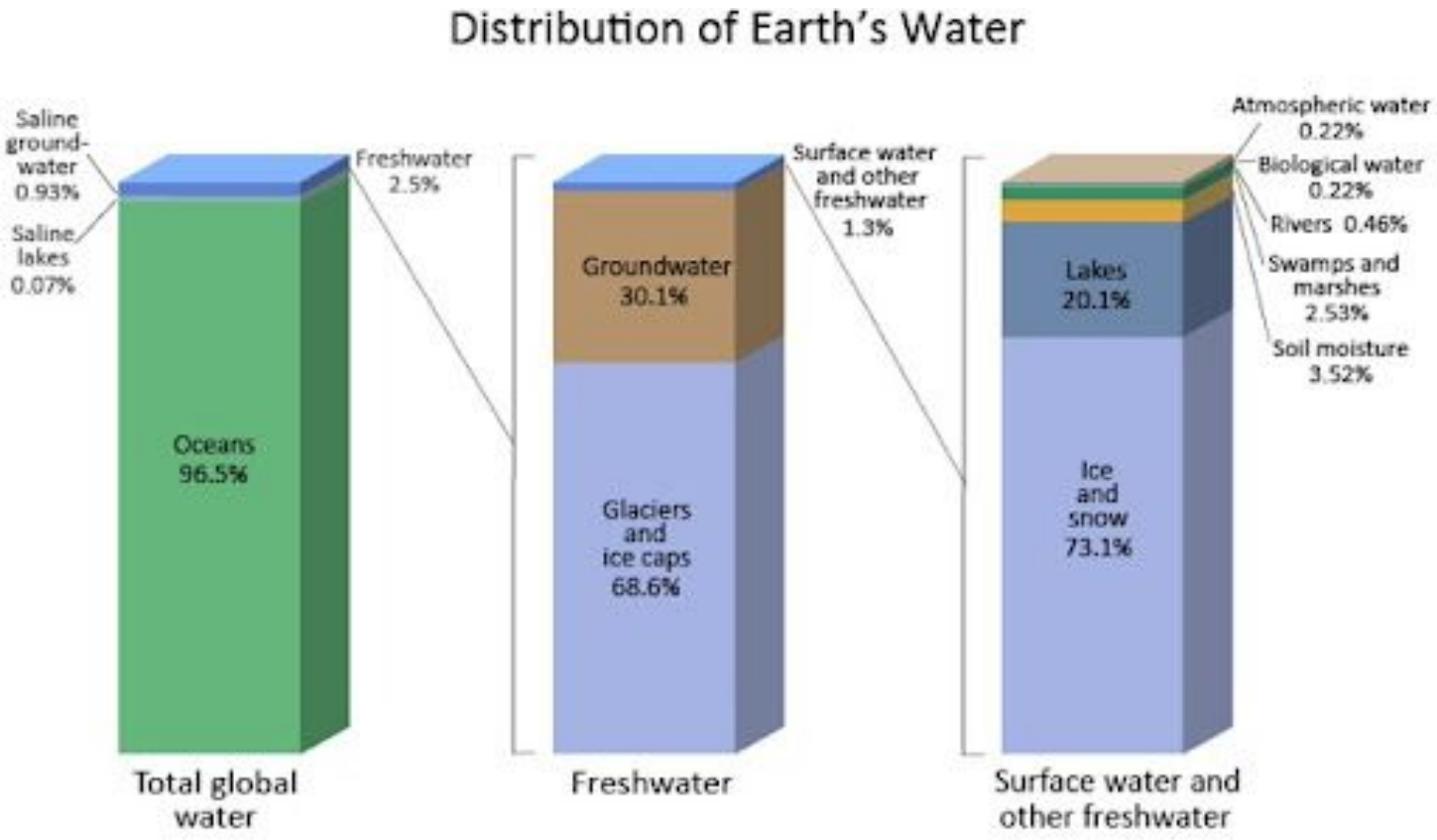
   c. Exosphere contains few atoms and extends into space without a clear boundary

