JunoCam at PJ44: What the pictures show

John Rogers (2022 Sep.1)

Juno's Perijove-44 (PJ44) occurred on 2022 Aug.17. Perijove was at latitude 36.6°N (planetocentric), over the NNTZ, and Juno crossed the equator at L1=319, L2=239, L3=159.

Special thanks are due, as always, to Gerald Eichstädt who processed all the images, now using an updated processing pipeline that compensates for the progressive reddening of the camera optics. He has made map projections of all the images but I have not yet composited the polar maps. This quick report deals only with some of the more interesting results.

North polar region

Figure 1 is our map of the north polar region at PJ44 (from a single long-exposure image). Figure 2 shows it paired with the map from PJ43, to cover the whole cluster of circumpolar cyclones (CPCs). The 8 CPCs of the octagon have persisted throughout Juno's mission, and we now see the whole of the central North Polar Cyclone as well.

There is one large AWO inside the octagon: unfortunately it is duplicated in this composite map, which it has 'photobombed' by moving from the PJ43 sector to the PJ44 sector between the perijoves. This AWO usually appears to be trapped approximately N of CPC-3, but it does wander to and fro slightly, and at PJ43 it was N of CPC-4 instead. Another AWO was trapped N of CPC-7 for most of the mission, but at present there is only a small vortex there.

Just outside the octagon, X marks an 'extra cyclone' at PJ43, possibly the same that formed another unit in the 'vortex crystal' from PJ30 to PJ40. If so it has drifted away in a clockwise direction, opposite to the flow of the outer parts of the CPCs. I suspected the same clockwise drift for another 'extra cyclone' that had been on the opposite side of the octagon for several perijoves; perhaps it is still present at PJ44 in the form of the elongated FFR S of CPCs-2 & 3? This is behaviour to be monitored further as the period reduces to 38 days and the illumination continues to improve.

Northern domains

Figure 3 shows some striking examples of FFRs in northern domains carrying dense bands of very bright pop-up clouds; these are methane-bright, as shown (e.g.) in image 44.
Gerald suggests that the relatively greenish haze, seen adjacent to the very bright pop-up clouds in images 46 & 48, is real.

The NNTB, seen at closest approach, showed some interesting cloud textures (Figure 4). Along the approximate latitude of the retrograde NNTBn jet there is a swathe of narrow linear bands, white and red and grey (better seen in image 50, not shown here). Adjacent to the N2 (NNTBs) jet, we see parts of two NNTBs jet spots, which look unusual, as signs of anticyclonic structure are subdued, and one appears to be partly overlaid by diffuse cloud patches.

Figure 5 is our global map, which is more extensive than previously, because in the inbound leg, JunoCam can now obtain a good series of images for mapping the northern hemisphere and even part of the SEB. Figure 6 is a ground-based map for comparison.

NEB & EZ: A new NEB(S) outbreak

The NEB has changed only slightly in the last few months, according to ground-based observations. It appears to be undergoing a peaceful, partial revival, but slowly, and it may have stalled. The northern part is still very faint. The central part contains brown streaks from the NEB(S) activity, especially as they sweep around the faded barges, and it is methane-

dark, but the darkening has not progressed rapidly. The southern part is the dark reddish-brown NEB(S), which is methane-bright, and it is increasingly disturbed by the small convective outbreaks that have been going on for over a year [ref.1]* The main active sector is now ~90° long, and the frequent outbreaks therein are now overlapping, while disturbance has spread all round the NEBs edge.

*Ref.1: J. Rogers et al., EPSC2022 abstract 17, 'The transformation of Jupiter's North Equatorial Belt in 2021-22.' https://britastro.org/section_information_/jupiter-section-overview/contributions-2020-onwards (scroll down to EPSC 2022).

