KINETIC MODELING OF NEUTRAL AND IONIZED SODIUM IN THE MOON'S EXOSPHERE. Valeriy Tenishev[1], Martin Rubin[2], Yinsi Shou[1], Michael R. Combi[1], [1]Department of Atmospheric, Oceanic and Space Sciences, University of Michigan, 2455 Hayward St., Ann Arbor, MI 48109, USA (vtenishe@umich.edu), [2]Physikalisches Institut, University of Bern, Sidlerstr. 5, CH-3012 Bern, Switzerland.

Introduction: The knowledge about the lunar environment is based on a large volume of ground-based, remote, and in situ observations. These observations have been conducted at different times and sampled different pieces of such a complex system as the surface-bound exosphere of the Moon. Numerical modeling is the tool that can link results of these separate observations into a single picture. Being validated against previous measurements, models can be used for predictions and interpretation of future observations.

Model: Molecular collisions in the lunar surface-bound exosphere are negligible. As a result, the structure and dynamics of the exosphere are determined mainly by the surface processes (except photoionization of the exospheric species). Modeling of the evolution of gas at such conditions will require solving of the Boltzmann equation, however, the collision integral can be neglected.

Among methods used for solving the Boltzmann equation, the Monte Carlo method has become the primary numerical tool for modeling gas in the collisionless or transitional regimes [1]. In this work, we have used the University of Michigan Adaptive-Mesh-Particle-Simulator (AMPS) code [2,3] developed within the frame of the Direct Simulation Monte Carlo Method [4], where an ensemble of model particles is simulated simultaneously, which allows us to obtain not only a steady-state solution but also capture the dynamics of the system.

The sodium in the exosphere is produced via impact vaporization, photon-stimulated and thermal desorption, as well as solar wind sputtering. Particle/surface interaction implemented in AMPS includes surface sticking and accommodation. Results of modeling the sodium population is illustrated in Fig. 1.

The unique feature of our approach is the coupling between AMPS and the University of Michigan MHD BATSRUS code that is used for simulation of the global solar wind/Moon's exosphere interaction. The solar wind ions flux, and the distribution of the magnetic and electric fields obtained with BATSRUS are exported into AMPS for calculation of the sputtering source rate and the Lorentz force, respectively. Neutral and ionized sodium ions are simulated simultaneously. The coupling scheme is illustrated in Fig. 2.

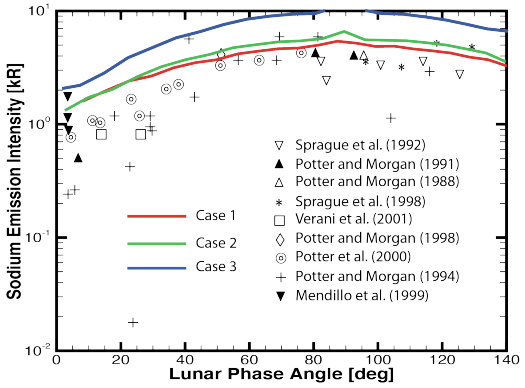

Figure 1. Modeled brightness of the sodium D_2 line at the lunar limb as it would be seen from Earth. The plot presents comparison of three different model results with available ground-based observations.

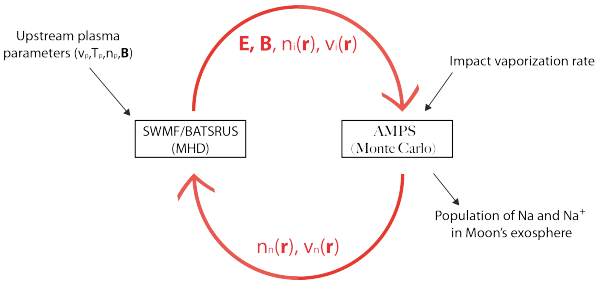

Figure 2. The distribution of the magnetospheric plasma and solar wind as well as electric and magnetic fields are calculated with BATSRUS. This information is used in AMPS to model sputtering of volatiles and tracing heavy ions. AMPS will be able to calculate the mass loading terms due to the pickup ions that can be used in the simulation of the plasma.

In this work we present first results of our coupled simulation of neutral and ionized sodium in the Moon's exosphere.

References: [1] Aristov V. (2001) *Kluwer Academic Publishers*. [2] Tenishev V. et al (2008) *Astrophys. J. 685, 659–677*. [3] Tenishev V. et al (2013) *Icarus 226 1538–1549*. [4] Bird, G. (1994) *Oxford University Press*.