JunoCam at PJ32: What the pictures show

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PJ32 was on 2021 Feb.21, with equator crossing at L1=167, L2=265, L3=41. It was just 3 weeks after geocentric solar conjunction, so there had been no ground-based observations of the track for more than 6 weeks.

Acknowledgements, abbreviations and conventions herein are as in our other recent perijove reports (e.g. PJ30).

North polar region

Circumpolar cyclones (CPCs)

Figure 1 is a composite map of the CPCs. The central North Polar Cyclone (NPC) is half seen, and it again appears to be offset from the pole, this time by 1.0° latitude. It was offset in a similar direction at PJ30 & PJ31. (However, we have not yet been able to estimate the accuracy of the north pole position in our maps, because of the limited illumination and field-of-view here up to now.)

The map includes CPC-7 (last seen at PJ28), which has been anomalously far from the pole throughout the mission, and still is. But the small AWO that has always separated it from the NPC is no longer present! I wonder whether a caterpillar-shaped feature on the N edge of CPC-8 might be a remnant of it, caught up in the cyclonic circulation of CPC-8. CPC-6 & 8 have now moved closer together so it's possible that CPC-7 is being expelled from the octagon. In a composite map of the CPCs from PJ30 to PJ32 (Figure 2), the polygon can be seen as a heptagon, centred on the off-pole NPC, and surrounded by several smaller or (CPC-7) more disturbed versions of 'filled CPCs'. But this arrangement could be only temporary.

CPC-8 has converted from a largely amorphous form at PJ27 to a well-formed spiral now. CPC-6, straddling the terminator, is partly overlaid by haze bands (one being a 'rainbow band') similar to some seen at PJ30 & PJ32 (Figures 1 & 2).

The Bland Zone and haze bands

Figure 3 comprises the CH4 and RGB maps of the northern hemisphere. The Bland Zone (BZ) is well defined, and interrupted by a curious cluster of small ovals (Figure 4a). Some linear bands are visible as usual. Further S, there are haze bands at the terminator, and the methane map shows many large diffuse patches and swirls in areas that were imaged near the limb; they were less visible when imaged at lower emission angle.

N2 (N.N. Temperate) domain

The map in Fig.3 enables us to locate the two largest *anticyclones in the NNTZ*, NN-LRS-1 (a long-lived reddish oval) & NN-WS-6/7 (formed by two AWOs merging last year), although both were only imaged very near the limb.

The closeup images (mapped by Björn Jónsson in Figure 5) show a striking strip of *red-brown NNTB*, with an impressive circulatory pattern at its f. end. Inside this curve there is a very bright, slightly orange cloud patch overlying a dark swirl, and outside it there are lanes of popup clouds, somewhat resembling the parallel lines in bands around cyclonic disturbances in Fig4(a&b).

On the S side of this NNTB are several typical *N2 jet spots* (vortices); the one at left in Fig.5 shows its anticyclonic circulation pattern very clearly.

N. Temperate & Tropical domains

Figure 6 is a global map from the images, in our usual style.

The NTB and NEB are both in the late stages of their typical great upheavals that occurred in 2020, and now quiescent. Thy show no large features in the JunoCam images, but are all filled with small-scale turbulence. The NTB is divisible into a dark grey north component, a browner component S of it, and a pale fawn southern fringe, which is only a feeble copy of the "big red stripe" of 2017. The NEB is still fully expanded at this longitude, and its ubiquitous small-scale turbulence is reddish. It includes what looks like an incipient barge – a cyclonic spiral trailing smaller vortices in its arms.

Equatorial Zone (EZ)

On the NEBs edge, there is a typical large NEBs dark formation (NEDF) visible in the later images (Figure 6). But in the closeup images there is a much smaller, but conspicuous, miniature version of a NEDF (Figure 7). There are faint whitish streaks of haze running over it and over the adjacent NEB, and rafts of tiny sharp-edged clouds scattered around it. I wonder if this is one of the faster-moving, possibly deeper features that sometimes appear; we should study ground-based images carefully in the coming months to see if such features are detectable.

The EZ is still filled with a rich diversity of cloud features (e.g. Figure 8). The EZ(N) is lightly shaded and slightly reddish, due to a dense mixture of white, grey and ochre streaks. A very prominent orange Equatorial Band (EB) still occupies the centre of the EZ. The EZ(S) is bright white with dark blue-grey streaks.

