Jupiter in 2022/23, Report no.6:
Final report on the high northern latitudes

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Summary and Introduction

Our previous reports this apparition have focussed on Jupiter's low latitudes that can be well resolved in ground-based images, covering nothing north of the NNTZ. Here we present a full report on the mid-to-high northern latitudes, from the NNTB to the north polar region (NPR), from amateur images as measured and mapped by the JUPOS team, and compared with JunoCam maps. In the N4 to N6 domains, JUPOS tracked many features, mostly bright (AWOs and cyclonic features). This coverage extends even further north than in previous years, beyond the northernmost (N7) jet, with measurements up to 76°N. Thus, for the first time, we show the systematic retrograde drift of FFRs that constitute the northernmost belt (~69-75°N). We also report the fourth recorded instance of an AWO moving from the N4 to the N3 domain, a remarkable phenomenon that is almost unknown outside this latitude band. These results extend those in our long-term report [ref.1] and our 2020 and 2021 reports [refs.2&3].

Abbreviations and conventions are as in previous reports, unless otherwise specified. Circulations are anticyclonic white ovals (AWOs) and cyclonic folded filamentary regions (FFRs). Latitudes are planetographic, except in the JunoCam maps where they are planetocentric. Longitudes are plotted in L3, but drift rates are generally given in L2 (DL2, deg/30d). DL3 = DL2 + 8.0 deg/30d. North is up in the figures.

Figure 1 is a map of the planet on 2022 Oct.1-6 by Damian Peach, from v-hi-res images that he took in Barbados, showing the amount of detail that can now be recorded. Figure 2 shows a few v-hi-res images of the high northern latitudes in August.

Figure 3 is our zonal drift profile (ZDP) from the N4 jet to the NPR in 2022, compared with the zonal wind profile (ZWP) from Cassini [ref.4]. Each point represents a separate track or (where a spot's speed varied) a track segment. Most of these measurements, and all above 63°N, were made by G.A. We see that JUPOS tracked many spots, whose ZDP agrees well with the shape of the Cassini ZWP, and thus with our previous results for the N4 to N6 domains, although it appears that no spots were tracked on the peaks of the prograde jets. Curiously, spots in the "northernmost belt" in the NPR were up to 1° south of the ZWP, while spots in the N5 domain were mostly ~1° north of the ZWP. The opposite displacements in different domains argue against any systematic error in measurement. It is possible that the ZWP is variable in longitude and/or time (a question that we hope to address with JunoCam images in the future); also, that AWOs (which are most of the more northerly spots in the N5 domain) are systematically further north than the background wind pattern of the N5 domain.

We have also used north polar projection maps to attempt visual tracking of features in the NPR. Visible-colour maps at intervals of <4 days can enable tracking of FFRs in the northernmost belt (see below). Methane-band maps, made by Andy Casely, are not shown here but were presented in our Juno PJ45 report; together with the JunoCam PJ45 map, they revealed the structure and rotation of the methane-bright North Polar Hood.

North polar region (NPR): First ZDP for the northernmost belt

This is the region north of the N7 jet at 69°N. JunoCam images consistently show a loose belt of large FFRs here, which we call the "northernmost belt"; it is evidently homologous to the "southernmost belt" that we characterised in the SPR [ref.5], and to belts in domains such as N4 and N5. It could, logically, be called the N7 belt, but we refrain from defining a N7 domain as this latitude band, like its southern-hemisphere counterpart but unlike the defined domains, is not bounded by a distinct prograde jet on its poleward side.

In this region, we have tracked many spots much further north than ever before, up to 76.4°N. (The previous record was 67.3°N, for one spot in 2011/12 and one in 2021 [ref.2].) Most spots were apparently short-lived, so the tracks are not very precise, but they are all consistent with a ZDP closely parallel to the Cassini ZWP (Figure 3). And for the first time they demonstrate the collective drift of the northernmost belt.

