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Asymmetric space weathering in northern and southern hemispheres on the Moon

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Space weathering on the Moon is generally known to be dominated by solar wind irradiation and micrometeorite impacts. They change the lunar regolith to optically mature by altering its compositions and spectral properties. The wall quadrants of lunar craters have the advantage of studying the optical maturity (OMAT) difference caused by the solar flux difference between opposing quadrants. The wall quadrants had been exposed on the surface for the same duration but the quadrants facing each other have different incident angles of the space weathering particles depending on the location.

Previous studies have found latitudinal and longitudinal dependencies of optical properties on the lunar surface. Following Sim et al., who studied the space weathering asymmetry inside lunar craters, here we apply the extended lunar crater database (Robbins et al.) to consider more and smaller craters. A total of 26,802 craters ranging from 2 to 150 km in diameter are used, more than 10 times the 1,872 in the previous study. We reproduce the dependencies with the improved processes—finding the rim, defining the inner structure, and dividing wall quadrants of the craters.

Furthermore, we find that the OMAT difference between the equator-facing (EF) and pole-facing (PF) walls has opposite trends in the northern and southern hemispheres at lower latitudes. Below 25 degrees, the EF wall is more mature than the PF wall in the northern hemisphere, but it is the opposite in the southern hemisphere. Unlike previously known, the hemispheres seem not to be symmetrically affected along the ecliptic plane. In particular, the degree of weathering on the EF and PF walls is significantly asymmetric near the equator. We speculate that this unexpected result is caused by asymmetric impacts of meteoroids in the northern and southern hemispheres on the Moon.

KEYWORDS The Moon, Lunar science, Lunar surface, Lunar craters, Planetary science, Surface processes