AERACEPT (Aerosol Rapid Analysis Combined Entry Probe/sonde Technology): Enabling Technology for Missions to the Venus Clouds

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AERACEPT (AErosol Rapid Analysis Combined Entry Probe/sonde Technology) is an early-stage technology allowing a single aeroshell body to act as both an entry vehicle and aerosol-sampling passive descent sonde. AERACEPT does not require heat shield separation, deployable parachutes, or descent control, thus reducing the mass, volume, and complexity of planetary aerosol sampling. AERACEPT is particularly well suited for a Venus mission, where the particles of greatest interest are within the subsonic descent regime.

AERACEPT uses the aeroshell's own velocity to drive aerosol capture and separation through a series of embedded inlets. It takes advantage of recently developed thermal protection materials (3D-CC and HEEET) in combination with heritage aerosol sampling technologies from both planetary and airborne science (high-speed inlets and particle separation). The trade space for a given descent trajectory includes the particle capture efficiency for a given size, the bias introduced in the sampled particle size and concentration distributions, and the thermal alteration experienced by the particles during their brief exposure to the internal flow environment.

AERACEPT is included in the Nephele mission concept study for a small spacecraft targeting the Venus middle and lower cloud layers. Nephele complements larger missions targeting Venus atmospheric gas analysis, such as DAVINCI and Venera-D, by specifically targeting cloud and haze particles. Because of the short lifetime of the probe in the lower atmosphere, Nephele requires a fast cadence of analysis of the captured particles, and includes the VOLTR dual optical spectrometer (SERS/LIBS) as part of its notional payload. Preliminary modeling based on the Nephele trajectory at 63 km to 39 km indicates AERACEPT can limit sample heating to 30-60 K above ambient. A modified particle tracking model has been implemented to estimate capture efficiency of particles larger than 0.1 µm and total sample volume as part of an inlet and interal flow path geometry trade study. Further modeling and empirical testing is underway to improve these estimates.