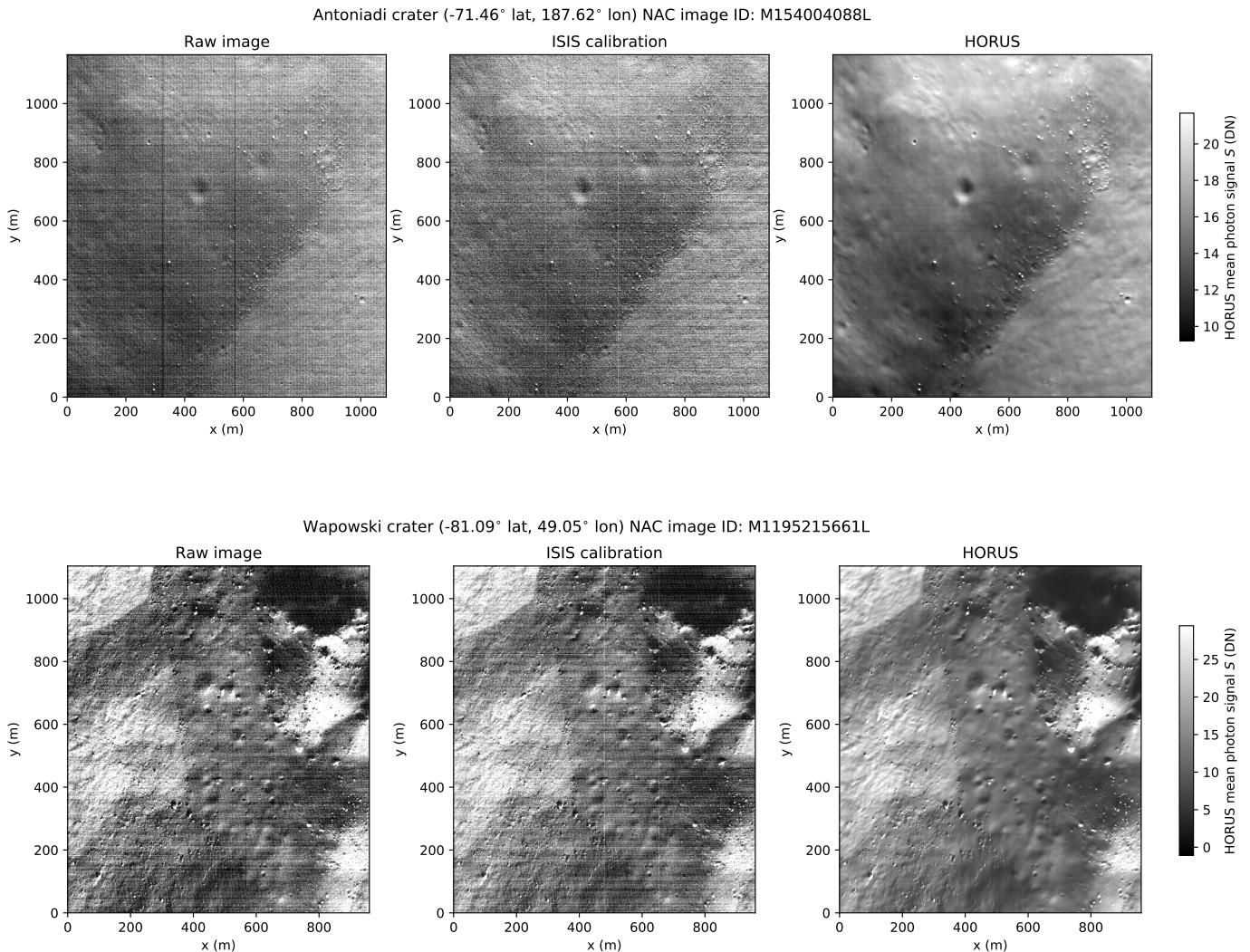


# Extreme Low-Light Environment-Driven Image Denoising over Permanently Shadowed Lunar Regions with a Physical Noise Model: Supplement

