Geophysical Research Abstracts
Vol. 14, EGU2012-13494, 2012
EGU General Assembly 2012

Schumann Resonances on Mars – a Two-layer Ground Case

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Schumann resonances (SR) are global resonances of electromagnetic waves in the range of extremely low frequencies (ELF) propagating in a cavity formed by a planetary surface and a lower ionosphere. SR are induced by electrical discharges, which on Earth are associated mainly with lightning. They were predicted by Winfried Otto Schumann in 1952.

SR are supposed to occur on Mars, although many properties of the Martian environment are still unknown. One of the most important problems in modeling SR on Mars is to estimate electrical properties of the Martian ground and their influence on ELF waves propagation.

The Martian crust is composed mainly of basaltic materials. Water, which causes significant increase in electrical conductivity of rocks, does not exist in liquid state at the surface of Mars. Therefore the Martian ground is believed to be a low conductive one. However, it is possible that some liquid water may be present at various depths below the surface.

In our previous study we have developed an analytical model, based on the characteristic electric and magnetic altitudes' formalism, that has allowed us to take into consideration the Martian ground. Using this new model, we found that basaltic ground of low conductivity greatly influenced the SR parameters.

In this work, we carried out simulations in order to characterize an influence of vertical changes in ground properties on the parameters of the Martian ground-ionosphere waveguide. We have considered several cases of a two-layer ground, in which the lower layer was of higher conductivity than the upper one.

The obtained results indicate how the SR parameters depend on electrical conductivity, permittivity, and depth of the layers. The results also point out the importance of studying SR on Mars and the need for further research in propagation of ELF waves in the Martian environment. SR can be used as a remote sensing tool for exploration of the Martian crust. Furthermore, they can be especially useful for groundwater detection.