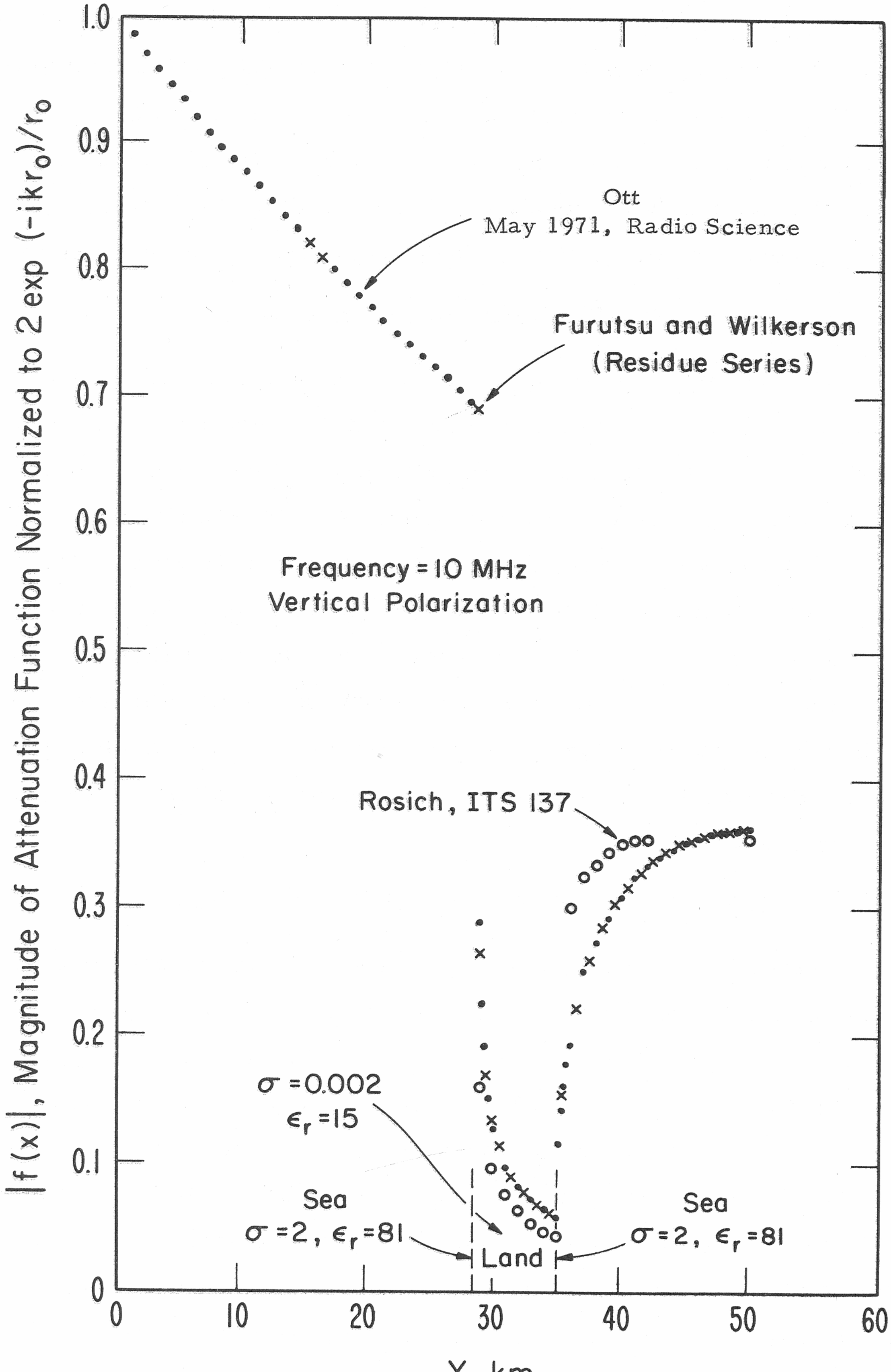


Figure 5. A sea-land-sea path. The profile is flat.

this example. The agreement between the solid circles representing (1) and the crosses, appears to demonstrate the validity of the formulation in treating mixed path propagation problems. The abrupt changes in conductivity and dielectric constant used in this example do not represent a realistic sea-land interface. The method is, however, capable of treating a continuous variation of conductivity and dielectric constant.

