Jupiter in 2024/25, Report no.7

(2026 Jan/Feb.)

John Rogers (BAA), Gianluigi Adamoli, Rob Bullen, Michel Jacquesson, Hans-Jörg Mettig, Marco Vedovato (JUPOS team), & Shinji Mizumoto (ALPO-Japan).

Summary

This will be our most complete report on Jupiter in 2024/25, and the first one to cover multiple regions since Report no.2 (2024 Nov.). Observations lasted from 2024 June to 2025 May, with opposition on 2024 Dec.7. There were two notable large-scale events: (1) the mid-SEB outbreak, initially covered in Report no.2, and here reviewed more fully; (2) the NTBs jet outbreak, initially covered in Report no.4, then thoroughly in Report no.5. Report no.6 (2025 April) listed the main phenomena in other regions, and serves as the summary for this present report. Here we supplement it with further details and drift rates for many features, and show some of the best images from observers.

*This report was first posted in 2026 Jan., but this is a revised version posted in 2026 Feb., with the section on 'High northern domains' expanded with full JUPOS analysis and JunoCam maps, adding two pages of text and a set of additional figures in **Appendix C**.*

Data and conventions

As always, we are very grateful to all the observers, whose images are the basis for this account. The JUPOS team and Shinji Mizumoto have measured spot positions on many of these images. Here we have measured drift rates from the JUPOS charts (taking average values if there were minor variations), and mean values (± standard deviation, with N = number of distinct track segments measured). Annotated JUPOS charts are in **Appendix A**. However, a comprehensive analysis of the JUPOS data with precise latitudes remains to be done.

We also make some reference to images from JunoCam, which continued to operate during the apparition from perijove (PJ) 61 (2024 May 12) to PJ72 (2025 May 7), except for PJ71. Because of Juno's evolving orbit, JunoCam's best images were of a restricted sector of the northern hemisphere during the final approach stage on each orbit. Hubble maps of the planet were made on 2024 Nov.19-20 (OPAL project) and have been used for the high northern domains; they could provide valuable hi-res dynamical information on features that we describe.

North is up in all maps and images herein. Maps are plotted in L3, but drifts are quoted in L2 (DL2, deg/30d). DL3 = DL2 + 8.0 deg/30d. Note that more frequent though smaller-scale maps were posted by Shinji Mizumoto on the ALPO-Japan web site [https://alpo-j.sakura.ne.jp/Latest/j_Cylindrical_Maps/j_Cylindrical_Maps.htm].

Maps from amateur images were posted in our 2024/25 reports nos.1 & 2 (for 2024 July, Oct., & Nov.) and in our reports on Juno PJ65 to PJ69 (maps from Sep. to Jan., in addition to those from JunoCam). Here we add maps from 2024 Aug. & Oct. (Figure 1) & Dec. (Figure 2), and a set from 2024 Jan. to April (Figure 3). To show more of the best images received, **Appendix B** presents image sets covering the longitudes of the mid-SEB outbreak from 2024 Nov. to 2025 April.

Below is a table summarising the mean speeds from this report for all prograde jets, zonal slow currents, and retrograding or slow-moving spots. See text below for full details. (Updated values for the N5 and N4 domains, from the new JUPOS analysis, are presented subsequently.)

Table:

Mean speeds of currents, 2024/25							
	(DL2, deg/30d)						
Domain/Jet	**Prograde jet**		**Zonal slow current**			**Retrograding/slow spots**	
	DL2	*SD*		***DL2***	*SD*	***DL2***	*SD*
N5			N5TC	**9.0**	2.2		
N4			N4TC	**6.0**	2.3		
N3			N3TC	**-17 to -29**			
N2	**-85.0**	1.9	NNTC	-3		**11.1**	5.6
N1 (N.Temp.)	[See Report no.5]						
N.Trop.			NTropC	**-1.6**	2.0	31	
NEBs: ***DL1***	**6.5**	5.2					
SEBn: ***DL1***	**-46 to -77**	(see text)					
S.Trop.			STropC	**0.2**	4.9	**114.1**	15.2
S1 (S.Temp.)	**-45 to -70**		STC	**-16.0**	0.5	**3.7**	3.4
	-86.2	1.9					
S2	**-108.0**	9.4	SSTC	**-27.1**	1.0	**-16.1**	0.9
S3	**-96.2**	6.7	S3TC			**9.3**	1.0
S4	**-133.0**	3.3	S4TC			**9.7**	2.9

High northern domains *[expanded analysis, 2026 Feb.]*

Little was known of the regions north of 47°N until spacecraft viewed the planet and then, from around 2010 onwards, amateur imaging became able to resolve numerous features in these high latitudes. We posted a detailed pre-Juno account covering the N3 to N6 domains [ref.N1 in box below], and then full analyses for the 2020, 2021/22, and 2022/23 apparitions combining JUPOS tracking data with feature identification on JunoCam and Hubble maps [refs. in box below]. (We have similar data for 2023/24 which has still to be analysed.) Now, we have repeated this exercise for 2024/25, for the N4, N5 and N6 domains and all the way up to 75°N. All this is based on extensive measurements and analysis by G. Adamoli in the JUPOS project.

The results thoroughly confirm our previous conclusions. North of the N7 prograde jet (mean latitude 68.4°N), there is a broad belt of FFRs (folded filamentary regions), with a weakly retrograding zonal slow current as in the N5 and N4 domains, but no jets are known further north. The N6 domain, between the N6 and N7 jets, is all rapidly prograding. The N5 and N4 domains display the usual pattern, i.e. many spots drifting with a steady, slowly retrograding slow current, plus two or more AWOs with faster or oscillating drift rates that were related to latitude.

