Jupiter in 2024/25: Report no.2:
Mid-SEB outbreak & other developments

John Rogers; Shinji Mizumoto (ALPO-Japan); Gianluigi Adamoli, Rob Bullen, Michel Jacquesson (BAA & JUPOS team). 2024 Nov.14

This is a brief report to present some recent maps and charts, and to note recent interesting developments, especially in the SEB (a new mid-SEB outbreak appeared on Nov.11) and also in the NEB (including two mergers of AWOs) and the NTB (measurements of the present speed of the NTBs jet). Other features mentioned in Report no.1 are still of note: the SED is still very conspicuous, and the brownish-grey colour of the EZ is probably still darkening. The area south of the GRS has been very disturbed, with STB spot 8 passing it, and now numerous dark spots in the STBn jet impinging on it.

Two labelled maps are shown, from 2024 Oct.10-11, by Rob Bullen (Figure 1) and 2024 Nov.2-3, by Simon Labergere (Figure 2).

SEB

An image on Nov.11 (02:13 UT) by Moises Portillo showed a very bright little spot in the SEB, which looked very like the start of a **new mid-SEB outbreak**. The spot was at L2 = 328, L3 = 105. In the first two days it was intensely methane-bright and starting to expand (Figures 3 & 4).

Kuniaki Horikawa (ALPO_Japan) notes that it occurred in a diffuse bright area that had been tracked since last apparition, when it was a white spot that drifted up to the preceding side of the GRS. It then drifted back, and throughout this apparition has remained at L2=320-330 (marked 'SEB-WS' in Figure 1). A Hubble map confirms that it was a cyclonic oval (Figure 5). The new outbreak seems to have occurred at its preceding end (Figure 3). This is further confirmation that many, and perhaps all, mid-SEB outbreaks occur within pre-existing cyclonic circulations.

The last such outbreak was in 2016/17. It began on 2016 Dec.29, and was well imaged by JunoCam at PJ4 (2017 Feb.2). For our account of it, see Ref.1. Ref.2 provided a thorough professional analysis of it, using wavelengths all the way from the optical (HST) to radio (VLA), with some of our amateur data, and concluded that the plumes are driven from the water cloud level but also bring up ammonia from deep in the atmosphere.

We can expect more bright white spots to develop at the source (roughly fixed in L2) and prograde from it, with impressive disturbance developing over the coming weeks and months. All observations will be welcome, particularly including images in methane filters.

Meanwhile the perennial disturbed ('rifted') region just f. the GRS is still active. Tiny red spots within it were pointed out by Mattia Piccoli (Italy) in July, and Greg Terrance (Missouri) in Sep.; they are also visible in some images by Isao Miyazaki (Japan). I think this is a colour associated with rapidly-changing cyclonic vortices in the SEB, probably not uncommon although these spots are so small that they are not often noticed.

Another notable red streak appeared on Oct.12 linking the **South Equatorial Disturbance (SED)** to the post-GRS rifted region (Figure 6); it lasted for a few days.

The SED had passed the GRS again on Oct.10 (Figure 6), and is still very prominent. Here we use 'SED' to refer to the main complex, consisting of a discontinuity in the SEBn with a very bright white area in the EZ(S) and complex streaks around it. (Elsewhere, the term sometimes includes the entire disturbed region of EZ(S), which now extends for a very long distance p. the main complex.) Note that the broad shading in central EZ is darker p. the SED (Figures 1 & 2), and there is a narrower, very methane-dark band in the EZ(S) p. the SED (Figure 6).

NEB

The **NEB expansion event** in 2023-24 was described in our 2023/24 Report no.5 [Ref.3]. The northwards expansion of the dark belt became complete during solar conjunction. Now it is maturing with the typical appearance of an array of AWOs and barges.

The **anticyclonic ovals** are identified on the attached maps (Figures 1 & 2) and JUPOS chart (Figure 7). The present set of AWOs comes from three sources:
(i) Some have existed for some years, and are labelled Z, B, and E (which merged with C around Sep.1)*.
(ii) Some developed from anticyclonic dark spots (ADSs), which emerged in the 2023 NEB expansion event, as tracked by Mizumoto in 2023/24 (Ref.3). These were numbered (ADS-1, 5, 6, etc.), so we have renamed them WS-1, 5, 6, etc. accordingly.
(iii) Several new AWOs have developed, as usual following a NEB expansion event. One of these is especially prominent so we have named it WS-7. Another merged with WS-E in late October*. We have not given names to the other small ones, which are probably not yet stable.

