3 Methods of radiocommunication

3.1 Frequencies

Radio frequencies should be selected according to propagation requirements, allocation to the service for which they are used and in accordance with licensing regulations of the country in which the station is operating.

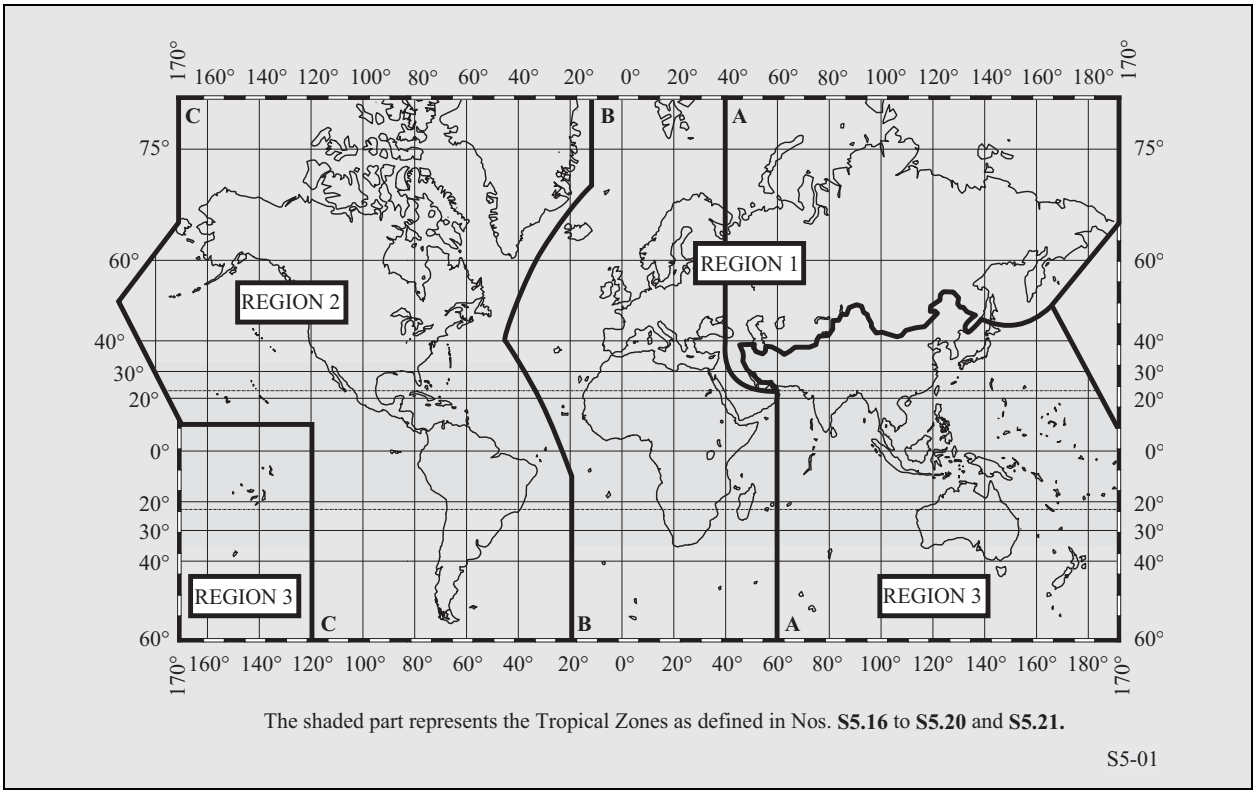
Example 1: An amateur station licensed to operate in the country may use a frequency of 7 050 kHz to communicate via sky wave with a station 300 km away, as this frequency is within the 7 MHz amateur allocation.

Example 2: A land mobile station licensed to operate in a country and assigned an operating frequency of 151.25 MHz may use this frequency to communicate up to about 60 km with other authorised stations.