New figures are in **Appendix C**. The JUPOS charts for the N5 and N4 domains were already given in **Appendix A**, but we now add a separate chart for the North Polar Region (Fig.N16), and a labelled copy of the N4 chart (Fig.N17). The JunoCam maps of the N2 to N6 domains were already given in Figure 4, and Fig.N18 is a labelled copy. Fig.N19 is a Hubble cylindrical map (Nov.19-20). Fig.N20 contains JunoCam north polar projection maps showing some of the more interesting features, usually at close to the original image resolution. Examples of amateur north polar projection maps are in Fig.N21. In all these maps, features tracked by JUPOS are indicated in green for the N4 domain, blue for N5 domain, and magenta for N6 (and N2). The most important anticyclonic ovals (AWOs) are numbered, and some other tracked spots are labelled with our working numbers with prefix w (white) or d (dark). The zonal drift profile from all the JUPOS data is in Fig.N22.

North polar region: 'N7 domain':

The broad belt of FFRs north of the N7 jet could be termed the N7 belt, although there do not appear to be any jets north of it to confine a 'N7 domain'. Or it could simply be called the 'northernmost belt', as we defined the equivalent 'southernmost belt' in the south polar region [Ref.6].

The JUPOS chart and ZDP chart for 70-76°N (Figs.N16 & N22) show many tracks for light spots or patches with consistent retrograding speeds between 71.0 and 75.1°N, averaging DL2 = +9.4 deg/30d (±5.4; N = 17 track segments). A few other light spots had prograding speeds, between 70-71°N, on the flank of the N7 jet. All the tracked features that could be identified in JunoCam maps, both retrograding (N=10) and prograding at lower latitude (N=2), were FFRs belonging to the 'N7 belt' (e.g. Figs.N20 & N21). The only previous measurement of the mean drift rate of this belt was in our

2022/23 report [ref. in box], with mean DL2 = +4.1 due to including slightly lower latitudes; the actual speed distribution is identical (Fig.N22).

The JUPOS data put lower limits on the lifetimes of some FFRs for the first time. While many of them were not followed for long, three were tracked for 2 months, and one of these possibly for 6½ months [spot w7, moving up and down in latitude with little change in speed]. These are all minimum lifetimes as they may be limited by ground-based image resolution and by changes in shape or brightness of the FFRs, which could also be splitting or merging.

N6 domain:

This corresponds approximately to the Bland Zone as seen in JunoCam maps. Three white spots were tracked in it, with rapidly prograding speeds (Fig.N16):

w1: DL2 = -74.0 for 5 weeks, at 64.9°N; the HST map (Fig.N19) shows it as a small bright white spot, probably an AWO.
w2: DL2 = -52.8 for 6 weeks, at 66.0°N; then decelerated to -42.5 before possibly accelerating. PJ68 images showed it as a small AWO (Fig.N20).
w3: DL2 = -44 (for 14 d), at 66.7°N, then accelerated, perhaps to ~-86 or even faster for several days. PJ66 images showed it as a bright cyclone, despite its high latitude (Fig.N20).
Omitting the fastest speeds but including two dark spots, these give a mean DL2 = -42.3 (±8.7; N=5) at 66.2 (±0.4) °N.

N5 domain:

AWO-1 is a large oval that has probably existed since 2016 or earlier [Ref.N6 in Box below]. (JunoCam maps have been essential for tracking it during solar conjunctions because of its huge variations in drift rate.) Throughout this apparition it had an oscillating track with a somewhat irregular period around 2.4 months (for 3 cycles). Its drift rate varied from DL2 = +4 to -40 and even ~-52. It was viewed by JunoCam at PJ65, PJ66, and PJ72 (Fig.N20, & Figure 5B).

There was a second large AWO (labelled N5-AWO-2), although its full track only became apparent when including JUPOS data from >64°N plus measurements on JunoCam maps (PJ67-PJ70) (Fig.N20). Its speed varied drastically from DL2 = -58 (Aug-Oct.) to +9 (Feb-Apr.).

Other white features tracked by JUPOS had typical retrograding drifts. One was a small AWO (w2, viewed at PJ66 & PJ67). Only one was identified as a compact FFR (w9, viewed at PJ69).

There were many other retrograding spots, mostly dark. Several were located in JunoCam maps but were mostly undistiguished small dark spots. Two appeared as substantial dark-rimmed ovals, but d9 was anticyclonic (PJ64), whereas d2 was cyclonic (PJ69 & PJ70: an example of a 'mini-barge' with some overlying white cloud).

From 59.0 to 62.0°N, mean DL2 = +10.3 (±4.1; N = 33), representing the zonal slow current (N5TC). The ZDP is typical (Fig.N22), identical to that in 2022/23, including a small offset from the Cassini ZWP.

N4 domain:

There were four AWOs, initially widely separated (e.g. Figs.N17 & N20), which converged as two remarkably synchronised pairs which merged in late Jan. (see Figure 6). The f. member of each pair was a northerly AWO oscillating (with very irregular period of ~1-2 months) about a prograding mean track (DL2 ≈ -22 for AWO-1, -14 for AWO-4). Around Jan.25-28, each merged with the p. member of its pair which was further south with a retrograding track (DL2 = +9 --> +4 for AWO-3, and +11 for AWO-2), then the merged oval continued on the northerly track (DL2 = -21 to -26).

When identified in JunoCam or Hubble maps, most of the other white spots were also AWOs, medium-sized (w5) or small (w6, w9, w17, w24). AWOs w5 and w6 both passed AWO-1, which was further north, without change of speed. The passage of w5 is shown in the Hubble map (Fig.N19). Only two identified white spots were FFRs: w2 (PJ55 & PJ66) and w37 (PJ69).

Almost all other features in the domain were retrograding spots, both dark and light (Figs.N17 & N22); from 49.5 to 53.0°N, mean DL2 = +6.5 (±3.1; N = 51, omitting one outlier), constituting the zonal slow current (N4TC). These included some of the small AWOs. The other AWOs, at >53°N, all lay on a smooth ZDP close to the spacecraft ZWP.

