

JunoCam at PJ42: What the pictures show

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PJ42 was on 2022 May 23, with equator crossing at L1=327, L2=183, L3=80. This was identical to the PJ41 track in L2, and 11.5° deg higher in L3, so many of the same features were in view. However, the spacecraft was tilted to give views closer to nadir (as at PJ38). During its approach, while capturing very distant views of Io and Europa, Juno had the best inbound views in the extended mission so far, usefully covering a long sector of the NEB. For comparison, ground-based images around this time are discussed in our [2022 report no.2](#) [https://britastro.org/section_information_/jupiter-in-2022-23 – go to Report no.2].

North Polar Region: Circumpolar cyclones (CPCs)

The CPCs are shown in [Figure 1](#). This map covers the same sector as at PJ41, with CPCs 6,7,8,1,2, and the NPC, and two small AWOs inside the polygon, all looking very much as they did at PJ41, in position and in morphology. (Part of CPC-3 is also seen.) This is a fine illustration of the stability of this polygon, while the surroundings have changed completely.

CPC-1, a typical ‘filled’ CPC, has an internal ring of 8 dark holes, which are now resolved as cyclonic eddies; some of them are separated by anticyclonic eddies. (The dark spots in these CPCs are typical and are identified as holes because they are bright in 5-micron images from the JIRAM instrument.) The central anticyclonic counter-spiral is also clearly resolved.

The Bland Zone & haze bands over northern domains

[Figure 2](#) is a hi-res north polar projection map down to 30°N, and [Figure 3](#) is a comparable, lo-res map emphasising terminator regions to show haze features. It displays the usual linear bands in the Bland Zone (BZ) at dawn (mainly dark) and dusk (mainly bright), and a plethora of bands over the N4 and N5 domains from the inbound images.

A specially interesting feature is a vividly red spot at 40°N in the N3 domain; the original (inbound) images of this are shown in [Figure 4](#). The bright red spot on the terminator, wreathed in white haze, coincides with a red cyclonic oval. Its brightness on the terminator suggests that it is not a brown shadow, but a high-altitude red haze, which is surprising for a cyclonic oval; their cloud-tops are normally at low altitude as they are dark in methane images. Unfortunately we do not have any methane images covering this one, but perhaps one could be found for a similar N3 feature at an earlier perijove.

PJ42 gave the best resolution so far of the texture in the Bland Zone ([Figure 5](#)). To the right in this figure, there is a neat pair of interconnected grey circulations in the N5 domain with arcs of popup clouds; one is anticyclonic, the other undefined but appears to be partly overlaid by diffuse dark grey haze. At upper right is a beautiful orange cyclone.

[Figure 6](#) is our global cylindrical map from PJ42; [Figure 7](#) is the hi-res portion. They can be compared with a ground-based map in our [2022 report no.2](#) [[link above](#)].

N2 domain

The PJ42 images show a striking band of very dense strips of popup clouds, extending obliquely across the NNTZ from a turbulent region of the NNTB. The PJ41 images also showed unusual structures here, including a similar band of popup clouds curving round an anticyclonic vortex. They are compared in [Figure 8](#), and actually represent the same oblique feature, although the associated vortices are different; between perijoves this feature has

moved $\sim +14^\circ$ in L3 but only $+3^\circ$ in L2, consistent with the usual N.N. Temperate Current. Ground-based maps [2022 report no.2; link above] show that it marks the following (west) end of a broad rifted sector of NNTB, as confirmed in the PJ42 images (Figure 7).

This happens to be the sector past which the exceptional AWO N3-w1 prograded, between its translocation from the N3 to N2 domain in 2021 Sep. (L2 \approx 186, L3 \approx 19) and its merger with NN-WS-6 in 2022 May (L2=117, L3=15) [2022 report no.2]. Another such band of popup clouds was seen along the N4 jet at PJ39, where it was perturbed downstream of an AWO translocating from the N4 to N3 domain, but there may not be close dynamical similarity. Rather, the band seen at PJ42 seems to outline the edge of the disturbed NNTB sector, whose turbulence may be pressing against it, and the band may be being stretched between the retrograde NNTBn jet and prograde N3 jet. Dynamical modelling would be needed to test these speculations.

On the NNTBs jet, the inbound images showed a substantial ongoing outbreak of dark spots, indicated in Figures 4 & 6.

North Equatorial Belt (NEB) and Equatorial Zone (EZ)

The NEB faded and narrowed drastically in 2021, leaving only a narrow dark NEB(S). But since late 2021 there have been multiple convective outbreaks within a sector of NEB(S), which have gradually spread dark brown tint northwards into the faded mid-NEB, and produced disturbances all around the NEBs edge (see our PJ41 report = 2022 report no.1). Meanwhile, barges in the northern NEB became very dark in 2021 but have faded a lot during solar conjunction in 2022. At the time of PJ42, the NEB continues to revive but only partially: while the NEBs edge is widely disturbed, and dark brown material is spreading far enough north to be drawn into loops around the fading barges, there is still no sign of convective ('rift') activity north of the NEB(S) [2022 report no.2; link above].

The inbound and perijove images combined (Figure 6) cover 3 of the 7 barges – two of them fading, plus the single barge that is still very dark – and 4 of the 6 AWOs – including the same ones imaged at PJ41. None are seen at high resolution, because in the closeup images, these features are viewed near the limb and have low contrast. However, the closeup images at both PJs show the brown material that is being drawn around the faded barge, which has strong streak-lines representing the zonal wind gradient, in contrast to the amorphous texture of the adjacent still-faded northern NEB.

The v-hi-res images best show the still-faint northern NEB, and in particular, some small crisp-edged cloud rafts there (Figure 9). This must be our best view yet of these features, which were first discovered by Björn Jónsson in a Voyager image of the southern EZ. They seem to be similar to popup clouds but are much wider.

The NEBs features are subdued in the closeup images, but some white spots were captured in 'look-back' images near the limb (Figure 7), and a more substantial bright NEB(S) outbreak was captured in the inbound images (Figures 4 & 6). Ground-based images showed that this had appeared on May 20 and was bright in RGB and methane on May 21. (It's no.14 in 2022 report no.2.)

In the EZ, the broad ochre band is much fainter than last year. There appear to be mesoscale waves on it (images 35 & 36), but there are also sharp contouring artefacts that become evident with amplification of the low-contrast images, and it is difficult to distinguish them. Mesoscale waves are more distinct on the cloud bands flanking the pale ochre EB, as usual.

