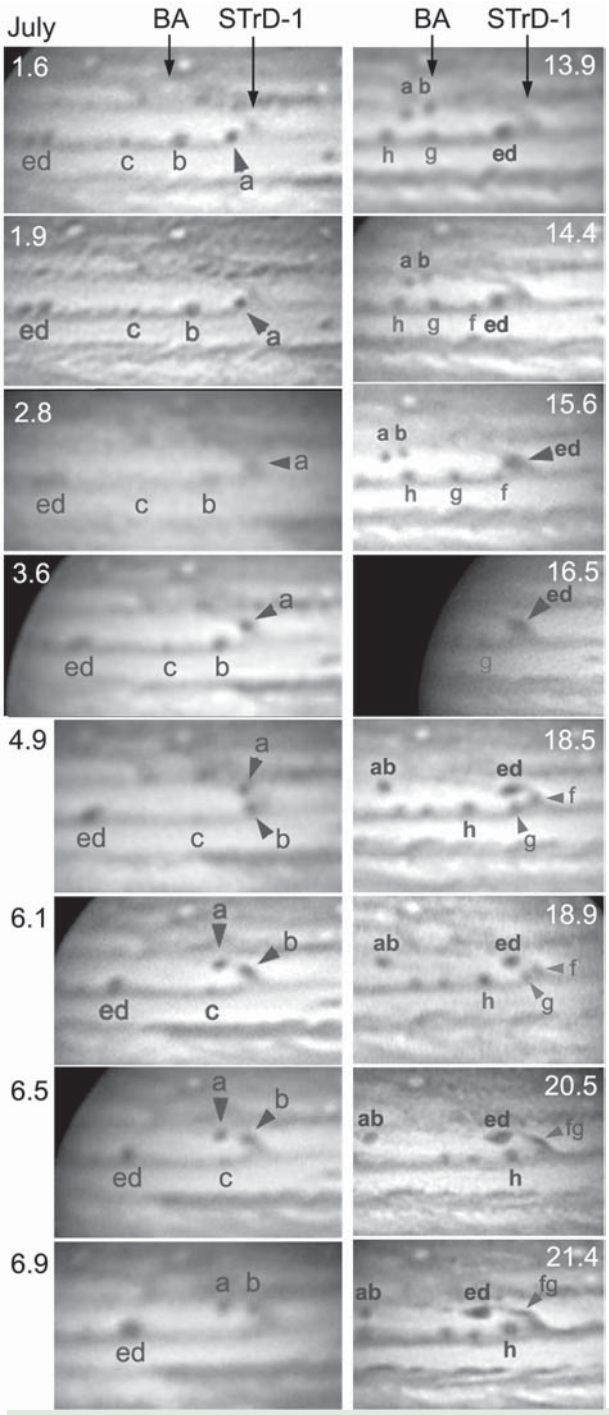
Jupiter Section

The climax of Jupiter's global upheaval



In the four months since our last report,[1] Jupiter's global upheaval has progressed surprisingly fast. Most notably, the South Equatorial Belt (SEB) faded as predicted, then the violent revival started even before the fading was complete. It has displayed an amazing phenomenon not seen for around 70 years, in which vortices running at ~60 m/s in a jetstream perform a U-turn: the Circulating Current.

First, though, came the spectacular outbreak on the superfast jetstream of the North Temperate Belt (NTB), which began on 2007 March 27. On May 8, the brilliant white spot at the preceding end caught up with the chaotic turbulence at the following end, and disappeared within two days. Thus the NTB had revived all round the planet: initially it was turbulent and grey, but by late May, a long segment of it was becoming reddish. In June and July, this reddish colour was intense: the NTB equalled the NEB as the reddest belts on the planet. This is a classic sequel to such superfast NTB outbreaks that occur during global upheavals, and has not been seen for over 20 years. Moreover, the disturbances also darkened the adjacent zones, so the whole northern hemisphere was dark and largely reddish.

The southern hemisphere, in contrast, was largely bright and brightening, as the SEB began to fade (whiten) as predicted. The southern belt component became progressively lighter and more diffuse from April onwards, as did the two South Tropical Disturbances attached to it. The belt faded fastest preceding the Great Red Spot, which became a prominent isolated reddish oval. On historical grounds, the SEB(S) was expected to continue fading until it was white, after which a violent 'Revival' would break out.