This table summarises the principal measurements of these zonal slow currents:

Drift rates for zonal slow currents in the high northern domains					
	Mean DL2 (deg/30d)	*+/- SD*	*Lat.(°Ng)*	*Mean DL2 (deg/30d)*	*+/- SD*
	N7 domain		range	**N6 domain**	
from our apparition reports:					
2022/23	4.1	8.7	70.5 to 75.0		
2024/25 (this report)	9.4	5.4	71.0 to 75.0	-42.3	8.7
	N5 domain			**N4 domain**	
from Rogers (1995) book:					
Historical (1900-1991)				1.4	2.8
from our long-term report:					
Our reports (2000-2016)	12	3		5.5	1
JUPOS (to 2016)	13	4		6	3
from our apparition reports:					
2020	12.3	6.9	59.0 to 61.9	7.2	3.2
2021/22	11.8	5.4	59.1 to 61.9	6.5	3.3
2022/23	10.9	2.5	59.0 to 62.0	6.7	4.6
2023/24	*tbd*			*tbd*	
2024/25 (this report)	10.3	4.1	59.0 to 62.0	6.5	3.1

JUPOS values refer to the features with consistent slow drifts in a limited latitude range in the centre of the domain.
Further north there are white spots (esp. AWOs) with a wide range of faster drifts on a latitude-speed gradient.

References to our previous reports on the high northern domains *[all posted on this web site]*

N1. Rogers J, Adamoli G, Jacquesson M, Vedovato M, & Mettig H-J (2017), **'Jupiter's high northern latitudes: patterns and dynamics of the N3 to N6 domains.'** https://britastro.org/node/11328

N2. Rogers J & Adamoli G, BAA Jupiter Section Report: **2020 no.9, "Final numerical report: Northern hemisphere".**

N3. Rogers J & Adamoli G, BAA Jupiter Section Report: **2021/22 no.9, "N4 to N6 domains"** [inc. JunoCam maps PJ33-PJ39].

N4. Rogers J, Adamoli G & Bullen R, BAA Jupiter Section Report: **2022/23 no.6, "Final report on the high northern latitudes"** [inc. JunoCam maps PJ41-PJ46].

N5. Rogers J, Adamoli G, Hansen C, Eichstaedt G, Orton G, Momary T, Jacquesson M, Bullen R, & Mettig H-J (2022). **'Jupiter's high-latitude northern domains: Dynamics from Earth-based and JunoCam imaging.'** EPSC Abstracts Vol. 16, EPSC2022-16. https://doi.org/10.5194/epsc2022-16

N6. Rogers J (2024/2026), BAA Jupiter Section: **'Tracking the large AWO in the N5 domain, 2025-2023'.** [Recently posted as 2022/23 Report no.9] https://britastro.org/section_information_/jupiter-section-overview/long-term-reports-publications/jupiters-long-lived-n5-oval

N3 domain:

Many dark and bright spots were tracked for several months each. They had typical prograding N3TC speeds from DL2 = -17 to -29, with a few even faster (DL2 = -36, -39, -47). We have not done a full analysis for this narrow domain.

N2 domain

Anticyclonic ovals:

There were just two large ovals, both almost fixed in L3 for most of the apparition:

NN-WS-4: A bright white oval throughout. Initially it had DL2 = +4 (July-Sep.), then -10.5 (Oct-Apr., with fluctuations). JunoCam imaged it at PJ65 and PJ66.

NN-LRS-1: Dull brown (rather than orange) due to the colour of its internal oval. DL2 = -10 (July-Nov.), then variable, slower speeds (Dec-Jan.), then -10 again (Feb-Apr.). It is shown in Figures B2-B6 (Appendix B), and JunoCam imaged it well at PJ63 and PJ70.

NNTB:

There was just one prominent dark segment of NNTB, present since 2024 August, with DL2 = -3 (Aug-Dec.). It was dark brown with rounded ends so could also be called a long 'barge'.

Maps in Oct-Nov. (Figure 7) show it 'fading' as cream-coloured cloud accumulates within it – a process that has been suggested by spacecraft images of such segments or barges in the NNTB and other belts, and in this case is continued in the JunoCam maps at PJ67 and PJ68 (Figure 4). This barge recovered in Dec., but then the pale clouds returned, and then it was disrupted in late Jan. by turbulence spreading north from the wake of the NTBs jet outbreak: well shown in Juno's PJ69 map (2025 Jan.28/29), where it appears to connect to a new FFR. Thereafter the outline of the dark segment was indistinct (although still recognisable). Indeed, everything in the NNTB latitudes appeared rather ragged in March-April.

The JUPOS chart shows many retrograding dark spots in the N2 domain: mean DL2 = +11.1 (±5.6; N = 10).

NNTBs jet:

There are usually dark spots (vortices) on the NNTBs (N2) prograde jet, but they tend to disappear during NTBs jet outbreaks. Up to late Jan., the JUPOS chart showed these spots at all longitudes, with DL2 = -85.0 (±1.9; N=11), with fewer thereafter. However, most of them were small and inconspicuous, and their reduction from early Feb. onwards could be due to decreased image resolution. On the other hand, JunoCam's images at PJ72 (2025 May 7; Figure 5D) showed intricate turbulence across the NTZ from the NTBs jet outbreak which suggests how these outbreaks can suppress the stable vortices on the NNTBs jet.

North Temperate domain

Our full account of the NTBs jet outbreak, up to mid-March, is in Report no.5. It can be seen in the maps in Figure 3, and Figure 13 includes the development of the third plume (no.5).

The great NTBs plumes had disappeared at the end of Feb., and this marked the transition to the next phase of the upheaval, in which the now-merged wakes of the plumes evolved into the reviving NTB. In mid-March, the reviving NTB(S) was starting to redden at some longitudes, and this continued to give an orange-tinted belt, with a narrow grey NTB(N) also present at some longitudes.

In methane-band images, the whole NTB had remained dark before and after the outbreak (as is usual since the haze distribution appears to be affected more by the zonal winds than by the underlying meteorology)[see Report no.5 for methane-band images during the outbreak]. But close examination shows that the latitude of the orange-tinted NTB(S) was actually light, implying that there was high-level haze or cloud here (Figures 3 (April 4-6) & 8).

However, one sector did not redden and faded considerably (L1 ~ 90-220 on March 28).

