

## **JunoCam at PJ27: What the pictures show (Part II)**

**John Rogers (2020 July 31)**

This part expands on Part I, with results from high-quality images and maps produced by Gerald Eichstädt and by Björn Jónsson.

### **North Polar Region**

*Circumpolar cyclones (CPCs):*

Figure 9 presents two north polar projection maps, by Gerald Eichstädt and by Björn Jónsson, respectively. They show four CPCs, with their characteristic morphologies, as well as part of the central North Polar Cyclone, which is increasingly well illuminated. The most interesting aspect is that the four CPCs are regularly arranged in latitude as in the original ditetragon. CPC-7 had been increasingly displaced from the pole during the mission, so since PJ5 it had been at  $\leq 82.3^\circ\text{N}$ , down to  $81.0^\circ\text{N}$  [Refs.1&2]. But now it is at  $82.4^\circ\text{N}$ , which is typical for filled CPCs – even though the AWO within the ditetragon, which appeared to be displacing CPC-7, is still there and as big as ever.

There are haze bands visible at the terminator, even overlapping the edge of the ditetragon.

*Haze bands & the North Polar Hood (NPH):*

Figure 10 shows a pair of composite north polar projection maps using Gerald's data, in colour and in the methane band. In the colour map, some haze bands can be seen near the terminator, but they are generally weak, except for one on the Bland Zone at bottom right of the map. In the methane map, some diffuse haze bands are evident near the terminator and the limb, and there is a faint hint of the main edge of the NPH at  $\sim 64^\circ\text{N}$  (the edge of the Bland Zone). The most obvious features in the methane map are the bright strips in the FFRs.

### **Northern domains**

Figure 11 is just one example of the spectacular turbulent regions in the far northern domains, including part of an FFR with overlapping layers of clouds and different colours.

Figure 12 shows the result of searching Gerald's unenhanced images for distinct haze layers at the limb. A short span of high-altitude haze layer is detected over the N3 domain.

### **Equatorial Region**

Figure 13 is a composite cylindrical map of the planet, made from Gerald's maps. Features can be identified by reference to Figure 2, the ground-based map.

The inset shows Gerald's map of images 32 & 33, covering the NEB and EZ, with a box enclosing the area where a bundle of red and white haze bands was identified in Part I of this report. This map shows that these bands are on the NEBs at their E and W ends, but in between they veer southwards into the EZ(N), as if pushed southwards by a bright white NEB rift that can be seen projecting into the EZ(N). Ground-based images, assembled in Figure 14, support this interpretation. This rapidly-forming NEB rift (black arrow) indeed broke through into the EZ(N) on June 1-2; narrow red and white streaks at that location were detected although not fully resolved, and could have been deformed southwards as suggested by the JunoCam map.

These rift breakthroughs are common, and Figure 14 shows two other examples in rapid succession. We have methane images corresponding to most of these ground-based images (the same series that showed 'Clyde's spot'),

and it appears that the bright rift breakthroughs are methane-bright, as are the red-brown sectors of NEB, and the brilliant white point eruptions in the NEB – although not the more extensive white rifts. However, the patterns are complex and it will be necessary to align the images using precise map projections before drawing final conclusions.

Full-resolution views of the EZ are in [Figure 15](#) (see maps in [Figure 13 inset](#)), showing a remarkable mixture of colours and textures. Despite the obliqueness of the views, very extensive arrays of mesoscale waves can be seen, covering most of the central and southern EZ, on several different types of cloudscape. Because some artefactual colour banding remains (indicated in the inset), the waves are more clearly shown in a monochrome copy. Waves like these have been detected throughout the Juno mission and recently catalogued [[Ref.3](#)], but at PJ26 and PJ27 they have appeared more widespread than ever.

## South Polar Region

[Figure 16](#) presents south polar projection maps in a format similar to our previous perijove reports. The complete colour map is in panel (A), with yellow circles outlining the positions of the CPCs, which are shown enlarged in panel (B). Panel (C) is a composite of the near-terminator regions to emphasise haze bands, and panel (D) is the methane-band map.

### *Haze bands and the South Polar Hood (SPH):*

The haze bands shown near the terminator ([Figure 16C](#)) are subtle but widespread, so the original photomosaic map is shown without any attempt at a diagram to show individual bands. Around the periphery, there are many bands with the usual oblique orientation. On the right-hand side, there are also weak bands running roughly E-W. On the left-hand side there are some longer, highly curved bands, and some of these are also visible as dark bands under higher sun in [Figure 16A](#).