STBn jet

There is still a substantial outbreak of dark spots prograding on the STBn jet (Figures 6&7). Their dynamical nature is quite mysterious. They are emerging preceding STB segment G, at $\leq -24.3^\circ\text{S}$ [27.2°S planetographic], but then mostly travelling at 22.5°S [25.3°S planetographic], which is an unusually low latitude, north of the canonical STBn jet. Images at recent PJs have shown them to be diffuse brown patches without clear evidence of vorticity; but in the PJ42 images, we see narrow streaks curving around them for the first time (Figure 10). Most of these streaks (esp. on the left of the figure) could represent waves on the flank of the jet, perhaps entraining the spots, rather than intrinsic vorticity, whereas one on the right does contain narrow concentric arcs (indicated by red arrows), probably lines of pop-up clouds.

S. Temperate domain

The global map (Figure 6) gives the most complete view yet of the S. Temperate domain since solar conjunction. There is now some kind of dark STB around half the planet. In order of increasing longitude: STB segment G (the descendent of Clyde's Spot/DS7) is a poorly-defined turbulent sector $>30^\circ$ long. Following it, cyclonic oval WS6 is embedded in dark STB that extends to oval BA. Following oval BA, STB segment A has continued to lengthen and is now $\sim 85^\circ$ long, up to the smaller STZ AWO. Around the remaining longitudes, the main STB is still faint, but the STBn jet spots and the 'Sf. tail' of segment A provide plenty of dark material along its edges. Spot 8 is confirmed as a dark brown oval.

S2 domain

The images give fine views of AWOs A2 to A5 ('String of Pearls') and cyclonic white oblongs and FFRs that are interspersed between them.

South Polar Region

Figure 11 is a composite map of the SPR. Three of the circumpolar cyclones (CPCs) can be discerned, but the central cyclone is now in darkness.

Figure 12 shows composite south polar maps emphasising the terminator regions to show the haze patterns. We see the same patterns that we have noted from PJ34 onwards:

At $\sim 50\text{-}62^\circ\text{S}$, there is a series of bands which appear $>$ -shaped at dusk but mainly the southern parts are visible at dawn.

At higher latitudes there are many narrow oblique bands, some quite long, including widespread bands at $\sim 75\text{-}80^\circ\text{S}$ visible across the sunlit side. These include signs of the Long Band, which is not conspicuous, but it ends as usual in bright and dark \supset -shaped 'hooks' that catch the sunlight on the terminator; contrast the dusk and dawn views in Figure 13 (white arrows).

Also in Figure 13 (black arrow) is what looks like a substantial shadow-casting band (upper left from the pole); it is also methane-bright (Figure 14, white arrow).

Figures (small copies)

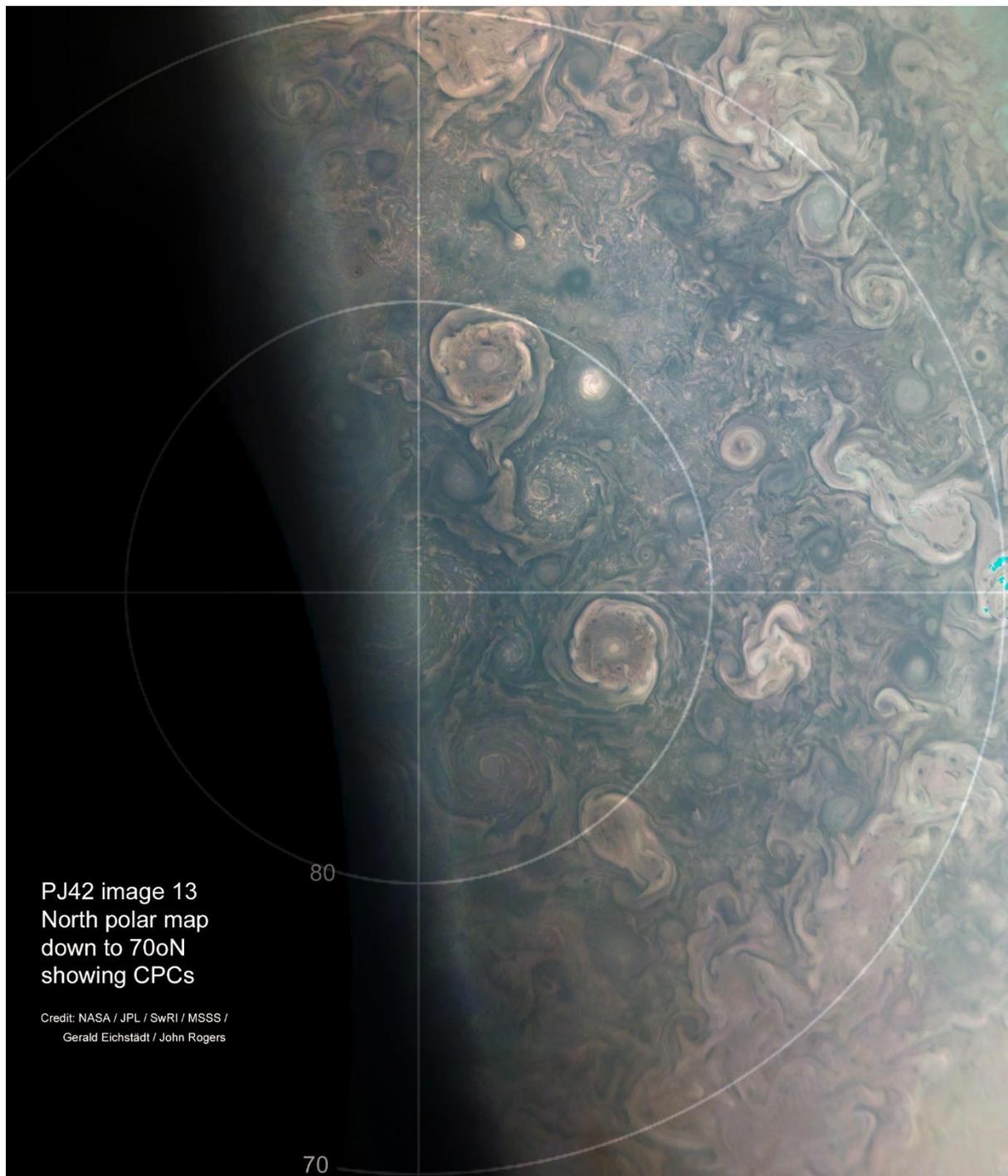


Figure 1: North polar map down to 70°N, showing the CPCs, from image 13 only. (Now that Juno passes so low and fast over the north pole, this single deep image shows as much terminator detail as the series of shorter-exposure images before and after.) L3=0 to right.

