Jupiter's South Temperate Domain, 2018-2024

John Rogers et al.

Figures

[small copies; full-size figures are in a separate ZIP file]

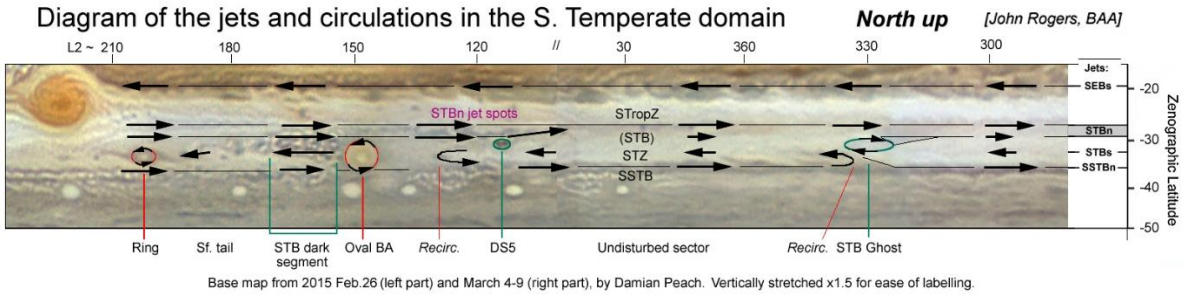

Figure 1a. Map of the domain with jets and major circulations marked, from 2015 Feb-Mar., copied from [Ref.R3]. (DS5 was the origin of the STB Spectre.)

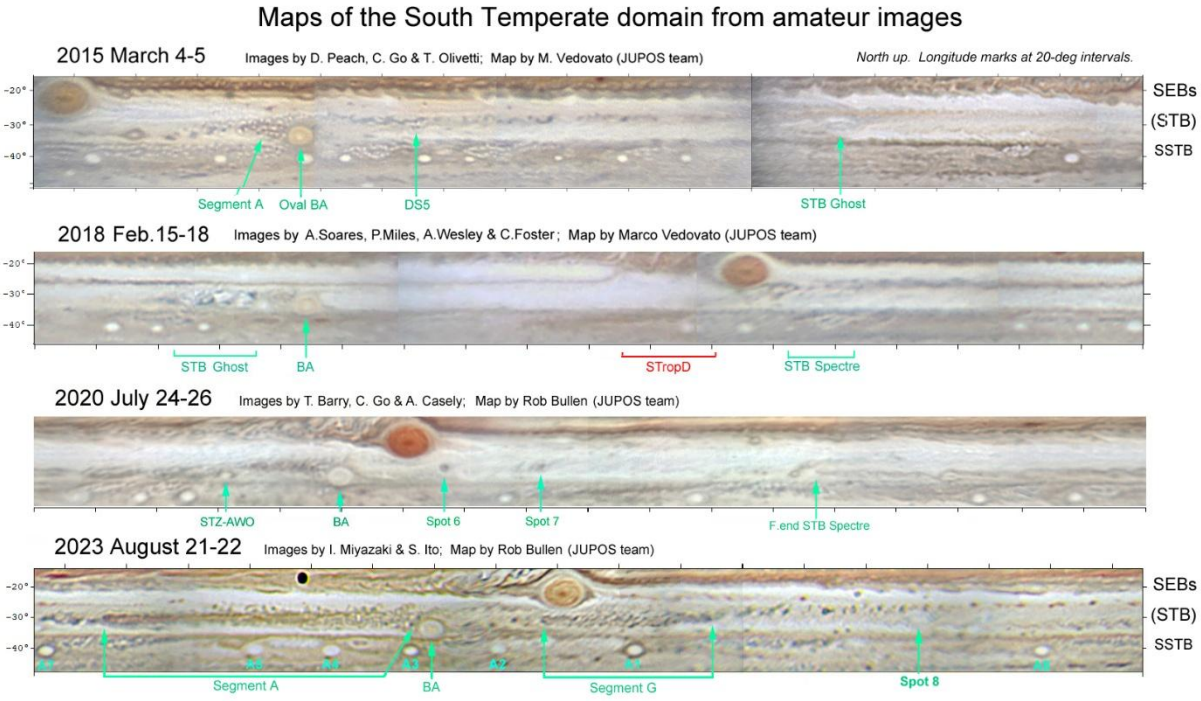

Figure 1b. Maps of the domain over the following years. (For full set from 2019 to 2024, see **Appendix B**. For JunoCam maps with flow patterns marked, see Figures 10 & 11.)

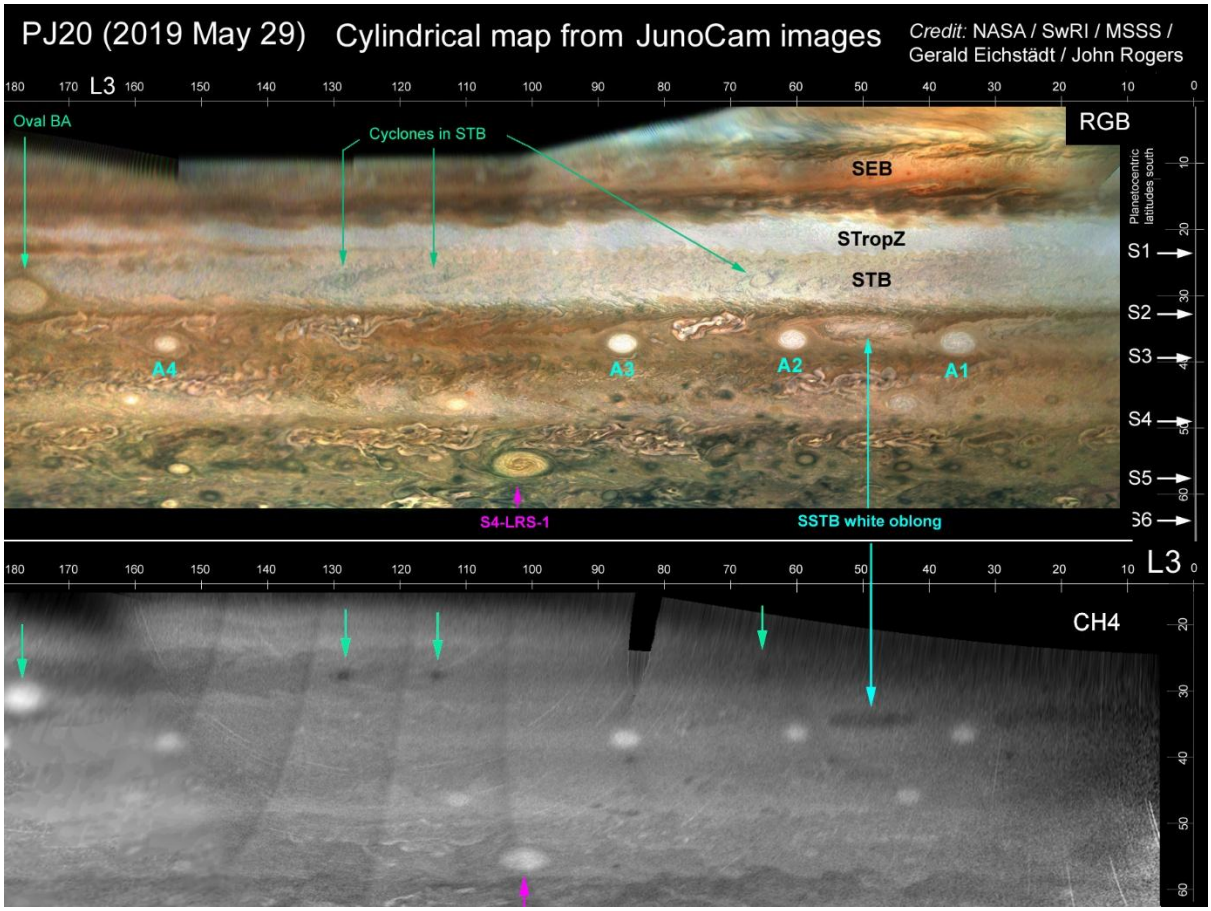

Figure 2. A pair of JunoCam maps at PJ20 showing an unstructured sector of the domain, in colour (RGB) and methane (CH4), with the latitudes of the jets marked. In both the S1 and S2 domains, anticyclonic ovals are methane-bright while cyclones and a cyclonic oblong are methane-dark.

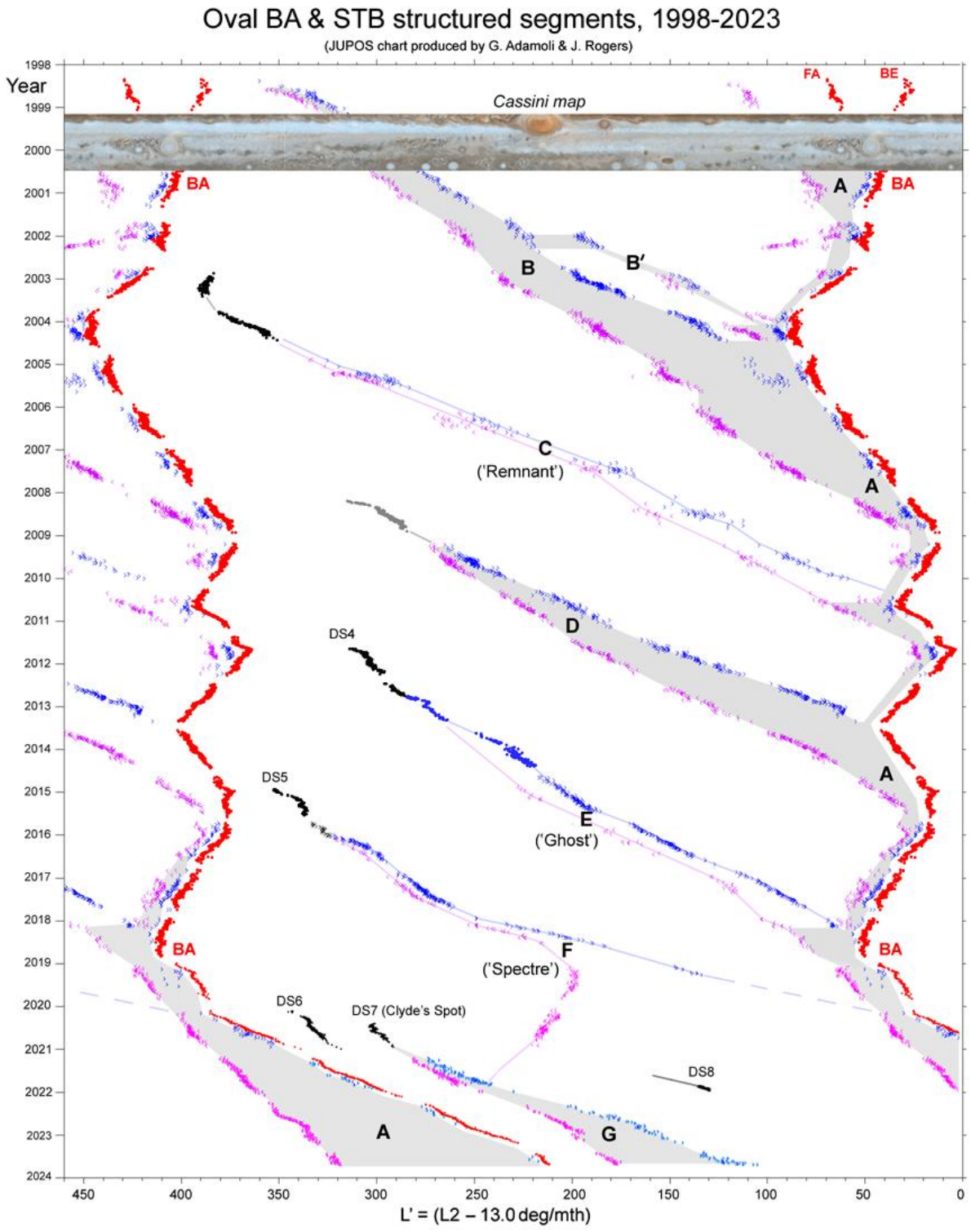

Figure 3. JUPOS chart showing the drifts of oval BA and the cyclonic structured sectors (B to G) from 1998 to 2023. Dark STB sectors are shaded.