The methane map ([Figure 16D](#)) shows the usual patterns, plus an unexpected novelty: methane-bright haze bands extending outside the SPH near the terminator, lying at various angles over the otherwise methane-dark S5 domain, and to even lower latitudes. These are seen not only in the composite map but also in individual maps of all images, near both morning and evening terminators. Some bands seen in [Figure 16C](#) align with them partially, but not completely. As with the recent decline in visibility of the NPH, we need to investigate whether the appearance of these methane-bright bands could be due to changes in Juno's viewing angle, but also bear in mind the possibility of real seasonal changes.

### *Circumpolar cyclones (CPCs):*

The progressive reduction in resolution and illumination over the south polar region is taking its toll: the PJ27 map ([Figure 16A&B](#)) only shows three CPCs distinctly, and for the first time, the central South Polar Cyclone (SPC) is not seen clearly, so its possible outline is shown dashed. (A small light oval dimly seen at L3~270, 87.2°S, may be its central disk, but as this is outside its previous range of longitudes, I reserve judgement on it.)

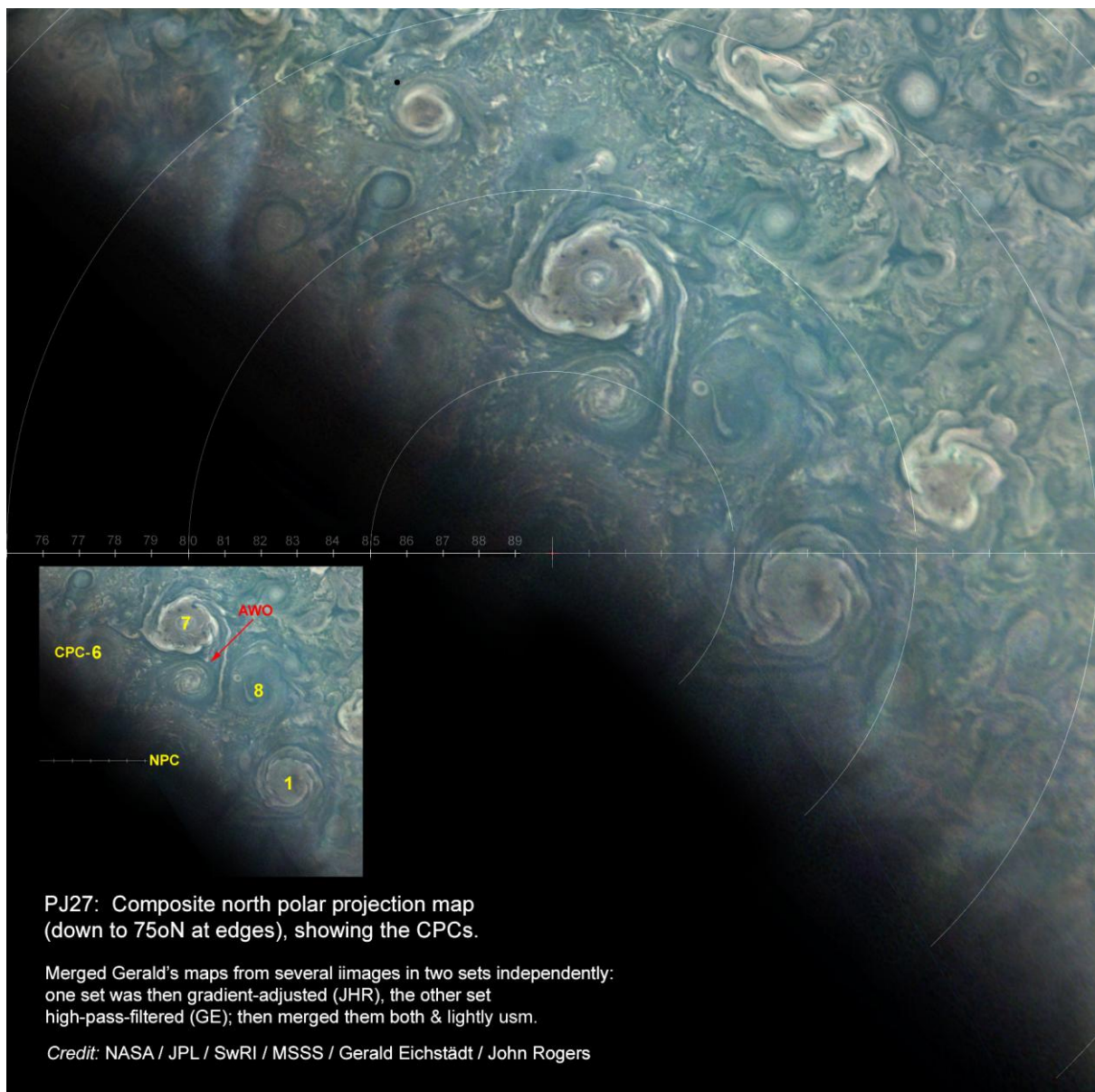
## Io rising

Finally: image 40 was timed to capture Io just as it was rising over the south polar region. As shown in [Figure 17](#) (processed by Björn Jónsson), Jupiter's atmosphere looks blue against dark space but red where it scatters the light from Io, just as Earth's atmosphere reddens the rising Moon.

