

## **JunoCam at PJ45: What the images show**

### **Part II: Jupiter**

**John Rogers (BAA) (2022 Oct.22)**

Juno's perijove-45 (PJ45) occurred on 2022 Sep.29. Perijove was at 37.4°N. Equator crossing occurred 15 minutes later, at L1=357, L2=309, L3=240.

Abbreviations and acknowledgements herein are as in our previous reports (e.g. PJ43).

JunoCam now gets a good sequence of approach images (e.g. [Figure 1](#)). They started ~1 hour after the Europa imaging and ~6 hours before north pole crossing, and covered more than half of the EZ and NEB (at resolution similar to the best ground-based images), and much of the northern hemisphere at higher resolution – though as the spacecraft was flying north from the equatorial plane, it did not get a good view of the North Polar Region until about an hour before it flew over it. This inbound coverage is included in our cylindrical map ([Figure 6](#)). Parts of the SEB & STB were included in both the inbound and post-perijove maps (afternoon and morning respectively), which could be blinked to show the zonal jets over ~5h 20m ([Anim-1](#)).

#### **North Polar Region**

[Figure 2](#) is our hi-res north polar projection map, down to 60°N at the edges. *The circumpolar cyclones (CPCs)* appear much as they did at PJ43 and PJ44.

#### *Haze features and the Bland Zone:*

The inbound methane images permitted lo-res mapping of the North Polar Hood (NPH) ([Figure 3](#)). Comparing the two PJ45 maps in [Figure 3](#), the interior of the NPH appears much darker in image 55, taken over the pole, than in the inbound images – confirming that the near-absence of the methane-bright NPH in images at recent perijoves must be due to the viewing angle, not to any intrinsic change in it.

[Figure 3](#) also compares the JunoCam map with ground-based maps several days before and after, from Andy Casely. Casely had noticed a large southward bulge in the NPH edge on Sep.25, and again on Oct.2, and the same feature is visible in the JunoCam map on Sep.29. The bulge, and the straight edge that runs for ~75° longitude p. it, rotated by -1.3 ( $\pm 0.2$ ) deg/day in these three maps, i.e. rapidly prograding like the underlying N6 domain and jet. It is notable that these and other wave-like features in the boundary are much larger than usual; more commonly we have found undulations of wavelength ~30-46° longitude, matching the spacing of the adjacent linear bands in the Bland Zone [unpublished analysis, 2018]. It's also notable that the bulge corresponds to an exceptionally dark linear band at the terminator (images 46 & 48 in [Figure 1](#); lower right in [Figure 2](#)).

We have previously found that the boundary of the NPH is usually close to the bright and dark linear haze bands that run obliquely across the Bland Zone, but their nature remains uncertain. The PJ45 images show long bands running all across the morning side of the planet, with exceptional resolution ([Figure 4](#)).

In [Figure 4](#), light blue arrows indicate a bright band, which is close to the boundary of the NPH; towards the (morning) terminator it is brighter, and also has a dark, brown band on its poleward side, which could be due to shadowing. White arrows indicate a much darker brown band further south, which provides a test case for hypotheses about these bands. As we noted for similar bands previously, it runs across white ovals without obviously reducing their contrast; it is probably methane-dark; and it is nearly continuous with more southerly bands which remain dark closer to the terminator. All these properties suggest that it is a thinning in an otherwise inconspicuous white haze layer. Indeed, while the whole region between the white and dark bands is slightly brownish and strongly methane-dark, there appears to be a slight whitish haze to the south (images 55 &

56 in [Figure 4](#)). On the other hand, this dark band is so dark and reddish as to keep alive the possibility that it is a band of reddish aerosol, similar to the red bands that we often see in the SEB(S).

## Northern domains

[Figure 5](#) shows a gallery of images from the NPR to the EZ. The first three images include the Bland Zone with the linear haze bands labelled as in [Figure 4](#). In the subsequent images, lines delineate the areas shown separately in the insets (close-up views of beautiful circulations in N4 and N3) and in subsequent figures.

## Global maps

[Figure 6](#) is our global cylindrical map at PJ45. Most of the map is from the inbound images; the perijove swathe is on the right. No images were taken after south pole crossing because of data volume limits.

[Figure 7](#) is a ground-based map for comparison, with the main features labelled.