Moreover, on Aug.16, one rotation before PJ44, Manos Kardasis discovered a new outbreak at a different longitude (L1=319), which seems to be particularly energetic given its intense methane-brightness at discovery, and its rapid development thereafter (Figure 7). Prior images showed it first on Aug.15. By great good fortune, this plume was within JunoCam's field of view at PJ44 (Figures 8 & 9). This is the third such stroke of luck: fresh outbreaks were also imaged at PJ38 and PJ39 [ref.1]. They all look similar: a thick mass of bright white clouds, with signs of spiral structure at its edges, surrounded by paler white and red hazes.

A striking feature is a red cloud band that completely surrounds the outbreak, with closely spaced waves in its eastern part. (We have seen similar red loops around apparently expanding cloud structures in some other latitudes.) The PJ38 and PJ39 outbreaks also had red cloud bands flanking them in part, but not as complete as at PJ44. They also showed signs of spiral structure in the bright plume, which I suggested was cyclonic as expected in the NEB, but actually in all these outbreaks it may well be anticyclonic and expanding (as in the upper levels of thunderstorms on Earth), contrary to the zonal wind gradient.

EZ: In the adjacent EZ, Figure 8 shows a row of small, sharp-edged white cloud rafts, and then a long series of mesoscale waves which lie across a dark bluish festoon. The full image 57 (not shown here) also shows very widespread but subtle mesoscale waves across the central EZ, as were observed last year when the EZ was much more orange.

SEB: The SEB had the clearest examples yet of anticyclonic vortices within the cyclonic belt (not shown here).

S. Temperate domain

PJ44 gave us a close-up view of the very interesting STB sector between oval BA and STB segment G, for the first time since PJ35. Figure 10 is a hi-res map of it. It is centred on cyclonic oval WS6, which has a remarkable 'yin-yang' pattern internally. To its right is STB segment G, which began life as Clyde's Spot in 2020, then became a turbulent dark spot or FFR named DS7. It was not clearly defined for the first half of 2022 due to low resolution, but now both ground-based and JunoCam images show that it is indeed a well-defined turbulent segment of STB, now ~37° long (see also Figures 6 & 10).

Animation-1 is a blink of two images, showing the cyclonic circulation within WS6 and in FFRs in the S1, S2 and S3 domains (the partially seen S1 FFR being STB segment G).

Figure 1. Map of the north polar region at PJ44 (from a single long-exposure image), down to 75°N at edges.