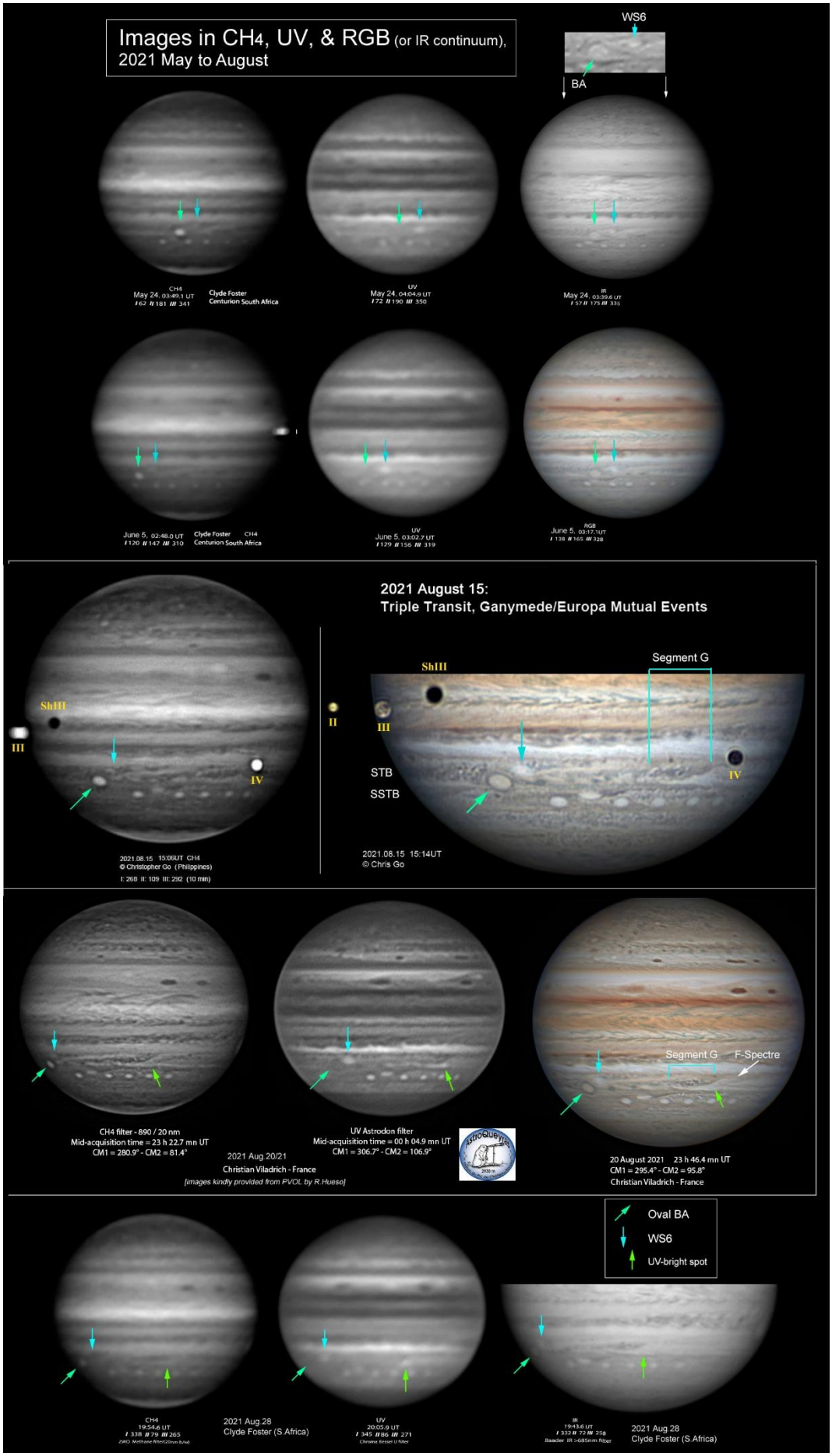
Images in CH4, UV, & RGB (or IR continuum),
2021 May to August
WS6
BA
CH4
May 24, 03:49.1 UT
I 62 II 181 III 341
Clyde Foster
Centurion South Africa
UV
May 24, 04:04.9 UT
I 72 II 190 III 350
IR
May 24, 03:39.6 UT
I 57 II 175 III 335
June 5, 02:48.0 UT
I 120 II 147 III 310
Clyde Foster CH4
Centurion South Africa
UV
June 5, 03:02.7 UT
I 129 II 156 III 319
RGB
June 5, 03:17.1UT
I 138 II 165 III 328
2021 August 15:
Triple Transit, Ganymede/Europa Mutual Events
ShIII
III
II
IV
2021.08.15 15:06UT CH4
© Christopher Go (Philippines)
I: 268 II: 109 III: 292 (10 min)
Segment G
STB
SSTB
2021.08.15 15:14UT
© Chris Go
CH4 filter - 890 / 20 nm
Mid-acquisition time = 23 h 22.7 mn UT
CM1 = 280.9° - CM2 = 81.4°
2021 Aug.20/21
Christian Viladrich - France
[images kindly provided from PVOL by R.Hueso]
UV Astrodon filter
Mid-acquisition time = 00 h 04.9 mn UT
CM1 = 306.7° - CM2 = 106.9°
Segment G
F-Spectre
20 August 2021 23 h 46.4 mn UT
CM1 = 295.4° - CM2 = 95.8°
Christian Viladrich - France
Oval BA
WS6
UV-bright spot
CH4
19:54.6 UT
I 338 II 79 III 265
2021 Aug.28
Clyde Foster (S.Africa)
UV
20:05.9 UT
I 345 II 86 III 271
IR
19:43.6 UT
I 332 II 72 III 258
2021 Aug.28
Clyde Foster (S.Africa)

Figure 4 *[on previous page]*, adapted from [Ref.R12].
Imaging in colour (RGB), the methane band (CH4, 889 nm) and near-ultraviolet (UV) reveals differences among individual features. Includes hi-res views of BA, WS6, and DS7 (Segment G) in 2021 May to August. The UV-bright spot is the small anticyclonic oval at the F-Spectre, which was just coming into contact with Segment G in Aug-Sep.

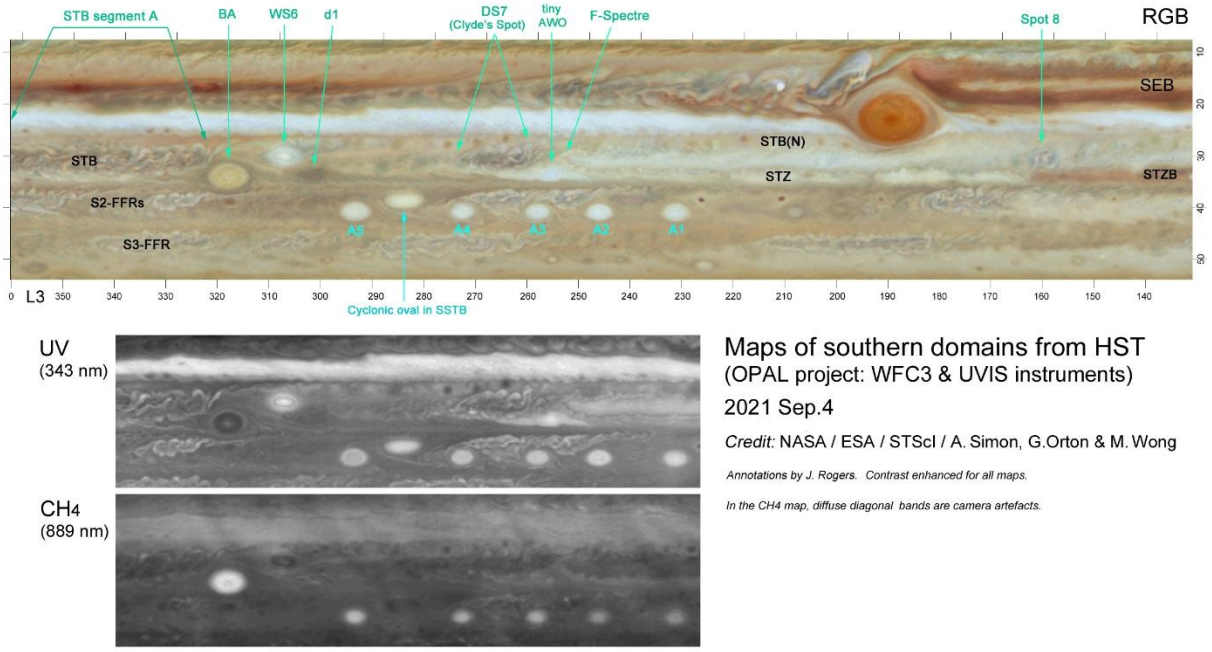

Figure 5, from [Ref.R12].
Maps from the Hubble Space Telescope OPAL project [Ref.P2]. Imaging in colour (RGB), the methane band (CH4, 889 nm) and near-ultraviolet (UV) reveals differences among individual features. Includes hi-res views of BA--WS6--DS7. By blinking two such maps taken ~10 hours apart, much detail of the winds in and around the indicated circulations could be seen [Ref.R12].

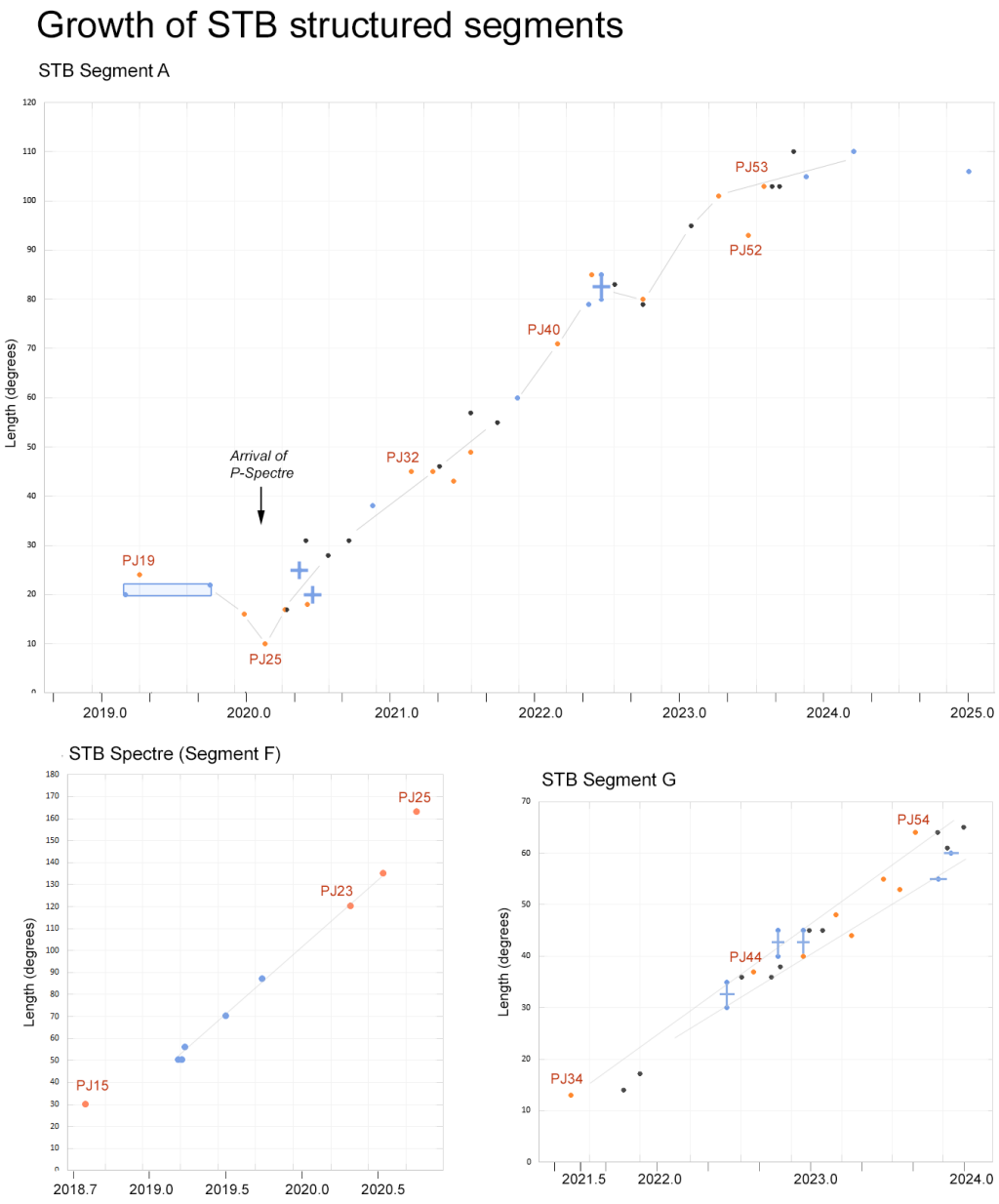

Figure 6. Growth of STB structured segments.
Black, measurements from amateur maps; orange, measurements from JunoCam maps; blue, consensus figures given in our interim reports. This is a preliminary sketch: many of these entries may be imprecise because the ends of the sectors were often ill-defined, but they are sufficient to show the overall trends, as indicated by lines.