Mesoscale waves are absent from the EZ(N), but they are present over almost all of the orange EB (Figure 8). And on both flanks of the EB there are lanes of puffy light clouds showing less regular mesoscale wave patterns: the one on the N flank is feather-shaped (as at PJ30), while on the S flank there are several parallel lanes of dense white clouds with such semi-regular wave-like periodicity, extending over half the EZ(S).

South Tropical domain

More mesoscale waves can be seen on the SEB(S), as well as meandering waves on the SEBs jet, and a long narrow red haze band (Figure 9). In Figure 9, two trains of mesoscale waves are indicated by white 'combs' to their left, but similar waves occupy most of the space between them. The meandering waves on the SEBs are marked by white asterisks; their mean wavelength here is ~3.8° longitude. The red haze band is indicated by red arrows, and there is a less vivid one a little way S of the SEBs. All these features were also recorded on the SEB(S) at PJ28 and PJ30, likewise in quiescent sectors.

A notable change since 2020 is the appearance of a new dark belt in the STropZ, i.e. a S. Tropical Band (STropB). The map (Figure 6) shows that it extends from the GRS, which has a massive dark grey collar around its S side, emerging in turn from a dark 'hook' on the f. side. The appearance is thus typical of the emergence of a STropB from the GRS, and similar to 2019 May, when the GRS was being disrupted by incoming vortices from the SEBs jet. Shinji Mizumoto and Andy Casely have worked out that the present hook and STropB could have been induced around 2021 Jan.25 (during geocentric solar conjunction), by a large SEBs vortex that had been seen approaching in late 2020.

S. Temperate domain

At PJ32, oval BA (which is now reddish again) was visible near the limb as anticipated (Figures 6&10), and JunoCam had an excellent view of the dark turbulent STB segment following it. This is now 45° long; it was 38° long in our last ground-based maps in 2020 Nov. Its continuing expansion, its obvious turbulence in the PJ32 images, and the rapid drift rate of oval BA since Nov., all indicate that this STB segment has remained highly active since the STB Spectre collided with it a year ago. It displays vivid examples of orange patches over cyclonic eddies.

The f. end of this STB segment is close to an AWO in the STZ, which is now very similar to the AWOs in the S2 domain (except that it is less methane-bright: Figure 11D). There is another, smaller AWO further f., in the STZ that is still darkened by all this STB activity.

High southern domains

S.S. Temperate (S2) domain:

There is a beautiful chain of four S2-AWOs (Figure 10), which we identify as A2-A5. Two groups have closed up together since last year, so that A1-A5 now form a single chain, mostly separated by FFRs, which show colourful structure. AWOs A7 and A8 can also be located in outbound images (Figure 6).

S3 domain:

This is largely blank, except for a loose chain of small dark rings (probably anticyclonic) straggling f. a FFR seen at the p. limb (Figure 10).

S4 domain:

S4-LRS-1 is nicely presented, on the S side of a FFR (Figure 10). Further f. there is a pair of small, very bright spots erupting within a small cyclonic feature.

South polar region

Figure 11 is a set of composite maps of the SPR, presented in the same style as at other recent perijoves. Juno now passes over the SPR at high altitude so the resolution of the images is poorer than earlier in the mission, but this impairment was compensated during the PJ32 outbound leg by taking every other image at very high quality, to reduce noise. Thus, major features can be recognised around almost the whole circumference (Fig.11A). It was possible to make some good animations, each one covering about one hour. In addition to the well-known jets, it includes an example of a weak prograde stream running obliquely up to 77° S.

Methane map and haze bands

The methane map (Fig.11D) shows the bright S. Polar Hood (SPH) with its wavy edge as usual, as well as all the red and white anticyclonic ovals at lower latitudes down to the GRS.

The maps of near-terminator regions (Fig.11C) show a dense pattern of striations over much of the area, both inside and outside the SPH, as at other recent perijoves. The only really conspicuous haze bands are at upper left, also shown in single-image maps in Figure 12. Here, the images show a complex mixture of dark and bright arc-shaped bands which undergo spectacular contrast reversals, not only between dusk and dawn, but even within 30 minutes just after dawn (images 92 & 94). The main set of concentric arcs coincides with a strongly methane-bright bulge of the SPH (Fig.12, right).

Circumpolar cyclones (CPCs)

Despite the low resolution, it is possible to identify all of the CPCs. Their estimated outlines and centres are marked in Fig.11B, albeit imprecisely. The gap between CPC-1 & 2 is wide. The central SPC has moved away from the pole (Figure 13), in a direction consistent with our prediction at PJ31.