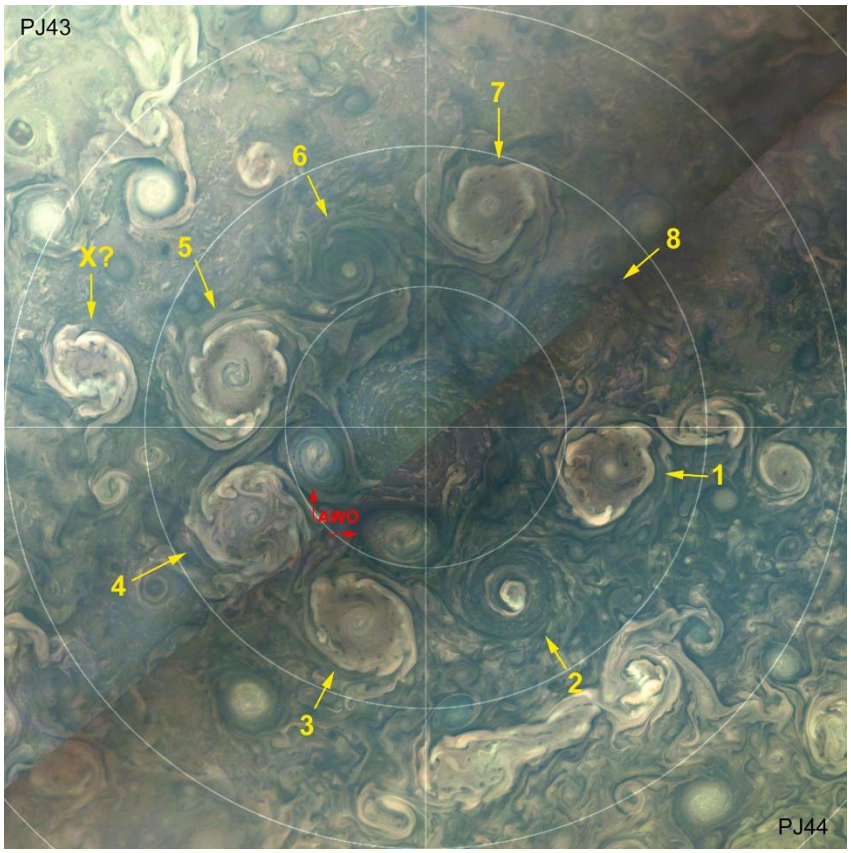

Figure 2. North polar projection maps from PJ43 and PJ44, down to 75°N at edges, combined to cover the whole cluster of CPCs (numbered). The AWO is duplicated. Credit: NASA / JPL / SwRI / MSSS / Gerald Eichstädt / John Rogers.