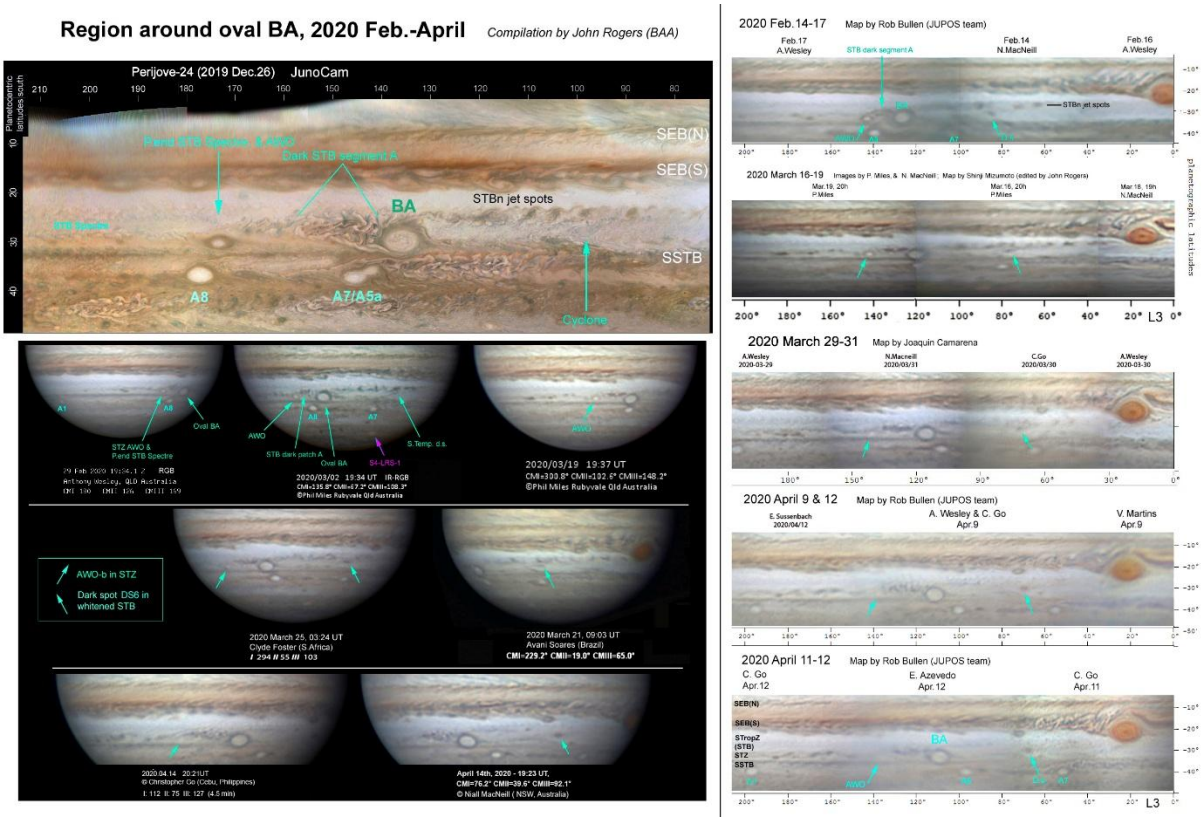

Figure 7, adapted from [Ref.R10]. JunoCam PJ24 & ground-based maps, showing oval BA as the P-Spectre arrives. The P-Spectre is distinct in the PJ24 map (2019 Dec.) but not thereafter, having contacted Segment A by late Feb., 2020. Segment A (just f. BA) reaches minimum size at that time then re-expands. AWO-b is prominent at its f. end. STBn jet spots are streaming p. BA from Dec. to March but not in April. The pale cyclone indicated in the PJ24 map evolves into the dark spot DS6 ('d.s.') from Feb. to April.

Section 3.1:

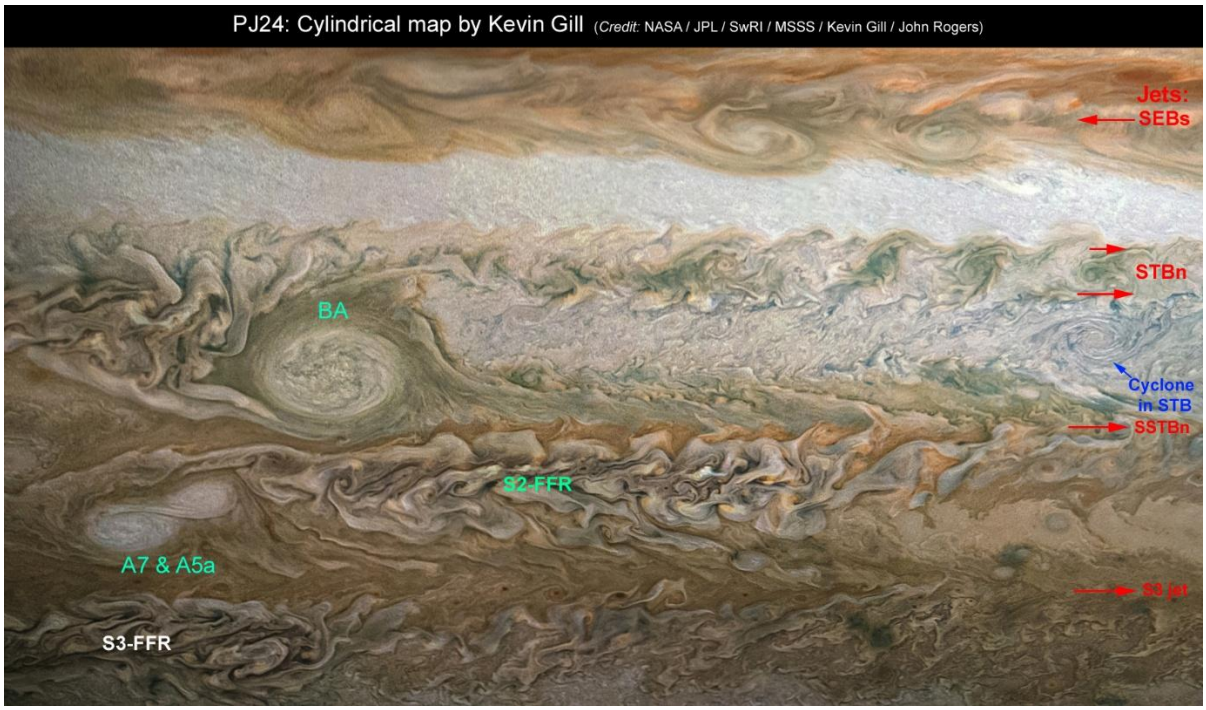

Figure 8. (Figures 8-10 are JunoCam labelled maps, showing oval BA & Segment A, copied from our perijove reports.) This is PJ24 (2019 Dec.26).

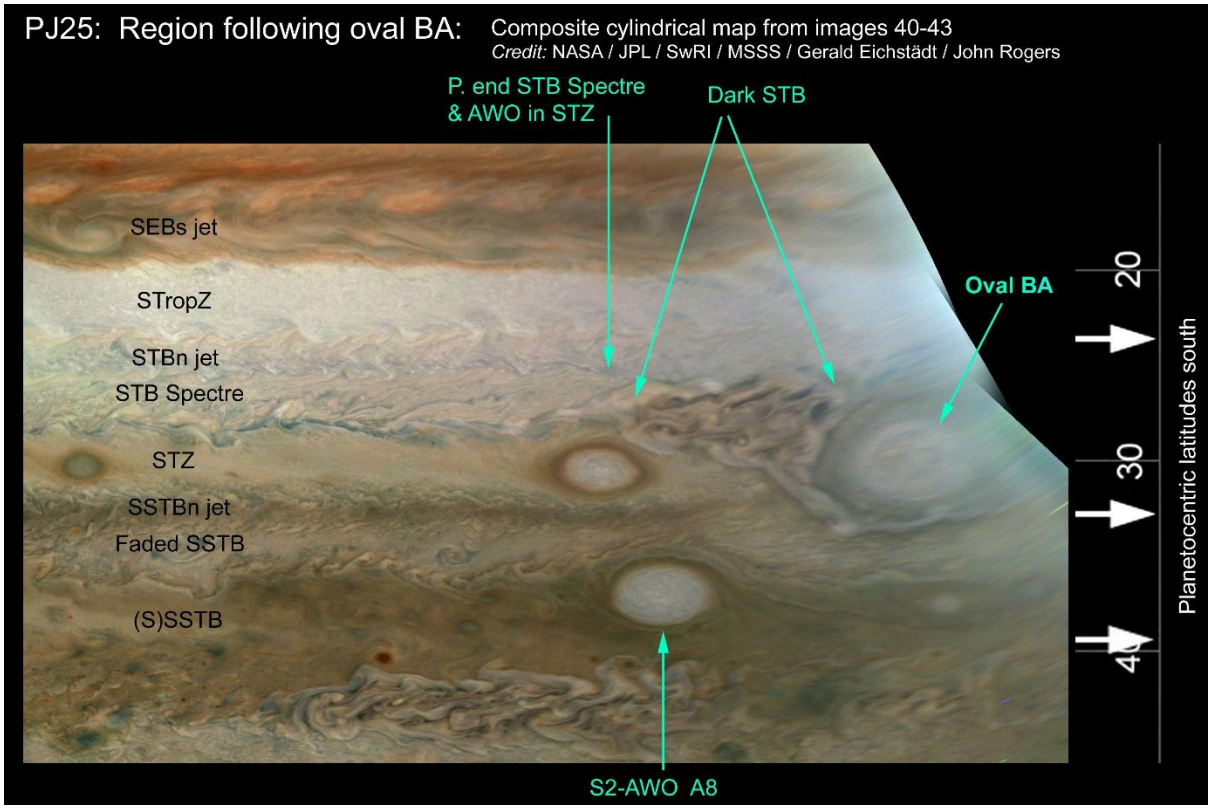

Figure 9. JunoCam map at PJ25 (2020 Feb.17), around the time that the p. end of the Spectre arrived at the short dark STB Segment A.

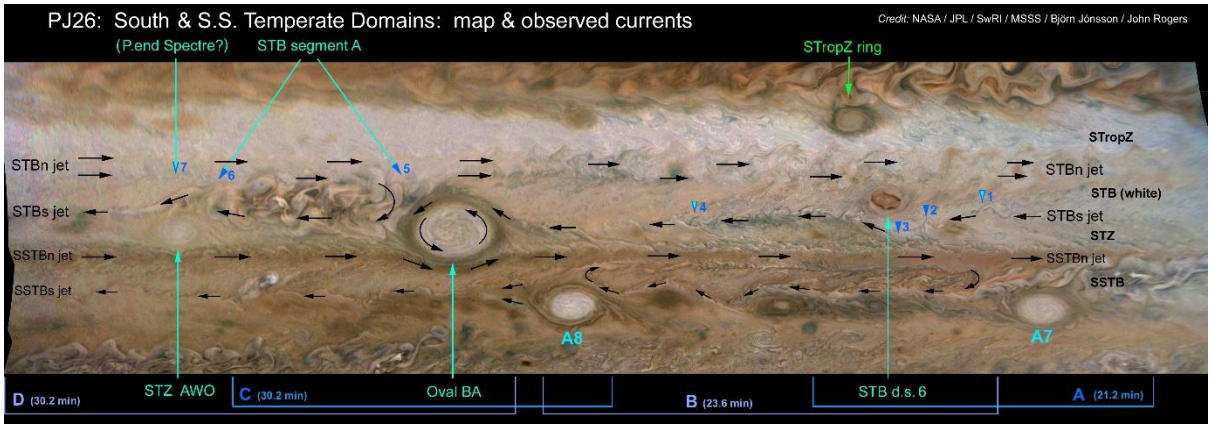

Figure 10. JunoCam map at PJ26 (2020 April 10). At PJ26, JunoCam obtained hi-res images including Spot 6 (DS6). Pairs of hi-res maps were blinked in Animations A to D covering the longitude ranges indicated, and winds observed are marked diagrammatically on this hi-res map from Björn Jónsson.

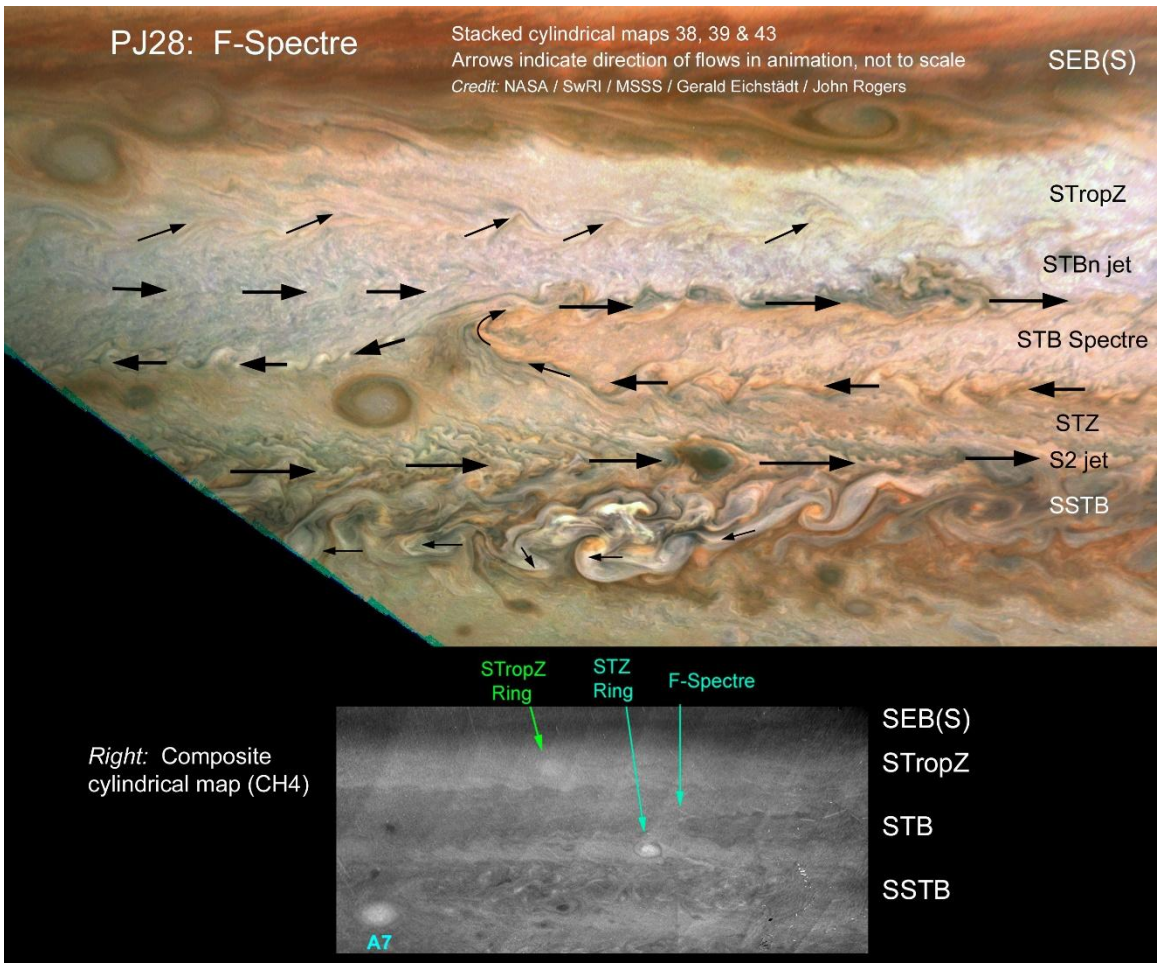

Figure 11. JunoCam map at PJ28 (2020 July 25), with a methane-band map at 1/3 scale, showing the f. end of the STB Spectre. Motions observed by blinking two maps are indicated diagrammatically.

