Geophysical Research Abstracts
Vol. 18, EGU2016-16655-1, 2016
EGU General Assembly 2016

Evaluation of Deep Space Ka-Band Data Transfer using Radiometeorological Forecasts and Radiometer Measurements

Mario Montopoli (4), Frank S. Marzano (1), Marianna Biscarini (2), Luca Milani (3), Domenico Cimini (5), Klaide De Sanctis (6), and Saverio Di Fabio (7)

(4) National Research Council of Italy, Institute of Atmospheric Sciences and Climate, (1) DIET - Dept. of Information Eng. Sapienza University of Rome, (2) DIET - Dept. of Information Eng. Sapienza University of Rome, (3) DIET - Dept. of Information Eng. Sapienza University of Rome, (5) National Research Council of Italy, Institute of Methodologies for Environmental Analysis, (6) Himet srl, (7) CETEMPS - Centre of Excellence, University of L'Aquila

Deep space exploration is aimed at acquiring information about the solar system. In this scenario, telecommunications links between Earth ground receiving stations and extra-terrestrial satellite platforms have to be designed in order to ensure the optimal transfer of the acquired scientific data back to the Earth. A significant communication capacity has to be planned when very large distances, as those characterising deep space links, are involved thus fostering more ambitious scientific mission requirements.

At the current state of the art, two microwave channel frequencies are used to perform the deep space data transfer: X band ($\sim$ 8.4 GHz) and Ka band ($\sim$ 32 GHz) channel.
Ka-band transmission can offer an advantage over X-band in terms of antenna performance with the same antenna effective area and an available data transfer bandwidth (50 times higher at Ka band than X band). However, Earth troposphere-related impairments can affects the space-to-Earth carrier signals at frequencies higher than 10 GHz by degrading its integrity and thus reducing the deep space channel temporal availability.

Such atmospheric impairments, especially in terms of path attenuation, their statistic and the possibility to forecast them in the next 24H at the Earth's receiving station would allow a more accurate design of the deep space link, promoting the mitigation of the detrimental effects on the link availability. To pursue this aim, meteorological forecast models and in situ measurements need to be considered in order to characterise the troposphere in terms of signal path attenuation at current and future time.

In this work, we want to show how the synergistic use of meteorological forecasts, radiative transfer simulations and in situ measurements such as microwave radiometry observations, rain gauges and radiosoundings, can aid the optimisation of a deep space link at Ka band and improve its performance with respect to usual practices.
The outcomes of the study are in the framework of the Radio-Meteorological Operations Planner (RMOP) project promoted by ESA for supporting the BepiColombo mission to Mercury.

More in detail, the methodology used in this work foresees the use of Fifth-Generation Penn State/NCAR Mesoscale Model (MM5) coupled with an Eddington-like radiative transfer model in order to convert the forecasted meteorological variables into radio-propagation parameters. Thus, in-situ observations from microwave radiometers are used to validate the weather forecasts in terms of integrated water paths in clear sky whereas radiosoundings and rain gauges will provide a reference for temperature and rain accumulations, respectively. Eventually, the final results will be shown in terms of improvements in the transferred data volume when the RMOP chain is implemented.