## References

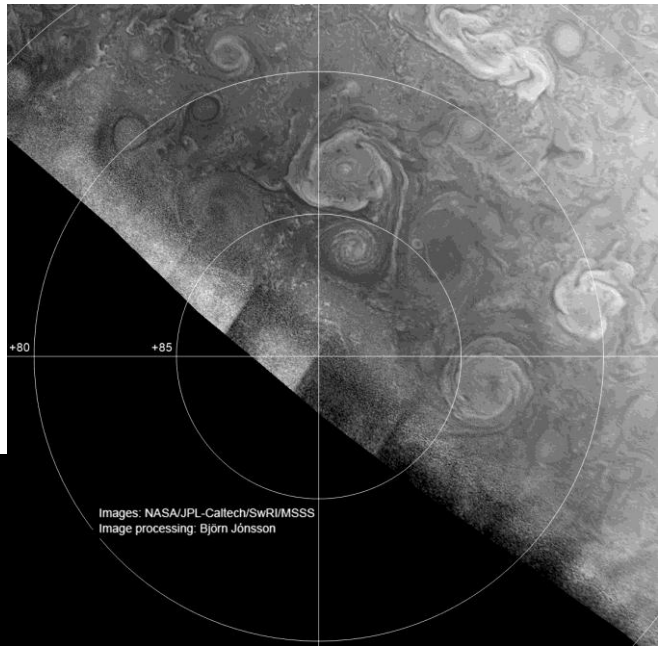
1. F. Tabataba-Vakili, J.H. Rogers, G. Eichstädt, G.S. Orton, C.J. Hansen, T.W. Momary, J.A. Sinclair, R.S. Giles, M.A. Caplinger, M.A. Ravine, S.J. Bolton (2019/20). **‘Long-term tracking of circumpolar cyclones on Jupiter from polar observations with JunoCam.’** Icarus 335, paper 113405.
2. J.H. Rogers, T. Stryk, G. Eichstädt, C.J. Hansen, G. S. Orton, T.W. Momary (2019). **‘Jupiter’s north polar region from Pioneer 11 to Juno.’** EPSC Abstracts Vol. 13, no.300. [Complete poster at:] <https://www.britastro.org/node/19341>
3. G.S. Orton et al. (2020, JGR, in press) **‘A Survey of Small-Scale Waves and Wave-Like Phenomena in Jupiter’s Atmosphere Detected by JunoCam.’**

