

Vesper: A Proposed Venus Discovery Mission

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Vesper, from the Latin for "evening star," is a proposed Discovery mission that will integrate key measurements with atmospheric models to investigate the coupled processes of chemistry and dynamics in the Venus middle atmosphere. The Vesper goal is to conduct a tightly focused study of the Venus atmosphere as part of a larger NASA program of comparative planetology. As indicated in the COMPLEX Report 1 - comparative planetology provides an important window to the uniqueness and fragility of Earth's terrestrial environment. This is particularly true with regard to comparative studies of Venus and the Earth, since both seem to have begun with similar atmospheric environments and both still exhibit remarkably similar middle atmospheres.

The Vesper mission has two main objectives:

- characterization of the global chemical system; and
- characterization of the global atmospheric circulation.

These objectives are tightly coupled through the influence of transport on the global chemical system, and the importance of aerosol and chemical constituents for forcing and tracing circulation. Both the instrument suite and the analysis approach are optimized to study this coupling.

Vesper Instruments

Vesper will accomplish its science goals using an orbiter with three instruments spanning the near-ultraviolet to submillimeter wavelengths. Vesper observations are optimized to acquire long-term, three-dimensional, global measurements of composition, dynamics, and clouds/hazes from below the global cloud layers to the upper. The science experiments are:

- Submillimeter Limb Sounder (SLS)
- Deep Atmosphere Spectral Camera (DASC)

- Near Ultraviolet Imager (NUVI)
- Radio Occultation Experiment (ROE)

The SLS will measure temperatures, composition, and wind velocities in the 75-120 km altitude range. Sensitivities are parts per trillion for some molecular species and meters per second for the winds. The DASC will image the clouds in the 1-2.5 μm interval and spectral windows where thermal emission from the surface and lower atmosphere emerge. With a spectral resolving power of $\lambda/\Delta\lambda = 600$, the DASC will yield constituent abundances below the clouds and will observe the motions of the clouds at spatial scales between 4 and 20 km. The NUVI will image the ultraviolet markings of the global cloud cover. Two wavelengths, 270 and 360 nm, will be used to distinguish between SO_2 and another ultraviolet absorber in the upper clouds. The ROE will employ the spacecraft's Xband transponder to derive precise temperature and pressure measurements between 4090 km altitude with better than 400 m vertical resolution. The Vesper polar elliptical orbit (500 x 4000 km, 2.3-hr period) will offer coverage at periapsis similar to that of a polar-orbiting meteorological satellite, and will resolve motions that drive the Venus circulation. At apoapsis, the large fields-of-view (FOV) of DASC and NUVI will allow global coverage and tracking of cloud features.

Unique Vesper Observations

Vesper will obtain unique observations (with global 4 Venus-years coverage) not measured by any previous Venus mission:

- observations of the vertical distribution of numerous chemical species in the middle atmosphere;
- simultaneous direct measurements of winds and temperatures in the middle atmosphere;
- high resolution observations of the troposphere using infrared windows through the clouds yielding lower atmosphere composition and surface temperature maps; and
- complete surveys of both polar regions (partially observed North Polar vortex and unobserved South Polar atmosphere).