STS-85 SHUTTLE PLUME OBSERVATION

Spectral Sciences, Inc. has had lead responsibility within the Midcourse Space Experiment (MSX) Program for the definition and analysis of experiments using the MSX satellite to observe plumes from Space Shuttle Orbiters. The images shown below are from one of those experiments.

These images, which are displayed in false color representations of radiance, include the STS-85 Orbiter Discovery (August 1997) during an orbit change burn. The Orbiter Discovery is at an altitude of 297 km and the engine is firing into the oncoming atmosphere to drop the perigee of the current orbit. The orbit change was timed to optimize the observation conditions, through collaboration between NASA and the MSX program with coordination provided by the Space Test Program.

The image that also includes a segment of the Earth is from the UVISI wide field visible imager. A vector originating at the Orbiter and showing its Earth relative direction and a frame showing the field of view of the second image have been added. The visible plume is faint and not readily apparent against solar glint, which contributes to the intensity in the center of the image.

The second image, results from the co-addition of 40 UVISI UV narrow field of view images and is dominated by the mid wave ultraviolet emission from the plume that results from the high velocity collisions (~11 km/s) between the plume and the residual atmosphere. The Orbiter Discovery is located just to the right of the brightest portion of the image.

The UV radiant intensity is indicated through a cycling palate of false colors to show contours of constant radiance on a non-linear scale, down to one percent of the peak radiance. The radiance is bright enough to outshine any UV stars or limb radiance in the background field. At the 4300 km range to Discovery the height of the image represents a distance of 119 km, indicating the vast extent of the plume radiance. The size of the radiant field is principally due to the roughly 10 km distance plume molecules will travel before they collide with an atmospheric species (atomic, molecular, or ionic).

Simultaneously measured spectra by one of the UVISI Spectrographic Imagers indicate that the predominant contribution to the mid-UV radiance is from Cameron band emission from electronically excited carbon monoxide. The shape of this radiance distribution has been important in determining that two consecutive interactions of a plume species with atmospheric atomic oxygen, where the second step has a considerable energy threshold, are responsible for producing the majority of the emitting species.