INSIGHTS INTO DIRECT ION PRECIPITATION OF THE LUNAR POLAR REGIONS. P. S. Szabo and A. R. Poppe, 1Space Sciences Laboratory, University of California, Berkeley (szabo@berkeley.edu).

Introduction: The accumulation and erosion of volatiles, in particular water ice, in the Moon’s polar regions has recently been of particular interest [1]. Solar wind protons will generally contribute to water formation on the Moon via the creation of hydroxyls and possibly direct formation of water [2,3]. Transport processes across the surface and through the exosphere can then bring volatiles to the poles. Direct ion impacts in the polar regions will further affect the volatile inventory by both implantation and sputtering. Here, He ions and heavier species cause much higher sputtering yields than precipitating protons [4]. It is thus important to quantify direct ion fluxes into the polar regions and to assess which species play a role here. Recent analysis of ARTEMIS measurements has revealed a non-ecliptic ion population that mainly occurs in the Earth’s magnetotail [5]. It was found to have a flux of $10^3$ times the solar wind flux, but no information on the ion masses is available yet. Another contribution in the form of ions that are reflected at the lunar surface can also be expected to gyrate into the polar regions. However, such ions could not be conclusively measured by ARTEMIS due to the spacecrafts’ near-equatorial orbit. To get these additional insights into ion precipitation of the Moon’s polar regions, we have now investigated measurement data from the JAXA mission Kaguya [6]. Kaguya was operated in a polar orbit and had mass-resolution capabilities, which make additional findings to the ARTEMIS data possible.

The Kaguya Mission: The SELENological and Engineering Explorer (SELENE), often referred to as Kaguya, orbited the moon from late 2007 to 2009 in a polar orbit, mostly with an altitude of 100 km. Among a wide array of instruments, it was equipped with a magnetometer (LMAG) and a plasma-investigation suite (PACE) consisting of instruments for the measurement of both ions and electrons [7]. Its two ion sensors IEA (Ion Energy Analyzer) and IMA (Ion Mass Analyzer) were mounted on opposite sides of the spacecraft to allow a full field of view (see Figure 1). Both instruments were equipped with electrostatic analyzers for energy-resolved ion flux measurements. IMA additionally included a time-of-flight mass analyzer to deduce the mass-over-charge states of the measured ions. Due to Kaguya’s three-axis-stabilization, IEA was always facing away from the Moon, while IMA allowed mass-resolved measurements of the ions that are mostly coming from the lunar surface.

Figure 1: A sketch of the Kaguya mission. (Image credit: NASA)

Ion Flux Analysis and Results: The angular resolution of the IEA instrument along with Kaguya’s low altitude of 100 km provides a good opportunity for mapping the ion fluxes onto the lunar surface. Based on the LMAP measurements of the interplanetary magnetic field (IMF) and the calculated solar wind convection electric field, we have implemented a numerical tracing algorithm to follow the ions’ paths until their impacts on the Moon. Combining data from the whole mission timespan, we can compare the precipitating fluxes for subsolar and polar points on the lunar surface. Compared to previous ARTEMIS measurements, we find an additional ion flux into the polar regions near the solar wind energy at oblique angles of incidence. The ion precipitation maps from IEA measurements can be used to study the local influence of ion impacts and the interaction of ions with the cratered lunar landscape more precisely. Further details on the IEA analysis as well as first results from IMA will be presented at NESF.