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# ULTRA-LOW ORBITS ON MARS FOR GRAVITY FIELD MEASUREMENTS AND ATMOSPHERIC SENSING APPLICATIONS

**Abstract**

Over the past decades Mars has been comprehensively mapped by diverse instruments, from both orbit and the planet's surface. However, a gap in sensing between approximately 50 km and 175 km altitude remains as no instrument has yet taken continuous measurements in this region. This paper investigates the possibility of operating a satellite between these altitudes and its potential applications.

There are tiny gravity variations on planetary surfaces and in space, and it is challenging to measure the weakest of such variations without a precise instrument. Gravity field measurements on Mars have been conducted by the Mars Global Surveyor, Mars Odyssey and Mars Reconnaissance Orbiter satellites, but none of these missions have used a gravity gradiometer instrument. Gradiometry measures acceleration differences over short baselines between proof masses of a group of accelerometers. The gravity signal is dependent on height and it rapidly attenuates with altitude. A very sensitive gravity gradiometer is able to accurately map the gravity field, but in order to measure the tiniest variations an orbit as close as possible to the surface is required. However, one of the main issues of placing a satellite at very low orbits is the increase in atmospheric drag. Nevertheless, due to Mars' thinner atmosphere, it may be possible to operate closer to the surface while maintaining an acceptable lifetime.

The use of a gradiometer would provide benefits in numerous areas, including geodesy and glaciology. This could improve our understanding of how the movement of the inner layers affected ocean and ice cap behavior on Mars. Additionally, a satellite orbiting at very low altitudes could constantly gather atmospheric data to improve existing computational models and could search for traces of methane, currently debated as evidence of life.

The method used in this study consists of modeling the aerodynamic flow interaction with the satellite using Monte Carlo simulation software (DS2V) and evaluating the lifetime and coverage characteristics of the satellite using an orbiting modeling tool (STK).