The 'reddish blob' on NTBs/NTropZ, 2025 March-May:

Marking the f. end of the reddish (brown) sector, an 'orange blob' developed in mid-March, on the NTBs edge at 24ºN. It was weakly methane-bright, esp. when near the limb (Figures 8 & B6) and it gradually became a darker brown. In ground-based images it always appeared diffuse or featureless, but JunoCam closeups at PJ72 (2025 May 7; Figure 5D) showed it to be clearly anticyclonic, and further south than before, at 22.8ºN. Its drift varied between DL1 = -28 and -11 deg/30d, with mean DL1 = -21 deg/30d. JUPOS measurements and analysis by G. Adamoli give the following mean values, followed by slower drift from the last amateur value up to PJ72.

Dates 2025	*DL1 (deg/30d)*	*Lat. (ºNg)*	*Lat. (ºNc)*	*Source*
March 14-30	-25.3	24.1	21.4	G.A.
April 2-8	-11.2	23.7	21.1	G.A.
April 11-25	-22.4	24.1	21.4	G.A.
April 28-May 7	*(+10)*	*22.8*	*20.2*	*JunoCam*

Thus the 'blob' was dynamically the same as the wave-like dark patches in the wake earlier (weakly anticyclonic ovals, in the latitude of the jet peak but with much slower drift); but then it moved south along an anticyclonic gradient towards the general zonal wind profile in the NTropZ, when it was imaged at PJ72 (May 7).

Similar 'reddish blobs' were recorded on orange NTBs in three previous cycles:
(i) in 1964-65 (alongside the first appearance of the orange NTB(S) in modern times, although no outbreak of super-fast spots was detected): mean DL1 = -53, 24.2ºN [ref. 1];
& after recent super-fast outbreaks:
(ii) in 2012: DL1 ≈ -30 (late July) to +23 (early Aug., further S) [ref. 2];
(iii) in 2020: One with DL1 = +39 (Oct.31—Nov.12). JunoCam PJ30 closeups showed it as an anticyclonic vortex like the present one, but even further south at 21.8ºN. Three others had DL1 ≈ +18; at least one was methane-bright, & it was seen forming as a methane-bright eddy in the NEBn wave pattern [ref. 3].

N. Tropical domain

N. Tropical Zone (NTropZ)

In March, the broad dark wake of the NTBs upheaval occupied virtually the whole NTropZ, only being separated from the expanded NEBn edge by a narrow strip at 20-22ºN. This strip ranged in colour from light ochre to bright white, and was still very disturbed by NTBs streaks interacting with the NEBn, especially with the AWOs. The expanded NEBn edge was becoming ragged in some sectors, possibly due to lighter clouds invading it from the disturbed NTropZ.

N. Equatorial Belt (NEB)

Following the 2023 NEB expansion event, a fine array of cyclonic brown ovals and anticyclonic white ovals ('barges & portholes') developed around the planet (Figures 1-3). JunoCam obtained some good images of them: see maps in Figure 9 & closeups in Fig.5(A&D).

Anticyclonic ovals: Six were already present at the start of the apparition in 2025 June (already described in report no.2): WS-6, WS-Z (long-lived, but no longer the brightest nor fastest), WS-1 (formerly a dark oval, now just grey), WS-E & C (which merged around 2024 Sep.1), WS-B, and ADS-5 (a dark grey oval which became white in Sep., but disappeared in Nov.). The 2025 NTBs jet outbreak did not cause general darkening of the pre-existing AWOs (unlike some previous instances) but WS-1 and large parts of WS-Z remained dull grey. One conspicuous new AWO, called WS-7, appeared in August, so there were again six prominent ones. Two smaller ones also appeared in Oct., both unnumbered: one disappeared in Feb., while the other remains shortly p. WS-6. Another new small one arose in 2025 Jan. and is shown in the PJ72 image in Figure 5D. All the AWOs were still affected by white streaks intruding from the disturbed NTropZ, maximally in late March, and probably still in April.

The JUPOS charts show that the six numbered AWOs had fairly steady drifts; the steadiest was WS-Z, with DL2 = -2.9 (June-Nov.) then -2.3 (Nov.-April). Taking the most stable segments of their tracks over several months, their mean DL2 = -1.6 (±2.0; N=8 track segments).

Cyclonic barges: None were present until mid-July, when one appeared, very small, just f. WS-Z. It gradually became very dark and reddish. Four more appeared during Sep., initially inconspicuous but becoming darker in Oct. – although all the barges remained quite small. In 2025 Jan., several even smaller ones appeared.

The development of the barges did not seem to be generally related to the passage of 'rifts' in the NEB, although the appearance of a pair of tiny barges around Jan.10-15 at L3 ~ 12 was suggestive; they could have arisen as eddies in the wake of a small rift. Closer study of the images might be worthwhile to investigate this question more thoroughly, and to enquire whether the variable drifts of barges were affected by passing rifts (see below).

The barges mostly had drifts in the same range as the AWOs. The five that appeared first, and so were tracked for longest, tended to alternate between stable drifts in the range DL2 = +3 to -2 (mean +0.5) and slightly faster, more variable drifts up to -5 (or -16 in one case). Omitting that outlier, their mean drifts were DL2 = -1.2 (±2.3; N=7 track segments).

The JUPOS chart also shows one white spot in Oct. running past WS-E with DL2 = +31, i.e. in the NEBn retrograde jet.

NEB Rifts:

Rifts were not very active nor prominent in this apparition, but some were observed throughout. There was a modestly disturbed sector of NEB ~50-120° long, from late June until Dec. There were also several small bright spots in the NEB that gradually expanded into oblique rifts: one lasted from June 29 until Sep., and others appeared at various longitudes in August and later, though they were not long-lived. There was only a little rifting in 2025.

Equatorial Region

There was much dark material in the EZ. NEBs dark formations (NEDFs) and festoons were conspicuous, and there was a broad, grey-brown or 'warm grey' Equatorial Band at all longitudes, indicating that a coloration event was again in progress, similar to 2006-07.

