3.4 IONOSPHERIC CHARACTERISTICS

Ionospheric Effects

rotation and scintillation effects are of major concern for satellite communications. Ionospheric scintillations are variations in the amplitude, phase, polarization, or angle of arrival of radio waves. They are caused by irregularities in the ionosphere which change with time.

Atmospheric Layers

A signal traveling between an earth station and a satellite must pass through the earth's atmosphere, including the ionosphere, as shown

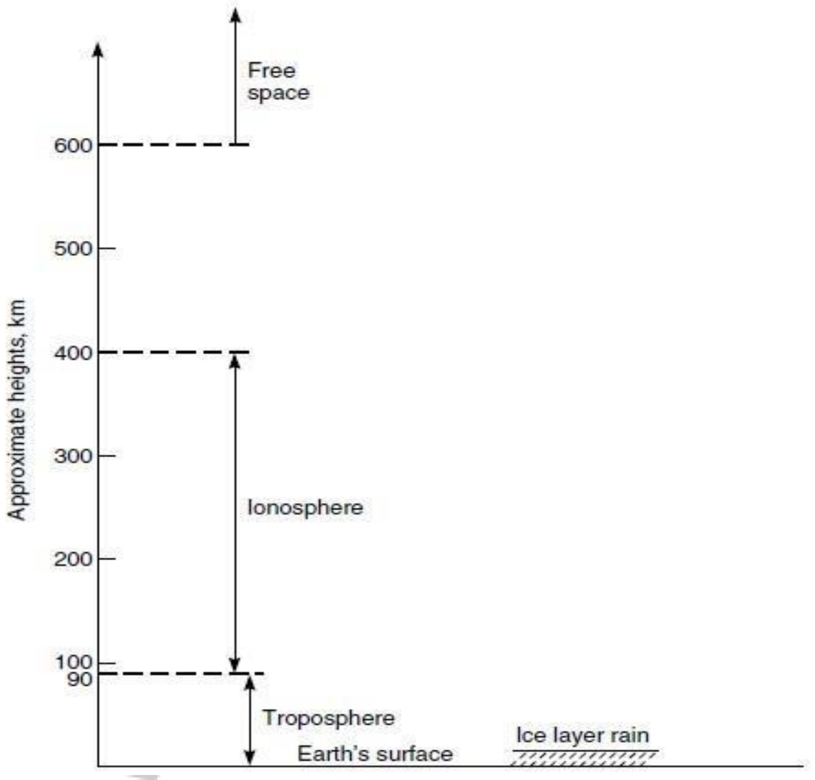
Atmospheric Losses

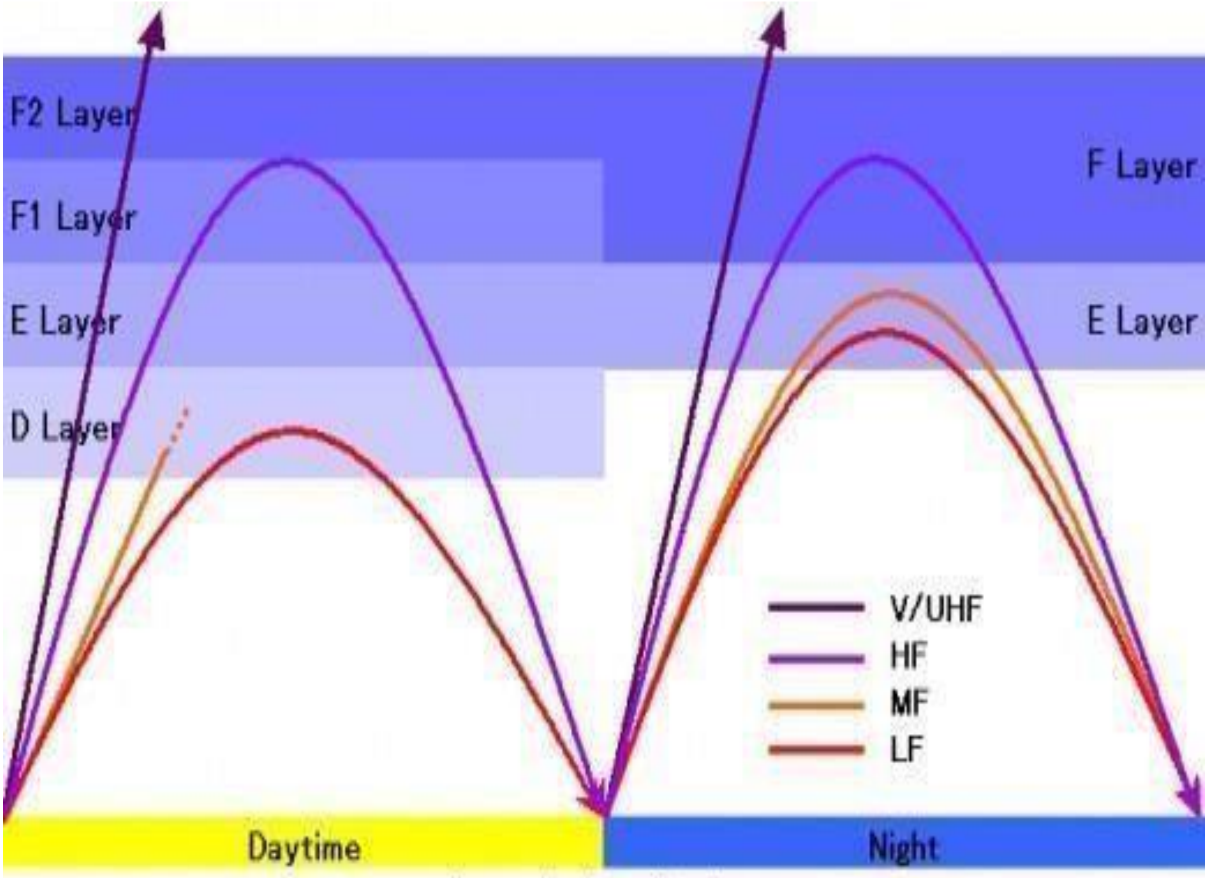
- Losses occur in the earth's atmosphere as a result of energy absorption by the atmospheric gases.
- The weather-related losses are referred to as *atmospheric attenuation* and the absorption losses by gases are known as *absorption.* **Atmospheric scintillation:**
- This is a fading phenomenon, the fading period being several tens of seconds.
- It is caused by differences in the atmospheric refractive index, which in turn results in focusing and defocusing of the radio waves, which follow different ray paths through the atmosphere.
- Fade margin in the link power-budget calculations are used for Atmospheric Scintillation.