3.1.1 International frequency allocations

The radio frequency spectrum is divided into bands of frequencies by means of international treaty conferences of the International Telecommunication Union (ITU). These bands are allocated to specific radio services and are listed in Article S5 of the international Radio Regulations. Some bands are allocated to the same service(s) worldwide, while others are allocated to different services on a regional basis. The three Regions are shown in the following map.

Figure – ITU radio regions



A simplified table of frequencies allocated to the amateur, fixed and mobile services is shown in Table 1.

Table 1 – Allocation to amateur, fixed and mobile services (simplified, footnotes omitted)

Region 1	Region 2	Region 3
1 810-1 850 AMATEUR	**1 800-1 850** AMATEUR	**1 800-2 000** AMATEUR FIXED MOBILE except aeronautical mobile
1 850-2 000 FIXED MOBILE except aeronautical mobile	**1 850-2 000** AMATEUR FIXED MOBILE except aeronautical mobile	
2 000-2 045 FIXED MOBILE except aeronautical mobile (R)	**2 000-2 065** FIXED MOBILE	
2 045-2 160 FIXED MOBILE		
	2 107-2 170 FIXED MOBILE	
2 194-2 300 FIXED MOBILE except aeronautical mobile (R)	**2 194-2 300** FIXED MOBILE	
2 502-2 625 FIXED MOBILE except aeronautical mobile (R)	**2 505-2 850** FIXED MOBILE	
2 650-2 850 FIXED MOBILE except aeronautical mobile (R)		
3 155-3 400	FIXED MOBILE except aeronautical mobile (R)	
3 500-3 800 AMATEUR FIXED MOBILE except aeronautical mobile	**3 500-3 750** AMATEUR	**3 500-3 900** AMATEUR FIXED MOBILE
	3 750-4 000 AMATEUR FIXED MOBILE except aeronautical mobile (R)	
3 800-3 900 FIXED LAND MOBILE		
3 950-4 000 FIXED		**3 950-4 000** FIXED
4 000-4 063	FIXED	
4 438-4 650 FIXED MOBILE except aeronautical mobile (R)		**4 438-4 650** FIXED MOBILE except aeronautical mobile
4 750-4 850 FIXED LAND MOBILE	**4 750-4 850** FIXED MOBILE except aeronautical mobile (R)	**4 750-4 850** FIXED Land mobile
4 850-4 995	FIXED LAND MOBILE	
5 005-5 060	FIXED	
5 060-5 450	FIXED Mobile except aeronautical mobile	
5 450-5 480 FIXED LAND MOBILE		**5 450-5 480** FIXED LAND MOBILE
5 730-5 900 FIXED MOBILE except aeronautical mobile (R)	**5 730-5 900** FIXED MOBILE except aeronautical mobile (R)	**5 730-5 900** FIXED Mobile except aeronautical mobile (R)
6 765-7 000	FIXED Land mobile	
7 000-7 100	AMATEUR AMATEUR-SATELLITE	
	7 100-7 300 AMATEUR	
7 350-8 100	FIXED Land mobile	
8 100-8 195	FIXED	
9 040-9 400	FIXED	
9 900-9 995	FIXED	
10 100-10 150	FIXED Amateur	
10 150-11 175	FIXED Mobile except aeronautical mobile (R)	
11 400-11 600	FIXED	

