JunoCam at PJ37: What the pictures show

John Rogers (2021 Nov.9)

Juno's perijove 37 (PJ37) was on 2021 Oct.16, with perijove at 30.7°N (planetocentric; over the NTZ), and equator crossing at L1=132, L2=219, L3=57.5. This report summarises aspects of the images in our usual style.

On its approach, Juno had a distant pass over Europa, and one of the images taken is in Figure 1 (by Björn Jónsson, including a synthetic comparison).

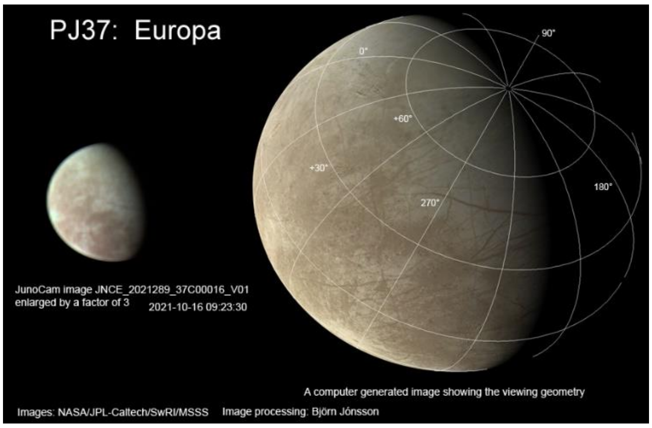


Figure 1

North polar region

As at the last two perijoves, Gerald Eichstädt has produced hi-res north polar projection maps of individual images and an automated composite of them, on which I have done further blending to enhance details at the terminator (Figures 2 & 3B).

As Juno's orbit drifts round closer to the terminator, we are now beginning to get useful inbound images again (e.g. Fig.3A), enabling some mapping of northern mid-latitudes and of terminator hazes on that side of the planet. Hopefully this will improve further over the coming year, with more of the planet being in JunoCam's field of view for more of the inbound phase, allowing more extensive mapping as in the first two years of the mission, although this will be constrained by the lower altitude of the spacecraft over the northern hemisphere. Perijove is currently about half way between the meridian and the terminator, as it was around PJ12, but there are significant differences in the inbound view. The view now (e.g. Fig.3A) does not yet show a complete narrow crescent as it did at PJ12, so we are not yet getting a similar high-phase-angle view of the North Polar Hood.

Circumpolar cyclones (CPCs)

Fig.2 shows the composite map down to 75°N at the edges, displaying the circumpolar cyclones. Five of the 8 are clearly seen, plus the outer arms of a fifth one (CPC-5), and the central NPC. The NPC is still displaced from the pole in the usual direction, by 0.9° latitude. CPC-7 is still displaced from the polygon, being at 81.8°N, and it looks increasingly ragged, though this may be in part due to its interaction with an AWO on its S edge. Anticyclonic vortices including this one are indicated by red arrows on the map; one N of CPC-1 has apparently persisted and grown since PJ36. A prominent FFR labelled 'IX?' on the map could be the same cyclone that was close to CPC-8 for several perijoves, but if so it had drifted out of the 'vortex crystal' at PJ36 and is now a typical FFR outside the polygon.