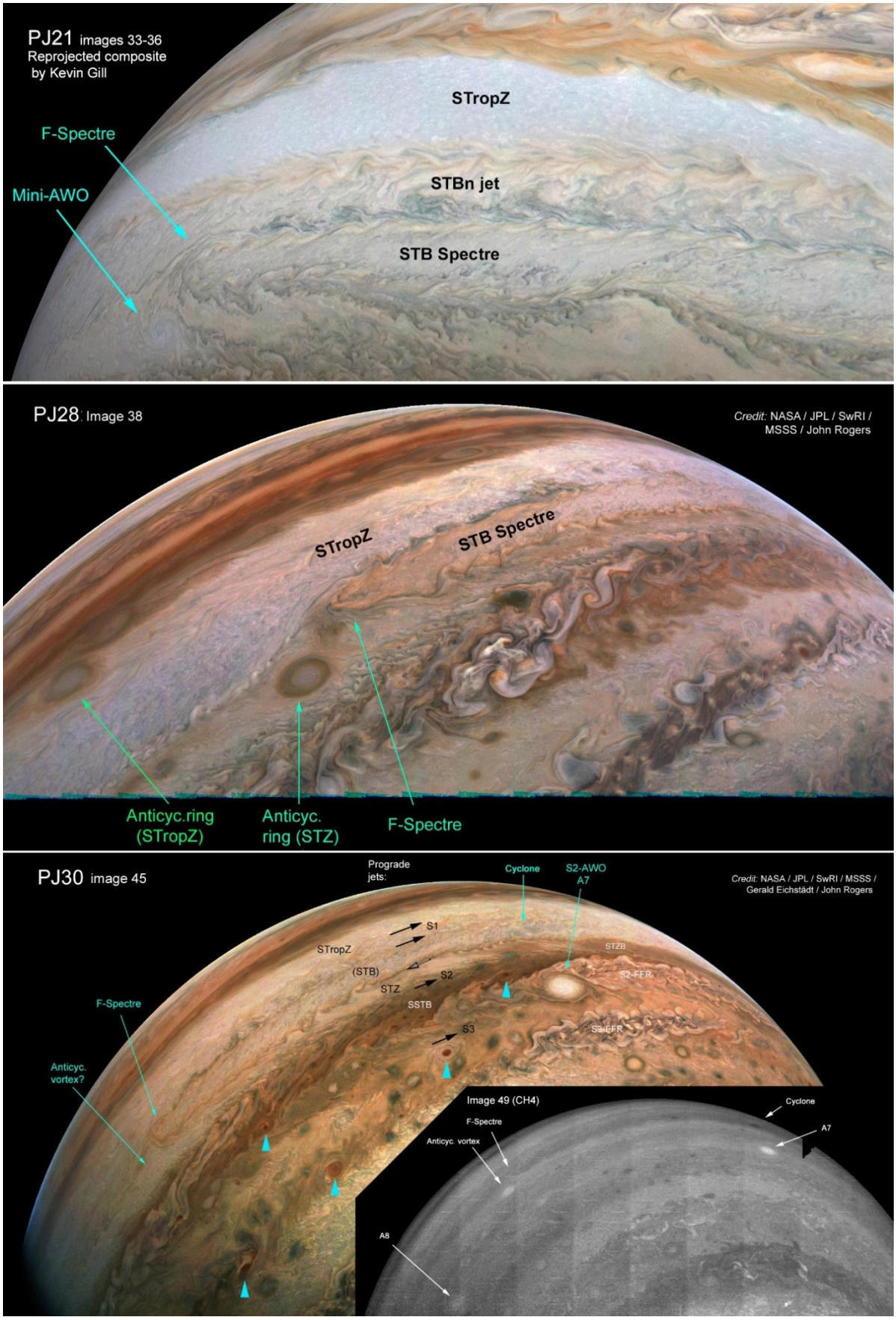

Figure 12. Images of the STB Spectre (f. part) at PJ21 (2019 July 21), PJ28 (2020 July 25), & PJ30 (2020 Nov.8), at full resolution, plus a methane-band image at half resolution.

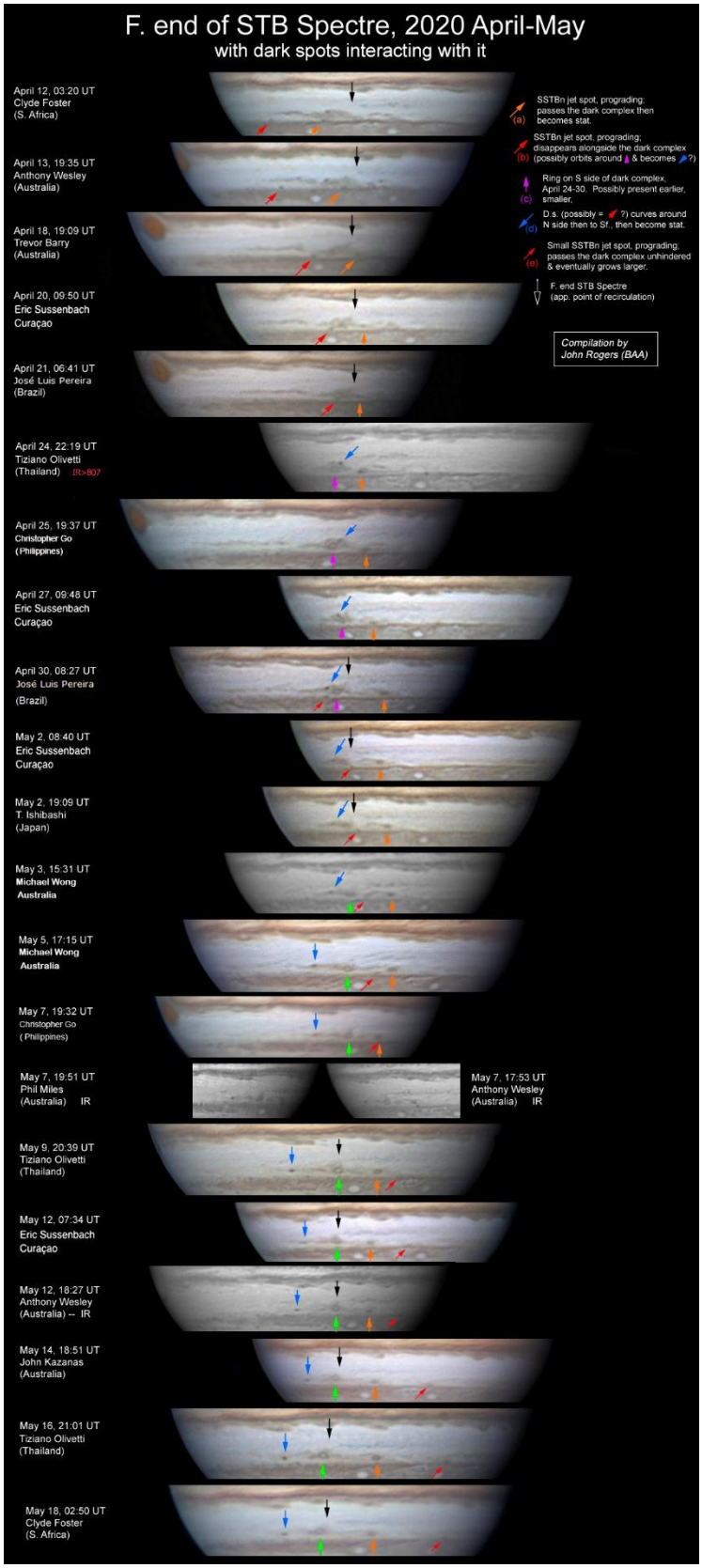

Figure 13 [from Ref.R11]. Motions of tiny features near the F-Spectre, possibly involved in the 'recirculation loop' (details are given on the figure). SSTBn jet spots approaching the F-Spectre would be expected to disappear or recirculate here, but in 2020 April/May one disappeared into the dark complex, one passed it then halted, and one passed it unhindered.

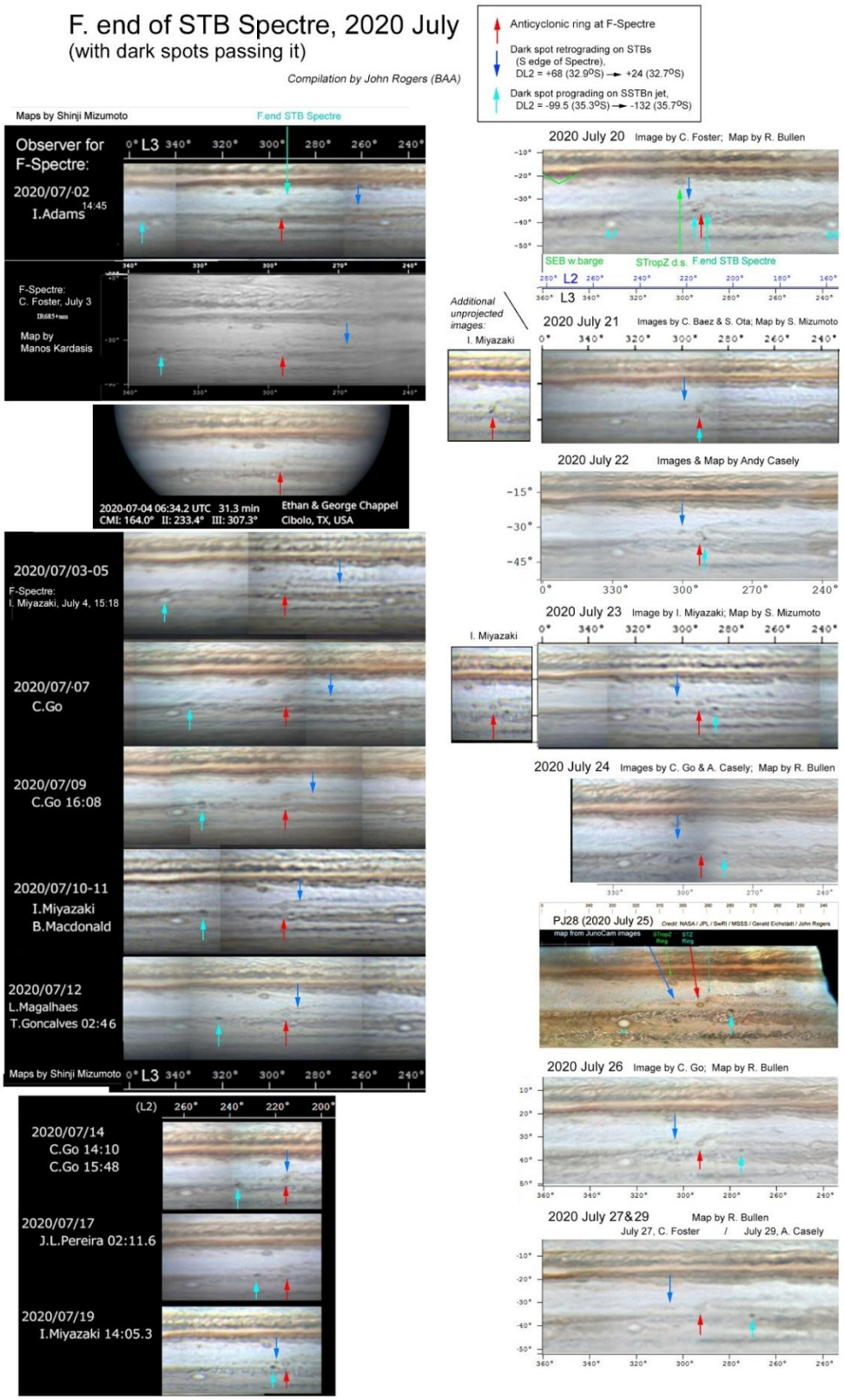

Figure 14. New composite of maps in 2020 July, continuing the record of motions at the F-Spectre after Fig.13. A STBs jet spot passes the F-Spectre on July 14 and abruptly decelerates. A SSTBn jet spot passes the F-Spectre unimpeded on July 21, though it is displaced southwards into a faster latitude. It had DL2 = -99.5 (u_3 = +36.8 m/s) at 35.2 (±0.3)°S up to July 21, then -131.8 (u_3 = +49.4 m/s) at 35.7 (±0.3)°S from July 25 onwards, which suggests that passing alongside the Spectre has pushed it southwards into the SSTBn jet peak.

