FDTD MODELING OF SCHUMANN RESONANCES ON EARTH AND OTHER PLANETS OF THE SOLAR SYSTEM

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Electromagnetic waves emitted by global lightning activity produce resonances in the Earth-ionosphere cavity. These resonances were first predicted by W. O. Schumann [Z. Naturforsch., 7a, 149, 1952] and therefore commonly referred to as Schumann resonances (SR). Because SR parameters (e.g., power, frequency and Q-factor) are mainly determined by the global lightning activity and conductivity profile in the lower ionosphere, these resonances are widely used in many remote sensing applications [e.g., Williams, Science, 256, 1184, 1992; Cummer, IEEE Trans. Antennas Propagat., 48, 1420, 2000; Roldugin et al., JGR, 109, A01216, 2004, and references therein]. In our previous study [Yang and Pasko, GRL, 32, L03114, 2005], a three-dimensional finite difference time domain (3D FDTD) model was used to solve SR problems in the Earth-ionosphere cavity under disturbed conditions associated with solar proton events and X-ray bursts. Also, a set of modeling studies had been conducted, which demonstrated a good agreement of SR parameters derived from the FDTD model with those obtained from previous well established numerical and analytical models [e.g., Sentman, JATP, 45, 55, 1983; Mushtak and Williams, JASTP, 64, 1989, 2002]. These results indicate that FDTD technique is suitable for solving realistic ELF problems in the Earth-ionosphere cavity [Yang and Pasko, 2005].

On January 14, 2005, HUYGENS probe landed on Titan, and started to explore this largest moon of Saturn. One of multiple missions of HUYGENS probe is to find if there are lightning discharges in the Titans atmosphere. It is believed that conducting properties of the Titans atmosphere are favorable for the formation of cavity for propagation of electromagnetic waves, so the existence of SR will give a support for the existence of the electrical discharges in the lower atmosphere on Titan. Meanwhile, the SR parameters are also useful in the study of the electromagnetic properties of Titans lower ionosphere. Several papers have recently been published in refereed literature, which discuss SR parameters on Titan [e.g., Morente et al., ICARUS, 162, 374, 2002; Nickolaenko et al., Planetary and Space Sci., 51, 853, 2003; Pechony and Price, Radio Sci., 39, RS5007, 2004]. In this talk, we will use our 3D FDTD model to predict the SR frequencies and Q-factors on Titan and will compare our FDTD results with those reported in the previously published papers. Besides Titan, we will also discuss SR on other planets, specifically Mars and Venus. The atmospheric conductivity profiles for these studies are derived from the previously reported ionospheric models for these planets [e.g., Pechony and Price, 2004; Molina-Cuberos et al., Adv. in Space Res., 33, 2309, 2004, and references therein].

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