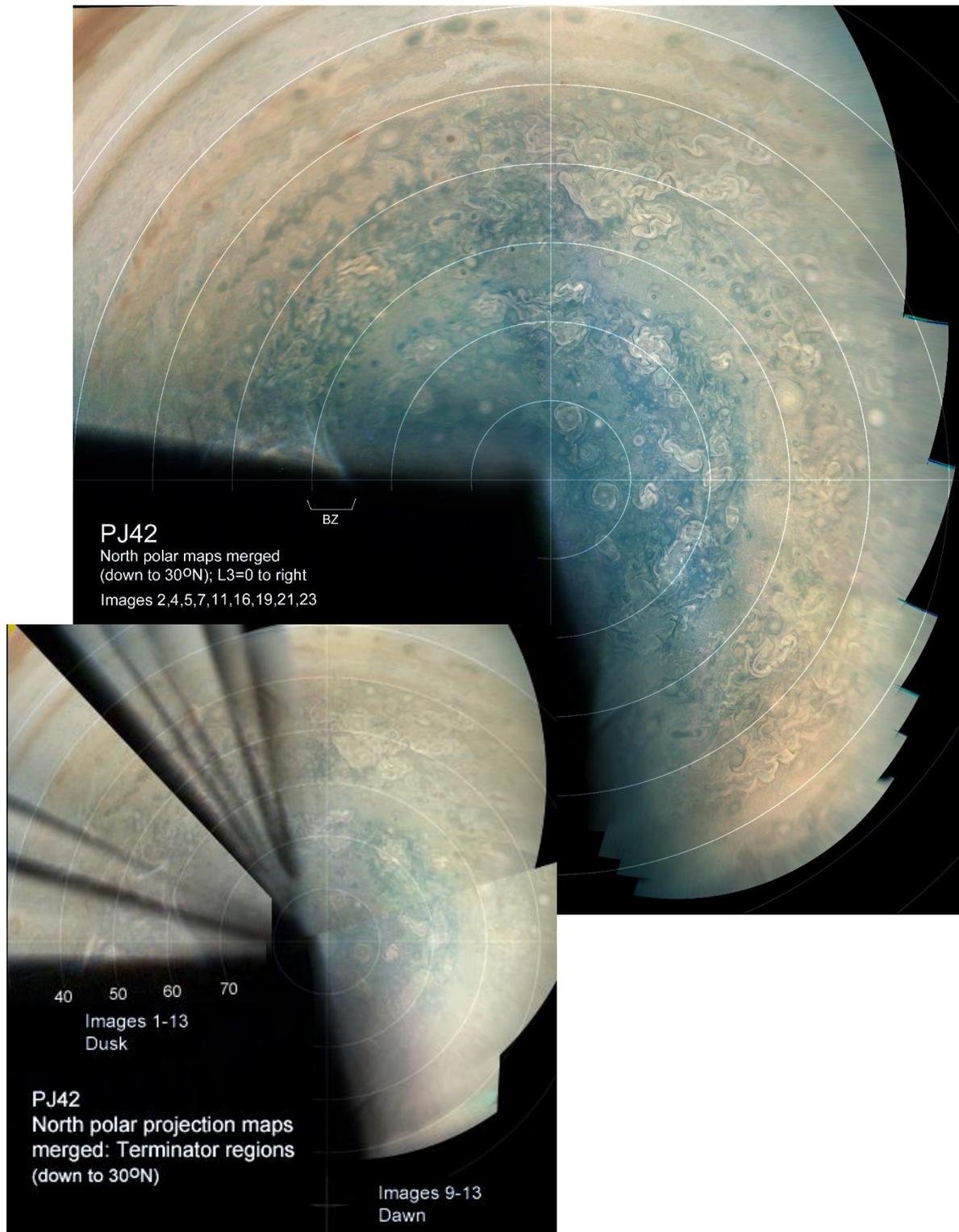


Figure 2: North polar projection map down to 30°N, hi-res (labelled)

Figure 3: North polar projection map down to 30°N, emphasising terminator regions to show haze features; lo-res.

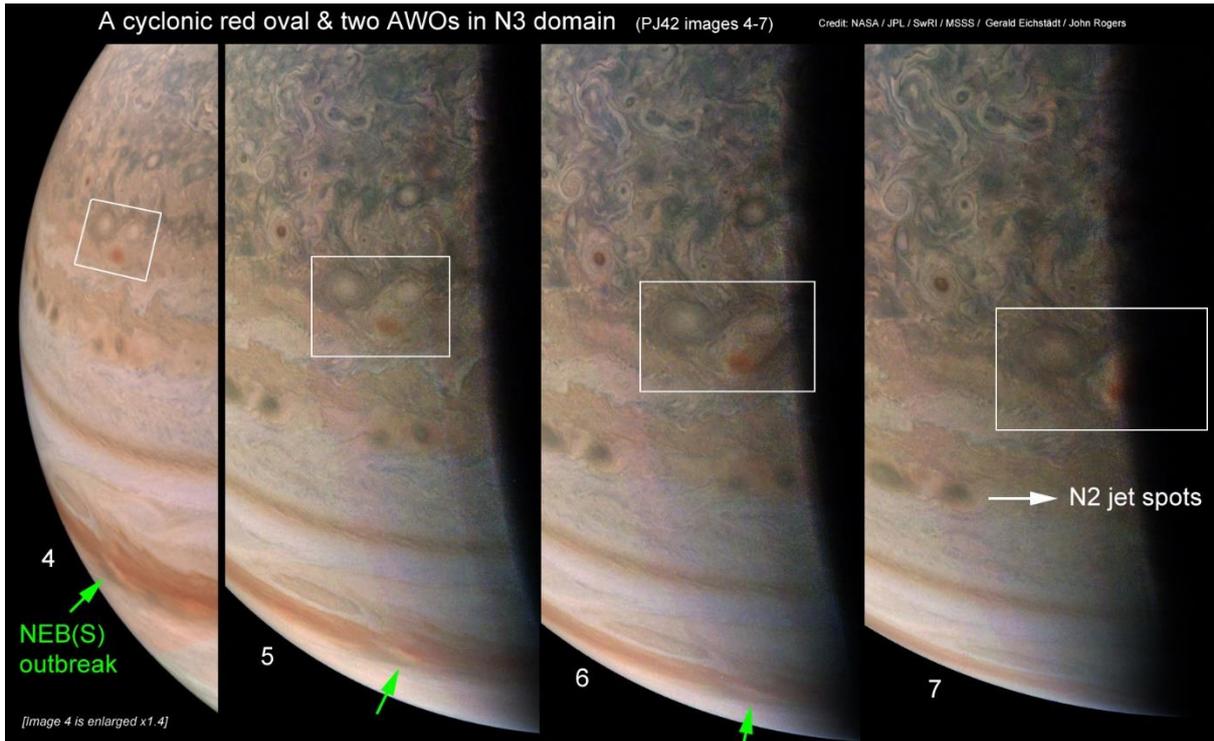


Figure 4: A cyclonic red spot at 40°N in the N3 domain, which appears bright red on the terminator; the original (inbound) images. North is up. (Images processed by Gerald Eichstädt & JHR.)

