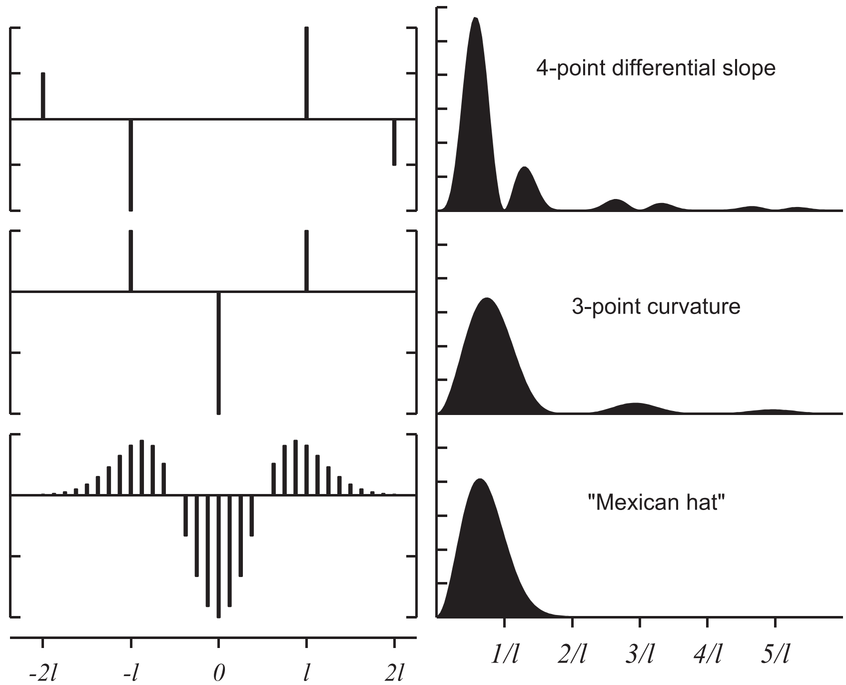

Fig. 6. Left panels, three examples of spatial kernels of several linear filters for characterization of along-profile roughness at a given baseline *l*, top to bottom: 4-point differential slope (used by Kreslavsky and Head (2000) and Rosenburg et al. (2011)), 3-point curvature used in this paper and defined by Eq. (1), and "Mexican hat". Vertical scale is arbitrary. A baseline equal to 8 shot-to-shot distances is chosen in this example. Right panels, spatial power spectra of the result of the application of these linear filters to an idealized Brownian walk profile ("brown noise"). Spectra are normalized by the total power (that is, the areas below the curve are the same).

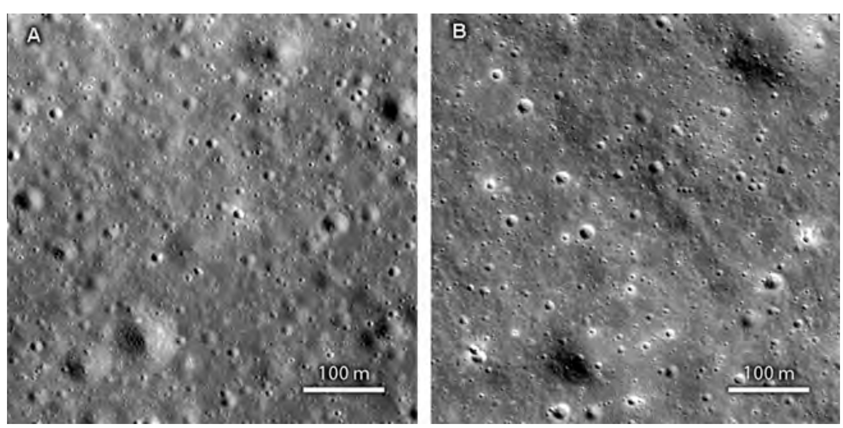

Fig. 7. High-resolution images of typical mare (A) and highland (B) surfaces taken under similar solar incidence angles of ~45°. Scale bars are similar to the baseline used for the roughness map in Figs. 2 and 3. Portions of LROC NAC images M137685293L (A) and M136572848R (B).

processes are not responsible for the roughness values at this scale (though they may slightly affect it). At the scale of kilometers, roughness reflects "bedrock geology": the surface is shaped by volcanic flooding of maria, large impacts, and tectonics.

Exact thickness of regolith layer in highlands is poorly measured and perhaps poorly defined (due to the absence of uniform consolidated substrate); indirect estimates (e.g., Shkuratov and Bondarenko, 2001; Fa and Jin, 2011) yielded the typical highland regolith thickness of ~10 m; recent measurements based on morphology of small craters by Bart et al. (2011) gave estimates within 6–8 m. As the characteristic vertical scale of roughness increases with horizontal baseline, the typical highland regolith thickness intersects this trend at ~1 km baseline, indicating that roughness at scales below this value is controlled by regolith processes while roughness at larger scales is controlled by bedrock topography. Rosenburg et al. (2011) found that the Hurst exponent within the lunar highlands commonly transitions from a high value near 1 to a lower value of ~0.8, with the transition occurring at approximately the 1-km scale, in good agreement with the roughness calculations presented here. This change in slope of the structure function is consistent with a transition between roughness regimes governed by different surface processes.

Formation and degradation of hectometer and smaller craters, and formation and gardening of regolith, are universal processes that occur everywhere on the Moon, to a first order, in a uniform way. Due to this, the difference between hectometer and kilometer scales also reflects different time scales: the hectometer-scale roughness maps show features younger than the characteristic time scale of reworking of the uppermost layer of the regolith, on the order of a meter. Thus, this is a feature of Copernican and, at least partly, Eratosthenian age, while the kilometer-scale rough-