

A FRESH LOOK AT THE HUYGENS RADAR ALTIMETER PROBLEM: NEW RESULTS AND SCIENCE OPPORTUNITIES

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ABSTRACT

The Huygens probe [1] carried two Frequency Modulation Continuous Wave (FMCW) radars during its successful descent through the Atmosphere of Saturn's largest moon Titan. While these radars were developed as probe systems, they were early identified as potential sources of scientific data on Titan's atmosphere and surface. A dedicated Radar Altimeter Extension (RAE), interfacing to the radars, was developed as a part of the Huygens Atmospheric Structure Instrument (HASI) [2]. Altitude and topographic data were acquired by the Permittivity, Wave and Altimetry (PWA) subunit of this instrument. Radar altitude and automatic gain control (AGC) data was recorded via the probe housekeeping data. The processing of the data after the successful Huygens mission revealed a significant deviation of the radar altitude profile from the profile elaborated by the Huygens Descent Trajectory Working Group (DTWG) [3]. A new initiative was started in order to identify the cause of the data mismatch. This effort included an independent re-calculation of the calibration factors, an assessment of hardware degradation and failure modes, and the reconstruction and analysis of probe test data from pre-launch test campaigns.

The basic design of the Huygens radars is introduced. Processing of data by RAE and HASI-PWA is explained, and altitude results from the Huygens radars and the DTWG are shown and compared. Radar design features and their impact on the radar performance and accuracy are presented, and possible degradation modes are derived. The results of pre-launch test campaigns are shown and compared to in-flight performance of the radars. Correction factors are proposed and an update of the HRA altitude profile is presented. A summary of the lessons learned is presented, and new science opportunities based on the corrected dataset are pointed out.

- [1] J-P. Lebreton et al, *An overview of the descent and landing of the Huygens Probe on Titan*, Nature 438, p. 758-764, 2005.
- [2] R. Trautner et al, *FMCW Radars for Planetary Landers: Lessons Learned from the Huygens Radar Altimeter*, presented at the International Planetary Probe Workshop #3, Anavyssos, Greece, 2003.
- [3] B. Kazeminejad et al, *Huygens' entry and descent through Titan's atmosphere – Methodology and results of the trajectory reconstruction*, Planetary and Space Science, Volume 55, Issue 13, p. 1845-1876, 2007.