Jupiter Section

Jupiter in 2009–2010: an interim report

In the past year, the appearance of Jupiter has changed dramatically, with the broadening of the North Equatorial Belt (NEB), and the virtual disappearance of the South Equatorial Belt (SEB). We have posted detailed reports on various phenomena on the Jupiter Section website, and this note summarises the more important ones.

2009 apparition

Our analysis of the 2009 apparition, including a preliminary survey of the JUPOS data, gives new insights into the major climatic cycles under way in three regions of the planet. These have been better observed in 2009 than at any previous occurrence.

The North Temperate Disturbance (NTD)

This uncommon phenomenon is a dark sector of the NTZ. It has developed as a late sequel to the vigorous revival of the NTB in 2007, and previous examples in 1972–'75 and 1988–'92 may have developed in similar circumstances after similar NTB outbreaks.

The NTBn had been remarkably sinuous ever since 2007. In 2009, some of the projections and streaks on the NTBn edge spread dark disturbance right across the NTZ, creating a new NTD. The observations have been analysed in detail by Gianluigi Adamoli and JHR, revealing the dynamical nature of the NTD for the first time (Figure 2).

We infer that the NTD is created by confines the *f.* end and generates dark vortices and streaks in the NTZ. Thus, initially local disturbances combine to form a persistent largescale structure.

junction of two phenomena: convective 'rifting' in the NTB, which defines its *p.* end and leads to disturbances on the retrograding NTBn jetstream; and recirculation from this jetstream at a NTBn projection, which de-

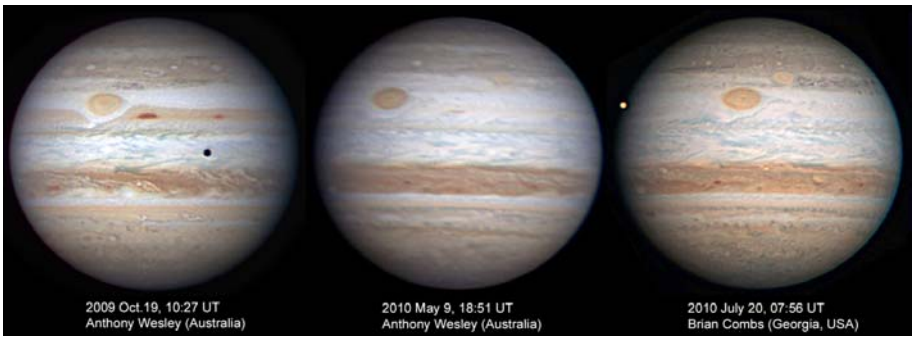

Figure 3. Images showing the GRS since our previous report (*Journal*, vol. 119, p.308). They show the continuing fading of the SEB, with the GRS standing out as an orange oval. *F.* it, very dark 'barges' developed and then faded. Just N of the GRS, a brilliant white spot is present in October and July, emitting parallel white and blue streaks *p.* it and thus creating the familiar 'blue triangle' that is a common feature of the faded SEB. Meanwhile the NEB broadening process reaches completion.

The NEB broadening event

This phenomenon, which currently occurs every 3 to 5 years, is defined by broadening of the NEB to the north. In 2009 it began on May 31 when a turbulent 'rift', interacting with a cyclonic 'barge', ejected a very dark vortex north into the NTropZ. Two more such vortices followed at the same site (NEBO-1 in Figure 1), and then two more at a second site (NEBO-2) . By the end of the year, the broadening event was proceeding all round the planet, partly by small dark spots or streaks extending into the NTropZ, and partly by general yellow-brown shading developing around them (Figure 3).

Concurrent events affected the whole width of the NEB. In mid-NEB, there was longitudinal expansion of a very active 'rift' system (from 2009 April onwards). On the NEBs, major dark 'projections' reappeared after a year's absence, and had an unusually slow drift rate (from early July onwards). The coincidence of all these phenomena suggested that they were all components of a single grand process. Indeed extensive rifts directly induced the NEBn outbreaks, and probably the appearance of the NEBs projections as well. A partial survey of previous NEB expansion events suggests that similar processes occurred, thus revealing a pattern of disturbance that involves the entire belt.

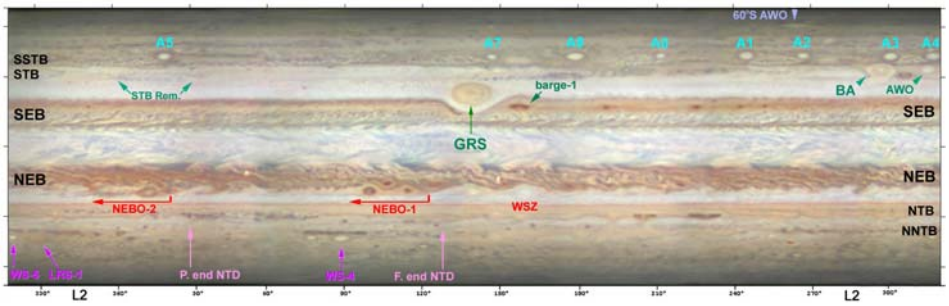

Figure 1. Map of the planet on 2009 September 5–6: Images and map by Damian Peach in Barbados. Major atmospheric features are labelled.