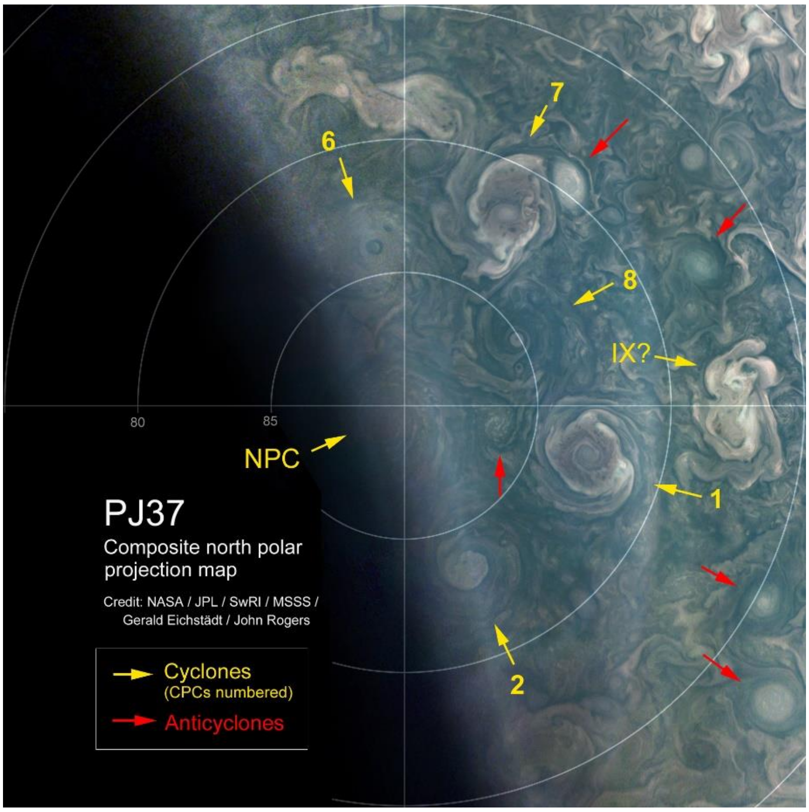
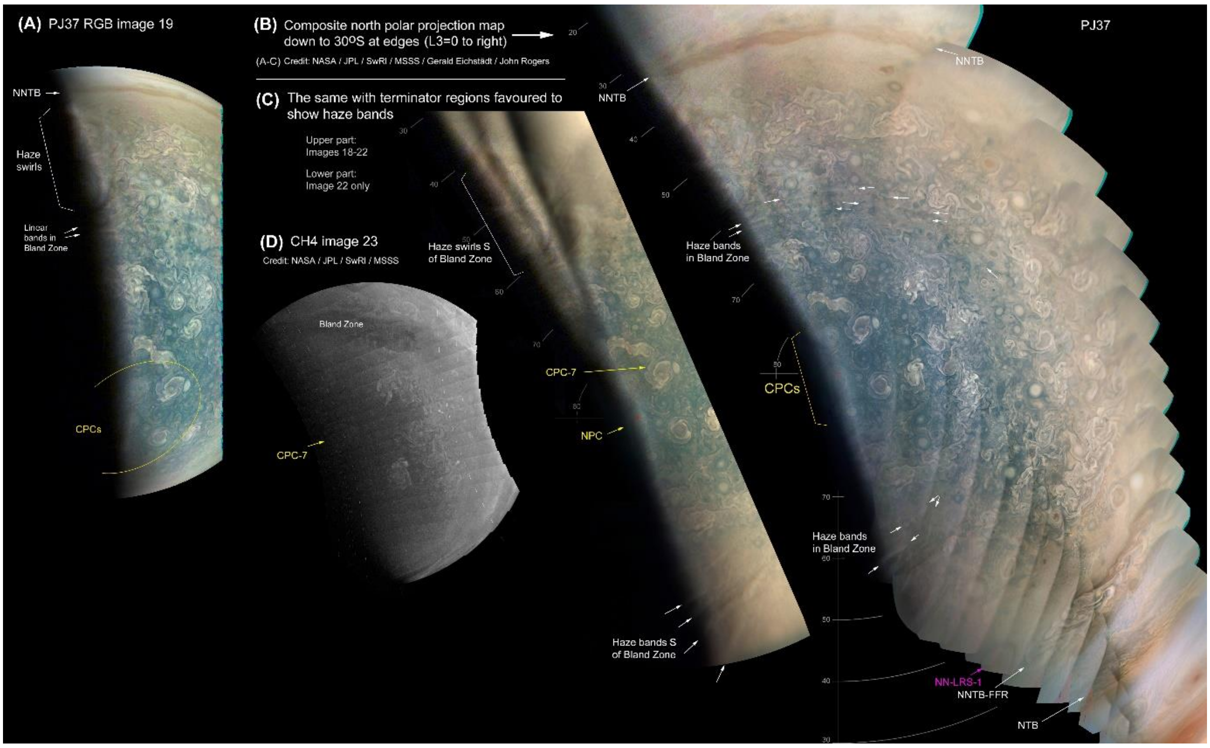


Figure 2

Figure 3



Haze patterns and the Bland Zone

Fig.3B is the composite map down to 30°N, at half scale. Features such as FFRs and AWOs are not obviously conserved since PJ36, although the Bland Zone has a disturbed sector in longitudes that overlap a disturbed sector at PJ36.

The linear haze bands in the Bland Zone are widespread (except in the disturbed sector), esp. in the upper half of the map, but unusually they run along lines of latitude rather than slightly obliquely. Fig.3C, a preliminary map showing the near-terminator regions, reveals dramatic haze swirls at 40-62°N in the upper part of the map, due to the crescent inbound images (e.g. Fig.3A). These must be part of the extended North Polar Hood (NPH) which was seen more clearly at PJ12. However, the main part of the NPH is still not evident in this map, nor in the methane image (Fig.3D). The Bland Zone in the upper half of Fig.3D is methane-dark, but the methane-bright area N of it seems to consist mainly of FFRs rather than NPH.

The closeup images of the mid/high northern latitudes show fantastic details, as always. One example is Fig.4 (image 29 -- also presented by Scott Bolton in the Zoom press conference on Oct.28). It shows a large FFR in the N4 domain with clouds at multiple levels. The highest are the very bright white popup clouds arising from the white cloud bands, some of which themselves cross above the orange cyclonic eddies and the surrounding grey and light-brown cloud decks. Similar multi-level, multicoloured cloud systems have been seen often in FFRs in the NNTB, including another example at PJ37 (see index images in Fig.7).

