Geophysical Research Abstracts
Vol. 21, EGU2019-9274, 2019
EGU General Assembly 2019

Returning to the Moon with HERACLES: An ESA-JAXA-CSA Joint Study

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Several space agencies identified the Moon as a target with large scientific and strategic benefits. Returning to the Moon not only yields fundamentally important science opportunities for our understanding of the Solar System but also allows us to test hardware and operational procedures for the exploration and utilization of space beyond Low Earth Orbit (LEO). The Human Enhanced Robotic Architecture Capability for Lunar Exploration and Science (HEREACLES) is a joint study of ESA, JAXA, and CSA with NASA and Roscosmos having observer status. Thus, HERACLES is an international effort in preparation of returning humans to the Moon and providing opportunities for unprecedented science, utilizing the lunar Gateway. HERACLES will land on the lunar surface, demonstrate surface operations, and will return ∼15 kg of lunar samples to the lunar Gateway and from there eventually to Earth by the astronauts. Hence, HERACLES will be a robotic pathway toward sustainable international human exploration of the Moon and beyond. Some of the key objectives of HERACLES include: (1) Preparing for human lunar missions by implementing, demonstrating, and certifying technology elements for human lunar landing, surface operations, and return; (2) Create opportunities for science, particularly sample return; (3) Gain scientific and exploration knowledge, particularly on potential resources; and (4) Create opportunities to demonstrate and test technologies and operational procedures for future Mars missions. HERACLES will consist of the Lunar Descent Element (LDE, JAXA), the ESA-built Interface Element that will house the 330 kg Canadian rover, and the Lunar Ascent Element (LAE, ESA) that will return the samples to the lunar Gateway. The rover will be powered by radioisotope batteries that will allow for driving more than 100 km and surviving the lunar night. The rover will be partly operated from astronauts on the lunar Gateway while it will be operated for most of the time from Earth. Once landed on the lunar surface, the rover will immediately collect a contingency sample and will then collect additional samples along a ∼35 km long traverse. The rover will carry a suite of scientific instruments (expected combined payload mass of 90 kg) that will allow us to comprehensively study the sampling locations and the context of the samples, as well as the geology along the traverse. The instrument suite will most likely include cameras, spectrometers, a laser reflector, and potentially some geophysical instruments (e.g., GPR). After having deposited the samples into the LAE, the rover will go on a >100 km long traverse. The international science definition team (iSDT) is evaluating a suite of potential landing sites, guided by the recommendations of the 2007 NRC report and several subsequently published documents. The list of potential landing sites includes the Schrödinger basin, the Moscoviense basin, Copernicus crater, Jackson crater, and some young basalts in the Flamsteed region. In summary, HERACLES will bridge the gaps between science, exploration and human space flight, and will allow us to accomplish many necessary steps in each of those domains.