The Europa and Enceladus Plume and Exosphere Cubesat (EEPEC) is a mission concept for a small spacecraft that can make observations of the plumes and/or exospheres of these two ocean worlds. Europa and Enceladus are active ocean worlds that are prime targets in the search for life in the solar system. Enceladus has demonstrated constant activity since the detection of its south polar hot spring plumes. Recent detections of potential plume-like activity on Europa and a well-known variable exosphere make it certain that higher mass particles, or “dust,” also play a key role in the evolution of the surface and near surface environments on Europa. Lessons from Enceladus tell us that dust detectors provide unique perspective on plume and ring dynamics and composition; the dust and gaseous plumes have provided information about the composition of the ocean below including its interactions with the plume. The spatial and mass distributions of dust and ice grains at both Europa and Enceladus have the power to constrain available energy and source for surface processes, detect and characterize geochemical activity, as well as constrain the chemistry of the ice shell and ocean. These represent three of the top five priorities of the decadal survey for Europa; for Enceladus, they would mark an enhancement to the results of Cassini. By implementing a series of dust investigations designed for high-risk environments on a small companion satellite to a larger mission, high caliber science is achieved both on a cadence the primary mission cannot support and with minimal risk to the primary spacecraft.

EEPEC is designed as a single flyby or one multi-flyby mission to explore in situ the exospheres and plumes of material emanating from the subsurface by conducting 25-km or lower flybys of active sources. EEPEC will carry as a main payload a deep space and Titan- or Saturnian system-optimized version of the P3D dust detector instrument that is flying on the Arrokoth Cubesat. This dust detector is a miniaturized version of the Cassini Compositional Dust Analyzer that uses a combination of charge-gating and piezoelectric detectors to characterize impacting dust and ice grains and to sort first order chemical composition. Our payload also has an optional miniaturized mass spectrometer for more detailed grain chemistry. Thus EEPEC will provide robust in situ measurements of material erupted from the subsurface or sputtered from the surface of Europa, sampling material that will be key to understanding Europa’s habitability.

The planning science objectives for EEPEC are to: 1) Measure the spatial and velocity distribution of particles in ocean world plumes and exospheres in order to characterize endosystems and exospheric activity, including plume dynamics; and 2) Measure the composition of the particles in ocean world plume and exospheres to constrain both the composition and energy in the exosphere and surface, in turn constraining ocean world habitability. EEPEC components, but does not repeat. science objectives achievable with the Europa Clipper mission. With either multiple flybys from one EEPEC cubesat, or two chances to observe two different areas with two EEPECs, the EEPEC mission provides new, high-reward observations to planetary science.