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MISSION DESIGN OF THE VENUS FLAGSHIP DECADAL STUDY

Abstract

The Venus Flagship Mission (VFM) was a 2019/2020 study conducted by NASA Goddard Space Flight Center to support the US National Academy of Sciences' 2020 Science decadal studies. At the beginning of the study, it was chosen to focus on the most challenging mission configuration, which would prove overall concept feasibility. Such configuration includes four assets that make use of a single launch with the landed asset being deployed from orbit around Venus rather than on arrival. An orbiter, first asset, also serves as a carrier for two other mission elements, aerobot and lander, during the interplanetary cruise and parts of the Venusian operations. Two small-satellites, which are launched with the orbiter/carrier and separate shortly after launch, are defined as the second asset. These small-satellites use solar electric propelled thrusters to navigate and insert into an elliptical Venus orbit prior to the orbiter arrival. The final remaining assets are an aerobot in the form of a balloon and the lander. The aerobot is deployed by the orbiter prior to Venus insertion. The lander is released months after the orbiter insertion, once the aerobot has ceased its operation, and the landing site has been mapped.

The mission timeline drives most of the four assets' operations. All assets launch together with the small-satellites separating after a 30-days checkout period. While the carrier continues its ballistic trajectory to Venus, the small-satellites will employ their low-thrust propulsion system to navigate and rendezvous with Venus prior to the carrier's arrival. Once captured by Venus's gravity, they will spiral down, reducing their altitude, to their final orbit. The carrier performs a Venus gravity assisted maneuver that reduces the orbital energy and changes the orbit's plane. Three days prior to the Venus insertion maneuver, the carrier releases the capsule containing the aerobot, which will enter Venus' atmosphere and deploy at 52-62 km high. Minutes after the aerobot reaches the atmosphere, the carrier inserts into a highly elliptical polar orbit. After the aerobot operations have ceased, the orbiter performs the lander deployment sequence and provides lander communications for 8 hours. Thereafter, the aerobrake campaign starts, lasting for approximately 1.5 years. Once the aerobraking is concluded, a final maneuver is made to circularize the orbit. For a duration of at least 2 years after the orbit becomes circular, the orbiter remains imaging the planet's surface.