The JUPOS chart for the N6 domain and NPR (>63°N) is shown in Figure 4, with measured tracks highlighted and colour-coded by latitude. (All these measurements were made by G.A.) Features in the "N7 belt", all white spots, are highlighted in brown. Figure 5 presents the JunoCam maps covering the same period, with the JUPOS-tracked spots labelled using the same colour coding (using our temporary numbering in each domain). Where they can be identified, eight of these spots are FFRs in the N7 belt from 70-75°N, ranging from its S edge to its N edge; one [w3] is a cyclone on its S edge, influenced by the N7 jet; and one [w2] is unclear. Spot w12 was tracked for longest, and showed coordinated latitude/drift variations in accordance with the local ZDP; it is also identified in the polar maps (below), and was presumably a FFR. The Hubble map from Nov.12 [ref.7] is especially useful as it was made just 6 days after the PJ46 map, so one can identify the same features, and their relative drifts are consistent with the JUPOS values.

These results for the N7 belt (northernmost belt) agree perfectly with what we have learned about the N4 and N5 domains [refs.1-3] and the "southernmost belt" (>67°S) [ref.5]. I.e., the JUPOS ZDP agrees with the 'blunt' ZWP from spacecraft (apart from the mysterious latitude offset), showing a modestly retrograding 'zonal slow current' across the cyclonic latitude of the belt. Here, the blunt peak of the Cassini ZWP has a mean DL3 ≈ +8 deg/30d (DL2 ≈ 0) from 71.5 to 75.0°N, and our data has a mean of **DL3 = +12.1 (DL2 = +4.1)** (±8.7) deg/30d from 70.5 to 75.0°N. This must be the mean speed of the FFRs, which occupy much or most of the space in these latitudes. Obviously there must be more rapidly retrograding speeds as part of the cyclonic circulations within the FFRs.

To complement these measurements, we also produced a series of north polar projection maps in the hope of visualising the drift of the N7 belt as a whole (e.g. Figure 6). R.B. made maps every 2-3 days from Sep.20-29; this period included Juno's PJ45. He mostly used Isao Miyazaki's images, for consistency, supplemented with some from other observers, notably Damian Peach, S. Ito, & J-L. Dauvergne. In practice, there were not always v-hi-res images for some sectors, and variations between images lead to imprecise projection, so it is not always easy to follow identified features in the NPR over several maps. As in the SPR [ref.5], maps must be separated by no more than 4 days to follow individual FFRs, as they change shape rapidly.

These closely spaced maps do allow us to identify some features that were tracked by G.A.'s positional measurements, and also a long chain of FFRs within the northernmost belt over Sep.22-29, covering ~80° longitude (yellow box in Figure 6, & Animation-1). It shows signs of retrograding motion, and approximate longitudes of various points on the FFR chain are plotted in Figure 7. Very approximate drift rates from this chart are around DL3 ~ +26 (±26) deg/30d; not inconsistent with the mean DL3 = +12 (±9) deg/30d for this belt from G.A.'s measurements. It's possible that a more extensive reanalysis of these data, beyond the scope of this report, could give more precise results.

The red points in Figure 7 refer to a FFR that is even further north than anything G.A. measured, at ~77°N, and it is not systematically retrograding. This is the first indication that speeds may become faster (eastwards) towards the polar cyclones, as in the SPR [ref.5], but regrettably the points do not give a consistent drift rate.

N6 domain

In this narrow domain, G.A.'s JUPOS measurements tracked three dark and three light spots (Figure 4: black and green respectively). All were rapidly prograding, but still close to the Cassini ZWP (Figure 3) (& compare refs.2&3).

One light spot at 67.2°N, influenced by the N7 jet, had DL2 = -90.2 deg/30d, which almost equals the fastest speed ever recorded in high northern latitudes (-91 deg/30d, for a similar spot at 67.3°N, in 2011/12) [ref.3]. Figure 8A from JunoCam probably shows the same spot earlier, when it was not moving so fast; it was then a compact but irregular cyclonic spot.

N5 domain

The JUPOS chart is shown in Figure 9, and JunoCam maps in Figure 10.

The JUPOS ZDP (Figure 3) shows an offset of about 1° lat. from the Cassini ZWP – unique to this domain – as discussed above. Latitudes of the principal AWOs are slightly less on JunoCam maps than from JUPOS, by 0.36° (±0.11°, n=5, for AWOs w5 & w11), but this does not fully explain the offset. This offset is especially notable in the anticyclonic (northern) part of the domain, where most of the points from 63.3 to 64.2°N represent the northerly, fast-moving AWO w5, which is very large and long-lived. It has now been tracked for four years [refs.3 & 6]. It is shown in amateur images in Figs.1, 2,& 6, and in JunoCam PJ41 close-ups in Fig.8B & ref.6. Another two points in this range refer to the somewhat smaller AWO w11. It would not be surprising if these large AWOs distorted the jets so as to lie further north than indicated by the ZWP. Indeed, their mean latitude when faster than DL2 = -24 deg/30d was 64.0°N, indistinguishable from the canonical peak of the N6 jet – although their maximum speeds (-56.4 deg/30d for w5, -57.1 for w11) were still less than the jet peak (-88 at 64.1°N, from Cassini). In JunoCam close-up images, these ovals often appear to lie across the latitude of the N6 jet, within the Bland Zone (e.g. Figure 8B).