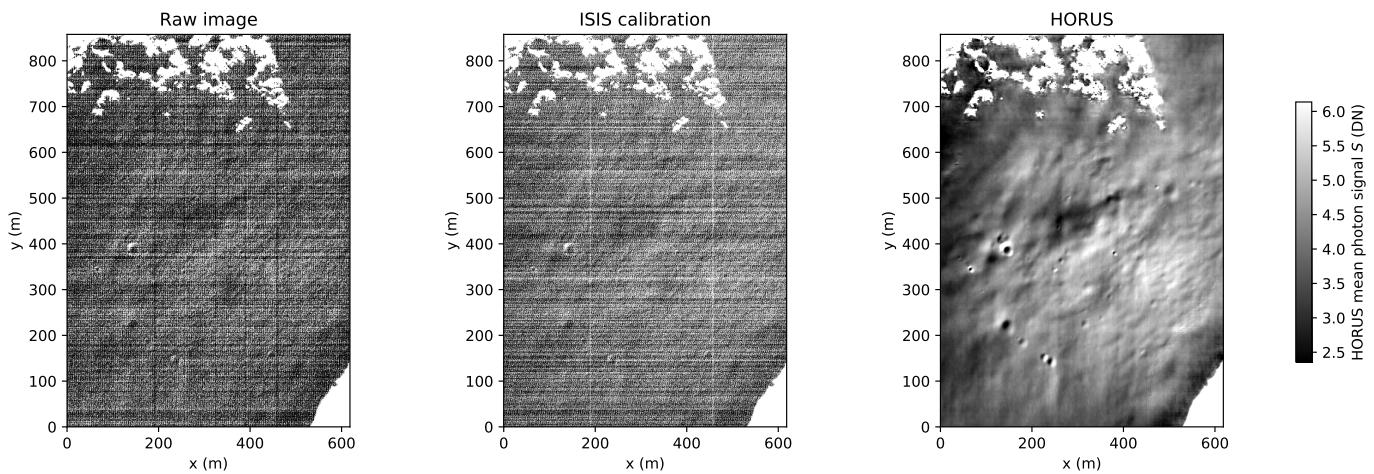
Ben Moseley, Valentin Bickel, Ignacio G. López-Francos and Loveneesh Rana

## 1 Examples of HORUS denoising on real images

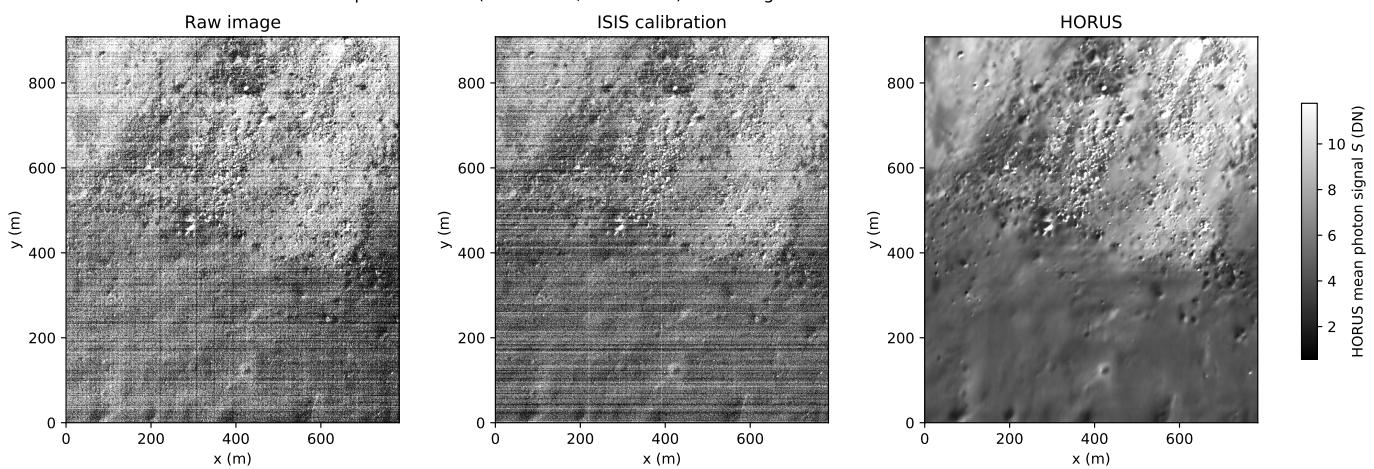
The figures below show more examples of HORUS applied to real NAC images of temporarily- and permanently-shadowed regions on the lunar surface. For each figure, left shows the input raw NAC Experiment Data Record (EDR) image, middle shows the raw image after the current calibration routine of the camera (ISIS) is applied and right shows the raw image after HORUS is applied. The colorbar is for the HORUS plot and shows the mean photon signal in Data Numbers (DN) estimated by HORUS. The examples are presented in order of decreasing latitude. Raw/ISIS image credits to LROC/GSFC/ASU.