NEBs edge

Many of the NEDFs were large and dark, with long festoons, though they sometimes had reduced contrast against the surrounding grey-brown shading. Some also had very bright white plumes at their f. edges. The NEDFs seemed to be quite variable, and the JUPOS chart only recorded piecemeal tracks: J.R. has annotated it conservatively (using shading or bars to indicate extended dark features) [v2]. But the JUPOS chart did not record them when they had irregular or diffuse forms, whereas Mizumoto's maps (made in L1 at intervals of 1-3 days) showed that most NEDFs were actually persistent, although sometimes varying greatly in appearance. From a quick preliminary study of those maps, J.R. has added shading to the JUPOS chart [v3] to indicate when NEDFs continued to exist. This shows that most of them actually lasted for many months. Actually there were 10 NEDFs which persisted from July to Sep., and 9 throughout Feb-Mar. (and mostly through April as well, though not plotted on this JUPOS chart). At least two of these persisted throughout the apparition, and although there were intervals when some of the others were not clearly recorded, they usually reappeared on their previous track within a month. This is consistent with their wave nature; the waves may become invisible or disrupted but tend to reappear.

Drift rates for the main NEDFs, over intervals of 2-3 months, ranged from DL1 ≈ -2.0 to +13.5: mean DL1 = +6.5 (±5.2; N= 13 track segments).

The JUPOS chart also shows many retrograding minor spots, but this is because we needed to extend the latitude coverage down to 9 or 10°N to capture the whole of the NEDFs, beyond the 7°N that we often use. So the retrograding tracks are probably normal features according to the zonal wind profile. More interesting are two bright plumes involved with large NEDFs in Jan., with prograding tracks (L1 ~ 100, DL1 = -18; L1 ~ 340, DL1 = -14).

SEBn edge with S. Equatorial Disturbance (SED)

The main complex of the SED (see Reports nos.1 & 2) is still present although it has sometimes been difficult to see. The JUPOS chart is useful in showing it as a slow-moving gap in the chain of SEBn spots (chevrons), along with a dark streak in the SEB(N), and Mizumoto's maps are useful in tracking it morphologically. It was conspicuous up to Dec.17-24, when it was at L1 ~ 100 with DL1 = +1.0 deg/day, passing the mid-SEB outbreak (Fig.10A). Thereafter it became more variable and often subdued, esp. difficult to identify from Jan.25 to Feb.11 as it approached and passed (Jan.28) the GRS. It tended to appear as a bright white oval without obvious rift, as on March 21-24 (L1 ~ 180, passing GRS) and April 2 (L1 ~ 200), though not thereafter. On April 11 it had its classic form again (L1 = 212), and it retained this over the following weeks. It was then distinguished by a particularly bluish patch, which was very dark in methane-band and IR-continuum images, up to the final images in late May – the same appearance that would be notable in the next apparition.

The speed of the SEBn jet spots (chevrons) reproduced the longitudinal gradient shown by the SED in previous decades: comparatively slow just p. the SED (and at slightly higher latitude, shown on the chart from lats.6-9°S), and faster further p. (shown on the chart from 5-8°S). Many spots could be seen accelerating individually. Mean speeds were:

Just p. SED:	DL1 = -45.7 (±6.6; N=10)
Further p:	DL1 = -61.1 (±7.1; N=11)
F. SED (till Dec. only):	DL1 = -77.0 (±2.8; N=7)

S. Tropical domain (SEB, GRS, STropZ)

The domain had its usual appearance, with a perennial region of convective disturbances just f. the GRS. In the sector f. this, several new dark streaks formed and evolved into two prominent red-brown barges, with DL2 = +3.5 and -2 deg/30d. The remainder of the belt was largely quiet until the mid-SEB outbreak erupted.

Mid-SEB outbreak

These are spectacular convective disturbances which only appear infrequently; this was the first for 8 years. Its first few days were covered in Report no.2. The first bright white spot appeared on 2024 Nov. 10/11, at the p. end of a diffuse bright area that had been tracked since the previous apparition as a cyclonic oval (a "white barge"); so this confirmed that such outbreaks typically appear within a cyclonic circulation.

Shinji Mizumoto posted daily maps of the outbreak on the ALPO-Japan web site [https://alpo-j.sakura.ne.jp/Latest/j_Cylindrical_Maps/j_Cylindrical_Maps.htm], which provide a complete view of the progress of the outbreak, as well as an animation. A subset of these maps is in Figure 10A and his chart of the white spots (convective plumes) is in Figure 10B. He tracked 6 individual plumes erupting from the f. end up to Dec.30. The first four came from a locus with DL2 = +0.5 deg/30d, so the source was nearly fixed in L2, as usual, although later it was more fixed in L3 for the last two plumes. Also, one plume erupted at the p. end on Dec.25. Some other, less conspicuous plumes also appeared at these two ends of the growing disturbance, but after Jan.17 the outbreaks at the f. end ceased, and the whole disturbance prograded, being ~55-75° long. It remained active internally, and in March its p. end prograded more rapidly, so by April 3 it spanned ~95° longitude. Around the end of April it contacted the perennial post-GRS disturbance, though still separated from it by an oblique dark band.

Sets of images of the outbreak are in Appendix B: Figure B1 is a set up to Jan., all from the UK, and Figures B2-B6 show some of the best images of it from Jan. (when it was notably beautiful with coloured fringes to the bright white plumes) through to April.

The prograding drifts of the white plumes are listed in Figure 10B; mean DL2 = -32.2 (±13.2; N=6).

Unusually, the JUPOS chart shows that the source quickly separated from the cyclonic circulation in which it arose, which re-formed as a dark barge within about a month, and turned reddish (Fig.10A). The white barge had DL2 = -2 in June-Aug. then DL2 = +5 (mid-Sep to early Nov., before the outbreak) (see JUPOS chart), then the re-formed dark barge had DL2 = +4 (late Nov. to late Feb.). With the source in Nov. being essentially fixed in L2, it seems that the self-sustaining convective disturbance was able to separate from the stable cyclonic circulation. It could not be recognised in the early weeks of the disturbance because irregular white streamers from the plumes were extending along this region, but in early Dec. the maps suggest that they were recirculating around a fixed dark grey streak – which was methane-dark like a cyclonic oval, in contrast to the methane-bright streamers from the plumes – and gradually stabilised as the disturbance around it diminished, so by late Jan. it was a prominent red-brown barge, which has persisted.