### 3.5 A Sea-Land-Sea Path With An Island

This example combines terrain features and mixed-path effects. The island is drawn to scale in figure 6 and its elevation is 250 m at the highest point. The magnitude of the attenuation function normalized to twice the free space field versus distance is plotted in figure 6. The antenna is vertically polarized and the frequency is 10 MHz. For comparison, the magnitude of the attenuation function for a flat island is also shown in figure 6. The most significant feature of figure 6 is that the terrain profile has a greater effect on the attenuation function on the island than do changes in the ground constants, and the residual effect of the profile well beyond the island is comparable to that of the change in ground constants.

### 3.6 A Sloping Beach At High And Low Tides

The profile is drawn to scale in figure 7 and the assumed ground constants used for the wet and dry sand are given in the figure. The transmitter is out at sea. As the tide rises, the wet sand in figure 7 is covered by water and as the tide recedes it exposes the wet sand. The magnitude of the attenuation function versus distance is shown plotted in figure 7. There is little difference in the attenuation function at high and low tide. However, the presence of the crest in the beach produces a peak in the attenuation function on the lit side and a shadow in back. This illustrates the importance of the terrain profile in mixed path problems.

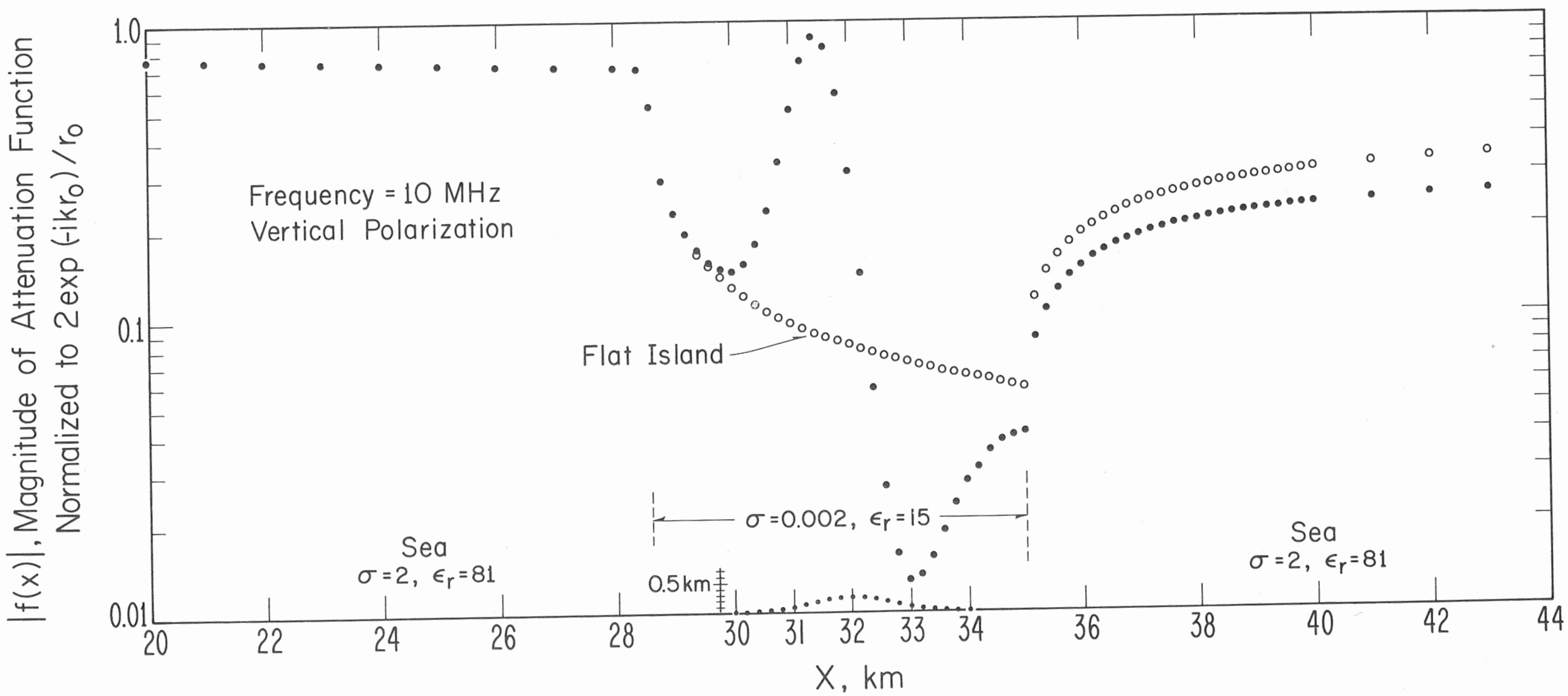


Figure 6. A sea-land-sea path with an island. The island is shown to scale in the insert.

