THE VENUS FLAGSHIP STUDY: ATMOSPHERIC SCIENCE FROM TWO DESCENT/LANDING VEHICLES AND TWO BALLOONS

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ABSTRACT

Descent probes have acquired atmospheric structure and composition data of the Venus atmosphere from local midnight to noon and from equatorial southern latitudes to 60 degrees north. However, measurements of Venus' deep atmospheric composition (the lowest scale height) have never been made, nor has the atmospheric structure been sampled during local afternoon through evening. Since the lowest scale height contains the bulk of Venus' massive atmosphere, and since thermochemical reactions between gaseous species are likely, little can be known about how the Venus atmosphere reacts with surface minerals until major, minor, and trace gases in the lowest scale height have been measured. Similarly, reconstruction of the solar tides and their influence on Venus' atmospheric superrotation is not possible without near-simultaneous measurements of the winds at all altitudes, and several local times of day.

The Venus Science and Technology Definition Team (VSTDT) was commissioned by NASA to study the science requirements, mission architecture, and payload for a flagship-class mission to Venus. The VSTDT concluded, among other things, that two paired lander and balloons to provide near-simultaneous vertical and horizontal measurements, were crucial for answering some of the outstanding scientific questions regarding the Venus atmosphere. Specifically, each lander and balloon would be equipped with accelerometers and atmospheric structure packages to measure the pressure, temperature, and densities from cloud tops to the surface. Precise tracking of the landers on descent and balloons during traverse, from an orbiter, would enable the reconstruction of vertical and horizontal winds in two vertical and horizontal slices of the atmosphere. Each lander and balloon would also have radiometers and nephelometers to measure the thermal and solar radiation fields, and cloud particle sizes and number densities. Landers would carry cameras to image the surface upon descent, and mass spectrometers for measuring noble gas isotopes and reactive species all the way to the surface. Magnetometers would look for remnant magnetic fields, perhaps indicative of a past planetary magnetic field.

The Venus Flagship mission's two cloud-level balloons would circumnavigate the planet, continually measuring vertical and horizontal winds and reactive gas species at 50-55 km. These measurements, highly complementary with the science from the two descent vehicles, would provide the best possible set of scientific experiments for understanding Venus' atmospheric general circulation and the origin of its mysterious superrotation.