However, on May 17, Chris Go (Philippines) discovered a new white spot appearing within a dark spot at L2=180° (Figure 2). This was notable because a bright outbreak imaged by *Voyager* in 1979 started precisely in the centre of such a cyclonic dark spot, and SEB Revival outbreaks in 1949 and 1993 were suspected of doing so as well. At first we could not be sure whether this would initiate the Revival, as it came much earlier than expected. But there were precedents in 1949 and 1955 when SEB Revivals started before the SEB was fully faded. Another similarity to the start of the 1949 Revival was the slow development of the initial source. But by early June it had developed the typical form of a SEB Revival outbreak. Although its activity was on a smaller scale than in some historical examples, this was more than compensated by the intricate details revealed by hi-res images. Bright and dark spots continued to arise at the source, with the turbulent white spots or streaks in the belt drifting to lower longitudes, and dark spots on SEB(S) rapidly 'retrograding' to higher longitudes (Figures 2 & 4).

This outbreak gave us a great opportunity to look for the circulations at the two South Tropical Disturbances (STrDs). A STrD is believed to be a reconnection between the westward jet on SEBs and the eastward jet on STBn, as was discovered by BAA visual observers in 1920. They recorded SEBs spots in a SEB Revival swinging round to the STBn and reversing their drifts, a phenomenon they called the Circulating Current. BAA observers recorded it again in 1932–'34. But since then, although there were observations of partial circulation at STrDs in 1979–'81 and 1993, there

Figure 1. The Circulating Current, recorded in hi-res images for the first time. Decimal dates in 2007 July are given. Dark spots a to h are travelling to the right on the SEBs. On encountering STrD-1, they swing south around its p. edge and re-emerge travelling to the left on STBn. Note the mergers of spots d and e (July 3), a and b (July 16–18), and f and g (July 19). The red oval BA is nearby. Images are as follows: July 1, 13:22 UT, Isao Miyazaki (Japan); July 1, 22:54 UT, Fabio Carvalho (Brazil); July 2, 18:20 UT, Sadegh Ghomizadeh (Iran); July 3, 15:14 UT, Miyazaki; July 4, 20:41 UT, Manos Kardasis (Greece) and Carmelo Zannelli (Italy); July 6, 02:56 UT, Larry Owens (Georgia, USA), July 6, 12:55 UT, Miyazaki; July 6, 22:04 UT, Pete Lawrence (UK). July 13, 22:47 UT, Jordi Ortega (Spain); 2007 July 14, 09:27 UT, Maurice Valimberti (Australia); July 15, 14:17 UT, Miyazaki; July 16, 11:53 UT, Chris Go (Philippines); July 18, 12:08 UT, Miyazaki; July 18, 21:25 UT, Jose Antonio Soldevilla (Spain); July 20, 13:31 UT, Go; July 21, 10:01 UT, Valimberti.

