

## **Jupiter in 2023/24: Report no.4: Jupiter at PJ57; a pair of impacts; and a 50<sup>th</sup> anniversary.**

John Rogers (BAA) (2024 March 3)

This is a summary of some notable events in 2023 Dec., although posted a couple of months late. (1) 50<sup>th</sup> anniversary of the first visit to Jupiter. (2) Two fireballs in 24 hours. (3) Amateur support for Juno's PJ57. (4) Summary of developments on the planet.

**(1) 50<sup>th</sup> anniversary of the first visit to Jupiter.** We passed this anniversary back in December – but let's celebrate it now. The first spacecraft flyby of Jupiter, by Pioneer 10, took place on 1973 Dec.4. [Figure 1](#) is Pioneer 10's best image of Jupiter.

For comparison, [Figure 2](#) and [Animation-1](#) show modern amateur images (2023 Dec. 1-10). Amateurs can now record more detail from Earth than Pioneer 10 could record up close! This series gives a comprehensive view all round the planet. The animation is another of the blink pairs from images taken 10 hours apart by Chris Go and Eric Sussenbach (also see Report no.3).

Fifty years on, we are again comparing amateur observations with images from a spacecraft, Juno. (I have been doing this for a long long time: [Figure 3](#).) In the interim, there have been superb flybys by Voyager 1 & 2, Galileo, Cassini, and New Horizons. But Juno is the first *spinning* spacecraft to take images at Jupiter since Pioneers 10 and 11 (and the first to fly over the polar regions since Pioneer 11 in 1974). Like the Pioneers, it takes images by scanning rather than snapshots, while its main instruments study the atmospheric thermal emissions and the magnetosphere – but of course the technology, and the image quality, are incomparably better. *This bulletin is posted simultaneously with our report on the PJ57 images, also on this web site.*

### **2. Two fireballs 24 hours apart!**

Two impact flashes on Jupiter had already been reported in 2023, but on Dec.28 and 29, two more were reported almost exactly 24 hours apart – the 12<sup>th</sup> and 13<sup>th</sup> recorded since 2010. Ricardo Hueso has summarised these events.

(1) Efrain Morales Rivera (Puerto Rico) saw a likely impact on his screen on Dec.28 at 23:52 UT, and reported it, but was not recording at the time. Conrado Serodio (Brazil) then searched his video and found just a single frame that showed a faint flash at that time ([Figure 4](#)). This was much fainter and briefer than most such fireballs, but both observers are well experienced and their positions (on the limb near 12°N) agreed well, so it seems likely to be a real event.

(2) Andres Arboleda (Colombia), reported a flash on Dec.29 at 23:57 UT, this time with a video detection (<https://www.facebook.com/andres.arboleda.5099>), fully on the disk of the planet at 30°N ([Figure 4](#)). It lasted 1.4 seconds in his video. JunoCam imaged the site of Arboleda's fireball 12 hours later ([Figure 5](#)). It showed nothing unusual there, although this was a very valuable observation, as it was the soonest spacecraft imagery for any of impact site since the Comet Crash in 1994.

**(3) Images supporting Juno's Perijove-57 on Dec.30** were obtained by many observers in the preceding 10 days. [Figure 6](#) is a compilation of some showing the longitudes that JunoCam imaged at best resolution, cropped to show the NEB. (*The full-size images are in the attached ZIP file.*) This sector is full of important features and was well imaged by JunoCam at PJ52, PJ55, PJ56, and PJ57. [Figure 5](#) is a hi-res JunoCam image of this region during the PJ57 approach on Dec.30 (*see also the PJ57 report*).

At left is White Spot Z, the long-lived AWO. 'ADS' is an anticyclonic dark spot (oval), created in 2023 Oct. in the early days of the rift system (see our 2023/24 Report no.1). In Nov. it apparently shrank to a small dark dot in a light ochre patch, which is here revealed to be the original oval, now with a pale ochre colour. At right is a typical dark brown barge, with another rift wrapping cyclonically around it, and a small brilliant plume to the south. These were rapidly evolving features; [Figure 6](#) shows NEBs dark formations and bright plumes passing the ovals and barges, with many tiny bright spots in the NEB(S). One of the latter expands suddenly between Dec.25-27, to send a bright streamer

(‘rift’) swirling north over the p. end of the barge, while a long, less bright streamer stretches Nf. past the orange ADS.