Figure 4

Figure 5

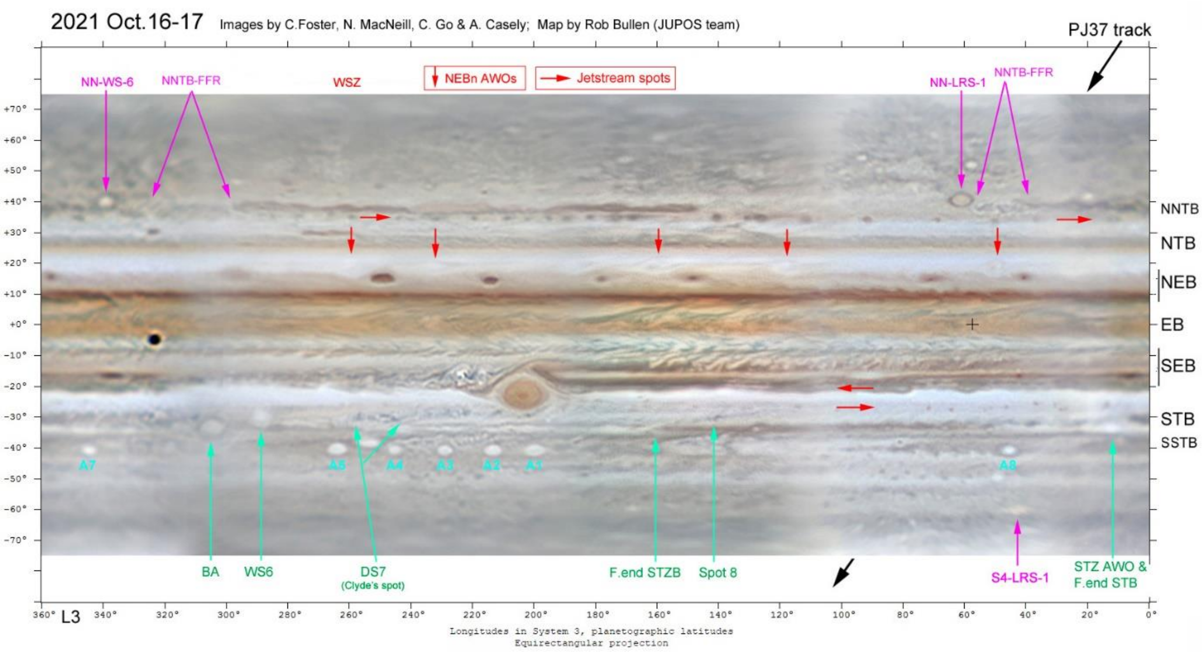
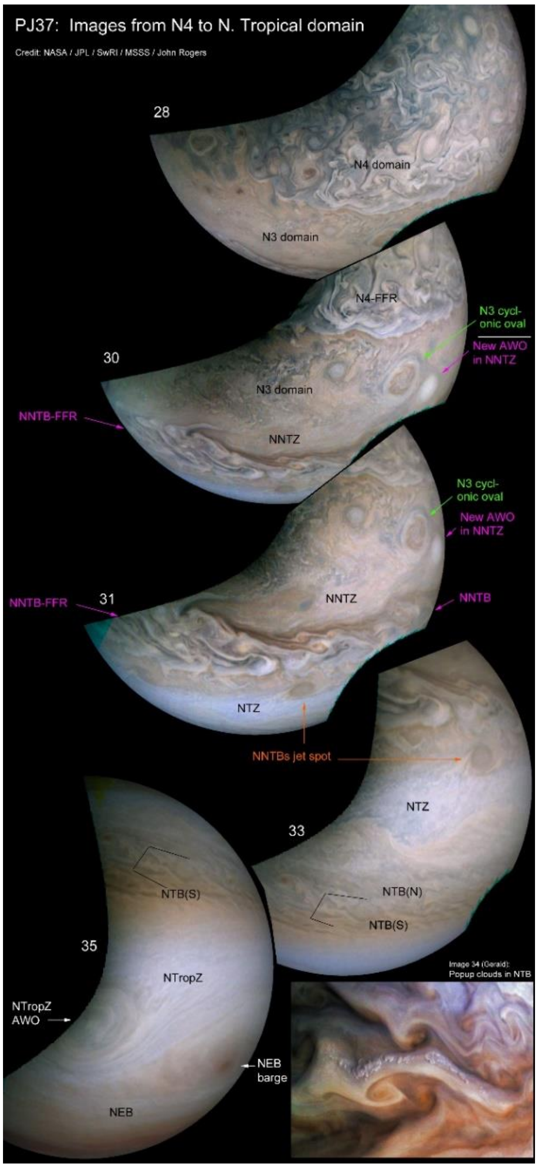


