

IAF SPACE OPERATIONS SYMPOSIUM (B6)  
Ground Operations - Systems and Solutions (1)

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JAXA 3-WAY DOPPLER SUPPORT TO ARTEMIS 1 MISSION

**Abstract**

As part of the NASA campaign to return astronauts to the moon, the goals of Artemis 1 mission were to demonstrate the ability to fly the Orion capsule to the moon's orbit, using the new Space Launch System, and return the Orion capsule safely to Earth. The capabilities are in preparation for human flights on subsequent Artemis missions. Mission navigation, and the role of orbit determination, is the key to achieve the goal of safe return of astronauts to Earth. Artemis 1 used 2-way Doppler and ranging from the NASA Deep Space Network (DSN) for orbit determination. To improve the orbit determination accuracy especially prior and during critical maneuvers, Artemis 1 also used additional 3-way Doppler data from other ground stations such as from the Japanese Aerospace Exploration Agency (JAXA). Although there was no astronaut onboard Artemis 1, the development and demonstration of this capability would make it readily available for use in later Artemis missions with astronauts onboard.

This paper presents a collaborative effort between NASA and JAXA to make 3-way Doppler data from JAXA tracking station available to the Artemis 1 Navigation team at the Johnson Space Center (JSC) in Texas, United States. It describes the system architecture and concept of operation of this capability. Testing efforts at the three ground stations – specifically, the 20-m and 34-m antennas at Uchinoura, and the 64-m antenna at Usuda – are discussed. Both aspects of system testing are highlighted: (1) the use of Artemis 1 recorded signal to ensure compatibility between ground and flight systems, and (2) the use of the Lunar Reconnaissance Orbiter as an emulation for Artemis prior to launch to validate other key functions in the system such as ephemeris processing, tracking spacecraft, data delivery and operational processes. Results from operation support provided to Artemis 1 during its flight in November-December 2022 are also captured.