In the centre of the group is the longest faded barge, 21° long, which still has a distinct outline in the JunoCam image (Figure 5), although its contrast is very low and it is overlaid by light-coloured streamers of cloud from the rift system. It is also overlaid by mesoscale waves, with a wavelength of 1.15° (1390 km), similar to those recorded in this same sector at PJ52. They are aligned with the expected retrograde flow along the N edge of the faded barge, and may form where the jet is accelerated by the barge circulation.

Figure 7 is a global map on Dec.30-31, produced by Rob Bullen. (He also produced a north polar projection map, which is included in the PJ57 report to show how amateur images can faithfully record features in the north polar region.)

#### (4) Summary of developments on the planet in 2023 Dec.

**NEB:** The NEB has continued to grow more active, particularly since the vigorous rift system appeared, beginning with the brilliant mid-NEB plume on 2023 Oct.8 [Report no.1]. Shinji Mizumoto has continued to track this rift system and dark spots produced from it, and details will be given in a subsequent report. The rift system has become extensive, and dark NEB material has been spreading north towards the NTropZ at many longitudes (e.g. Figures 1, 6 & 7).

We wished to know whether this rift system qualified as the slow, northerly type which are associated with NEB expansion events; they typically drift slower than  $DL2 = -2.8$  deg/day, being at  $\sim 13-14^\circ N^*$ . The plume in Oct. began with a latitude of  $\sim 12.5^\circ N$  and was most often centred at  $\sim 13^\circ N$ , though sometimes spreading more widely, so its latitude was not diagnostic. But its speed has been measured by Mizumoto as  $DL2 = -2.4$  deg/day in Oct., then  $-1.75$  deg/day in Nov. & Dec., definitely in the ‘slow’ range for NEB rifts. This suggests that the increased darkening northwards at present, and the dark spots that have appeared in the NTropZ, may indeed represent a slowly developing NEB expansion event. This is 3-4 years after the 2020 event, which would be normal, except that it implies the cycle has been unaffected by the extreme fade and quiet revival of the NEB in 2021-22!

\*[Ref: Rogers JH (2019 Feb.) JBAA 129 (no.1), 13-26. ‘Jupiter’s North Equatorial Belt and Jet: I. Cyclic expansions and planetary waves.’ <https://britastro.org/node/9140>.]

**SEB:** The rifted region f. the GRS has been quite active throughout this apparition, with frequent methane-bright plumes [Report no.1]. In mid-Nov. it began to expand further, with appearance of new white plumes at higher longitudes: Nov.15, at  $L2 = 82$ ; Dec.7, at 96; Dec.20, at 101; Dec.29, at 103; Jan.10, at 107. (The GRS was at  $L2 = 45$  in mid-Nov., and  $L2 = 50$  in late Dec.) The last source remained active until mid-Jan., and since then it has gradually contracted towards the GRS as the enhanced activity subsides.

**STropZ:** A curious dark feature developed at  $L2 \approx 240$  during Dec., apparently formed by expansion of one of the dark grey streaks that lie in northern NTropZ, surrounding a tiny white spot (anticyclonic vortex?). It can be seen interacting with another spot in our map on Dec.30 (Figure 7; also see PJ57 map, at  $L3=293$ ). We wondered if it would become a S. Tropical Disturbance, but this has not happened and it has not interacted with the STBn jet. Instead, it flattened in 2024 Jan., so in late Jan. and Feb. it has been merely a dark streak (still at  $L2 \approx 240$ ).

**STB:** Oval BA had been white, but has recently become somewhat reddish again. Other major features in the S1 and S2 domains continue without major changes.