Figure 6



Left: **Figure 7** *Below:* **Figure 8**

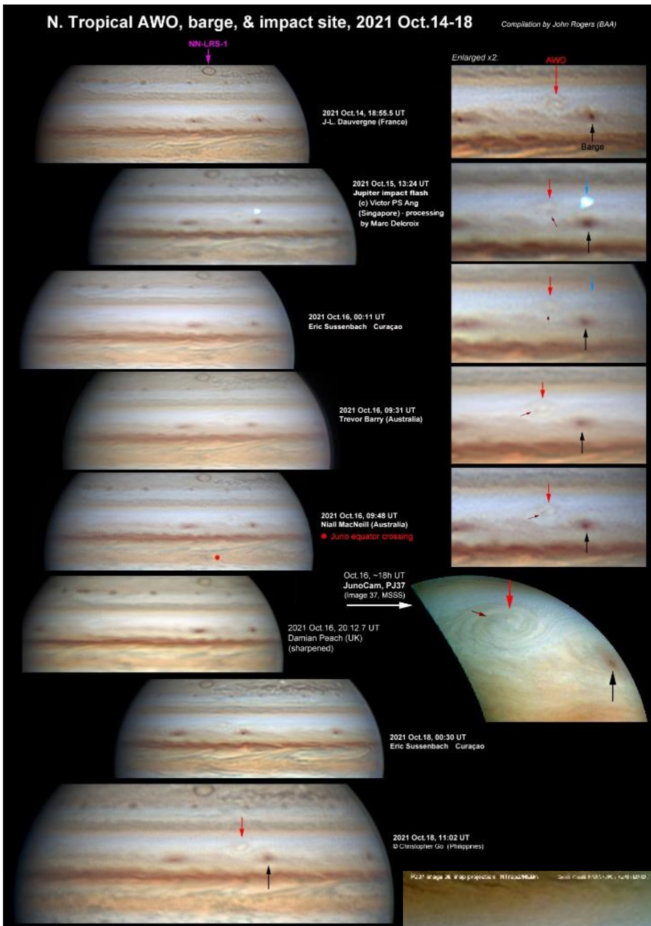


Figure 9

Lower latitudes

Fig.5 is a ground-based map of Jupiter around PJ37, produced by Rob Bullen.

Fig.6 is the PJ37 JunoCam map, produced by Gerald Eichstädt, with contrasts adjusted.

Fig.7 is a set of reduced-scale images from JunoCam giving an overview from the N4 to the N. Tropical domain.

Just S of the NNTB FFR, there is a NNTBs jetstream spot, clearly showing its anticyclonic spiral structure. The ground-based map shows that there is an extensive outbreak of these spots at present.

N. Tropical domain and an impact site

The N. Tropical domain was specially interesting, as JunoCam obtained one of its best-ever views of a major AWO here, and a more distant view of a very intense barge, within the context of this year's exceptional cloud textures. And just 28 hours before the flyby, ground-based observers recorded an impact fireball on the N. Tropical Zone which, by great good luck, fell within the PJ37 field of view. Figs. 7-10 show the region (Fig.9 at half scale).

Fig.8 is a set of amateur images of this region from Oct.14-18, including the fireball on Oct.15 at 13:24 UT. (This was the eighth such impact recorded, the first having been in 2010.) No trace of the impact was visible in images by I. Miyazaki taken just 20 minutes later, nor in most subsequent images. (The image by E. Sussenbach, 12 hours after the impact, has a tiny faint spot just E of the impact site, but this could be just detector noise.) In the JunoCam images (Figs.9 & 10), the impact site is near the limb; no definite trace is visible. This is useful to know, as this is the most prompt and hi-res examination ever made of the site of one of these impacts, and it contrasts with the intense and long-lasting dark clouds left by the Comet Shoemaker-Levy 9 impacts in 1994, which were larger.

The AWO is one of at least five that dominate the NTropZ this year (Fig.5). In ground-based images, they have had reduced contrast recently, but are still large features. Sometimes the only bright part is a small spot in the northern half; this appearance is not unfamiliar, and previous JunoCam images have suggested that it arises from a concentration of popup clouds in the northern part of the AWO. The AWO viewed at PJ37 showed unusually distinct anticyclonic spiral white streaks in recent months (e.g. the ground-based map in our PJ36 report, and a hi-res image on Sep.24 by D. Peach). Prior to PJ37, its visible contrast was reduced, but hi-res images (Fig.8) still showed dynamic structure in the days preceding PJ37.

These ground-based images showed a small dark spot orbiting clockwise (anticyclonically) around the AWO on Oct.15-16 (smallest brown arrows in Fig.8 enlargements). At PJ37 it has arrived at the 10 o'clock position, where the JunoCam closeups show it as an extended irregular complex of slightly diffuse dark bands, which seem to mask the anticyclonic structure and could be overlying it (Figs.9 & 10). On the S edge of this dark material is a mesoscale wave-train, of very short wavelength and barely perceptible above the noise, but discernible in independently-processed versions by Björn and by Gerald (Fig.10).

Along the S edge of the whole AWO, presumably on the retrograding jet, there is another mesoscale wave-train, alongside an unconnected sinuous wave-train (Fig.10, top, brown arrows). Other notable features in the AWO, mainly in its N half, are bands of densely-packed popup clouds (Fig.10, top).

Fig.10 is image 36 partitioned into sectors which are differentially enhanced in contrast. On the right are other views of the boxed areas from the same or other images. Apart from the top sector already described, the other sectors include the strange texture of faint sinuous haze bands running at all angles over the NEB; this is probably the cloud cover that makes the NEB so pale this year. These bands cross over (or under?) faint longitudinal streaks of colour, which are not attributable to the instrumental artefact of colour stripes although there is some interference (compare the two panels at bottom). In the third sector down, there are also widespread semi-periodic mesoscale waves in the pale mid-NEB. Part of this sector is enlarged at right, also showing a cluster of crisp-edged cloud rafts. These were also seen in the NTB(N) & (S) at PJ36, while the mesoscale waves were seen in the NTZ at PJ35 and the NEB at PJ36. The crisp-edged cloud rafts could be elaborations of popup clouds such as those seen in the NTB in Fig.7 (inset at bottom right), although popup clouds were not a feature of the EZ(S) where these rafts were first discovered.