D. Water—makes up about 70% of Earth's surface


UPPER ATMOSPHERE
EXOSPHERE
The farthest layer
640 to 64,000 km (400 to 40,000 mi) above Earth's surface
The air dwindles to nothing as molecules drift into space.
THERMOSPHERE
Where the temperature rises
80 to 640 km (50 to 400 mi) above Earth's surface
Even though the air there is thin, it absorbs so much solar radiation that the temperature can reach up to 230° C (440° F). Within the thermosphere are the ionosphere and magnetosphere. The ionosphere contains electrically charged particles that can interfere with radio broadcasts. Charged particles in the magnetosphere are affected by Earth's magnetic field and under the right conditions, create the beautiful, shimmering Northern and Southern Lights.
MIDDLE ATMOSPHERE
MESOSPHERE
Where shooting stars blaze
50 to 80 km (31 to 50 mi) above Earth's surface
Space debris begins to burn up as it enters the mesosphere. The temperature drops as you leave Earth dipping to as low as -90° C (-130° F) at the top of the layer.
STRATOSPHERE
Where the protective ozone layer floats
16 to 50 km (10 to 31 mi) above Earth's surface
The concentration of protective ozone peaks at about 22 km (14 mi) up. The stratosphere contains 20 percent of the molecules in the atmosphere and gets warmer as you go away from Earth.
LOWER ATMOSPHERE
TROPOSPHERE
Where weather forms
Up to 16 km (10 mi) above Earth's surface
Storms take place in the troposphere, which contains about 75 percent of the atmosphere. The troposphere extends eight km (five mi) up from Earth's surface at the North and South Poles and 16 km (10 mi up) at the Equator. It gets cold near the top, as low as -75° C (-103° F).
EARTH


THE CHEMISTRY OF THE NORTHERN LIGHTS
DURING SOLAR STORMS, THE SUN SENDS PLASMA PARTICLES TOWARD THE EARTH VIA SOLAR WIND. THIS IS KNOWN AS A CORONAL MASS EJECTION AND IS THE GENESIS OF THE AURORA BOREALIS.
Plasma
THE HIGHLY CHARGED PLASMA COLLIDES WITH OXYGEN AND NITROGEN ATOMS IN THE LAYER OF OUR ATMOSPHERE CALLED THE THERMOSPHERE.
e
Nitrogen
e
Oxygen
THIS COLLISION CAUSES THE ATOMS' ELECTRONS TO MOVE FAR FROM THE NUCLEUS, CREATING EXCITED YET UNSTABLE ATOMS.
e
Nitrogen
THERMOSPHERE
e
Oxygen
TO RELAX BACK INTO A STABLE GROUND STATE, THE ATOMS RELEASE THE EXCESS ENERGY IN THE FORM OF PHOTONS.
e
Nitrogen
e
Oxygen
THESE PHOTONS, TINY PACKETS OF LIGHT, ARE THE COLORS WE SEE.

