Jupiter's South Equatorial Belt Outbreak Spots and the SEB Fade and Revival Cycle

41.17

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0. ABSTRACT

Amateur planetary imagers chronicled the 2007 upheaval of Jupiter, providing an opportunity to observe the Fade/Revival Cycle of the South Equatorial Belt (SEB). When the outbreaks of convective white spots in the SEB stopped, the SEB faded and the wake of the GRS disappeared. When an outbreak appeared, the SEB revival occurred--and the GRS wake became turbulent once more. The distinctive dark red color of the SEB is also associated with material brought up by SEB outbreaks.

This poster shows the SEB Fade and Revival cycle and how the SEB Outbreak plays a role in this cycle, as derived from images from various amateur astronomers, along with images from the Hubble Space Telescope, ground based observatories and various spacecraft.

1. Introduction

The 2007 global upheaval of Jupiter presented a very good opportunity to observe the full cycle of the SEB fade and revival. This poster presents:

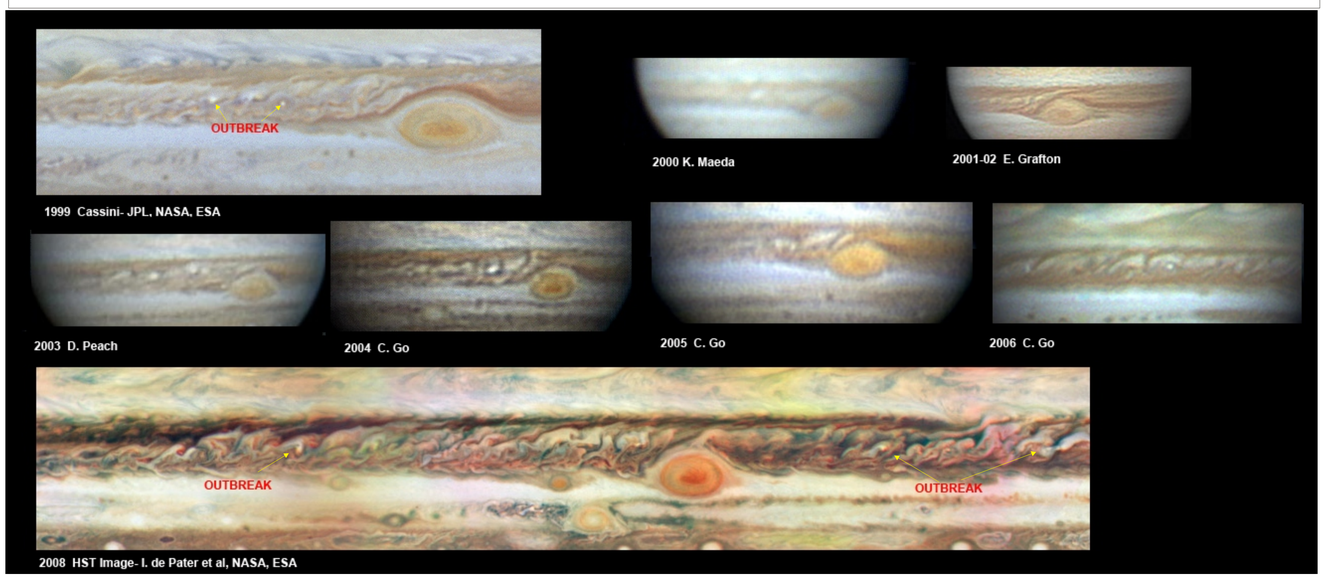
- The SEB outbreaks in the Normal SEB
- The 2006-2007 SEB Fade 2007
- The SEB Outbreak and Revival of 2007
- Jetstream Vortices in the Circulating Current of the South Tropical Zone

2. The SEB Outbreak in the Normal SEB

Jupiter's South Equatorial Belt is located between -8°S to -20°S. This belt is normally dark brown in color. The SEB cycle occurs at intervals of 3-15 years.[1 and 3] During the normal period between fades and revivals, continuous SEB outbreaks occur especially in the immediate area following the Great Red Spot(GRS). The Galileo Orbiter observations showed that the white spots in these outbreaks are clusters of thunderstorms undergoing vigorous moist convection.[2]

Animations made from images by the Cassini spacecraft have shown the interaction of these outbreaks in what appears to be the wake of the GRS. Amateur images from the years 1995-2006 have shown that these outbreaks erupted continuously throughout these years.

