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GENERATION OF POTASSIUM IN THE LUNAR EXOSPHERE. M. Sarantos[1], A. Colaprete[2], S.A. Rosborough[3,1], D. Janches[1], R. Oliversen[1,5], E. Mierkiewicz[4,5], D. Kuruppuaratchi[4,5]. [1]NASA Goddard Space Flight Center, Greenbelt, MD, USA, [2]NASA Ames Research Center, Mountain View, CA, USA, [3]University of Maryland, College Park, MD, USA, [4]Embry-Riddle Aeronautical University, Daytona Beach, FL, USA, [5]Visiting Astronomer, National Solar Observatory. (menelaos.sarantos-1@nasa.gov)

Introduction: Measurements of Na and K resonant scattering emission from the Ultraviolet Visible Specrometer (UVS) on the Lunar Atmosphere and Dust Environment Explorer (LADEE) spacecraft showed many trends: a brightening of the exosphere during major streams such as Geminids, a repeatable monthly variation, and a correlation of the exosphere to surface composition [1]. These measurements provided a unique opportunity to better understand how lunar gases are released from the surface and how they interact with the lunar regolith.

Simulations: A large number of Monte Carlo simulations were performed to constrain the generation and migration processes. Many separate runs were necessary because of uncertainties in the rates and temperatures for proposed source processes, uncertainty in the photodesorption cross section, and uncertainty about the loss rate to the subsurface.

"Steady-state" simulations were used to identify constraints imposed by the observed variation with lunar phase. The simulations shown here assumed that impact vaporization and solar wind sputtering were periodic functions of lunar phase and were convolved with the distribution of surficial potassium [2]. The simulations assumed that the solar wind is unable to release fresh adsorbates for four days every month, approximately when the Moon resides inside the Earth's magnetosphere. This potassium reservoir was tracked for 60 lunations in each case.

As potential source processes for adsorbates we considered: (1) impact vaporization with two different initial velocity distributions (having Maxwellian temperatures of 2,000-5,000K); (2) sputtering from the bulk; and (3) photon-stimulated desorption of K released by sputtering but trapped in the porous regolith ("Ion-Enhanced PSD"). Initial velocities for PSD corresponded to a temperature of 1,200 K. For desorption of adsorbates by UV photons we considered desorption cross sections that caused the residence times of adsorbates on the surface of grains to vary from a few hours to several days between successive bounces. Photoionization, transport to Permanently Shadowed Regions, and loss to the subsurface were considered as sink processes.

Results: The modeled exosphere reflects the surface composition closely but with reduced amplitude over the variation of potassium in the soil because of the high initial velocities and subsequent migration of gases [Fig 1]. Results indicate that impact vaporization from sporadic meteoroids is the main source process for K adsorbates. However, given the inferred sink rates from Geminids [3], the modeled rates required to populate the atmosphere were approximately 25% higher than estimated impact vaporization rates [4]. Furthermore, an exosphere consisting only of impact-derived gases would peak too early in lunar phase. We conclude that a solar wind source, releasing free metals from minerals with yield=0.03/ion, is necessary and sufficient to supplement the residual exosphere. Its effect is most evident when KREEP soils are exposed to magnetosheath plasma. According to further simulations (not shown here), constraints from ground-based observations [5] are consistent with this interpretation of a mix of sources, with the additional finding that the photodesorption yield must necessarily be temperature-dependent.

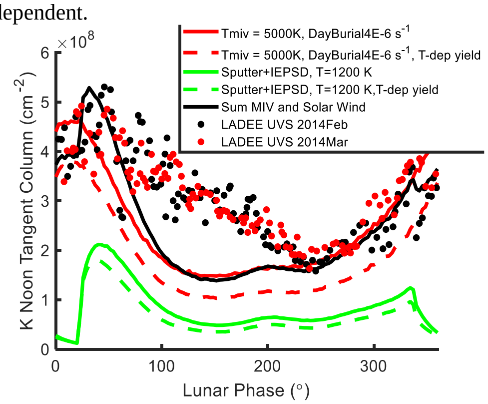

Figure 1. The potassium column abundance and its observed variation with lunar phase measured by LADEE is consistent with impact vaporization as the primary source of K atoms, with secondary but important contributions (~1/3 of total source) from the solar wind as ion-enhanced diffusion (IE-PSD).

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