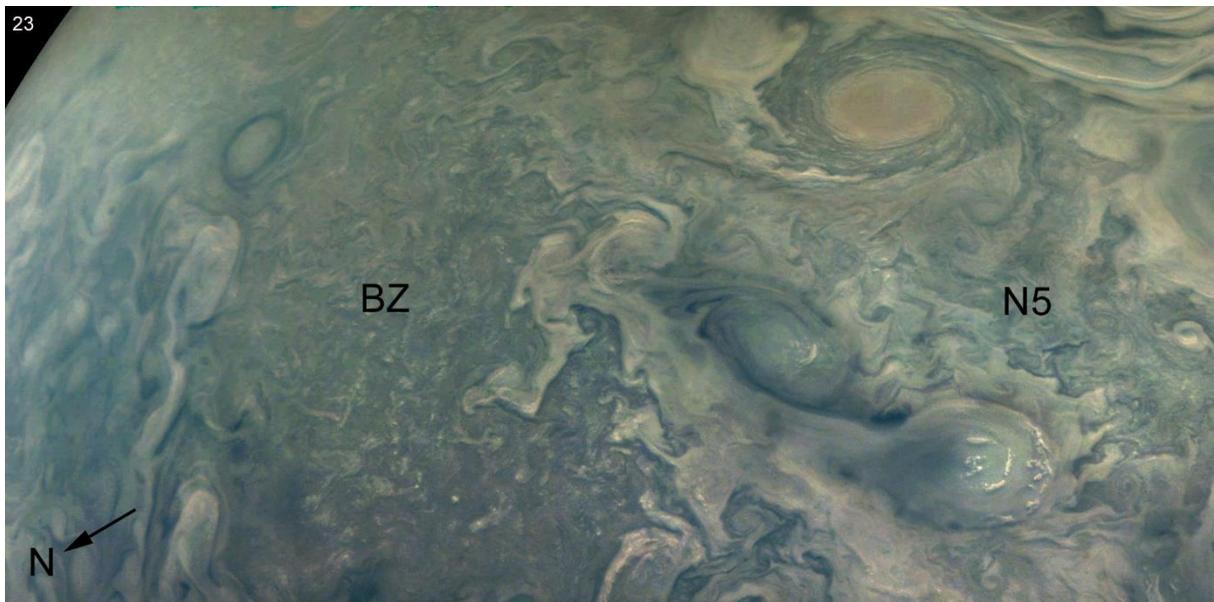


Figure 5 (Image 23): The best resolution so far of the texture in the Bland Zone and some small circulations in the N5 domain. (Image processed by Gerald Eichstädt & JHR.)

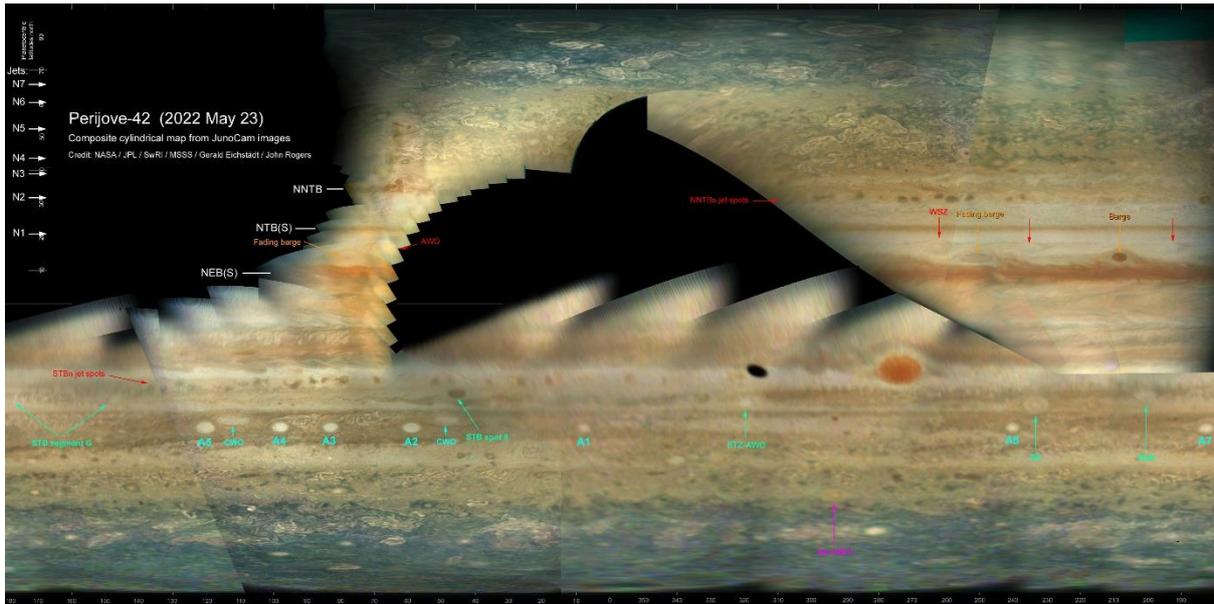
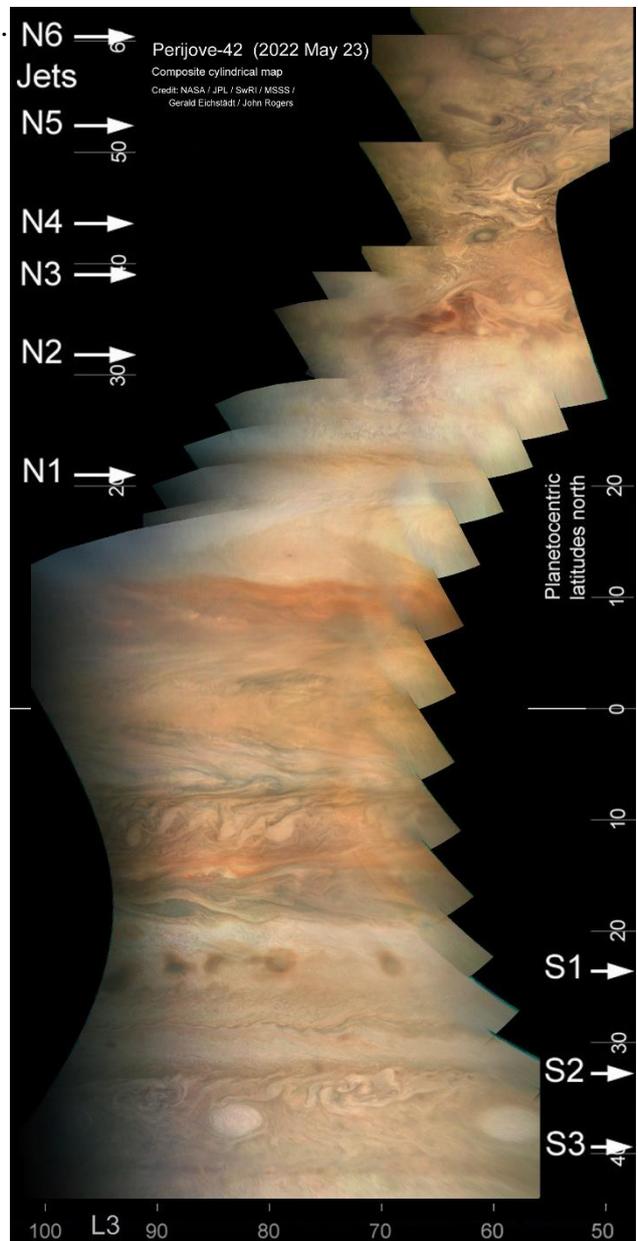