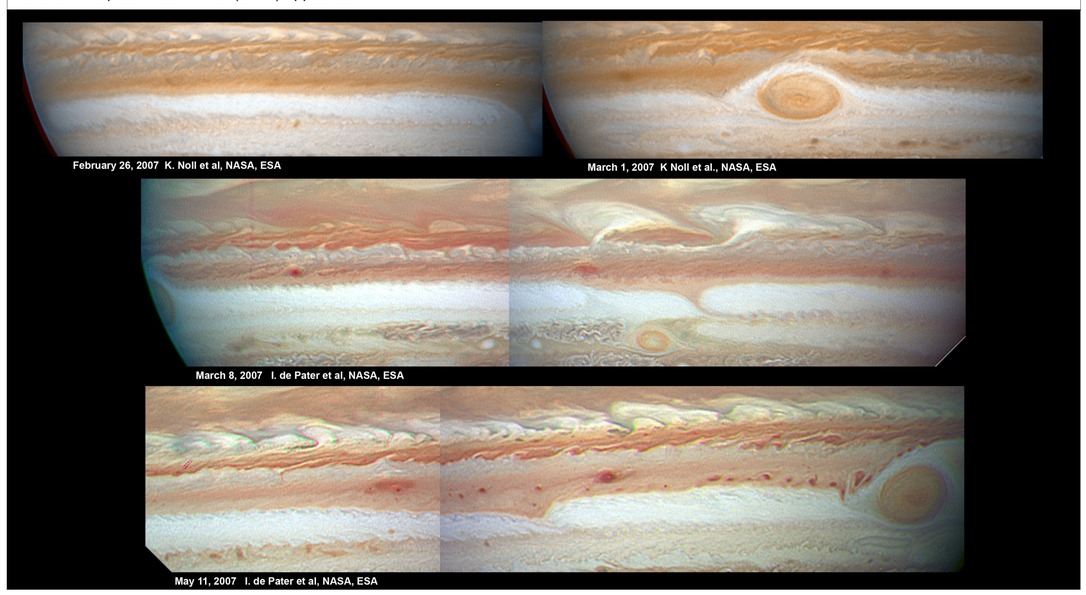
The outbreaks stopped during late 2006, and this heralded the beginning of Jupiter's global upheaval, which resulted in the fading of the SEB.



3. The 2006-2007 SEB Fade

During the second half of 2006, the SEB outbreak activity ceased. The reddish-brown color of the SEB slowly faded. The fade was more pronounced during April 2007. The fade continued despite the appearance of the revival outbreak spot during May of 2007. While the area following the GRS revived, the area preceding the GRS continued to fade and even reached the zonal white color.

It should also be noted that during the period when the SEB outbreak ceased, the South Equatorial Disturbance (SED) became more pronounced and the South Tropical Disturbance (STrD) appeared.



4. The SEB Outbreak and Revival of 2007

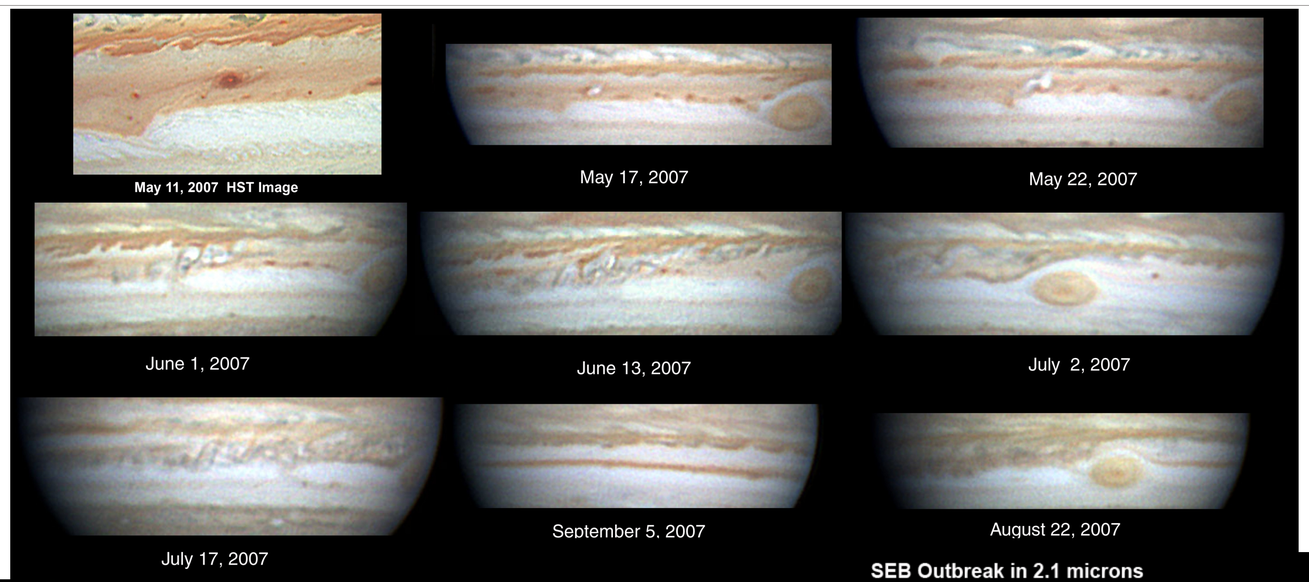
On May 17, 2007, a small bright white spot appeared overlapping a dark cyclonic oval at 17-18° S (shown below on the HST May 11 image). It had probably erupted inside the dark oval (just like the one observed by Voyager 1[1 and 3]), and was already expanding out of it. This spot turned into a major outbreak that revived the SEB. The outbreak spread very quickly in both directions.

