White spot Z: its history and characteristics, 1997-2013

John Rogers (British Astronomical Association)

APPENDIX:
NOTES FROM THE HISTORY OF WHITE SPOT Z

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Figure 4: JUPOS chart for N.Tropical domain, 1997-2003 (in L2).
Figure 5A: JUPOS chart for N.Tropical domain, 2001-2013 (in L2).
Figure 5B: the same in L3.
(Charts produced by H-J. Mettig.)

Table of WSZ drift and latitude (from our previous reports)

Excerpts from our previous reports concerning white spot Z:
published reports (apparitions of 1998, 2000/01),
a new summary (2002/03), and on-line reports (2006-2013).
The reports with illustrations are all on-line at:
http://www.britastro.org/jupiter/reports.htm

Figures 6-10: Sets of images showing WSZ, 2011-2013.

(Full-size versions of the figures are in an attached ZIP file.)

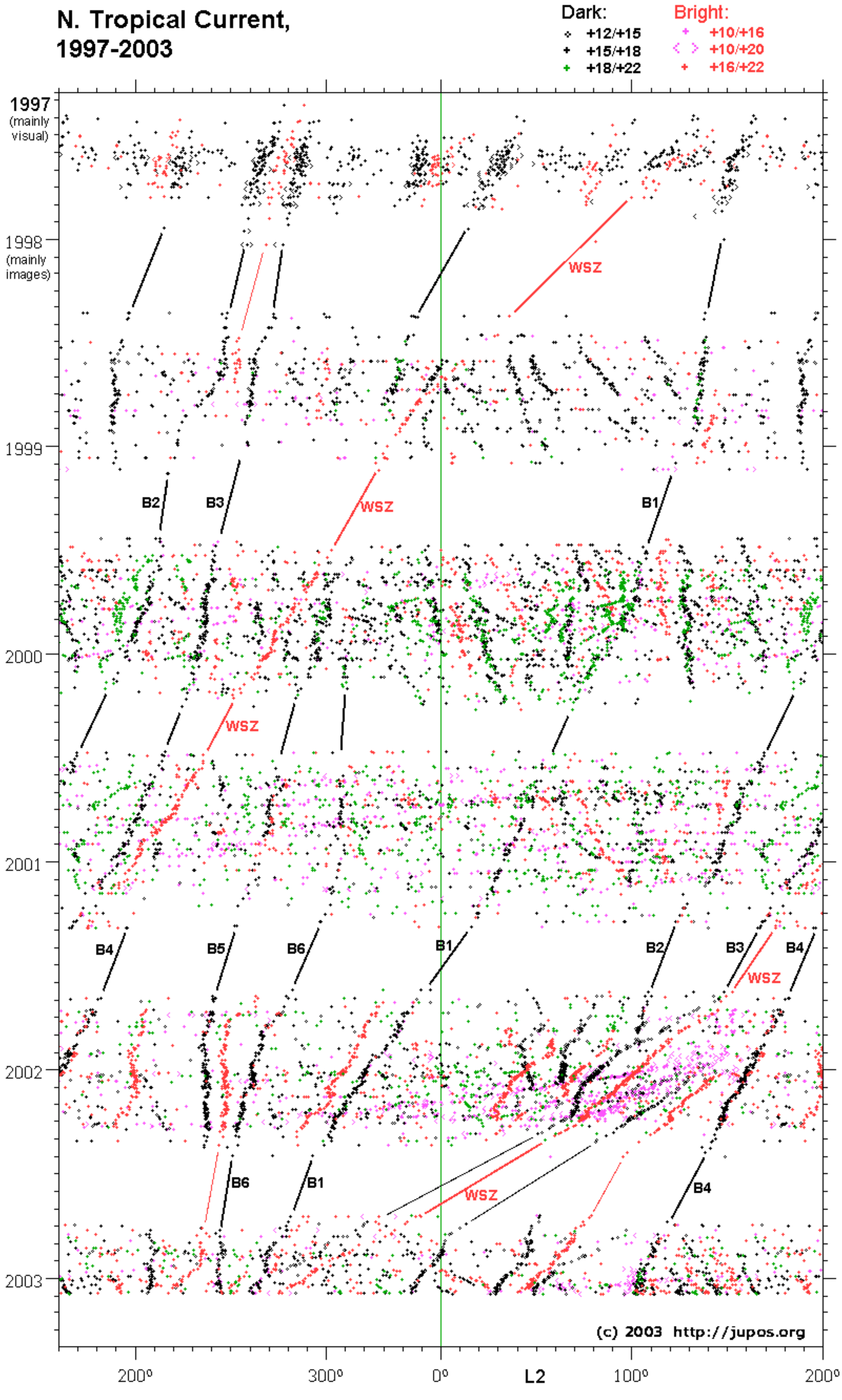


Figure 4: JUPOS chart for N.Tropical domain, 1997-2003 (in L2).

Figure 5A: JUPOS chart for N.Tropical domain, 2001-2013 (in L2). Track of WSZ is marked in red.

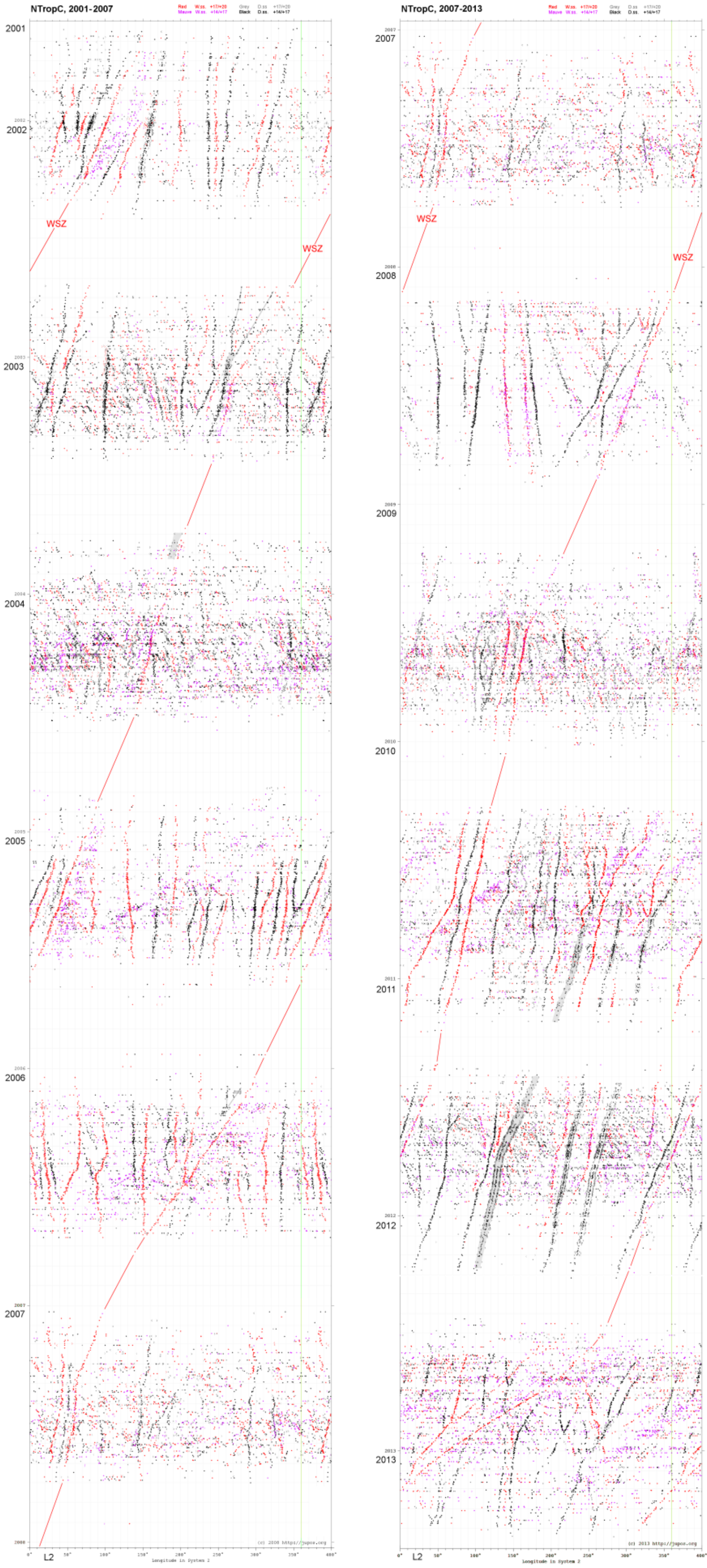


Figure 5B: JUPOS chart for N.Tropical domain, 2001-2013 (in L3). Track of WSZ is marked in red.

