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Study of Electrical Activity in Martian Dust Storms with the Deep Space Network antennas

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Abstract

Evidence for non-thermal emission produced by electrostatic discharges in a deep Martian dust storm has been reported by Ruf et al. 2009 [1]. Such discharges had been detected with an innovative kurtosis detector installed in a 34m radio telescope of the Deep Space Network (DSN) in June of 2006. The kurtosis (the fourth central moment of the signal normalized by the square of the second central moment) is extremely sensitive to the presence of non-thermal radiation, but is insensitive to variations in the intensity of the thermal radiation and instrument gain. The non-thermal radiation was detected while a 35 Km deep Martian dust storm was within the field of view of the radio telescope and presented signatures of modulation by the Martian Schumann Resonance.

Encouraged by this discovery, several attempts have been made within the DSN to confirm the detection using the R&D antenna (DSS-13) and other antennas in the Madrid and Goldstone complexes, but using a very limited receiver, in terms of recorded data rates, the Very Long Baseline Interferometry (VLBI) Science Receiver (VSR). We are planning to initiate an extensive monitoring of Mars emission in a non-interfering basis while our antennas are tracking various Mars probes, using the Wideband Very Long Baseline Interferometry (VLBI) Science Receiver (WVSR). The WVSR is a very flexible open-loop digital backend that is used for radio science and spacecraft navigation support in the DSN. This instrument allows us to sample a larger bandwidth than with previously used detectors. The processing to look for the kurtosis signature will be performed in software, limited only by the computer capacity. Additionally there are plans to develop an even more powerful custom-built detector based in CASPER technology and Graphic Processing Units for enhance computational power.

This contribution will describe how we plan to select the target Mars tracking passes from the DSN schedule. An automated process will generate appropriate observing scripts for the WVSR and will start the observation. The reduction pipeline will process the recorded signals in quasi real-time, computing the kurtosis. In addition, Martinez's PhD thesis will study and implement alternative and novel detection algorithms, as the implementation of higher order moments calculation in order to find clues about the underlying emission mechanism. In the event of detection, an automated detection alert application will notify the observers and store raw and process data in a database until the event trigger is no longer seen.

References

[1] Ruf, C., Renno, N.O., Kok, J.F., Bandelier, E., Sander, M.J., Gross, S., Skjerve L. and Cantor, B.: Emission of non-thermal microwave radiation by a Martian dust storm, Geophysical Research Letters, 36, L13202, 2009.