The earth

Generally, atmosphere layers are hot if they contain gases that absorb some of the light that penetrates to that depth. Transparent layers are cool. The temperature of a layer is generally found by the balance between absorption of solar radiation (heating) and the emission of radiation (cooling). A planet reaches a temperature at which there is a balance between absorption of solar radiation and the emission of infrared radiation by the planet’s surface.

The material in the atmosphere, which absorbs solar radiation most actively in ozone. Ozone absorbs electromagnetic waves in the ultra-violet wavelength band. It mainly resides in the stratosphere. Nevertheless, emission and absorption of terrestrial radiation occur at any levels, and the amounts are larger as temperature is higher. Absorption of solar radiation, on the other hand, is mostly limited to the ozone layer. Therefore, resulting equilibrium temperature is high in the ozone layer and low elsewhere.

The part of solar radiation that transmit through the ozone layer, though somewhat absorbed in atmospheric constituents and clouds, mostly arrives at the surface (of sea and land) and is absorbed there. In the troposphere, the atmosphere tend to lose energy by radiation alone, but it is compensated by the energy transfer from the surface by means of vertical motion of air (i. e. by convection), and relatively high temperature is maintained. The vertical distribution of temperature in the troposphere is essentially determined as the result of convection.

The atmosphere emits terrestrial radiation downward as well as upward. Therefore, terrestrial radiation from the atmosphere arrives at the surface in addition to solar radiation transmitted through the atmosphere. The atmosphere, containing water vapor and carbon dioxide, also absorbs a large part of terrestrial radiation emitted by the surface. The surface air temperature in reality (approximately 287 K) is significantly higher than the temperature of the radiation emitted by the earth to space (255 K), because of the effect of the atmosphere absorbing and re-emitting terrestrial radiation. Stratospheric cooling and tropospheric warming are intimately connected, not only through radiative processes, but also through dynamical processes, such as the formation, propagation and absorption of planetary waves. At present not all causes of the observed stratospheric cooling are completely understood.

The Earth's rotational axis is inclined 23. 5 degrees from the perpendicular to the plane of the Earth's orbit. The orientation of the Earth's axis relative to the Sun and its rays changes continuously as our planet speeds along its orbital path. Twice a year the Earth's axis is positioned perpendicular to the Sun's rays, when all places on Earth except the poles experience equal periods of daylight and darkness. These times are the equinoxes, the first days of spring and fall, and they occur on or about March 21 and September 23, respectively.

As the Earth orbits the Sun, the inclined axis causes the Northern Hemisphere to tilt towards the Sun for half of the year, i. e. the spring and summer seasons in North America. During this time, more than half of the Northern Hemisphere is in sunlight at any instant of time. During the other half of the year, i. e. the fall and winter seasons in North America, the axis tilts away and less than half of the Northern Hemisphere is in sunlight. The tilting of the Southern Hemisphere relative to the Sun's rays progresses in opposite fashion, reversing its seasons relative to those in the Northern

Hemisphere. The changing orientation of the Earth's axis to the Sun's rays determines the length of daylight and the path of the Sun as it passes through the sky at every location on Earth. The continuous change in the angular relationship between the Earth's axis and the Sun's rays causes the daily length of daylight to vary throughout the year everywhere on Earth except at the equator.

At the equator the daily period of daylight is the same day after day. The changing path of the Sun through the sky produces over the year a cyclical variation in the amounts of solar radiation received that exhibit maximum near the equinoxes and minimum near the solstices. The relatively little variation in the amounts of solar energy received over the year produces seasons quite different from those experienced at higher latitudes. Away from the tropics, the variations in the amounts of solar radiation received over the year increase as latitude increases. The amounts of sunlight received exhibit one minimum and one maximum in their annual swings. The poles have the greatest range since the Sun is in their skies continuously for six months and then below the horizon for the other half year.

All seasonal changes are driven by changes in the amount of the Sun's energy reaching the Earth's surface (i. e., the amount of insolation). For example, more energy leads to higher temperatures, which results in more evaporation, which produces more rain, which starts plants growing. This sequence describes spring at mid-latitudes. Since visible light is the main form of solar energy reaching Earth, day length is a reasonably accurate way to gauge the level of insolation and has long been used as a way to understand when one season stops and the next one starts.