Region 1	Region 2	Region 3
12 100-12 230	FIXED	
13 360-13 410	FIXED	
13 410-13 570	FIXED Mobile except aeronautical mobile (R)	
13 870-14 000	FIXED Mobile except aeronautical mobile (R)	
14 000-14 250	AMATEUR AMATEUR-SATELLITE	
14 250-14 350	AMATEUR	
14 350-14 990	FIXED Mobile except aeronautical mobile (R)	
15 800-16 360	FIXED	
17 410-17 480	FIXED	
18 030-18 068	FIXED	
18 068-18 168	AMATEUR AMATEUR-SATELLITE	
18 168-18 780	FIXED Mobile except aeronautical mobile	
19 020-19 680	FIXED	
19 800-19 990	FIXED	
20 010-21 000	FIXED Mobile	
21 000-21 450	AMATEUR AMATEUR-SATELLITE	
21 850-21 924	FIXED	
22 855-23 000	FIXED	
23 000-23 200	FIXED Mobile except aeronautical mobile (R)	
23 200-23 350	FIXED	
23 350-24 000	FIXED MOBILE except aeronautical mobile	
24 000-24 890	FIXED LAND MOBILE	
24 890-24 990	AMATEUR AMATEUR-SATELLITE	
25 010-25 070	FIXED MOBILE except aeronautical mobile	
25 210-25 550	FIXED MOBILE except aeronautical mobile	
26 175-27 500	FIXED MOBILE except aeronautical mobile	
27.5-28	FIXED MOBILE	
28-29.7	AMATEUR AMATEUR-SATELLITE	
29.7-47	FIXED MOBILE	
	47-50 FIXED MOBILE	**47-50** FIXED MOBILE
	50-54 AMATEUR	
	54-68 Fixed Mobile	**54-68** FIXED MOBILE
68-74.8 FIXED MOBILE except aeronautical mobile	**68-72** Fixed Mobile	**68-74.8** FIXED MOBILE
	72-73 FIXED MOBILE	
	74.6-74.8 FIXED MOBILE	
75.2-87.5 FIXED MOBILE except aeronautical mobile	**75.2-75.4** FIXED MOBILE	
	75.4-76 FIXED MOBILE	**75.4-87** FIXED MOBILE
	76-88 Fixed Mobile	
		87-100 FIXED MOB ILE
137-138	Fixed Mobile except aeronautical mobile (R)	
	138-144 FIXED MOBILE	**138-144** FIXED MOBILE
144-146	AMATEUR AMATEUR-SATELLITE	
146-148 FIXED MOBILE except aeronautical mobile (R)	**146-148** AMATEUR	**146-148** AMATEUR FIXED MOBILE
148-149.9 FIXED MOBILE except aeronautical mobile (R)	**148-149.9** FIXED MOBILE	

<table>
<tr><th>Region 1</th><th>Region 2</th><th>Region 3</th></tr>
<tr><td>150.05-174 FIXED
MOBILE except aeronautical mobile</td><td colspan="2">150.05-174 FIXED MOBILE</td></tr>
<tr><td rowspan="3"></td><td>174-216 Fixed Mobile</td><td rowspan="3">174-223 FIXED MOBILE</td></tr>
<tr><td>216-220 FIXED</td></tr>
<tr><td>220-225 AMATEUR</td></tr>
<tr><td>223-230 Fixed Mobile</td><td>FIXED MOBILE</td><td>223-230 FIXED MOBILE</td></tr>
<tr><td>401-406</td><td colspan="2">Fixed Mobile except aeronautical mobile</td></tr>
<tr><td>406.1-430</td><td colspan="2">FIXED MOBILE except aeronautical mobile</td></tr>
<tr><td>430-440 AMATEUR</td><td colspan="2">430-440 Amateur</td></tr>
<tr><td>440-450</td><td colspan="2">FIXED MOBILE except aeronautical mobile</td></tr>
<tr><td>450-470</td><td colspan="2">FIXED MOBILE</td></tr>
</table>

3.2 Propagation

Radio signals are electromagnetic waves that travel through the Earth's atmosphere and into space. These waves propagate by means of difference mechanisms, such as surface wave, direct or space wave (line-of-sight), diffraction (knife-edge propagation), ionospheric refraction (sky wave), tropospheric refraction and tropospheric ducting. Ionospheric propagation varies according to time of day, season of the year, solar activity (sunspot number), path distance, and location of the transmitters and receivers. Tropospheric propagation is somewhat related to weather conditions.

Recommendation ITU-R P.1144, the guide to the propagation methods of Radiocommunication Study Group 3, may be used to determine which propagation methods should be used for different applications. Computer programmes are also available and are available from ITU-R.