Figure 6: Global cylindrical map from PJ42.

Figure 7: Hi-res portion of the global map.



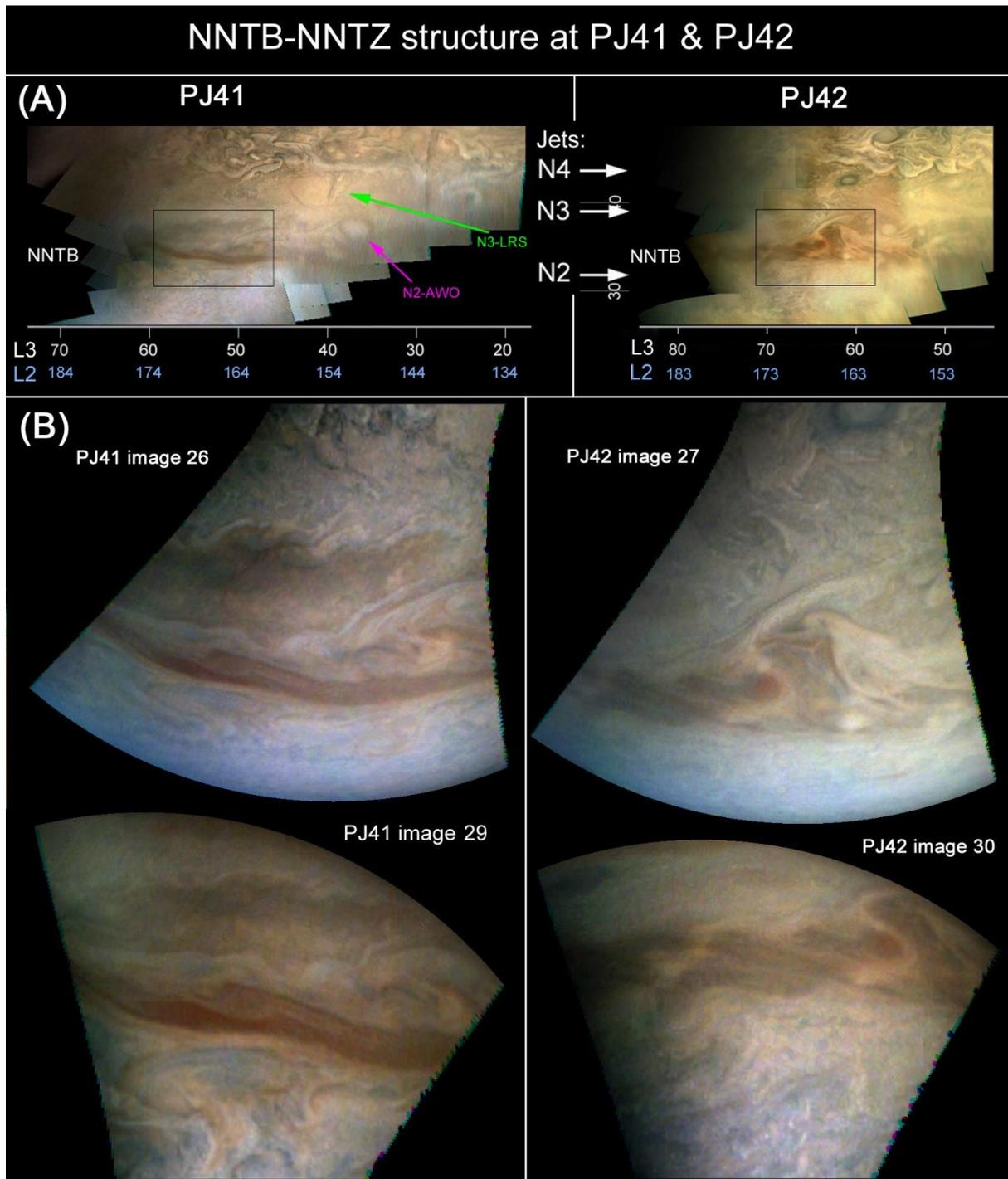


Figure 8: Part of the N2 domain, where striking bands of popup clouds extend obliquely across the NNTZ adjacent to a turbulent region of the NNTB, seen at PJ41 and PJ42. (A) Excerpts from our cylindrical maps. (B) Initial images posted on the JunoCam web site. (C) [next page] Full-quality images processed by Gerald Eichstädt & JHR.