IONOSPHERIC EFFECT

Signal degradation:

The ionosphere can cause radio signals transmitted between a satellite and a ground station to scatter, refract, and reflect in unpredictable ways, leading to signal degradation and interference. This can result in reduced signal strength, errors in data transmission, and even loss of communication



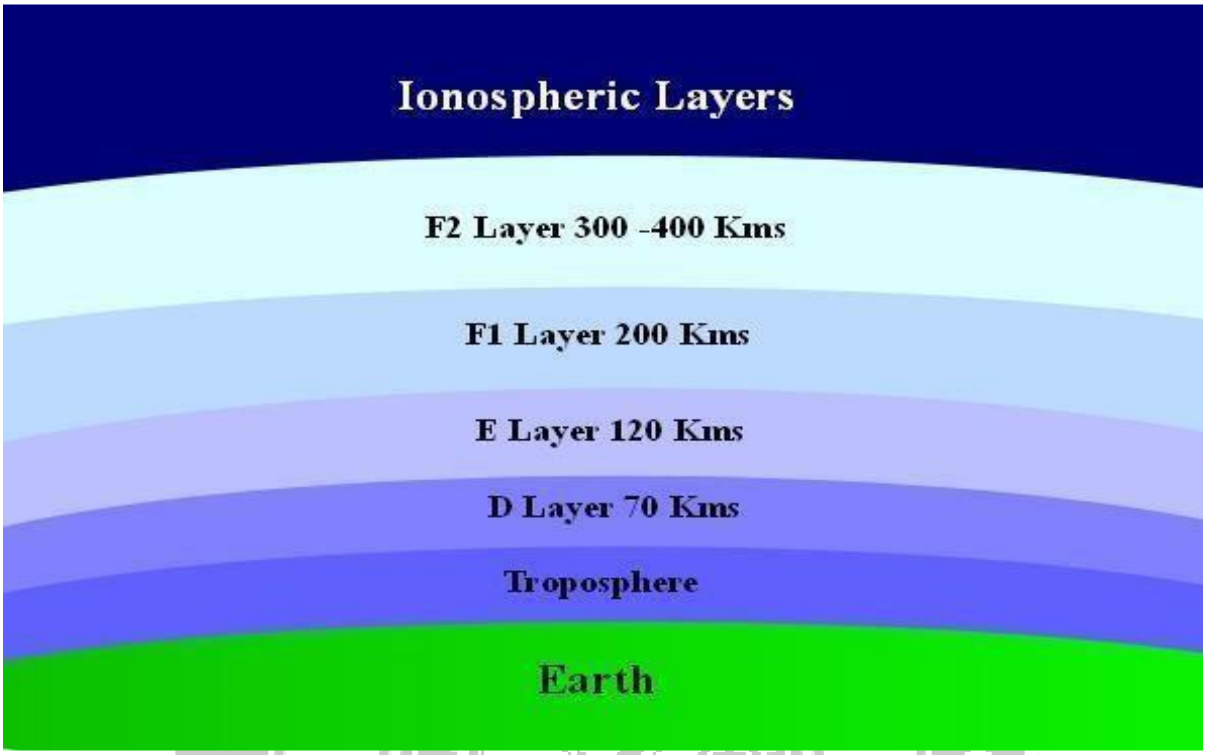


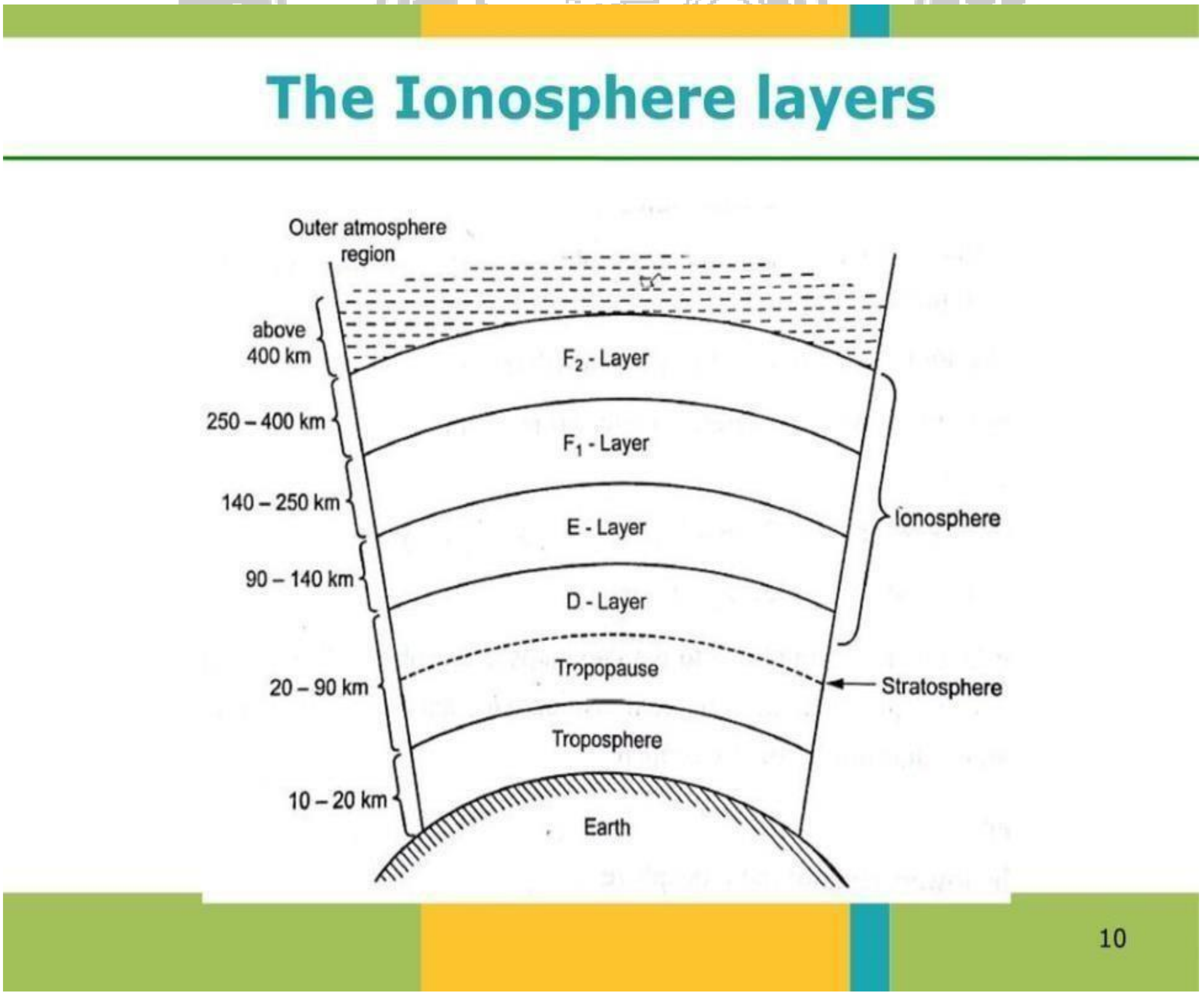
Ionospheric reflection
(under normal condition)