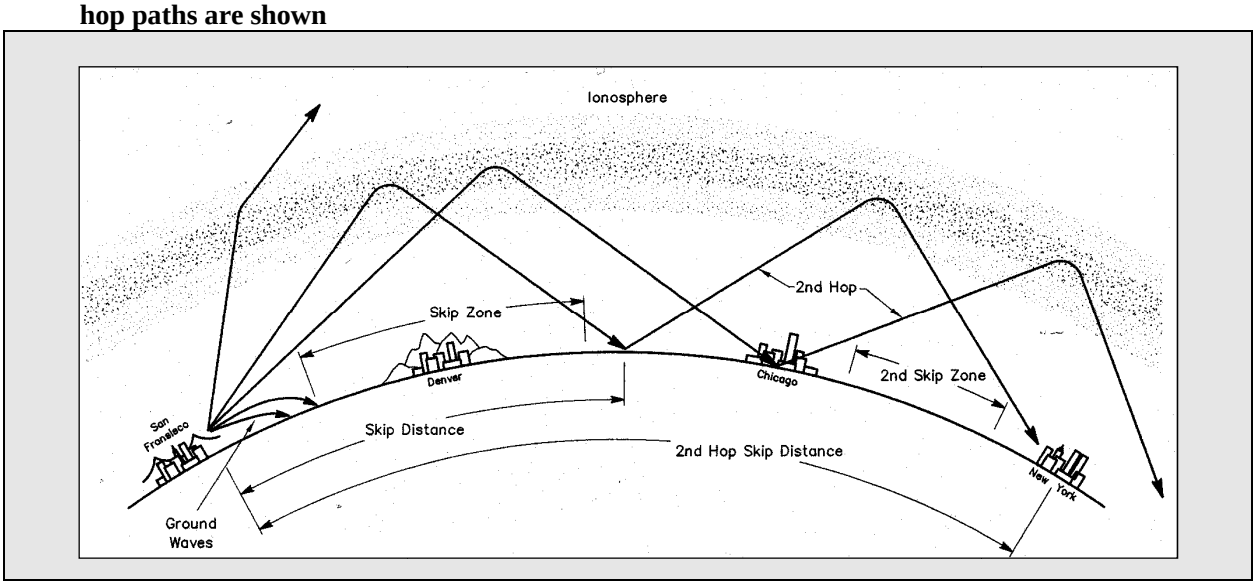
3.2.1 Ground wave

Ground waves are those confined to the Earth's lower atmosphere. Distances are dependent on transmitter power, antenna efficiency, ground conductivity and atmospheric noise levels. Ground-wave propagation curves for frequencies between 10 kHz and 30 MHz are given in Recommendation ITU-R P.368. For practical emergency communications, ground waves are useful only at lower high frequencies (near 3 MHz) and for relatively short distances of a few kilometres.

3.2.2 Sky wave propagation

Sky waves use the Earth's ionosphere to refract the signal. The ionosphere is formed by several layers, which are identified by letters of the alphabet. The *D layer* lies between about 60 and 92 km above the Earth. The *E layer* is about 100 to 115 km above the Earth. The D layer is used for medium frequency sky wave propagation. The D and E layers absorb signals at frequencies in the lower part of the HF band around 3 MHz. The *F layer* (about 160 to 500 km) may split into two layers, F_1 and F_2 and can support frequencies over the entire HF band at long distances. Frequencies and distances vary according to the specific path, time of day, season and solar activity. Sky wave propagation for the frequency range 2-30 MHz may be predicted using Recommendation ITU-R P.533.