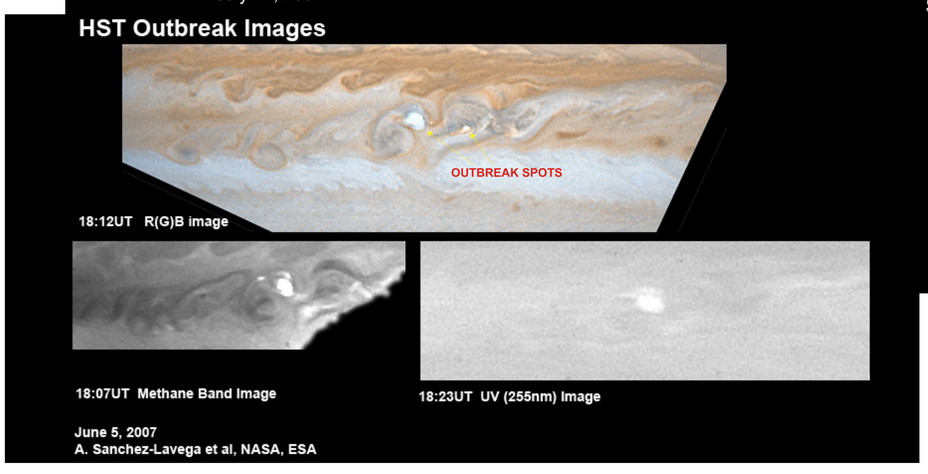
As usual in a SEB outbreak, new white spots appeared repeatedly at the same source: on May 17, 25, 27, June 2, and June 5 (images by D. Peach & P. Haese; measurements by H-J. Mettig et al.). These first five spots all appeared on the extended track of the dark cyclonic oval, which was no longer visible as the outbreak developed, and all appeared at the same latitude: 17.9 (+/- 0.5) °S.[4] (See Figure and Table below)

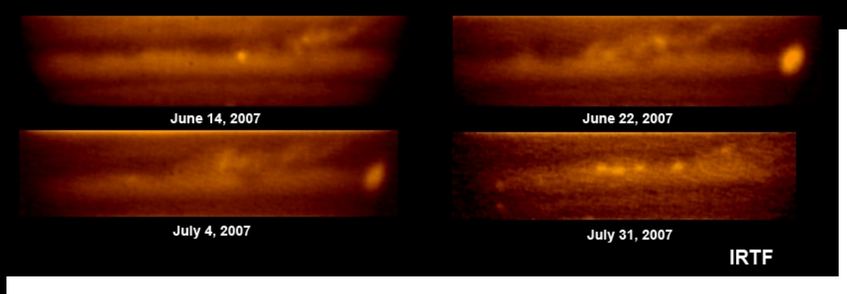
The HST image below also show the fifth outbreak spot which was extremely bright across the UV to IR wavelengths. This outbreak also created some dark anticyclonic vortices.

NASA's IRTF was able to cover the development of the outbreak at 2.1microns. These images show that the outbreak and the material it has brought up is above the cloud level of the SEB.

When the outbreak material reached the GRS, the GRS "wake" was revived. The outbreak brought out materials that turned red when exposed to the upper atmosphere of Jupiter.







5. Jetstream Vortices in Circulating Current in the South Tropical Zone (STrZ)

The jetstream anticyclonic vortices created by the interaction of the materials excavated by the SEB outbreak went around the STrZ circulating current. In the August 23, image below, it can be seen that one of the vortex even turned red. One of these vortices probably became the STrZ Little Red Spot. This phenomenon was also observed during the last fade/revival event in 1993.[5]

When Jupiter emerged from solar conjunction in 2008, the SEB was back to normal.