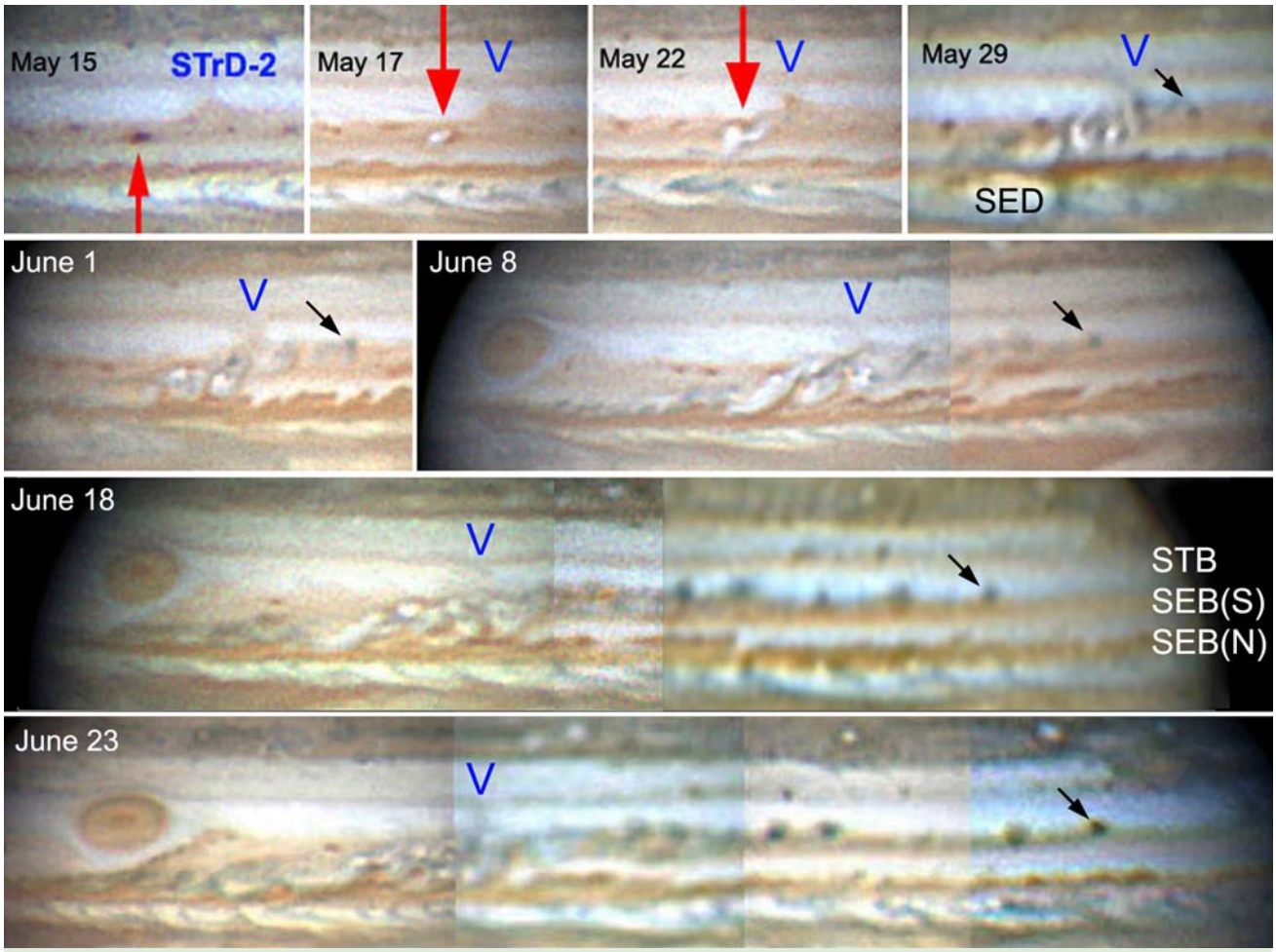


Figure 2. Origin and development of the SEB Revival. A small dark spot on May 15 was the location of the initial bright spot on May 17 (red arrows below & above). This was very close to STrD-2, which darkened briefly (May 22) but then persisted as a very faint feature (marked V); it apparently had no physical connection with the outbreak source. From the source, bright spots advanced to the left towards the GRS, and dark spots ran in the opposite direction ('retrograding' on SEB(S): the leading spot is marked by the oblique arrow). Images are as follows: 2007 May 15, 16:21 UT, Paul Haese (Australia); May 17, 16:56 UT, Chris Go (Philippines); May 22, 16:20 UT, Go; May 29, 17:08 UT, Daniel Chang (Hong Kong, China); June 1, 15:22 UT, Go; June 8, 15:25 UT, Go, plus 16:07 UT, Tiziano Olivetti (Thailand); June 18, 13:32 & 14:40 UT, Go, plus 15:37 UT, Chang; June 23, 12:11 UT, Anthony Wesley (Australia), plus later images by Isao Miyazaki (Okinawa, Japan).

have been no conclusive observations showing spots transferring fully into the STBn jetstream. Now, the full spectacle of the Circulating Current has ben recorded in hi-res images for the first time.

This happened when the retrograding dark spots on SEB(S) encountered STrD-1. Starting on July 1 as predicted, the whole chain of spots recirculated from SEBs to STBn. Observers worldwide were needed to follow these rapid events. With bad weather covering Australia and the tropics, the initial events were recorded most of all by Isao Miyazaki in Okinawa; but observers elsewhere managed to make valuable contributions too – especially ten new contributors in ▸ *p. 230*

