JUNOCAM IMAGES OF EUROPA. C. J. Hansen[1], M. Ravine[2], P. Schenk[3], G. C. Collins[4], E. Leonard[5], M. Caplinger[2], J. Keane[5], F. Tosi[6], S. Bolton[7]. [1]Planetary Science Institute, 1700 Fort Lowell, Tucson, AZ (cjhansen@psi.edu), [2]Malin Space Science Systems, CA, [3]Lunar and Planetary Science Institute, TX, [4]Wheaton College, MA, [5]Jet Propulsion Laboratory, CA, [6]Italy National Institute for Astrophysics, [7]Southwest Research Institute, TX.

Introduction: On 29 September 2022 the Juno spacecraft, in a polar elliptical orbit around Jupiter, made a close pass by Jupiter's moon Europa. Juno's JunoCam visible imager took four color images of Europa with coverage over an area spanning 15W - 80E, centered just north of the equator. Attributes of the images are listed in Table 1. Resolution is comparable to or better than previous Galileo coverage that had a resolution of 1 - 6 km. The first image was acquired near the sub-jovian point at a phase angle of ~90 deg, excellent lighting for discerning topography along the terminator.

Mounted on a spacecraft spinning at 2 rpm, JunoCam pushframe red-green-blue images are acquired as the spacecraft rotates and the field of view sweeps across the target. Due to the very low altitude this pass was rapid and just a sector of Europa was imaged at low emission angles. A mosaic of the 4 images, shown in Figure 1, includes the western extent of Annwn Regio (chaos terrain), and the large ringed feature Callanish. Rays from Pwyll are visible on the eastern limb.

Table 1. *JunoCam Europa image attributes*

Image	Altitude (km)	Spatial scale (km)	Subs/c Lat	Subs/c Lon (W)
1	1515	1.0	11.8	0.3
2	2738	1.8	13.7	348.2
3	4069	2.7	14.5	341.6
4	5443	3.7	14.9	337.5

JunoCam Images: The JunoCam field of view is 58º, 1600 pixels across in the cross-rotation dimension. One image is acquired on one spacecraft rotation so hypothetically an image could be 360º but in this case we imaged for ~120º, sufficient to capture Europa across its edges visible to JunoCam. The spacecraft was so close to Europa that only the area from ~60N to 50S is included in an image. The start time of the first image was 2022-09-29T09:38:05.7. The Europa images are spaced by one minute.

New Maps: JunoCam images of Ganymede showed that even when resolution is similar to previous coverage, the high quality of JunoCam images enables vastly improved identification of surface features, especially at high incidence angles along the terminator [1]. The new Europa images show that Europa has "lost" one of its named craters, Gwern – it is now clear that the intersection of linear ridge features simply produced a quasi-circular pattern in previous images. JunoCam images also provide new detail at Midir crater. The Midir data is challenging to interpret in terms of topographic shading versus albedo, and does not fit expectations for a simple bowl-shaped crater.

One particular patch of Europa mapped with low resolution Galileo images can be replaced now with higher resolution images with better lighting, shown in Figure 2. That in turn allows us to update the existing geologic map, in particular differentiating chaos terrain from "dark plains", a terrain type not previously identified at the global scale, by considering both albedo and texture [2]. Extended mapping of two bright bands (Corick Linea at 19N and an un-named band at 39N) shows evidence for global symmetry in stress states [3].

Figure 1. This approximately true color image is a combination of all 4 Europa images, projected from the location of the spacecraft at the time the 4th image was acquired. The terminator is at a longitude of ~10W and the east limb is at 270W. The image was processed by one of JunoCam's essential citizen scientists, Björn Jónsson, attribution cc nc sa.

Terminator Topography: Numerous pits 500m to 900m deep are revealed along the terminator. A newly identified trough is aligned with previously identified surface features likely associated with true polar wander [3]. Large blocks along the terminator cast shadows.

Figure 2. Zooming in on the patch of terrain poorly imaged by Galileo, lineae are more prominent and can be traced across to existing previous higher resolution coverage. Smooth areas are likely ancient bands. Extensions of previously identified arcuate troughs are also visible.

Plume Search: There is a great deal of interest in whether or not there are active eruptions at Europa manifesting as plumes. All evidence to date implicating plumes is consistent with vapor eruptions - there is no data showing possible particulates. In spite of that, we looked carefully at the terminator and the limb for signs of an eruption. Figure 3 shows a highly stretched version of the first image and Jupiter-shine illuminates the territory along the dark side of the terminator. This allows us to determine that bright spots along the terminator are not eruptions but rather are associated with high points of the terrain.

Figure 3. A contrast-enhanced version of the first image shows the dark side of Europa illuminated by Jupiter-shine. This allows us to look at bright spots along the terminator that might have been interpreted as eruptions and link them instead to existing terrain. This image was processed by JunoCam citizen scientist Brian Swift, cc by.

The limb of Europa in the 4th image was at ~90E, where plumes have been reported previously [4, 5]. However, an eruption would have to occur at just the right longitude (limb or terminator) and just the right time when Juno flew by, so the probability of a detection was never very high. Also, the phase angle was not ideal for detection of small particles. A non-detection does not add any new constraints to current activity at Europa. We are planning to compare JunoCam images to Galileo images for change detection of surface changes but that requires very careful removal of the photometric function to be certain apparent changes are not just due to lighting differences.

Color Images: One promising aspect of the new set of images is the potential to carry out regional stratigraphic analysis of lineae with images all acquired at the same time and lighting. We will report on color analysis of lineae similar to the analysis of Galileo images on the anti-jovian side of Europa done by Geissler et al. [6] that showed an apparent evolution of lineae from cracks to ridges to triple bands to ancient bands. Figure 4 shows a small area of the second JunoCam image with similar cross-cutting lineae.

Figure 4. A prominent triple band is observed here, as sometimes cutting through and sometimes being cut by other lineaments.

Summary: New results from the acquisition of new high resolution images with different lighting shows the value of re-imaging previously covered areas even at similar resolution.

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References: [1] Ravine, M. et al. (2022) *GRL* 49:e2022GL099211. [2] Leonard, E. J. et al. (this meeting). [3] Collins, G. C. et al. (this meeting). [4] Schenk, P. et al. (this meeting). [5] Sparks et al., (2016) *ApJ 829:121*. [6] Arnold et al., (2019) *GRL* 46:1149. [7] Geissler, P. et al., (1998) *Icarus* 135:107.