SEBs jet

There were variable numbers of retrograding rings on the SEBs jet. They were tracked individually by Mizumoto and his chart is in Figure 11. Numbers 1 to 19 reached the GRS between 2024 July 23 and 2025 Feb.15, an average rate of one every 11.5 days. The JUPOS chart shows them being generated over a long distance f. the post-GRS SEB disturbance. Most had DL2 between +113 and +129: mean = +122.4 (±5.8; N=11 track segments). If 4 track segments with DL2 between +86 and +95 are also included, mean = +114.1 (±15.2; N=15 track segments)

The most substantial one with full speed was a large ring that arose in mid-Sep. and reached the Red Spot Hollow (RSH) around Nov.10 [Mizumoto no.10]. There was little sign of it within the RSH, but it may be significant that a long-lived dark spot appeared f. the GRS on almost the same track on Nov.19; this reached the RSH again on Feb.17-18 [Mizumoto no.19] (Figure 13) after circum-navigating the planet, including passing the mid-SEB outbreak. But this was the last one with full retrograding speed, apart from two inconspicuous spots. Volleys of SEBs dark spots arose in the sector f. the post-GRS disturbance in early Oct. and in late Jan., but had lesser retrograding speeds DL2 ≈ +73 to +43.

GRS

The GRS remained very small, with a length of only 11.2º (Mizomoto) or 11.5º (JUPOS) throughout this apparition. After an unexplained one-off shift of -4º long. during solar conjunction, its average drift was steady at DL2 = -1.75 (±0.05) deg/30d (Figure 12).

One example of a red flake from the GRS is shown in Figure 13. Its origin is unclear: although two SEBs jet spots had recently entered the RSH and very dark grey material was spreading around the GRS, there was little red nor methane-bright material before the flake appeared at the p. end of the GRS on Feb.8-11. Then it circulated around the GRS, appearing at the f. end on Feb.14, at the p. end again on Feb.16-17, then at both ends on Feb.19.

STropZ

The JUPOS chart tracked a variety of small dark spots in the STropZ, as follows:
--A series of minor spots/streaks in the waning STropB p. the GRS, July-Dec., 24-26°S: DL2 range from -52 to -82: mean = -66 (±13: N=6).
--Two more prograding spots in March-April, ~26°S: DL2 = (i) -78 --> -65; (ii) -74.
--A prominent dark grey spot in June-Sep.(oscillating with mean DL2 = -12) then Oct-Nov. (DL2 = -9, almost fixed at L3 = 46); ~23°S.
--A retrograding, elongated dark grey spot in Feb-Apr., ~22-23°S; DL2 ~ +14. Weakly reddish and methane-bright on April 9 (C. Pellier images).

S. Temperate (S1) domain

Our comprehensive report on this domain from 2018 to 2024 was posted in 2025 Dec.[ref.4]. This only extended to the 2023/24 apparition. Since then the domain has not changed much.

STBn jet

There were many dark spots on the STBn jet, mostly prograding from the p. end of STB Segment G, as in other recent apparitions.
In Aug-Sep., they were accelerating from an initial DL2 = -48 (±2) to ill-defined faster speeds as they approached Spot 8; they did not pass it. In Oct-Nov., they emerged p. Segment G with DL2 ranging from ~-45 to -70, and approached the GRS, but did not pass it. In 2025 Jan., as the p. end of Segment G was passing the GRS, these spots did travel p. the GRS, getting as far as Spot 8. But the activity declined rapidly in late Jan. and was only sporadic thereafter. The few spots measured in Jan-Mar. had DL2 ranging from -47 to -84.
There were also several spots tracked alongside Segment G, in Sep-Oct., but these had lower latitude and faster speed (DL2 ~ -82) and probably came from Segment A past oval BA.

Some groups of spots were also recorded alongside Segment A. They had consistently rapid speed, mean DL2 = -86.2 (±1.9; N=13).

STB & STZ

There is still one large anticyclonic oval, called BA, and dark STB spanning all but ~150° of longitude. In order of increasing longitude, the features are:
-- A largely whitish sector, except for the dark STBn jet spots prograding from STB Segment G as described above, and travelling as far as the GRS (up to Dec.) or Spot 8 (2025 Jan. onwards).
--STB Segment G (evolved from Clyde's Spot that appeared in 2020), now 67-->74º long. The turbulence in this dark sector has become largely confined to its central region.
--Short gap between Segment G and BA, marked by small dark spots retrograding Sf. Segment A.
--Oval BA, which has moderately weak orange colour (in an internal annulus as usual) throughout the apparition. Some hi-res images are in Figure 14.
--STB Segment A. Now 120º long, and internally differentiated. There is a turbulent sector (FFR) immediately f. BA, and the f. part of Segment A is split by at least one red 'mini-barge' (actually three successively, almost stationary in L3), then a paler streak near the f. end which evolved from reddish to cream-coloured. This f. part is shown in Figures B1-B6 (Appendix B).
--A largely whitish sector except for retrograding dark spots in the STZ which constitute the 'Sf. tail' of Segment A. Drift rates are listed below; they did not repeat the unusual speeds recorded in 2023/24.
--Spot 8, a white cyclonic circulation in an oblique, pale bluish-grey sheath, with a similar but smaller cyclone ~20° p. it. The pair have persisted like this since early 2023. Both are dark in methane-band images. Some hi-res images are in Figure 14.

