Direct Numerical Simulation of Comet Impacts and Low-Density Atmospheric Flow on the Moon

B. D. Larignon (University of Texas at Austin), E. Pierazzo (University of Arizona), D. B. Goldstein, P. L. Varghese, L. M. Trafton, C. Moore and A. C. Walker (University of Texas at Austin)

The present work uses a hybrid numerical method to simulate a comet impact on the Moon and the ensuing rarefied atmosphere. The impact event is simulated using the SOVA hydrocode while the expansion atmosphere is simulated using the Direct Simulation Monte Carlo (DSMC) method. The macroscopic data provided by the hydrocode simulation are used as input in the DSMC code to create simulated water molecules. The molecules that are not destroyed due to loss processes such as escape, ionization or dissociation will be followed as they hop around the Moon until they get trapped in a cold trap. After the initial impact event, it is expected that a certain fraction of molecules will be lost to space as their velocity will be larger than the escape velocity. The remaining molecules will fall to the surface and accommodate to the local surface temperature. The molecules that hit the surface of the Moon on the sunlit side will be nearly instantaneously reemitted while molecules on the dark side will stay on the surface until the dawn terminator reaches their location. The molecule will continue to bounce until it is destroyed or captured in a cold trap. The present DSMC code has been modified from its previous version in order to run 3D parallel simulations on scalable supercomputers. Hybrid SOVA-DSMC results at the early stages of the impact will be presented for a vertical impact as well as later time DSMC results showing the evolution of the expansion plume.