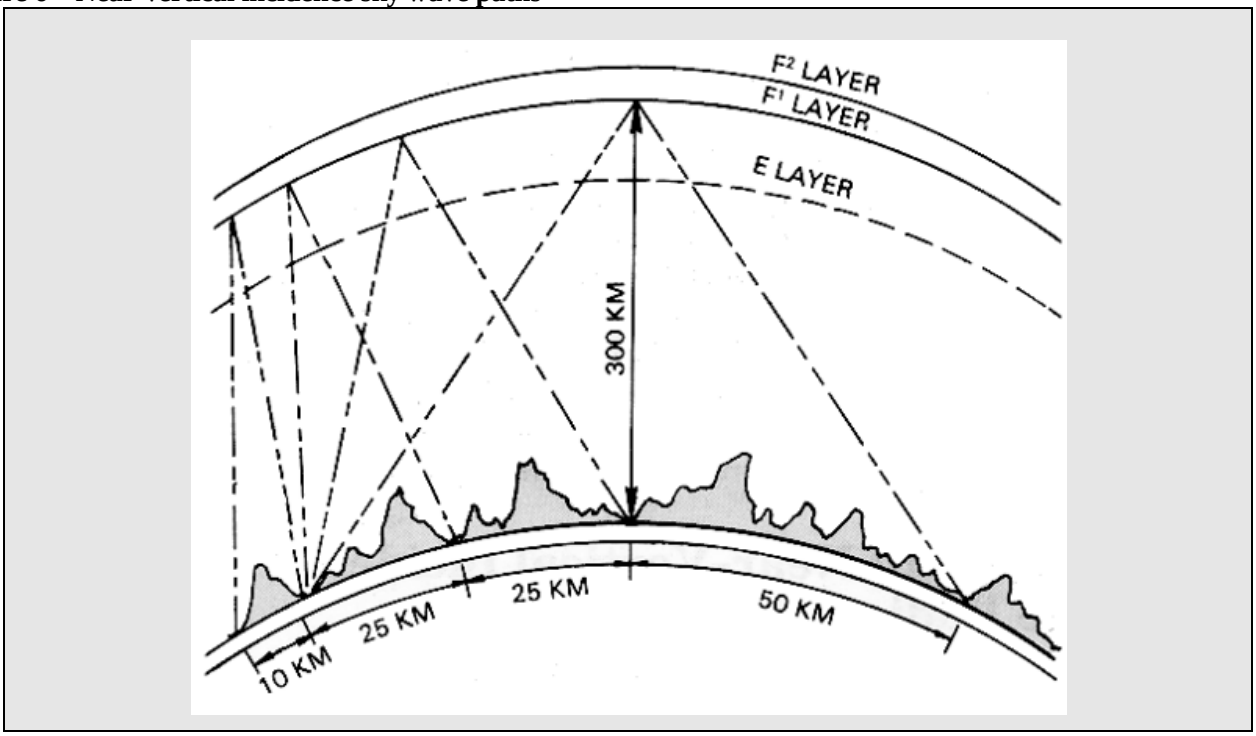
Figure – Illustration of how HF radio signals travel through the ionosphere. Frequencies above the maximum usable frequency (MUF) penetrate the ionosphere and go into space. Frequencies below the MUF are refracted back to the Earth. Ground waves, skip zones and multiple hop paths are shown



3.2.2.1 Near-vertical-incidence sky wave

Near-vertical-incidence sky wave (NVIS) is a term describing high angle ionospheric paths covering short distances. It is particularly useful for distances just beyond those practical for VHF or UHF. To be successful, it is necessary to select frequencies below the critical frequency, which means that frequencies will be in the 2-6 MHz range, the higher end during the daytime and the lower part of the range at night. Antenna take-off angle is essentially straight overhead so a practical antenna is horizontally polarised and just a few meters above ground.