## Figures

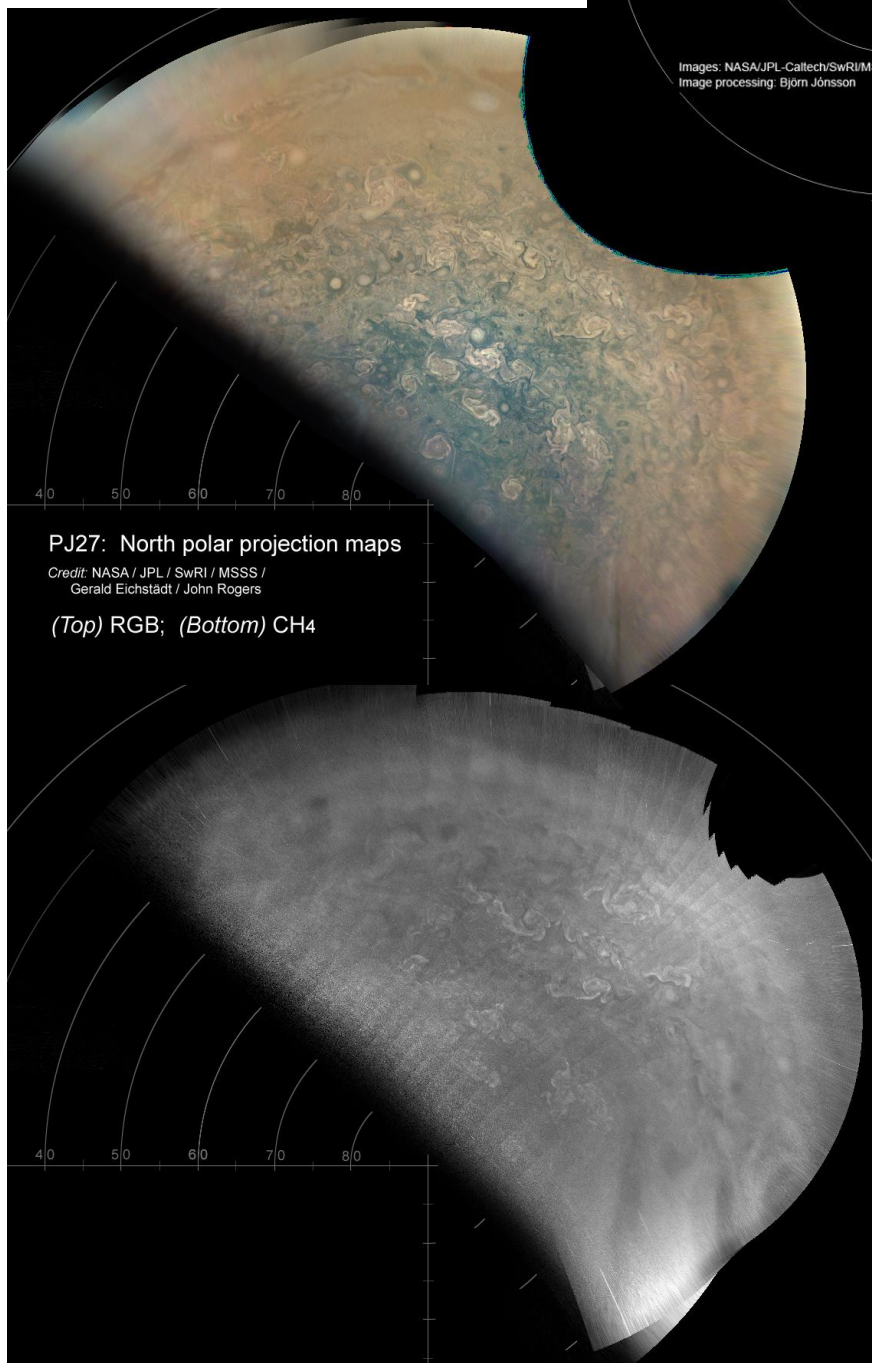


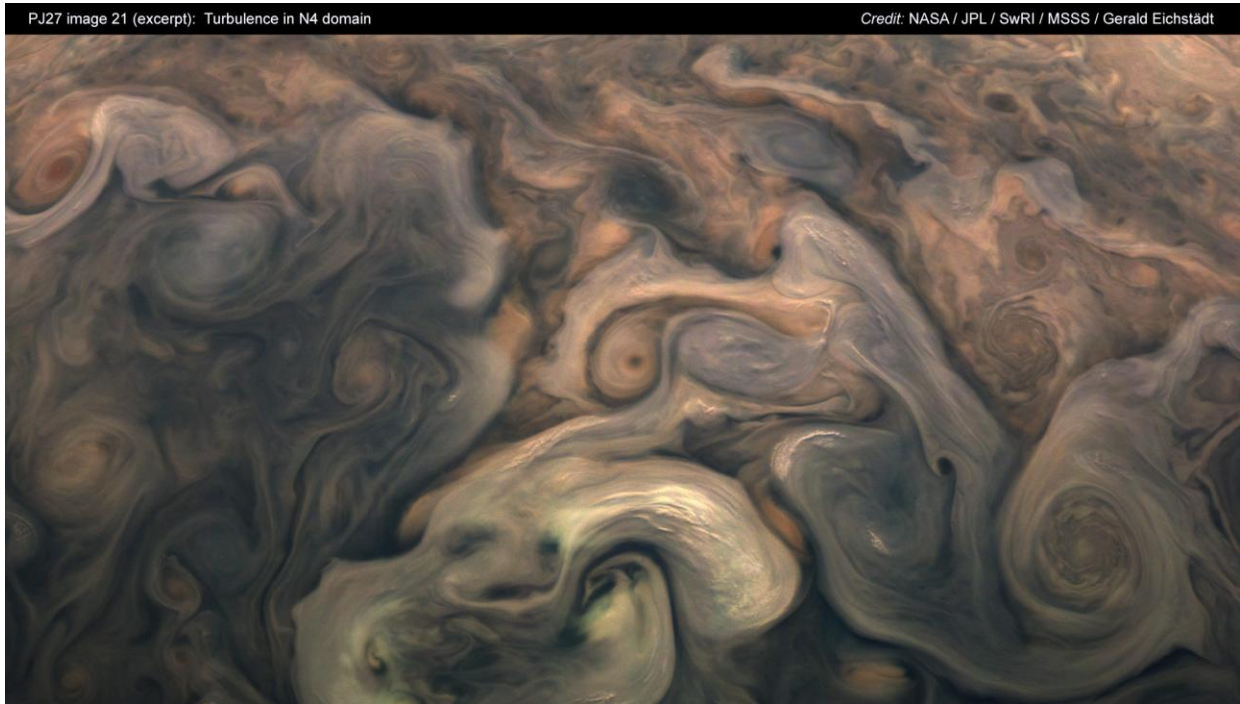
**Figure 9.** North polar projection maps: (A) by Gerald Eichstädt and JHR (with planetocentric latitudes as usual). L3=0 is to the right.

