



## **Introduction to HF Radio Propagation**

### **1. The Ionosphere**

#### **1.1 The Regions of the Ionosphere**

In a region extending from a height of about 50 km to over 500 km, most of the molecules of the atmosphere are ionised by radiation from the Sun. This region is called the ionosphere (see Figure 1.1).

Ionisation is the process in which electrons, which are negatively charged, are removed from neutral atoms or molecules to leave positively charged ions and free electrons. It is the ions that give their name to the ionosphere, but it is the much lighter and more freely moving electrons which are important in terms of HF (high frequency) radio propagation. The free electrons in the ionosphere cause HF radio waves to be refracted (bent) and eventually reflected back to earth. The greater the density of electrons, the higher the frequencies that can be reflected.

During the day there may be four regions present called the D, E, F1 and F2 regions. Their approximate height ranges are:

- D region 50 to 90 km;
- E region 90 to 140 km;
- F1 region 140 to 210 km;
- F2 region over 210 km.

At certain times during the solar cycle the F1 region may not be distinct from the F2 region with the two merging to form an F region. At night the D, E and F1 regions become very much depleted of free electrons, leaving only the F2 region available for communications.

Only the E, F1 and F2 regions refract HF waves. The D region is very important though, because while it does not refract HF radio waves, it does absorb or attenuate them (see Section 1.5).

The F2 region is the most important region for HF radio propagation because:

- it is present 24 hours of the day;
- its high altitude allows the longest communication paths;
- it reflects the highest frequencies in the HF range.

The lifetime of free electrons is greatest in the F2 region which is one reason why it is present at night. Typical lifetimes of electrons in the E, F1 and F2 regions are 20 seconds, 1 minute and 20 minutes, respectively.

Because the F1 region is not always present and often merges with the F2 region, it is not normally considered when examining possible modes of propagation. Throughout this report, discussion of the F region refers to the F2 region.





















































