IONOSPHERE PROPAGATION

The **ionosphere** is a part of the upper atmosphere, from about 85 km to 600 km altitude, comprising portions of the mesosphere, thermosphere, and exosphere, thermosphere and exosphere, distinguished because it is ionized by solar radiation. It plays an important part in atmospheric electricity and forms the inner edge of the magnetosphere. It has practical importance because, among other functions, it influences radio wave Propagation to distant places on the earth.

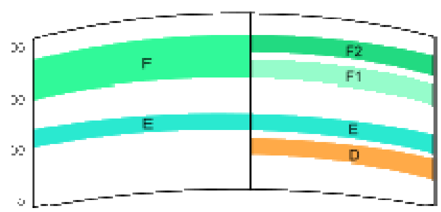
In a region extending from a height of about 90 km to over thousands of kms, most of the molecules of the atmosphere are ionized by radiation from the Sun. This region is called the *ionosphere*

At greater heights- intensity of ionizing radiation is very high, few molecules are available for ionization, ionization density is *low*

As height decreases- more molecules are available due to reduced atmospheric pressure, ionization density is higher (closer to the earth)

But as height decreases further, ionization density decreases though more molecules are available since the energy in the ionizing radiation has been used up to create ions.

Hence, ionization is different at different heights above the earth and is affected by time of day and solar activity



Ionospheric Layers

At the night the F layer is the only layer of significant ionization present, while the ionization in the D and E layers is extremely low. During the day, the D and E layers become much more heavily ionized, as does the F layer which develops an additional weaker region of ionization known as the F1 layer. The F2 layer persists by day and night and is the region mainly responsible for the refraction of radio waves.

D Layer:

The D layer is the innermost layer, 60 km to 90 km above the surface of the Earth. Ionization here is due to Lyman series alpha hydrogen radiation at a of 121.5 nanometer (nm).. In addition, with high solar activity hard X rays (wavelength < 1 nm) may ionize (N_2, O_2). During the night cosmic rays produce a residual amount of ionization. Recombination is high in the D layer, the net ionization effect is low, but loss of wave energy is great due to frequent collisions of the electrons (about ten collisions every msec). As a result high-frequency (HF) radio waves are not reflected by the D layer but suffer loss of energy therein. This is the main reason for absorption of HF radio waves, particularly at 10 MHz and below, with progressively smaller absorption as the frequency gets higher. The absorption is small at night and greatest about midday. The layer reduces greatly after sunset; a small part remains due to galactic cosmic rays. A common example of the D layer in action is the disappearance of distant AM broadcast band stations in the daytime.

E Layer:

The E layer is the middle layer, 90 km to 120 km above the surface of the Earth. Ionization is due to soft X-ray (1-10 nm) and far ultraviolet (UV) solar radiation ionization of molecular oxygen(O_2). Normally, at oblique incidence, this layer can only reflect radio waves having frequencies lower than about 10 MHz and may contribute a bit to absorption on frequencies above. However, during intense Sporadic E events, the E_S layer can reflect frequencies up to 50 MHz and higher. The vertical structure of the E layer is primarily determined by the competing effects of ionization and recombination. At night the E layer rapidly disappears because the primary source of ionization is no longer present. After sunset an increase in the height of the E layer maximum increases the range to which radio waves can travel by reflection from the layer.

E_S

The E_S layer (sporadic E-layer) is characterized by small, thin clouds of intense ionization, which can support reflection of radio waves, rarely up to 225 MHz. Sporadic-E events may last for just a few minutes to several hours. Sporadic E propagation makes radio amateurs very excited, as propagation paths that are generally unreachable can open up. There are multiple causes of sporadic-E that are still being pursued by researchers. This propagation occurs most frequently during the summer months when high signal levels may be reached. The skip distances are generally around1,000 km (620 mi). Distances for one hop propagation can be as close as 900 km [500 miles] or up to 2,500 km (1,600 mi). Double-hop reception over 3,500 km (2,200 mi) is possible.

F Layer:

The F layer or region, also known as the Appleton layer extends from about 200 km to more than 500 km above the surface of Earth. It is the densest point of the ionosphere, which implies signals penetrating this layer will escape into space. At higher altitudes the amount of oxygen ions decreases and lighter ions such as hydrogen and helium become dominant, this layer is the topside ionosphere. Here extreme ultraviolet (UV, 10–100 nm) solar radiation ionizes atomic oxygen. The F layer consists of one layer at night, but during the day, a deformation often forms in the profile that is labeled F_1. The F_2 layer remains by day and night responsible for most skywave propagation of radio waves, facilitating high frequency (HF, or shortwave) radio communications over long distances.

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