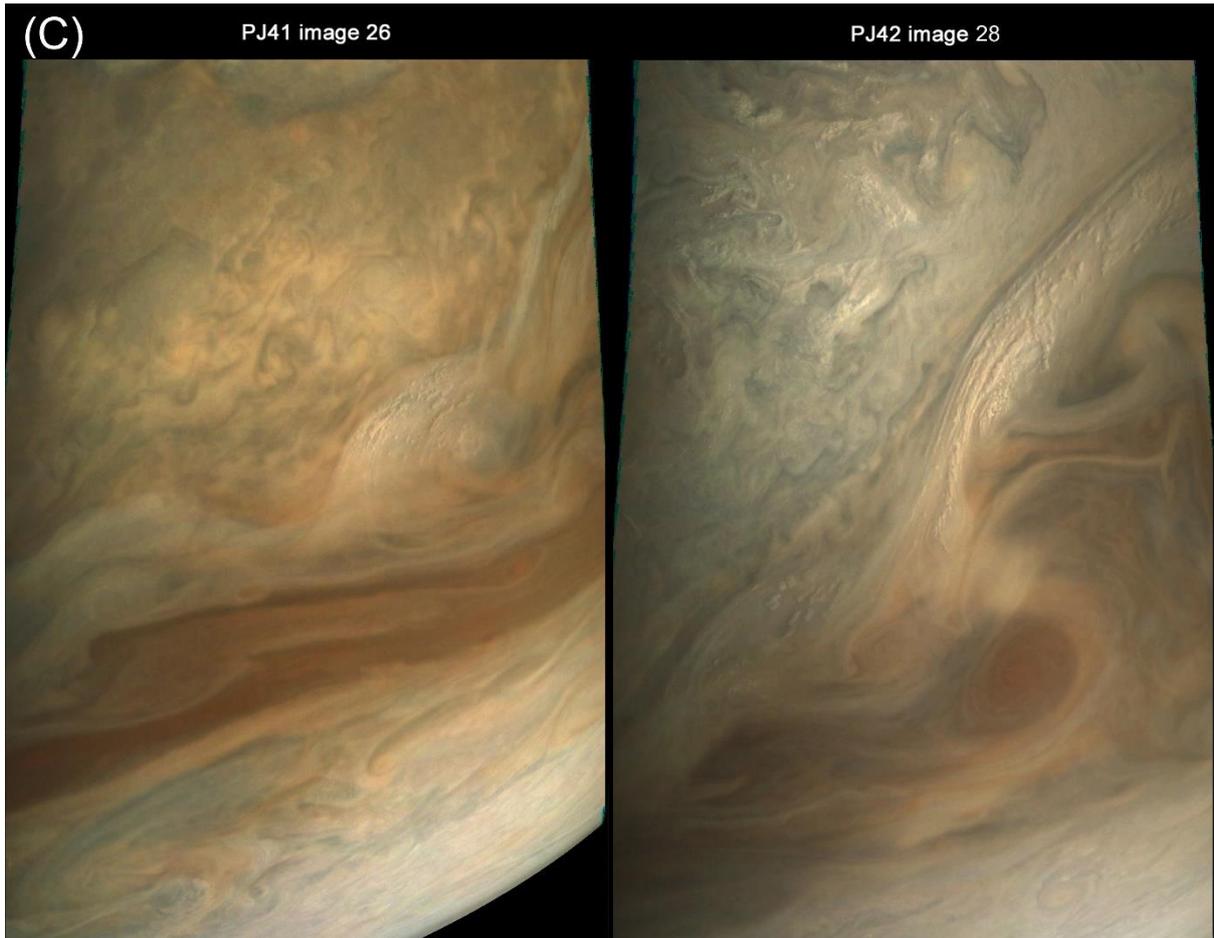


Figure 8C.

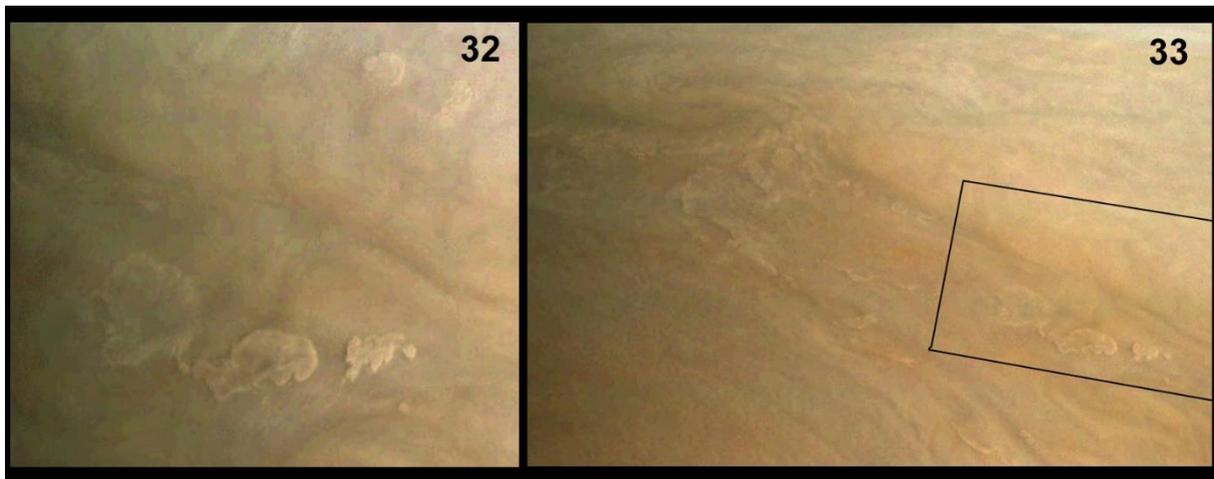


Figure 9 (Images 32 & 33): Small crisp-edged cloud rafts in the faint northern part of the NEB. (Image processed by Gerald Eichstädt & JHR.)



Figure 10 (image 40). Closeup view of STBn jet spots.