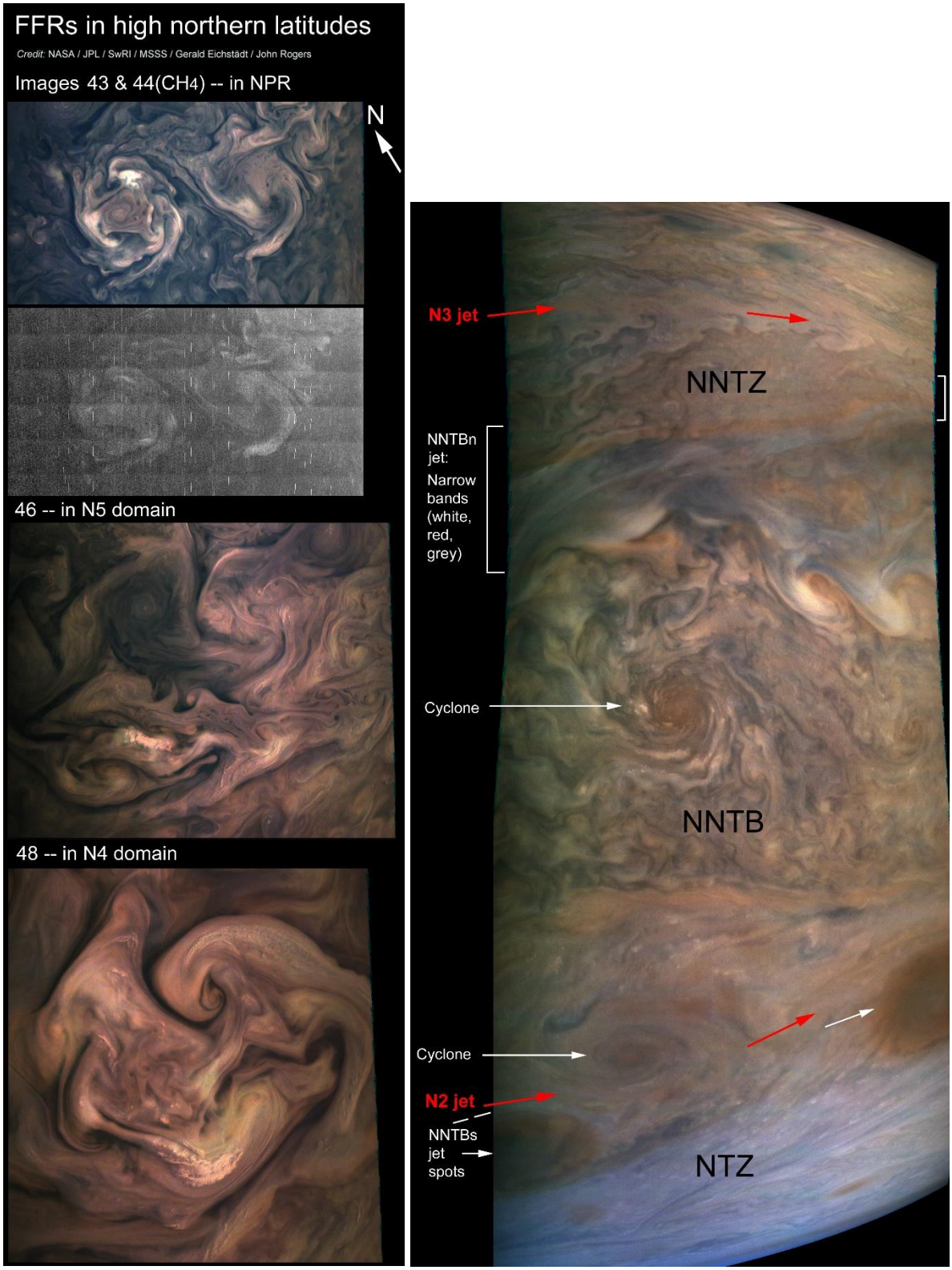

Figure 3 [L]. Some striking examples of FFRs in northern domains carrying dense bands of very bright pop-up clouds. These are Gerald's full-resolution versions, without further colour adjustment, with the scale increasing through the series.

Figure 4 [R]. Image 51 showing cloud textures in the NNTB. (The image was taken at perijove, from nominal altitude of 3696 km, though because of Jupiter's oblateness, the altitude was actually lower for image 52, 3557 km.) Approx. mean locations of the N2 and N3 jets are marked in red, though the N2 jet is probably distorted by the adjacent circulations. Version by Gerald, colour-adjusted.

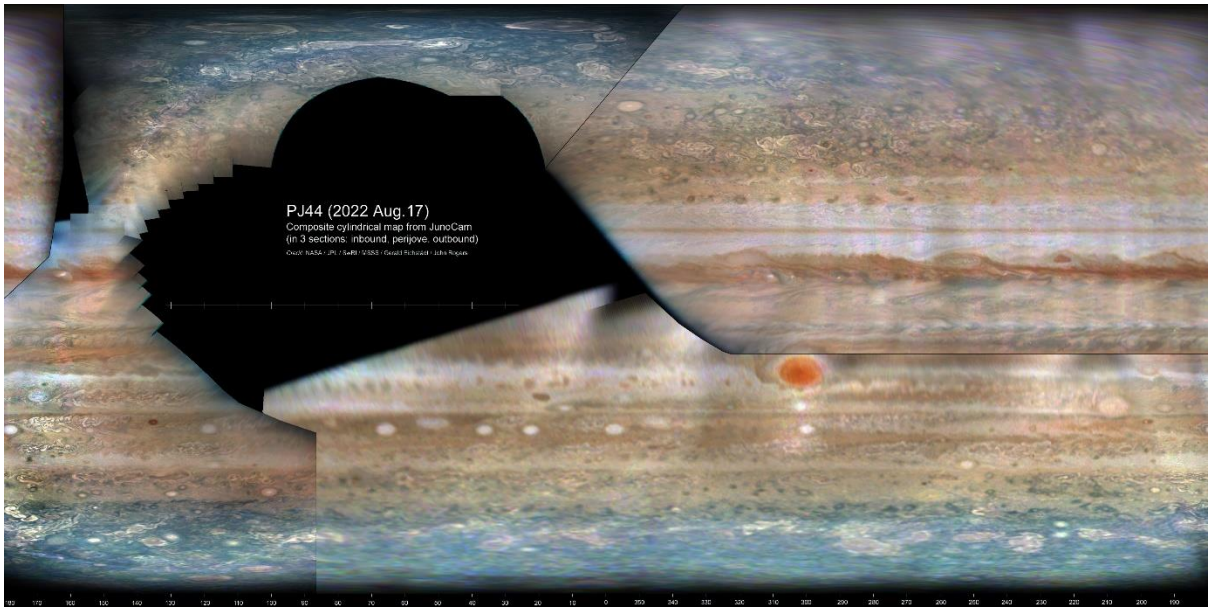

Figure 5. Composite global map for PJ44.