**Figure 9 (right):** North polar projection maps: **(B)** by Björn Jónsson (from red-light images, and with planetographic latitudes). L3=0 is to the right.

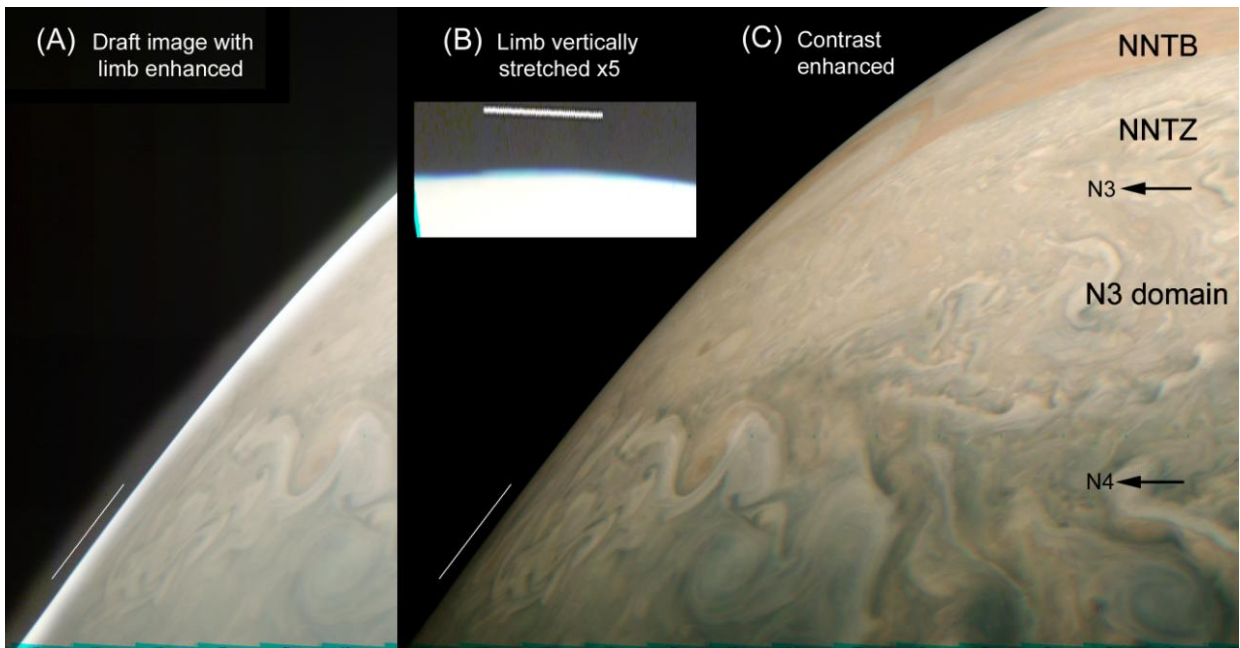