*These two **mergers of AWOs** are fully shown with complete sets of maps in Figure 8, by Mizumoto. He also posted an animation of the second merger, in: https://alpo-j.sakura.ne.jp/kk24/j241031r.htm The second one clearly shows how part of the smaller oval spirals into the large one while the remainder of it spins off to the left. We have often seen evidence for this happening in anticyclonic 'mergers', but this is an especially clear demonstration of it.

NTBs jet

The NTB is essentially absent. In our 2023/24 report no.3 (Appendix) we found that the NTBs jet speed was +147 (±7) m/s, and we stated: "The jet is approaching its superfast state, so a new dramatic outbreak is expected in 2024 or 2025."

In 2024, the JUPOS chart showed an exceptionally distinct and long-lived feature throughout July & August: the f. end of a dark streak in the NTropZ/NTBs latitude, with DL1 (sic) = -97 deg/30d! There has been another with the same speed in Sep & Oct. These are the most long-lived features that JUPOS has ever tracked with such a speed outside the NTBs outbreaks. G.Adamoli did a JUPOS analysis on the first streak, finding

DL1 = -97.8 deg/30d, u3 = +142.1 m/s, lat. 23.5ºN (July 4 – Aug.30)

and on several much shorter tracks, giving an overall average of:

DL1 = -100.4 (±3.9) deg/30d, u3 = +143.3 (±1.7) m/s, lat. 23.5 (±0.3)ºN.

This is nearly (but not quite) as fast as the speeds we measured in the NTBs jet last year; the streaks and their speeds are similar to what we measured in 2004, 3 years before the 2007 outbreak. Nevertheless, this does not rule out an outbreak in 2025 as measurements have not consistently shown an accelerating trend towards past outbreaks.

STB

Figure 9 is an annotated JUPOS chart of the S. Temperate domain. The main features are now stable, and STB spot 8 passed the GRS recently without notable change. There is again a dense outbreak of dark spots in the STBn jet p. STB Segment G, which are now interacting with the GRS.

References

1. J. Rogers (2018 Dec.), BAA: '2016-17, Report no.17: Summary of the mid-SEB outbreak'.
https://britastro.org/section_information_/jupiter-section-overview/jupiter-in-2016-17/2016-17-report-no-17-summary-of-the-mid-seb-outbreak

A full display of the outbreak was posted on ALPO-Japan:
S. Mizumoto, '2016-2017 Mid-SEB Outbreak Final Report'.
<alpo-j.asahikawa-med.ac.jp/kk17/j170923s.htm>

2. I. de Pater et 17 al. (2019) [including L. Fletcher & J. Rogers]. 'First ALMA millimeter wavelength maps of Jupiter, with a multi-wavelength study of convection' Astron.J. 158:139 (2019). DOI 10.3847/1538-3881/ab3643.

3. Jupiter in 2023/24, Report no.5: 'Increasing activity of the NEB (Mid-NEB plume and NTropZ anticyclonic dark spots)' by Shinji Mizumoto (ALPO-Japan)
https://britastro.org/section_information_/jupiter-section-overview/jupiter-in-2023-24/report-no-5-neb-activity

---

Figures

(small copies on following pages; full-size figures in associated ZIP file)

