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


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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
- The 2006-2007 SEB Revival
- 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 -4°S to -20°S. This belt is normally dark brown in color. The SEB cycle occurs at intervals of 3-15 years.** 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.** 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 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.**

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

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 **, 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, 27, 27, June 2, and June 5 (images by D. Peach & P. Haase; 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. (See Figure and Table below)

The SEB outbreaks in the Normal SEB

4. The SEB Outbreak and Revival of 2007

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The HST image below also shows the outbreak spot which was extremely bright across the UV to IR wavelengths. This outbreak also created a new bright spot at 17° S which was already expanding out of it.

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

The jetstream anticyclonic vortices created by the interaction of the materials accelerated by the SEB outbreaks moved 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.

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

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 outbreak/revival 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 observatories and theoretical modeling, and by further observations to establish the common features of such global outbreaks.

Notes:

*Images, except those noted were taken by Christopher Go at Cebu City, Philippines using an 11” Schmidt-Cassegrain telescope and a CEM 12AX7/17 camera.
- IRTF images were taken by Glenn S. Orton and Pedro Yanamandra-Fisher using NASA’s Infrared Telescope Facility in Mauna Kea, HI.

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

<table>
<thead>
<tr>
<th>Year</th>
<th>L2 (°S)</th>
<th>Observer</th>
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<tbody>
<tr>
<td>2007</td>
<td>17.9</td>
<td>Go</td>
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<td>2007</td>
<td>17.9</td>
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<td>18.2</td>
<td>Peach</td>
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<td>2007</td>
<td>18.6</td>
<td>Carvalho</td>
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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].

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

The jetstream anticyclonic vortices created by the interaction of the materials accelerated by the SEB outbreaks moved 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.

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