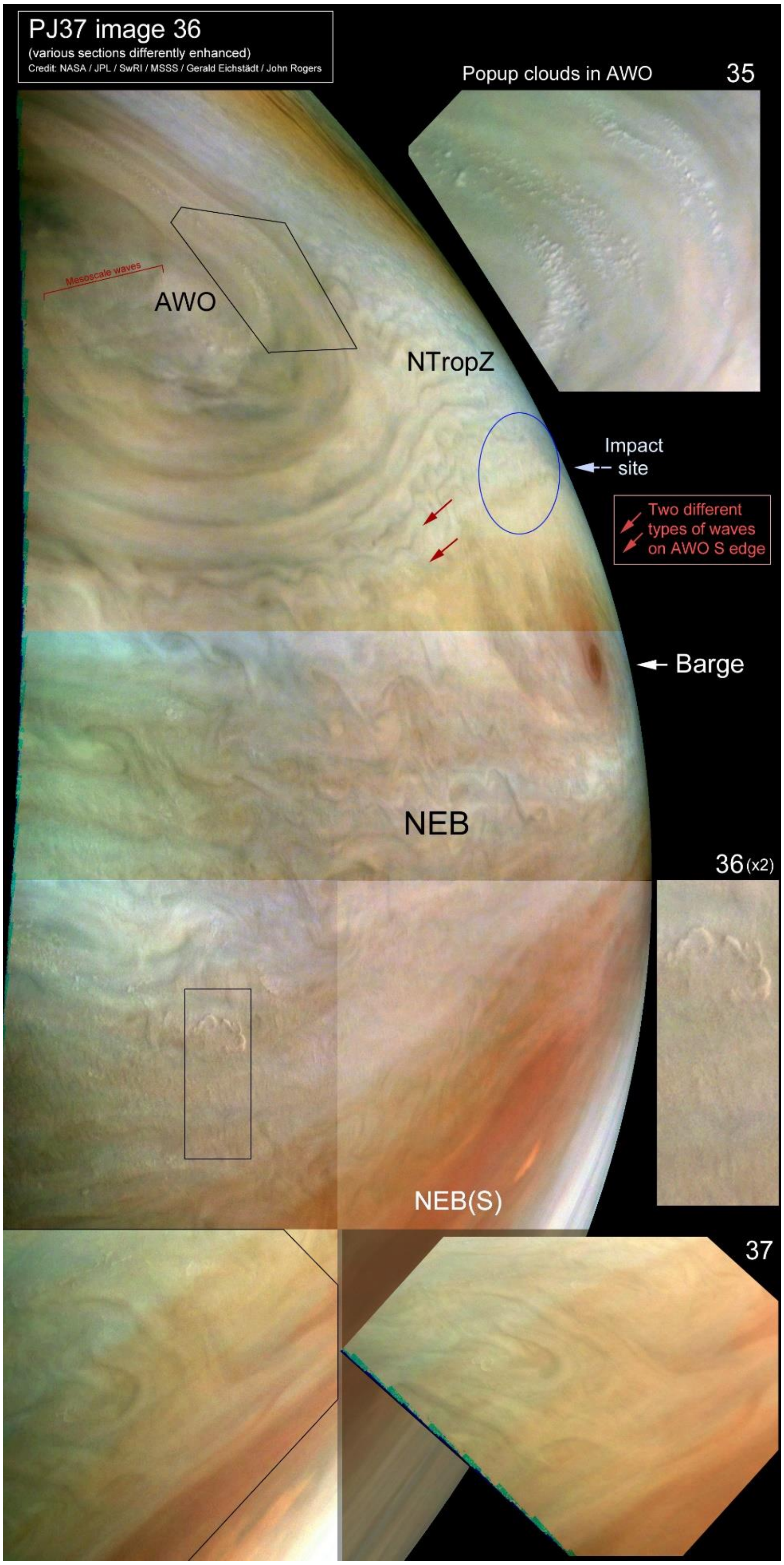


Figure 10

Equatorial Zone

The orange EB is still mostly covered with subtle mesoscale waves, mostly semi-regular (best seen in image 39, not shown here). There are also some on narrower cloud bands in EZ(S).

S. Tropical domain

The SEB is still comparatively quiet, away from the GRS, and images such as Fig.11 confirm interesting features that we have noted before. In the supposedly cyclonic latitudes of the northern SEB, at several previous perijoves we have noted whitish ovals that appear *anti*cyclonic, and Fig.10 shows an unmistakable example of one (AWO). Near the SEBs edge, at many perijoves from PJ28 onwards, we have noted long sinuous bands of reddish haze, and faint mesoscale waves on the SEBs jet; both of these phenomena are indicated in Fig.10, although the mesoscale waves are minimal.