The drift rates of major features were as follows:

Table:

Drift rates of long-lived features			
	<u>*Start*</u>	<u>*End*</u>	<u>*DL2*</u>
Across conjunction:			<u>*(deg/30d)*</u>
Oval BA	2024 Jan.	2024 July	-18.3
F.end Seg.A	2024 Feb.	2024 July	-15.5
Spot 8	2024 Feb.	2024 July	-15.7
P.end Seg.G (~)	2024 Jan.	2024 Aug.	-15.8
F.end Seg.G	2024 Jan.	2024 Sep.	-15.8
2024/25 apparition:			
P.end Seg.G	2024 Nov.	2025 Apr.	-16.4
Oval BA	2024 Sep.	2025 Apr.	-16.4
F.end Seg.A	2024 Sep.	2025 Apr.	-15.8
Spot 8	2024 July	2025 May	-15.3

STZ: There were many slow-moving dark spots forming the 'Sf. tail' of Segment A, with mean DL2 = +3.7 (±3.4; N=7). There were also such spots Sf. Segment G (p. BA), although they only had very short tracks in this short space, with mean DL2 ≈ -1 (±2; N=4).

SSTBn (S2) jet

A row of small dark spots on the SSTBn jet arose in 2024 Oct. at L3 ~ 260-310, i.e. alongside STB Segment G. The line expanded with several more appearing as they prograded with DL2 ranging from -93 to -116; mean DL2 = -108 (±9; N=6). They persisted until Jan-Feb. when some had already moved alongside STB Segment A and decelerated.

This jet was covered in our long-term S2 domain report up to 2023 [ref.5]; notably, from 2005 onwards it was consistently faster than before (in contrast to the S3 jet). It only a few spots on it from

2013-2023. But subsequently, in late 2023, we recorded many SSTBn jet spots with a well-defined ZDP [shown as Fig.27 of ref.4], and a mean peak speed was DL2 = -123.4 (±8.9; N=19), with individual tracks ranging up to DL2 = -136. Our new value for 2024/25 is not as fast but still consistent with the post-2004 acceleration of this jet.

S2 (S.S. Temperate) domain

This domain was, as usual, dominated by the 7 long-lived AWOs (A1 to A8, with no A6). Their drift rates were diverse up to Sep. but then averaged DL2 = -27.1 (1.0; N=7) from Sep. to April, defining the SSTC – after omitting the accelerated motion of A8 from Feb. to April which had DL2 = -34.5.

The cyclonic formations between the AWOs included the following (shown partially, but not completely, on the JUPOS chart):

A8-A7 and A7-A5: Each sector contained a very dark segment, Aug.-Nov., which broke up in Nov. Thereafter some maps show a FFR but others just a dark region.
A5-A4: This was an off-white oblong in Aug-Sep., which then darkened, but regained its whiteness in late Feb.
A4-A3: This contained a small white or off-white oval throughout.
A3-A2: A small FFR in Aug-Sep., later rather dark.
A2-A1: A white oblong throughout (apart from Dec. when it was off-white or irregular).
p. A1: A FFR was sometimes resolved here; otherwise dull.
f. A8: Initially a long off-white strip with dark spots on S side, then a better-defined off-white oblong, becoming brighter white in 2025.

Following A8 and A1, in Aug-Oct., there were some slow-moving dark spots in the SSTZ; mean DL2 = -16.1 (±0.9; N=4). Those f. A8 ended at a more stable spot (marked Spot A on the JUPOS chart) which was a larger dark spot in July-Aug., then a ring in Sep., and a tiny bright white spot from Nov. to March. This must be a tiny anticyclonic spot, entirely similar to those which sometimes develop at the f.end of 'Sf. tails' in the S1 domain.

S3 jet

Many spots were recorded in the S3 prograding jet, from August to March, mostly arising near S2-AWO A2, and disappearing precisely at A8, without deceleration. Most of them were dark, and perhaps all of them if the many light spots recorded p. A1 were actually gaps between dark spots. (Only a few were recorded alongside the main array of S2-AWOs.) Mean DL2 = -96.2 (±6.7; N=19).

Previous records of this jet, up to 2022/23, were described in ref.5. Our ground-based speeds for it from 2012-2022 were very consistent, with means from DL2 = -94 to -103, usually about -98. Our result for 2024/25 is very much the same.

High southern domains

S3 domain

Three AWOs were tracked, all small, with wildly varying speeds:
(1) DL2 = +10 (Aug-Oct.) then rapidly switched to -61 (Oct-Feb., slightly varying).
(2) Alternating between fast & slow; the slowest and longest segment had DL2 = +5 (Sep-Nov.). It merged with no.1 on Dec.27 (image by P. Casquinha).
(3) Irregular motion at first; DL2 = -44 (av., Oct.& Nov.), then +2 (av., Dec.&Jan.).

There were also some slow-moving dark spots, mean DL2 = +9.3 (±1.0; N-6).

S4 jet

This jet displayed two rarely detected features, which we also reported in 2022/23 (see our 2023 Report no.8 for a detailed account and discussion), and have also identified on the JUPOS chart for 2023/24 (not previously reported):

(1) Spot(s) travelling close to the peak speed of the jet;

(2) A wave-train on the jet. This consists of a series of undulations in the boundary of the dark south polar region at ~52°S, with a phase speed of DL2 = -24 (±3); but individual tracks are short and the

disturbance as a whole moves with a group speed of DL2 = -93 (±3). We had also detected a wavetrain with virtually identical parameters in 2016. This wave-train is shown in Figure 15.

Mean values for the drift rates are given in this table:

Parameters of spots and waves in S4 jet							
Dark spot(s)		*N*	*DL2*	(deg/30d)			
2022 June-July		1	-118				
2023 (late)		1	-136	oscillating			
2024 Sep-Dec.		5	-133	+/-3			
Wave-train:		*Wavelength*		*Phase vel.(DL2)*		*Group vel.(DL2)*	
		(deg)	+/-	(deg/30d)	+/-	(deg/30d)	+/-
2016		15		-27	7	-112 or -94	approx
2022		14	1.5	-27	4	-96	approx
2023	Aug-Sep.	15		-24	2		
2024/25	Oct.&Jan.	14	1	-24	3	-93	3

S4 domain

There were two major anticyclonic ovals, both well tracked (see JUPOS chart):

--S4-LRS-1, clearly reddish for most of the apparition. Its speed alternated between fast and slow segments (DL2 ≈ -33 and -2), with one 4-month slow segment with DL2 = +3.5 (mean, Sep-Jan.). It has probably existed since at least 1994 (our data) or 1987 (other authors) or even earlier.