However, the most northerly and fast-moving spot of all in N5 was w16, with DL2 = -61.4 at 64.2°N over 12 days; it may actually have been a cyclonic feature of the N6 domain.

At lower latitudes in N5, where the ZDP and ZWP are blunt (i.e. drift rates are independent of latitude), the JUPOS data give a mean drift rate as follows, defining the zonal slow current (**N5TC**):

--from 59.0—62.0°N: Mean **DL2 = +10.9 (±2.5) deg/30d**, lat. 60.6 (±0.8)°N (N=16).
This agrees well with the long-term average of +13 deg/30d [ref.1], and with last year's results [ref.3]. More broadly:
--from 58.0—62.9°N: Mean DL2 = +5.8 (±7.6) deg/30d, lat. 60.3 (±1.5)°N (N=27).

There are a few examples of spots in this range migrating in latitude without changing drift – as also seen in N4, in this and previous apparitions.

We examined the JunoCam maps (Figure 10) to identify the features tracked in the JUPOS chart (Figure 9). The fast-moving, northerly white spots, as noted above, were AWOs w5 and w11, and enigmatic spot w16. White spots sharing the general retrograde drift turned out also to be AWOs, though smaller and more southerly: w14, w1, and w2 (all at PJ44), and w7 (at PJ45 & PJ46; probably = w2). AWOs w5 and w7 passed each other on Oct.23, without incident, as shown in Figure 11.

The only FFR-like features identified were w12 (PJ43), and w9 & w17 (PJ44) – but all these, being small FFRs at 58.0—58.6°N near the south side of the N5 domain, had speeds that were not retrograding but were nearly stationary in L2 or L3 (see ZDP in Figure 3). So the 2022 data could not directly confirm our 2021 conclusion that the general retrograde drift is the bulk drift of the large FFRs of the domain, although it is consistent with it.

N4 domain

We analysed the N4 domain in the same way, with the JUPOS chart in Figure 12. The results are very satisfying. About 30 spots, dark and bright, were tracked, and they follow a ZDP close to the Cassini ZWP (Figure 3), as we have found in previous years. From 50.5 to 53.5°N we see the mildly retrograding drifts that define the **N4TC**, with a mean **DL2 = +6.7 (±4.6) deg/30d**, 52.2 (±0.8)°N (N=48) – very similar to previous values [refs.1-3]. Spots here often change their latitude, sometimes by a large amount, while retaining their drift.

Many of these spots can be identified on JunoCam maps (Figure 10), and almost all of them are either AWOs or FFRs. The FFRs were w7 (seen at all perijoves from PJ42 to PJ46), and a chain of five seen at PJ45 & PJ46, all of which are typical examples with the general retrograde drift (N4TC). So this is a clear confirmation of our understanding of the dynamics of this domain. The largest AWOs were w16 and w19 (which passed each other on Sep.23; Figure 6 & Animation-1) and w29 (which then went into the N3 domain; see below), and there were many smaller AWOs. We have tracked and identified 11 of them altogether, and their relative latitudes are consistent with the ZDP.

Migration of an AWO across the N4 jet:

N4-AWO-w29 moved from the N4 to the N3 domain – the fourth time that we have recorded this remarkable behaviour since 2011 [ref.3]. It was one of the largest AWOs in N4 (only w19 being comparable). The JUPOS data (Figures 12&13) show it was initially a normal N4 feature with typical retrograding drift adhering to the Cassini ZWP, with just a minor fluctuation around the start of July when it temporarily accelerated slightly and it began a progressive drift southward, through the cyclonic part of the domain.

From Sep.1 to 7 it moved very rapidly south across the N4 jet (Figure 13). On Sep.2 its drift rate changed suddenly from retrograding (N4TC) to the near-constant prograding speed typical of the N3 domain (N3TC). At all times it was close to the Cassini ZWP, except that it never adopted the rapid speed of the N4 jet.