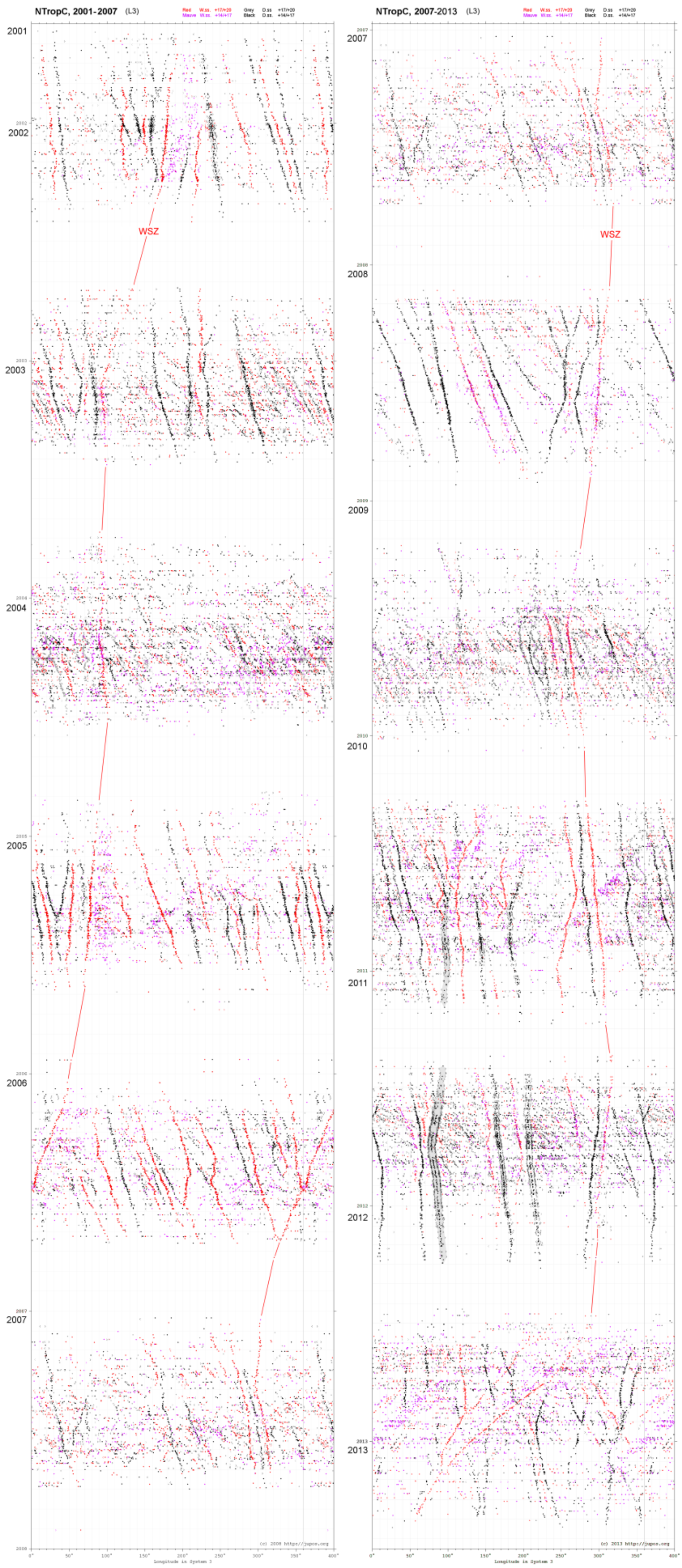


Table 1:

White spot Z: Drift & latitude from our reports

Dates(approx)	*DL2*	*Lat* (Bay)	*Lat* (WO)	*Lat* (N w.s.)
1997jun-oct	-10,5			
1998may-oct	-10	17		
1998oct-1999feb	-5,7	17		20,2
1999jul-2000mar	-5,6	17,3		
2000jun-2001apr	-6		19,1	
2001oct-2002mar	-10,5		19,0	
2002 may-sep	-15			
2002sep-nov	-18,5			
2002nov-jan	-15			
2003 feb-may	-7			
2003 jun-sep	-10			
2004 jan-feb	-10	17,5		
2004 mar	-3	17		
2005 jan-aug	-10		19,1	
2005dec-2006jan	-12		19,4	
2006 feb-may	-18,6		19,6	
2006 july-oct	-18,8		19,4	
2007 jan-apr	-11		19,2	
2007may-jun	-1,5			[Grey: 18,1]
2007jul-sep	-6			[WS: 18,7]
2008 mar-nov	-11			(21)
2009 mar-july	-12			
2009 july-sep	-5			
2010 apr-nov	-5,5		18,5	
2011 jun-2012 jan	-11,1			20,2
2012 jan-mar	-8,8			20,4
2012 aug-sep	-31		19,2	
2012 oct-nov	-42			
2012 nov-dec	-38			
2013 aug	-23			
Mean:		**17,2**	**19,2**	**20,3**
SD:		**0,23**	**0,31**	**0,12**
2013 nov		S.edge:	Methane:	N.w.s:
(Measurements by	-13	16,8	18,9	20,2
G. Adamoli: n=6)	SD:	0,38	0,27	0,46

Most of these values are from our published or interim reports.
Others are from unpublished JUPOS analysis by G. Adamoli.
Some values are preliminary, and they have not been calculated for all date ranges.
See Fig.3 for a chart.

Jupiter in 1998/99

John H. Rogers & Hans-Jörg Mettig

A report of the Jupiter Section (Director: John H. Rogers)

The most important event was the merger of the famous long-lived white ovals BC and DE in the South Temperate region. This occurred in early 1998 during solar conjunction. The merged oval 'BE' was slightly larger, of low contrast, but distinct in good images. The remaining oval, FA, was gradually converging on oval BE.

In the South Equatorial Belt, a major new 'mid-SEB outbreak' of turbulent white spots began during solar conjunction and spread most of the way around the planet. The EZ/NEBs edge was unusually disturbed, with especially large and variable projections and plumes. The NEB had reverted to its usual width after the expansion event of 1996. The array of 'barges' that formed as part of the expansion event persisted along its north edge, though they were shrinking during the apparition. One rapidly-moving white spot destroyed barges in its path and created small new ones in its wake.

J. Br. Astron. Assoc. **111** (no.6) p.321 (2001)

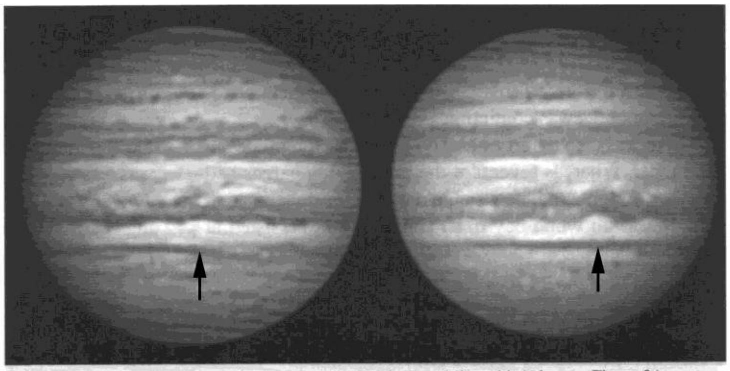


Figure 13. Images showing white spot Z on NEBn, by Isao Miyazaki. (Also see Figure 9.)
(A) Aug.3, 20.20 UT, CM1 56, CM2 7. Big barge no.8 on p. side; spot Z on CM, visible as a shallow bay in NEBn with a tiny white oval in N. Tropical Band. Also note NTB rift on f. side. Also, GRS is near f. limb with first signs of S. Tropical Band emerging p. it.
(B) Nov.16, 10.48 UT, CM1 94, CM2 327. Spot Z is now a big bright bay, just f. CM. Big barge no.8 (on CM) has almost disappeared; instead, dark material is accumulating in a new big barge f. spot Z.