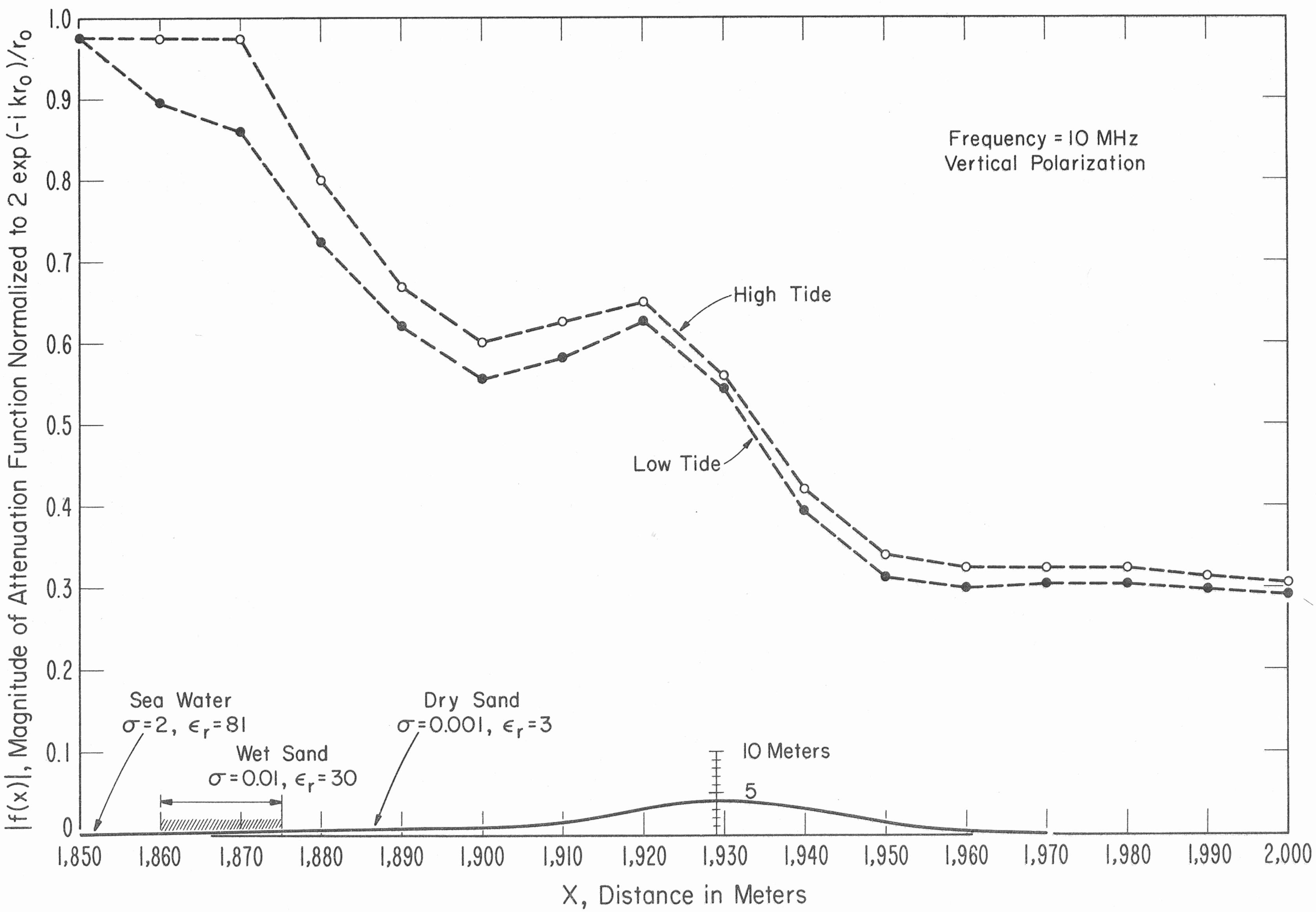


Figure 7. A sloping beach at high and low tides.