The images (Figure 14) show that from Aug.29 onwards, the AWO had a bright extension in the NW-to-SE direction, as if being stretched towards the N4 jet. On Sep.4, it was just resolved as double, as it crossed the jet; and on Sep.6, the SE part was the brighter, leaving a bright 'tail' still spanning the jet. Thereafter it became a stable AWO in N3; but the bright 'tail' split off as a separate small AWO remaining in N4, which we tracked thereafter as spot w28, with typical retrograding drift.

AWO-w29 was not imaged by JunoCam as it crossed the jet, but had been recorded near the limb while inbound on July 5 (PJ43) and Aug.17 (PJ44) (Figure 10). The PJ43 images (Figure 14A) showed that the oval was already distorted. This is perhaps not surprising for an anticyclonic oval in the cyclonic environment of these latitudes. Moreover it was in contact with a small cyclonic structure, and they still seem to have been together at PJ44; this pairing could propel the pair southwards [Gerald Eichstädt, personal communication].

Why do AWOs in N4 so frequently cross the prograde jet into N3, while this behaviour has never been seen in other domains, except once from N3 to N2 [ref.3]? N4 has several characteristics that could enable AWOs to drift more freely in latitude than in other domains [ref.1]: it is the broadest of the domains north of 35°N, and is especially dominated by large FFRs with intense thunderstorms. Association with FFRs or smaller cyclones might be able to drive AWOs south -- although some previous examples showed no evidence for such pairings. Moreover, AWOs might be expected to be unstable in the cyclonic part of the domain and then while crossing the jet. How they can persist in their southward movement and survive crossing the jet is still an open question.

N3 domain

The JUPOS chart for N3 (Figure 15) shows many tracks of small bright and dark spots, all prograding as usual. We have not done a ZDP analysis for this domain, as most spots showed similar drift rates with a mean **DL2 = -21.3 deg/30d** (±1.9; N=10) (the typical **N3TC** drift rate), with a few faster and slower tracks giving a full range from -9.5 to -51.2 deg/30d (the latter presumably associated with the N3 jet).
Further south, a few short-lived dark spots were recorded moving at the peak of the N3 jet (see Figure 18).

N2 domain

Our 2022/23 reports nos. 2 & 3 covered the main aspects of this domain up to October, esp. the long-lived AWOs in the NNTZ. Here we give further details throughout the apparition. Maps of the domain are in Figure 10 (from JunoCam) and 16 (from amateur images). The JUPOS chart is in Figure 17, and the ZDP is in Figure 18.

NNTZ ovals:

Three long-lived ovals still persisted throughout the apparition: NN-WS-4, NN-WS-6, and NN-LRS-1. They are shown in Figures 19 & 20. Initially there was a fourth AWO, which had translocated from the N3 domain in 2021, but it merged with WS-6 in May [see 2022-23 Report no.2]. WS-6 also probably merged with two very small ovals p. it in late Oct. (see PJ45 & PJ46 maps in Figure 10). Descriptive notes:

LRS-1: Quite strongly red throughout the apparition. Initially rimless and hard to discern in amateur images, but a grey rim gradually developed, so by Dec. it was well defined with a very dark grey rim. Very methane-bright, as always.

WS-6: Bright white throughout the apparition. Dark grey rim, until 2023 Jan. when this largely disappeared. Very methane-bright, though slightly less so than LRS-1.

WS-4: Smaller than the others, and usually inconspicuous. Up to July, a pale, low-contrast central region (reddish in JunoCam images), surrounded by a grey or bluish annulus. In Aug. & Sep. the central region became white, then the whole oval became dull whitish with a dark grey rim (Oct.-Jan.), more visible than before. Only the small central region was moderately methane-bright.

All 3 ovals had variable drift rates in the usual range (Figure 17). Average DL2 values were as follows:

LRS-1:	June-Sep.	-17 deg/30d
	Sep-Nov.	-7*
	Dec-Feb.	-4
WS-6:	May-June	-3
	July-Feb.	-7* (typical range -3 to -16)
WS-4:	June-Jan.	-9*

*There were oscillations in drift rate. WS-6 performed three cycles with a period of 2.3 months from July to Feb. LRS-1 performed one cycle with similar period from Sep. to Nov. WS-4 showed less regular oscillations with similar period.