Figures

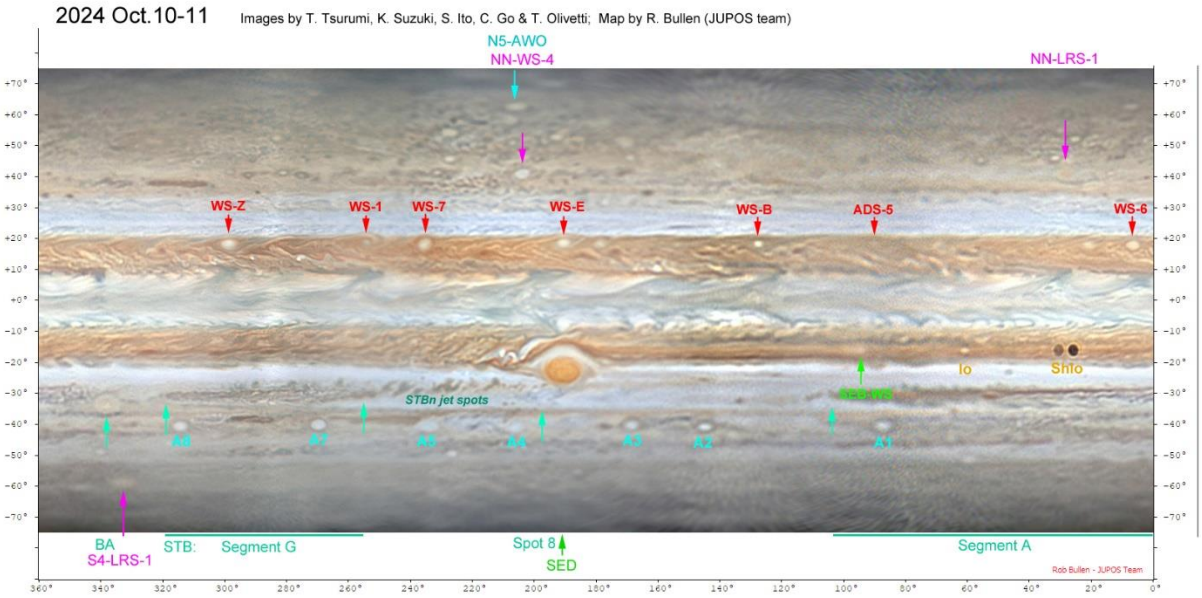

Figure 1. Map of the planet on 2024 Oct.10-11, by Rob Bullen.

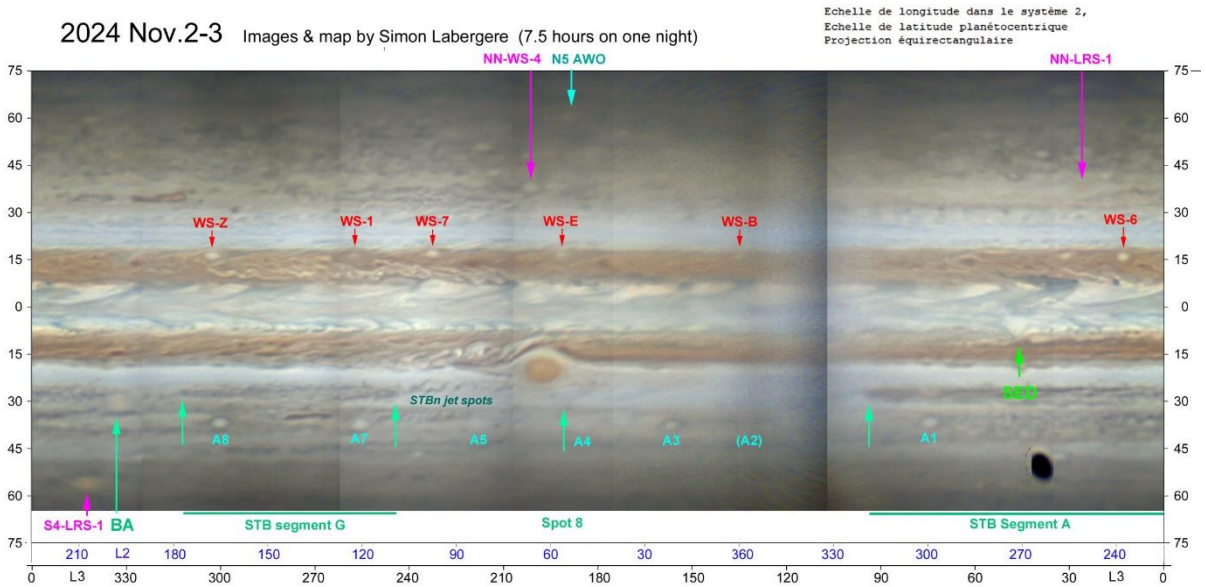

Figure 2. Map of the planet on 2024 Nov.2-3, by Simon Labergere (all made from one night's observations).