-----

**Figures** (small copies on next pages):

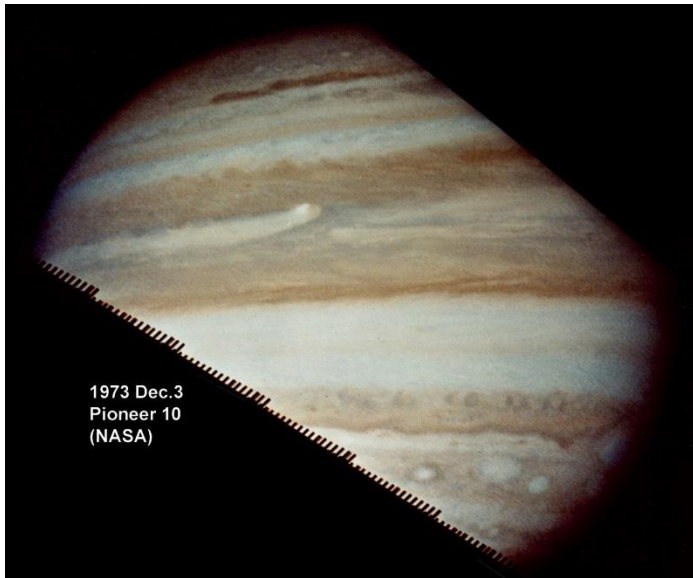


Figure 1

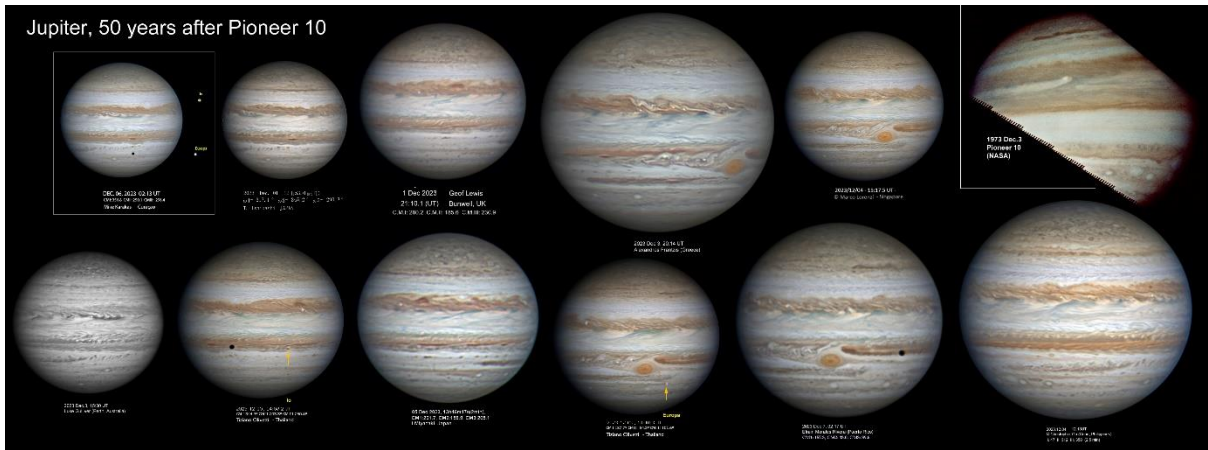