**Figure 10 (below).** Composite north polar projection maps, in RGB & CH4.





**Figure 11.**

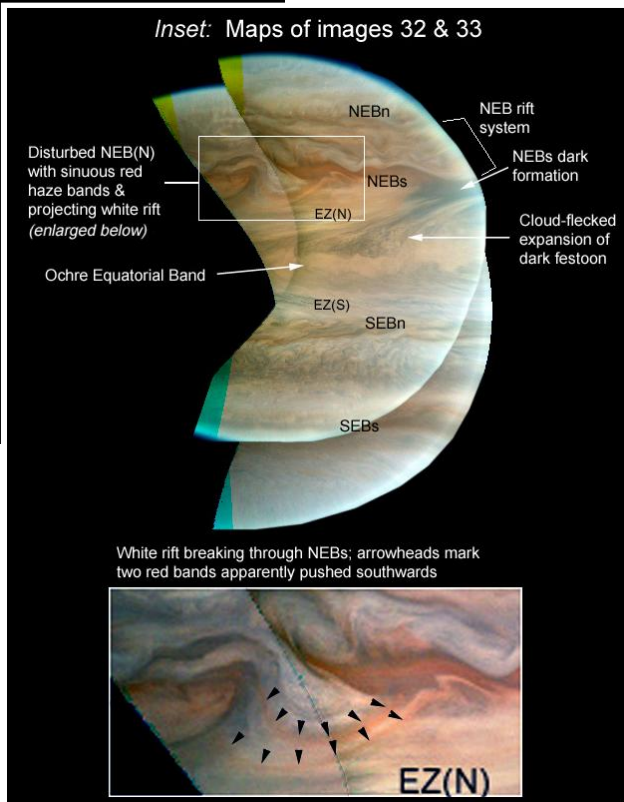
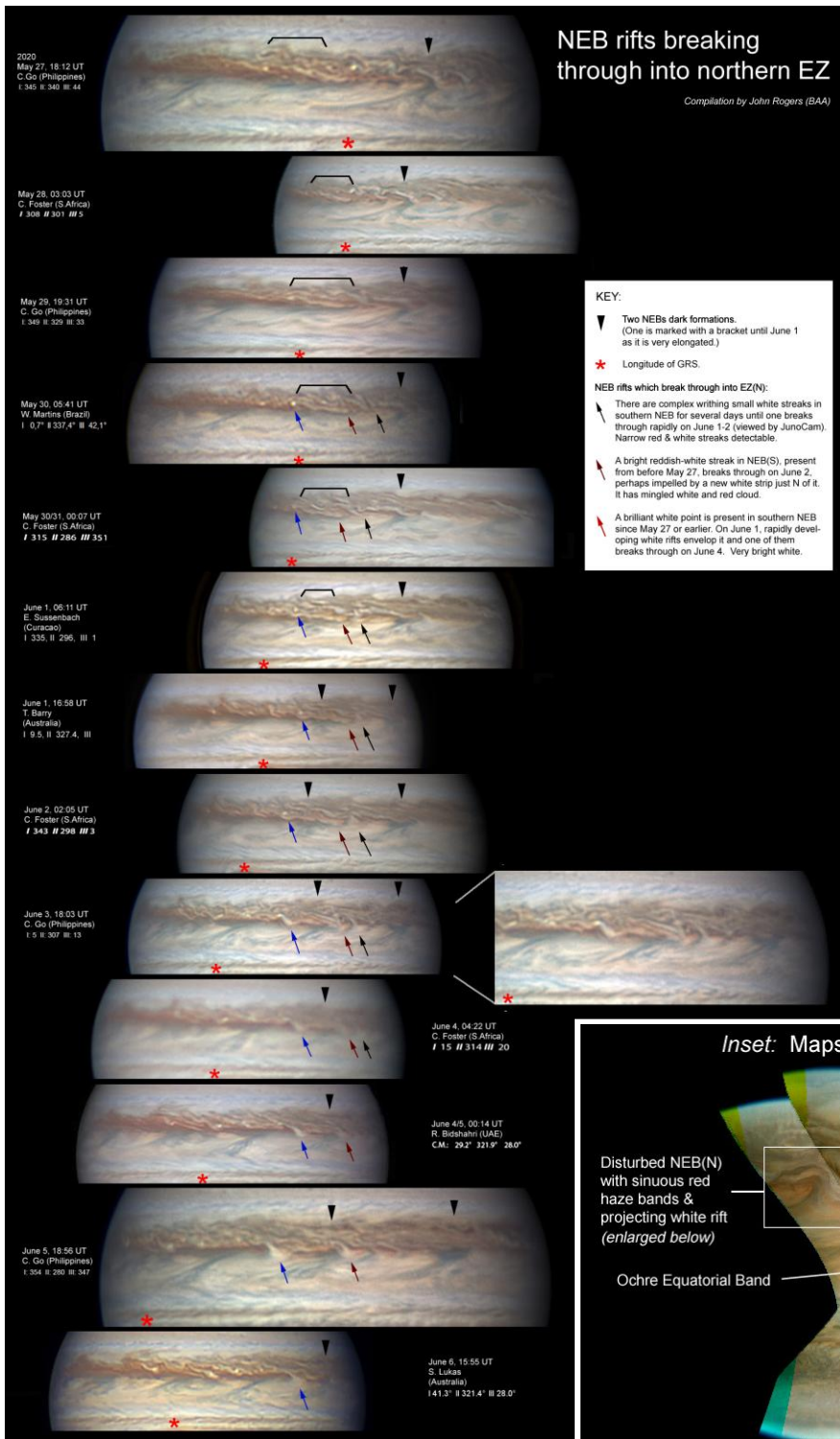