## NEB & EZ

JunoCam captured close-up views of the only dark barge that has not faded ([Figures 5 & 8](#)). As with previous views of NEB barges, its clouds appear diffuse – although extensive, subtle, semi-regular mesoscale waves are visible in the white NTropZ nearby.

An undisturbed stretch of NEB(S) was seen during the flyby.

Two days later, amateur images showed a new bright outbreak appearing in it [see our forthcoming 2020 Report no.3]. It was at L1=27 on Oct.1.5, and (brighter) at L1=25 on Oct.3.2, so if it had existed on Sep.29 it would have been at L1=29 (L3=272). This was outside JunoCam's perijove swathe. The inbound map showed a small unremarkable light spot there, also seen in amateur images on Sep.30, possibly irrelevant, although the outbreak appeared within it on Oct.1.

Many of the images of the NEB and EZ had compression artefacts due to the low light levels and low contrast, but there was enough data volume to transmit image 70 without lossy compression. It shows a variety of cirrus-like clouds, tiny compact clouds, and more-or-less periodic mesoscale waves in the EZ(N) ([Figure 9A](#)). In the EZ(S), image 72 showed more substantial puffy white clouds ([Figure 9B](#)).

## Southern hemisphere

*SEB:*

In the northern half of the SEB, we again see white ovals with spiral structure that suggests they are anticyclonic ([Figure 10, red asterisks](#)). In fact, our 5-hour blink of maps ([Anim-1](#)) suggests that these 'AWOs' prograde with little sign of vorticity or velocity gradient, consistent with some zonal wind profiles from previous spacecraft and Hubble maps. This arrangement has not been studied thoroughly, but perhaps the morphology results from this low-vorticity band being embedded in the overall cyclonic gradient of the SEB.

*STropZ & STB:*

At present there is a dark grey S. Tropical Band around more than half of the planet, and a dark or turbulent STB segment (segment A) ~80° long following oval BA ([Figure 7](#)). In the space between them, the JunoCam images show a chaotic tangle of cloud structures ([Figure 10, bottom](#)), probably between the two components of the STBn jet. The adjacent STB segment A looks very different with a typical pattern of streaks and orange eddies representing its strong cyclonic gradient.

*S4 domain:*

S4-LRS-1 is nicely shown (at top centre in [Figure 11](#)), and has a striking bright-and-dark streak along its S edge; blinking two maps shows that this moves with the S5 jet.

## **South Polar Region**

[Figure 11](#) is a map of the SPR, down to 60°S at the edges. A bright arc of haze on the dusk terminator could be the following end of the Long Band. The south pole is now in darkness but we can still discern three of the CPCs, indicated in the inset.

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### **Figures:**

Figure 1. Examples of the inbound images, both RGB and CH4. (The raw methane images had a ‘snowstorm’ of bright pixels and streaks, due to radiation hits and hot pixels; here they have been ‘cleaned up’ by noise removal in Photoshop, and brightness gradients adjusted.)

Figure 2. North polar projection map, down to 60°N at the edges.

Figure 3. North polar projection maps in the methane band, from JunoCam and from ground-based images several days before and after PJ45. (The maps are rotated 180° relative to Figure 2.)

Figure 4. Images after north pole crossing, showing the linear bands over the Bland Zone. See main text for description. (North is approximately up.)

Figure 5. Images from the NPR to the EZ, roughly aligned in latitude (from the initial MSSS post on the JunoCam web site). The first 3 images include the Bland Zone with the linear haze bands labelled as in Figure 4. In the subsequent images, lines delineate the areas shown separately in excerpts from Gerald’s full-resolution versions, in the N4 and N3 domains (insets in this figure) and in NEBn and EZ(N) (Figures 8 & 9A). (North is up in all these images.)

Figure 6. Global cylindrical map at PJ45.

Figure 7. Global ground-based map on the day of PJ45, with the main features labelled.

Figure 8. Close-up view (image 67) showing part of the only NEB barge that has not faded, and subtle, semi-regular mesoscale waves in the white NTropZ nearby. (See Figure 5 for context.) Processed by Gerald Eichstädt.

Figure 9. Close-ups of the EZ. (A) Image 70 (without lossy compression): EZ(N). (B) Image 72: EZ(S). Processed by Gerald Eichstädt.

Figure 10. Image covering the SEB and STB (image 75). Red asterisks indicate ‘AWOs’ (see text). The boxed area is shown at full resolution at the bottom.

Figure 11. Composite south polar projection map, down to 60°S at the edges.

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