Figure 2

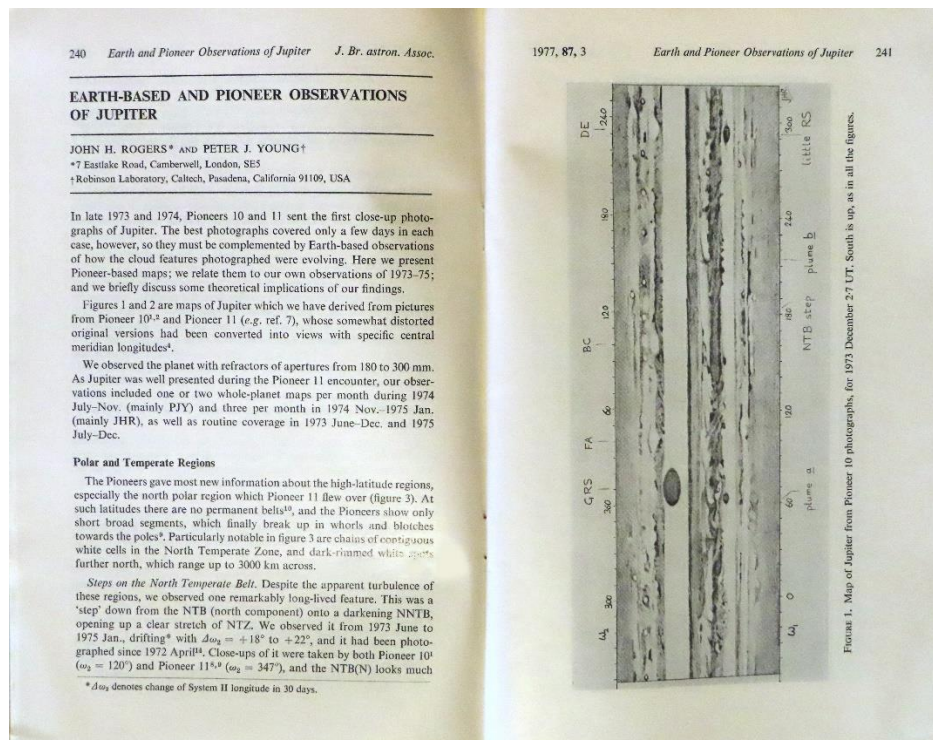
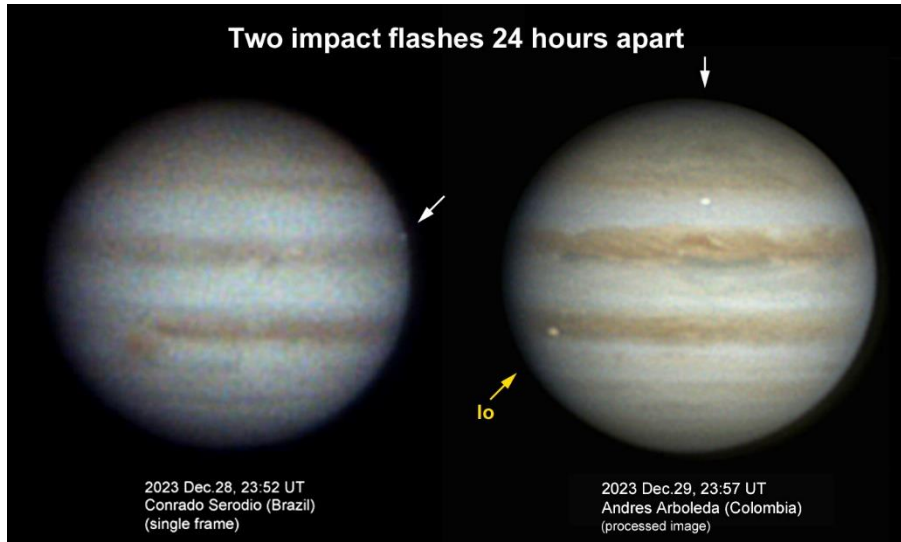
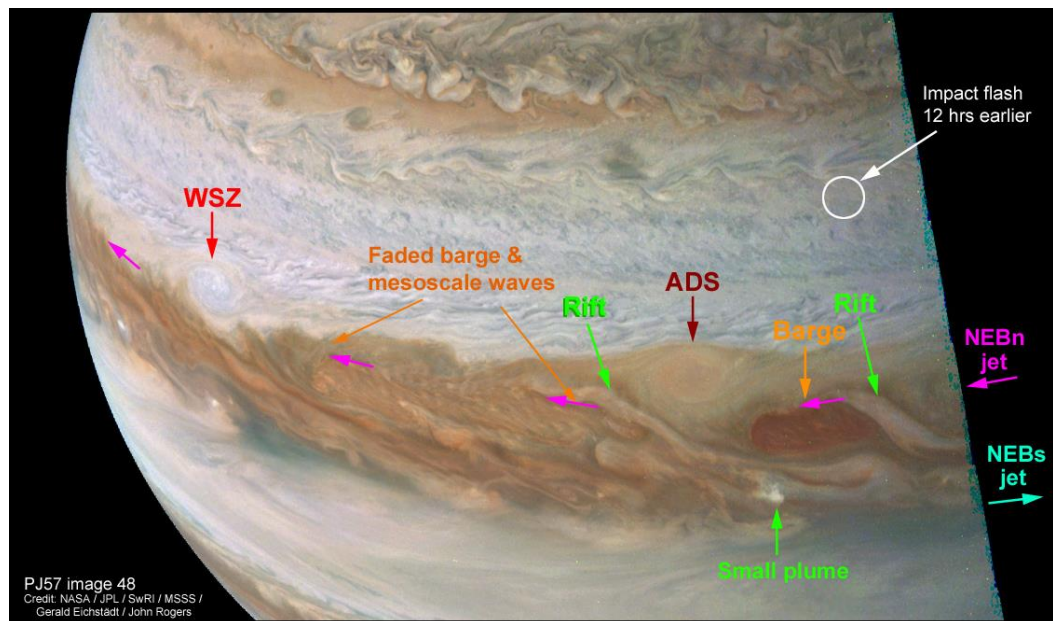


