CLASSIC THEORY OF HF RADIO PROPAGATION

During the day, solar radiation collides with the molecules in our ionosphere, ripping off electrons. These electrons are called "free electrons" because they are not attached to an atom or molecule. All of these free electrons cause the density of the ionosphere to increase. The more dense the ionosphere, the higher the frequency that is reflected back to earth. Our electron density is what determines the maximum usable frequency (MUF), and the action of solar radiation separating electrons from the molecules is called ionization.

Solar radiation causes ionization to stratify, that is, to form three distinct layers.The layer closest to the earth is called the D-Layer. It does not reflect signals generally, but does absorb some of the energy, and hence the D-Layer is often called the "absorption layer." unfortunately it attenuates the wave as it travels through in both directions.The lower the frequency the greater the attenuation. This encourages HF operators to use the highest frequency possible to make reliable contact with other stations.

The next lowest is the 'E-layer' which refracts radio waves and is used for daylight communications up to approximately 300 miles. Frequency selection is important as if the frequency is too high it will pass through the E-Layer and be refracted by the next higher layer and will not return to earth within the 300 mile desired working distance.

The highest is the 'F-layer' which separates during daylight hours into the indistinct F1 and F2 layers. These layers also refract radio waves and are used for 'long-haul' daytime communications over 300 miles.

Your 10m signal must travel through the D-Layer, getting attenuated, then bounces back from the E or F layer to some exotic DX spot, passing through the D-Layer for more absorption again. But since solar radiation has to travel the farthest to get the D-Layer, absorption is usually fairly minimal. So far, during the middle of the day, we have moderate absorption, and good skip propagation.

AT SUNDOWN ... solar radiation no longer strikes our ionosphere right above our heads, and ionization stops. This means there is no solar radiation to form free electrons. In fact, without this solar radiation, these free electrons tend to get attracted back to recombine with their host molecules. This is called "recombination". Recombination, when it starts to get dark, causes the electron density to go down, forcing the MUF to go down as well, which is why by total darkness, 10m (and a bit later 15m) are completely dead. The MUF is far below 28 MHz.

The D-Layer is the first layer where ionization stops, since the sunlight no longer reaches near the surface of the earth, but is still illuminating (and ionizing) the ionosphere far above our heads. (For the same reason, we can see satellites pass overhead in the early evening ... it's dark on the ground, but the satellites are still being illuminated.) As the D-Layer goes into recombination, the electron density goes down, and the absorption does down. HF signals increase dramatically in strength and concentration.This is why signals appear stronger at night, because there is less absorption by the D-Layer at night.

The E layer decays more slowly and is often usable well after dusk for effective communications.

The daytime F1 and F2 layers combine very early after sunset and separate soon after sunrise and are called the F-layer.This layer settles at approximately the height of the daytime F2-layer. For most late nighttime operation only the F-layer is usable.