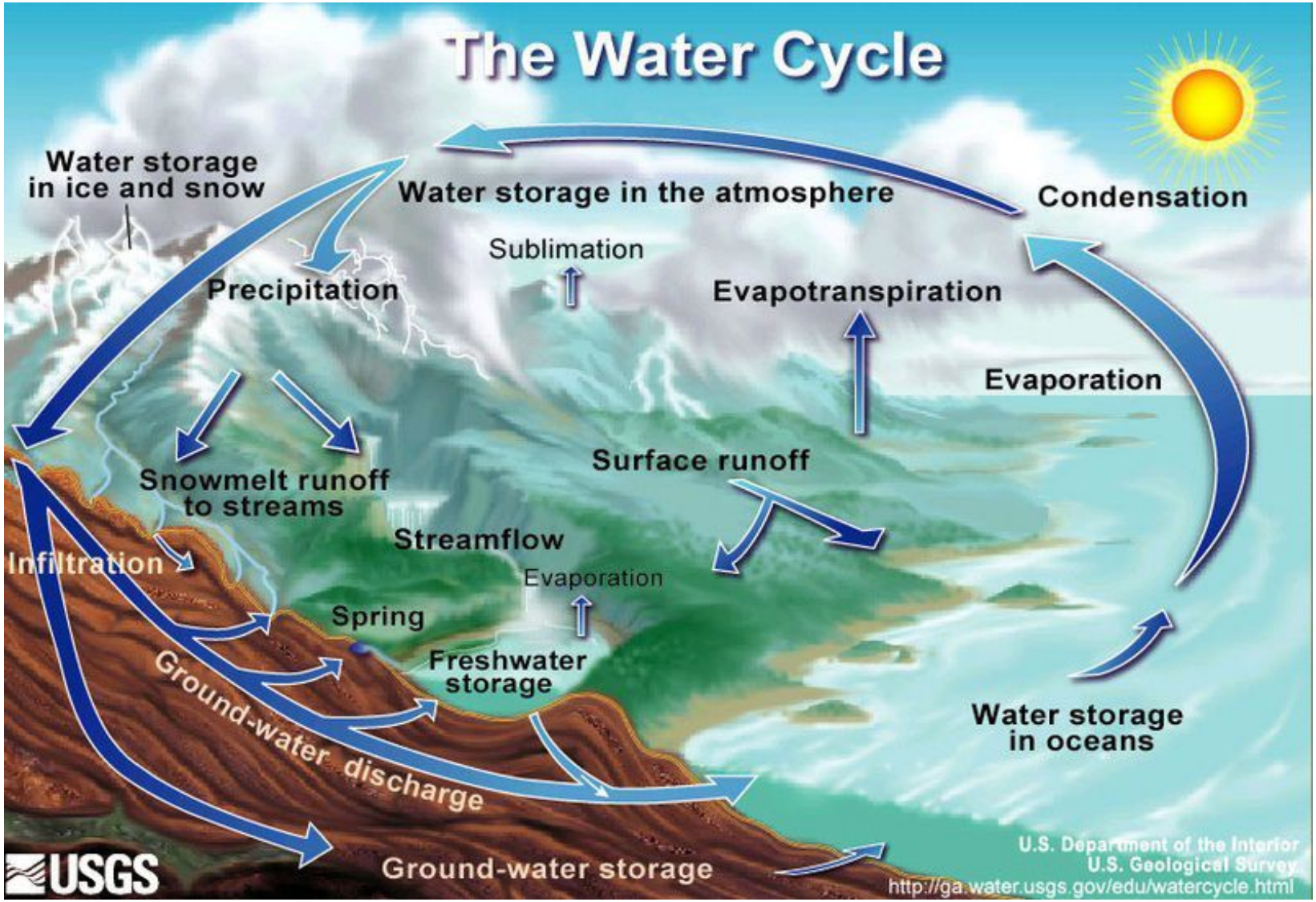
D. Water—makes up about 70% of Earth's surface



Source: Igor Shiklomanov's chapter "World fresh water resources" in Peter H. Gleick (editor), 1993, Water in Crisis: A Guide to the World's Fresh Water Resources.

E. **Water cycle**—water is in constant motion.

1. Sun provides water cycle's energy.
2. Water on the surface absorbs heat and evaporates, entering the atmosphere.
3. Condensation—water vapor changes back into liquid.
4. Clouds of water become heavy and water falls to Earth as precipitation.
5. The cycle repeats itself continuously.


The Water Cycle
Water storage in ice and snow
Water storage in the atmosphere
Condensation
Sublimation
Precipitation
Evapotranspiration
Evaporation
Surface runoff
Snowmelt runoff to streams
Streamflow
Infiltration
Evaporation
Spring
Freshwater storage
Ground-water discharge
Water storage in oceans
Ground-water storage
USGS
U.S. Department of the Interior
U.S. Geological Survey
http://ga.water.usgs.gov/edu/watercycle.html