--S4-AWO-2 had intermediate speeds between ~-20 and -4.

An even smaller AWO was noticed in Oct., and merged with S4-LRS-1 on Oct.18-20 (Figures 15 & 5C).

There were also many slow-moving dark spots all around the domain, with mean DL2 = +9.7 (±2.9; N=11).

S5 domain & S6 belt

JUPOS measurers particularly recorded many high-latitude white spots in October. Some of these were prograding between latitudes 63-66°S, i.e. in the S5 domain. Three had DL2 from -32 to -36, one -47, and three from -55 to -62.

Three others were retrograding, between latitudes 70-72°S; the best-tracked had DL2 = +8.0 (Aug-Oct.), the others about +1 and +14. These may have been either FFRs or AWOs in the southernmost ('S6') belt. According to our published analysis up to 2021 [ref.6], which combined JUPOS and JunoCam measurements, this belt has mean DL2 ≈ +16 (±2) deg/30d, and we will extend this comparison up to the present in a future report.

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Figures

Figure 1A. Map, 2024 Aug.20-21.

Figure 1B. Map, 2024 Oct.19-20.

Figure 2. Maps, 2024 Dec.28-29, in RGB (top) and CH4 (bottom).

Figure 3. Maps in 2025 Jan. to April.

Figure 4. JunoCam cylindrical maps of northern domains, PJ61 to PJ73.

Figure 5. JunoCam images of anticyclonic ovals at PJ66 (A-C) and PJ72 (D), at full resolution, from our PJ66 and PJ72 reports. (A) PJ66 (2024 Oct.22): NEBn WS-E (L3 = 192), with a smaller one; the latter is about one month old, and beginning to swing round WS-E prior to partially merging with it (see BAA 2024/25 Report no.2 & https://alpo-j.sakura.ne.jp/kk24/j241031r.htm).
(B) The long-lived N5-AWO (L3 = 201). (C) S4-LRS-1 (L3 = 338), which had interacted and probably merged with a newer, smaller AWO a few days earlier and is still somewhat distorted.
(D) PJ72 (2025 May 7): The reviving NTB with orange NTB(S) and turbulent NTB(N)/NTZ, and the reddish blob in the NTropZ; and the broadened NEB with a new AWO a few months old. (See our PJ72 report for wider views.)

Figure 6. Images in 2025 Jan. showing two mergers between pairs of AWOs in the N4 domain.

Figure 7. Excerpts from maps in 2024 Oct-Nov. showing a NNTB 'barge' becoming masked by cream-coloured clouds.

Figure 8. Images in 2025 March & April showing the NTBs/NTropZ 'reddish blob' (white arrow).

Figure 9. JunoCam cylindrical maps of the N. Tropical domain, PJ61 to PJ72.

Figure 10A. Subset of S. Mizumoto's daily maps of the mid-SEB outbreak, including several in CH4.

Figure 10B. S. Mizumoto's chart of the white spots in the mid-SEB outbreak, in L3.

Figure 11. S. Mizumoto's chart of the GRS region, particularly dark spots and rings retrograding in the SEBs jet; plotted in L2.

Figure 12. Charts of the GRS longitude, (a) by the JUPOS team, in a system moving at +1.78 deg/30d in L2; (b) by Shinji Mizumoto of the ALPO-Japan, in a system moving at +1.71 deg/30d in L2. The usual 90-day oscillation is obvious, and the acceleration during the latest solar conjunction. Mizumoto also pays careful attention to the intermittent phenomena of the 'Hook' (dark band from the SEB around the f. and S sides of the GRS, which appears at intervals of 1-2 years, and generates a S. Tropical Band at the p. side) and the 'Chimney' (bright white rift in the rim of the Red Spot Hollow, which appears in synchrony with the 90-day oscillation). (c) Length of the GRS, by S. Mizumoto.

Figure 13. Images showing a red, methane-bright 'flake' at the edge of the GRS, 2025 Feb. The third principal NTBs plume (numbered no.5) is also indicated.

Figure 14. Images of STB Spot 8 and Oval BA in 2024 Nov-Dec.

Figure 15. Excerpts from maps by S. Mizumoto, showing S4-LRS-1 interacting with a small AWO. The wave-train on the S4 jet, on the edge of the dark polar region, is also shown.

Appendix C: New figures:

Figure N16: JUPOS chart for the N6 domain and North Polar Region including the northernmost belt. (The existing N5 chart included these features but here they are shown separately.)

Figure N17: JUPOS chart for the N4 domain (as in **Appendix A** but with principal AWOs labelled).

Figure N18: JunoCam cylindrical maps of the northern domains (as in Fig.4 but identifying features tracked by JUPOS).

Figure N19: Hubble Space Telescope map on 2024 Nov.19-20, labelled. The map is from the OPAL project (A.A. Simon, M.H. Wong & G.S. Orton): https://archive.stsci.edu/hlsp/opal/
Acknowledgement: "This work used data acquired from the NASA/ESA HST Space Telescope, associated with OPAL program (PI: Simon, GO13937), and archived by the Space Telescope Science Institute, which is operated by the Association of Universities for Research in Astronomy, Inc., under NASA contract NAS 5-26555. All maps are available at http://dx.doi.org/10.17909/T9G593."

Figure N20: JunoCam north polar projection maps; features tracked by JUPOS are indicated. White arrows indicate tracked FFRs in the northernmost ('N7') belt.

Figure N21: Examples of north polar projection maps from amateur images in 2024 Oct. AWOs tracked by JUPOS are labelled (green for N4, blue for N5). White arrows indicate examples of FFRs in the 'N7 belt' which can be identified on both maps, though not necessarily tracked.

Figure N22: The overall ZDP from the JUPOS measurements in 2024/25. (Open symbols are uncertain.) This is plotted on the same scale as in our 2022/23 report [ref. in box], for comparison; they are identical, including slight offset in latitude on N side of N5 domain relative to Cassini ZWP.