N. Tropical region

The NEB was narrower than last year; it had reverted to its usual width after the expansion event of 1996. As well as the dark bluish sectors of NEB(S), there were sectors of very dark brown NEB(N), mainly seen alongside or following the passage of the rift. (These may have been enhanced by image processing.)

Along the NEBn edge, there were many dark red-brown spots and streaks. These were the array of 'barges' that formed in early 1997 as part of the expansion event, now left exposed on the edge of the narrowed belt. They are tracked in Table 6 and Figure 12. They all diminished in size and/or intensity as 1998 progressed, consistent with the typical lifetime of 1–2 years. They were not as well-defined as barges in some apparitions, being either small very dark spots, or streaks or bulges with ill-defined ends.

The sector from L2 ~270–60 was variable; there were often minor features not listed in the table, whereas the listed dark spots were occasionally lost in longer NEB(N) streaks when a NEB rift had passed. This sector was also disturbed by the remarkable white spot which we call 'Z' (Figures 9 & 13).

White spot Z, one of the 'bays' in NEBn, was persistent although not always conspicuous, as it was moving through a region of variable dark streaks on NEBn. It had an exceptionally fast drift (DL2 = −10; no.10 in Table 6; see Figure 12). It could be identified with a 1997 white spot with similar rapid drift, and/or a slower-moving white spot p. it; the former probably overrode or merged with the latter during solar conjunction, maintaining average DL2 = −10 throughout. Although the main white bay, like others, had a latitude of ~17°N, it was accompanied by a tiny white spot due north at 20°N, within the bluish N.Trop.Band (Figure 13A). This latitude is more typical for anticyclonic spots in NTropZ and suggests that spot Z was more substantial than the other 'white bays'. As it moved along the NEBn edge, white spot Z seems to have greatly influenced the dark 'barges'. It came up to and destroyed a tiny dark spot p. it (no.9), and then in October it impacted on the largest dark barge which had persisted since 1997 (no.8). This had been a variable dark streak, and in early October was not distinguishable as a NEB rift had passed, but on Oct. 18 the interaction with white spot Z had induced a northward dark projection from the p. part of dark streak no.8. In November, as the white bay Z pressed against the f. end of the barge, the bay deepened and slowed to DL2 = −5°/mth, while the barge was deformed and then faded. Meanwhile a new dark barge formed f. the white bay Z, stationary at L2 =352. Images from Nov. 16 to Dec. 5 even suggest that very dark material may have flowed from the old barge to the new barge around the south edge of the bay (Figure 13B). The white bay Z was still very deep in January, at L2 =336; and the big new barge or bulge f. it also persisted. Indeed, these were only the leading members of a series of prominent bays and bulges which then developed in the sector L2 350–50 in Nov–Dec. (Most of them are not listed in Table 6 as drifts were not well determined, but they include no.14 which became prominent from November onwards.)

New dark spots ('mini-barges') were being created following white spot Z throughout the apparition (nos.11–14 in Table 6). These had not existed in 1997 before white spot Z passed by, and they had positive DL2 in contrast to other NEBn barges. They were probably newly created in the wake of white spot Z where it destabilised the retrograding NEBn jetstream, and the spots were probably retrograding because they were interacting with this jetstream [cf. *Voyager* data, chapter 8.4 of ref. 5]. The JUPOS chart (Figure 12) tracked additional spots of this type f. spot Z

Jupiter in 2000/01:

Rogers J, Mettig H-J, Peach D, & Foulkes M, J.Brit.Astron.Assoc. 114 (no.4), 193-214 (2004).

'Jupiter in 2000/2001: Part I: Visible wavelengths: Jupiter during the Cassini encounter.'

NEBn/NTropZ:

The fastest-moving spot was still the northerly, long-lived, and evidently powerful white spot Z, at 19ºN, still rapidly prograding (DL2 = -6º/mth). This white oval has existed since 1997 and has always had a faster drift than other NEBn features. It eliminates other spots p. it, and new spots are created f. it. In early August, 2000, it was gradually approaching another AWO in the same latitude, which either disappeared or merged with WSZ. Over subsequent months [as the NEB expansion event proceeded], the strip of NTropZ flanking WSZ gradually become dull yellow-brown, until WSZ appeared as a brilliant 'porthole' within the expanded NEB.

In Nov., WSZ came up to the f. side of a barge.... Thereafter, both moved on together, 9º apart, with the original speed of WSZ. The area of NEB around the pair became lighter again. This interaction was beautifully imaged by Cassini in 2000 Dec. (hi-res map) and in 2001 Jan. (crescent image). The latter image suggested that the brightening of the adjacent NEB was due to the opposite circulations of the white spot and barge drawing light NTropZ material through the narrow gap between them.

<u>Jupiter in 2002/03:</u>

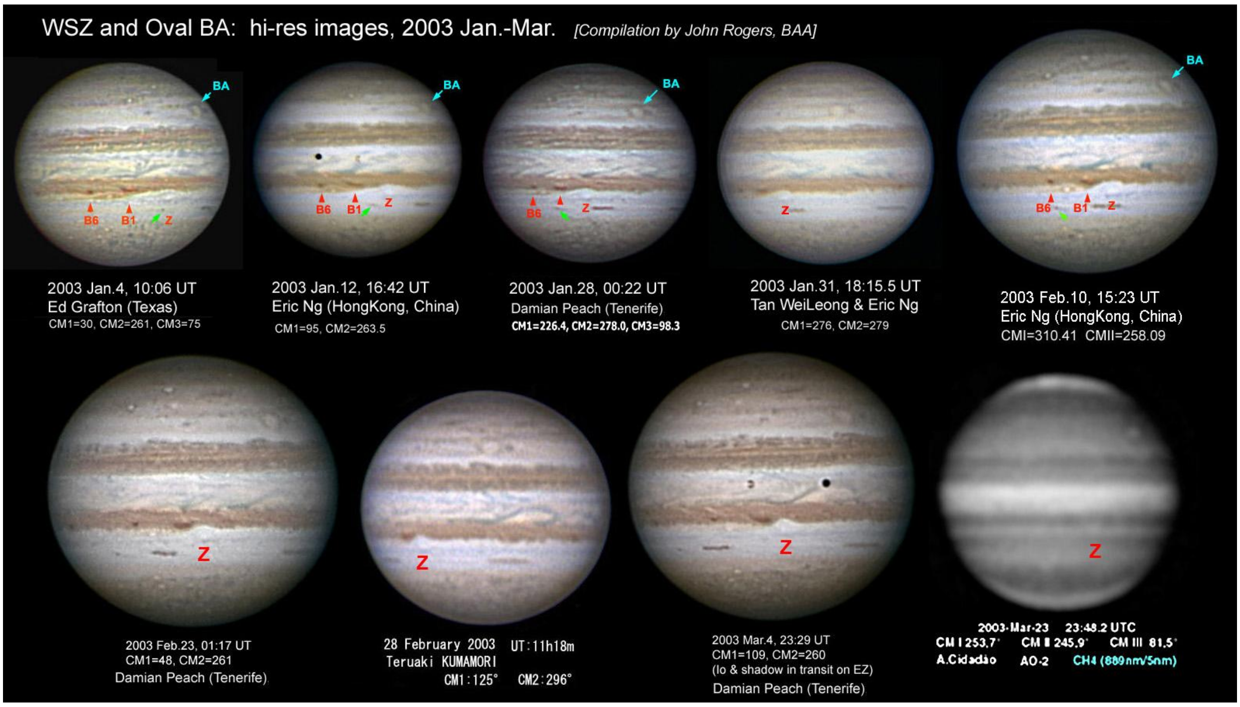
[Summary, 2013:]

WSZ had an unprecedented fast speed of DL2 = -18.5 deg/mth in 2002 Sep-Nov., slackening slightly to -15 deg/mth in Nov-Jan. Dark barge B1 was travelling just p. WSZ, and in Dec. it merged with another one p. it [described in: Rogers & Mettig (2006), Icarus 185, 244]. The merged barge (B1) then advanced on another barge (B6); but instead of merging, they rebounded in 2003 Jan., with B1 suddenly decelerating.