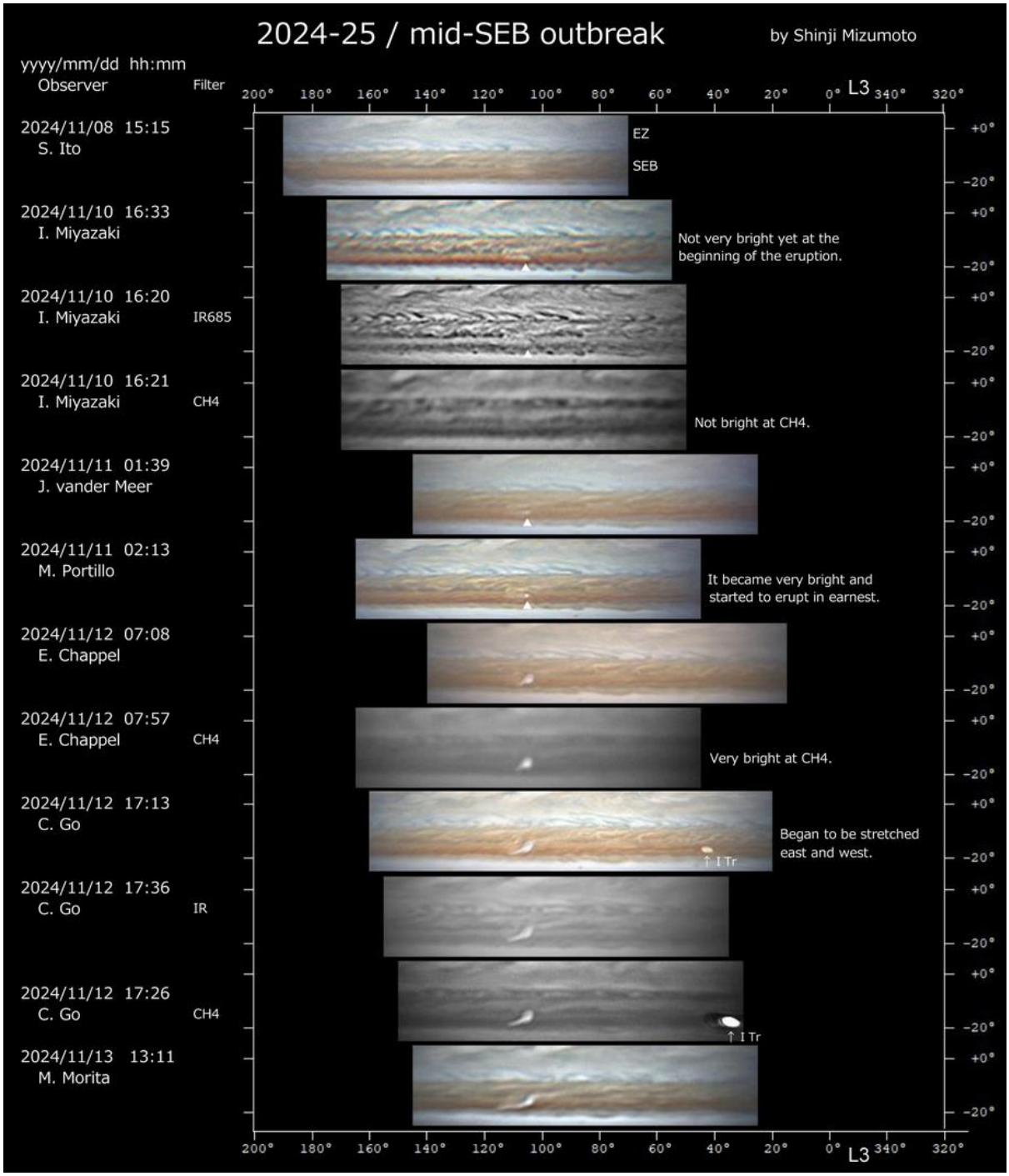

Figure 3. The earliest images of the outbreak, aligned as strip-maps by Shinji Mizumoto.

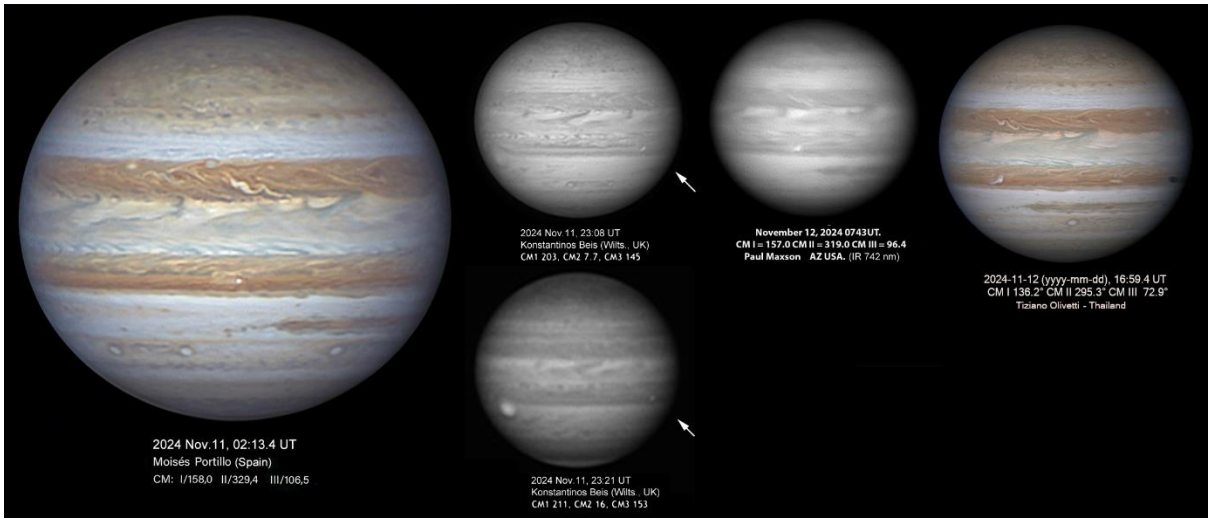

Figure 4. Other images of the outbreak on the first two days. (Also note a bright rift in the NEB, which began on Nov.1 or 2. It's not the first such rift after the expansion event – a similar one started in July, another in August – but it is especially bright.)

