DYNAMIC MOON: NEW IMPACTS AND CONTEMPORARY SURFACE CHANGES. E.J. Speyerer[1], R.Z. Povilaitis[1], M.S. Robinson[1], P.C. Thomas[2], R.V. Wagner[1], [1]School of Earth and Space Exploration, Arizona State University, Tempe, AZ, [2]Cornell Center for Astrophysics and Planetary Science, Cornell University, Ithaca, NY.

Introduction: Random bombardment by cometary and asteroidal materials shape and alter the surface of the Moon as well as other planetary surfaces. While this concept is not new, observations from the Lunar Reconnaissance Orbiter Camera (LROC) [1] provide our first detailed look at surface changes associated with these impact events. Since the start of the mission, LROC has acquired over a million Narrow Angle Camera (NAC) images of illuminated terrain. From this collection, 14,092 are observations of regions of the Moon where previous NAC observations with similar lighting geometry exist (i.e. incidence angle difference <3°, incidence angle < 50°, and nadir pointing). These before and after image pairs, called temporal pairs, enable the search for a range of surface changes, including new impact craters, secondary disturbances, and mass wasting events that formed between the time the first and second images are acquired.

New Impact Craters: To date, NAC temporal pairs have uncovered 222 resolved impact craters ranging in diameter from 1.5 to 43 m. Furthermore, reimaging of two of the impact flashes recorded on 3/17/2013 and 9/11/2013 by Earth-based observers revealed 18 and 34 m diameter craters, respectively [2-4].

Using ratio images created from the temporal pairs, we can analyze the reflectance change and expanse of surface changes associated with each impact event. **Fig. 1** shows the result of an impact that created an 18 m crater (42.6.°N, 257.8°E). The new impact formed four distinct reflectance zones around the crater: proximal high reflectance zone, proximal low reflectance zone, distal high reflectance zone, and distal low reflectance zone. These complex patterns and reflectance zones are present at multiple new impact craters, including the 3/17/2013 impact crater [2].

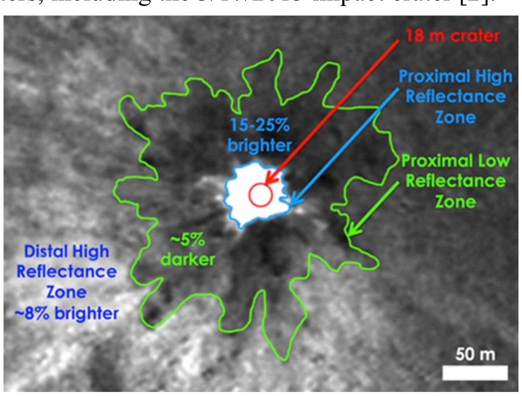

Fig. 1- Ratio image of an 18 m crater showing a series of distinct ejecta zones around the impact site. The distal low reflectance zone is outside of the image area.

Secondary Surface Changes: In addition to capturing new impact craters, NAC temporal pairs have also uncovered over 47,000 small reflectance changes, or "splotches". These splotches do not exhibit visible crater rims, but only modify the observed surface reflectance (**Fig. 2**). While some of the splotches might be the result of small, primary impact craters (< 3 pixels), most splotches are the result of secondary surface disturbances associated with larger, nearby impact events. Robinson et al. [2] identified 248 splotches around the 3/17/2013 impact site. While splotches are generally circular, Robinson et al. [2] noted that some splotches were wedge shaped and pointed back to the primary impact crater indicating a likely emplacement direction. Our analysis of temporal pairs has also identified clusters of splotches around other new impact craters supporting the idea that many splotches are secondary features.

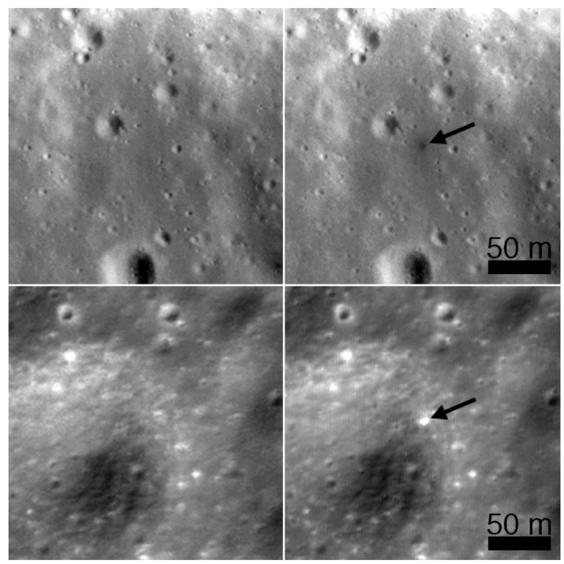

Fig. 2- Temporal pair showing a new low reflectance (top row) and high reflectance (bottom row) splotch.

Summary: LROC NAC temporal imaging enables the detection and measurement of new impact and secondary surface changes. These observations provide a new view on the cratering process itself. Continued observations through the LRO mission will enable us to refine the contemporary impact rate and quantify the rate of regolith gardening caused by secondary surface changes.

References: [1] Robinson M.S. et al. (2010) *Space Sci. Rev.*, 150, 1-4, 81-124. [2] Robinson M.S. et al. (2015) *Icarus,* 252, 229-235. [3] Madiedo J.M. et al. (2014) *MNRAS*, 439, 3, 2364-2369. [4] http://lroc.sese.asu.edu/posts/810.