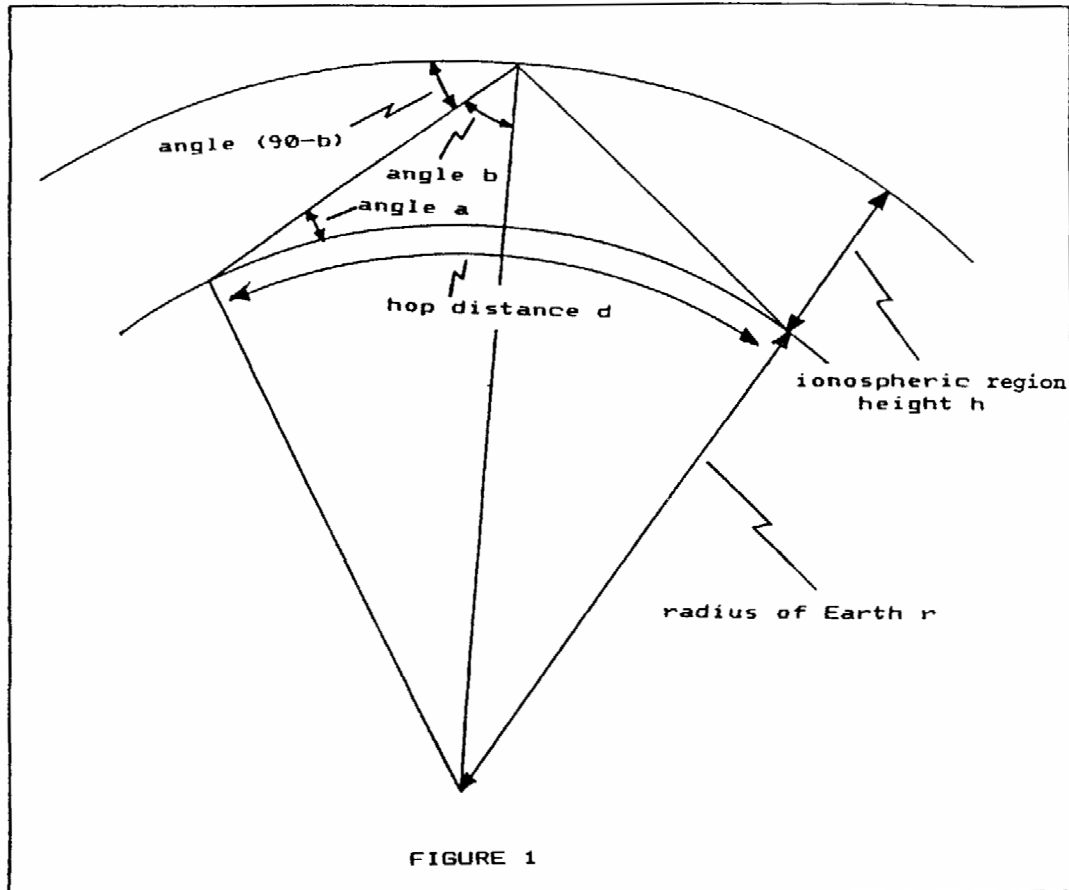


Elevation Angles Required for 6m Sporadic E
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Model of Earth-Ionosphere System

The model of the Earth-ionosphere system is shown in Figure 1.



From spherical geometry, three equations are used to determine the hop distance d , the angle b , and the M-factor (the M-factor is the MUF divided by the critical frequency):

$$\text{hop distance } d = 2 r \{90 - a - \sin^{-1}[r \sin(a + 90) / (r + h)]\} / 57.3$$

$$\text{angle } b = \sin^{-1}[(r / r + h) \sin (a + 90)]$$

$$\text{M-factor} = 1 / [\sin(90-b)]$$

For the hop distance d in km, the radius of the Earth r is assumed to be 6371 km.

Required foE_s

Using the three equations in the previous section, the hop distance and required sporadic E critical frequency foE_s for various elevation angles can be calculated. This data is shown in Table 1. The height of the E_s layer is assumed to be 105 km, and the operating frequency is assumed to be 50.1 MHz.

angle a	hop distance d	angle b	M-factor	required foE_s
0°	2297 km	79.67°	5.58	8.98 MHz
5°	1438 km	78.53°	5.03	9.96 MHz
10°	965 km	75.96°	4.04	12.40 MHz
15°	700 km	71.85°	3.21	15.61 MHz
20°	537 km	67.59°	2.62	19.12 MHz
25°	428 km	63.08°	2.21	22.67 MHz
30°	350 km	58.43°	1.91	26.23 MHz

Table 1 – Required Sporadic E Critical Frequencies

Maximum Mid-Latitude foE_s Values

Data from several mid latitude ionosondes in the North American sector (Dyess AFB, Wallops Island, Millstone Hill, and Boulder) were reviewed for maximum foE_s values during the summer of 2006 (June 1 through August 31).

The highest foE_s value observed was 11.9 MHz. To allow for higher foE_s values that would occur at a very low probability, this value was increased by 25% to about 15 MHz.

From Table 1, this 15 MHz value says 6m sporadic E propagation is limited to a minimum distance of around 700 km, which requires an elevation angle of about 15°. For E_s at shorter distances on 6m, there simply isn't enough ionization to refract energy at angles higher than about 15°.

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The conclusion of this analysis is that elevation angles from 0° to 15° are important for 6m sporadic E propagation.