SEB white oval (white arrow) & Oval BA (red arrow)
2024 Jan.5-6, Hubble S.T.
Credit: NASA/ESA/STScI/A.Simon, M.Wong & G.Orton

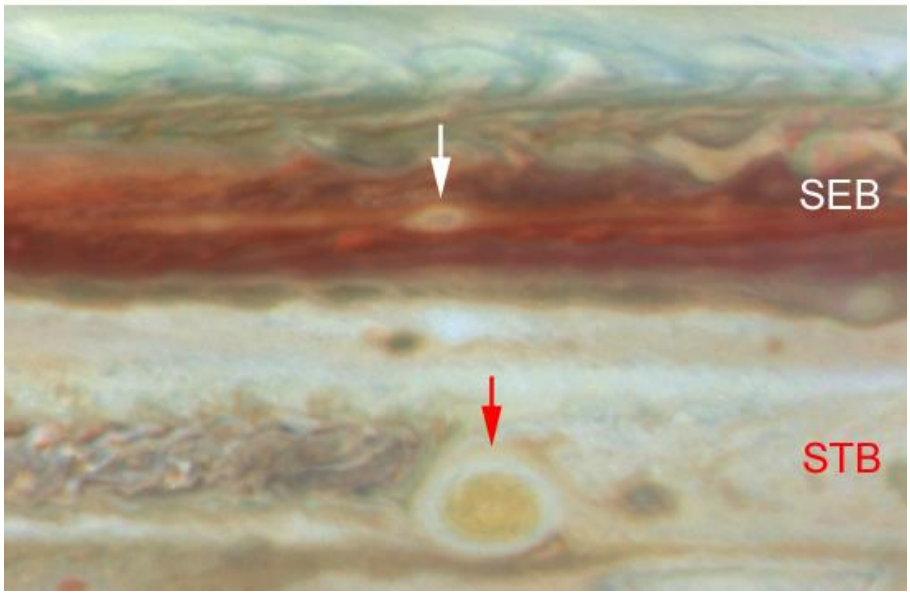

Figure 5. Excerpt from a HST map on 2024 Jan.5-6, showing the cyclonic white oval in which the outbreak later began. From: https://archive.stsci.edu/hlsp/opal. "This work used data acquired from the NASA/ESA Hubble Space Telescope, associated with OPAL program (PI: Simon, GO13937), and archived by the 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."