Figure 3





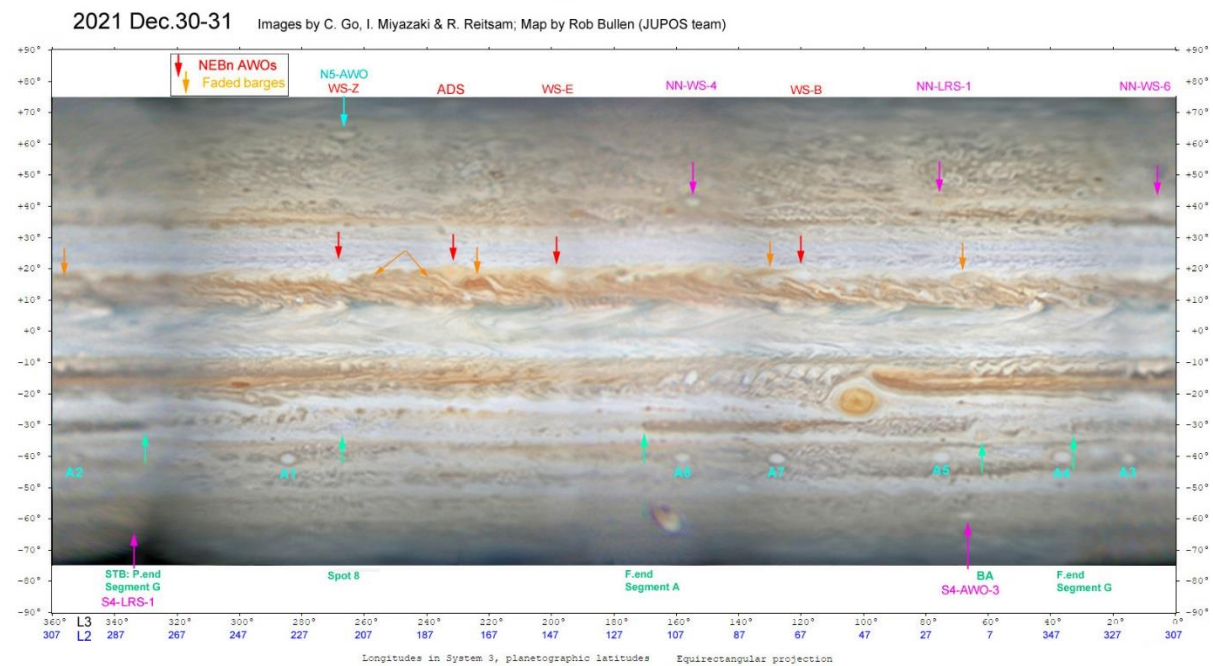
**Figure 4**



**Figure 5**  
(right)