**Figure 12.**

**Figure 13 [on next page]:** Composite cylindrical map of the planet.

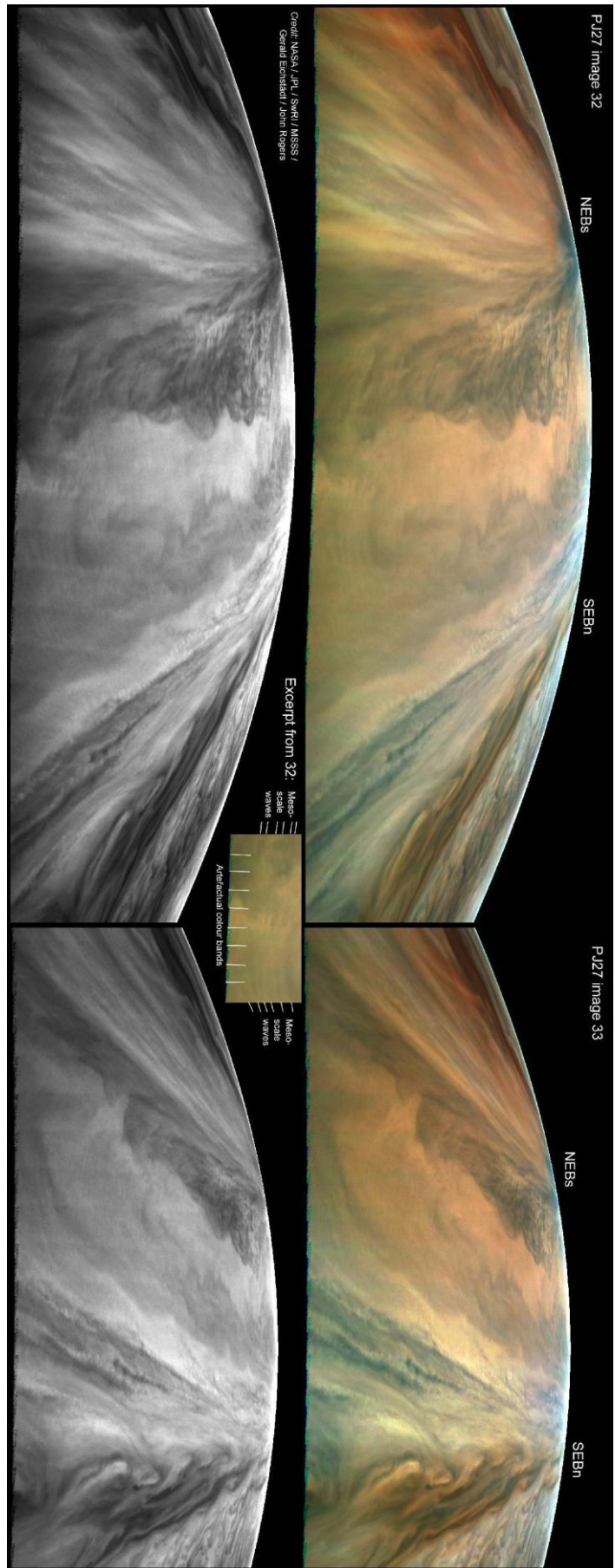
*Inset:* maps of individual images 32 & 33, merged, with a box enclosing the area where a bright white NEB rift is expanding southwards into the EZ(N), possibly accounting for the loop of two red haze bands as indicated by arrowheads.





**Figure 14.** Ground-based images showing NEB rifts breaking through into the EZ(N). Three examples are described in the legend at upper right, including the one which broke through on June 1-2 and is shown in the [Figure 13 inset \[copied at right\]](#).

**Figure 15.** Full-resolution views of the EZ: parts of images 32 & 33 (see [Figure 13 inset](#) for location). The lower panels are monochrome copies which show the mesoscale waves more clearly.