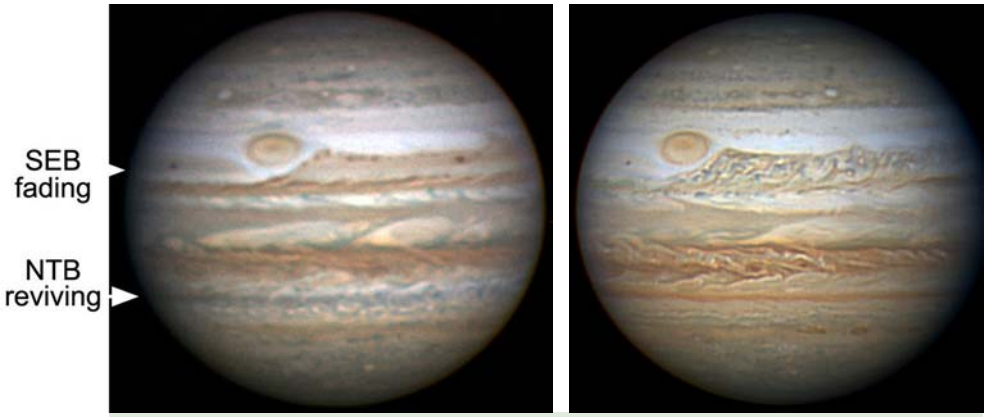


Figure 3. Hi-res colour images of Jupiter with the Great Red Spot. *Left*: 2007 May 5, 16:27 UT, Zac Pujic (Queensland, Australia). The view just before the SEB outbreak. The southern SEB has faded considerably (compare with pictures on cover of 2007 June *Journal*), though small cyclonic very dark spots remain. The revived NTB is grey and very turbulent. *Right*: 2007 July 22, 11:08 UT, Anthony Wesley (NSW, Australia). The SEB Revival is now well advanced, having filled the SEB with turbulence down to the GRS, but the SEB(S) is still almost invisible to the left of the GRS. The revived NTB is strongly reddish.

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southern Europe, and one in Iran. So STrD-1 was imaged on two out of every three rotations of the planet during July.

Figure 1 shows the phenomenon in detail. The leading spot (a), and many following it, reversed their drift rates from DL2 = +120°/month (–58 m/s) to –93°/month (+37 m/s). In many cases, spots merged (a–b, d–e, f–g, and others since), either before, during or after their recirculation; so without this intensive monitoring, it would have been hard to keep track of them.

Meanwhile the SEB source region, at L2 ~ 180°, continued to produce bright and dark spots in a scene of great turbulence. The disturbed sector extended down to the GRS in late June. The SEB sector between STrD-1 and GRS was unaffected by all this, and continued to fade until, in July, the southern two-thirds was almost invisible. But in late July, diffuse darkening of SEB(S) began to penetrate gradually f. STrD-1, and disturbance on SEB(N) spread p. the GRS, so this sector too is set to revive as a dark belt. We may then look forward to fading of the GRS, and onset of reddish colour across the revived SEB.

John Rogers, *Director*

1 *J. Brit. Astron. Assoc.*, **117**(3), 113–115 (2007 June)

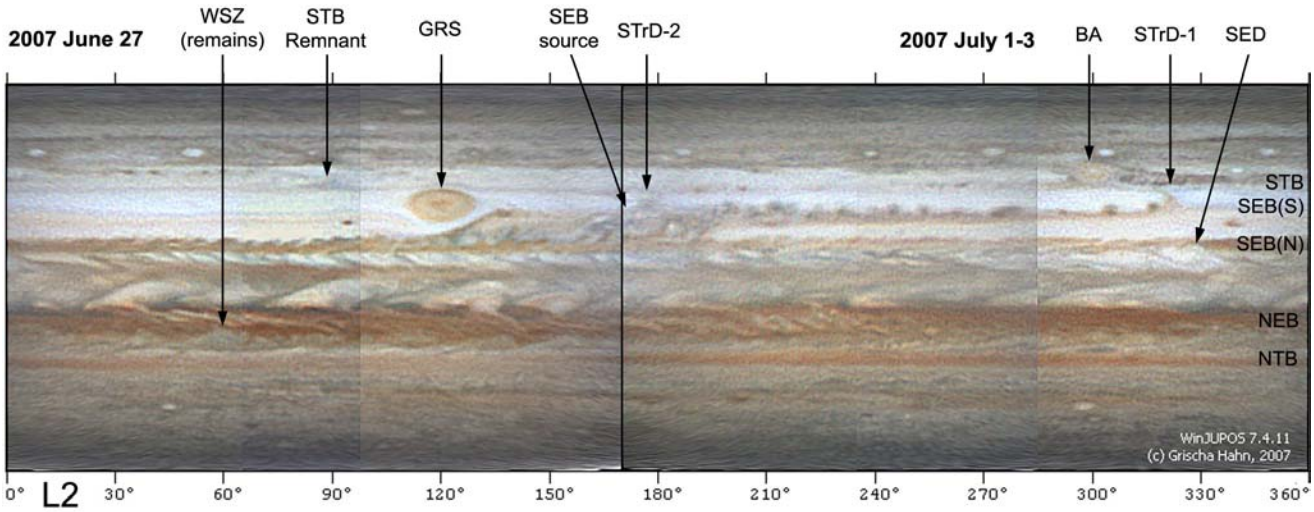

Figure 4. Map of Jupiter on June 27 (left half) and July 1–3 (right), showing the SEB Revival at its most active, the dark Equatorial Zone, and the red revived NTB. Other long-lived features are marked. It was on June 27 that the SEB disturbance initiated two striking phenomena having arrived at the Red Spot Hollow: a very dark rim on the f. side of the Hollow, and a long series of 'waves' on the SEB(N) p. the Hollow. Images by Chris Go (Philippines), made into a cylindrical projection map by Grischa Hahn using his WinJUPOS software.