### 3.7 Two Gaussian Hills

The profile is drawn to scale in figure 8. The separation of the hills is such that a null instead of a peak in the attenuation function is produced on the lit side of the second hill. Obviously there are an infinite number of combinations of hills that will in turn produce an infinite number of possible combinations of nulls and peaks in the attenuation function. The method will, in principle, treat any number of hills and valleys. The hills need not have Gaussian profiles; any smooth function of distance is acceptable.

### 3.8 A Gaussian Hill (transmitting frequency of 10 MHz)

The profile as well as the magnitude of the attenuation function versus distance is shown in figure 9. The results in figure 9 differ somewhat from those published earlier by Berry (1967). Near the crest of the hill small oscillations in the attenuation occur which were not present when the transmitting frequency was 1 MHz. One possible explanation for these wiggles is numerical instability. However, this explanation was discarded when finer subdivisions of the integration interval failed to remove the oscillations. At present, they can only be explained in terms of an interference effect between a ground-reflected wave and the ground wave the former being stronger at 10 MHz than at 1 MHz. This case represents a quasi upper limit in the capability of the computer program in terms of frequency and slopes. That is, higher frequencies can be treated but the terrain cannot change as fast as it does in figure 9. Conversely, more rapid changes in terrain can be treated provided the frequency is less than it is in figure 9. Since the slopes in figure 9 are near unity, we have a heuristic uncertainty principle for our computer program

$$y' f \leq 10 \text{ (MHz)} .$$

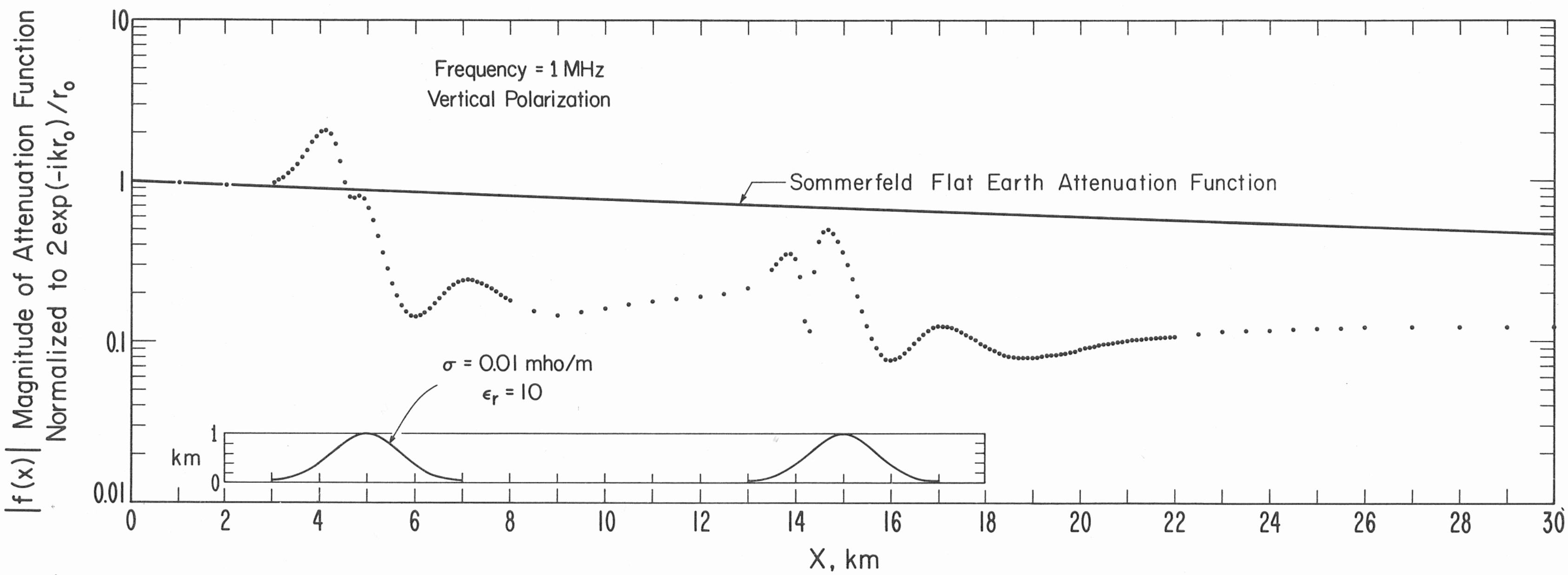


Figure 8. Two Gaussian-shaped ridges.