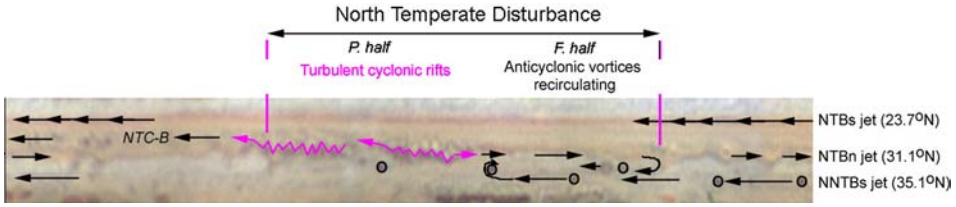

Figure 2. Model for the dynamics of the NTD. (The base map is from 2009 Sep 10–11 by Damian Peach.)

The SEB fading

This year's events reveal or confirm several consistent features of the fading phase of the SEB cycle, including positive phenomena in a phase which is otherwise characterised by absence of visible disturbance. First, cessation of turbulent rift activity in the SEB – which ceased suddenly at the start of June – was almost immediately followed by the onset of fading, confirming the connection that had been noted in 1988–'89 and in 2007. Visible fading of the SEB began in 2009 August, and was proceeding rapidly by October.

Meanwhile, five 'barges' (cyclonic dark ovals) formed in the SEB from mid-June onwards at progressively higher longitudes. This rapid process may represent a reconfiguration of the the retrograding SEBs jet. When the rifted region *f.* the GRS was active, the jet would have carried turbulence and perhaps vortices.

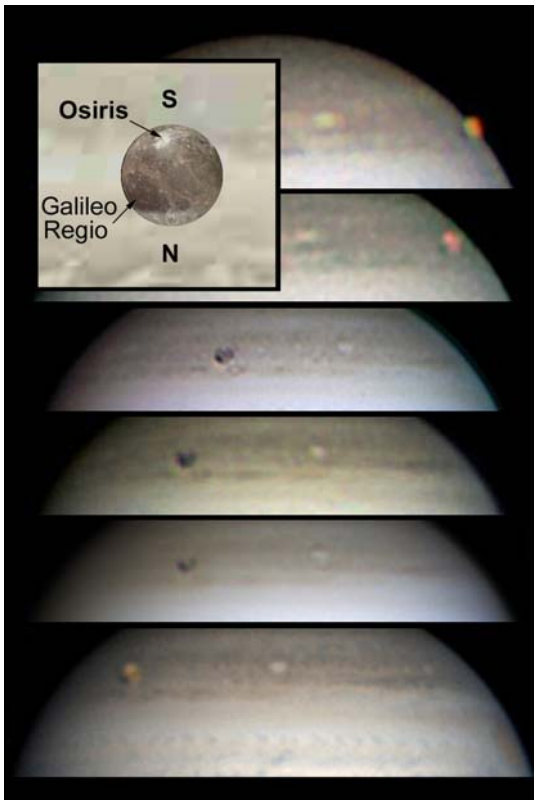

Figure 4. Ganymede passes in front of Jupiter, 2010 July 23. Features resolved on the satellite include the ray crater Osiris and the dark area Galileo Regio. (Inset: Synthetic view using spacecraft imagery, from the *WinJUPOS* program.) *From the top:* 00:59 UT, John Sussenbach, Netherlands; 01:06 UT, Sussenbach; 02:43 UT, Daniele Gasparri, Italy; 02:57 UT, Ian Sharp, UK; 02:59 UT, Antonello Medugno, Italy; 03:18 UT, Damian Peach, UK.

After the switchoff of activity, the jet probably became smooth-flowing but meandering, giving rise to the barges as eddies on its N side.

The GRS soon became a well-defined isolated orange oval, as usual (Figure 3). Immediately N of it, in October, a bright white spot and blue streak appeared. The bright spot was a methane-bright plume, which apparently acted like a miniature SEB outbreak, and was the source of the blue streak or triangle which has often been seen when the SEB is faint.

2010 apparition

The SEB fading continued

In 2010, the SEB fading has continued until the belt is virtually invisible (Figure 3) – the most complete disappearance since 1990. The SEB(N) was the last component to fade, and as it did so it consistently appeared greenish, a rare colour on Jupiter. The barges have faded away too, but a small blue-grey patch appeared on the N*p*. edge of each one (probably regions where the winds deflected around the barges cleared the clouds). The GRS is dark and strongly orange (Figure 3). The SEB Revival will no doubt consist of spectacular outbreaks of dark and bright spots, as usual, and it could start any time in the next year or two.

The S.Temperate domain

There are always two to four large-scale complexes in the S.Temperate region, each consisting of one or more long-lived anticyclonic or cyclonic circulations. In 2009 there were three such complexes. One contained the great oval BA plus a smaller anticyclonic white oval (AWO); another was the 'STB Remnant', a pale blue cyclonic circulation; and the third was a new dark segment of STB, which passed the GRS in late 2009 (Figures 1&3).

In 2010, the STB Remnant caught up with the AWO *f*. BA, and so these three circulations all collided on June 17. The arrival of the STB Remnant apparently impelled the AWO into contact with oval BA, leading to the rapid merger of the two anticyclonic circulations. Meanwhile, on the same date, a brilliant, methane-bright white plume erupted within the STB Remnant, initiating a never-before-observed outbreak in the cyclonic circulation, including intense convection at the source and rapid motion on the retrograding STBs jet.

These events seem to be miniature versions of phenomena observed in the S. Tropical domain. The merger may have been similar to the merger of the GRS and Little Red Spot in 2008, while the eruption in the STB Remnant was like a miniature version of a SEB Revival outbreak. During July, the STB Remnant established itself as a STB segment *f*. oval BA, but was still very turbulent, and emitted new dark spots on the STBn jetstream.

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