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Global Energetic Neutral Atom Map of the Lunar Surface

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Until recently, it was tacitly assumed that the solar wind ions that impinge onto the lunar surface are almost completely absorbed (< 1% reflection). This assumption has been invalidated by recent observations made by IBEX and SARA/Chandrayaan-1, which showed an average global energetic neutral atom (ENA) albedo of 10% – 20% (e.g. McComas et al. [GRL 2009] and Wieser et al. [PSS, 2009]). Having analysed all available measurements from the Chandrayaan-1 Energetic Neutral Analyzer (SARA/CENA), we present two global ENA maps of the lunar surface. The low energy map contains ENAs in the energy range (7 eV – 169 eV) and the high energy map contains ENAs in the energy range (169 eV – 3.5 keV). Together, the maps contain all ENAs within SARA/CENA's complete energy range (7 eV – 3.5 keV). The maps cover ∼82% of the lunar surface, with almost complete coverage of the lunar farside. In the high energy part of the lunar ENA map several magnetic anomalies can be identified, whereas in the low energy part only the large magnetic anomaly associated with the South Pole-Aitken basin is clearly observed. By comparing SARA/CENA ENA maps to different lunar magnetic field maps, we found that they correlate better with the surface crustal magnetic field map than with the map showing the magnetic field at an altitude of 30 km. This implies that the main interaction between the solar wind plasma and the Moon occurs close to surface. Our high energy ENA map exhibits a strong anti-correlation with the map showing the flux of lunar deflected protons (Lue et al. [GRL 2011]) and appears to be an inverted image thereof. In addition, features in the ENA maps correlate with albedo features of swirls in the South Pole-Aitken basin. No obvious correlation with either the lunar topography or lunar geology map was found.

The strength of ENA imaging together with ion reflection imaging lies in the fact that details of solar wind interaction with surfaces in the presence of electric and magnetic fields on the surface can be remotely studied. Whereas the technique of ENA imaging is still young, it has proven it's worth in investigating planetary surfaces not protected by an atmosphere and will be subject to many upcoming missions (e.g. with the proposed PEP instrument on the JUICE mission, designated to investigate Ganymede and Europa).