(It may be relevant that a tiny AWO, embedded in a brown strip of NEB(N), was present between these two barges. This AWO may be WS4 from the previous apparition; it was exposed by the fading of the northerly sector of NEBn between B6 and B1, which was a remnant of the NEB expansion in 2000.)

WSZ continued at high speed until it came into contact with barge B1 in 2003 Feb., when it suddenly decelerated likewise, to DL2 = -7 deg/mth.

In 2003 Jan.-March, hi-res images showed that WSZ was a prominent white bay in NEBn, just f. the dark barge B1. Its previous oval outline was not visible; there was a faint grey streak in the S half, and a tiny, very bright white spot on its N edge (similar to one seen in 1998).



Jupiter in 2006: *Report no. [10]:*
NEBn: The enigmatic encounter with white spot Z (Report, 2006 July 30)

Here is a preliminary report on that encounter of two anticyclonic white ovals. White spot Z (WSZ) is the brilliant, long-lived, rapidly-moving AWO at 19 deg.N, White spot Y was another one p. it, which at first was almost as big and bright. [From Feb. to May, WSZ was moving at DL2 = -19 deg/mth, which I think must be its fastest speed ever in its 9-year history.]
The encounter did not go at all according to expectations! In brief, they converged rapidly until 11 deg apart, but then almost stopped for 12 days. Then, with both spots shrinking, WSY suddenly began to swing round the S side of WSZ (or *vice versa* -- June 27); but 2 days later it had emerged on the Sf. side of WSZ without any definite merger (June 29). Thereafter, observations were scanty, but it appeared that the shrunken remnant of WSY moved on f. WSZ and disappeared, while WSZ itself slowly split into 2 halves! By July 21 it seems to be almost back to normal.

Observations in more detail: ......

Discussion:
......Here are some preliminary ideas about what happened with WSZ. It may become clearer when the measurements have been completed by the JUPOS team.
1) Approach: Why did the AWOs suddenly stop converging when they were so close, and remained apart for 12 days? There was definitely no cyclonic circulation between them, ... It looks as WSY and WSZ hit a 'buffer zone' around each one which prevented them getting any closer.

2) Encounter: The simplest interpretation is that WSY did not merge with WSZ: it squeezed around the S side of WSZ and survived for about a week, although it was smaller and its cloud-cap was reduced (dull yellowish instead of white), and then it disappeared. Measurements of the latitudes on July 1 (from 3 images by Miyazaki, Akutsu, and Go) give 20.8 deg.N for WSZ and 19.7 deg.N for the remnant of WSY, all +/- 1 deg. This confirms the visual impression that it was WSZ which moved N, rather than WSY which moved S! And the remnant of WSY was still in the anticyclonic domain (N of the retrograding jet which is at 17.6 deg.N), so it was not a cyclonic eddy created in the interaction.
Perhaps AWOs in the NEBn, or WSZ in particular, behave differently from those in temperate domains. Such white ovals in the NEBn have never previously been observed to merge – sometimes one like WSY has disappeared before reaching WSZ (though we have never previously watched two of them approach so close at such speed). There are several features of the wind patterns in the N. Tropical domain which differ from those in temperate domains, and might lead to different behaviour when AWOs interact:

a) The domain is not symmetrical, because of the long gradient of speed towards the great equatorial jet.
b) The vorticity may be comparatively low in the NEBn AWOs. These AWOs, unlike most temperate ones, do not have high cloud-caps to make them bright in methane images. Legarreta & Sanchez-Lavega (2005) measured vorticities of anticyclonic ovals all over the planet, from Voyager and Galileo images, including one of these NEBn portholes in 1997. Its maximum wind speed (38 +/- 11 m/s) and mean vorticity (4.2 +/- 1.2 x10^-5 /s) were among the lowest for any oval measured, similar to a NTBs jet spot, and much weaker than a NNTBs jet spot or the S.Temp. or S.S.Temp. AWOs.
c) WSY may have been weaker than WSZ (which is always bright and persistent), so perhaps the interaction was unequal, more resembling the interactions of SEBs jetstream spots with the GRS..... This behaviour is quite similar to the interaction of WSY with WSZ, but again it emphasises that mergers of anticyclonic ovals do not happen very easily.

On the one hand, we cannot rule out that some energy or material was transferred from WSY to WSZ: certainly WSY was fatally weakened by the encounter.
On the other hand, perhaps we should acknowledge the observational evidence that anticyclonic spots do not readily merge, and the events in the S. Temp. and S.S. Temp. domains are the exception rather than the rule!

3) Aftermath: What happened to WSZ from July 1 to 11? It looked as if it split into two, but there was no evidence for the components orbiting each other nor converging; and sometimes extra tiny bright components were present, at the limit of resolution. Was a part of WSY really orbiting within WSZ? Or did dark streaks get mixed up in WSZ? So far this is just another unsolved riddle to add to the list of the dynamics of this amazing storm. Perhaps our best hope is for another AWO to collide with WSZ next year and repeat the event, so that we can follow it fully next time!

Jupiter in 2007: *Report no.[20]:*
FINAL NUMERICAL REPORT

In the NEBn, most of the barges and AWOs from previous apparitions (which were very distinct in 2005 and 2006) disappeared **(Figs.27 & 28).** Some were eliminated by white spot Z, (WSZ), some by mergers, and some by rifts. Even WSZ decelerated (suddenly in April) and faded to near-invisibility as a grey patch. So, with very extensive rifting in the NEB, and turbulence in the NTropZ from the NTBs outbreak, few barges or AWOs remained. But some new barges appeared in July, and WSZ revived somewhat in August.

There were three ongoing climatic processes, any of which might have explained the disappearance of the barges and AWOs:
1) the stage of the NEB expansion cycle: the barges and AWOs had proliferated after the last NEB expansion event in 2004, and would be expected to reduce in number after a few years.
2) the NEB rifting activity, which commonly destroys barges.
3) the NTBs outbreak, which generated intense turbulence in the NTropZ.

White spot Z (WSZ) **(Fig.29)** has existed since 1997. In early 2007 it was a rapidly prograding white oval with very bright core, as usual. But then in late April it suddenly lost both its rapid drift, and its brilliance, and its powerful regional influence. This happened just after the leading white plume in the NTBs outbreak passed it. At this time WSZ had just come up f. barge no.2 (with AWO no.1 ahead of it), and WSZ suddenly halted in L2: they formed a stable triplet thereafter. (This would not have happened in previous years: WSZ always pushed or destroyed other spots which it encountered.) AWO no.1 became small and dim at this time, but always remained as a white oval. WSZ also became much dimmer than before. Then during May, WSZ lost its white cloud cover altogether, and it would have been lost but for the modern hi-res colour images. With turbulent NTB reviving alongside, it was progressively disrupted by grey streaks until by late May it was entirely grey **(Fig.29)**. It remained thus until Aug.7 when a bright white spot erupted in it [lat. 18.6 (+/-0.4)°N]. This mostly dissipated within a couple of days, but left WSZ as a distinct grey ring with a tiny white core, until late August. (This event adds to my suspicion that WSZ was not a simple anticyclonic oval, but had some characteristics of the equatorial plumes: theoretical modelling would be of interest.)

Jupiter in 2008:

Interim report no. [2] [May 2008].

Many barges & AWOs.... inc. still white spot Z (WSZ), revived in brightness and speed since its obscurity in 2007, with DL2 = -11 deg/mth. Some of the barges and AWOs p. it share this rapid drift, and are colliding with others which don't.