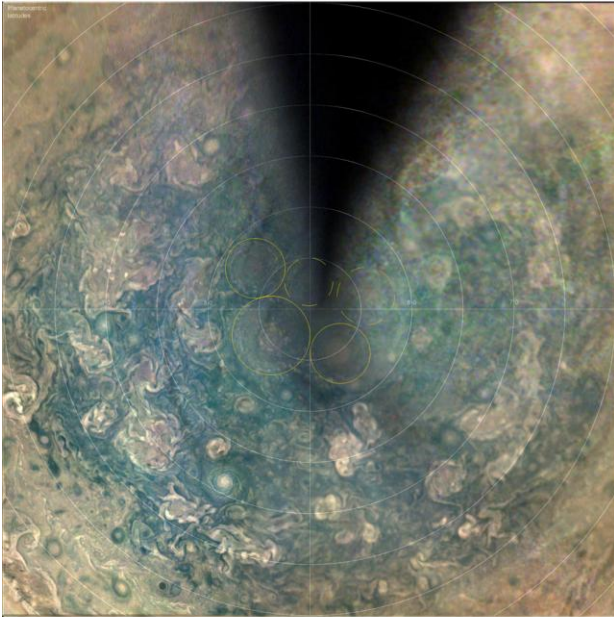


# PJ27: South polar projection maps

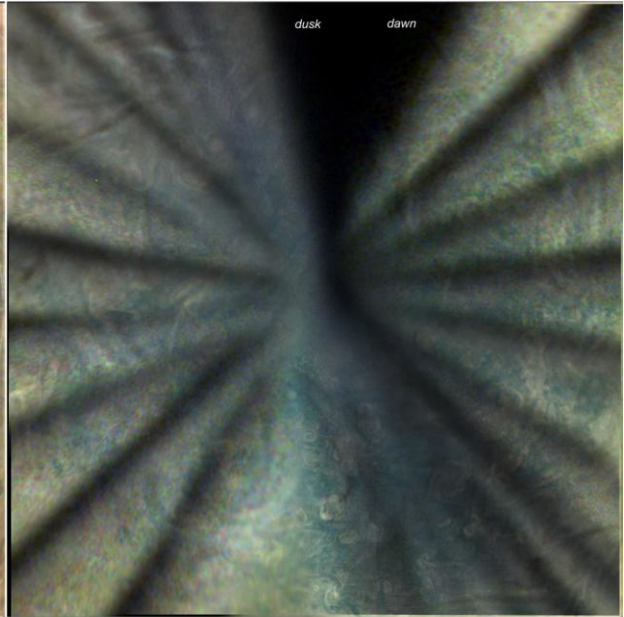
L3=0 to left.

Credit: NASA / JPL / SwRI / MSSS / Gerald Eichstädt / John Rogers

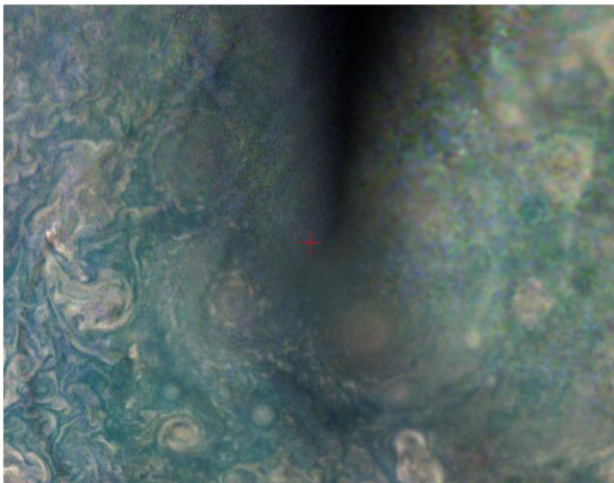
(A) RGB, down to 60oS at edges (half scale)



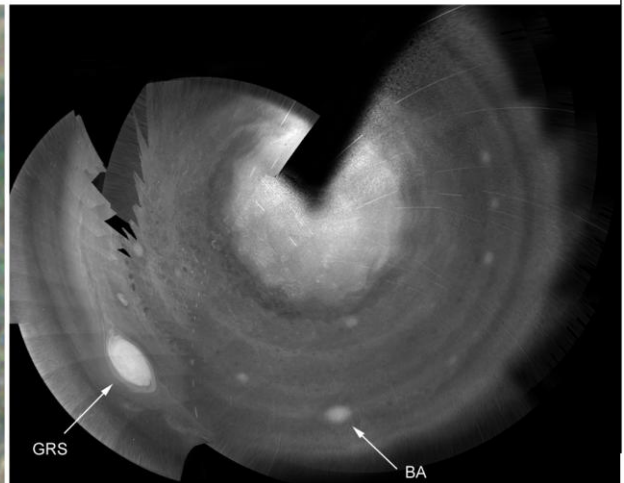
(C) RGB, down to 60oS at edges (half scale), showing near-terminator regions



(B) RGB, showing the CPCs (full scale)



(D) Methane band, down to equator at L & R edges



**Figure 16.** South polar projection maps.



**Figure 17.** Io rising over the south polar region.