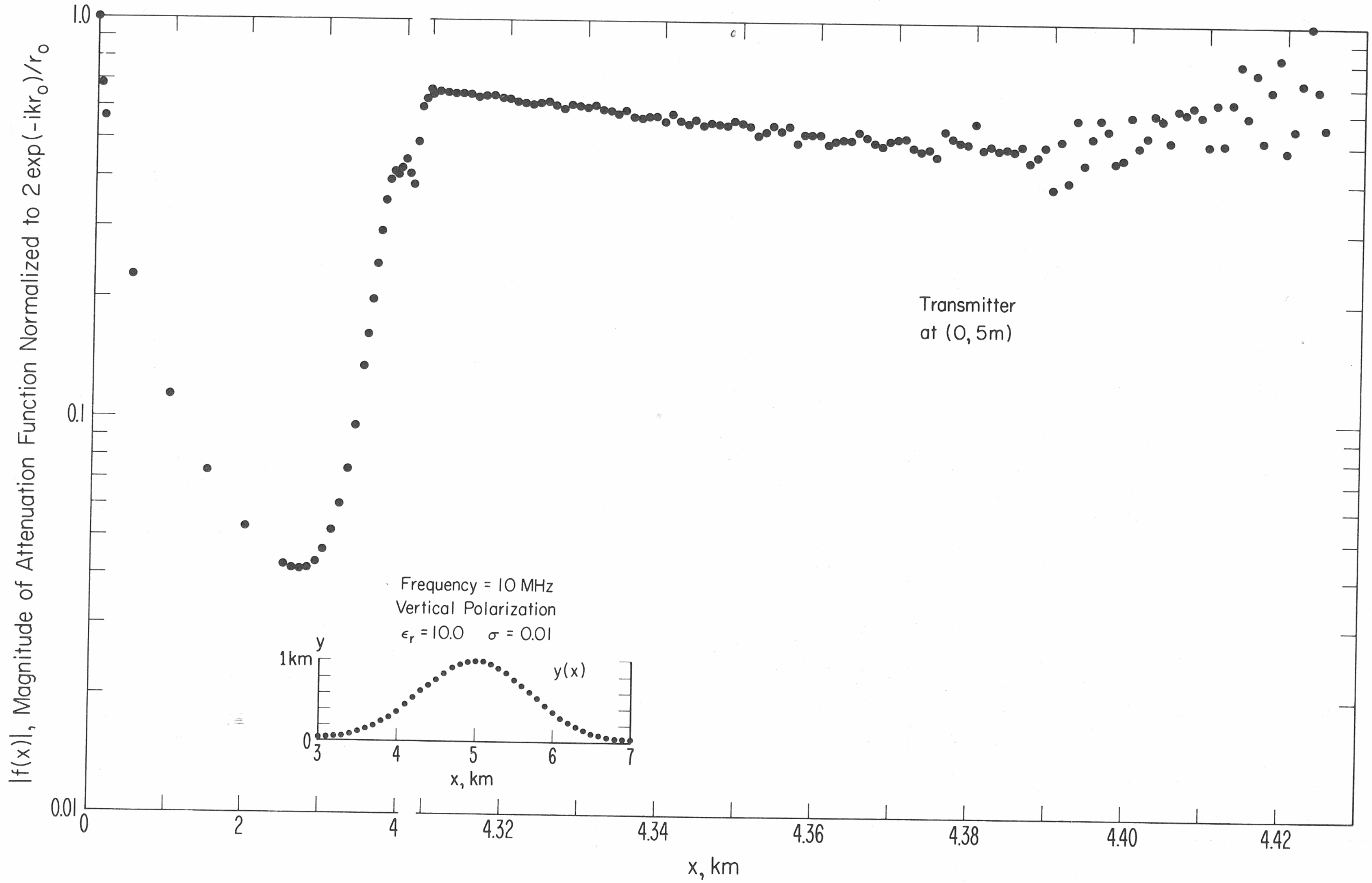


Figure 9. A Gaussian-shaped ridge at 10 MHz.