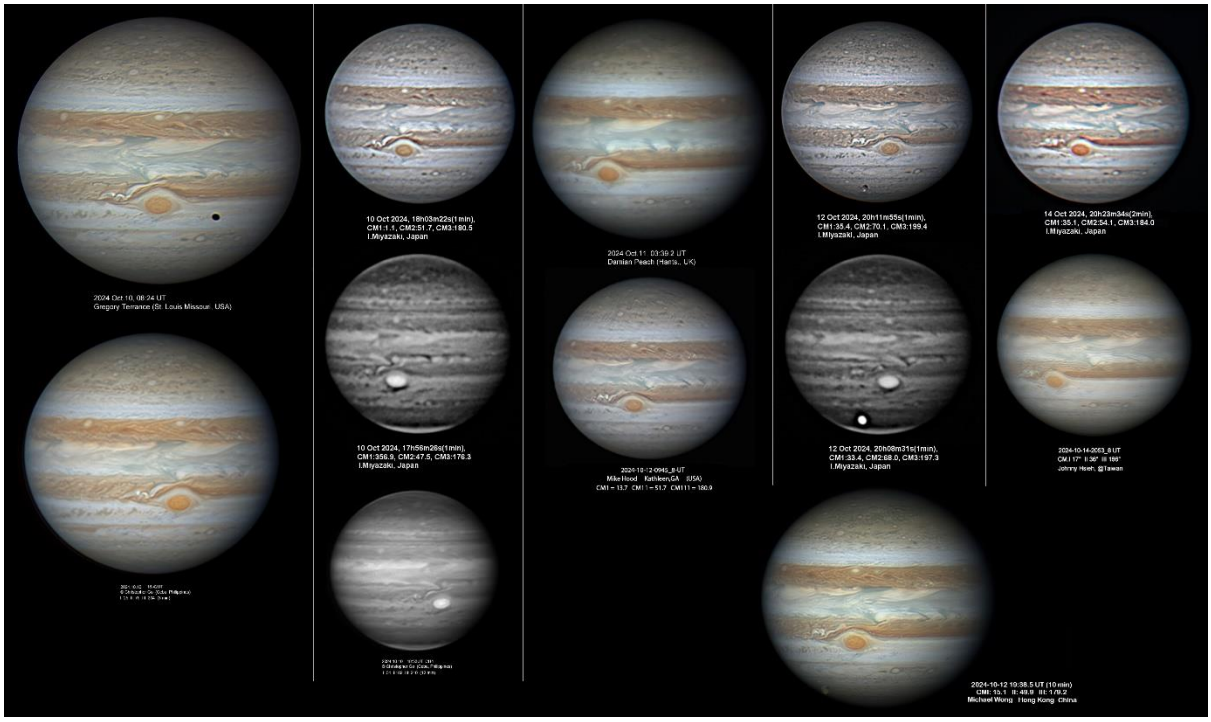

Figure 6. The SED passing the GRS, with conjunction on Oct.10. Note a bright red streak connecting the SED to the convective rifts f. the GRS on Oct.12 & 14. Methane-band images are also included, showing the complex pattern of streaks around the SED.