Most important was the collision of two AWOs p. WSZ, in early April (L2 ~320). Although lo-res obs'ns would have suggested they merged, hi-res images showed they did not! Both AWOs shrank as they approached, especially the Sp. one, which then squeezed S of the Nf. spot, breaking up as it did so, and then disappeared. The tiny remaining spot then drifted to lower L2. All this is exactly what happened when a white oval encountered white spot Z in 2006 June. It shows that the paradigm for mergers of AWOs which we have reported in temperate latitudes (Rogers et al., Icarus, 2006b) does not hold for the NTropZ. In fact, no true merger of AWOs has ever been recorded in this latitude. Theoretical study is needed to understand why these AWOs behave differently.

Another interesting phenomenon was the 'rocking' of the little dark barge on the Sp. edge of white spot Z, during the encounter of the AWOs on its p. side. It might have a period of about 5 days although there were not enough data to prove it.

All the other encounters have been between small (cyclonic) barges, and they probably do merge,.... all but one of these interactions are occurring just p. white spot Z, so I imagine that white spot Z is causing them, as with previous mergers of barges.

Jupiter in 2008: Interim report no. [6] [Aug.2008].

...bright white bays. One of these is white spot Z (WSZ): hi-res images show it encompasses a smaller, very bright white spot quite far north in the NTropZ (~21 deg.N?). [E.g: Wesley, May 9; Grassmann & Salway, July 16; Kazanas & Go, July 23; Go, Aug.9; Barnes, Aug.12; Salway, Aug.24.]

Jupiter in 2009:

Interim report no. [2]: **Interim Report on the NTrZ outbreak.** [July 14, 2009].

.....The long-lived white spot Z is rapidly approaching the source of the outbreak, and may cause further agitation as it approaches. This year, white spot Z consists of a bright bay in NEBn plus a small brilliant spot in NTropZ at 20 deg.N, moving at -12 deg/month.

From June 5-20, a NEBn dark projection squeezed past it with DL2 = +39 deg/month, one of the fastest retrograding speeds ever observed for a coherent feature here on the NEBn jet. This feature could have been created from the big NEB rift just before the main outbreak. White spot Z was at L2 = 175 on July 1 (40 deg. f. the outbreak), and the NEBn shows small-scale disturbance in this interval.

Interim report no. [7]: **Interim Report, with new insights into the NTZ disturbance, NEB expansion, and SEB fading**

...Just one conspicuous white bay (WSZ). WSZ was still moving fast (DL2 = -12), but soon after the NEBO-1 outbreak, a new, similar white bay (WSY) formed on its f. side, and WSZ suddenly decelerated, to form a stable pair with WSY.

(We have already made compilations showing a NEBn dark projection retrograding past WSZ, June 4-23, DL2 = +34: a rare detection of the NEBn jetstream).

The chart shows several short-lived little spots retrograding f. WSY and f. WSZ in the summer, some with DL2 = +20 (near-jetstream speed), others closer to DL2 ~ 0 (inc. b6). Some such spots are typical f. WSZ, and some were also visible at other longitudes, but the concentration in this region suggests additional disturbance of the NEBn jet by the NEBO-1 eruption.

Jupiter in 2012/13:

Interim report no.3 (*2012 Sep.20*)

Progress of Jupiter's great northern upheaval, 2012 July-August.

i) At least one barge and one AWO seem to have survived from last year. The AWO is the well-known old White Spot Z (Fig.6b); but it was a dark grey spot in June, and is still largely shrouded in grey streaks.

ii) Some of the AWOs are actually transformations of the very dark grey spots seen in June! Of 5 such dark spots here named d4-d9, 3 or 4 were replaced by white spots, and detailed inspection of images shows what happened (Figs.5&6; *Note 3*). Spots d7, d8 and d9 were each replaced by a small white spot in early July, apparently displacing the dark grey material into streaks around it. However, these white spots were again masked by dark grey streaks later in July, only to reappear in August, drifting faster (White spots A and Z).

Note 3: Spots in NTropZ:

The dark grey spots in June, at 18-19 deg.N, were at L2 ~ ..... 274 (d9). Spots d7, d8 and d9 were each replaced by a small white spot in early July, apparently displacing the dark grey material into streaks around it. However, these white spots were again masked by dark grey streaks later in July, only to reappear in August, moving faster than the original dark spots. ....

The AWO which replaced spot d9 was the well-known old White Spot Z (Fig.6b). White spot Z first appeared in 1997 after an earlier NEB broadening event, and has always been the fastest-moving AWO in the NTropZ. Now it has accelerated to the remarkable speed of DL2 = -31 deg/month. It was identified by each of the JUPOS measurers independently during their analysis of July images. It had a brief white outburst on July 8, but then became dark grey again. It became lighter again at the start of August, but still still remained an obscure grey lozenge surrounded by grey streaks (Fig.6b) – exactly the same aspect that it had in 2007 June after the NTB outbreak [Ref.2, inc. Fig.29] before it recovered its usual brightness.

Interim report no.9 (2013 Jan.):

Interim report on Jupiter, 2012 Aug.-Dec.

These barges and ovals are charted in Fig.6..... as well as the long-lived white spot Z (DL2 = -42 in Oct-Nov., probably faster than ever before, and DL2 = -38 in Nov-Dec.). As many as 10 small dark brown barges have also developed, but several have undergone mergers or been disrupted by rifts, leaving only about 4 now. [White ovals A and B merged in Nov.] White spot Z, now a fully white oval with DL2 = -42 (!), although sometimes showing signs of disturbance, is now converging on the merged oval so a similar interaction could take place in the coming months.

Interim report no.10 (2013 March):

Jupiter update: NNTBs jet; NEBn white ovals; new SED; STB near oval BA.

2) NEBn white ovals merging (Figs.1 & 2)

Observers were keenly watching the two great white ovals on the NEBn, white spot A and white spot Z, as they approached each other in 2013 Jan., and they interacted closely between Feb.10-19, a dramatic "wrestling match" leading to a partial merger. Unfortunately there were gaps of several days without images during this time. But the event seems to have been similar to previous such encounters. The p. oval (WS-A) squeezed round the S side of the f. one (WS-Z), becoming a white loop. Part of this loop probably merged with WS-Z, but part detached and continued in the f. direction (L2 ~ 16 --> 20), at least up to March 8.

Figure 6-10 ***(following pages):***
Images of White Spot Z, 2011/2013
(omitting the period of NEB Revival in 2012)