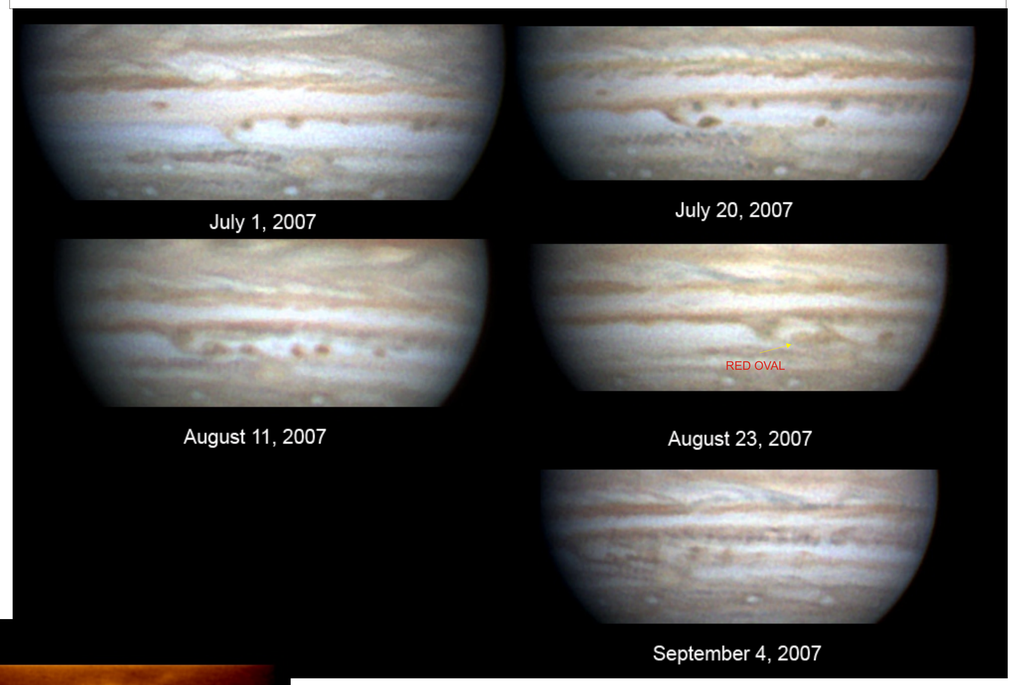
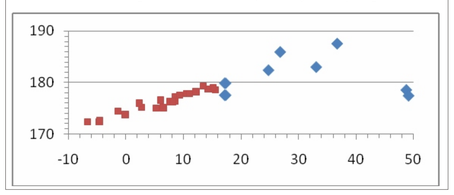


TABLE: Longitudes of new white spots in the outbreak, all at same latitude.

2007	L2	Observer
May 17.7	177.6	Go
(double)	179.9	Go
May 25.2	182.4	Peach
May 27.2	185.9	Peach
June 2.5	183	Haese
June 6.1	187.5	Peach
June18.2	178.6	Carvalho
(& 18.6)	177.5	Go

FIGURE: L2 vs. days (May) for the minibarge [brown squares, 17.1 (+/-0.5) °S] and new white spots in the outbreak [blue diamonds, 17.9 (+/-0.5) °S].



6. Future

Last year's global upheaval provided an opportunity to trace the development of the SEB cycle. For the first time, the entire cycle of the SEB revival/outbreak has been documented from start to finish in great detail. Amateur planetary imagers have documented the onset of SEB fading with high spatial and temporal resolution; verified that a SEB Revival outbreak can begin within a cyclonic dark oval; and recorded the STrZ Circulating Current. This constant monitoring allowed the HST and infrared observatories to target specific important events during this upheaval.

There are still many open questions: What causes such powerful outbreaks that spreads around the planet in a few months? Is the nature of NTB and SEB outbreaks the same? Why do the NTB and SEB outbreaks occur almost at the same time?

These questions will hopefully be resolved by further analysis of atmospheric structure from visible and infrared observations and theoretical modeling, and by further observations to establish the common features of such global upheavals.

Notes:

[1]*Rogers, J.H., 1995.* **The Giant Planet Jupiter.** Cambridge Univ. Press, Cambridge, UK.

[2]Gierasch P.J. et al. **'Observation of moist convection in Jupiter's atmosphere.'** Nature 403, 628-630 (2000).

[3] *A. Sanchez-Lavega,et al,* **The Southern Equatorial Belt of Jupiter, I: Its life cycle.** Icarus 112, (1996) Article No. 0067

[4]*Rogers, J.H. And H-J Mettig (in preparation),* **Jupiter in 2007: Final Numerical Report.**

[5]*A. Sanchez-Lavega,et al,* **The Southern Equatorial Belt of Jupiter, II: The Onset and Development of the 1993 disturbance.** Icarus 121, (1996) Article No. 0068

- Images, except those noted were taken by Christopher Go at Cebu City, Philippines using an 11" Schmidt-Cassegrain telescope and a DMK 21AF04 camera.
- IRTF images were taken by Glenn S. Orton and Padma Yanamandra-Fisher using NASA's Infrared Telescope Facility in Mauna Kea, HI

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