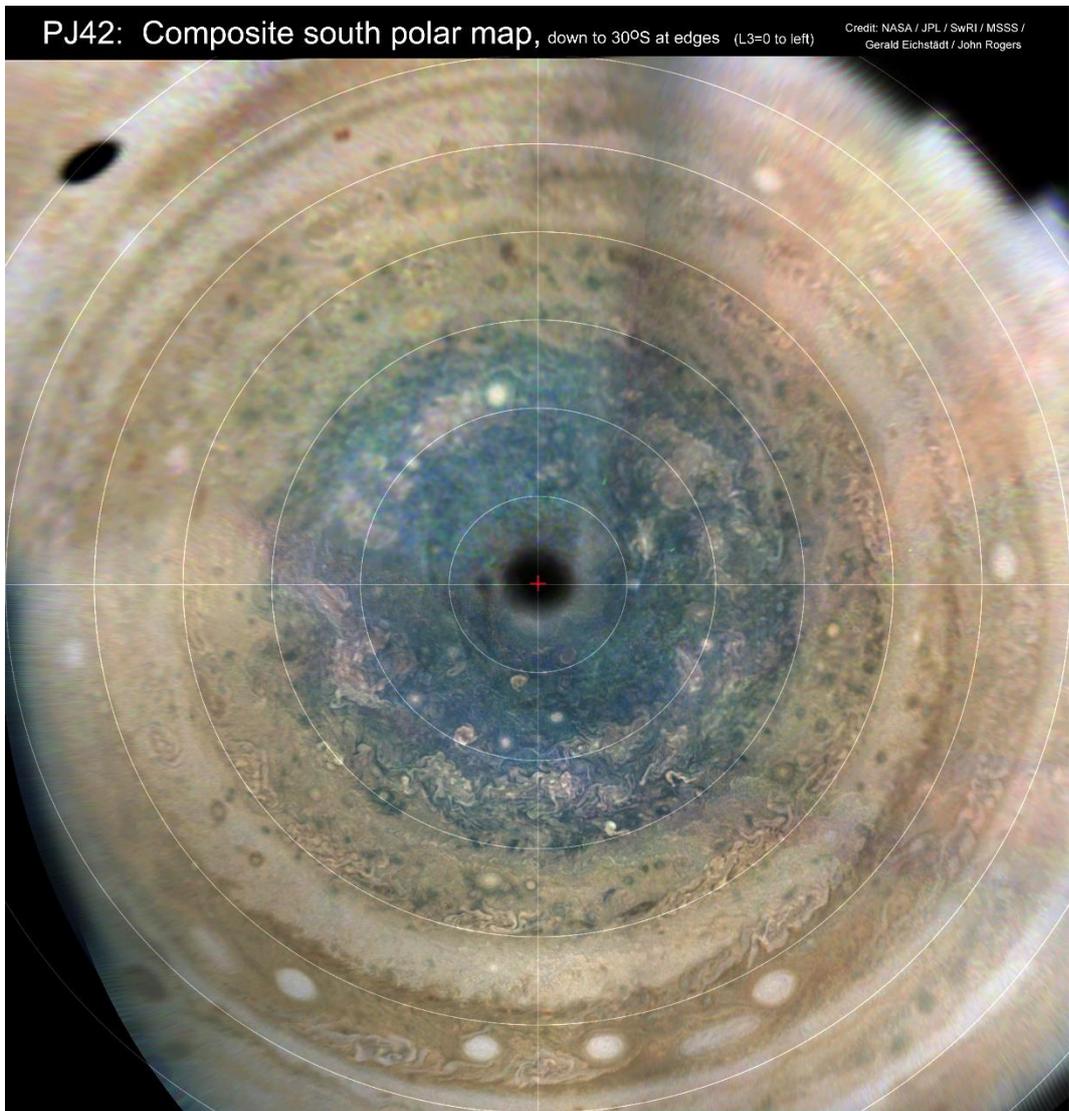


Figure 11: Composite south polar projection map covering the whole SPR.

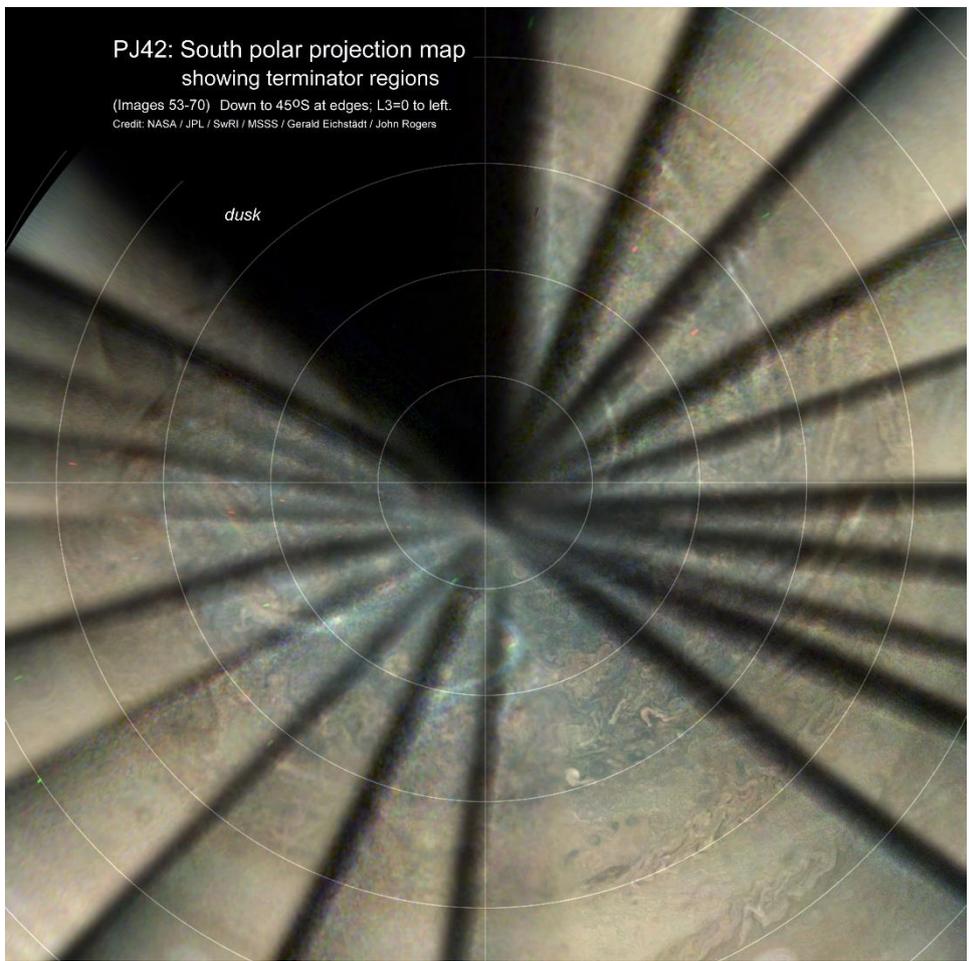
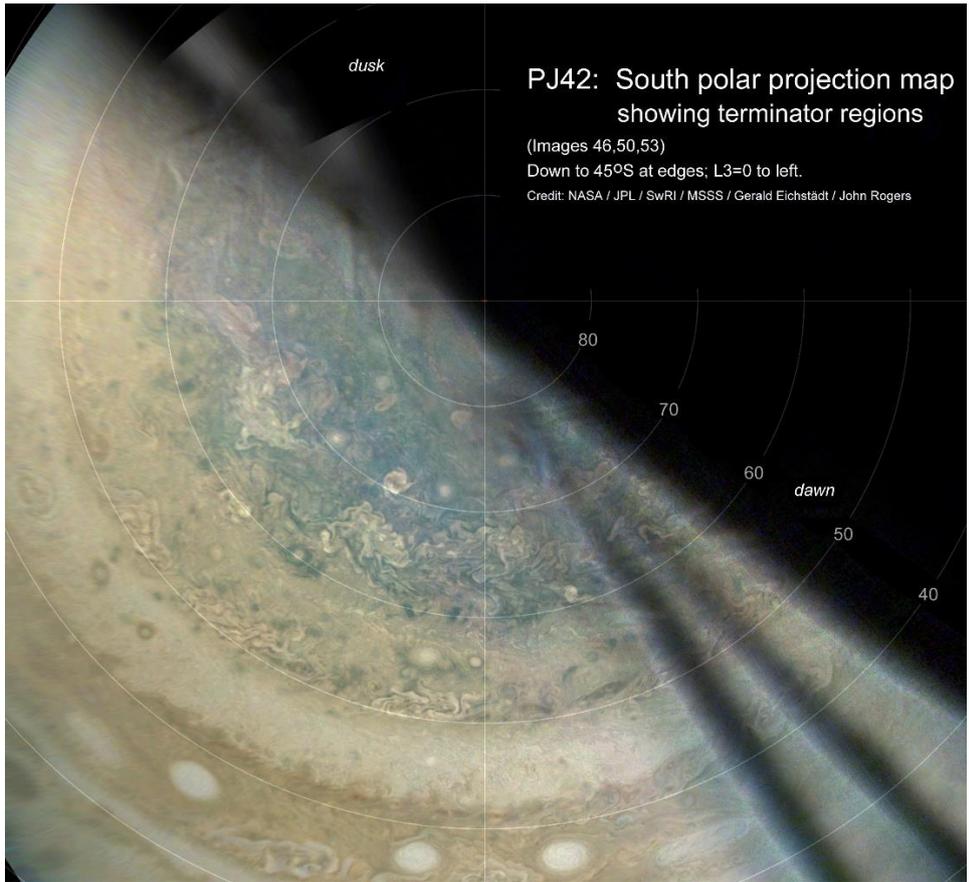