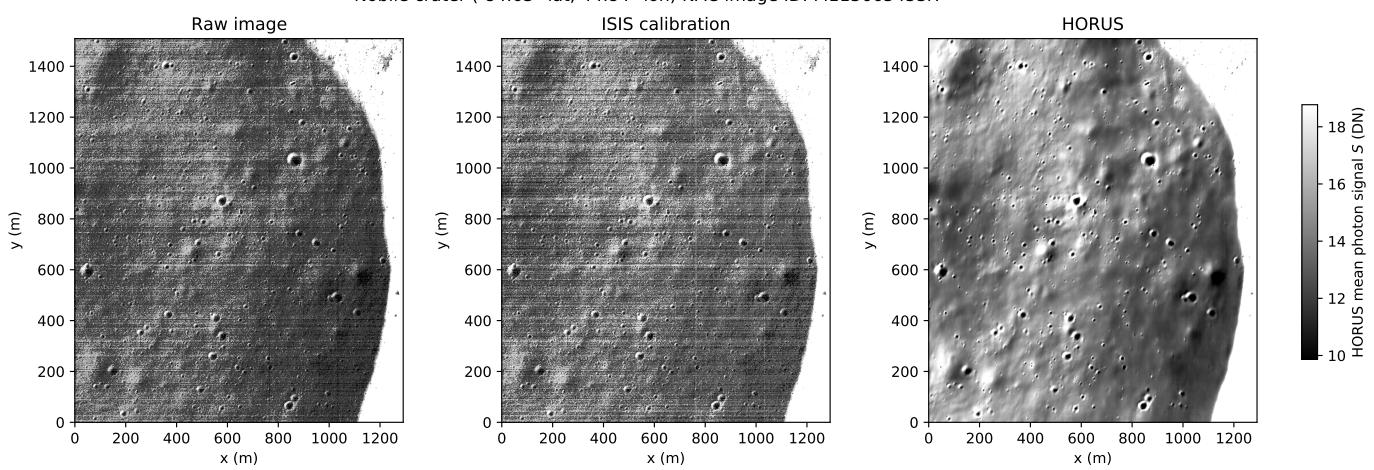
Wiechert crater ( $-82.29^\circ$  lat,  $170.47^\circ$  lon) NAC image ID: M1163801508R



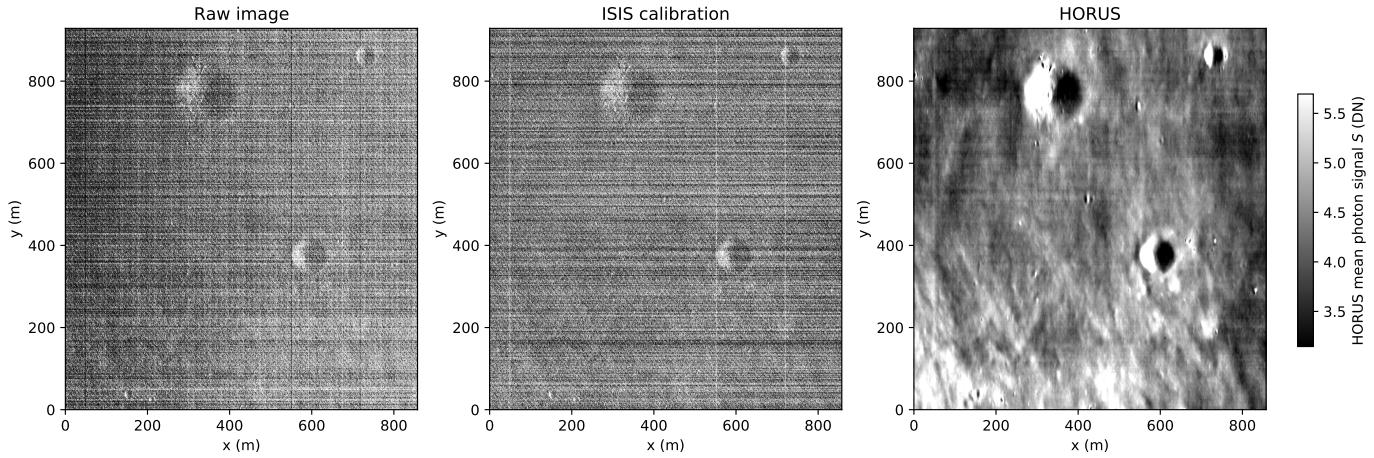
Wapowski crater ( $-82.46^\circ$  lat,  $51.78^\circ$  lon) NAC image ID: M1199927204R