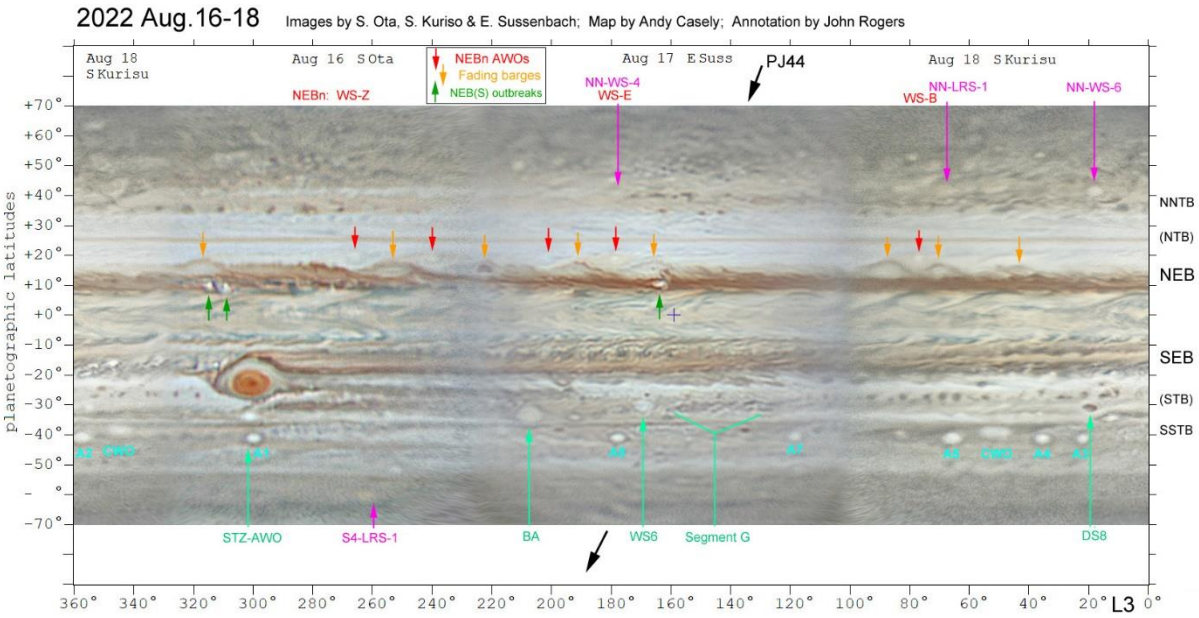

Figure 6.