Figure 12: Composite maps emphasising the terminator regions to show the haze patterns.

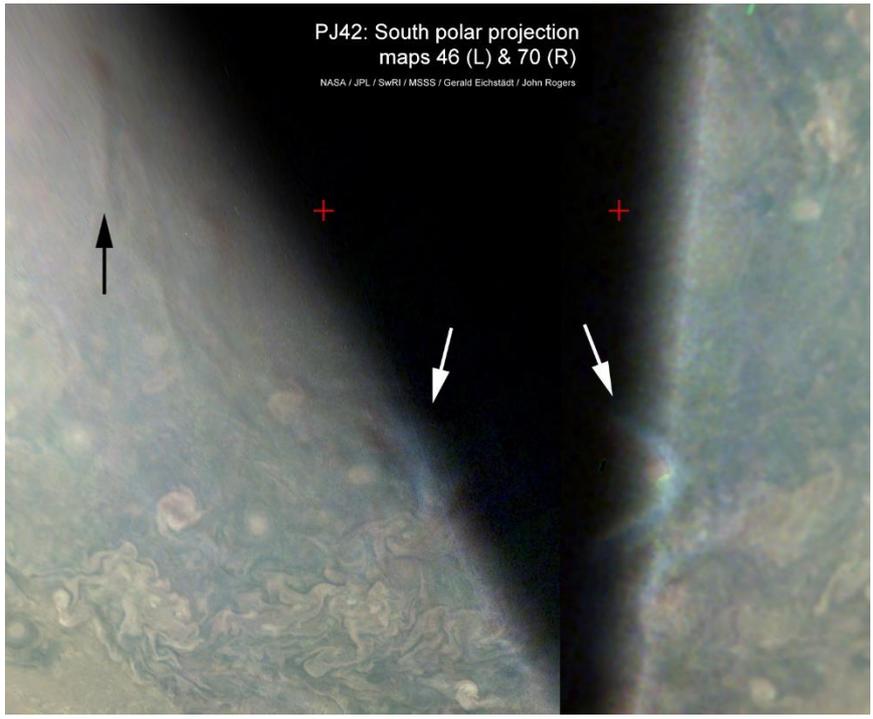


Figure 13: South polar projection maps showing the following end of the Long Band catching the sunlight at dusk (image 46) and dawn (image 70).

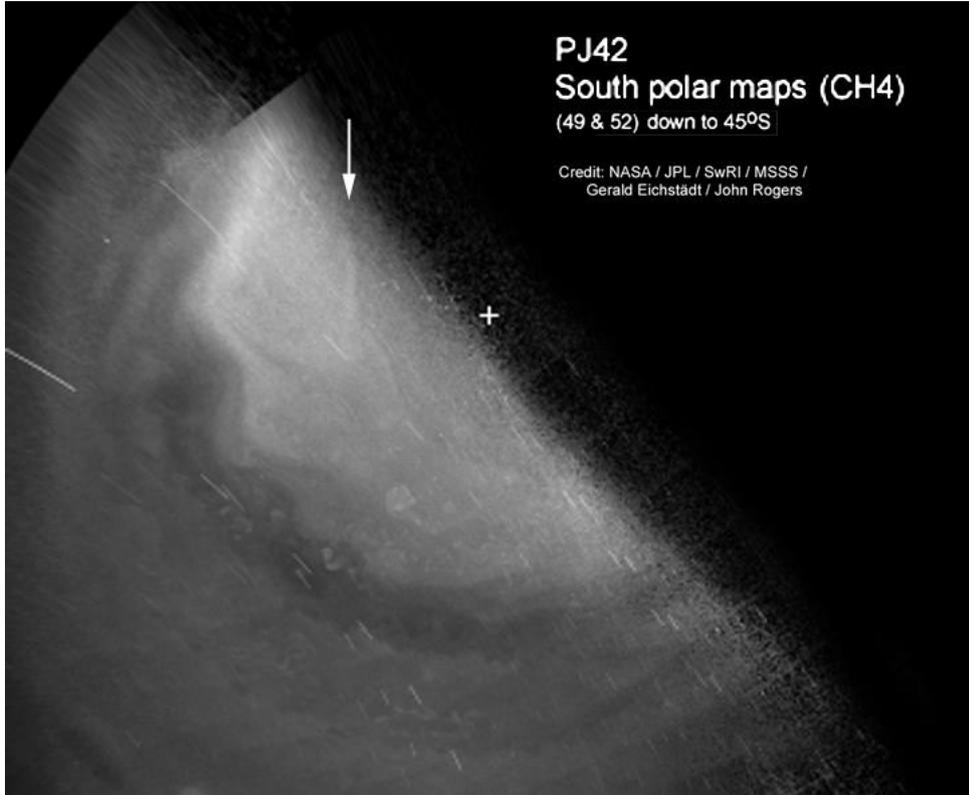


Figure 14: Methane-band map of part of the SPR (from lo-res versions of two images).
