**TITLE:** Highly accurate surface propagation for Mars Helicopter mission.

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**ABSTRACT**:

NASA’s Jet Propulsion Laboratory has developed the first Mars helicopter: Mars Ingenuity. The helicopter has the capability to transmit to and receive data from a Mars Rover located at a distance ranging up to 1 kilometer. The antenna designs and propagation on the Mars surface will be addressed in this talk. After multiple successful flights, our team collected enough data to compare the accuracy of our models accounting for shadowing effect, multipath, polarization loss, and fading.

Ingenuity was originally slated to operate for 30 days on Mars, conducting a technology-demonstrating mission designed to test whether or not powered, controlled flight is possible on Mars. However, with the overwhelming success of its first flights, NASA has decided to extend the helicopter mission and shift it into a new phase where it will act as a scout for the Rover. It has been operating on Mars for more than a year. This came with numerous challenges - with one of the biggest being the telecommunication link prediction in adverse communication scenarios with complex surface topology and non-line-of-sight (NLOS) scenarios. Our team at the Jet Propulsion Laboratory developed and demonstrated a highly accurate link budget prediction using the Parabolic Equation method taking into account the actual surface topology of Mars. It was verified using 14 flight cases before being entirely infused into the mission operation tools to plan each flight of the helicopter to ensure this asset will not be lost on the surface of Mars.