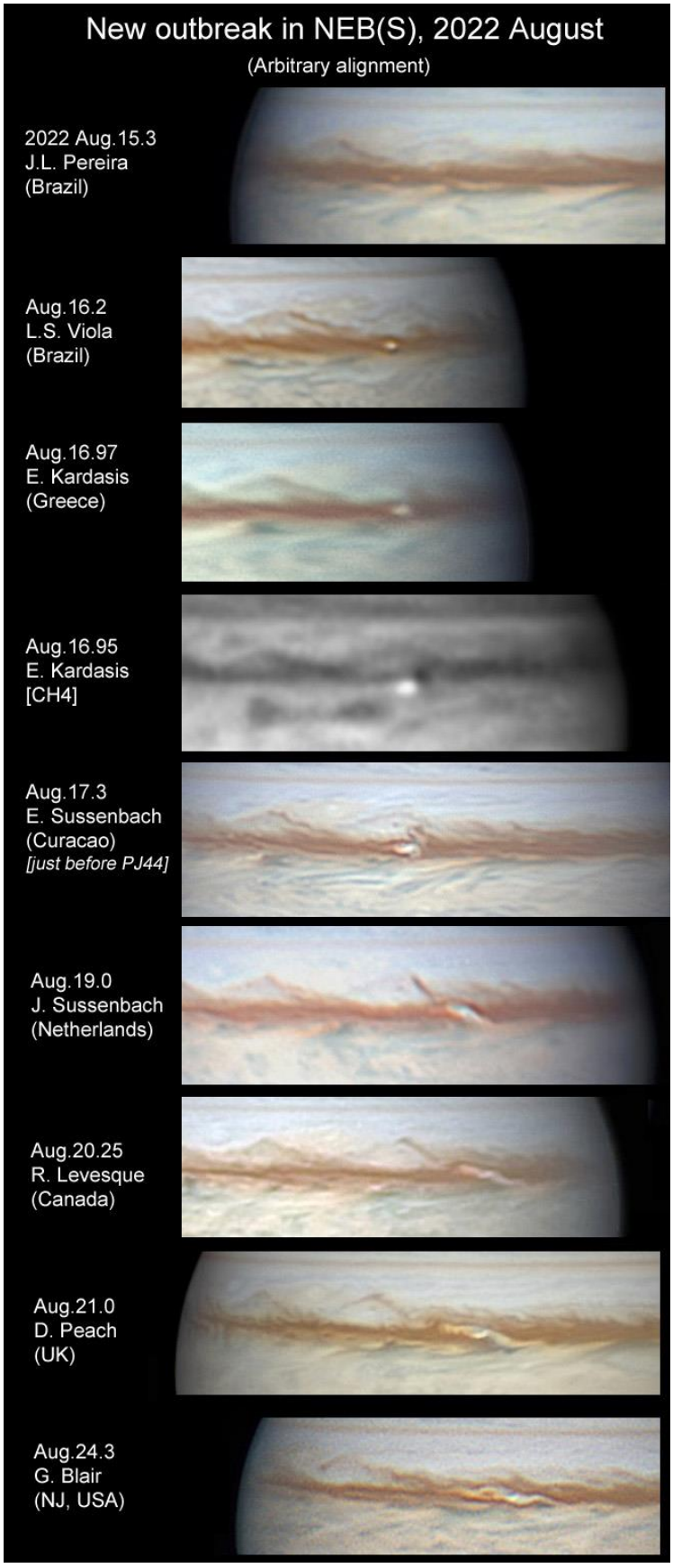

Figure 7. A series of ground-based images showing development of the NEB(S) outbreak.