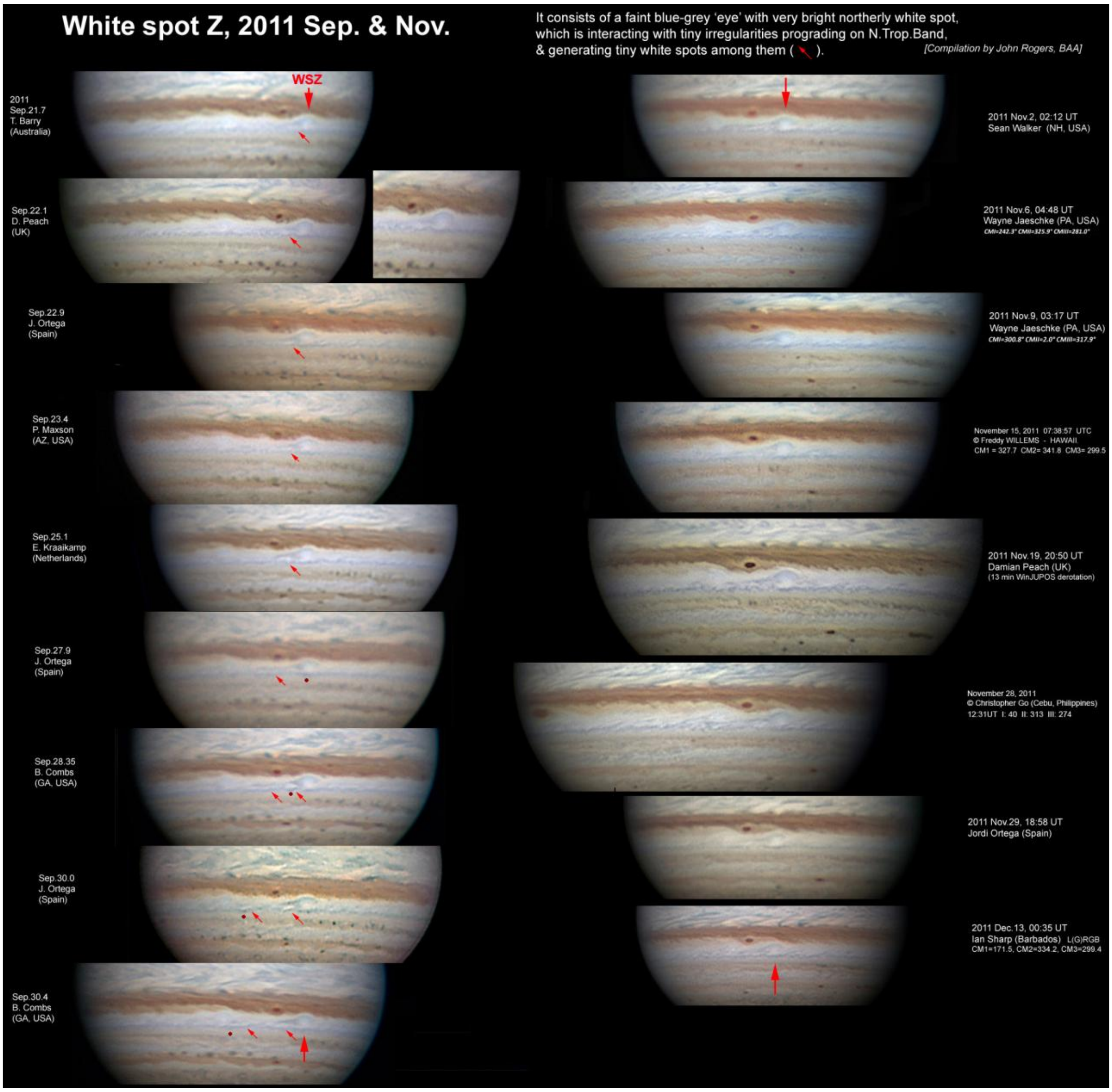
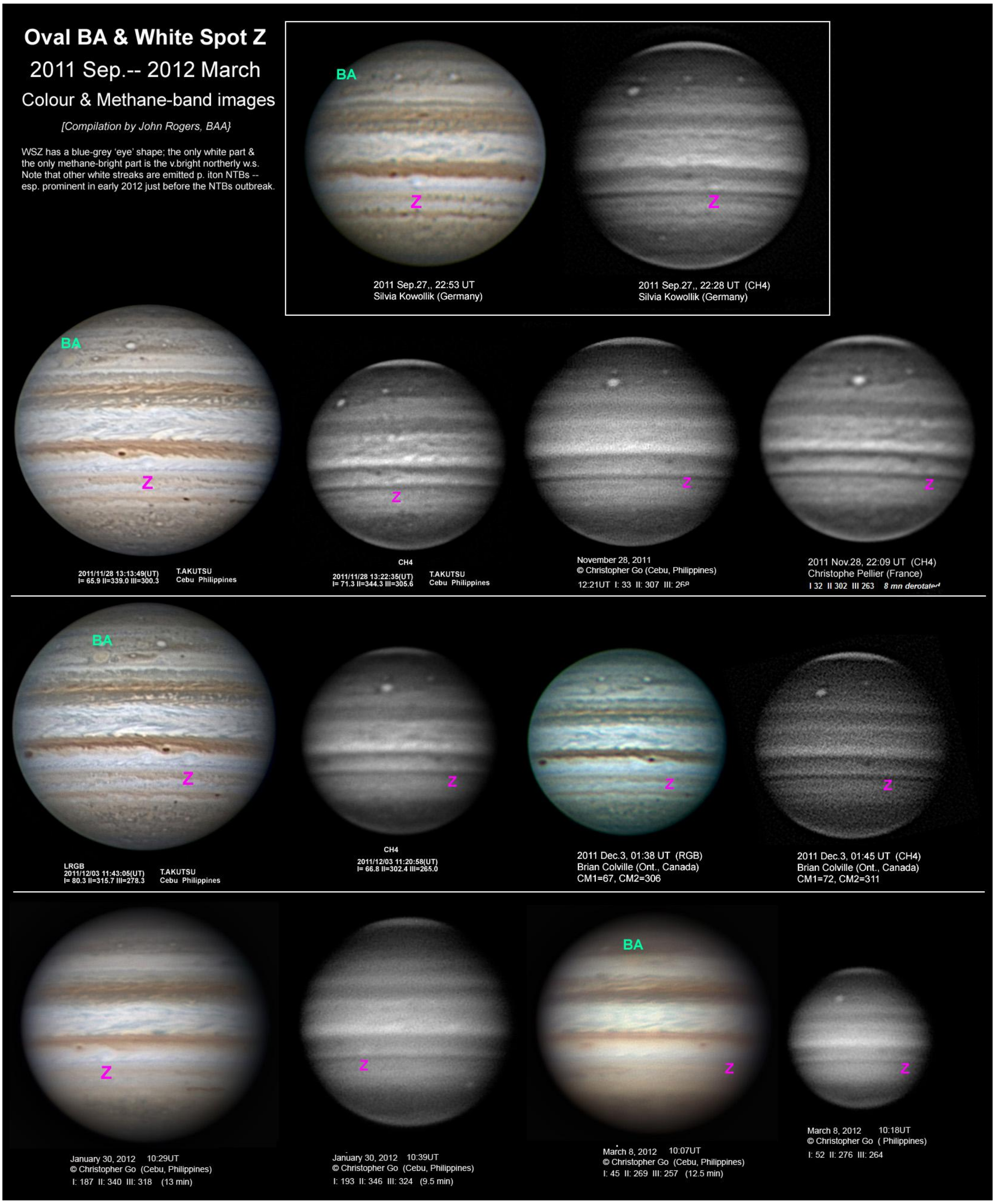
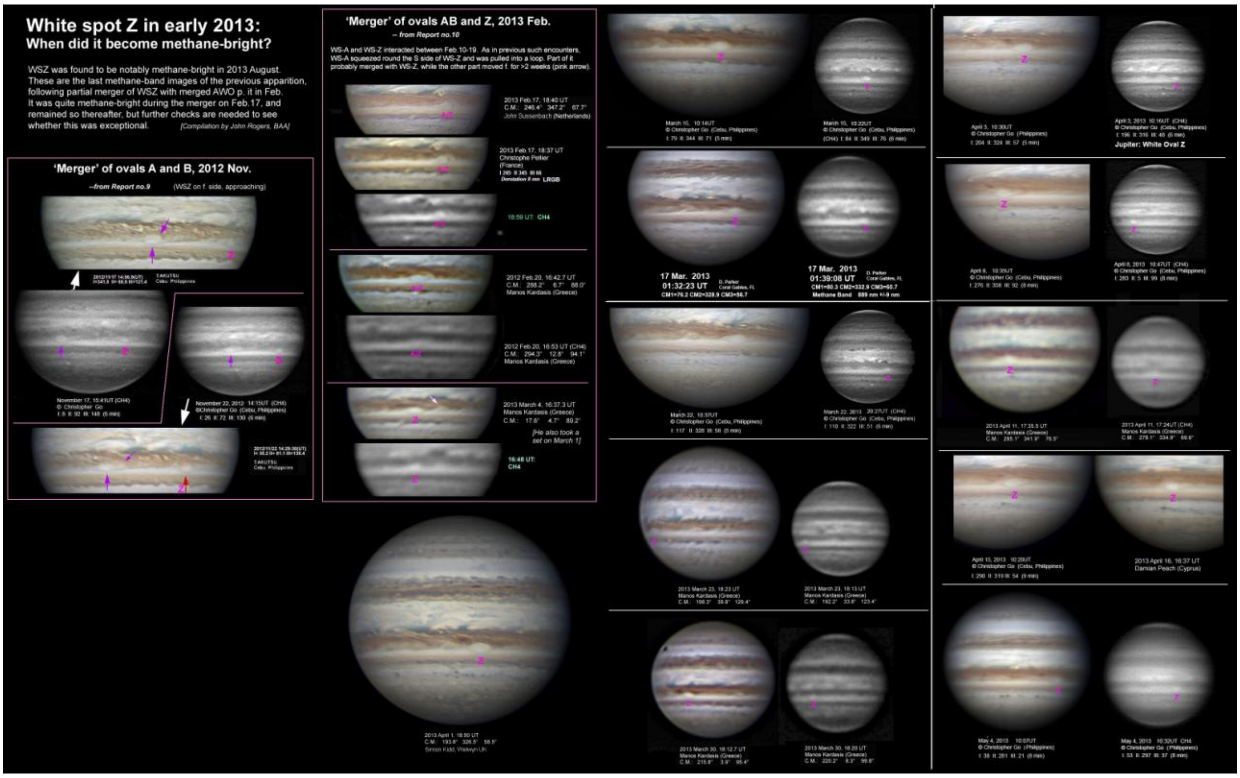