Section 3.2f:

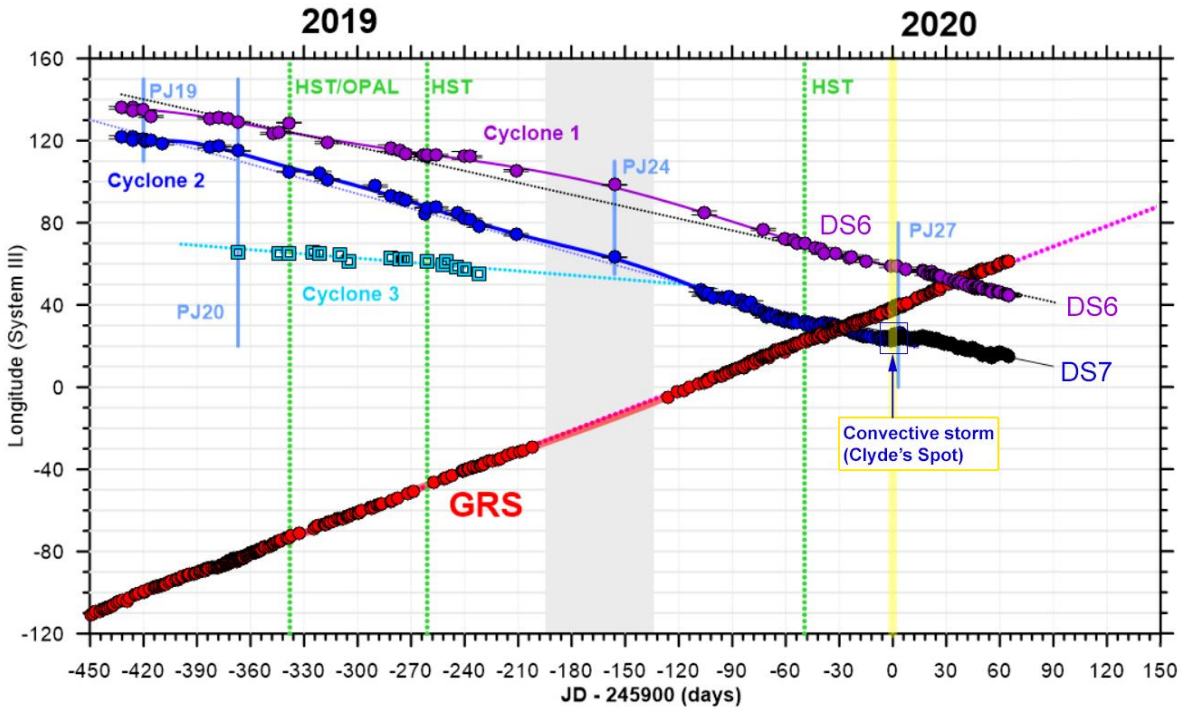

Figure 15 [adapted from Hueso et al., Ref.P3]. Tracking of small pale cyclones in the whitened STB (nos.1,2,3) which transformed into spots DS6 and DS7. From images by HST, Juno (PJ20 to PJ27), and ground-based observers.

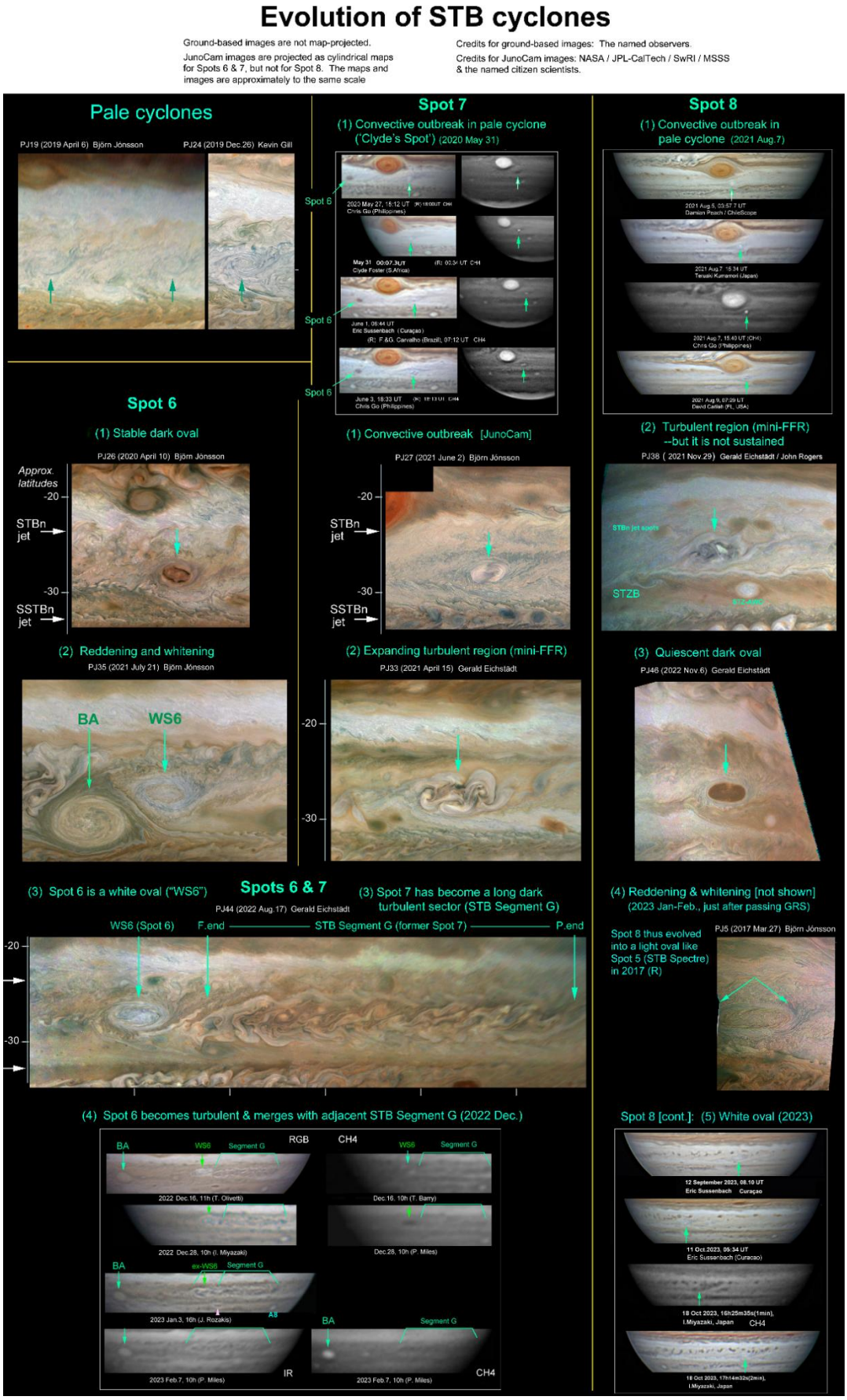

Figure 16. Overview of spots, 6, 7 & 8, showing their various transformations.

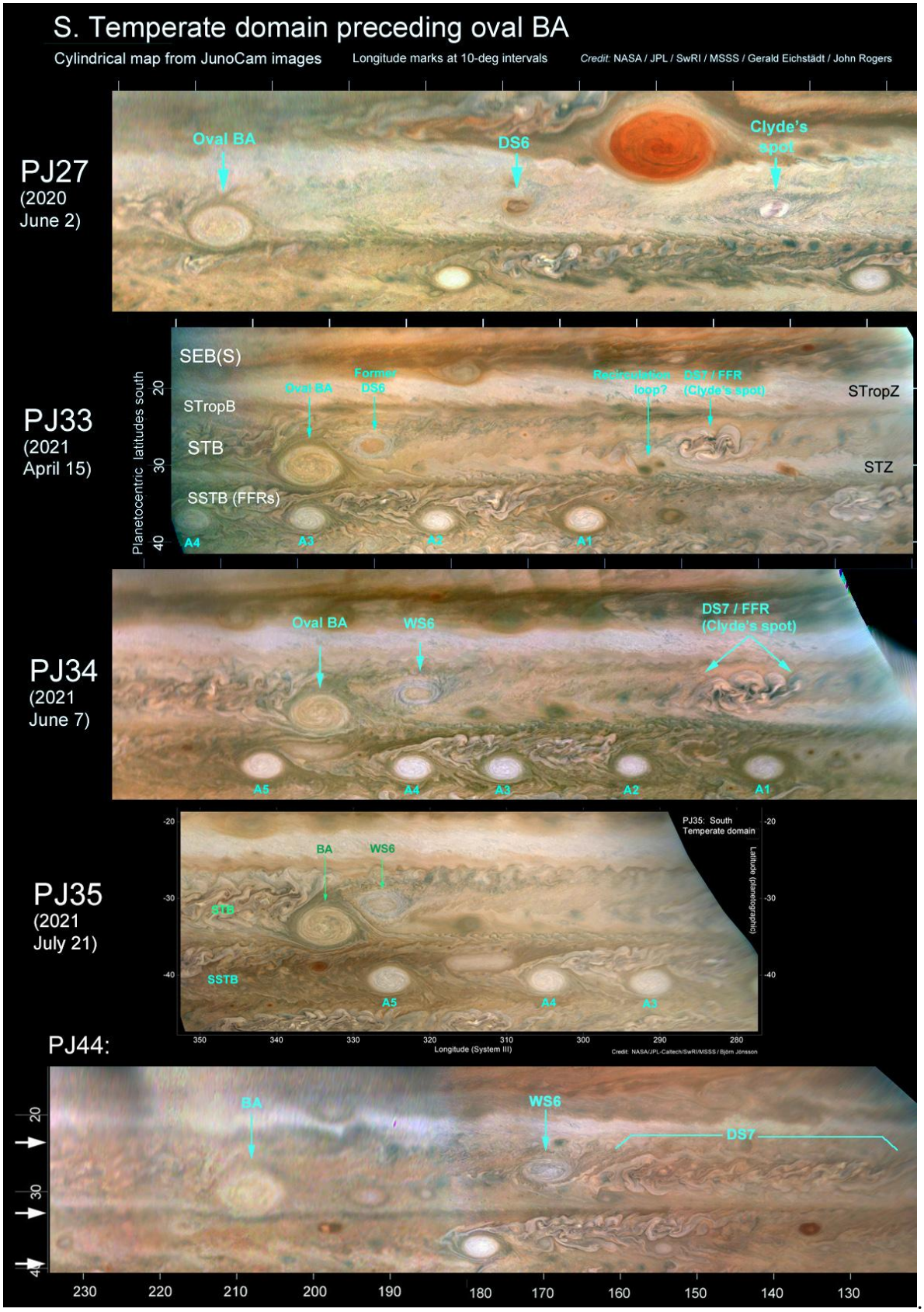

Figure 17. JunoCam maps from PJ27 to PJ35, & PJ44. These show Oval BA, Spot 6 (transforming from DS6 into WS6) and Spot 7 (Clyde's Spot transforming into DS7 as an expanding FFR).

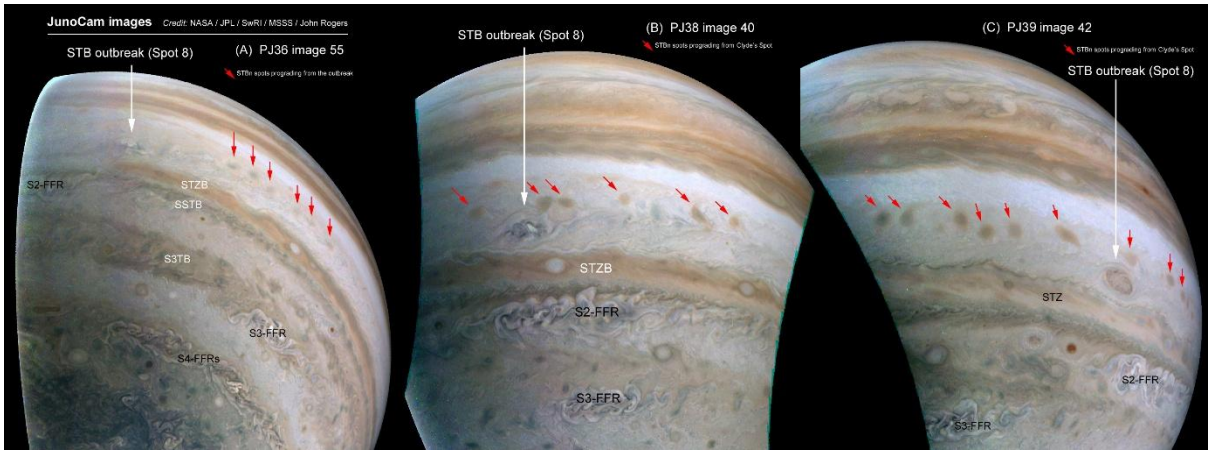

Figure 18. JunoCam images, PJ36-PJ39, showing Spot 8 & STBn jet spots.