To the south, in the broad *STBn jet*, Fig.11 shows a series of brown, roughly circular spots. These are also shown in Fig.5; they developed in the STBn jet where it was disturbed by the new STB outbreak in August. Six of them can be seen in PJ37 images. They all appear to consist of translucent brown haze overlying the tangled white streaks that are seen along this latitude, with no evident vorticity. This is consistent with several previous spacecraft data from Voyager onwards, that STBn jet spots sometimes show little or no vorticity.

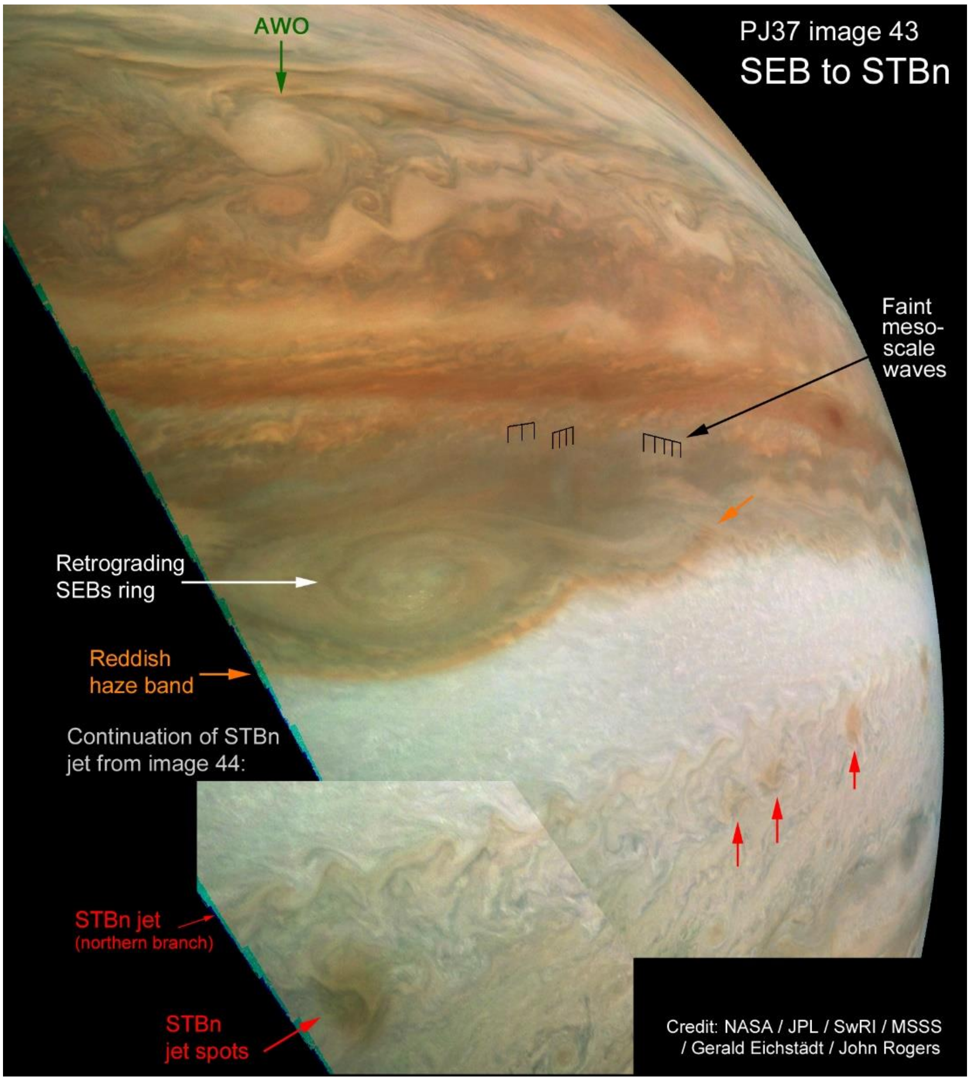


Figure 11

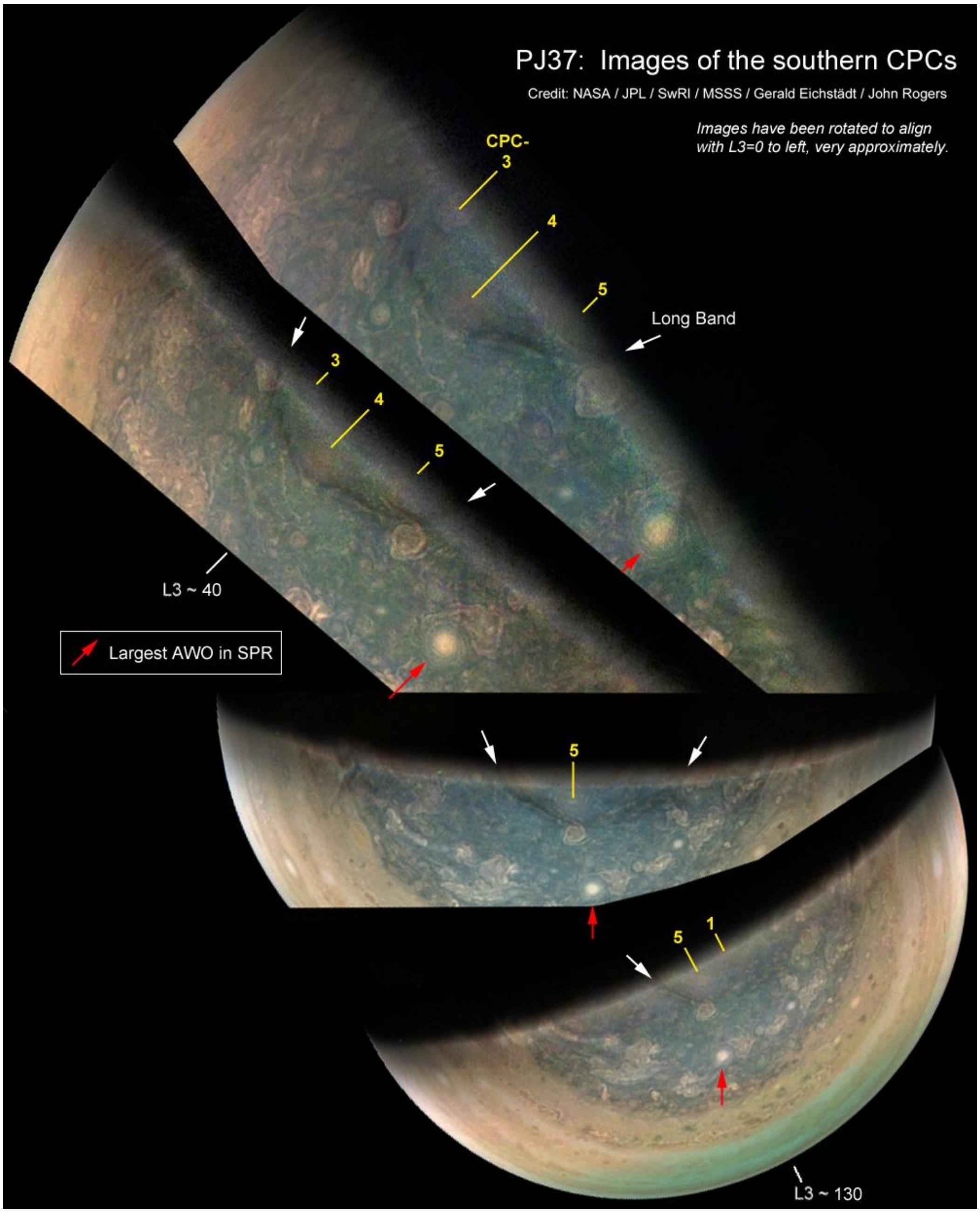
South polar region

Fig.12 is a set of images covering the south polar pentagon. Composite south polar projection maps are presented in Fig.13 (RGB), Fig.14 (methane band), and Fig.15 (near-terminator regions in RGB, to show haze bands). All are cropped at ~45°S at the edges, as they showed no haze bands at lower latitudes. L3=0 is to the left in all.

Circumpolar cyclones (CPCs)

Only 3 or 4 of the CPCs can be identified in Fig.12, but blending all the images enables us to locate (probably) all 5 of them in Fig.13. However, the resolution is poor, and the central cyclone is no longer visible as the sun has set on it since the equinox, so we cannot continue tracing its long-term motion.

Figure 12



Haze bands and South Polar Hood

The most impressive feature in these images is the revived Long Band of haze, which is a prominent dark band or bundle visible right across the sunlit disk, spanning ~180° of longitude around the pentagon (white arrows in Figs.12 & 13). Like the original Long Band it is tangential to CPCs 4 & 5. In the terminator maps (Fig.14) it is surprisingly inconspicuous, although its NW extremities show up as bright bands to the right.

Fig.14 shows more conspicuous arrays of haze bands further from the pole. At ~63-71°S, in the dusk map, there are are oblique bright haze bands, including 'rainbow bands', matching the underlying zonal wind gradient south of the S6 jet. Some may be related to the edge of the South Polar Hood (Fig.13). Also, at ~54-62°S in both the dusk and dawn maps, there are oblique bands at various angles over the S4 and S5 domains, similar to those described at recent perijoves.

