Ionosphere

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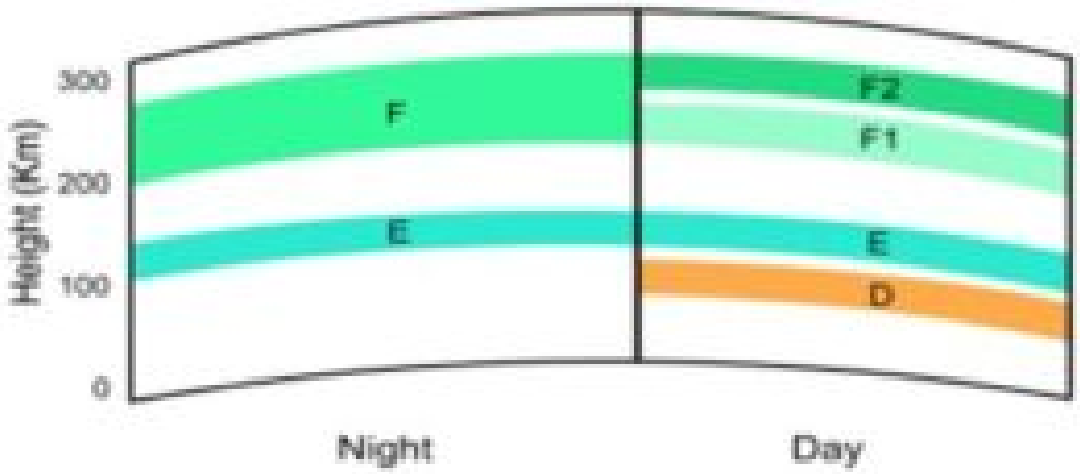
About Ionosphere

- This is the zone containing charged particles called ions. It lies from the upper mesosphere to the thermosphere.
- The charged particles are ionized by absorption of cosmic rays, gamma rays, X-rays and shorter wavelengths of ultraviolet rays.
- It is in this layer that incoming space vehicles and meteorites begin to heat due to friction.
- Above this layer i.e. above 480km, atomic oxygen is prevalent and beyond that first helium is more common and then hydrogen atoms predominate.
- The ionosphere is a deep layer of electrically charged molecules and atoms (which are called ions) in the middle and upper mesosphere and the lower thermosphere, between about 60 and 400 kilometers (40 and 250 miles). The ionosphere is significant because it aids long-distance communication by reflecting radio waves back to Earth.
- It is also known for its auroral displays, such as the “northern lights” that develop when charged atomic particles from the Sun are trapped by the magnetic field of Earth near the poles. In the ionosphere, these particles “excite” the nitrogen molecules and oxygen atoms, causing them to emit light, not unlike a neon light bulb.

Ionospheric Irregularities

- Ionosphere has been divided into different sets of layers during day and night



D Layer

- The D layer explains why the AM Radio gets disturbed during day time, but quite smooth in night time.
- We see in the above graphics that the D layer is the innermost layer, 60 km to 90 km above the surface of the Earth.
- At this layer, the net ionization effect is low, but loss of wave energy is great due to frequent collisions of the electrons.
- This is the reason that the high-frequency (HF) radio waves are not reflected by the D layer but suffer loss of energy therein.
- The absorption is small at night and greatest about midday.
- This causes 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, with the primary source of ionization being soft X-ray (1-10 nm) and far ultraviolet (UV) solar radiation ionization of molecular oxygen (O2).
- This layer disappears in the night because the primary source of ionization is no longer present.
- The practical value of this layer is that it reflects

long radio-waves back to earth, which enables them to be received at a distance, rather than disappear into space. It is also known as HEAVISIDE-KENNELLY LAYER.

F-Layer

- The F LAYER extends from about 200 km to more than 500 km above the surface of Earth.
- The E-layer allows the penetration of short-radio waves, which continue until they reach the APPLETON LAYER.
- The Appleton layer reflects short-radio waves (which have penetrated the HEAVISIDE-KENNELLY LAYER) back to earth.
- This is also supposed to be the region where polar AURORAS occur and where most of the meteors burn themselves out.

Ionospheric Electron Density (IED)

- The ionosphere exists between about 90 and 1000 km above the earth’s surface.
- Radiation from the sun ionizes atoms and molecules here, liberating electrons from molecules and creating a space of free electrons and ions.

Studying IED

- The ionospheric variability is greatly influenced by both solar originated processes and the neutral atmosphere origin.
- Scientists have tried to model the ionosphere using theoretical and empirical techniques; however, the accurate prediction of electron density is still a challenging task.
- In recent years, **Artificial Neural Networks (ANNs)** are showing potential to handle more complex and non-linear problems.

What is Significance of IED

- Due to the ability of ionized atmospheric gases to refract high frequency (HF, or shortwave) radio waves, the ionosphere can reflect radio waves directed into the sky back toward the Earth.
- Radio waves directed at an angle into the sky can return to Earth beyond the horizon.
- This technique, called “skip” or “skywave” propagation, has been used since the 1920s to communicate at international or intercontinental distances.

Aurora

- The luminous effect of electro-magnetic phenomena in the ionosphere is known as Aurora, visible in high latitudes as red, green and white arcs, draperies, streamers, rays and sheets in the night sky, best developed at a height of about 90 km.
- Probably, aurora is the result of magnetic storms and of electrical discharges from the sun during periods of sun-spot activity, causing ionization of gases, though this is still a matter of research.
- It is called the Aurora Borealis (or northern lights) in the northern hemisphere and the Aurora Australis in the southern hemisphere. Occasionally the Aurora borealis is seen in England, but it is more common in northern Scotland, presenting a magnificent spectacle in northern Scandinavia and northern Canada.

Artificial Neural Networks (ANNs)?

- ANNs are computing systems vaguely inspired by the biological neural networks that constitute animal brains.
- Such systems “learn” to perform tasks by considering examples, generally without being programmed with task-specific rules.
- For example, in image recognition, they might learn to identify images that contain cats by analyzing example

images that have been manually labeled as “cat” or “no cat” and using the results to identify cats in other images.

- They do this without any prior knowledge of cats, for example, that they have fur, tails, whiskers and cat-like faces.
- Instead, they automatically generate identifying characteristics from the examples that they process