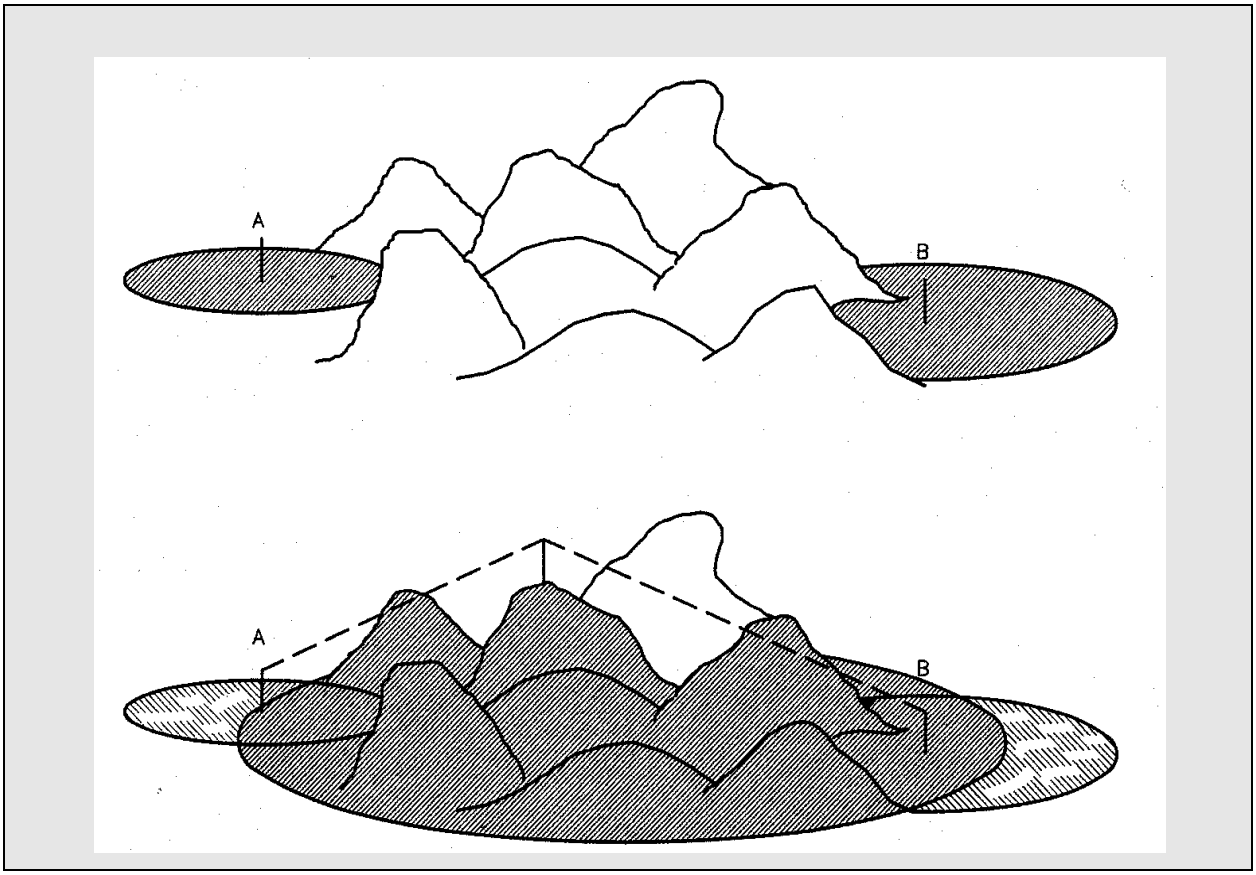
Figure 6 – Near-vertical incidence sky wave paths



6 Repeaters

A single repeater station in a favourable location (on a hill or atop a building) may be used to retransmit signals between points not having line-of-sight.

Figure 7 – In the top drawing, stations A and B are unable to interoperate because propagation is blocked by hills. In the bottom drawing, a repeater station is able to relay signals between stations A and B



All radios in these systems are normally in the standby state on a control channel, ready to receive a selective calling signal. A calling station looks for and finds an idle traffic channel and stores its number in its memory. Then the calling station transmits on a control channel, a selective calling signal including at least its own identity, the identity of the called station and the number of the identified idle channel. The standby stations detecting their identity code in the received signal, move to the indicated traffic channel and enter into communication. At the end of the communication all units return again to the standby mode.