Figure 13

PJ37: Composite south polar projection map, down to ~45^{o} at edges

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

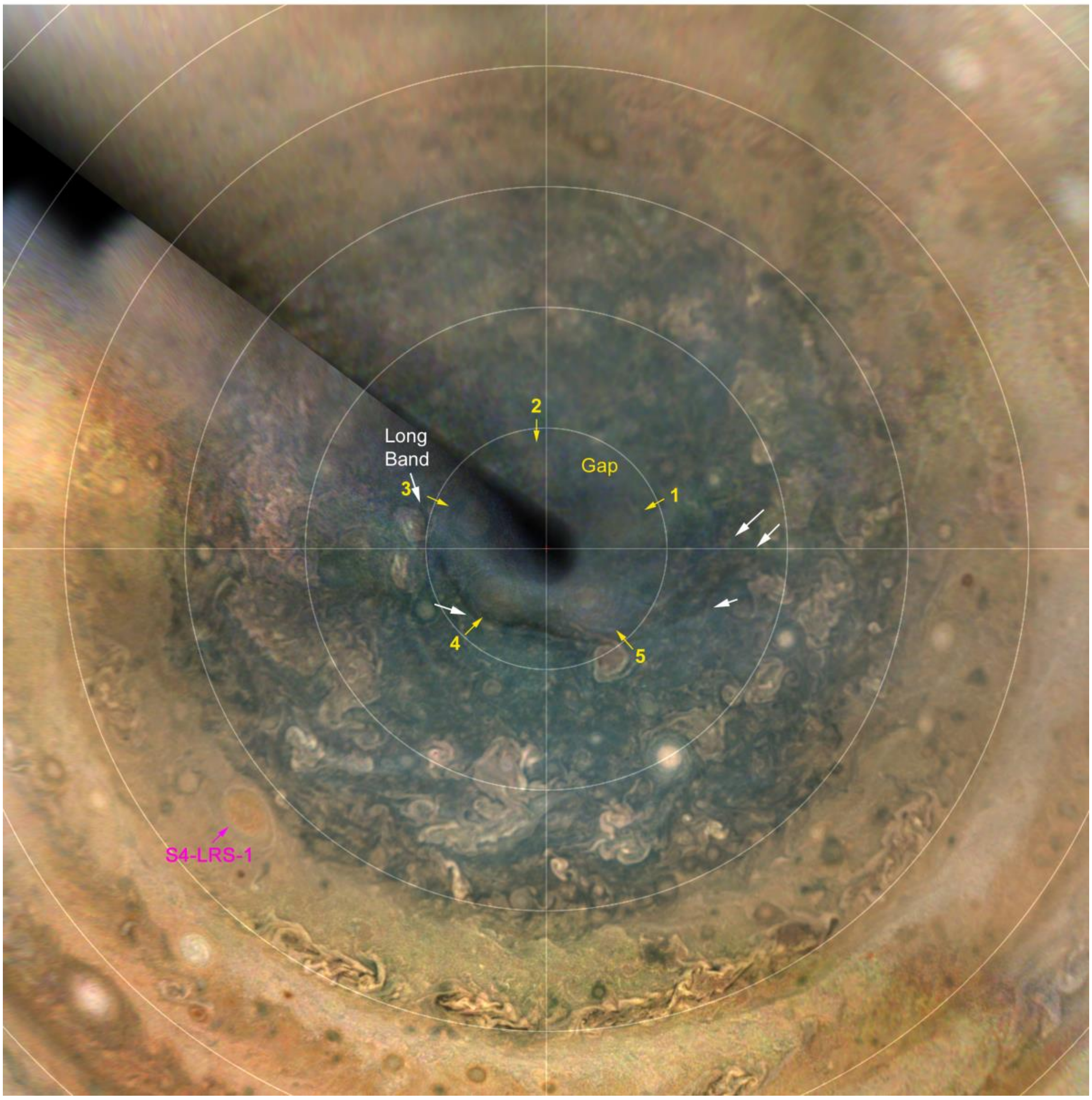


Figure 14

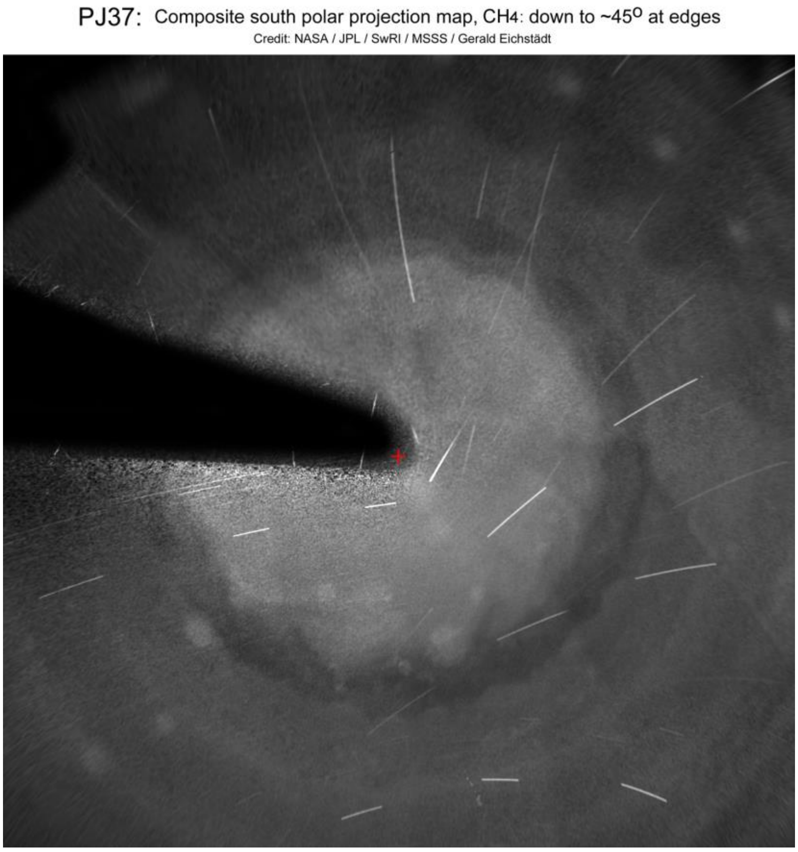


Figure 15