ARTEMIS and the Moon's Sphere of Influence

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Abstract. Though in many ways the Moon provides only a passive obstacle to ambient plasma, the presence of the Moon can actually affect the surrounding environment to surprisingly large distances. With the new ARTEMIS mission, we can study these effects with unprecedented detail, utilizing its comprehensive plasma instrumentation and two-point measurement capability. We observe protons reflecting with surprisingly high efficiency above small-scale crustal magnetic anomaly regions, producing plumes of protons with densities approaching the solar wind near the surface and up to ~10% of the solar wind even thousands of km from the surface. We also see pickup ions produced from the ionization of the neutral exosphere and/or sputtering from the surface, forming a narrow plume extending many tens of thousands of km laterally outward from the surface. In addition, we observe perturbations of the plasma and significant wave turbulence extending along magnetic field lines from the surface, forming a precursor region and significantly affecting the inflowing plasma to distances of tens of thousands of km or more upstream. All of these plasma populations extend the Moon's sphere of influence by orders of magnitude compared to what would be expected for a purely passive absorber. In turn, each of these processes and associated charged particle populations allows us to connect plasma observations back to the Moon's surface and exosphere, potentially informing us about processes as diverse as surface weathering, volatile implantation, electrostatic charging of the surface, and the source and loss processes of the tenuous lunar exosphere.