Speeds and latitudes over shorter intervals are plotted in Figure 18 to show the ZDP. All three ovals adhered to a single ZDP in this apparition, very close to the Cassini ZWP, in contrast to results in earlier decades. This may be because WS-6 and LRS-1 are now about the same size, and WS-4 only slightly smaller, according to the JunoCam maps.

A new white spot in the NNTZ appeared on Jan.29, in a bay within undulations of the NNTBn, just as a double dark spot in N3 was passing by. The JunoCam PJ47 map on Dec.14-15 already showed a small reddish anticyclonic vortex in the NNTZ alongside the converging N3 dark spots (green box in Figure 10).

NNTB sectors:

Maps are in Figure 16. Half the circumference was much disturbed, with two large FFRs. The other longitudes appeared quiet. As there were no distinct stable sectors of dark NNTB, we do not have a drift rate for the NNTC.

(i) The sector between WS-6 and LRS-1 had been unusually disturbed [see Report no.2 & PJ42 report] and from June to Oct. there was still a large FFR spanning at least half of this sector, and the NNTZ here was darkened. The disturbance also extended for a variable distance following LRS-1, and there was often another large FFR in this sector. In 2023 Jan. the sector between WS-6 and LRS-1 had calmed down and the NNTZ there cleared. However, there was still disturbance including a FFR f. LRS-1, as well as a darkening NNTB now extending up to WS-4. (This sector was well covered in Juno's inbound maps at PJ45 and PJ46: see Figure 10.)

(ii) The remainder of the domain appeared quiet: the NNTB was very faint and fawn-coloured, and the NNTZ was mostly clear. The main features were the dark jet spots prograding along the NNTBs edge. But it was also in this quiet sector that retrograding dark spots were found, as described below.

Retrograding spots:

The JUPOS analysis detected an unusual number of retrograding small dark spots, mostly with DL2 = +10 to +23 at 40-41°N, just north of the retrograde jet peak (Figure 18). Exceptionally, there were a few with even faster retrograde speeds, DL2 = +32 to +45, significantly beyond the Cassini ZWP; these fell into two groups as noted below. While they show that the retrograde jet here can be faster and broader than previously known, these were only very small spots in limited sectors, and did not reveal any particular structures to explain their behaviour. Most of the retrograding spots seem to have arisen from the large FFR f. LRS-1, but some arose from recirculation of tiny spots on the N3 prograde jet, in a generally quiet sector.

The retrograding spots occurred in three sectors:

(1) P. WS-4, June to Sep. (see maps in July in Figure 20). These were all arising at or near L3 = 128, at the f. end of the FFR f. LRS-1; in July there was also a stationary dark spot here [white arrow on maps in Figure 20]. They fell into two branches, northern and southern (white brackets on maps). Most were in the northern branch with DL2 = +10 to +23, lat. 40.5 (±0.2)°N (N=6); but there were three in a southern branch with DL2 = +34 to +41, lat. 38.5 (±0.3)°N (N=3), constituting the exceptionally fast southern group.

(2) F. WS-4, 2022 Sep. to 2023 Feb. In Sep-Oct. there were just two spots, which apparently came from set (1), passing WS-4. Later, there were more, including dark streaks, which may have arisen similarly although their tracks were less clear.

(3) Part way between WS-4 and WS-6, June to Jan. These spots were infrequent, and most or all began as prograding spots on or near the N3 jet (at 41.5-42.1°N), which moved south (to 40-41°N) and reversed their drift. Of five retrograding spots tracked here, three constituted the exceptionally fast northern group, with DL2 from +32 to +45. This was on a long quiet white sector of NNTZ, but it was narrow with irregular N and S edges showing possible wave structure (see JunoCam maps at PJ42 & PJ44 in Figure 10), which perhaps enabled the recirculations.

NNTBs jet

There were numerous small dark spots prograding in the N2 (NNTBs) jet throughout the apparition (e.g. NNTB maps in Figures 10, 16, 20; JUPOS chart in Figure 21). Their speeds were very uniform with a mean DL2 = -84.7 deg/30d (±3.6; N=35). They were present at almost all longitudes, but from late Sep. to late Nov. the chart shows that new ones were appearing a short way p. (downstream of) NN-WS-6, possibly induced by the FFR f. WS-6.

