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Estimating the incidence of K-filtering processes in the transionospheric propagation of VLF and MF waves

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A numerical simulation of the propagation characteristics of VLF and MF waves propagating from ground to space is performed. The MF waves which are considered here are those for which X < (1 +Y), with X = fpe2/f2 and Y = fce/f , i.e. those which may cross the ionosphere at frequencies below the F-layer maximum plasma frequency. The ionospheric characteristics are provided by the International Reference Ionosphere (IRI) model. The collision frequencies are derived from the effective theoretical and experimental electron collision frequency gathered by Aggarwal et al.(1979). A special attention is given to the propagation characteristics of the waves near the plasma cutoff frequencies (X =1) located at the bottom and at the top of the ionosphere. For each cutoff frequency, it is shown that two successive k- filtering effects are produced. The first one is relative to the mode coupling which takes place at X=1, the waves with k vectors strictly parallel to the Earth magnetic field direction B0 being always transmitted, and the width of the angular spectrum finally transmitted depending on the collision frequencies. The second one is relative to the associated density gradients and to the distribution in k vectors of the absorbed power, the absorption levels being much more important for oblique waves than for longitudinal waves. The results so obtained show that strong k- filtering effects are observed on VLF waves above $\sim$ 100 kHz, and on MF waves. Below 100 kHz, the IRI model being stopped at 2000 km, the only conclusion which can be drawn is based on the propagation characteristics observed at the vicinity of the first X=1 cutoff frequency. However it can be considered that the efficiency of the k-filtering effects is decreasing with the wave frequencies. Finally it is shown how those results may be used to interpret DEMETER data.