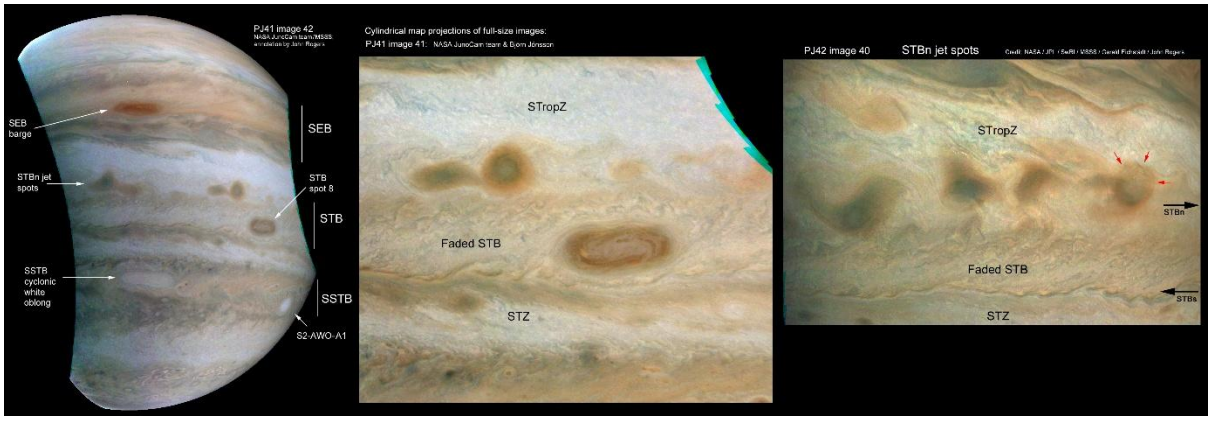

Figure 19. JunoCam image at PJ41 (Spot 8 & STBn jet spots) and closeup of STBn jet spots at PJ42.

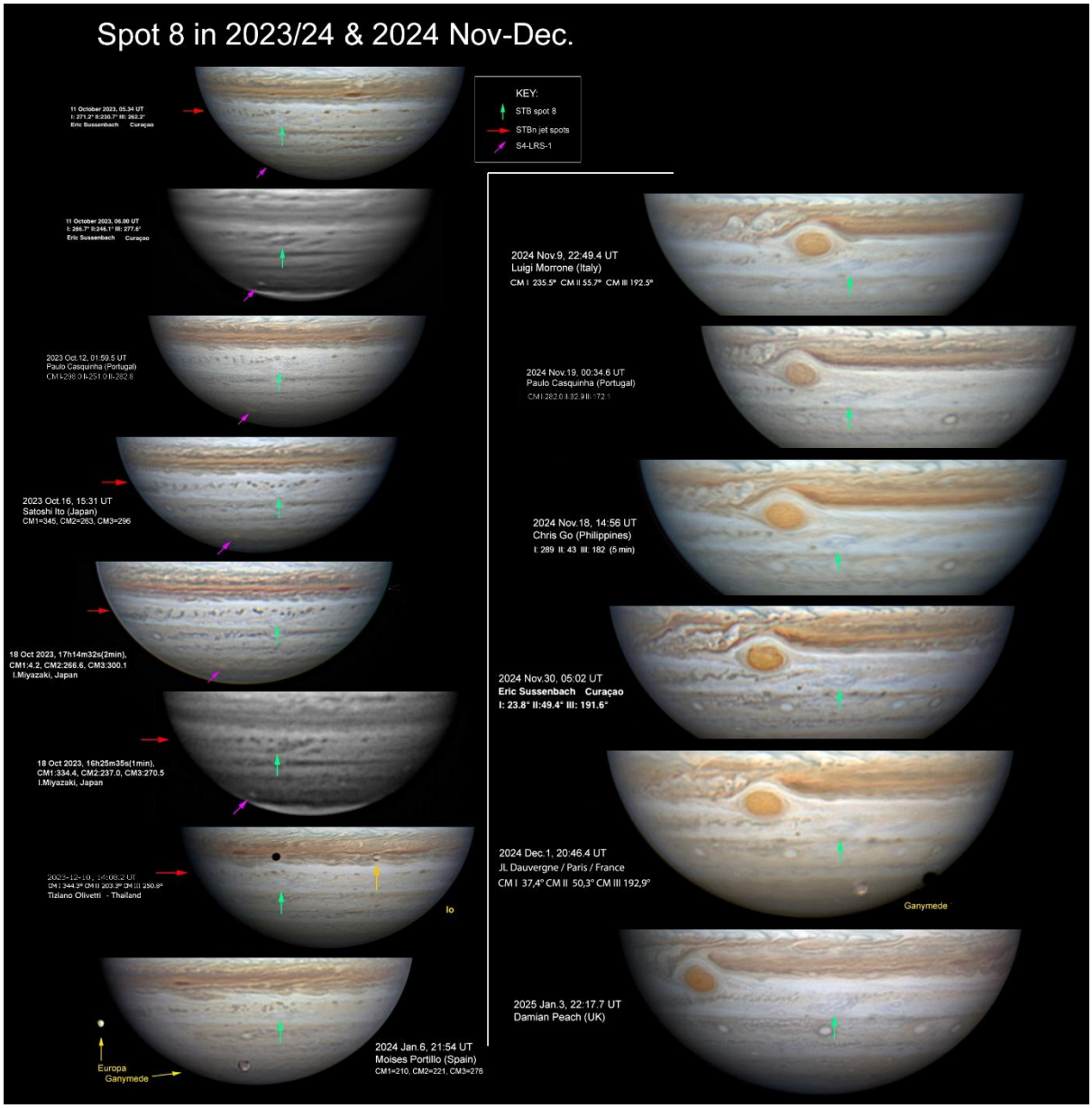

Figure 20. Spot 8: new compilation of hi-res ground-based images in 2023 & 2024. Note also the smaller cyclone ~20° p. Spot 8. CH4 images show that both were methane-dark, esp. their pale bluish envelopes.

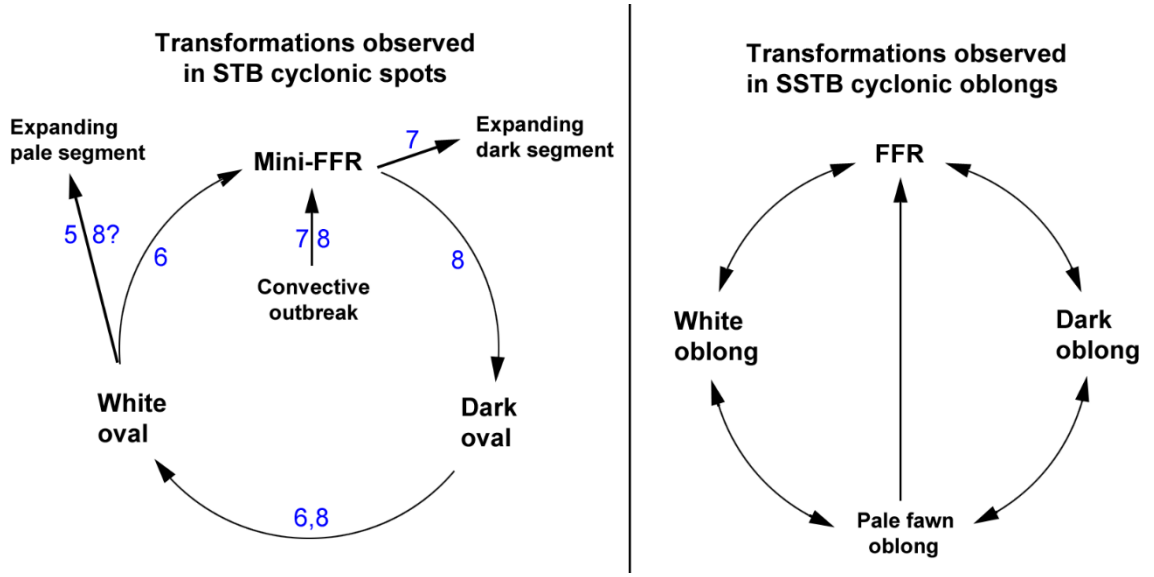

Figure 21. Diagram of observed transformations of cyclonic circulations in the STB and SSTB.

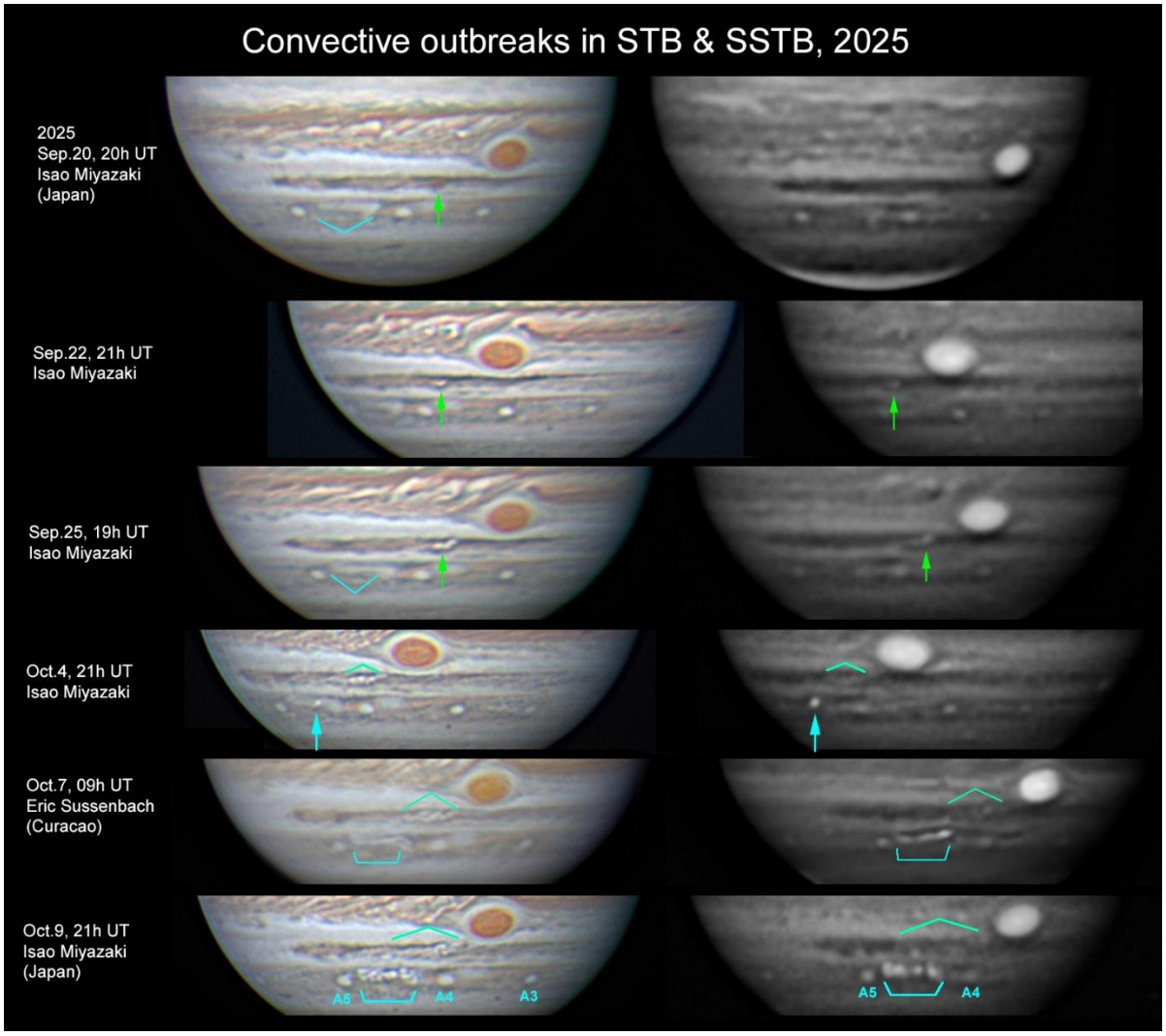

Figure 22. Early stages of the outbreaks in the STB (2025 Sep.) and SSTB (2025 Oct.), from Ref.R17.

Section 4.1 (Segment A etc):

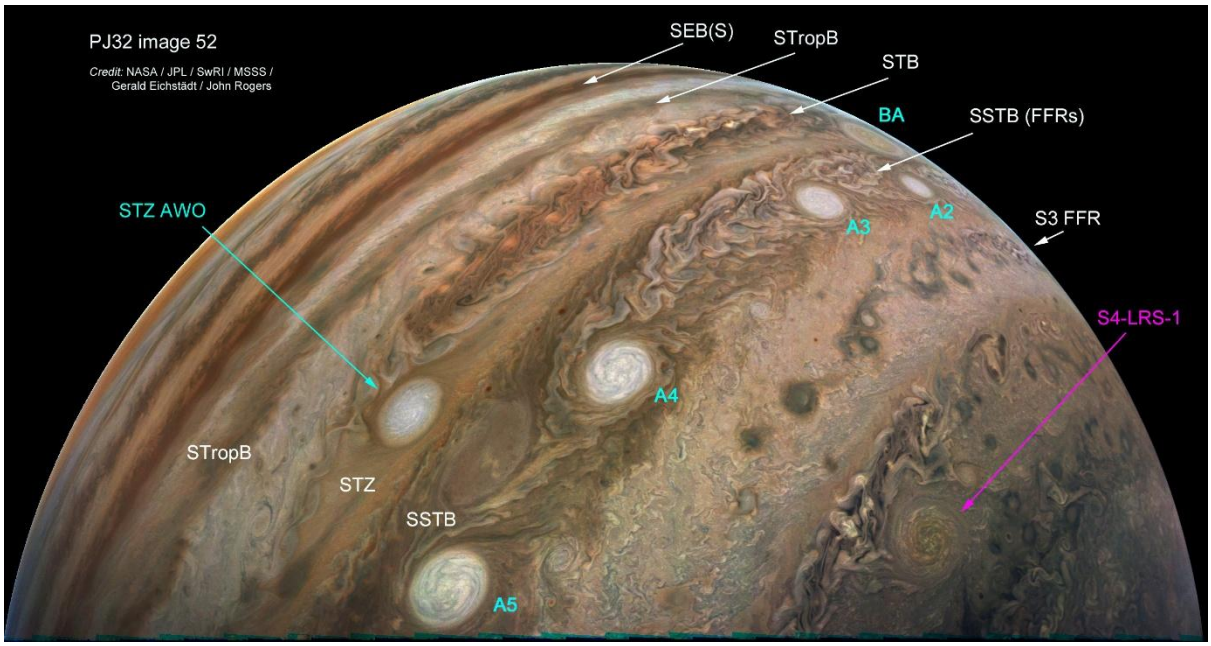

Figure 23. JunoCam image at **PJ32** (2021 Feb.21), covering STB Segment A, containing turbulence on different scales in its p.(R) and f.(L) parts. Above the STB is a dark grey S. Tropical Band, and the space between them is filled with a chaotic tangle of cloud structures, between the two components of the STBn jet. STZ AWO-b is conspicuous.