The chart shows that two of these spots merged around July 28 at L3=124 (indicated in red in Figures 20 & 21), to create a more southerly, slower-moving dark spot with DL2 = -57 to -66 deg/30d. It seems to have blocked or merged with two of the more typical spots, but itself disappeared in late Sep. as it was passing WS-6, perhaps disrupted by the FFR. In early Jan., two similar spots appeared on approximately the same track, with DL2 ~ -50 and -60.

A series of small dark streaks appeared near L3 ~ 0 in Nov. (again near WS-6), which had faster drifts than the typical jet spots, DL2 = -96 to -106, matching the average peak jet speed recorded by spacecraft.

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References

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Ref.7: Hubble (OPAL) maps, 2022 Nov.12. The Hubble Space Telescope (HST) takes comprehensive sets of images once a year in the OPAL project [NASA / ESA / STScI / A. Simon, G. Orton & M. Wong]. "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." The maps are also posted here: https://archive.stsci.edu/prepds/opal/.

Figures

Figure 1. Map of the planet on 2022 Oct.1-6 by Damian Peach, from v-hi-res images that he took in Barbados.

Figure 2. Some v-hi-res images of the NPR in August.

Figure 3. Our JUPOS-derived zonal drift profile (ZDP) from the N4 jet to the NPR in 2022, compared with the zonal wind profile (ZWP) from Cassini [ref.4]. Each point represents a separate track or (where a spot's speed varied) a track segment. Most of these measurements, and all above 63°N, were made by G.A.

Figure 4. The JUPOS chart for the N6 domain and NPR (>63°N), with measured tracks highlighted and colour-coded by latitude. Features in the "N7 belt", all white spots, are highlighted in brown.

Figure 5. JunoCam maps in 2022. Latitude scales are planetocentric (°Nc), rather than planetographic (°Ng) as in the rest of this report. JUPOS-tracked spots are labelled north of ~60°Ng (57°Nc), i.e from the northern fringe of N5 up to the NPR. The last map is from Hubble [ref.7].

Figure 6. Examples of north polar projection maps in 2022 Sep. The yellow box encloses the chain of FFRs tracked in the 'northernmost belt' (part of this chain of FFRs is also shown in JunoCam's PJ45 map on Sep.29). Yellow arrows mark FFRs tracked by G.A. The green loop encloses a pair of N4-AWOs gliding past each other.

Figure 7. Approx. longitudes of various points on the FFR chain in the northernmost belt, and one at ~77°N, in 2022 Sep., from data in Animation-1.

Figure 8. JunoCam images of (A) a prograding cyclone in the Bland Zone (N6 domain); (B) the large long-lived N5 AWO w5.

Figure 9. JUPOS chart for the N5 domain.

Figure 10. JunoCam maps, with JUPOS-tracked spots indicated in the N5 domain (with our temporary numbering) and N4 domain (unnumbered except on the HST map, apart for a few referred to in the text), and the NNTZ (ovals).

Figure 11. N5 AWOs w5 and w7 passing each other on Oct.20-26. (Excellent images were also taken on these dates by C. Go, L. Gulliver, N. MacNeill, J. Palmer, J. Rozakis, & C. Serodio.)

Figure 12. JUPOS chart for the N4 domain.

Figure 13. Lat. & long. tracks & ZDP for N4-AWO-w29 as it crossed the N4 jet. (The jet's mean latitude is 47.0°N from Cassini, 47.4°N from all spacecraft, although we do not know its exact position while N4 crossed it.)

Figures 14. Images & maps showing N4-AWO-w29 before, during, and after it crossed the N4 jet into the N3 domain.

Figure 15. JUPOS chart for N3 domain.

Figure 16. N2 domain: JUPOS maps by R.B. (from amateur images).

Figure 17. N2 domain: JUPOS chart.

Figure 18. N2 domain: ZDP.

Figure 19. Hi-res images including NN-LRS-1 and -WS-6, in Oct. (left) and Dec. (centre & right), in RGB and CH4.

Figure 20. Maps of the N2 domain sector between NN-WS-4 & NN-LRS-1 in July, showing the volleys of retrograding spots (white brackets) and a stationary dark spot (white arrow) following a FFR, and a pair of NNTBs jet spots which merged (red arrows).

Figure 21. JUPOS chart of the N2 (NNTBs) jet, in a system moving with DL3 = -90 deg/30d (DL2 = -98 deg/30d).