SUBMILLIMETER WAVE DIFFERENTIAL ABSORPTION RADAR FOR WATER VAPOR SOUNDING IN THE MARTIAL ATMOSPHERE

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Abstract

In this study we report on the current state-of-progress of the Water Sounding Short-range Radar (WASSR) project. WASSR is a frequency modulated continuous wave (FMCW) differential absorption radar (DAR) instrument and will facilitate estimation of near-surface water vapor profile on Mars. The scope of the work presented here includes a discussion of (i) the science background and motivation for profiling water vapor near the Martian surface and (ii) submillimeter wave radar system implementation and characterization.

1. Science Background and Motivation

Improved atmospheric modelling and incorporation of additional weather and climate processes into the models has resulted in a renewed interest in even the small amount of water vapor found in the Martian atmosphere. For instance the incorporation of the tenuous Martian clouds and their heating and cooling effects in Mars climate models showed a surprisingly large effect on the atmospheric processes [1], [2], [3]. Furthermore the presence of perchlorate, an extremely hygroscopic salt, as identified first by the wet chemistry experiment onboard the Phoenix lander [3] points to interesting water vapor-surface interactions that were previously thought to be minor and unimportant. The near-surface water vapor profile estimation made possible with the WASSR instrument can thus provide critical measurements that facilitate better understanding of atmospheric water vapor dynamics as well as it's interaction with the Martian surface.

2. System Implementation and Characterization

The WASSR system is currently being assembled for bench-top testing and algorithm implementation. Specifically, the RF back-end components have been procured and a brass-board setup has been constructed for FMCW signal generation and characterization. SMMW components such as tripler and integrated sub-harmonic mixer and horn, both developed internally at JPL, are being characterized for conversion efficiency and noise figure. Results of these characterizations along with achievable water vapor profiling sensitivity will be presented and discussed at the ISSTT 2020 meeting. Furthermore, algorithm validation using a gas-cell spectrometer-type setup is planned and will be presented as well. This setup is critical for a proof-of-concept demonstration of the applicability of the DAR technique for water vapor profiling at Mars-like meteorological conditions.

References

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