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Mars Exploration – Science, Instruments and Technologies (3B)

Author: Dr. Andrea Delfini
Sapienza University of Rome, Italy, andrea.delfini@uniroma1.it

Dr. Davide Micheli
Telecom Italia S.p.A, Italy, davide.micheli@telecomitalia.it
Dr. Roberto Pastore
Sapienza University of Rome, Italy, roberto.pastore@uniroma1.it
Dr. Marta Albano
Agenzia Spaziale Italiana (ASI), Italy, marta.albano@asi.it
Prof. Fabio Santoni
Sapienza University of Rome, Italy, fabio.santoni@uniroma1.it
Dr. Fabrizio Piergentili
Sapienza University of Rome, Italy, fabrizio.piergentili@uniroma1.it
Prof. Mario Marchetti
Associazione Italiana di Aeronautica e Astronautica (AIDAA), Italy, marchettimario335@gmail.com
Dr. Giuliano Muratore
Telecom Italia SpA, Italy, giuliano.muratore1@gmail.com

MARS ENVIRONMENT INFLUENCE ON TELECOMMUNICATIONS SYSTEMS: THERMAL AND ELECTROMAGNETIC SOIL & ATMOSPHERE CHARACTERIZATION

Abstract

During the last decades, Space Agencies programs of long-term missions addressed to the future Mars colonization moved the aerospace research interest toward the knowledge of how the environmental conditions peculiar of the 'red planet' could represent scientific and technological tasks to be tackled, in order to deal with such a big challenge. Among very many matters, a still open question is to understand how proper the Martian environment would be for the telecommunications systems daily used on Earth, or whether it should be necessary to establish different stable systems on Mars by finding, in particular, alternative solutions with respect to the conventional cellular technologies exploited on Earth so far. The present work describes an experimental characterization performed by simulating some representative Martian environmental conditions – i.e., by reproducing well defined chemical/physical surrounding in terms of atmospheric parameters and soil compositions, as from the available literature data – and analyzing both the electromagnetic field propagation characteristics and the thermal behavior of the involved materials. The electromagnetic characterization is focused on the measurement of the environmental microwave absorbing cross section, which is essential to assess how the electromagnetic fields used in mobile phone systems are subject to absorption and scattering by all the materials constituting the planet's surface and atmosphere, as well as (eventually) by other objects. Such measure is carried out by means of a so called reverberation chamber, which is a fine-tuned facility able to simulate the space environment in terms of temperature and atmosphere, as well as the related electromagnetic chaotic propagation: various types and combinations of Martian soil and atmosphere are reproduced in volumes about 300 mm wide and 50 mm high, and the obtained results are compared with the properties of some typical terrestrial conditions. Alongside, furthermore, a detailed analysis of the heat transport properties of the adopted materials is performed, in order to evaluate how the thermal behavior of the environmental systems under

test might affect the electromagnetic absorption and the reflection by the ground. Using an advanced numerical method known as the inverse method, heat capacity and thermal conductivity are analyzed; such approach is especially suitable for solving these kinds of problems, since a number of physical parameters coincide to reliably determine material properties. The preliminary results show that the effects of the surrounding environment on the electromagnetic propagation must be strictly considered in order to design efficiently mobile telecommunications systems operating on Mars.