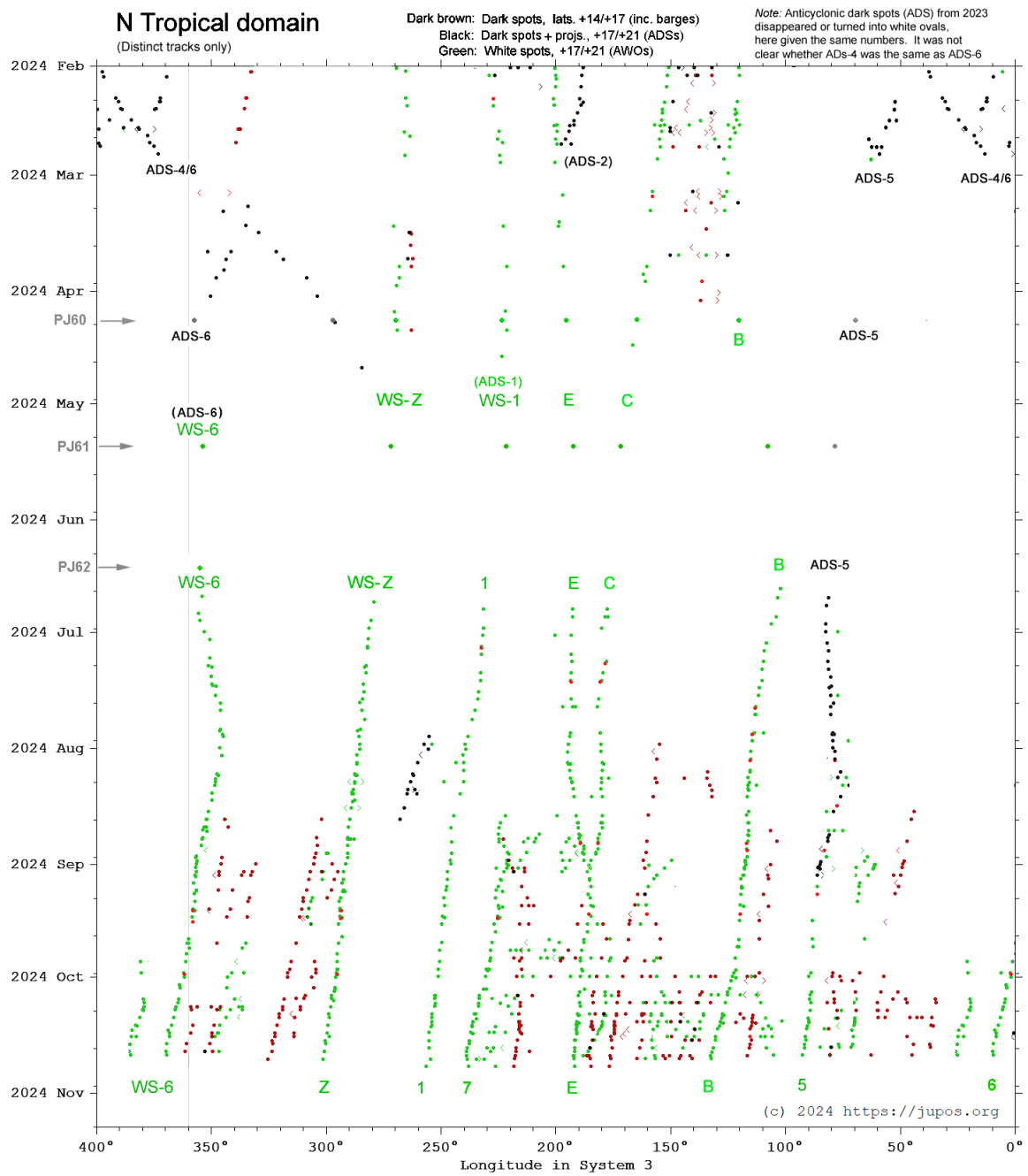

Figure 7. JUPOS chart of the NEBn/NTropZ in 2024, including information from ALPO-Japan and from JunoCam maps during solar conjunction.

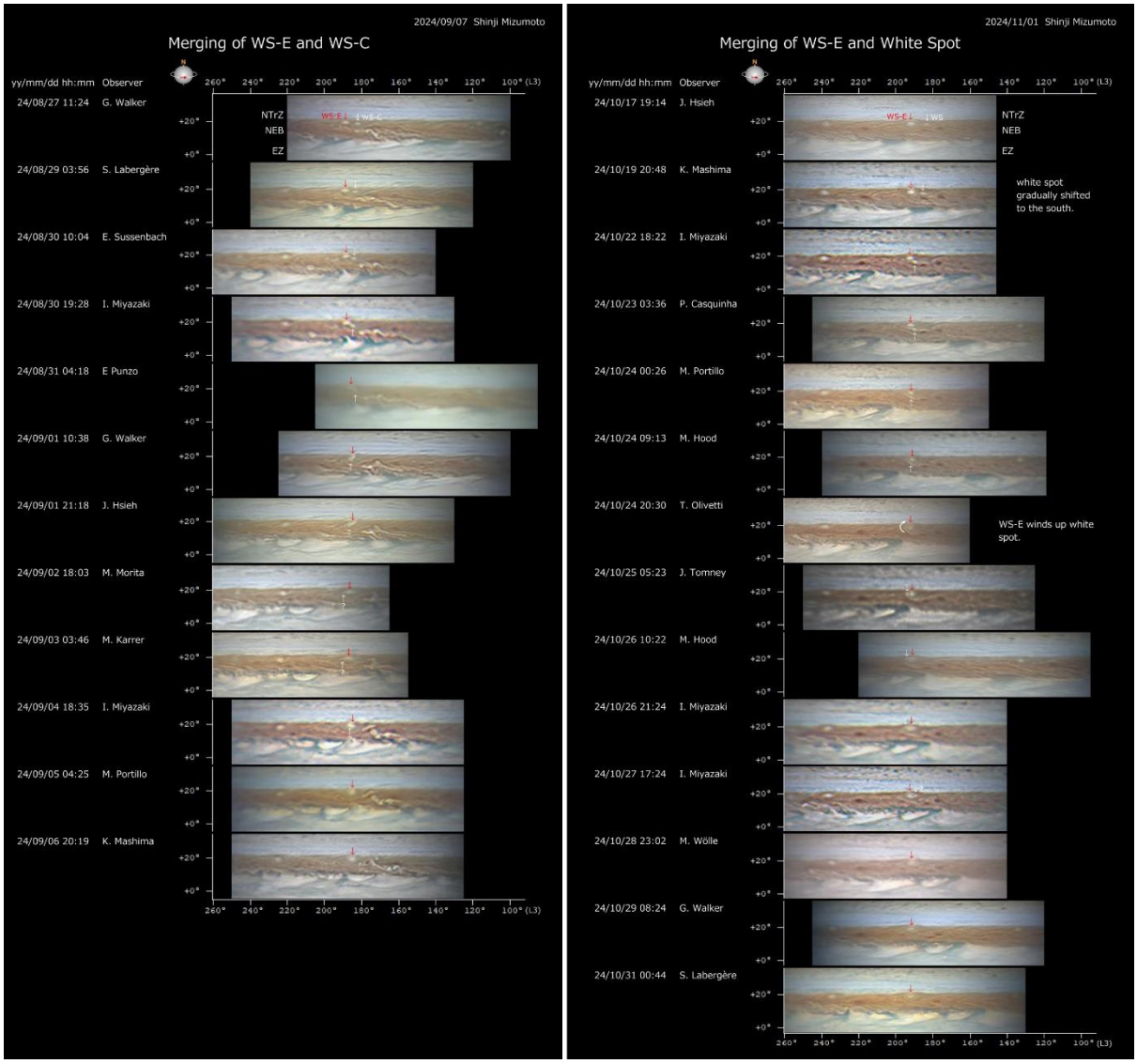

Figure 8. Strip-maps documenting two successive mergers of NEBn AWO-E: first with AWO-C and then with a new unnamed AWO. Maps are from the ALPO web site (https://alpo-j.sakura.ne.jp/Latest/J_repotrs.htm).

