The Science Behind Nasa's Lunar Atmosphere And Dust Environment Explorer. R. C. Elphic[1], G. T. Delory[2], E. J. Grayzeck[3], T. Colaprete[1], M. Horanyi[5], P. Mahaffy[4], B. Hine[1], D. Boroson[6], and J. S. Salute[3], [1]Planetary Systems Branch, NASA Ames Research Center, MS 245-3, Moffett Field, CA, 94035-1000, [2]Space Sciences Laboratory, University of California, Berkeley CA 94720, [3]Planetary Science Division, Science Mission Directorate, NASA, Washington, DC 20546, [4]NASA Goddard Space Flight Center, Greenbelt, MD, 20771, [5]Laboratory for Atmospheric and Space Physics, University of Colorado, Boulder, CO 80309, [6]Lincoln Laboratory, Massachusetts Institute of Technology, Lexington MA 02421

Introduction: Nearly 40 years have passed since the last Apollo missions investigated the mysteries of the lunar atmosphere and the question of levitated lunar dust. The most important questions remain: what is the composition, structure and variability of the tenuous lunar exosphere? What are its origins, transport mechanisms, and loss processes? Is lofted lunar dust the cause of the horizon glow observed by the Surveyor missions and Apollo astronauts? How does such levitated dust arise and move, what is its density, and what is its ultimate fate?

The LADEE Mission: NASA's Lunar Atmosphere and Dust Environment Explorer (LADEE) is currently under development to address these questions. LADEE will determine the composition of the lunar atmosphere and investigate the processes that control its distribution and variability, including sources, sinks, and surface interactions. LADEE will also determine whether dust is present in the lunar exosphere, and reveal its sources and variability. LADEE's results are relevant to surface boundary exospheres and dust processes throughout the solar system, will address questions regarding the origin and evolution of lunar volatiles, and will have implications for future exploration activities.

LADEE's top objectives are:

(1) Determine the composition of the lunar atmosphere and investigate the processes that control its distribution and variability, including sources, sinks, and surface interactions.

(2) Characterize the lunar exospheric dust environment and measure any spatial and temporal variability and impacts on the lunar atmosphere.

LADEE must be capable of measuring a minimum detectable density of 10^{-4} grains/cc, for grain sizes from 100 nm to at least 1 micrometer in radius.

The LADEE Payload: LADEE employs a high heritage instrument payload: a Neutral Mass Spectrometer (NMS), an Ultraviolet/Visible Spectrometer (UVS), and the Lunar Dust Experiment (LDEX). It will also carry a space terminal as part of the Lunar Laser Communication Demonstration (LLCD), which is a technology demonstration. The LADEE NMS will make in situ measurements of exospheric species, and covers a mass range of 2-150. It draws its design from mass spectrometers developed at GSFC for the MSL/SAM, Cassini Orbiter, CONTOUR, and MAVEN missions. The UVS instrument is a next-generation, high-reliability version of the LCROSS UV-Vis spectrometer, spanning 250-800 nm wavelength, with high (<1 nm) spectral resolution. UVS will remotely sense the composition and scale heights of various exospheric species, and the spatial distribution of dust, if it exists. It will also perform dust occultation measurements via a solar viewer optic. LDEX senses dust impacts in situ, at LADEE orbital altitudes of between 20 and 50 km, for a particle size range of between 100 nm and 5 μm. LADEE will be the first mission based on the Ames Common Bus design.

LADEE Science Mission Profile: LADEE's science orbit is driven by the top level science objectives. Whereas the ideal orbit is low-altitude circular over the nominal science mission duration of 100 days, but it is impractical to maintain this within a reasonable fuel budget. The lunar gravity field severely perturbs a low-altitude circular orbit, bringing about mission termination in a matter of days.

LADEE's orbit design is retrograde with low inclination. This permits NMS and LDEX to ram exospheric species and dust over the dawn terminator while shadowed from the sun, minimizing solar UV and outgassing interference. Figure 1 illustrates the altitude-vs-orbit angle sampling for the nominal science mission. The sunrise terminator is at the center.

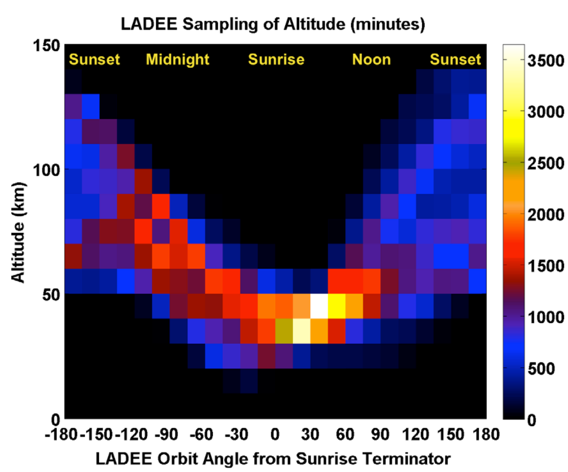

Figure 1. LADEE altitude sampling during the nominal science phase (100 days).