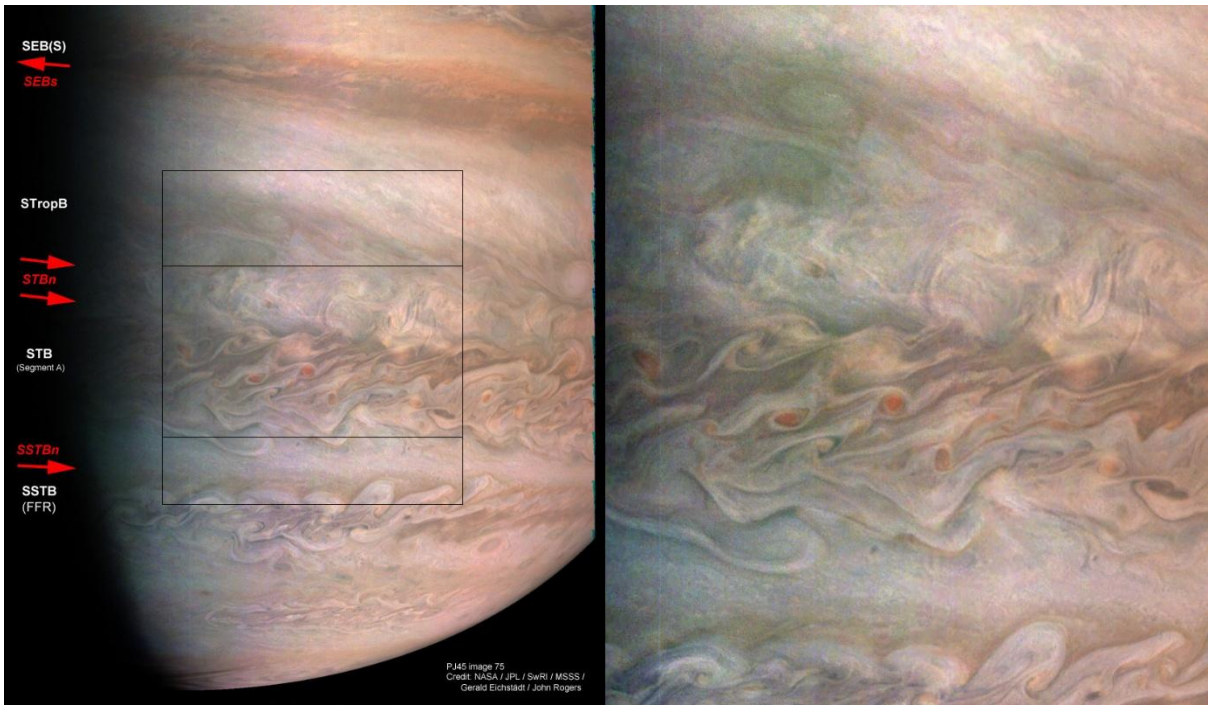

Figure 24. JunoCam image at **PJ45** (2022 Sep.29), covering STB Segment A, containing turbulence on different scales in its p.(R) and f.(L) parts. Above the STB is a dark grey S. Tropical Band, and the space between them is filled with a chaotic tangle of cloud structures, probably between the two components of the STBn jet.

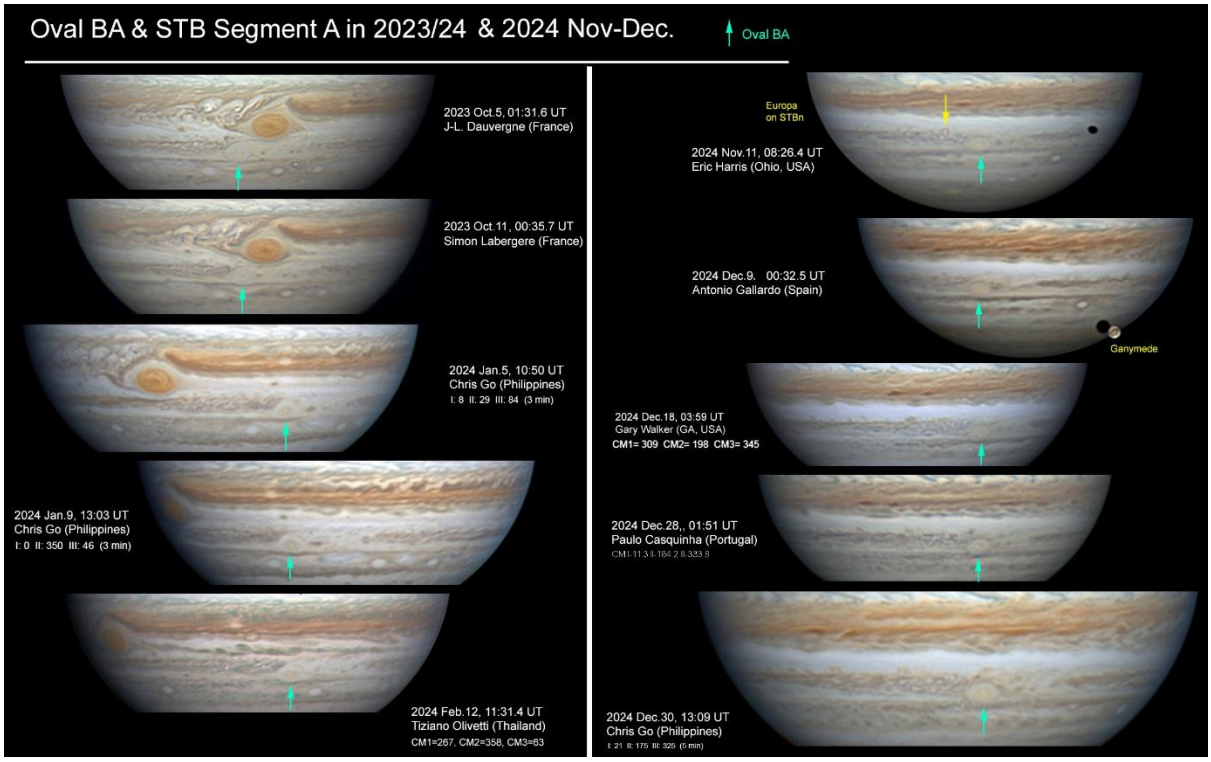

Figure 25. Oval BA and Segment A: new compilation of hi-res ground-based images in 2023 & 2024.

Section 4.2 & 5: ZDPs & ZWPs

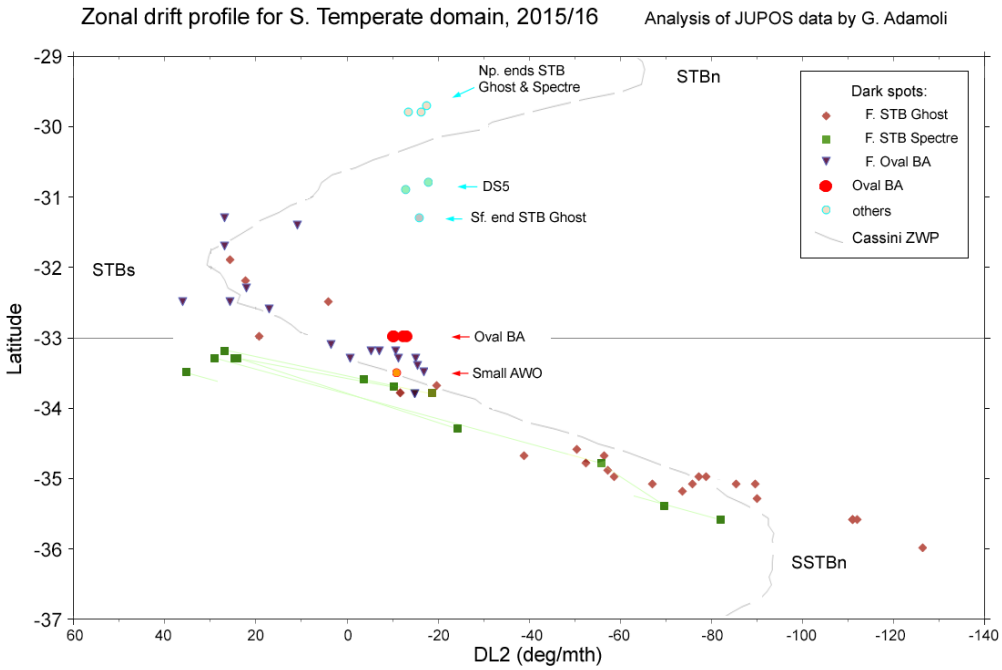

Figure 26. ZDP for the domain in 2015-16. [From Ref.R8. This was not included in Ref.R2]. Light green lines connect points for individual spots with variable tracks f. the STB Spectre. The Cassini ZWP [Ref.P5] is shown for reference.

Figure 27. Full set of ZDPs, 2019-2023 *[on next page]*.

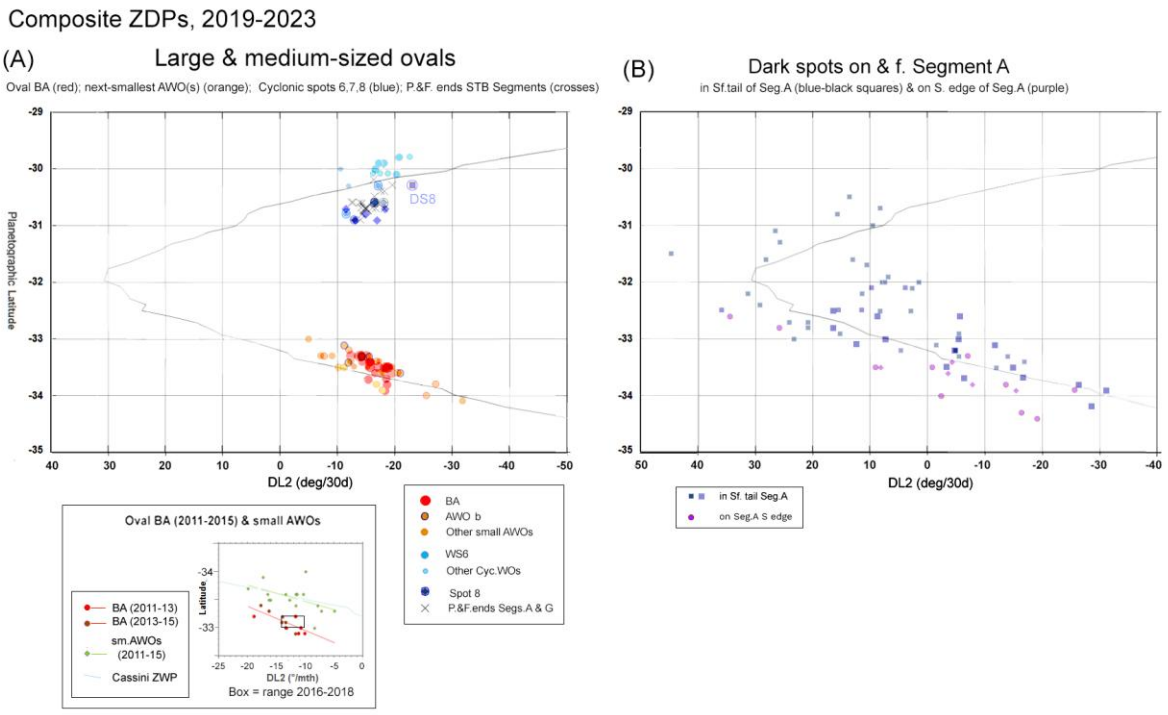

Figure 28. Collected ZDPs for (A) BA and smaller AWOs and (B) Segment A and its Sf. tail. Data from different years in Fig.27 are here overlaid. Inset at lower left is the ZDP for oval BA in earlier years, adapted from from Ref.R2.