Temperature is a number that is related to the average kinetic energy of the molecules of a substance. If temperature is measured in Kelvin degrees, then this number is directly proportional to the average kinetic energy of the molecules. Heat is a measurement of the total energy in a substance. That total energy is made up of not only of the kinetic energies of the molecules of the substance, but total energy is also made up of the potential energies of the molecules. So, temperature is not energy. It is, though, a number that relates to one type of energy possessed by the molecules of a substance.

Because adding heat energy usually results in a temperature rise, people often confuse heat and temperature. In common speech, the two terms mean the same: “ I will heat it” means I will add heat; “ I will warm it up” means I will increase the temperature. No one usually bothers to distinguish between these. Adding heat, however, does not always increase the temperature. For instance, when water is boiling, adding heat does not increase its temperature. This happens at the boiling temperature of every substance that can vaporize. At the boiling temperature, adding heat energy converts the liquid into a gas without raising the temperature.

When energy is added to a liquid at the boiling temperature, its converts the liquid into a gas at the same temperature. In this case, the energy added to the liquid goes into breaking the bonds between the liquid molecules without causing the temperature to change. The same thing happens when a solid changes into liquid. For instance, ice and water can exist together at the melting temperature. Adding heat to ice-water slush will convert some of the ice to water without changing the temperature. In general, whenever there is a change of state, such as the solid-liquid or the liquid-gas transition, heat energy can be added without a temperature change. The change of state requires energy; so added energy goes into that instead of increasing the temperature.

The Celsius scale has been calibrated to the physical properties of pure water. It illustrates the significance of water as physical matter in all forms. The normal freezing point of water was set as 0 °C and the normal boiling point of water was set at 100 °C.

Mirages are optical phenomena produced by refraction of light rays through air layers with large temperature gradients. An inferior mirage (i. e. it appears below its actual position) occurs when the temperature initially decreases rapidly with height. Light rays from the sky moving through the layers will be refracted upward in the less dense air (i. e. bent toward the denser air) giving the appearance of a layer of water. When seen from the ground or water a superior mirage (i. e. it appears above its actual position) occurs when there is a pronounced inversion near the surface, and normally over the sea or a large body of water. A distant object within the inversion layer, even something below the horizon, will appear in the sky above its actual position – possibly totally upside down or the upper portion upside down, but certainly distorted and wavering.

A rainbow is the atmospheric optical phenomenon observed by solar light's being reflected and refracted by the round water drops floating in the air. Because the refraction angle varies in the wavelength of the light, rainbow seems divided into seven colors from inside blue to outer red. The observer will see this concentration of reflected light rays as an intensified colored light band. This band consists of the first reflection rays from all the raindrops which lie on the surface of a cone, subtended at the observers eye, with an angular radius of 42° from an axis line drawn from the sun (directly behind the observer) through the observer's head and extended down-sun to the antisolar point i. e. below the horizon where the shadow of the observer's head might be.

The Parhelia. When ice crystals are distributed on some condition in the sky, we can observe the lumps of light like the two suns in both sides of real sun. In case that ice crystals are distributing at random, the refracted light of 22 degrees by the solar light forms the " 22 degrees halo". But when crystal distributed being their bottom plate paralleling to the ground is superior, only refracted solar light on the right and left of the sun 22 degrees apart reaches observer. These refracted lights are detected as the Parhelia. It sometimes seems that some colors are separated like a rainbow.

Circumzenithal arc. Refraction through the edges of plate crystals with nearly horizontal bases may produce a circumzenithal arc which is part of a circle, possibly one third, centered directly above the observer's head and above the sun, just outside the 46° halo position. The halo may also be visible. The circumzenithal arc cannot occur when the sun's elevation exceeds 32°.

Wave clouds. When air is lofted over a mountain range, it cools, saturates and condenses a windward-side cloud. The air surmounting the summit is just about at saturation, sometimes withrespectto ice and at other times with respect to water, depending on the temperature and the height of the mountain barrier. Forcing air up over the overlying atmosphere causes a spring-like rebound and so the air stream downwind from the mountain barrier often undergoes an undulatory wave-like motion. At the crest of such waves, the airmass is supersaturated and a “ wave-cloud” condenses out.