

Anisotropic Meteoroid Fluxes and Impact Gardening in the Lunar Polar Regions. J. R. Szalay¹, P. Pokorný^{2,3}, M. Horányi^{4,5,6}, A. R. Poppe⁷. ¹Department of Astrophysical Sciences, Princeton University, ²Space Weather Lab., GSFC/NASA, ³Department of Physics, Catholic University of America, ⁴Department of Physics, University of Colorado Boulder, ⁵Laboratory for Atmospheric and Space Physics, ⁶Institute for Modeling Plasma, Atmospheres, and Cosmic Dust, ⁷Space Sciences Lab., University of California Berkeley

Introduction: The Moon is continually bombarded by interplanetary meteoroids. While the surfaces of bodies with atmospheres are largely protected from meteoroids, which largely ablate in the atmosphere, the Moon's surface is completely exposed to meteoroid impacts. Each impact produces orders of magnitude larger ejecta mass than the primary meteoroid, most of which is bound and returns to the surface. In this way, meteoroid impacts continually rework the lunar regolith in a process called impact gardening.

Water is thought to be continually delivered to the Moon over geological timescales by water-bearing comets & asteroids and produced continuously in situ by the implantation of solar wind protons into oxygen-rich minerals exposed on the surface. Meteoroids are an unlikely source of water due to their long UV exposure in the inner solar system, but their high-speed impacts can mobilize secondary ejecta dust particles, atoms and molecules. Other surface processes that can lead to mobilization, transport, and loss of water molecules and other volatiles include solar heating, photochemical processes, and solar wind sputtering. However, since these drivers are minimized at high latitudes, particularly in Permanently Shadowed Regions (PSRs), dust impacts are an important driver governing the evolution of volatiles in these regions.

High Latitude Meteoroids: Impacting meteoroids are produced from a variety of cometary and asteroidal sources. Ground-based radar and visual observations of meteors have revealed a highly anisotropic impactor distribution at 1 au. The meteoroid environment at the lunar polar regions has been difficult to constrain, given the paucity of available data. While a large portion of meteoroids impact near the lunar equator, recent Earth-based observational and modeling efforts have revealed a persistent, high-speed and high-inclination source of meteoroids at 1 au (Pokorný et al., 2014) that continually bombard the lunar polar regions (Figure 1).

In-situ ejecta measurements were made at the Moon by the Lunar Dust Experiment (LDEX) onboard the Lunar Atmosphere and Dust Environment Explorer mission. LDEX observations enabled a detailed understanding of the structure of the impact generated, permanently present lunar ejecta cloud and subsequent gardening rates near the lunar equatorial plane (Szalay and Horanyi, 2016). A key result of the LDEX measure-

ments revealed that low flux, yet high speed meteoroid populations can liberate significant quantities of impact ejecta due to the steep speed dependence of ejecta production (Szalay and Horanyi, 2015) and suggest the high latitude sources may also generate significant quantities of impact ejecta. Here, we extend LADEE's equatorial measurements to the lunar polar regions using advanced models of anisotropic meteoroid impactors at the Moon to constrain the associated impact gardening rates. We also discuss the potential liberation of water at the Moon due to the various meteoroid sources at 1 au.

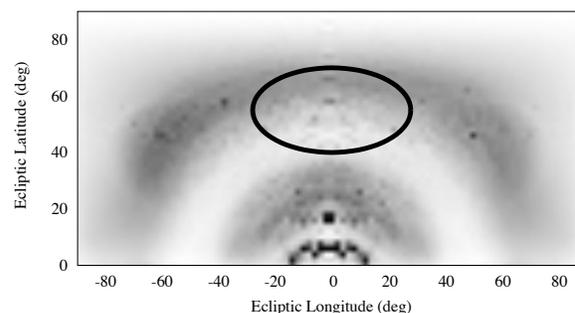


Figure 1. Adapted from Pokorný et al. (2014). Modeled radiant distribution of meteoroids impacting Earth in the northern hemisphere centered on the apex direction. The oval indicates the high latitude population that may be responsible for liberating significant quantities of impact ejecta in the lunar polar regions.

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