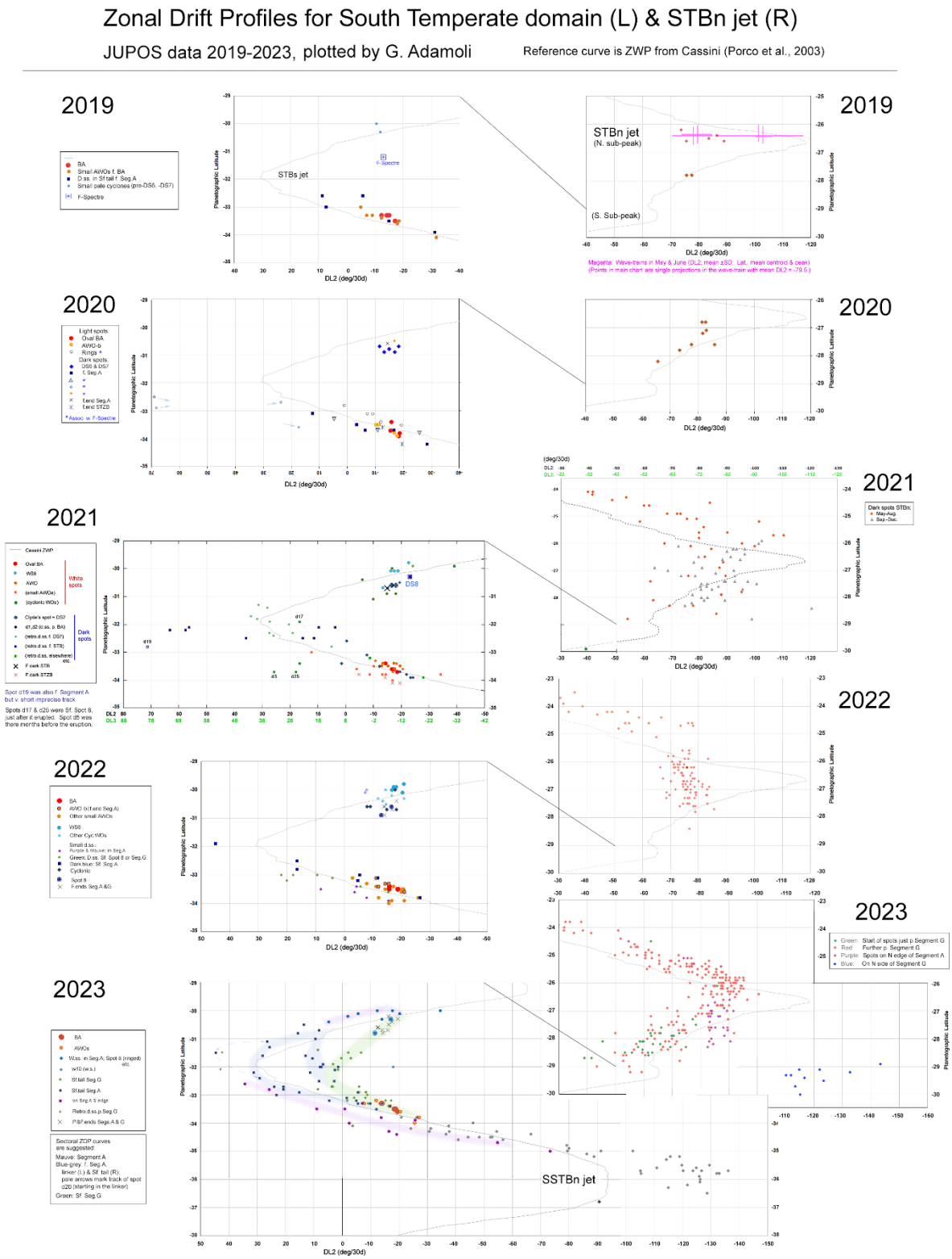

Figure 27. ZDPs for the S. Temperate domain (L) and STBn jet (R), for 2019 to 2023, from JUPOS data analysed by G. Adamoli; most of this is previously unpublished. The Cassini ZWP [Ref.P5] is shown for reference.

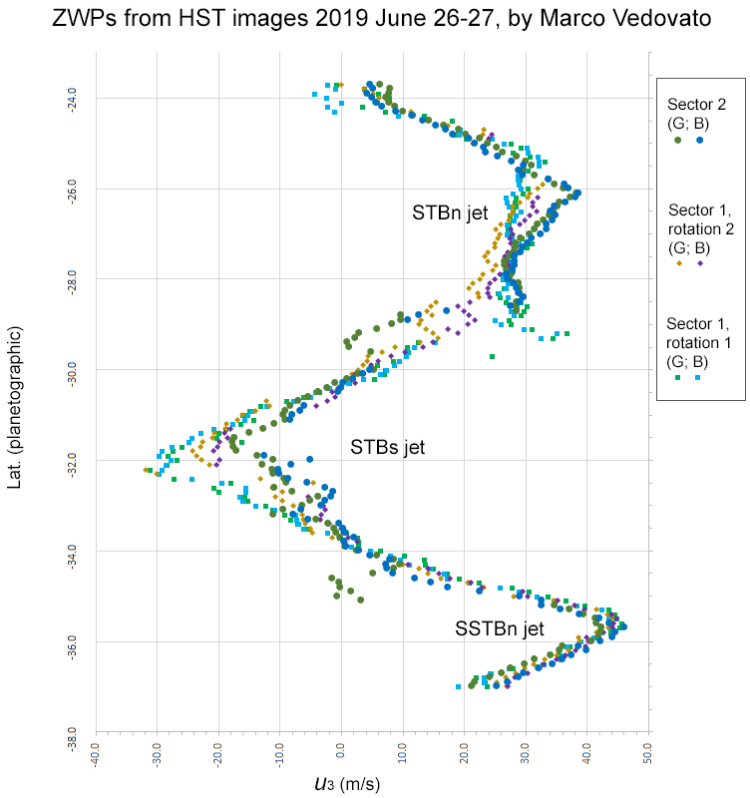

Fig.29. ZWP from HST images on 2019 June 26-27, by M. Vedovato.

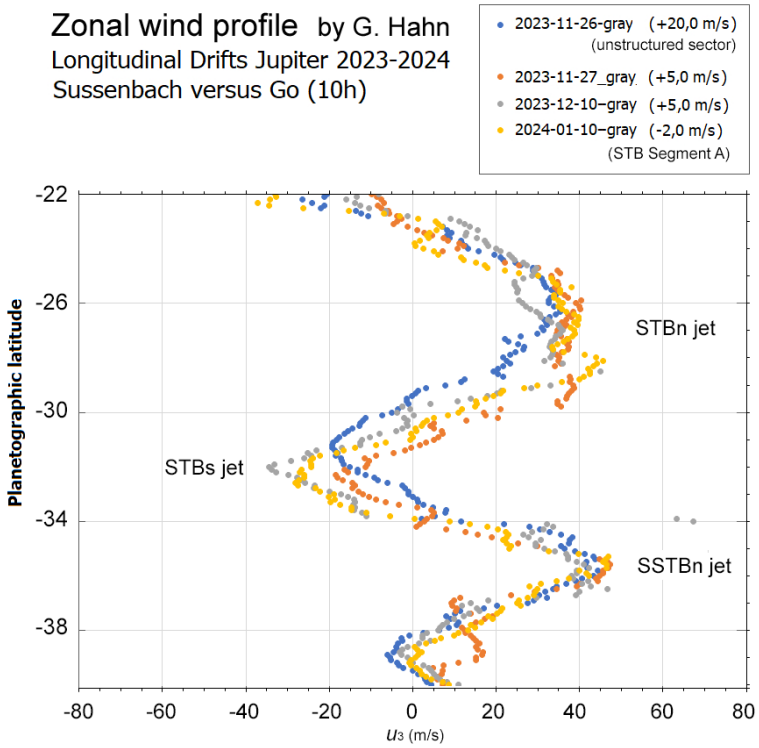

Fig.30. ZWP from ground-based images between 2023 Nov. and 2024 Jan.10; images by E. Sussenbach and C. Go, ~10 hours apart; ZWPs by G. Hahn.

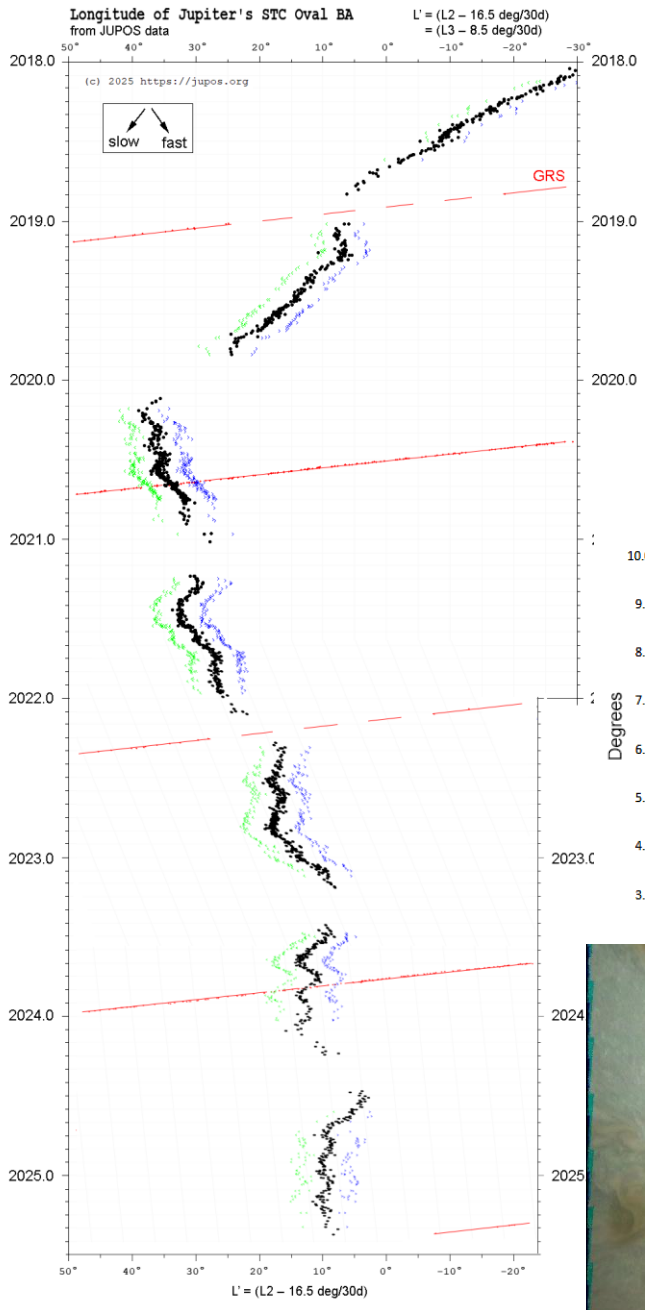

Fig.31. JUPOS chart showing drift of Oval BA, in a special longitude system.

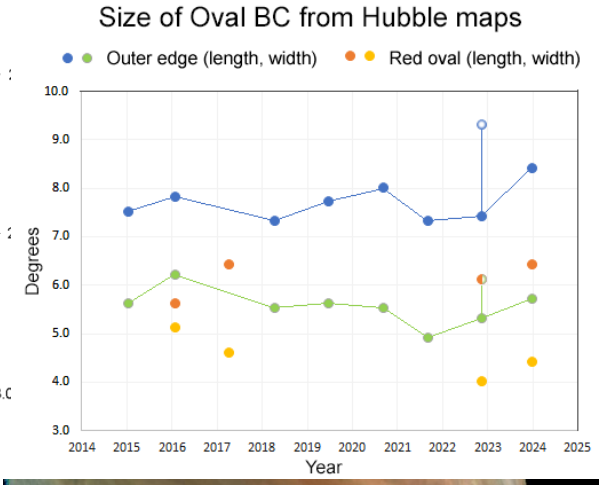

Fig.32 *[upper right]*. Dimensions of Oval BA measured from Hubble (OPAL) maps [Ref.P2] by J.H.R.

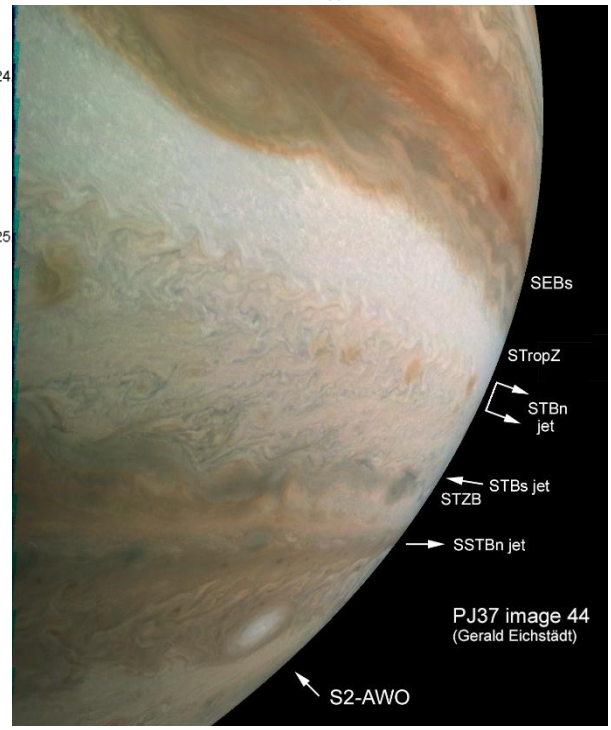

Fig. 33. JunoCam image at PJ37.
Includes wavy structure on the STBn and STBs jets. STBn jet spots are translucent brown disks overlying white streaks with no evident vorticity.