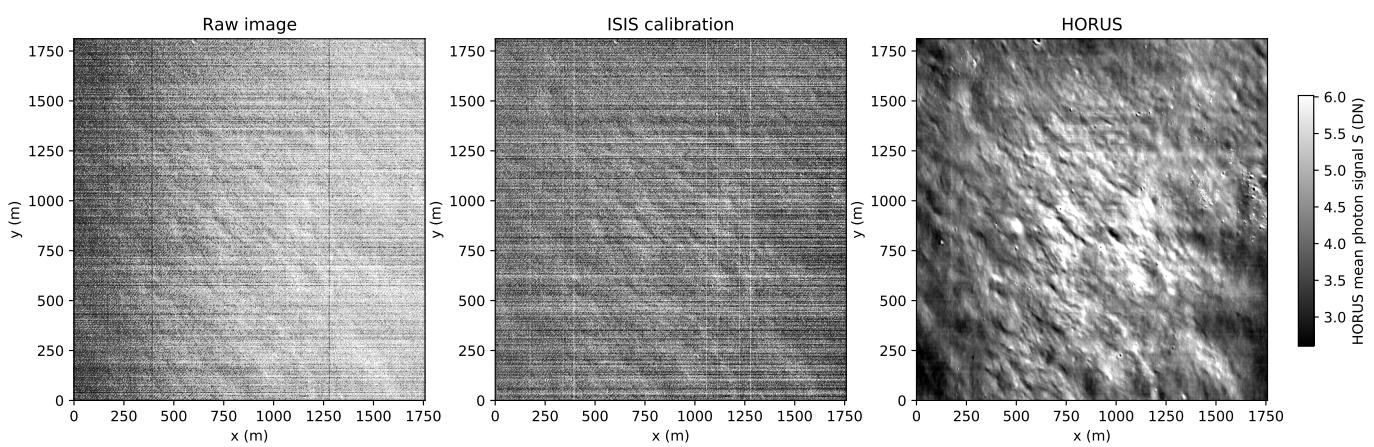
Nobile crater ( $-84.63^\circ$  lat,  $44.84^\circ$  lon) NAC image ID: M113665453R



Kocher crater (-84.66° lat, 224.63° lon) NAC image ID: M1201910632L



Kocher crater (-85.46° lat, 222.40° lon) NAC image ID: M181922216L



## 2 Examples of HORUS denoising on synthetic images

The figures below show more randomly selected examples of HORUS applied to our synthetic test set of images; please see the main paper for a detailed description of how these images are generated. For each figure, from left to right; the clean image  $\tilde{S}$  generated by rescaling a normal sunlit NAC image to low photon counts; the noisy image  $\tilde{I}$  after noise from our physical noise model is added; the HORUS denoised image  $\hat{S}$ ; the difference between the clean image and the HORUS denoised image. For each figure, the top colorbar is for the clean and HORUS denoised images and shows the mean photon signal, bottom colorbar is for the difference image. The examples are presented in order of decreasing noise.  $\tilde{S}$  image credits to LROC/GSFC/ASU.