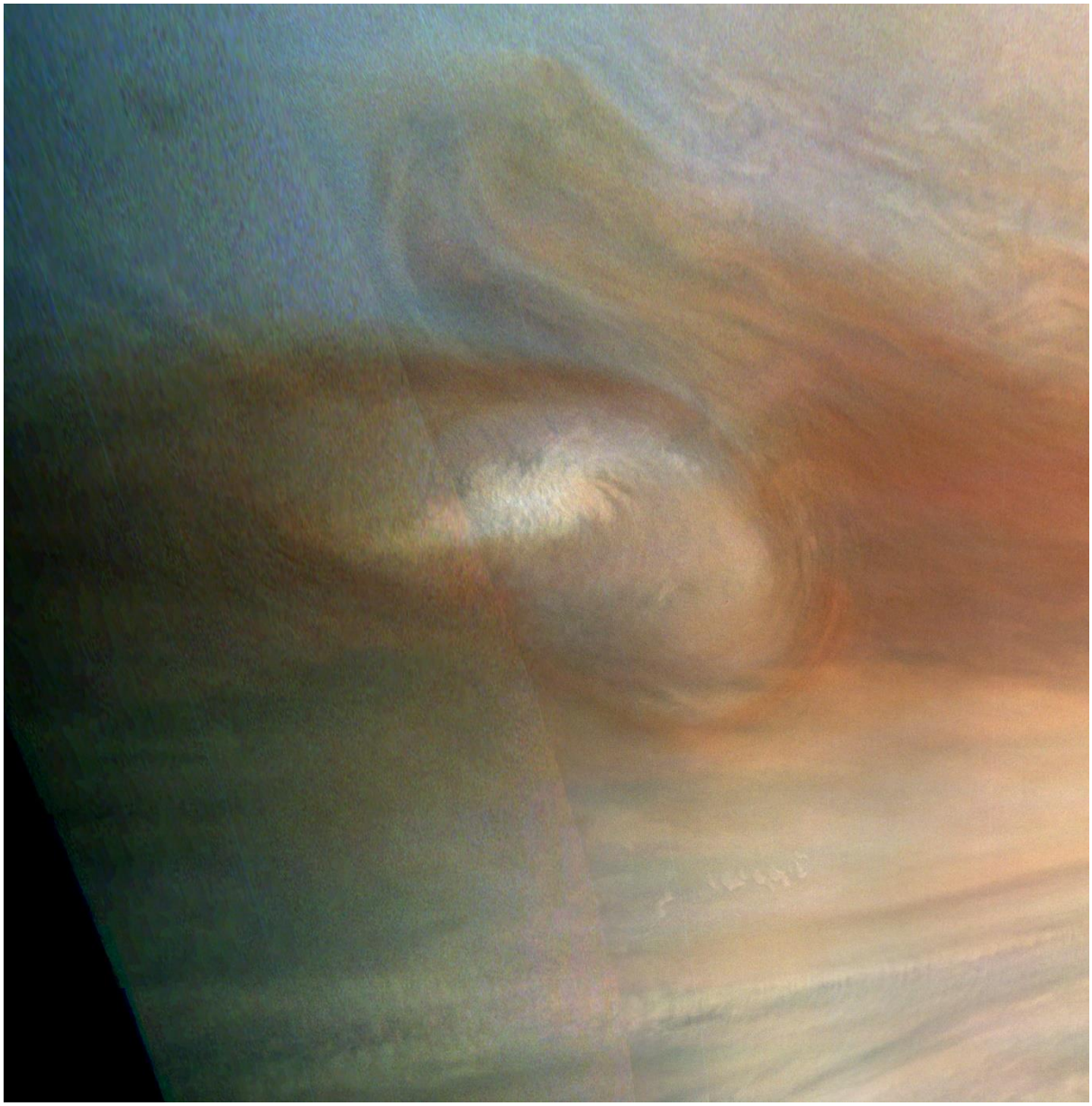

Figure 8. Hi-res cylindrical map from images 57 & 58, covering the NEB(S) outbreak, and some mesoscale waves across a dark bluish festoon in the EZ(N) below. As image 57 was the only close-up of the new NEB(S) outbreak, it is very fortunate that it was the one low-latitude image transmitted at high quality with lossless compression, in a trial to overcome the artefacts that have been appearing due to lossy compression in other recent images.