**Figure 6**  
(next page)

**Figure 7**  
(below)



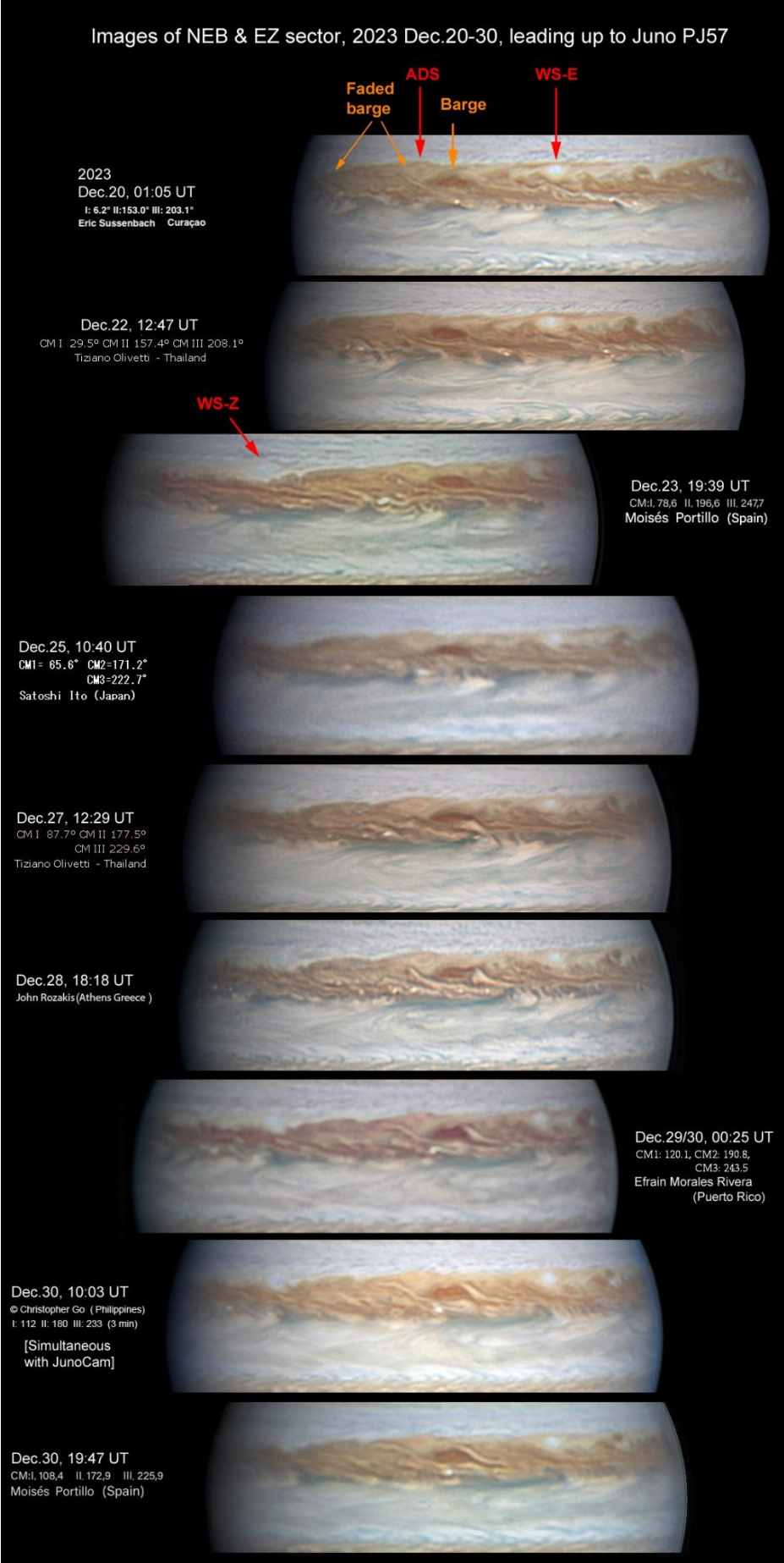


Figure 6