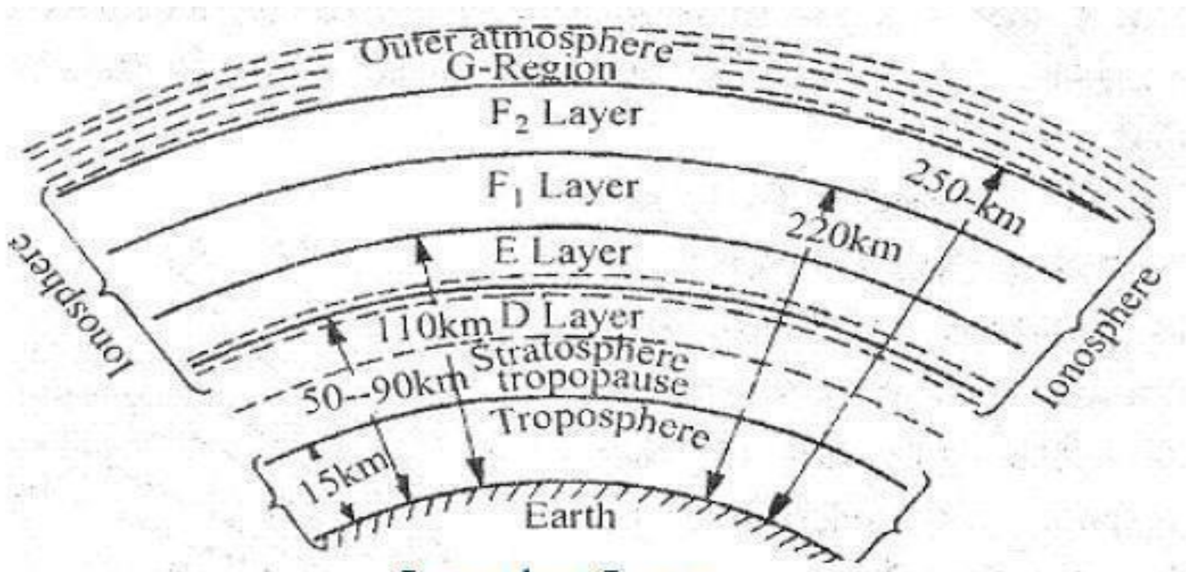
3.6 Ionospheric Effects

- Radio waves traveling between satellites and earth stations must pass through the ionosphere.
- The ionosphere is the upper region of the earth's atmosphere, which has been ionized, mainly by solar radiation.
- The free electrons in the ionosphere are not uniformly distributed but form in layers, which effect the signal.

Ionospheric Layers



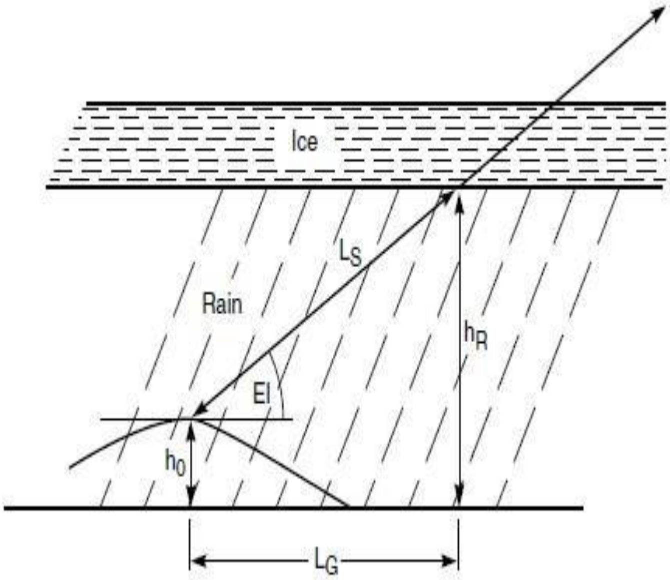




Ionosphere Layers

3.7 Rain Induced Attenuation

- Rain attenuation is a function of *rain rate.* The rain rate is measured in millimeters per hour. The total attenuation is given as $A=\alpha L$ dB
- *α-Specfic attenuation*
- *L- Effective path length* of the signal through the rain
- The geometric, or slant, path length is shown as L_S. This depends on the antenna angle of elevation and the *rain height* h_R, which is the height at which freezing occurs.



$$L_S = \frac{h_R - h_O}{\sin El}$$

- The effective path length is given in terms of the slant length by $L = L_S r_p$
- where r_p is a *reduction factor* which is a function of the percentage time p and L_G, the horizontal projection of L_S. $L_G = L_S \cos El$
- With all these factors together into one equation, the rain attenuation in decibels is given by,

$$A_p = aR_p{}^b L_S r_p \text{ dB}$$

Link budget calculations

Equivalent Isotropic Radiated Power:

- A key parameter in link budget calculations is the equivalent isotropic radiated power (EIRP).
- An isotropic radiator with an input power equal to GP_S would produce the same flux density. Hence this product is referred to as the equivalent isotropic radiated power.