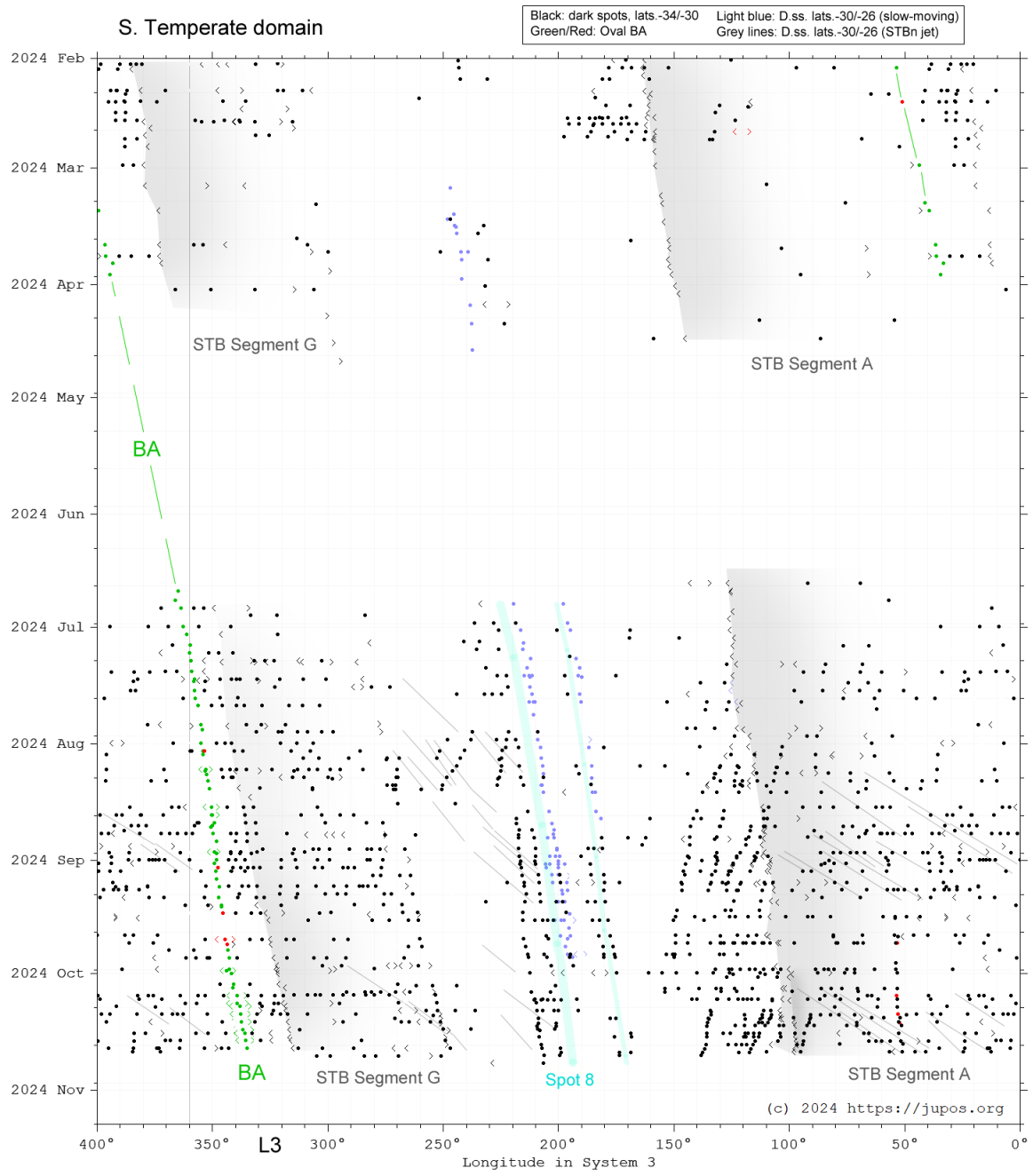

Figure 9. JUPOS chart of the S. Temperate domain.