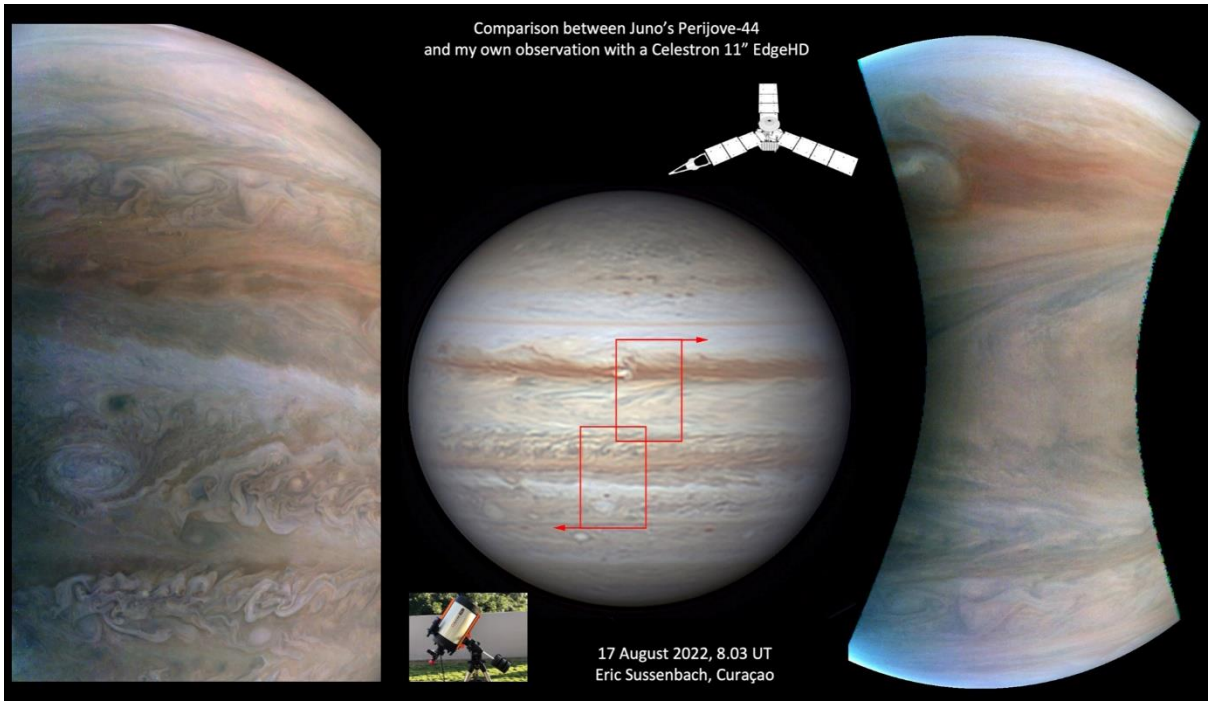

Figure 9. Eric Sussenbach's comparison of his own image, taken one rotation after the perijove, with two JunoCam images.

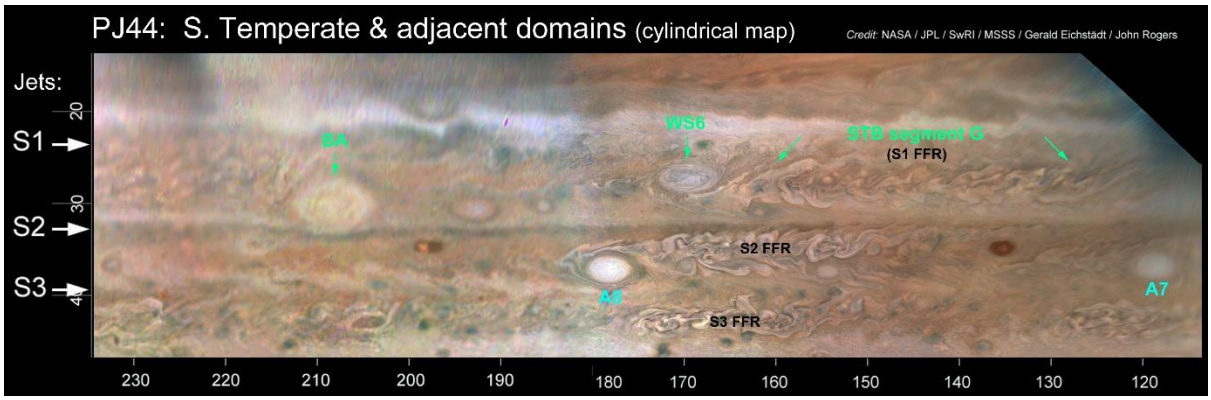

Figure 10. Hi-res map of the STB sector between oval BA and STB segment G.

Animation 1. This a blink of Gerald's hi-res maps of images 61 & 67, showing circulation within WS6 at top, and in FFRs in the S1, S2 and S3 domains. (The partially seen S1 FFR is STB segment G, the descendent of Clyde's Spot.) The images were taken 30.9 min apart.