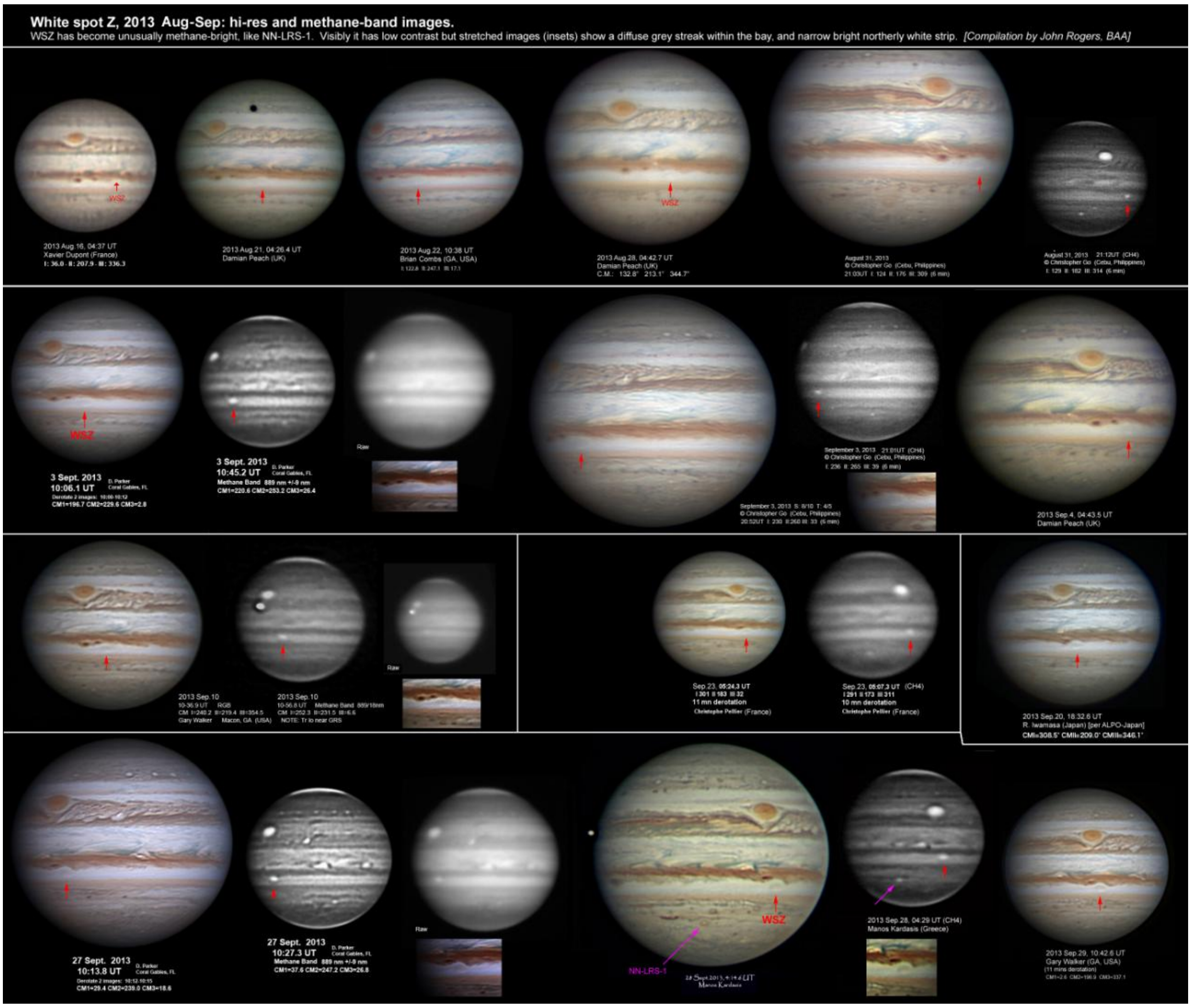
Figure 6



Oval BA & White Spot Z
2011 Sep.-- 2012 March
Colour & Methane-band images
[Compilation by John Rogers, BAA}
WSZ has a blue-grey 'eye' shape; the only white part & the only methane-bright part is the v.bright northerly w.s. Note that other white streaks are emitted p. iton NTBs -- esp. prominent in early 2012 just before the NTBs outbreak.
BA
Z
2011 Sep.27,, 22:53 UT
Silvia Kowollik (Germany)
2011 Sep.27,, 22:28 UT (CH4)
Silvia Kowollik (Germany)
2011/11/28 13:13:49(UT)
I= 65.9 II=339.0 III=300.3
T.AKUTSU
Cebu Philippines
CH4
2011/11/28 13:22:35(UT)
I= 71.3 II=344.3 III=305.6
T.AKUTSU
Cebu Philippines
November 28, 2011
© Christopher Go (Cebu, Philippines)
2011 Nov.28, 22:09 UT (CH4)
Christophe Pellier (France)
LRGB
2011/12/03 11:43:05(UT)
I= 80.3 II=315.7 III=278.3
T.AKUTSU
Cebu Philippines
CH4
2011/12/03 11:20:58(UT)
I= 66.8 II=302.4 III=265.0
2011 Dec.3, 01:38 UT (RGB)
Brian Colville (Ont., Canada)
CM1=67, CM2=306
2011 Dec.3, 01:45 UT (CH4)
Brian Colville (Ont., Canada)
CM1=72, CM2=311
January 30, 2012 10:29UT
© Christopher Go (Cebu, Philippines)
I: 187 II: 340 III: 318 (13 min)
January 30, 2012 10:39UT
© Christopher Go (Cebu, Philippines)
I: 193 II: 346 III: 324 (9.5 min)
March 8, 2012 10:07UT
© Christopher Go (Cebu, Philippines)
I: 45 II: 269 III: 257 (12.5 min)
March 8, 2012 10:18UT
© Christopher Go (Philippines)
I: 52 II: 276 III: 264

Figure 7


White spot Z in early 2013:
When did it become methane-bright?
WSZ was found to be notably methane-bright in 2013 August. These are the last methane-band images of the previous apparition, following partial merger of WSZ with merged AWO p. it in Feb. It was quite methane-bright during the merger on Feb.17, and remained so thereafter, but further checks are needed to see whether this was exceptional.
[Compilation by John Rogers, BAA]
'Merger' of ovals A and B, 2012 Nov.
--from Report no.9
(WSZ on f. side, approaching)
'Merger' of ovals AB and Z, 2013 Feb.
-- from Report no.10
WS-A and WS-Z interacted between Feb.10-19. As in previous such encounters, WS-A squeezed round the S side of WS-Z and was pulled into a loop. Part of it probably merged with WS-Z, while the other part moved f. for >2 weeks (pink arrow).
2013 Feb.17, 18:40 UT
John Sussenbach (Netherlands)
2013 Feb.17, 18:37 UT
Christophe Pellier (France)
18:59 UT: CH4
17 Mar. 2013
01:32:23 UT
17 Mar. 2013
01:39:08 UT
Methane Band
Jupiter: White Oval Z


White spot Z, 2013 Aug-Sep: hi-res and methane-band images.
WSZ has become unusually methane-bright, like NN-LRS-1. Visibly it has low contrast but stretched images (insets) show a diffuse grey streak within the bay, and narrow bright northerly white strip. [Compilation by John Rogers, BAA]
WSZ
2013 Aug.16, 04:37 UT
Xavier Dupont (France)
2013 Aug.21, 04:26.4 UT
Damian Peach (UK)
2013 Aug.22, 10:38 UT
Brian Combs (GA, USA)
2013 Aug.28, 04:42.7 UT
Damian Peach (UK)
3 Sept. 2013
10:06.1 UT
3 Sept. 2013
10:45.2 UT
Methane Band
2013 Sep.4, 04:43.5 UT
Damian Peach (UK)
2013 Sep.10
2013 Sep.20, 18:32.6 UT
R. Iwamasa (Japan) [per ALPO-Japan]
27 Sept. 2013
10:13.8 UT
27 Sept. 2013
10:27.3 UT
Methane Band
NN-LRS-1
2013 Sep.28, 04:29 UT (CH4)
Manos Kardasis (Greece)
2013 Sep.29, 10:42.6 UT
Gary Walker (GA, USA)

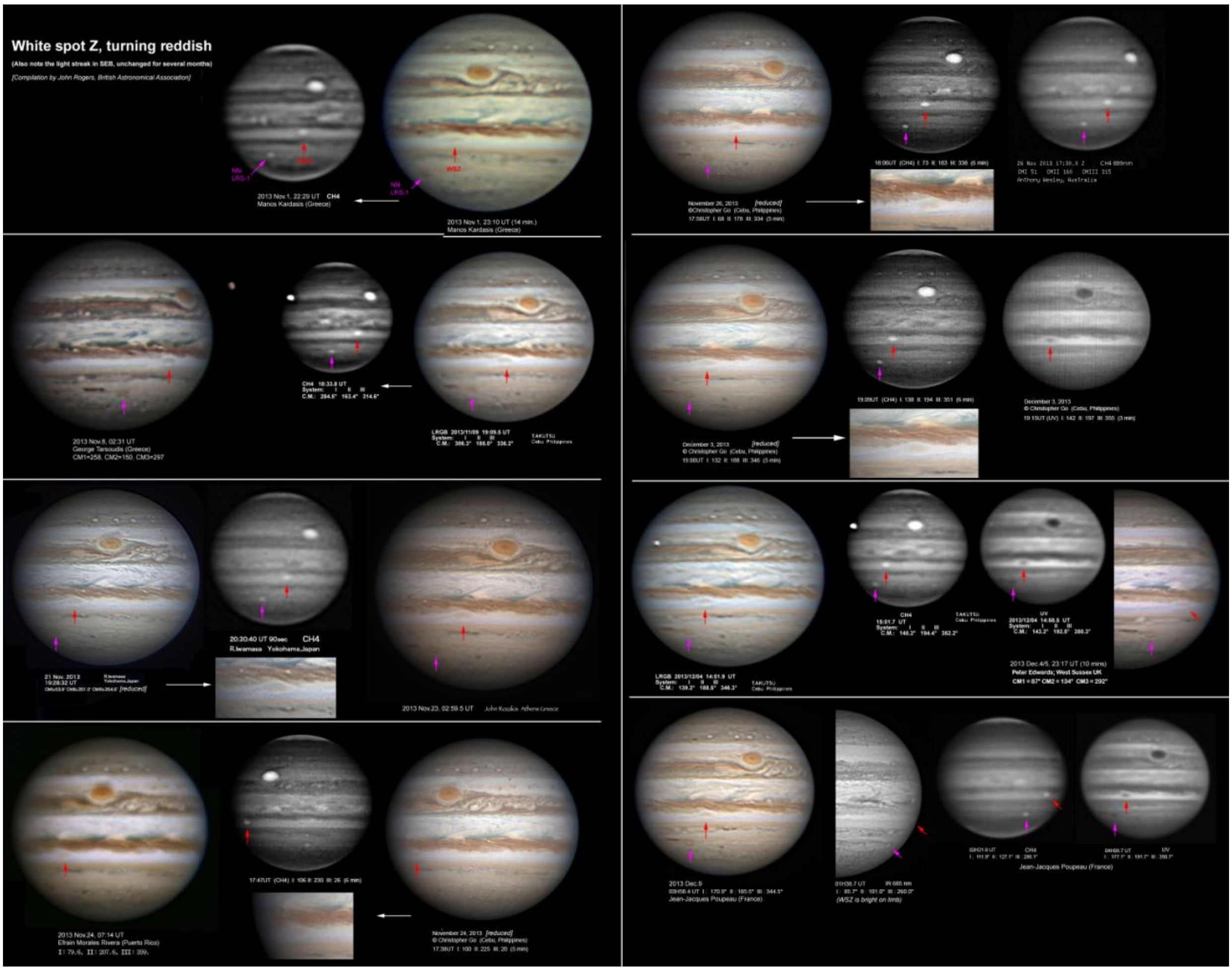

White spot Z, turning reddish
(Also note the light streak in SEB, unchanged for several months)
[Compilation by John Rogers, British Astronomical Association]
NN-LRS-1
WSZ
2013 Nov.1, 22:29 UT CH4
Manos Kardasis (Greece)
2013 Nov.1, 23:10 UT (14 min.)
Manos Kardasis (Greece)
2013 Nov.8, 02:31 UT
George Tarsoudis (Greece)
CM1=258, CM2=150, CM3=297
CH4 18:33.8 UT
System: I II III
C.M.: 284.5° 163.4° 314.6°
LRGB 2013/11/09 19:09.5 UT
System: I II III
C.M.: 306.3° 186.0° 336.2°
TAKUTSU
Cebu Philippines
21 Nov. 2013
19:28:32 UT
[reduced]
20:30:40 UT 90sec CH4
R.Iwamasa Yokohama,Japan
2013 Nov.23, 02:59.5 UT
John Kazakos Athens Greece
2013 Nov.24, 07:14 UT
Efrain Morales Rivera (Puerto Rico)
I: 79.6, II: 207.6, III: 359.
17:47UT (CH4) I: 106 II: 230 III: 26 (6 min)
November 24, 2013 [reduced]
© Christopher Go (Cebu, Philippines)
17:38UT I: 100 II: 225 III: 20 (5 min)
November 26, 2013 [reduced]
©Christopher Go (Cebu, Philippines)
17:58UT I: 68 II: 178 III: 334 (5 min)
18:06UT (CH4) I: 73 II: 183 III: 338 (6 min)
26 Nov 2013 17:30.0 Z CH4 889nm
CMI 51 CMII 160 CMIII 315
Anthony Wesley, Australia
December 3, 2013 [reduced]
© Christopher Go (Cebu, Philippines)
19:00UT I: 132 II: 188 III: 346 (5 min)
19:09UT (CH4) I: 138 II: 194 III: 351 (6 min)
December 3, 2013
© Christopher Go (Cebu, Philippines)
19:15UT (UV) I: 142 II: 197 III: 355 (3 min)
LRGB 2013/12/04 14:01.9 UT
System: I II III
C.M.: 139.2° 188.5° 346.3°
TAKUTSU
Cebu Philippines
CH4
15:01.7 UT
System: I II III
C.M.: 145.2° 194.4° 352.2°
TAKUTSU
Cebu Philippines
UV
2013/12/04 14:58.5 UT
System: I II III
C.M.: 143.2° 192.5° 350.3°
2013 Dec.4/5, 23:17 UT (10 mins)
Peter Edwards; West Sussex UK
CM1 = 87° CM2 = 134° CM3 = 292°
2013 Dec.9
03H58.4 UT I: 170.9° II: 185.5° III: 344.5°
Jean-Jacques Poupeau (France)
01H38.7 UT IR 685 nm
I: 85.7° II: 101.0° III: 260.0°
(WSZ is bright on limb)
CH4
UV
Jean-Jacques Poupeau (France)

Figure 10